

Sealing Systems for International Safeguards Circa 2008

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Caveat

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Overview

- ▶ Agency Nuclear Missions
- ▶ Nuclear Verification Components
- ▶ The Role of Sealing Systems
- ▶ A Gallery of Seals as of 2008
- ▶ Appendix: Useful Technical Disciplines



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Agency Nuclear Missions

- ▶ Then. Created June 1957 as an independent United Nations Agency responsible for
 - Promotion of peaceful uses of nuclear energy and particularly nuclear power generation
 - Prevention of proliferation of such uses into nuclear weapon programs
- ▶ Now. Three Primary Nuclear Missions
 - Technology Development
 - Safety and Security
 - Verification



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Safeguards is About Verification

- ▶ Objective. To provide credible assurance to the international community that nuclear materials and other items placed under safeguards are not diverted or misused; for States with comprehensive safeguards agreements, to provide credible assurance that all nuclear material remains in peaceful activities; and to support the efforts of the international community in connection with nuclear disarmament.



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Technical Support for Safeguards

- Ensures the development, acquisition, implementation, performance, maintenance and management of Safeguards Technical Equipment.
- Provides necessary documentation, procedures, and technical training for Safeguards Technical Equipment.
- Provides the administrative co-ordination of activities of Member State Support Programs.
- Coordinates the Safeguards Department's equipment needs, budgets, and expenditures.
- Coordinates analytical services associated with safeguards and environmental sample analysis.



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Seals Unit Mission Area

- ▶ Staffing. Seven (5.5 to 8) staff members are responsible for
 - Operations. The Agency fields about 30,000 passive seals a year, 2000 active seals, and 350 special seals. Costs are logarithmic.
 - Technology Development. As many as a dozen active development projects, with more pending.
 - Vulnerability Assessments. Several formal vulnerability assessments, with more pending.



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Sealing Systems

▶ Purpose

- Complementary to Nuclear Material Accountancy (NMA)
- Reduces effort required to carry out NMA verification given Continuity of Knowledge (CoK) applies
- Provides diversion detection capability for some strategies not covered by NMA verification

▶ Classes of Sealing Systems

- Passive Seals
- Active Seals
- Special Sealing Systems

▶ Future concepts include both sealing systems and containment verification methods



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Agency Sealing Systems

- ▶ Passive Sealing Systems
 - Metal Cup Seal
 - Cobra Seal
 - Adhesive Seal
- ▶ Active Sealing Systems
 - VACOSS Seal
 - EOSS Seal
- ▶ Special Sealing Systems
 - ARC and USSB Seal (Underwater Application)
 - TRFS Seal (Remote Monitoring Application)
 - RMSA (Development Example)



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Metal Seal with Insulated Wire



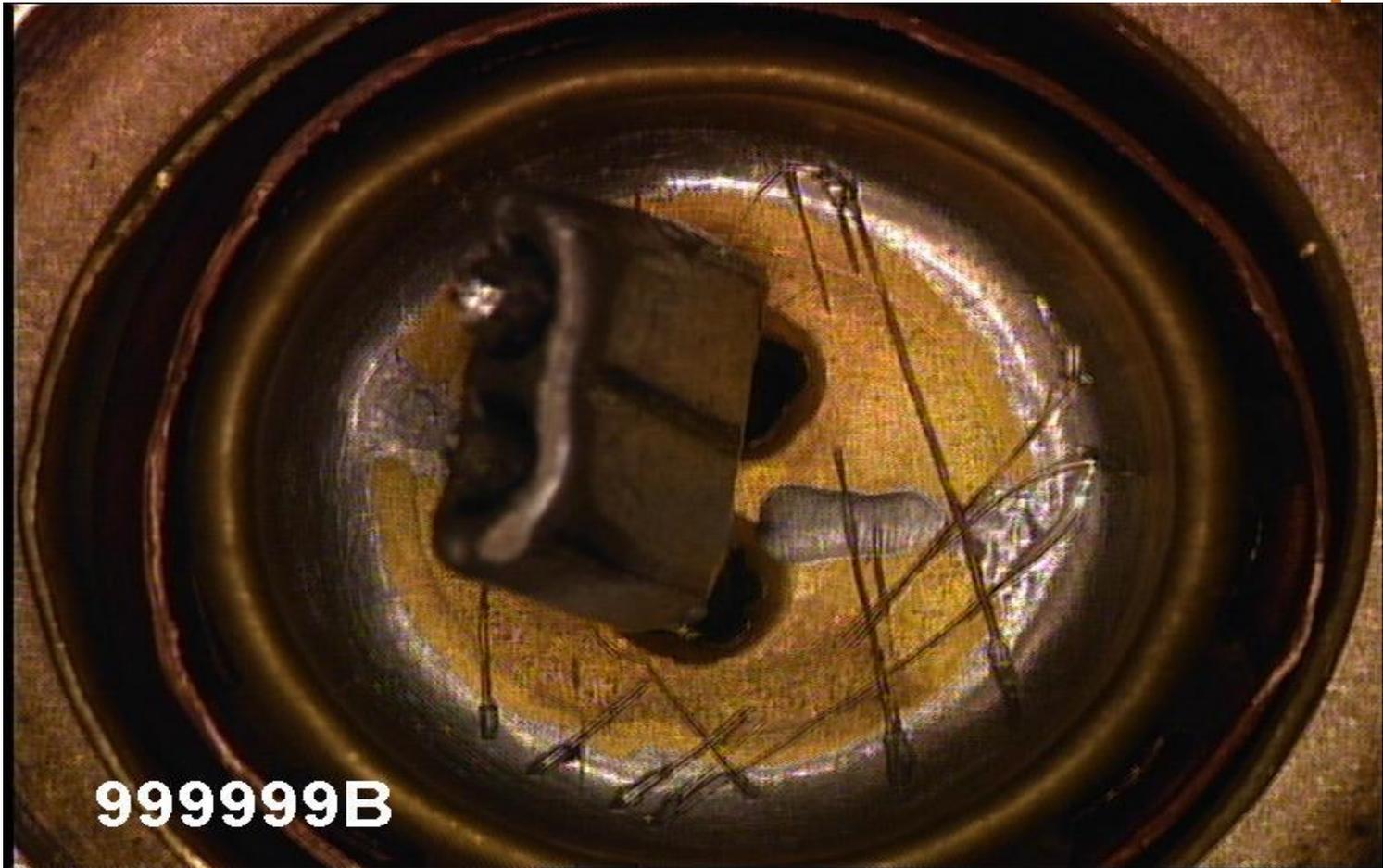
Metal Seal with Stainless Steel Wire



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Metal Seal with Stainless Steel Crimp



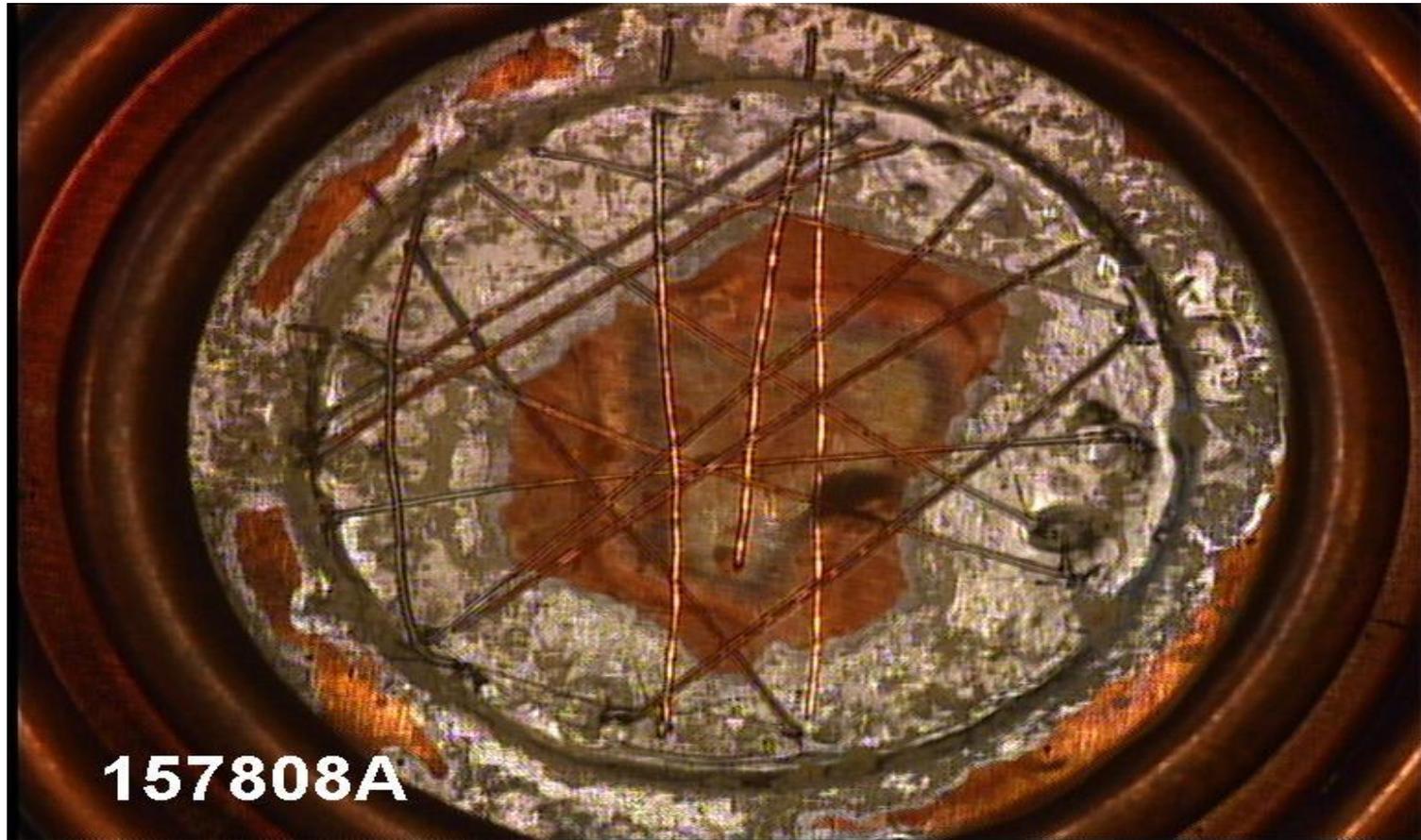
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Sample Signature Element



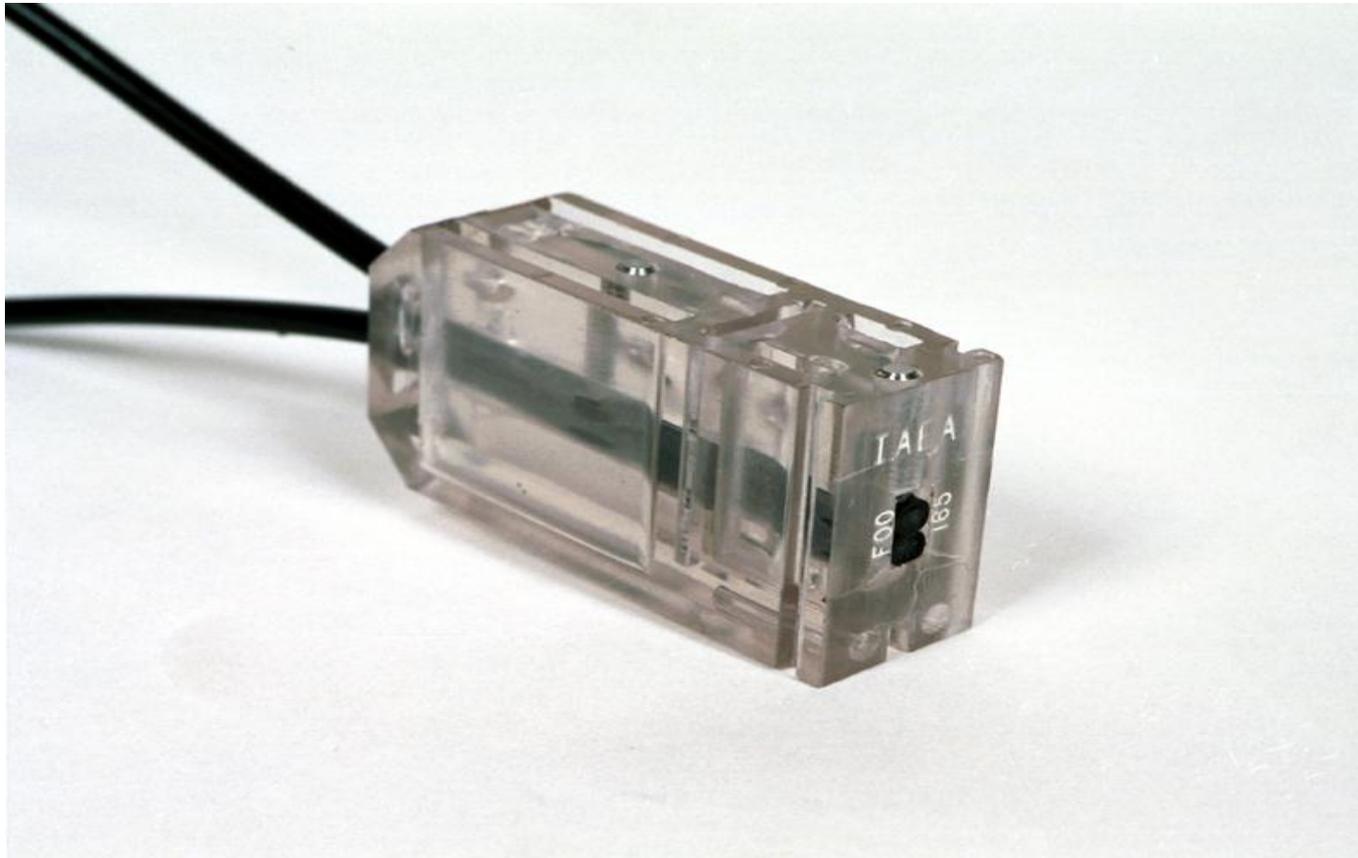
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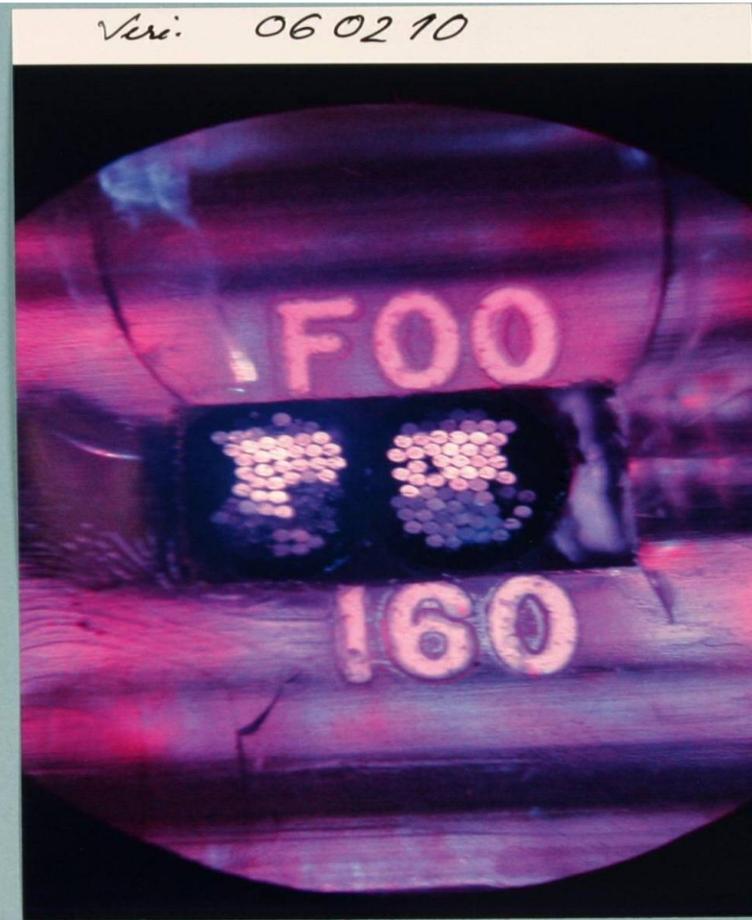
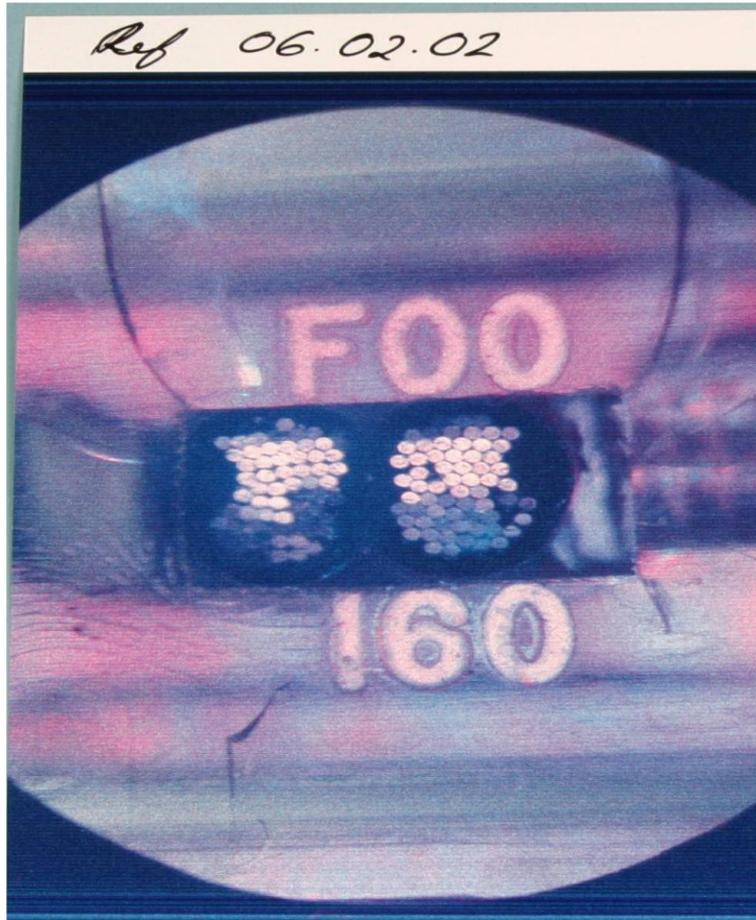
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Cobra Seal



Cobra Seal Images



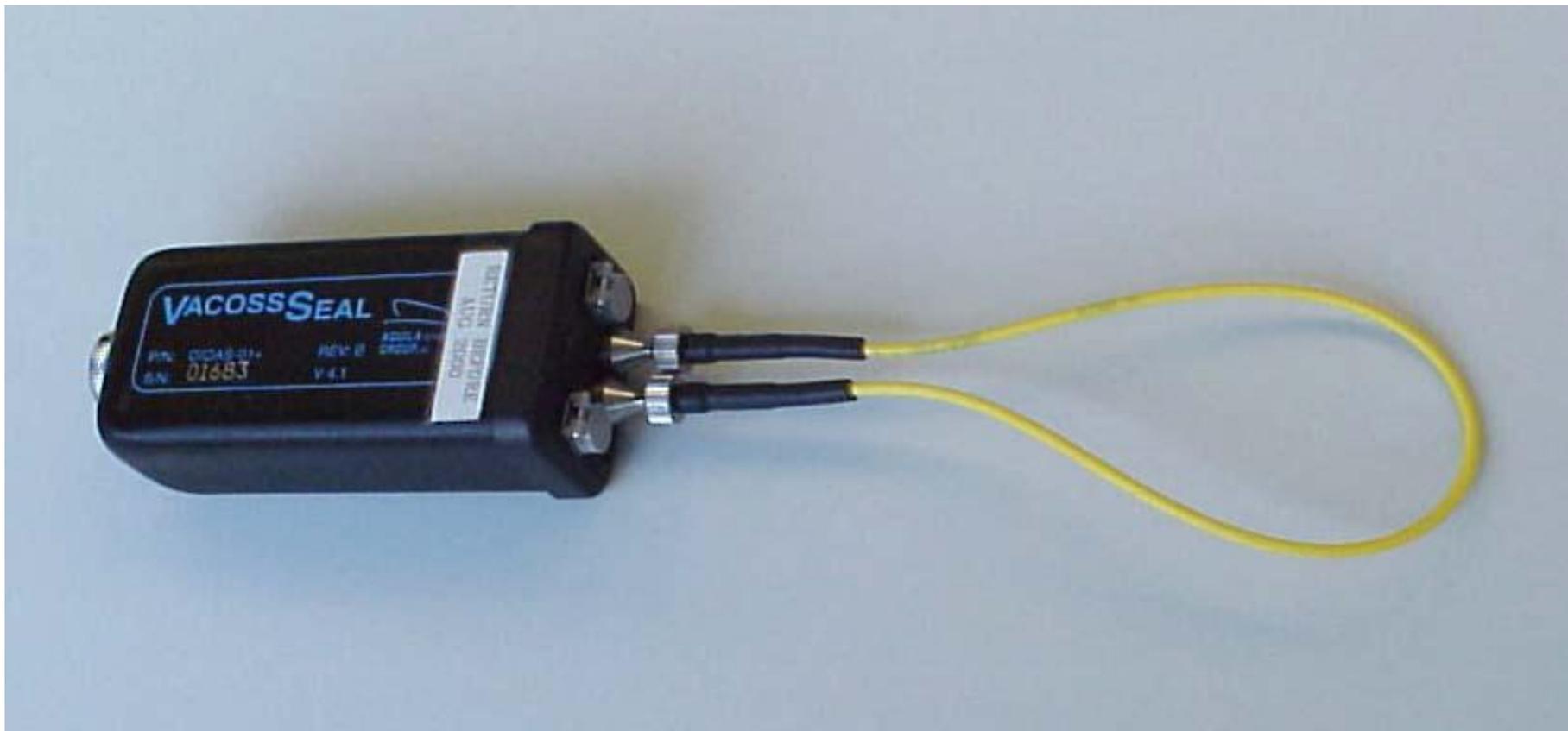
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Adhesive Seal



VACOSS Seal



Electro Optical Sealing System



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Special Systems - USSB



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Data Example - USSB



EUROPEAN COMMISSION
JOINT RESEARCH CENTRE



SILab

TEST CANDU - Version 1.00

Seal0684-00

Container Number :
Seal Number : Seal Phase :
Date Measure : Time :
Inspection Number :
IAEA Inspector :
Site :
Reading Head : Transducer :

Seal0684-01

Container
Seal Number : Seal Phase :
Date Measure : Time :
Inspection Number :
IAEA Inspector :
Site :
Reading Head : Transducer :

RESULTS

UNBROKEN and IDENTIFIED

Correlation on Identity : 0.995

Correlation on Integrity : 0.936



Quit

Data Example - USSB



EUROPEAN COMMISSION
JOINT RESEARCH CENTRE



SILab

TEST CANDU - Version 1.00

Seal0684-00

Container Number :
Seal Number : Seal Phase :
Date Measure : Time :
Inspection Number :
IAEA Inspector :
Site :
Reading Head : Transducer :

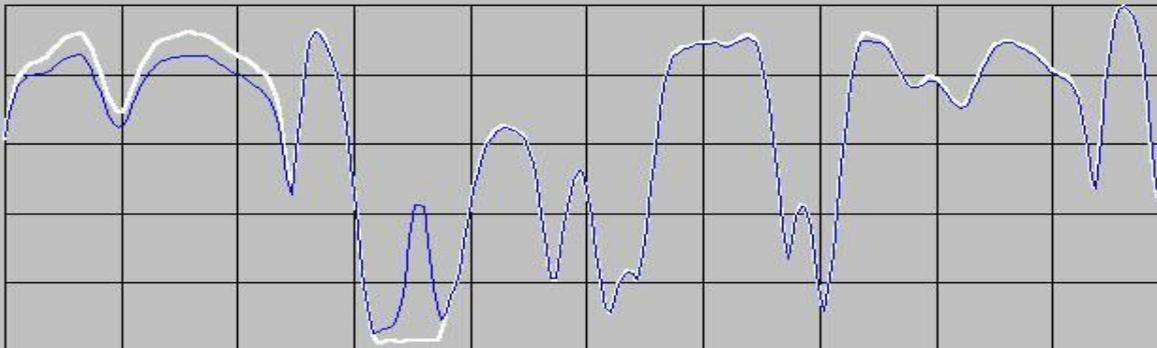
Seal0684-02

Container
Seal Number : Seal Phase :
Date Measure : Time :
Inspection Number :
IAEA Inspector :
Site :
Reading Head : Transducer :

RESULTS

BROKEN and IDENTIFIED

Correlation on Identity : 0.995
Correlation on Integrity : 0.000



Quit

Special System - DataSeal



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Future Concepts

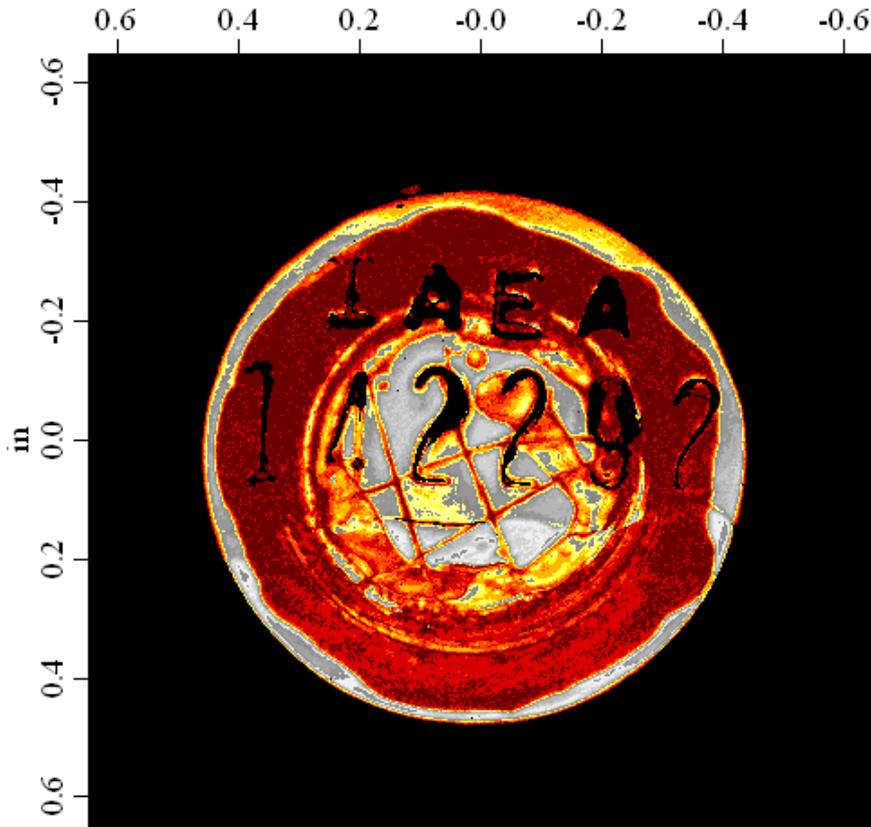
- ▶ Sealing Systems. Primary objectives include on-site or in-situ verification of passive sealing systems, quantification of wire integrity, remotely monitored sealing arrays, and other seal modernization programs. *Cost/benefit studies increasingly important.*
- ▶ Containment Verification. Primary objectives include surface and/or three dimensional volume monitoring methods, and tamper monitoring of conduit.



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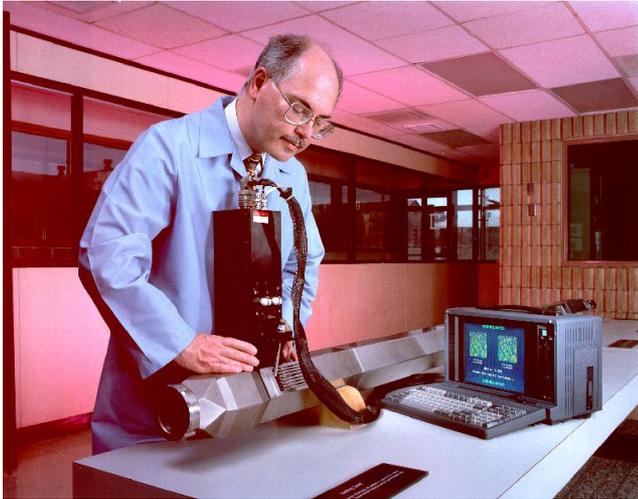
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Ultrasonic Imaging of Internal Features

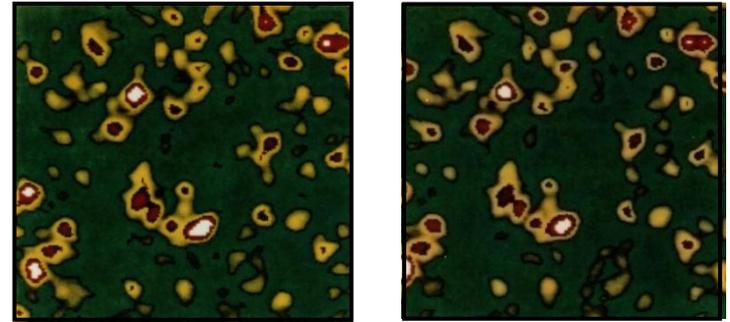


Ultrasonic image of top cap, thermal palette representation, ~ 0.025" from front surface interface as obtained from Idaho National Laboratory.

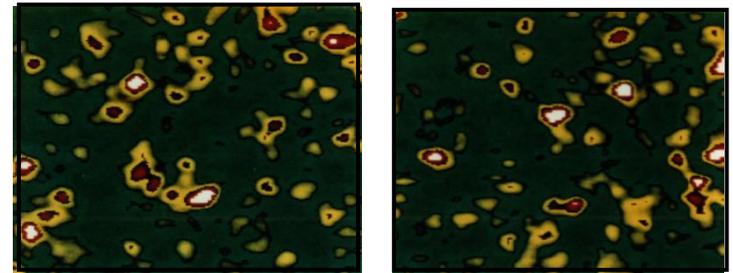
Ultrasonic Intrinsic Signatures



**UIT Signature
Acquisition from the
Closure Weld of a
Fuel Assembly
Surrogate**



Matching Signatures



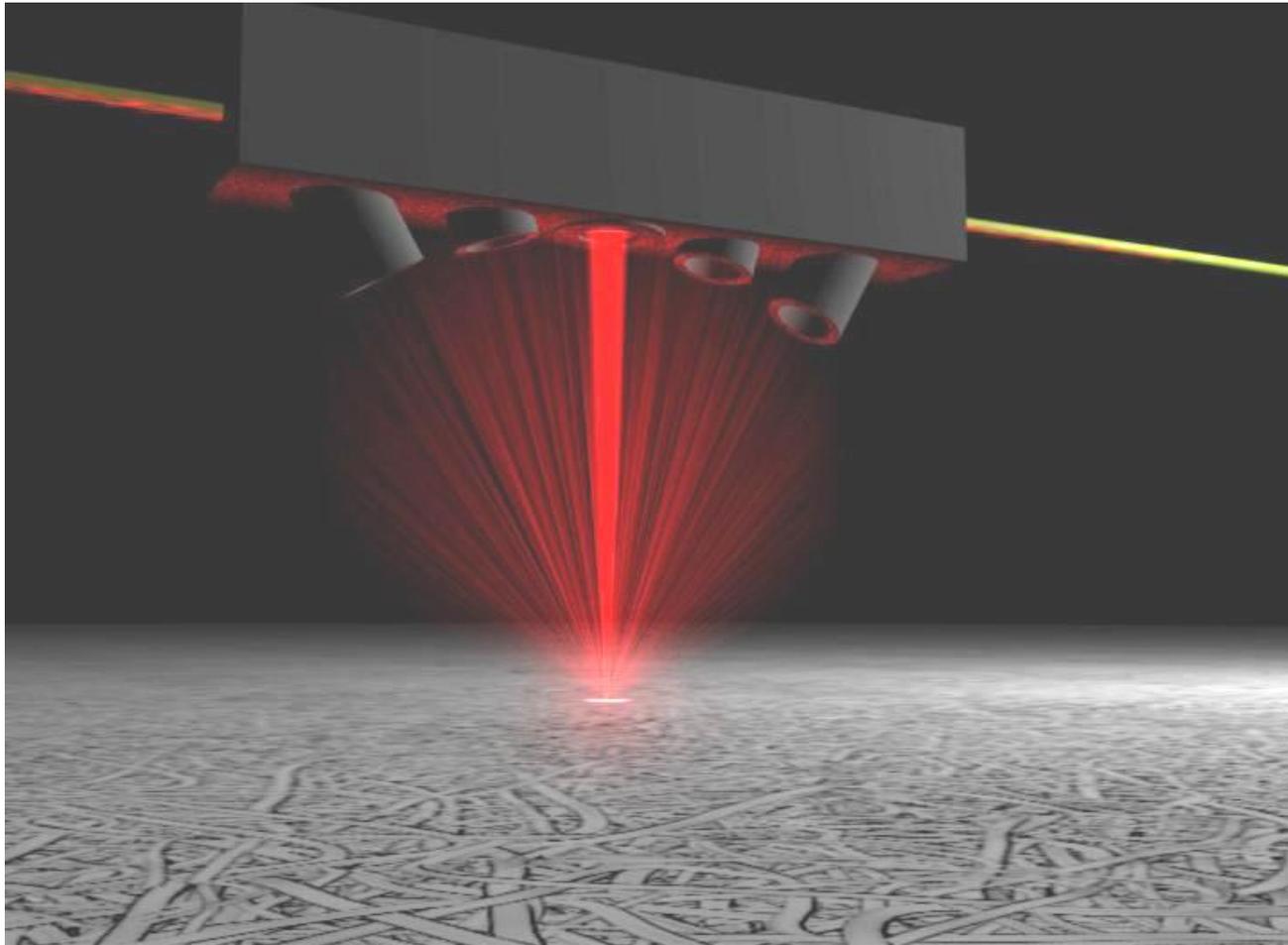
Non-matching Signatures



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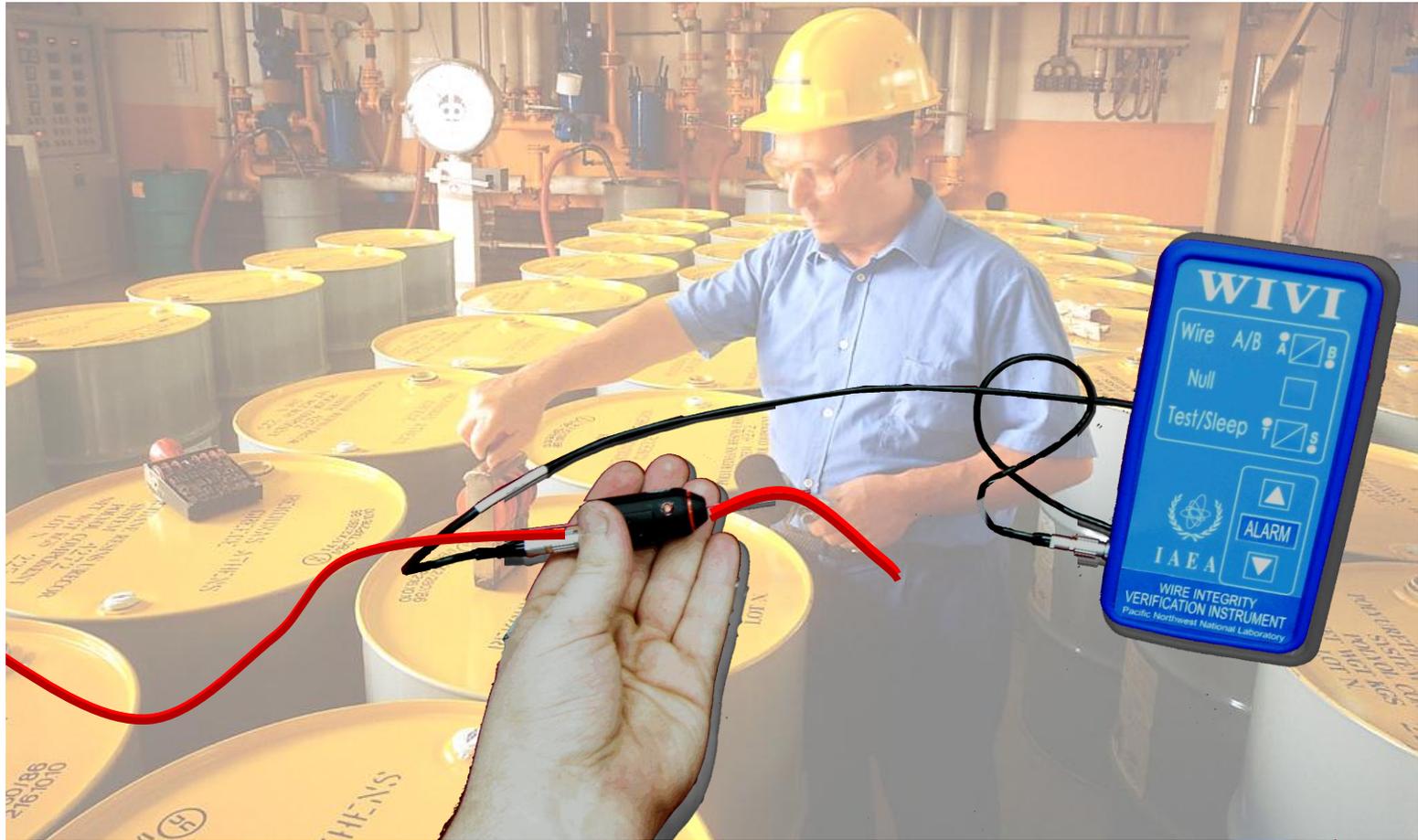
Laser Surface Authentication



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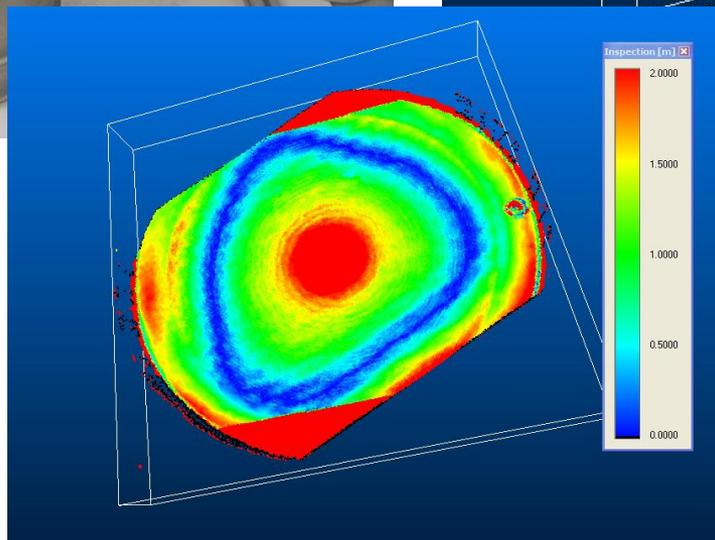
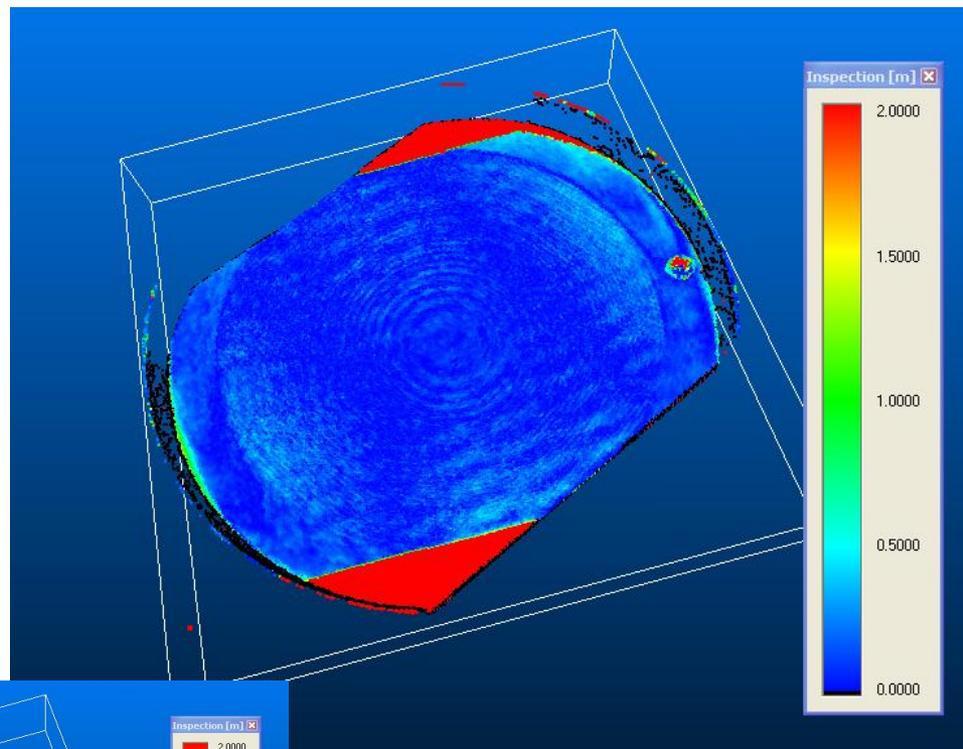
Wire Integrity Verification



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Laser Surface Mapping



Matching Signatures

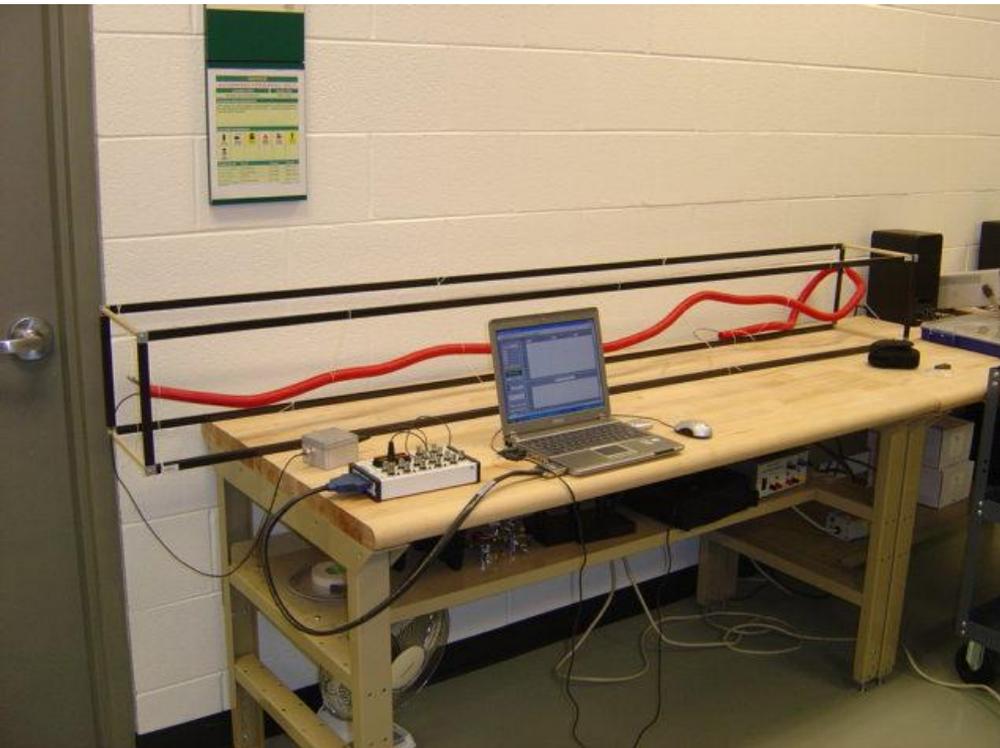
Non-matching Signatures



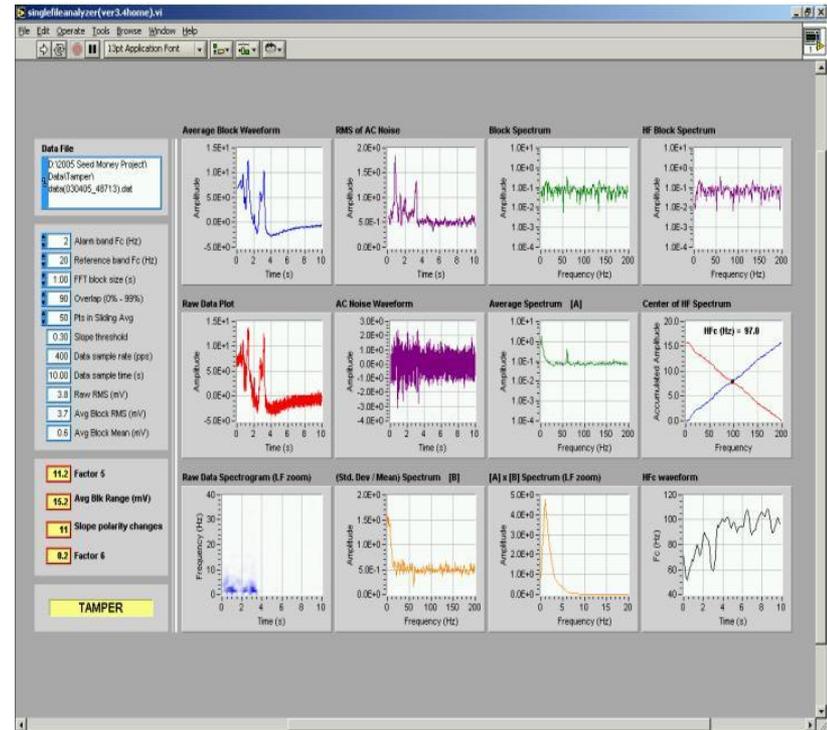
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Conduit Monitoring



Bench Scale Prototype



Signal Analyzer

Summary

- ▶ The Agency Seals Unit is responsible for the operations, maintenance, logistics, development, deployment, and vulnerability assessment of all Agency sealing systems.
- ▶ Seal Deployments typically include up to 30,000 passive seals, 2000 active seals, and 350 special sealing systems. Costs are logarithmic.
- ▶ Future concepts may include laser surface authentication, ultrasonic technology, eddy current technology, remotely monitored sealing arrays, and new techniques in containment verification. *Cost/Benefit issues are now increasingly important.*



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Technical Disciplines Required



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Operations Research

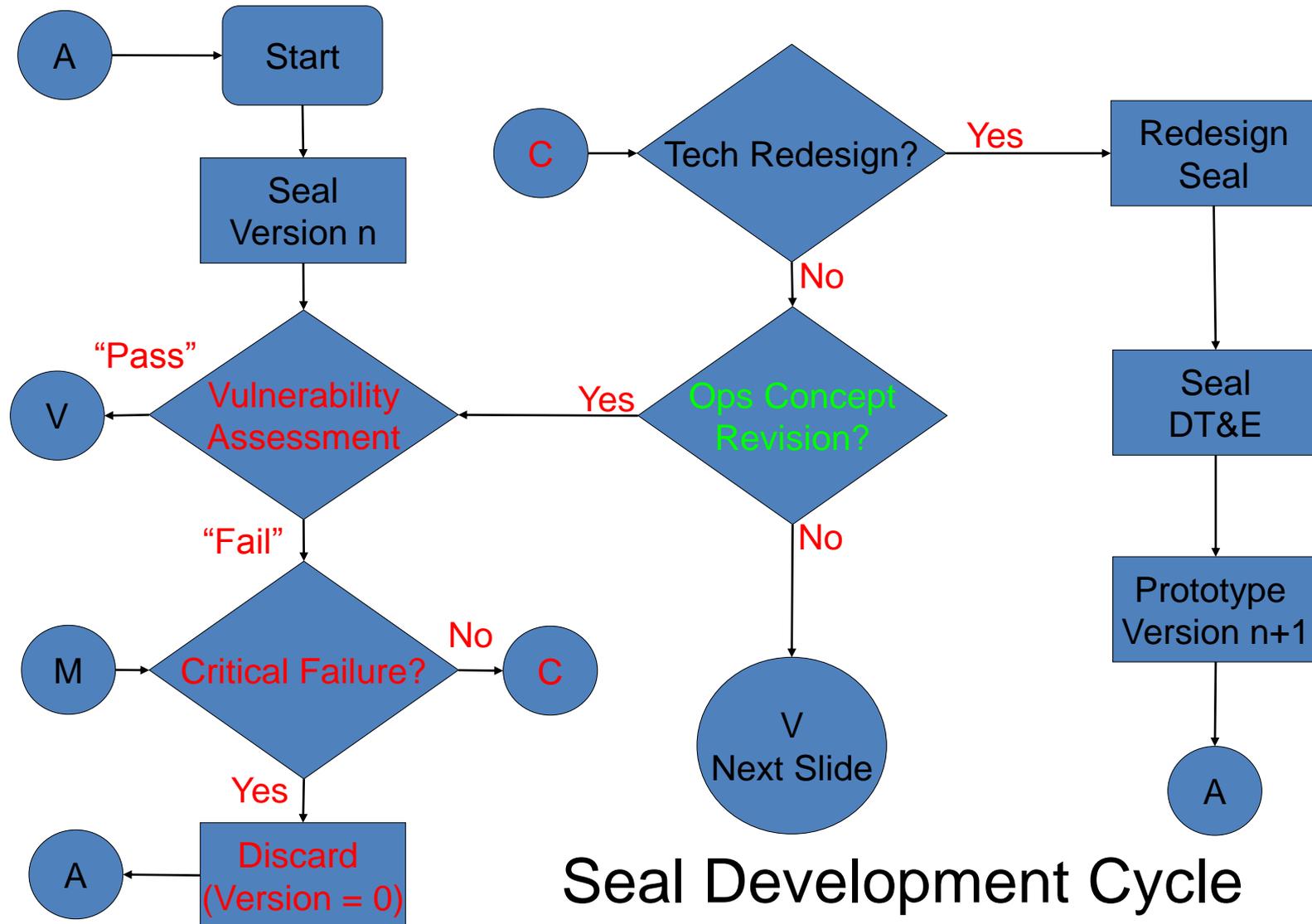
- ▶ Systems Engineering Processes



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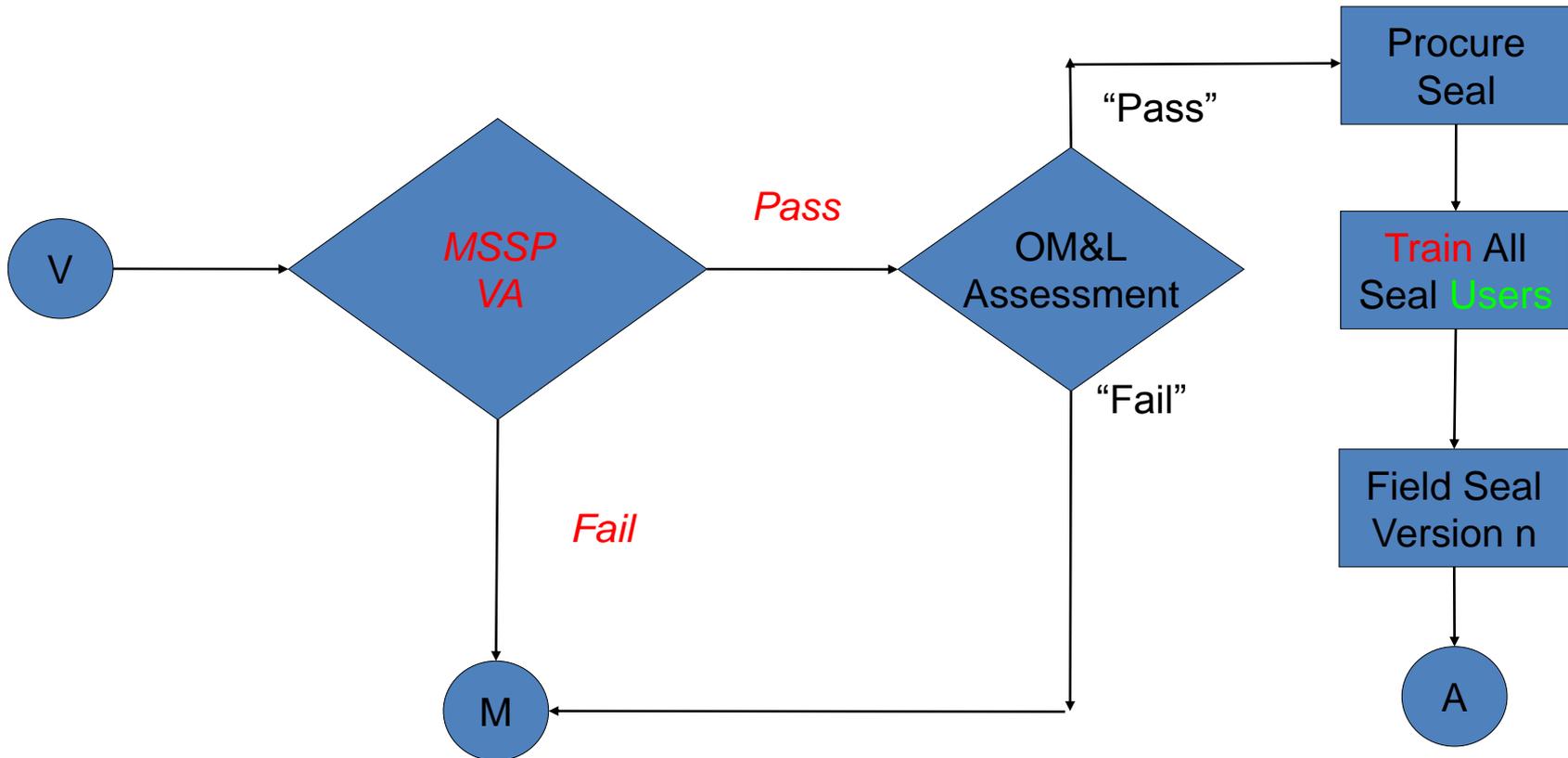
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Development and Deployment Process



Seal Development Cycle

Development and Deployment Process



Seal Validation and Deployment Cycle

Reliability Engineering

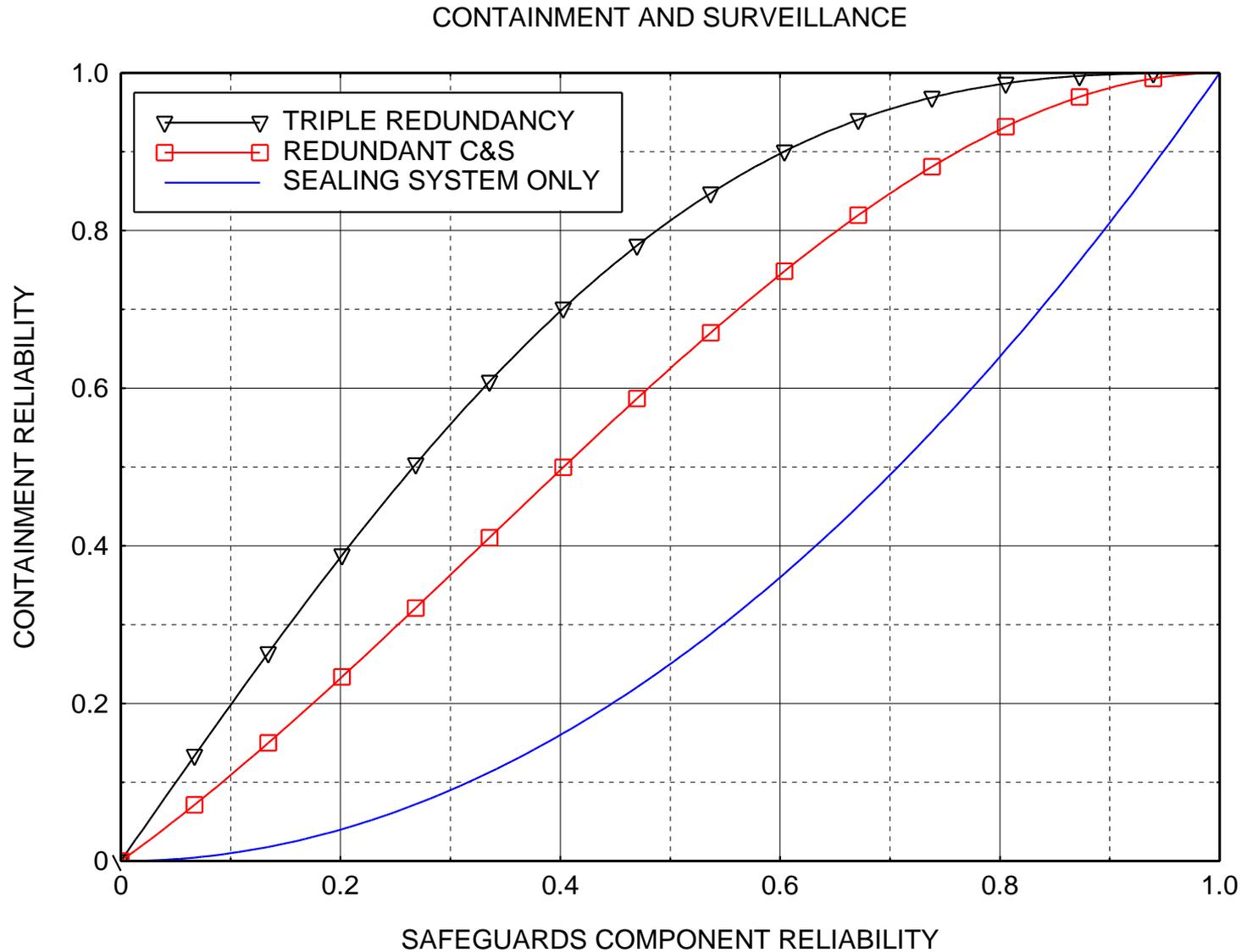
- ▶ Attacker and Defender Modelling



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Containment and Surveillance



Statistics

- ▶ Nonparametric Estimation

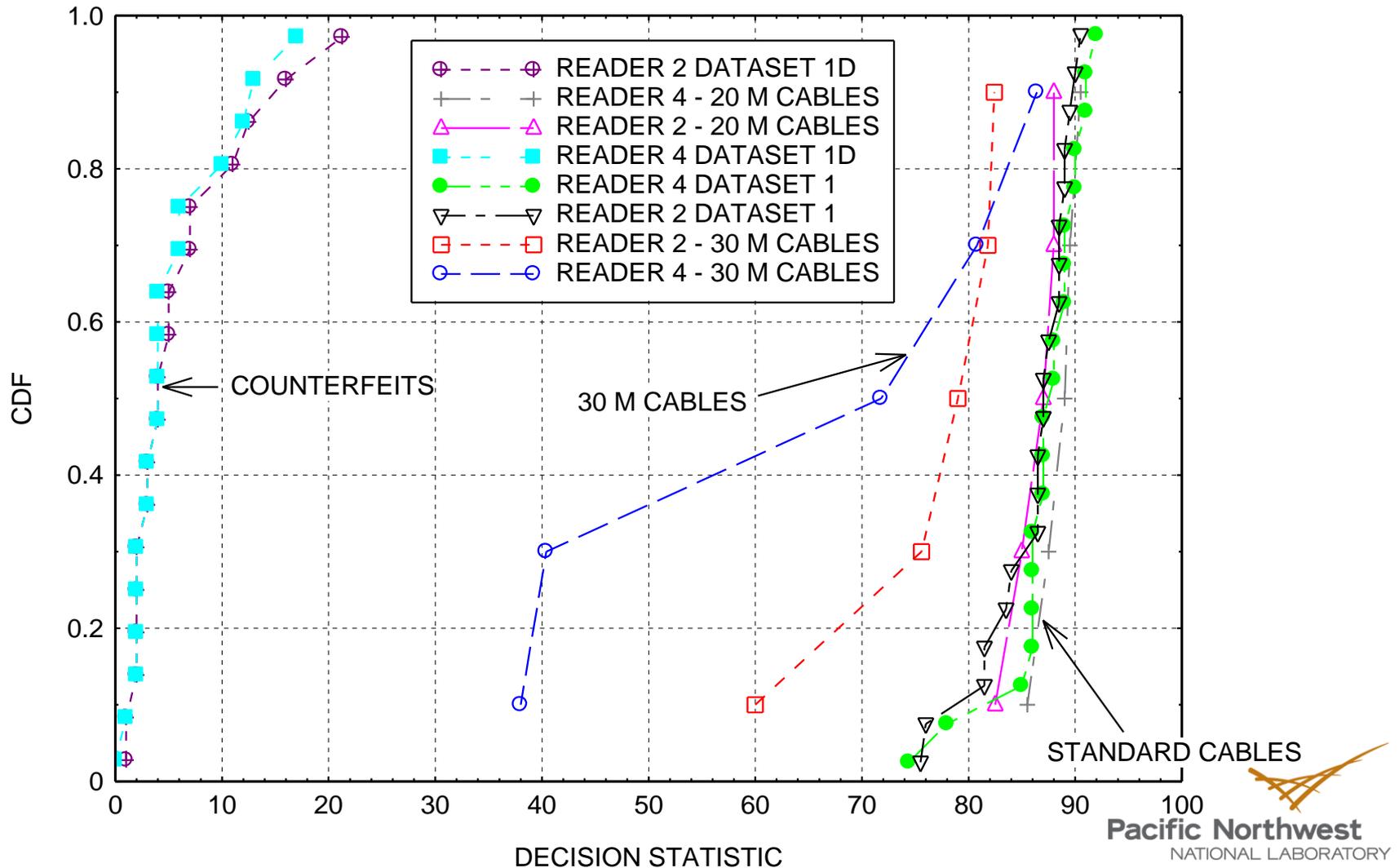


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Test and Evaluation

PROTOTYPE RESULTS



Reference Document

International Atomic Energy Agency

ANNUAL REPORT 2006



See www.iaea.org



IAEA

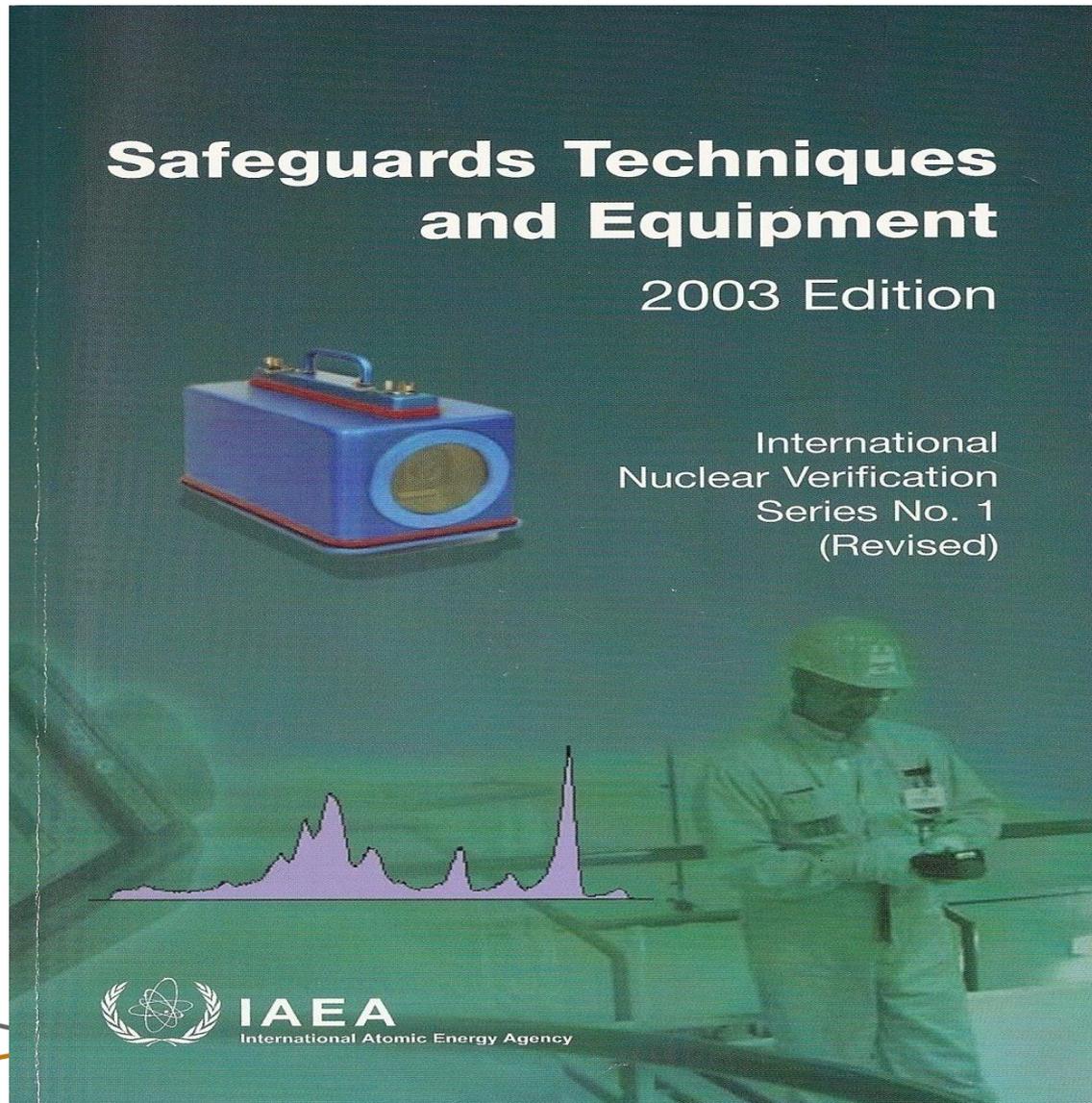
Atoms for Peace: The First Half Century



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Reference Document



Safeguards Techniques and Equipment

2003 Edition

International
Nuclear Verification
Series No. 1
(Revised)

 **IAEA**
International Atomic Energy Agency


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