Audit Trail Criteria
Measuring Systems

NIST Office of Weights & Measures

Objectives

- After the completion of this presentation, using your references and notes, you will be able to:
  - describe the 3 categories of sealing for liquid measuring devices;
  - determine the sealing requirements that apply to each of the 3 categories of liquid measuring devices; and
  - list the two types of metrological parameters that must be sealed.

Overview

- History
- Audit Trail Requirements
- Examples & Use
- Benefits

Introduction

- Audit trails accepted in 1989
- Audit trails provide more information than a lead-and wire seal
- Many benefits to users and weights and measures officials

Introduction (continued)

- Same notification requirements apply
- Weights and Measures officials and service personnel must understand
  - Audit trail format
  - Audit trail requirements
  - How to use the information from audit trails

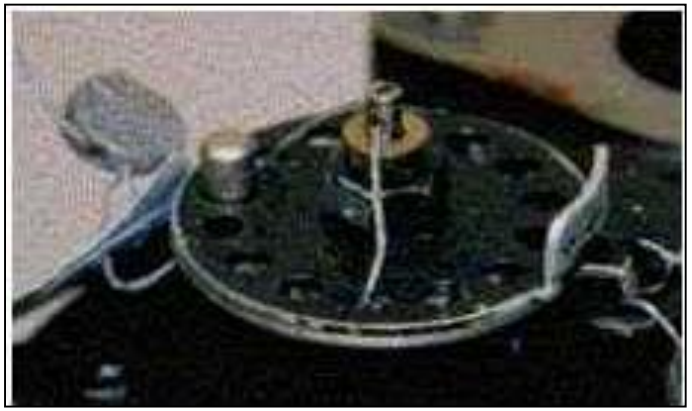
Sealing and Security Seals History

- Before 1979
  - Only lead and wire seals permitted
  - Only adjustments for performance requirements were required to be sealed

Sealing and Security Seals History

- Sealing wire threaded through
  - Screws or pins with holes
  - Movable or removable covers

- Prevents access to adjustment without breaking seal



Sealing and Security Seals History

- 1979 : Pressure sensitive security seals permitted

- 1985: G-S.8. Added; applied to all electronic adjustable components

Sealing and Security Seals History (continued)

- 1989: G-S.8. Amended
  - Approved means of electronic audit trail recognized
  - Seal features and parameters affecting metrological integrity
    - adjustments affecting accuracy
    - selection of operations that affect compliance with Handbook 44
  - Maintain record of changes to sealable parameters

Sealing and Security Seals History (continued)

- 2007: G-S.8.1. Added
  - Multiple weighing or measuring elements with common provision for sealing
    - Changes to metrological parameters must be individually identified

G-S.8. Provision for Sealing

- G-S.8. recognizes security means other than physical seals

- Alternative forms of security must be an "approved means"
  - Guidelines for "approved means" established for scales and liquid-measuring devices

- Must seal any adjustment that affects the "metrological integrity" of the device

  That is…..

G-S.9. Metrologically Significant Software Updates

- Added 2016
- A software update that changes metrologically significant software is considered a “sealable event”
- Metrologically significant
  - anything that affects compliance with NIST Handbook 44

Metrological Parameters to be Sealed

- Parameters that can affect the measurement features that have a significant potential for fraud
- Features of parameters whose range extends beyond what is appropriate for device compliance with Handbook 44 or suitability of equipment requirements

Two Types of Parameters to be Sealed

- Adjustment Parameters:
  - Parameters whose values are expected to change as a result of accuracy adjustments
- Configuration Parameters:
  - Parameters whose values are expected to be entered once only and not generally changed after all initial installation settings are made

Five Philosophies/Principles for Sealing

1. Need to seal depends on:
   - Ease of facilitation of fraud
   - Likelihood that fraud will not be detected

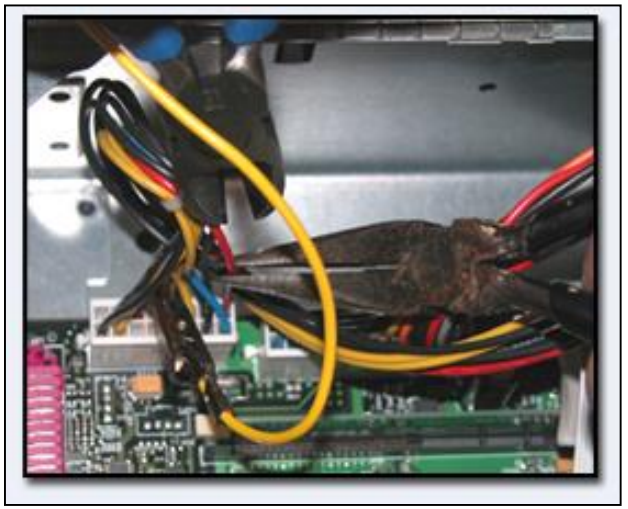
2. Features/Functions used in routine operation do not need to be sealed (e.g., setting unit prices).

Five Philosophies/Principles for Sealing

3. If selection of parameter would result in obvious error, parameter is not required to be sealed.

4. If menu of parameter options is available, access to menu of options must be sealed.

5. If a physical act (e.g., cutting jumper wire) is required to change parameter, parameter is not required to be sealed.



Typical Parameters and Features to be Sealed

- Defined in NCWM Publication 14
  - scale features and parameters
  - liquid-measuring device features and parameters
  - other device type features and parameters

Liquid-Measuring Device Features and Parameters (Example from Past Edition)	
Typical Features or Parameters to Be Sealed	**Typical Features or Parameters Not Required to Be Sealed**
Calibration Parameters ▪ Measuring element adjustment (both mechanical and electronic) ▪ Linearity correction values	▪ Analog-to-digital converters ▪ Quantity division value (display resolution) ▪ Double pulse counting ▪ Communications
Configuration Parameters ▪ Measurement units (e.g., gallons to liters) ▪ Octane blend setting for retail motor-fuel dispensers ▪ Any tables or settings accessed by the software or manually entered to establish the quantity (e.g., specific gravity, pressure, etc.) ▪ Density ranges ▪ Pulsers ▪ Signal pick-up (magnetic or reluctance) ▪ Temperature probes and temperature offsets in software ▪ Pressure and density sensors and transducers ▪ Flow control settings, (e.g., flow rates for slow-flow start, quantity for slow-flow start and stop) ▪ Temperature compensating systems (on/off) ▪ Differential pressure valves As a point of clarification, the flow control settings referenced above are those controls typically incorporated into the installations of large-capacity meters (wholesale meters). The reference does not include the point at which retail motor-fuel dispensers slow product flow during a prepaid transaction to enable the dispenser to stop at the pre-set amount.	

Definition of “Remote” Device

- Not required for the measurement operation of the primary device or to compute the transaction information (in any mode)
- Not a permanent part of the primary device
- Able to adjust another device or change a device’s sealable configuration parameters

Categories of Devices –Overview

- Category 1
  - No remote configuration capability
- Category 2
  - Remote configuration capability
  - Hardware enabling access for remote communication
- Category 3
  - Remote configuration capability
  - Unrestricted access to configuration parameters or adjustments
- Criteria may vary for other device types
  - Additional/fewer categories (e.g., grain moisture meters)
  - Sometimes more stringent

Table S.2.2.
NIST HB 44 Liquid-Measuring Devices Code (2019 ed.)

Table S.2.2. ***Categories of Device and Methods of Sealing***	
Categories of Device	***Methods of Sealing***
Category 1: *No remote configuration capability.*	*Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.*
Category 2: *Remote configuration capability, but access is controlled by physical hardware.* *The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.*	*[The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.]** *[*Nonretroactive as of January 1, 1996]*
Category 3: *Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).* *[Nonretroactive as of January 1, 1995]* *The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.* *[Nonretroactive as of January 1, 2001]*	*An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available on demand through the device or through another on-site device. The information may also be available electronically. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. (**Note:** Does not require 1000 changes to be stored for each parameter.)*

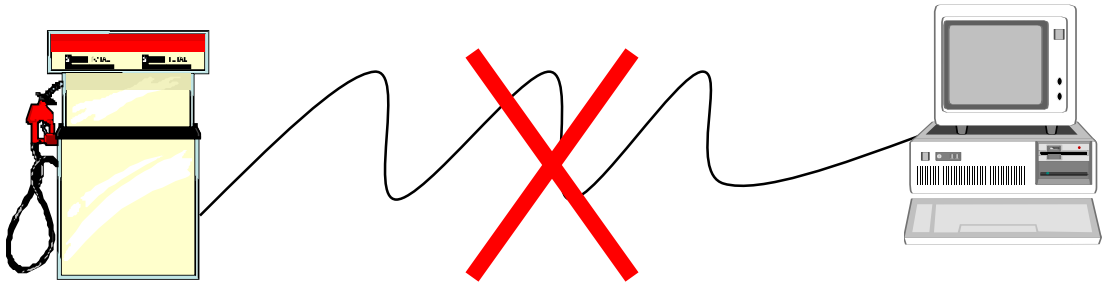
[Nonretroactive as of January 1, 1995]

(Table Added 1993) (Amended 1995, 1998, 1999, 2006, and 2015)

Measuring Devices – Example Category 1

- No remote configuration capability
- Access to adjustments/configuration only at the device
- Sealing:
  - physical seal or
  - two event counters (minimum form of audit trail)

Example: ECR/Console may authorize sales, but can NOT Remotely Configure Dispenser



ECR/Console

Measuring Devices Category 2

- Remote configuration capability
- Access to remote configuration is controlled by physical hardware on site
- Clear indication when in configuration mode
  - including indication on any recorded representation

Measuring Devices Category 2

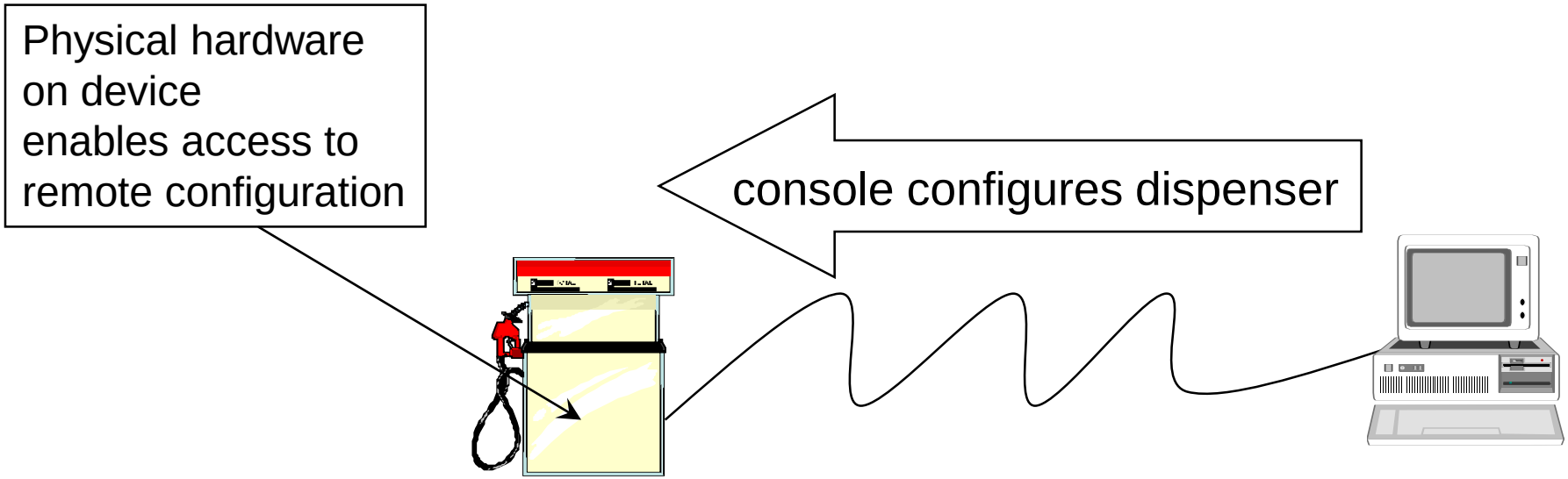
- Sealing:
  - hardware enabling access for remote communication sealed using a physical seal

  OR
  - device receiving parameters sealed with two event counters (calibration and configuration)

- Event counters can be located at individual measuring device or at system controller
  - Adequate number of counters required to monitor individual devices at the location
  - Means to generate hard copy of audit trail info if counters are at system controller

Measuring Devices – Example Category 2

Category 2 - Example:



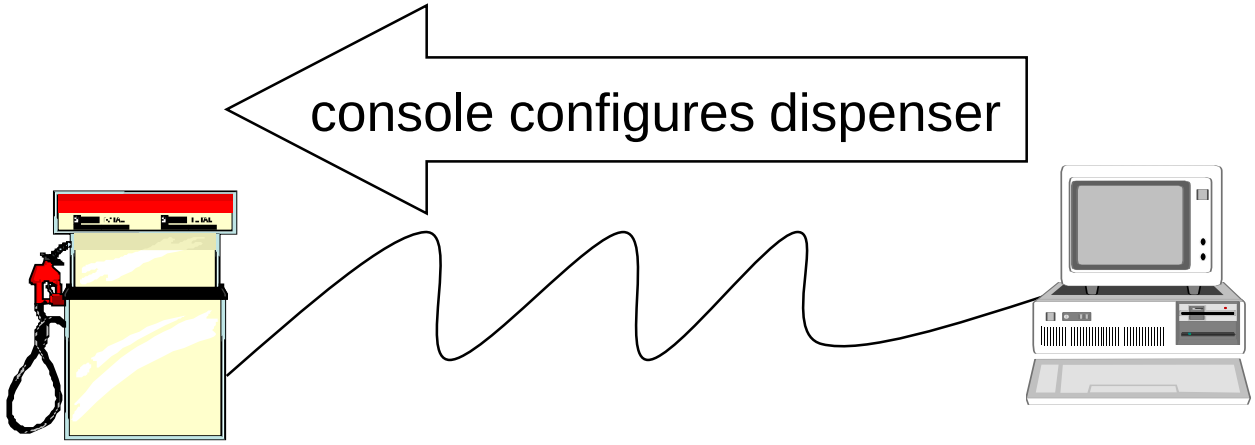
Measuring Devices
Category 3

- Remote configuration capability
- Access to configuration parameters or adjustments unrestricted or controlled through software switch (e.g. password)
- Clear indication when in configuration mode
  - including indication on any recorded representation
- Sealing:
  - event logger (or centralized event logger)
    - includes event counter, parameter ID, date, time, new value
    - printed copy available through on site device
      - electronic copy may also be provided *in addition to* hard copy

Measuring Devices – Example Category 3

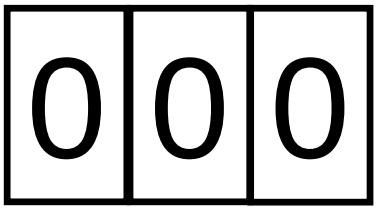
Category 3 - Example:

unrestricted access (i.e., anytime)

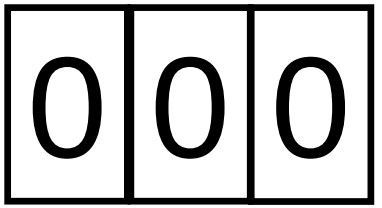


Minimum Form of Audit Trail

- Two event counters:
  - One for adjustment parameters
  - One for configuration parameters
- Capacity of 0 to 999 for each counter
- Counter increments once each time access mode is entered and an adjustment is made



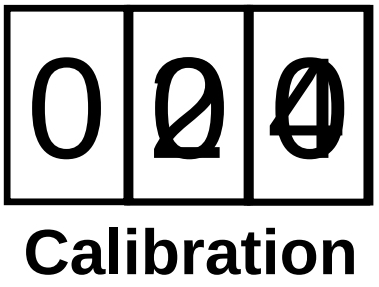
Calibration

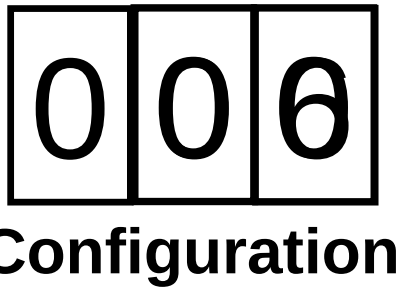


Configuration

Minimum Form of Audit Trail

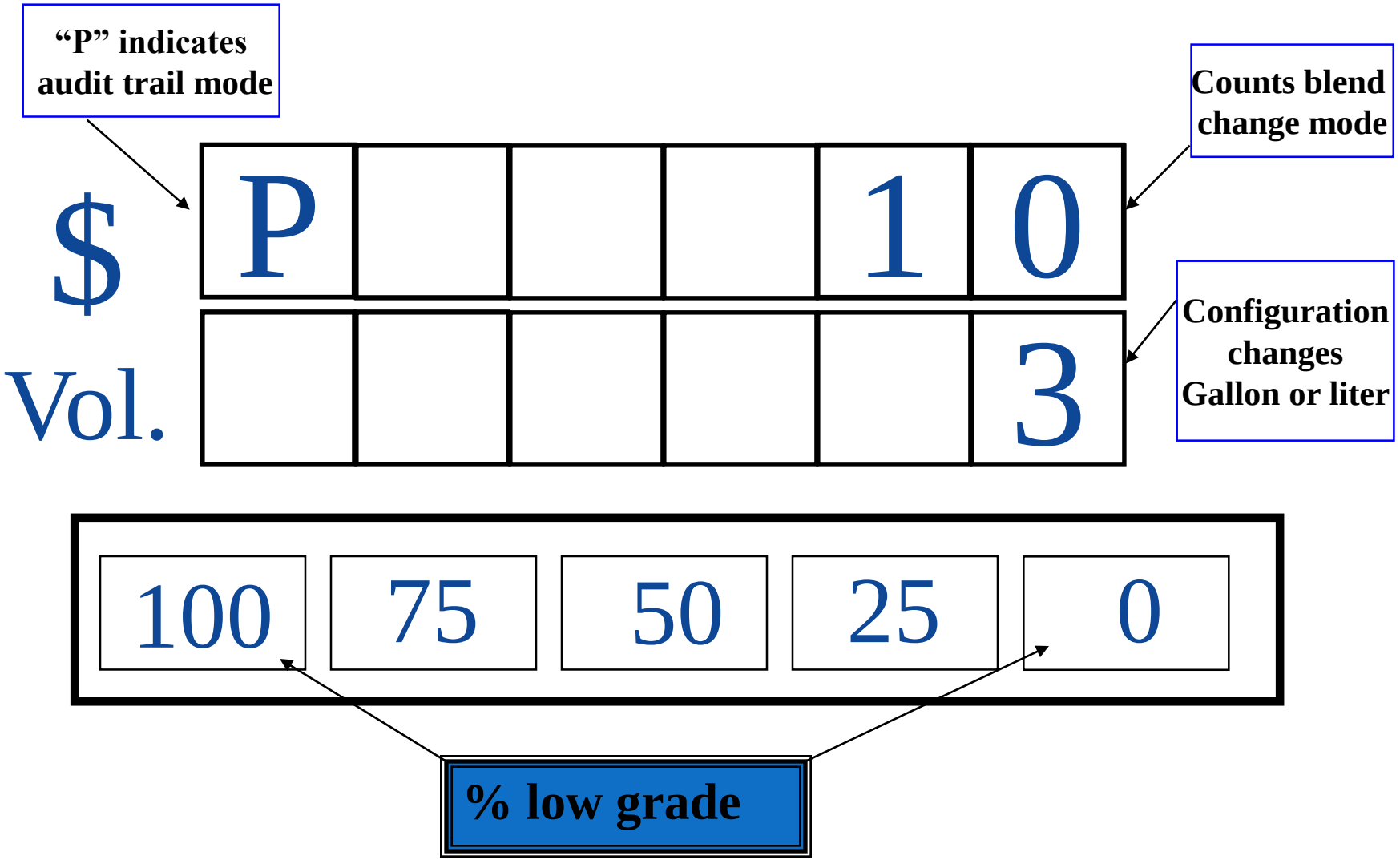
- Two event counters:
  - One for adjustment parameters
  - One for configuration parameters
- Capacity of 0 to 999 for each counter
- Counter increments once each time access mode is entered and an adjustment is made





Example – Viewing Scale Event Counter

RMFD Example–
Encore/Eclipse Audit Trail Display



Example Courtesy of Gilbarco Veeder-Root

Event Logger

- Required on systems with remote configuration with unrestricted access

- Requires:
  - Event Counter
  - Time
  - Date
  - ID of parameter changed
  - New value for parameter

Event Log – Example

Event Counter	Date	Time	Parameter Identification	New Values	Explanatory Comments
323	3/12/02	09:00	span	46.838	Span adjustment.
322	3/12/02	08:59	AZSM	1	Zero tracking range set to 1 division.
321	12/22/01	13:31	samples avg	16	Samples per update set to 16.
320	12/22/01	13:33	span	42.838	Span adjustment.
319	12/22/01	13:32	AZSM	3	Change in the zero tracking range.
318	8/17/01	14:14	AZSM	1	Zero tracking set to 1 division.
317	8/17/01	14:08	span	46.838	Span adjustment.
316	8/17/01	14:03	samples avg	4	Samples per update set to 4.
315	8/17/01	13:55	zero	520	Coarse zero (dead load) is 520 lb.
314	8/17/01	13:33	AZSM	0	Zero tracking turned off.
313	3/6/01	10:25	span	46.231	Span adjustment.

Event Logger (continued)

- Hard copy printout must be available on-site upon demand from the system
  - Electronic copy may be provided *in addition*
- Needs to retain 10 entries per sealable parameter
- Not required to retain more than 1000 events in the logger for all parameters combined

Centralized Event Logger

- Changes through the device sent to and retained in centralized event logger
- It shall not be possible to circumvent the event logger
  - Changes to sealable parameters made through the device (rather than the central device) shall also be recorded in the centralized logger

Centralized Event Logger (continued)

- Devices which have stand-alone operation must have the minimum form of audit trail for the stand-alone operation
- Hard copy of event logger contents must be available on demand from on-site device
- Large numbers of devices on a network may require a logger with capacity for more than 1000 events
  - Example: service station console with a centralized logger for all dispensers at the station

Access to Audit Trail Information General

- Described in the NTEP Certificate of Conformance

- Viewing or printing contents:
  - must be “convenient”
  - must be separate from calibration or set-up mode
  - must not affect normal operation before or after access
  - may be through a supervisor’s mode
  - may require a key to access

Access to Audit Trail Information General

- Displayed or printed information shall be readily interpretable by the inspector
- Order of displayed or printed information is most recent to oldest event

General Requirements for Audit Trails

- Adjustment mode accesses only sealable parameters

- An event counter shall be able to count at least 1000 values (e.g., 000 to 999)
  - Increments only *once* while in the configuration mode regardless of the number of changes while in that mode
  - Counter increments *only* when parameter is changed

General Requirements for Audit Trails (continued)

- Audit trail data shall be:
  - Stored in non-volatile memory
  - Retained for at least 30 days if power is removed
  - Protected from unauthorized erasure, substitution, or modification
- When the event logger storage capacity is full, any new events shall cause oldest event to be deleted

Physical Seal Compared to Audit Trail

- Physical seal:
  - Broken seal indicates access to the sealed features or adjustments
  - Viewed as a deterrent

Physical Seal Compared to Audit Trail (continued)

- Audit Trail:
  - Indicates if changes were made to adjustments or to configuration parameters
  - Indicates number of times the changes were made
  - Record of changes serves as a deterrent
  - Retains the last values of electronic adjustments or octane blend settings on event logger

EXAMPLE - Event Log – Pump 1, Meter 1

Event Counter	Date	Time	Parameter	
1	7/3/08, Thurs	5:10 p.m.	Meter	
2	7/7/08, Mon	5:00 a.m.	Meter C	
3	8/8/08, Fri	5:15 p.m.	Meter Cal	
4	8/11/08, M		Calibrati	
5	8/			
6				9 Pulses/gal
7				Pulses/gal
8				ulses/gal
9				
10				ons
11				992 Pulses/gal
12	11/		tion	1044 Pulses/gal
13	12/12/08		Meter Calibration	989 Pulses/gal
14	12/15/08, on	5:30 a.m.	Meter Calibration	1041 Pulses/gal
15	12/24/08, Wed	5:15 p.m.	Meter Calibration	994 Pulses/gal
16	12/29/08, Mon	5:35 a.m.	Meter Calibration	1040 Pulses/gal
17	12/31/08, Wed	5:05 p.m.	Meter Calibration	999 Pulses/gal
18	1/5/09, Mon	6:00 a.m.	Meter Calibration	1043 Pulses/gal
19	1/9/09, Fri	5:44 p.m.	Meter Calibration	993 Pulses/gal
20	1/12/09, Mon	5:53 a.m.	Meter Calibration	1040 Pulses/gal

Meter Calibration	994 Pulses/gal
Meter Calibration	1040 Pulses/gal

12/24/08, Wed	5:15 p.m.
12/29/08, Mon	5:35 a.m.

y

nd

weekend

Labor Day

Thanksgiving

weekend

Christmas

New Years

weekend

Benefits of Audit Trails

- Provides industry with an alternative to physical security seals
- Provides more information than physical security seals
  - Record audit trail information on inspection report
- Device owner can use to detect employee tampering

Benefits of Audit Trails (continued)

- Evidence to weights and measures of the number, frequency, and types of changes
- Alerts inspector when investigation is necessary
- Deterrent to fraudulent manipulation of parameters

Other Resources on Audit Trails

- NIST Special Publication 1010, June 2004
  - Developed by Juana Williams, NIST WMD
  - Interactive, self-study CD ROM
  - Audit Trail Criteria
  - Interactive example
  - CD ROM and study guide

- For information about CD ROM, contact:
  - Juana Williams, NIST WMD
    - Tel: 301-975-3989
    - E-mail: juana.williams@nist.gov

Audit Trails – Review

- Describe the 3 categories of sealing for liquid measuring devices;
- Determine the sealing requirements that apply to each of the 3 categories of liquid measuring devices; and
- List the two types of metrological parameters that must be sealed.

Questions??

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