



W E L C O M E

RITA Intelligent Transportation Systems
Joint Program Office

Welcome



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The screenshot shows the RITA website header with the logo and navigation menu. The main content area is titled "ITS Professional Capacity Building Program" and includes sections for "Welcome to ITS Professional Capacity Building", "ITS Technical Assistance", "News", and "Scheduled T3 Webinars".

ITS Professional Capacity Building Program

Updated June 3, 2011

Welcome to ITS Professional Capacity Building

The ITS Professional Capacity Building (PCB) Program provides comprehensive, accessible, and flexible ITS learning for the transportation industry. By using the program, public agencies can build and sustain a capable and technically proficient ITS workforce, and transportation professionals can develop their knowledge, skills, and abilities while furthering their career paths.

The plan, [ITS Professional Capacity Building: Setting Strategic Direction 2010-2014](#), describes the strategy the ITS PCB Program is pursuing to create a 21st century learning environment and build an ITS profession that leads the world in the innovative use of ITS technologies.

ITS Technical Assistance

The ITS PCB Program offers technical assistance resources to State and local transportation agencies, and to FHWA Field Offices.

- [ITS Peer-to-Peer Program](#) helps resolve ITS challenges by speaking to your peers.
- The ITS Help Line provides [technical support by e-mail](#) or telephone 866-367-7487.

Scheduled T3 Webinars

Register now for these upcoming T3 webinars:

Date	Time	Topic
June 23, 2011	1:00 PM – 2:30 PM ET	2011 Enhancements to the ITS Knowledge Resources Websites: Improving Access to Information on ITS Benefits, Costs, Lessons Learned and Deployment
June 29, 2011	1:00 PM – 2:30 PM ET	Open Payments, Mobile Payments and Personal Identification Verification (PIV) Acceptance – Overview of Innovations in Public Transit Payment Systems

[View T3 webinar archives](#)

News

- Act Now! [Fee Waived for June CITE Blended Course](#)
- NTI Offering: [Implementing Rural Transit Technology](#)
- T3 Webinar playback and archives now available for 1/18/2011 webinar: ["The Emergence of Open Electronic Payment Systems in Public Transit"](#)
- New NTI Course: [Implementing Contactless Fare Collection Systems](#)
- T3 Webinar Archive Now Available: [Open Source Alternative to Deploying Transportation Management Systems](#)
- T3 Webinar Archive Now Available: [TSAG Case Studies Workshop and Webinar - NG9-1-1 What's Next Forum & Webinar](#)
- Two new CITE offerings: [Road Weather Information Systems \(RWIS\) Equipment and Operations](#) and [Configuration Management for Traffic Management Systems](#)
- Added to the T3 Archives: [8/3/10 Webinar: TSAG Case Studies Workshop and Webinar — 2009 Fort Hood, Texas Army Base Shooting Incident: A Multi-Agency](#)

WWW.PCB.ITS.DOT.GOV/STANDARDSTRAINING



T313

Applying Your Test Plan to the NTCIP 1204 v03 ESS Standard



Target Audience

- Engineering staff
- Operations and maintenance staff
- Traffic management staff
- Testing staff (testing personnel and systems integrators, with specialized capabilities)
- Public and private sector staff



Instructor



Russ Brookshire
Product Manager
Intelligent Devices
Suwanee, GA, USA



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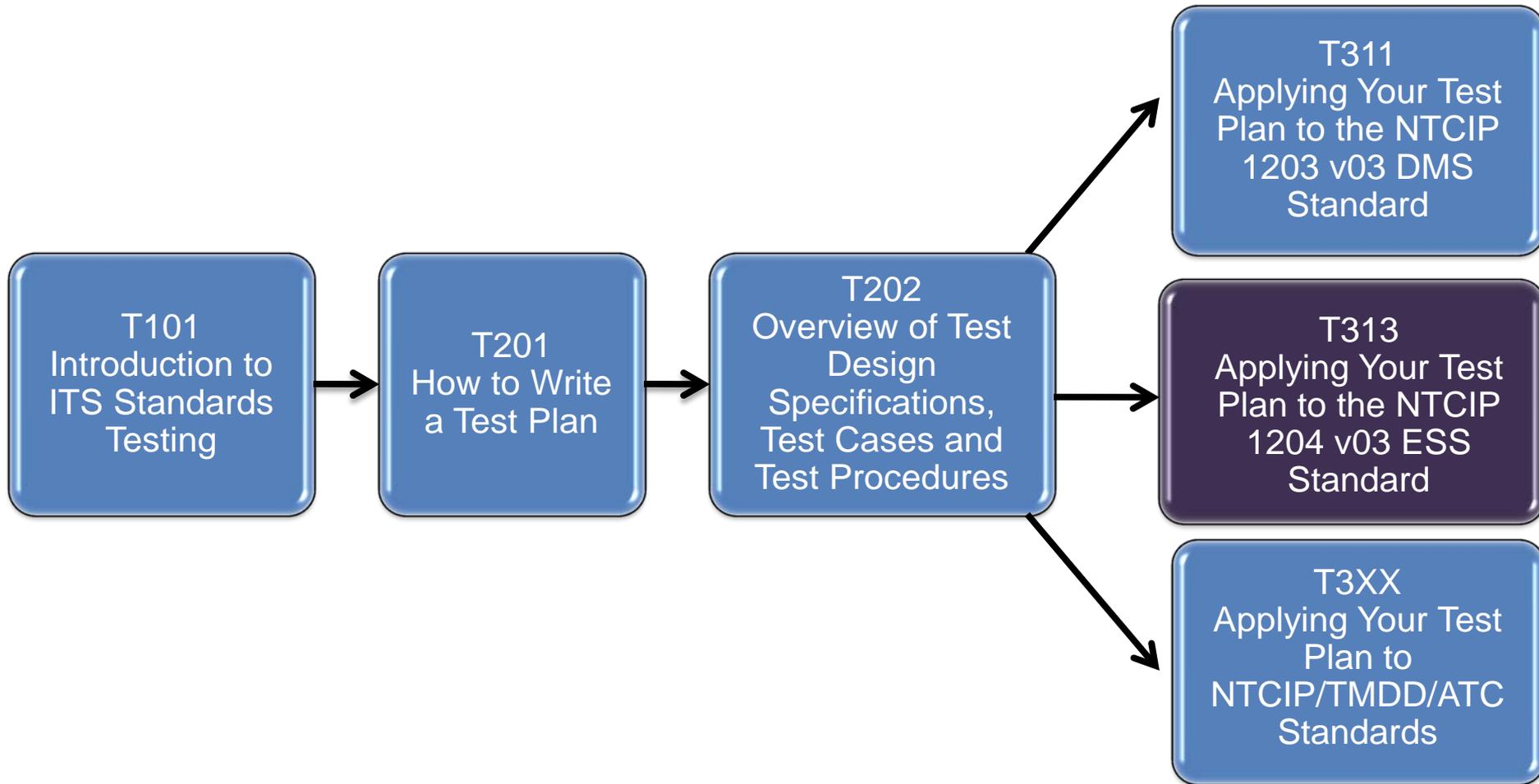


Recommended Prerequisites

- T101: Introduction to ITS Standards Testing
- T201: How to Write a Test Plan
- T202: Overview of Test Design Specifications, Test Cases, and Test Procedures
- A313a: Understanding User Needs for ESS Systems Based on NTCIP 1204 v03 Standard
- A313b: Specifying Requirements for ESS Systems Based on NTCIP 1204 v03 Standard



Curriculum Path (Testing)

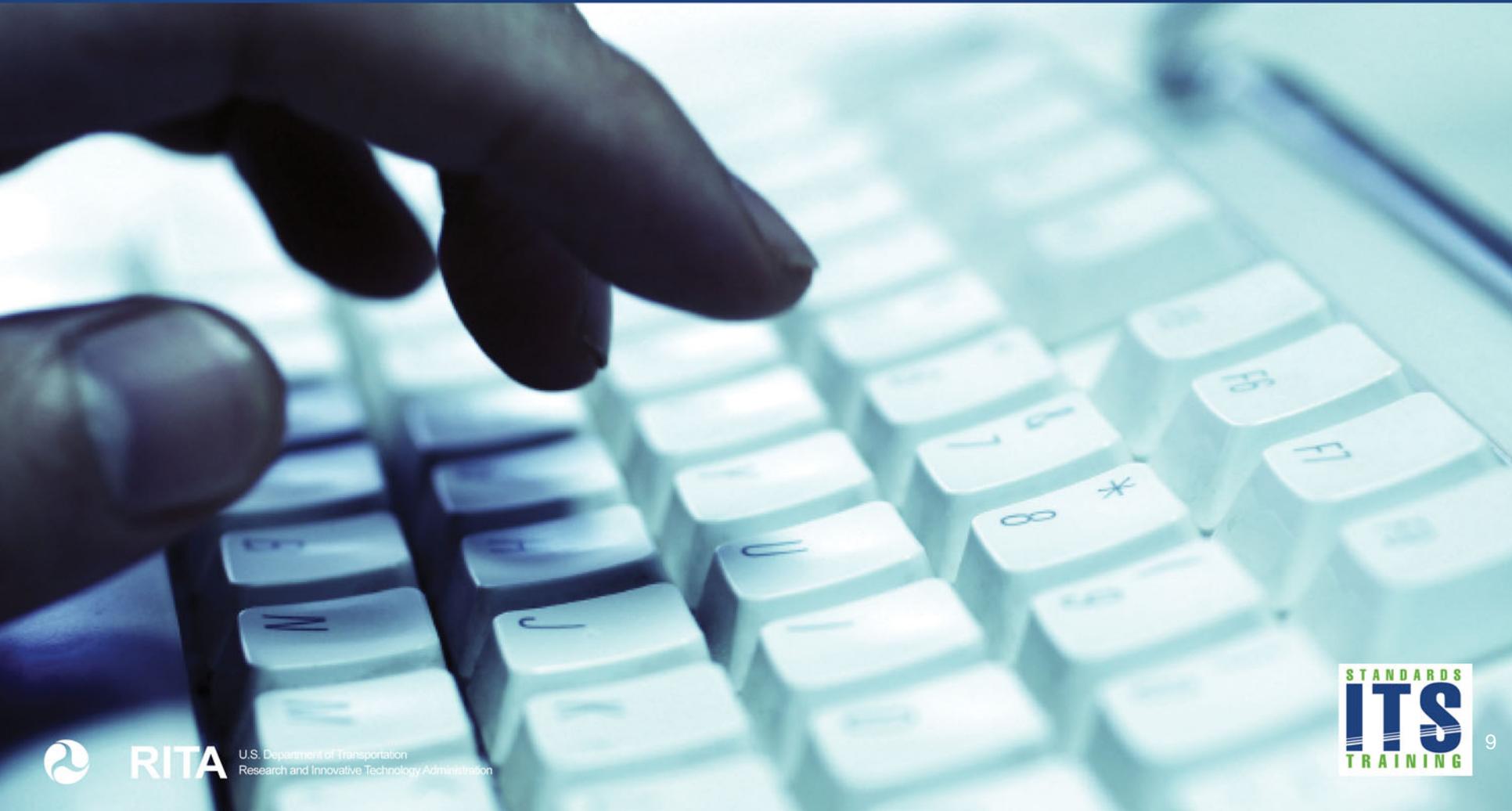


Learning Objectives

1. Describe, within the context of the testing lifecycle, the role of test plans and the testing to be undertaken.
2. Identify key elements of NTCIP 1204 relevant to the test plan.
3. Describe the application of a good test plan to an ESS system being procured.
4. Describe a process of adapting a test plan based on the selected user needs and requirements



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Environmental Sensor Station

Why Would an Agency Need to Remotely Monitor Environmental Conditions?

- To extend monitoring to locations that are not covered by weather bureaus
- To inform motorists of hazardous driving conditions
- To determine when to close a mountain pass, bridge, or overpass due to winter conditions
- To determine when to deploy snowplows or salt and sand trucks

Enter response in the chat pod



Environmental Sensor Station

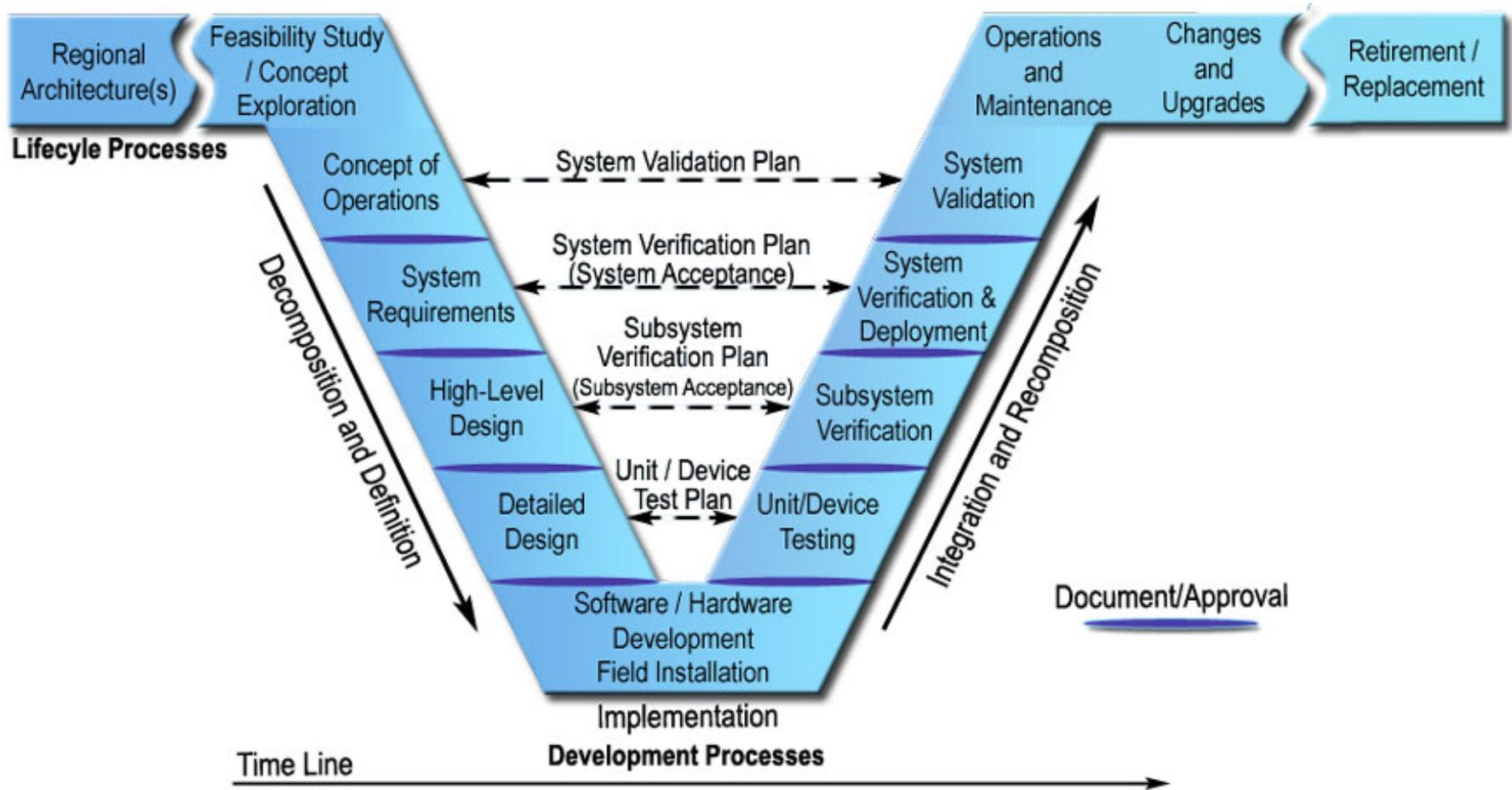
May remotely monitor:

- Wind speed and direction
- Temperature, humidity, and pressure
- Precipitation type and rate
- Snow accumulation
- Visibility
- Pavement conditions and treatment
- Radiation
- Water level
- Snapshot camera
- Air quality

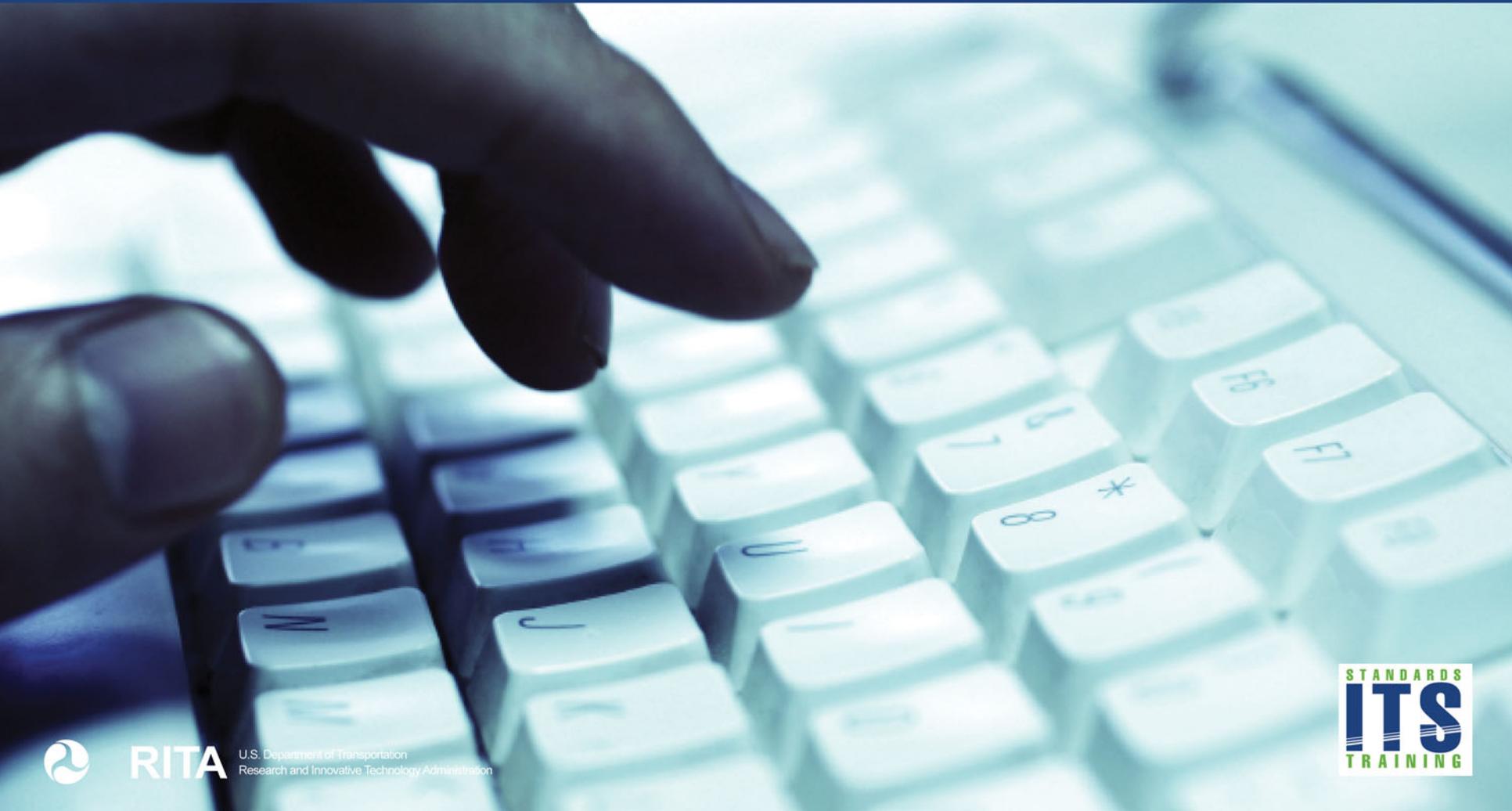


Courtesy: Intelligent Devices, Inc.

The Project Lifecycle



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Testing and Standardization

Why Perform Formal Testing?

- To validate the system against the user needs
- To verify compliance with the procurement specifications
- To verify conformance to the standard

Enter response in the chat pod



Review of Test Plans

A Test Plan is a Management-Level Document That Defines:

1. What item is to be tested and when
2. How it is to be tested
3. Who is to test it
4. In what detail the item is to be tested

**Test Plan (TP)
for
NTCIP 1204 v03
ESS Standard**

Review of Test Plans (cont.)

What Item is to be Tested, and When is it to be Tested?

- **Unit / Device Test** – covers an item and its interfaces
- **Subsystem Verification** – tests the item, its communications, and other items that communicate with the test item
- **System Verification** – ensures that the entire system meets the system requirements
- **System Validation** – used to show that the system as implemented meets the original user needs

Review of Test Plans (cont.)

How is the Item to be Tested?

- NTCIP conformance testing typically takes the form of interface testing, using NTCIP test software.
- Recognize that some testing may require specialized equipment to simulate environmental conditions.



Review of Test Plans (cont.)

Who is to Perform the Testing?

- Agency personnel, out-of-house expert, manufacturer's representative? Each have pros and cons...
- Agency personnel: familiar with user needs; may not be familiar with technical details of the devices.
- Out-of-house expert: technically qualified; may be expensive or unavailable.
- Manufacturer's representative: familiar with the device; may not be familiar with user needs.



Review of Test Plans (cont.)

In What Detail is the Item to be Tested?

- **Communications** – does the unit being tested conform to the communications standard?
- **Functionality** – does the unit exhibit the functionality defined in the specifications?
- **Performance**: speed, reliability, capacity.
- **Hardware**: materials, strength, vibration.
- **Environmental**: temperature, humidity, water intrusion, ice buildup, corrosive environment.



Test Plan-Related Documents



Test Design Specifications (TDS)

A document specifying the details of the test approach for a feature or combination of features and identifying the associated tests.



Test Case Specifications (TCS)

A document specifying inputs, predicted results, and a set of execution conditions for a test item.



Test Procedure Specifications (TPS)

A document specifying a sequence of actions for the execution of a test.

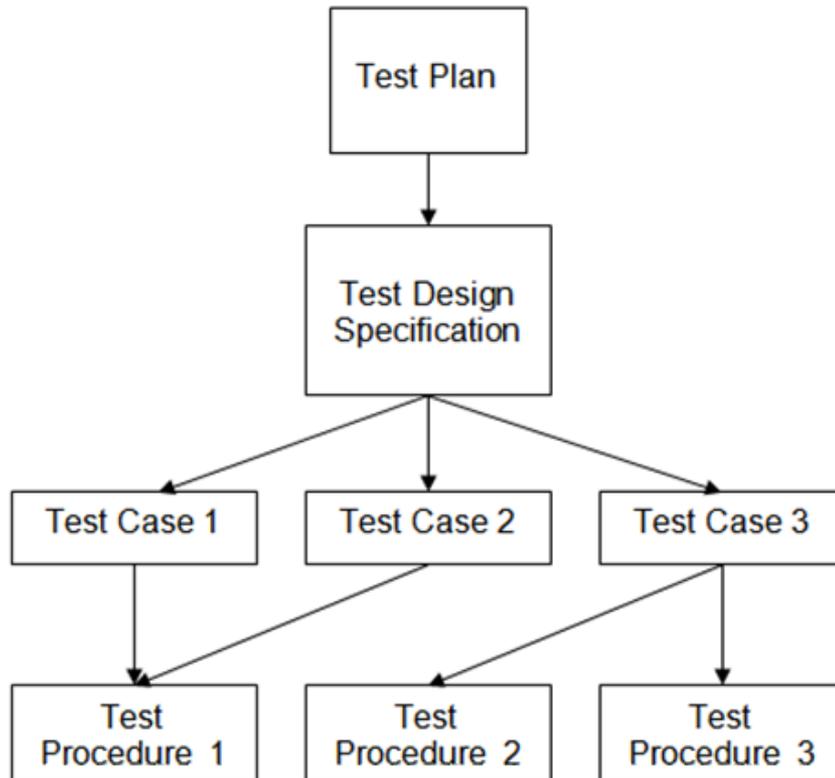
NTCIP 1204 and Test Documents

Which Documents are Included in the ESS Standard?

- **Test Plan:** Not included
- **Test Design Specifications:** Not included
- **Test Cases:** Included in ESS standard combined with Test Procedures
- **Test Procedures:** Included in ESS standard combined with Test Cases



Test Plan Layout



- Each Test Plan (TP) has a Test Design Specification
- Each Test Design Specification (TDS) may reference multiple Test Case Specifications
- Each Test Case Specification (TCS) may reference multiple Test Procedure Specifications (TPS)

NTCIP Family of Standards

- NTCIP is a family of communications protocol standards
- ESS utilize two data dictionaries:
 - NTCIP 1201, Global Objects, for defining time and reports.
 - NTCIP 1204, *Environmental Sensor Station Interface Protocol*, defines the parameters (objects) supported by the ESS
- Other NTCIP standards define how the device communicates with the central:
 - Dial-up
 - Serial
 - Ethernet



NTCIP 1204 - ESS

■ DIALOGS

- NTCIP defines how the Central interacts with the field devices by means of dialogs
- Defining dialogs and objects ensures interoperability of elements of final system

■ OBJECTS

- NTCIP uses SNMP – Simple Network Management Protocol
- NTCIP 1204 defines the objects (parameters) that ESS supports
- Objects store values
- Central can retrieve (GET) or store (SET) values
- *windSensorLocation.1* is a read-write object
- *windSensorSpotSpeed.1* is a read-only object

NTCIP 1204 ESS Published Versions

- **Previous versions:**
 - NTCIP 1204: 1998 v01.13 – without SEP
 - User needs, requirements, and dialogs were *not included*.
 - Conformance is defined by *Conformance Groups*.
 - NTCIP 1204 v02 – with SEP
 - User needs, requirements, and dialogs are included.
 - Conformance is defined by the Protocol Requirements List (PRL).
 - Additional objects were added to supersede version 1 objects.
- **Current NTCIP 1204 v03-with SEP:**
 - User needs, requirements, and dialogs are included.
 - ESS Test Procedures are included.
 - Conformance is defined through standardized test procedures.

Why Use NTCIP 1204 v03?

- Test procedures are published:
 - They facilitate testing to ensure conformance to the standard.
 - Device manufacturers, system integrators, and users can independently verify conformance to the standard.
 - Reducing the possibility of incompatibility in the final built system.
- We recommend use of NTCIP 1204 v03 with test procedures



Elements of NTCIP 1204 Useful for Testing

- Protocol Requirements List (PRL) – maps user needs to requirements and specifies which requirements are mandatory or optional, allowing agency to select optional requirements
- Requirements Traceability Matrix (RTM) – associates each requirement with its dialog and the associated objects
- Dialogs – define standardized interaction between management station (Central) and field device.
- Requirements to Test Cases Traceability Matrix (RTCTM)
- Test cases / test procedures



Example NTCIP 1204 Dialog

- Most NTCIP 1204 requirements use GET.
- For a requirement, its dialog defines what objects and in what order the actions are to be performed.

4.2.14 Retrieve Pavement Surface Condition

The standardized dialog for a management station to retrieve precipitation presence shall be as follows:

- a) (Precondition) The management station shall be aware of which row of the table is to be retrieved.
- b) The management station shall GET the following objects for the pavement sensor of interest:
 - 1) `essSurfaceStatus.x`
 - 2) `essSurfaceTemperature.x`
 - 3) `essPavementSensorError.x`
- c) The management station shall GET `pavementSensorModelInformation.x`.

NOTE—This is an NTCIP 1204 v02 object that may result in a `noSuchName`. This level of detail was not provided in NTCIP 1204 v01.

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NTCIP 1204

Which of the following are included in NTCIP 1204 version 2?

- A. Protocol Requirements List
- B. Requirements to Test Cases Traceability Matrix
- C. Test cases
- D. Test procedures
- E. All of the above



CASE STUDY



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Example of ESS Installation

ESS location includes:

- Wind speed and direction
- Traffic monitor (optional)
- Camera (optional)
- Temperature and relative humidity sensor



Photo: Intelligent Devices, Inc.

Test Documents for ESS using NTCIP 1204

For this example ESS installation, we will:

- Create a **test plan** to give overview of testing.
- Use Protocol Requirements List (**PRL**) of NTCIP 1204 to create **test design specification**.
- Use Requirements to Test Cases Traceability Matrix (**RTCTM**) to determine required **test cases/test procedures**.
- Define inputs and test conditions for individual **test cases/test procedures**.



Sample Test Plan for ESS

Refer to Page 7 of the Student Supplement

Sample Test Plan Includes:

- **Test Items** – an ESS
- **Features to be Tested** – all requirements selected in the Protocol Requirements List (PRL)
- **Features not to be Tested** – any requirement that is not selected in the PRL
- **Approach** – defines the traceability of the requirements to the Test Cases with the Requirements to Test Cases Traceability Matrix (RTCTM)



Sample Test Plan for ESS (cont.)

Refer to Pages 7–9 of the Student Supplement

- **Item Pass/Fail Criteria**
- **Suspension Criteria and Resumption Requirements**
- **Test Deliverables** – includes the format of the documents
- **Testing Tasks** – promotes coordination between parties
- **Environmental Needs** – defines the physical space, tools and communications environment needed



Sample Test Plan for ESS (cont.)

Refer to Pages 10-11 of the Student Supplement

- **Responsibilities** – defines WHO is responsible for tasks
- **Staffing and Training Needs** – defines the qualifications of the staff required
- **Schedule** – defines the timeline in general terms
- **Risks and Contingencies** – what happens if things go wrong
- **Approvals** – verify that everyone is on board



Test Design Specification (TDS)

- **Test Design Specification** – *A document specifying the details of the test approach for a feature or combination of features and identifying the associated tests.*
- The agency selects the options necessary to meet the functional requirements using the **PRL** in NTCIP 1204.
- Next, a determination is made on which test cases are required to verify conformance with the standard using the **RTCTM**.



TDS: ESS Features to be Tested

1. **Functional requirements** are selected by the agency using the PRL in the NTCIP 1204.
2. Functional requirements can be **mandatory** or **optional**.

Example: Functional requirement “*Retrieve ESS Characteristics*” is mandatory.

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
F.1.2	Generic Features			M	Yes	
F.1.2.1	Retrieve the Device Identity			M	Yes	
		3.5.1.1.1	Retrieve ESS Characteristics	M	Yes	
		3.5.1.1.3	Configure ESS Manager	M	Yes	
		3.5.2.1.1	Retrieve Atmospheric Pressure Height	Pressure:M	Yes NA	

TDS: Features to be Tested (cont.)

- “Retrieve Atmospheric Pressure Height” is mandatory, but is conditional on “Pressure” having been selected.

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5.2	Sensor Manager Features			O.1 (1..*)	Yes / No	
2.5.2.1 (Weather)	Monitor Weather Conditions			O.2 (1..*)	Yes / No / NA	
2.5.2.1.1 (Pressure)	Monitor Atmospheric Pressure			O.3 (1..*)	Yes / No / NA	
		3.5.2.3.2.1	Retrieve Atmospheric Pressure	M	Yes / NA	
		3.6.1	Required Number of Atmospheric Pressure Sensors	M	Yes / NA	The ESS shall support at least ____ atmospheric pressure sensors.

F.1.2	Generic Features			M	Yes	
F.1.2.1	Retrieve the Device Identity			M	Yes	
		3.5.1.1.1	Retrieve ESS Characteristics	M	Yes	
		3.5.1.1.3	Configure ESS Manager	M	Yes	
		3.5.2.1.1	Retrieve Atmospheric Pressure Height	Pressure:M	Yes / NA	

TDS: Features to be Tested (cont.)

- Conformance testing for sensors is optional, but (1..*) means at least one must be selected.
- For our example, one wind sensor has been selected, and atmospheric pressure is not required.

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5.2	Sensor Manager Features			O.1 (1..*)	Yes / No	
2.5.2.1 (Weather)	Monitor Weather Conditions			O.2 (1..*)	Yes / No / NA	
2.5.2.1.1 (Pressure)	Monitor Atmospheric Pressure			O.3 (1..*)	Yes No NA	
		3.5.2.3.2.1	Retrieve Atmospheric Pressure	M	Yes NA	
		3.6.1	Required Number of Atmospheric Pressure Sensors	M	Yes NA	The ESS shall support at least ____ atmospheric pressure sensors.
2.5.2.1.2 (Wind)	Monitor Winds			O.3 (1..*)	Yes / No / NA	
		3.5.2.3.2.2	Retrieve Wind Data	M	Yes / NA	
		3.6.2	Required Number of Wind Sensors	M	Yes / NA	The ESS shall support at least <u>1</u> wind sensors.

TDS: Determine Test Case Using RTCTM

- RTCTM links a requirement to one or more test cases that are required to be performed to verify conformance to the standard.

NTCIP 1204 v03 - Protocol Requirements List (PRL)

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5.2.1.2 (Wind)	Monitor Winds			O.3 (1..*)	Yes / No / NA	
		3.5.2.3.2.2	Retrieve Wind Data	M	Yes / NA	
		3.6.2	Required Number of Wind Sensors	M	Yes / NA	The ESS shall support at least <u>1</u> wind sensors.

NTCIP 1204 v03 - Requirements to Test Case Traceability Matrix (RTCTM)

Requirement		Test Case	
ID	Title	ID	Title
		C.2.3.3.2	Retrieve Atmospheric Pressure
3.5.2.3.2.2	Retrieve Wind Data	C.2.3.3.3	Retrieve Wind Data
3.5.2.3.2.3	Retrieve Temperature	C.2.3.3.4	Retrieve Temperature

Example Test Case: “Appropriate”

C.2.3.3.3 Retrieve Wind Data

Test Case: 3.3	Title:	Retrieve Wind Data	
	Description:	This test case verifies that the ESS allows a management station to determine current wind information.	
	Variables:	Required_Wind_Sensors	PRL 3.6.2
	Pass/Fail Criteria:	The device under test (DUT) shall pass every verification step included within the Test Case to pass the Test Case.	
Step	Test Procedure	Device	
5	FOR EACH value, N, from 1 to Supported_Wind_Sensors, perform Steps 5.1 through 5.22.		
5.1	GET the following object(s): »windSensorAvgSpeed.N »windSensorAvgDirection.N »windSensorSpotSpeed.N »windSensorSpotDirection.N »windSensorGustSpeed.N »windSensorGustDirection.N »windSensorSituation.N	Pass / Fail (Sec. 3.5.2.3.2.2)	
5.2	VERIFY that the RESPONSE VALUE for windSensorAvgSpeed.N is greater than or equal to 0.	Pass / Fail (Sec. 5.6.10.4)	
5.3	VERIFY that the RESPONSE VALUE for windSensorAvgSpeed.N is less than or equal to 65535.	Pass / Fail (Sec. 5.6.10.4)	
5.4	VERIFY that the RESPONSE VALUE for windSensorAvgSpeed.N is APPROPRIATE.	Pass / Fail (Sec. 5.6.10.4)	

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ESS Test Design - Approach

How is the Response Value Determined to be “Appropriate”?

5.4	VERIFY that the RESPONSE VALUE for windSensorAvgSpeed.N is APPROPRIATE.	Pass / Fail (Sec. 5.6.10.4)
-----	--	--------------------------------

- A. Estimate of wind by on-site personnel
- B. By monitoring or simulating the output of the sensor – e.g., a variable voltage to simulate the output
- C. By simulating an input into the sensor – e.g., a motor used to rotate the propeller of the wind sensor
- D. By controlling the environment - .e.g., a calibrated wind tunnel
- E. All of the above

Test Case Specification (TCS)

- **Test Case Specification** – *A document specifying inputs, predicted results, and a set of execution conditions for a test item.*
- Only a single instance of NTCIP 1204 v03 Test Case 3.3 is required to verify CONFORMANCE to the standard, whereas more instances may be required to verify COMPLIANCE with the project specifications.



Test Case Specifications (cont.)

IEEE 829 vs. NTCIP

- NTCIP 1204 v03 combines Test Cases and Test Procedures, but references them as Test Cases.

C.2.3.3.3 Retrieve Wind Data

Test Case: 3.3	Title:	Retrieve Wind Data	
	Description:	This test case verifies that the ESS allows a management station to determine current wind information.	
	Variables:	Required_Wind_Sensors	PRL 3.6.2
	Pass/Fail Criteria:	The device under test (DUT) shall pass every verification step included within the Test Case to pass the Test Case.	
Step	Test Procedure	Device	
5	FOR EACH value, N, from 1 to Supported_Wind_Sensors, perform Steps 5.1 through 5.22.		

Test Case Specifications (cont.)

- To test the system under different wind conditions, such as Calm and Hurricane, the NTCIP Test Case/Test Procedure can be run twice under different conditions.

Page 15 in the Supplement

NTCIP 1204 Test Case	Simulated Wind Speed	windSensorSpotSpeed.n	windSensorSituation.n
C.2.3.3.3	0 km/h	0	3 (calm)
C.2.3.3.3	> 118 km/h	> 118	11 (hurricaneForceWinds)

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Test Case Specifications

Which of the following are NOT defined in Test Case Specifications according to IEEE 829?

- A. Inputs
- B. Execution conditions
- C. Steps to execute – these are defined in test procedure
- D. Expected results specifications
- E. All of the above



Test Procedures Specifications (TPS)

- **Test Procedure Specification** – *A document specifying a sequence of actions for the execution of a test.*
- Standard test procedures ensure that the conformance testing is performed in the same manner on separate test occasions.
- It is important not to skip any steps in the test procedures to ensure proper conformance testing.



Test Procedures

- Per the IEEE 829 definition, the Test Procedure only defines the steps necessary to test the function.

Pages 16-17 in the Supplement

C.2.3.3.3 Retrieve Wind Data

Test Case: 3.3	Title:	<i>Retrieve Wind Data</i>	
	Description:	<i>This test case verifies that the ESS allows a management station to determine current wind information.</i>	
	Variables:	<i>Required_Wind_Sensors</i>	<i>PRL 3.6.2</i>
	Pass/Fail Criteria:	<i>The device under test (DUT) shall pass every verification step included within the Test Case to pass the Test Case.</i>	
Step	Test Procedure	Device	
1	CONFIGURE: Determine the number of wind sensors required by the specification (PRL 3.6.2). RECORD this information as: »Required_Wind_Sensors		
2	GET the following object(s): »windSensorTableNumSensors.0	Pass / Fail (Sec. 3.5.2.3.2.2)	

Additional Test Documents

- In addition to the test plan, test design specifications, test case specifications, and test procedure specifications, the following are also used:
 - A **test item transmittal** is used to document transferring a test item between entities and includes its status.
 - **Test logs** document the testing that occurred.
 - **Test incident reports** provide a means of recording anomalies that occurred during the testing.
 - The **Test Summary** is typically a short report providing the results of the testing.



What Have We Learned Today?

We Now Know How to Apply a Test Plan to the ESS Standard

- The **Test Plan** defines the testing to be performed from a *management-level perspective*
- ESS test plans cover the What, How, Who, When and To What Detail of the testing



What Have We Learned Today? (cont.)

Describe :

- **Test design specifications** detail the testing to be performed.
- **Test case specifications** define the inputs, outputs and test conditions that apply to testing an ESS feature.
- **Test procedure specifications** define the steps to be performed to test an ESS feature.

What Have We Learned Today? (cont.)

Identify and Use Key Elements of the NTCIP 1204 v03 Standard to Standardize Testing:

- **Protocol Requirements List (PRL)** shows the requirements selected for a project.
- **Requirements to Test Cases Traceability Matrix (RTCTM)** defines the test case(s) necessary to verify conformance to the selected requirements.
- Linking PRL to RTCTM.

Where to Find More Information

- **Systems Engineering Guidebook for Intelligent Transportation Systems Version 3.0** (The “V” Systems Engineering Model) (<http://ops.fhwa.dot.gov/publications/seitsguide/seguide.pdf>)
- **IEEE Std 829-1998** - IEEE Standard for Software Test Documentation
- **NTCIP 1204 Version v03.08**, National Transportation Communications for ITS Protocol, Object Definitions for Environmental Sensor Stations (ESS) (www.ntcip.org)
- **NTCIP 1201 Version v03.13a**, National Transportation Communications for ITS Protocol, Global Object Definitions (www.ntcip.org)
- **NTCIP 8007 Version 1.21**, National Transportation Communications for ITS Protocol, Testing and CA Documentation within NTCIP Standards (www.ntcip.org)
- **NTCIP 9001 Version v04**, National Transportation Communications for ITS Protocol, The NTCIP Guide (www.ntcip.org)



QUESTIONS?



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