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Surveillance Metrics at LANL: An Overview

Jeff I. Abes, W-9

9/4/14

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Metrics Fulfill Surveillance Program Objectives

Objective 1

Identify defects that can affect weapon performance

Metric M1

Probability that the program of record can sample defects

Objective 2

Baseline margins and trends at the component and material level

Metric M2

Confidence that the data either do (or do not) meet a specification, now or in the future

Objective 3

Develop predictive assessment capabilities

Metric M3

Probability that enough data has been collected to identify shifts from predictive models

Surveillance Metrics provide us with:

- A measure of the health of the Surveillance Program
- A measure of how confident the Surveillance Program is in the data and the conclusions drawn from them
- Indications of areas where increased data currency is needed
- Indications of tests that may need to be revised

Surveillance Program Metrics assess the surveillance program, not the health of the stockpile

Slide adapted from Development and Use of Surveillance Metrics at LANL (U), A. M. Peters, 2014 JOWOG 31

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Metrics Follow an Established, Straightforward Process

- Data already gathered for all major components of all LANL weapon systems, e.g., 89 tests for the W76-1
- Mathematica notebooks make calculation of metrics simple
- Roll up from test level automated using Microsoft Excel spreadsheets with Visual Basic
- Regular updating of test-level metrics and roll up as data comes in

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Roll Up Structure Reflects Our Reasons for Testing

Component and Metric Combination, e.g., Polymers and Assess Margins and Trends Now

Defect/Anomaly Classification	Importance	Defect/Anomaly Type	Importance	Test	Importance
Material Change	0.3	Composition Change	0.5	Gravimetric Test	0.5
				Liquid Chromatography	0.5
		Chemical Change	0.5	Differential Scanning Calorimetry	0.65
				pH Test	0.35
Mechanical Change	0.4	Manufacturing Defect	0.4	Visual	0.1
				Ultrasonic Test	0.9
		Mechanical Property Change	0.6	Tensile Test	0.95
				Compression Test	0.05
Electrical Change	0.3	Resistance Change	0.7	Resistance Subcomponent 1	0.8
				Resistance Subcomponent 2	0.2
		Voltage Change	0.3	Voltage Subcomponent 1	0.8
				Voltage Subcomponent 2	0.2

- Roll up is a weighted average from test level (right) to component level (left)
- Weights come from subject matter expert elicitation, typically meetings with component engineers and system engineers

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Roll Up Provides Quick View of Surveillance Program Health

Surveillance Metrics					
Wxx or Bxx	Sample Defects		Understand Margins and Trends	Predictability	
	Probability of Sampling Static Defects (%)	Probability of Sampling Aging Defects (%)	Combined Confidence (%) to Assess Margins and Trends, Now and In the Future	Probability of Detecting a Change in Mean (%)	Probability of Detecting a Change in Variance (%)
NEP D&I	100	100	N/A	N/A	N/A
GTS	100	95	90	98	88
DCA	95	45	100	50	30
HE	100	100	95	80	60
Pit	90	70	80	95	85
CSA	30	20	10	60	50
Polymers	100	99	99	90	70

Numbers shown are for illustrative purposes only

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Drill Down is Easy to the Component Level...

Component, e.g., Polymers, Gas Transfer System, Pit, High Explosive

Test	Sample Defects		Understand Margins and Trends			Predictability	
	Probability of Sampling Static Defects (%)	Probability of Sampling Aging Defects (%)	Assess Margin – No Trend (%)	Assess Margins and Trends Now (%)	Future Margin and Trend Assessment (%)	Probability of Detecting a Change in Mean (%)	Probability of Detecting a Change in Variance (%)
Test 1	100	100	N/A	N/A	N/A	N/A	N/A
Test 2	N/A	N/A	90	N/A	N/A	100	95
Test 3	N/A	N/A	N/A	95	85	90	80
Test 4	80	40	N/A	N/A	N/A	N/A	N/A
Test 5	20	10	N/A	N/A	N/A	N/A	N/A
Test 6	N/A	N/A	60	N/A	N/A	80	70
Test 7	N/A	N/A	N/A	65	55	70	60

Toy numbers shown above

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...and to the Level of Individual Test Data

Confidence at least 90% of data is, or is not bound by limit(s); no trend observed [M2a]

HOW WELL DO WE UNDERSTAND CURRENT DATA WITHOUT A TREND?

Confidence at least 90% of data is, or is not bound by limit(s); with trend observed [M2b]

HOW WELL DO WE UNDERSTAND CURRENT DATA WITH A TREND?

Confidence at least 90% of data is, or is not bound by limit(s); future projection [M2c]

WHAT IS OUR FUTURE EXPECTATION?

Graphics from [Development and Use of Surveillance Metrics at LANL \(U\)](#), A. M. Peters, 2014 JOWOG 31

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Data Mining has been extensive - Metrics are data driven

This represents evaluation of almost 35 years of history for all critical surveillance data streams.

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The Surveillance Metrics Program at LANL is Fully Implemented

- Metrics established, and used for this and other projects (see earlier B61-12 REST presentation)
- Status of surveillance for each weapon system available at a glance
- Data gathered and available upon request – only updating remains
- Useful for everything from sampling defects that arise in a few years to long-term trending

We have arrived at surveillance tools for the era of nuclear weapons that must last for decades.

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Metrics are Supporting the Weapons Program

- Presented at Surveillance Annual Assessment reviews
- Assist in B61 LEP Surveillance planning
- Metrics reported in Weapon Cycle Reports
- Metrics roll-up Framework used to inform the ADX weapon aging and skill set team of the ADX Offsite, which provides input to the Predictive Capability Framework Council, to provide information about the potential weapon problems covered by surveillance testing
- Metrics used for warhead gas study
- Surveillance Metrics Assessment Working Group has been established between LANL and SNL (have met twice on technical exchange meetings)

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Data Gathered for Surveillance Metrics have Other Benefits

- Upfront effort of collecting and co-locating data results in only having to update with new data
 - No more weeks of copying data from pdfs before responding to data requests
- Baseline for Enhanced Surveillance Campaign Studies
- Used for several Significant Finding Investigations/Significant Finding Notifications
- Same day answers to Red Team questions
- Annual Assessment Review data plots and analyses
- Input for component reliability calculation

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Metrics are in Continuous Improvement and Refinement

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Metrics Drive Value Stream Analysis

Slide from Development and Use of Surveillance Metrics at LANL (U), A. M. Peters, 2014 JOWOG 31
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Backup

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Data Gathered From Many Sources

- Pantex DataMarts
- Pantex Cycle Reports
- Y-12 [CSA] Reports
- Kansas City Plant and Pantex spreadsheets
- Classified PDMLink database
- Spreadsheets in workers' individual accounts
- Originally huge number of files across many locations; all now available in spreadsheet form on a shared drive

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Number of Data Points by Component and Type, B61

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Number of Data Points by Component and Type, W76-0

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Number of Data Points by Component and Type, W78

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Number of Data Points by Component and Type, W88

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Number of Data Points by Component and Type, W76-1

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Number of Data Points by System, Component and Type

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