Field-Portable Thin Layer Chromatography Propellant Stability Test Kit

Moving Forward

PIKA – Pelatron Consortium

Presenters:
Harvey Kim, Pelatron TLC Program Manager
Wendy Church, PIKA TLC Program Manager

Agenda

- TLC Background and History — Harvey Kim
- TLC Implementation/Training — Wendy Church
- Technology Transfer — Harvey Kim

What?

- Field-portable thin layered chromatography (TLC) system developed by Lawrence Livermore National Laboratory's Forensic Science Center
- Developed under contract by the Defense Ammunition Center to detect the level of stabilizers in aging propellant stock
- Reduced sample size (100 mg per sample), reduced waste, reduced per sample cost
- On-site quantitative and qualitative results within hours

Why?

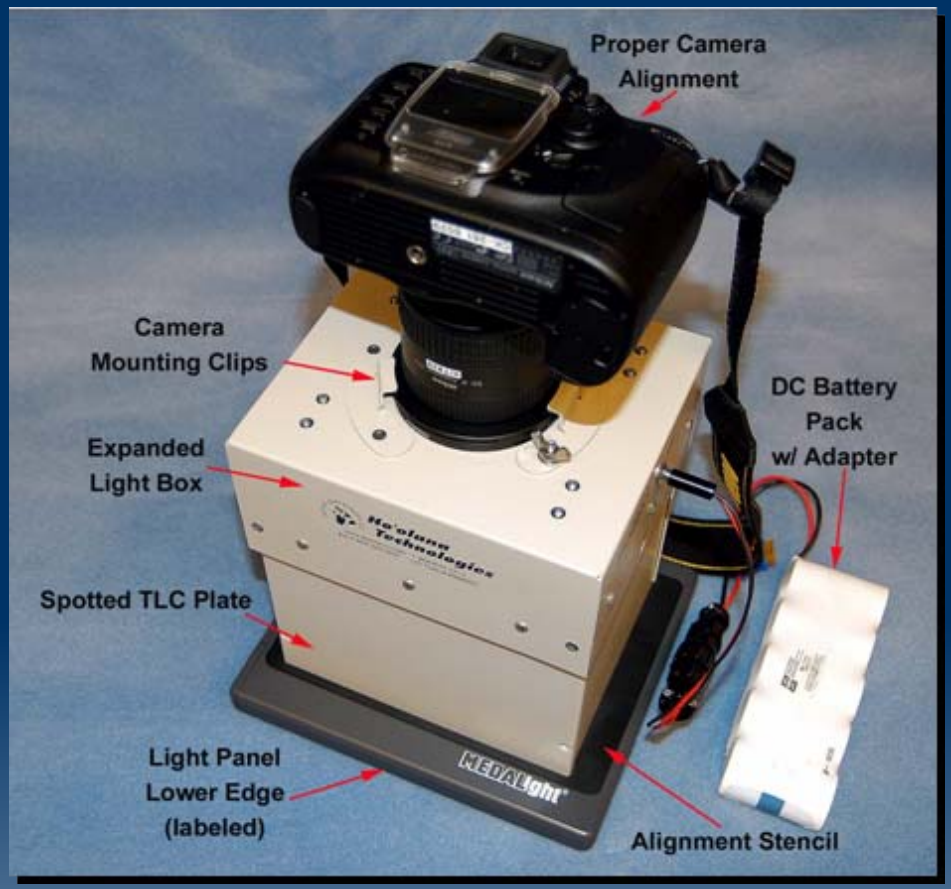
- Aging propellants needing stabilization testing
- Increasing incidents of self-ignition endangering life, property, and environment.
- Another tool to screen propellant stabilization in the field – identify strongly stabilized propellant lots, only send suspect propellants to laboratory

Components

Propellant crusher, vial rack, dip basket with plate

Camera on light box, computer, balance, process tank, developing tank, heating plate

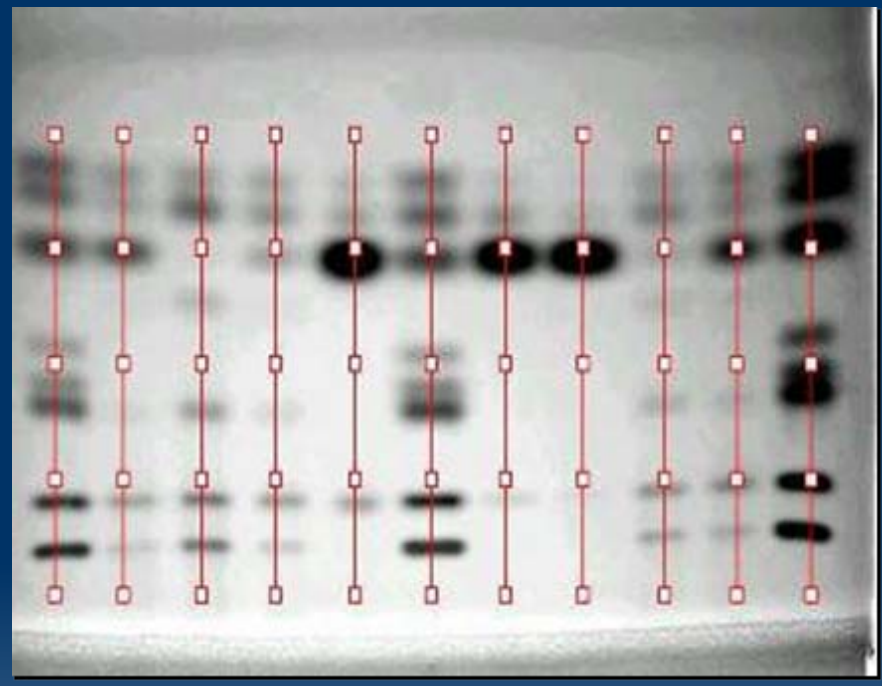
Digital Imaging System



- Digital Camera
  - ✓ Nikon D100
- Light Box
  - ✓ internal UV light and filter
- Light Panel w/temp
  - ✓ source for white light
- Battery Pack

Digital Imaging Analysis

Developed TLC plate



Digital image with lane identification

TLC Process

Computer Analysis

Sample Prep

Documentation

Plate Spotting

Plate Development

Coloring

Imaging

Propellant Stabilizer Analysis

- Determination of % total remaining ‘effective’ stabilizer (%RES)
- High throughput screening
- Simple
- Cost effective
- Field portable
- Minimal waste

TLC Project History

- 1997 - Initial funding – DAC contracted LLNL to develop system.
- 1999 - LLNL developed a TLC system to determine the percent remaining effective stabilizer (%RES) in propellant samples.
- 2003 – 50 TLC kits manufactured by Ho`olana LLC in Hilo, HI.
- Nov 2004 - PS-TLC system validated by DAC and endorsed by the Army Propellant Surveillance Laboratory (APSL).
- Jul 2006 – PS-TLC system validated by the PSSB (joint services)
- Aug 2006 – First training class, Tooele, UT
- Jan 2007 – Second training class, Hawthorne, NV
- April 2007 – Third training class, Aberdeen, MD

Certified and Validated

- 2004 - Certified for use by the Army
- July 2006 – Certification and Validation by the Propellant Surveillance Safety Board, a subgroup of the Joint Ordinance Commander's Group

Technology Transfer Team

PIKA INTERNATIONAL, INC.

- Cliff Ancelet
- Kate Anthony
- Wendy Church

- Rich Whipple
- Greg Klunder

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- Kaleo Elia
- Helene Elia
- Eric Kim
- U`ilani Peralta
- Harvey Kim

TLC Trainings

- Three trainings conducted since last August
  - ✓ Tooele Army Depot (TEAD)
  - ✓ Hawthorne Army Depot (HWAD)
  - ✓ Aberdeen Proving Grounds (APG)
- Two-weeks (80 hours)
- TLC Kits signed over to each facility for continued use

TLC Training at TEAD

TLC Training at HWAD

TLC Training at APG

TLC Training Objectives

- Provide JMC installations with capability to perform real-time, on-site propellant stability testing
- Transfer TLC Kit from LLNL to Pelatron and PIKA for future development and distribution

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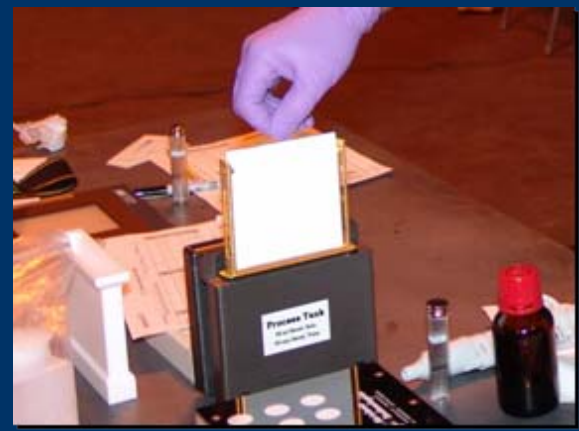
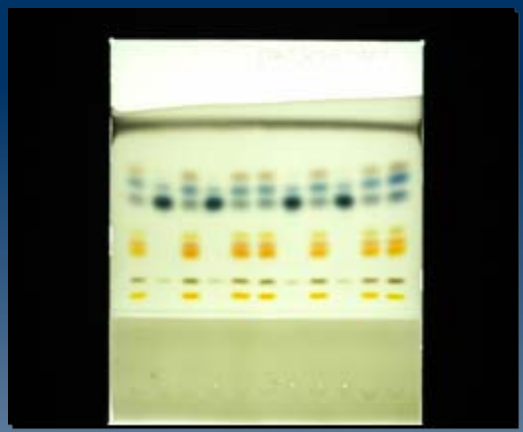
Training Curriculum

1) Propellant grains are cut and weighed

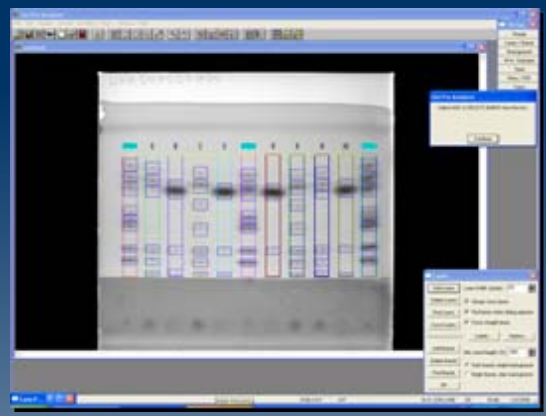
2) Dissolved propellants are spotted onto TLC plate



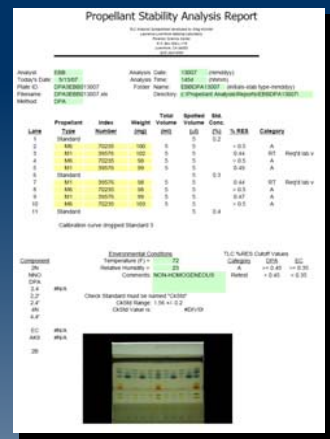
3) TLC plate is developed and colored



4) TLC plate image is captured



5) Digital image is analyzed by GelPro application



6) %RES and Propellant Stability Analysis Report

TEAD Training
August 14 – August 24, 2006

- Eleven Students
- Fourteen Propellant Samples
- Average Temperature > 90 degrees
- Average Relative Humidity < 20 percent
- Students from TEAD and the PIKA-Pelatron Team

- Training led by LLNL with Pelatron and PIKA acting as assistant instructors and students

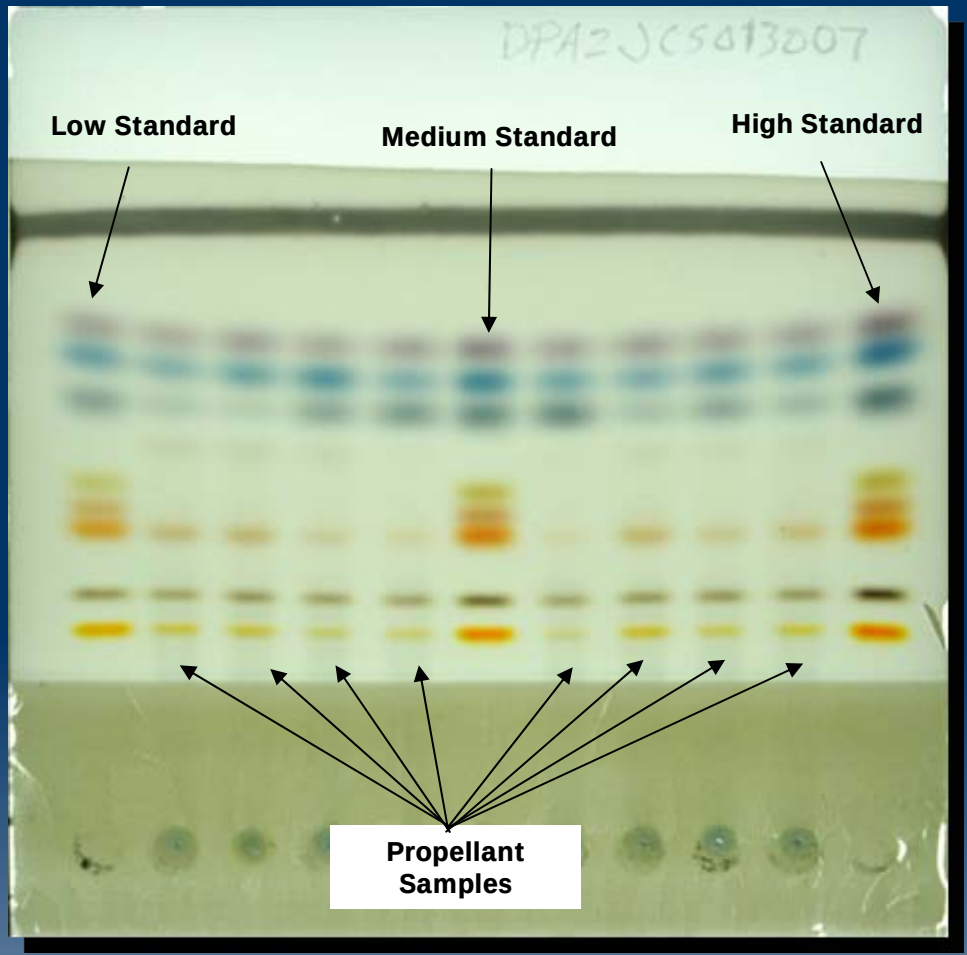
HWAD Training
January 22 – February 1, 2007

- Eleven Students
- Eighteen Propellant Samples
- Average Temperature = 70 degrees
- Average Relative Humidity = 20 percent
- Students from Day & Zimmerman, APSL, and HWAD
- Training led by Pelatron and PIKA with LLNL acting as assistant instructors

APG Training
April 23 – May 4, 2007

- Eight Students
- Nine Propellant Samples
- Temperature Ranged from 60 to 80 degrees
- Relative Humidity Ranged from 30 to 50 percent
- Students from APG and YPG
- Training led by Pelatron and PIKA with LLNL acting as observers and technical advisors

Propellant Stability Analysis



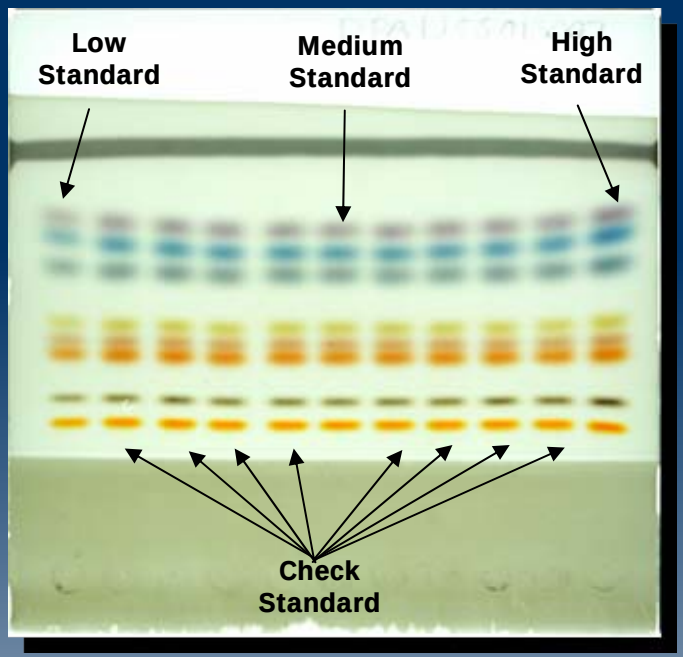
2-NDPA
NNO-DPA
DPA

2,4-DNDPA
2,2'-DNDPA
2,4'-DNDPA

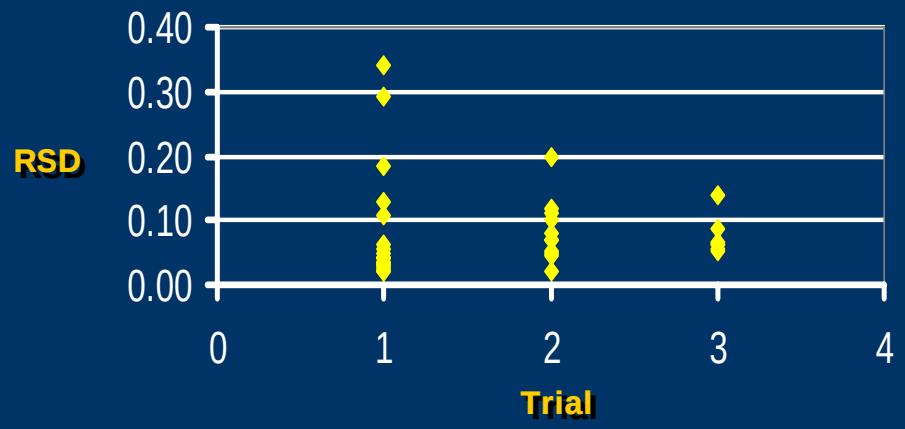
4-NDPA
4,4'-DNDPA

Reproducibility Results

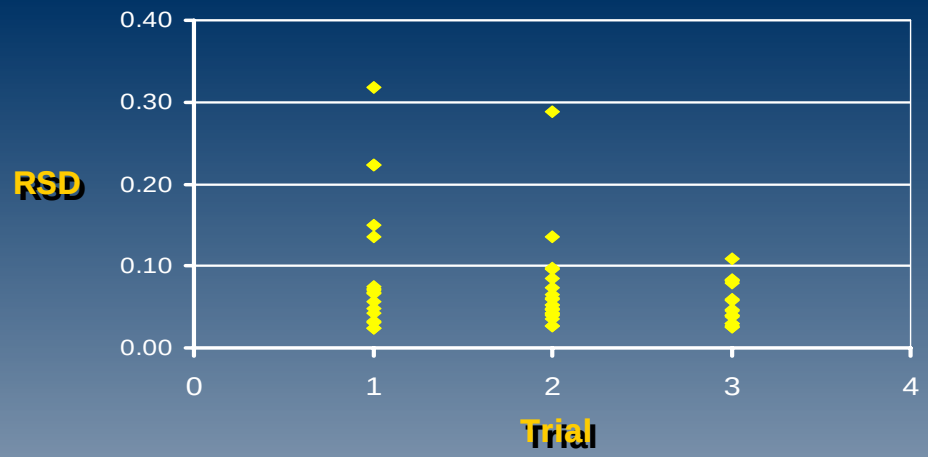
- Analyze check standard in all sample lanes
- Measure of ability of the TLC procedure



Tooele Reproducibility Results

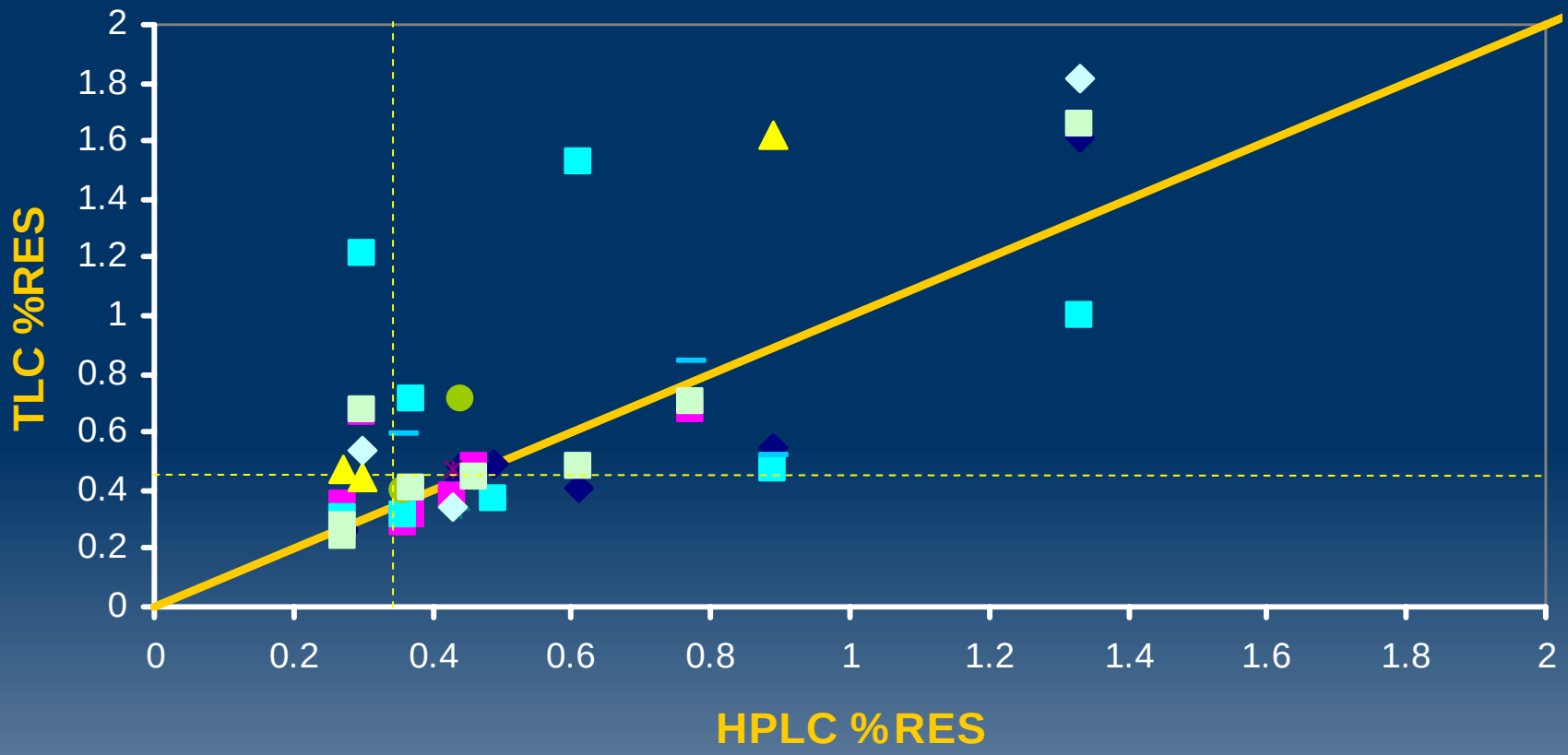


Hawthorne Reproducibility Results



Analysis Results

HWAD Analysis



TLC Training Summary

- Completion of Technology Transfer
- Field results correlate well with lab results
- TEAD, HWAD, APG, and YPG now have capability to perform real-time, onsite analysis of propellant stability

Technology Transfer

- Three two-week fieldings to train Army technicians to use the TLC kits
  - ✓ Tooele Army Depot, UT
  - ✓ Hawthorne Ammunition Depot, NV
  - ✓ Aberdeen Proving Grounds, MD
- Mobile Analysis Teams to perform TLC analysis as needed by the military
- End-user service and support
- Data collection and analysis for kit effectiveness
- Supply chain system for replacement parts, consumable supplies, manufacturing kits, etc.

Technology Transfer

- Maintain integrity of TLC system
  - ✓ Quality Assurance/Quality Control (QA/QC) of TLC process and results
  - ✓ Certified TLC Analysts and Operators
  - ✓ Re-certification and training
- Continuing education
- Strategic implementation

Certification Levels

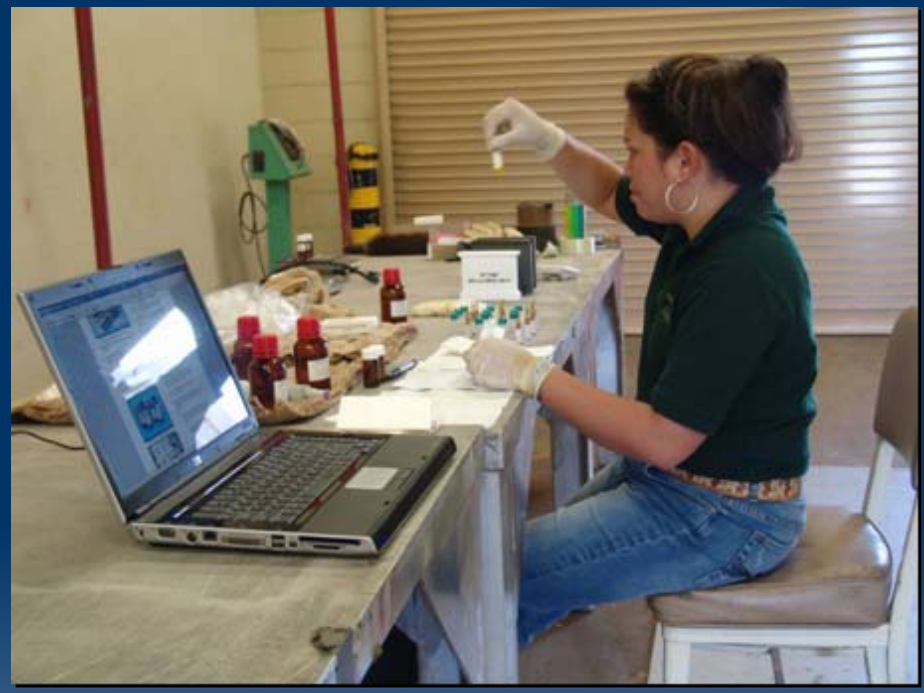
- Level 1 Certified PS-TLC Operator
  - ✓ Able to perform analysis of propellant stabilizers under supervision of a Level 2 Certified PS-TLC Analyst
  - ✓ All TLC analysis results must review and certified by a Level 2 Certified PS-TLC Analyst.
  - ✓ Level 1 Operators require additional experience and education to become Level 2 Analysts.
- Level 2 Certified PS-TLC Analyst
  - ✓ Able to perform independent analysis of propellant stabilizers and certify the results.
  - ✓ Able to assist and mentor Level 1 Certified PS-TLC Operators.
  - ✓ Able to review and certify reports and plates performed by Level 1 Certified PS-TLC Operators.
  - ✓ Able to submit official results
- Certification Criteria
  - ✓ Points awarded based on practical exercise, written exam, and an oral analysis

End User Support

- TLC Sales and Support – Pelatron primary point-of-contact
  - ✓ Website: www.pelatron.com/tlc - best practices, FAQ's (frequently asked questions), updates and patches, online continuing education, shopping cart
  - ✓ Phone: toll-free (866) 460-1356
  - ✓ Fax: (801) 660-4297
  - ✓ Email: TLC@pelatron.com

Hawaiian Jade

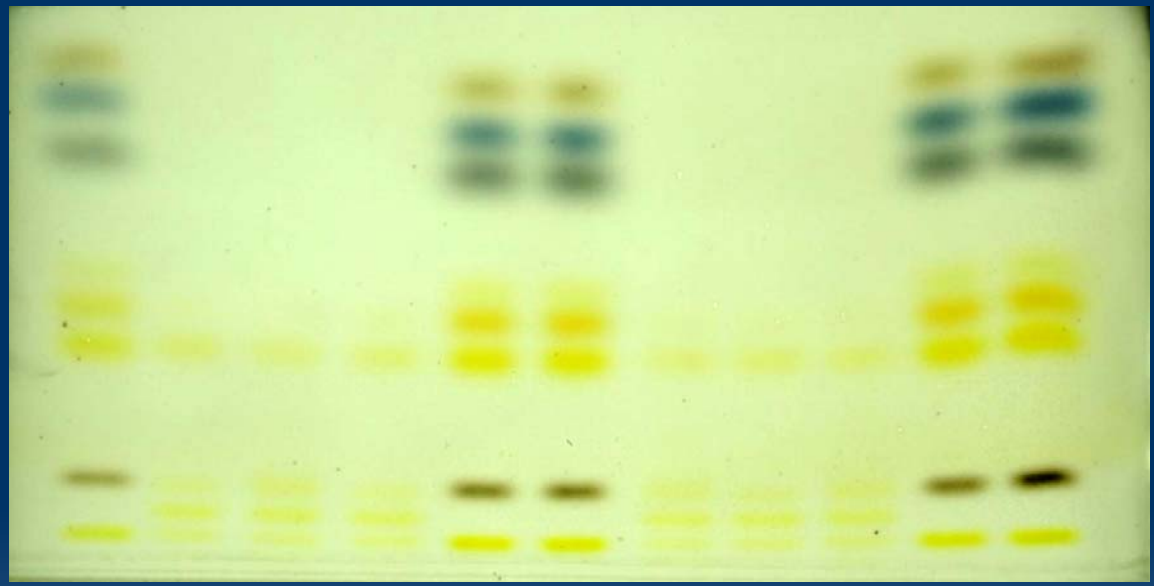
- Unknown propellants washing up on Hawaiian shores – Jan/Feb 07
  - ✓ People collecting and making necklaces of Hawaiian Jade
  - ✓ Most collected by Army and destroyed
- PIKA-Pelatron team analyzed propellant grains for stability



Hawaiian Jade

- Tested for DPA, EC/AK, 2NDPA stabilization
- Identified
  - ✓ DPA stabilized
- Results
  - ✓ very poor stabilization
  - ✓ .12% %RES

Hawaiian Jade



2-NDPA
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DPA

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2,4'-DNDPA

4-NDPA
4,4'-DNDPA

Acknowledgement

The PIKA-Pelatron Consortium greatly appreciates the Defense Ammunition Center and the scientists at the Lawrence Livermore National Laboratory Forensic Science Center for the TLC technology, their guidance, their expertise, and their un-ending momentum to enable the TLC technology transfer process.

As we express thanks in Hawaii,

Mahalo Nui Loa!


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Questions?