

# T309: Applying Your Test Plan to Ramp Meter Control (RMC) Units Based on NTCIP 1207 Standard v02

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## Module Description

This module assists user agencies in their efforts to create test plans specific to their ramp meter control (RMC) needs based on the NTCIP 1207 Standard v02. Prior to developing such a test plan, the user is expected to be knowledgeable about the NTCIP 1207 Standard v02 and testing methodologies. The agency is also expected to have developed its own user needs and requirements related to the NTCIP 1207 Standard (discussed in modules A309A and A309B).

This module is based on the IEEE 829 formats for test documentation and reviews sample test documentation that should result from performing the tests identified, including test logs, test summary, and test incident reports. It also guides agencies in verifying that delivered products comply with the agency's NTCIP specifications.

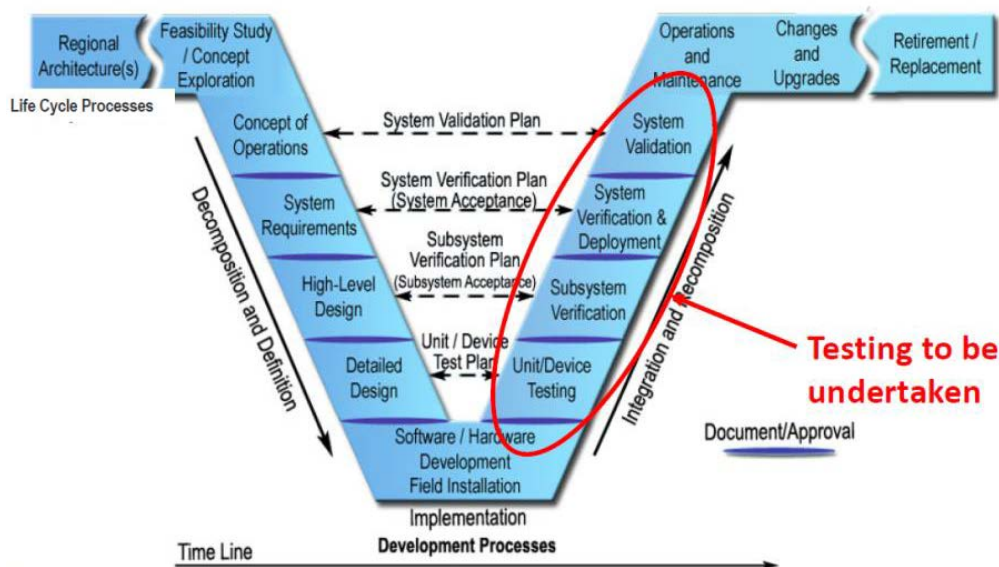
This module includes example test cases and test procedures for specific requirements that reflect the four different methods of testing (inspection, analysis, demonstration, and formal test). It discusses how the tests may be selected during various testing phases, such as prototype, factory acceptance, and site acceptance tests. This module also covers the role of verification—ensuring the product was built right—as part of the testing life cycle, and presumes well-developed requirements traceable to user needs as discussed in modules A309a and A309b. The module covers the last step in the test cycle to insure that the product will be contractually accepted by the agency as built.

## 1. Introduction/Purpose

- Final contract acceptance for Procurement
- Clear, unambiguous quality gate for Designers and Manufacturers
- Ongoing incoming inspection test during deployment for Installers
- Ongoing diagnostic test for deployed equipment for Maintenance

## 2. Samples/Examples

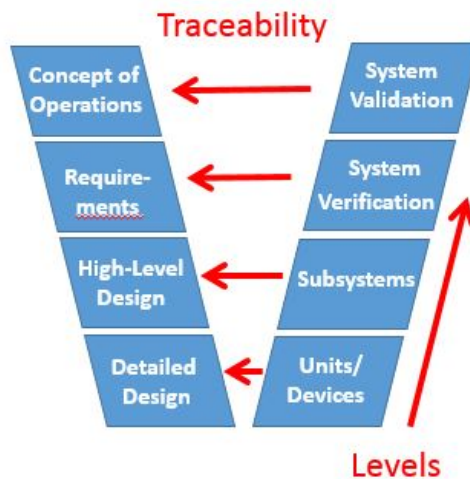
Within the systems life cycle, Module T309 covers the elements of the Vee model shown:



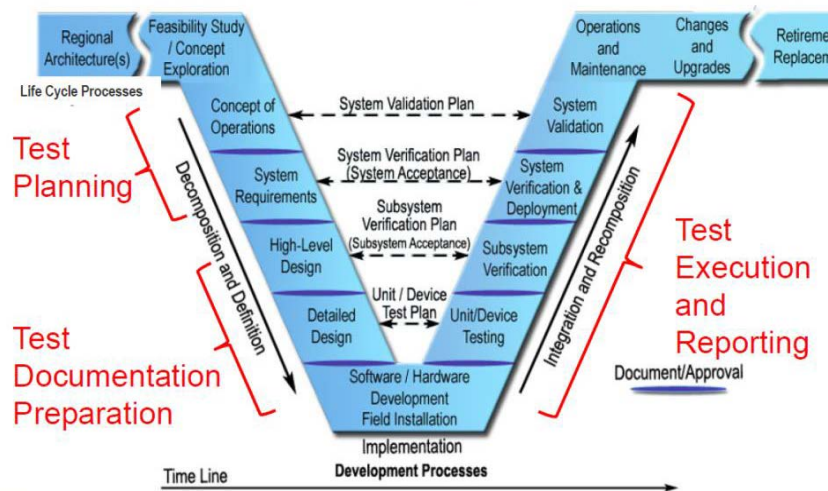
RMC units are tested at each level, using level tests as defined in the IEEE 829 Standard:



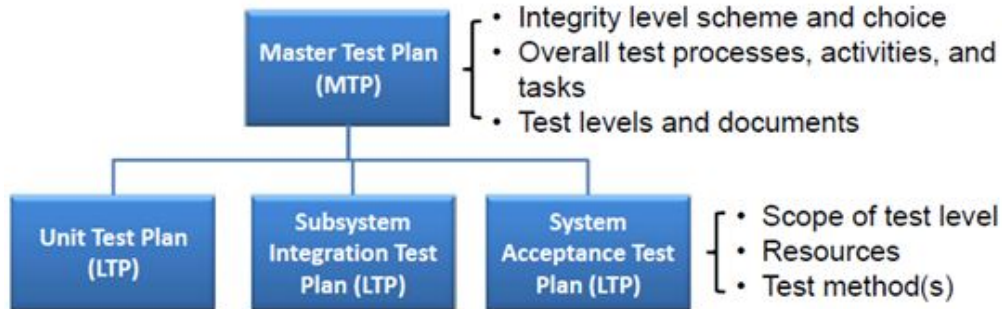
Each level test of the RMC unit is traceable back to the left of the Vee model as shown:



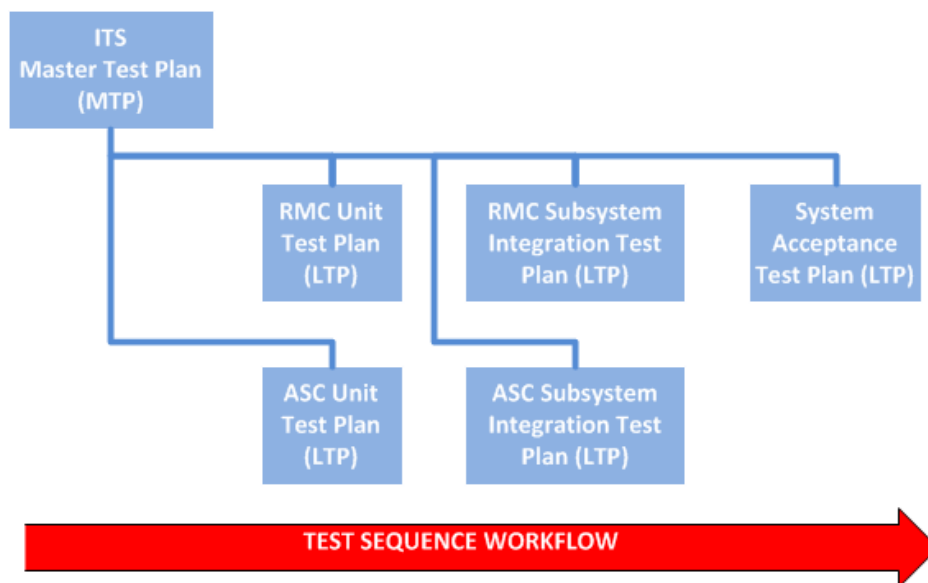
Test workflow is conducted in three steps as Planning, Documentation, and Execution with Reports:



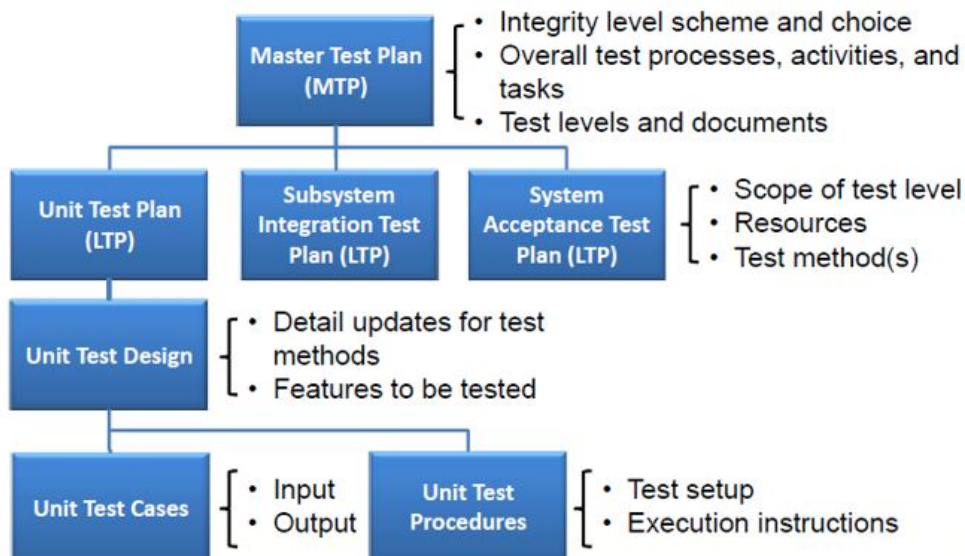
The IEEE 829 Standard describes level test plans and the master test plan. The master test plan is not required:



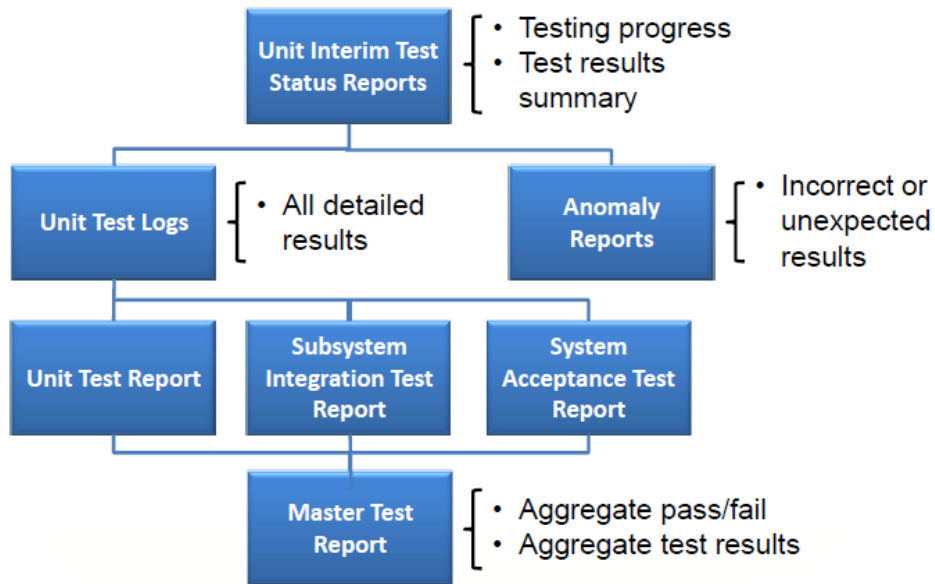
Test sequence work flows from master test plan if used, then unit, subsystem, and acceptance tests:



The IEEE 829 Standard describes test documentation as shown:



Additional test documentation described by IEEE 829 Standard:

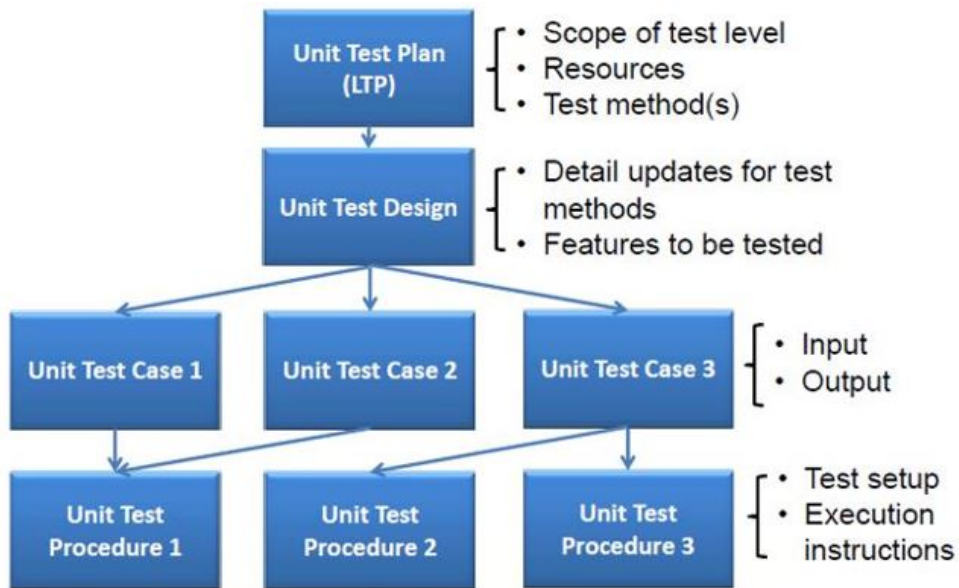


Example of a ramp meter Requirements Test Case Traceability Matrix:

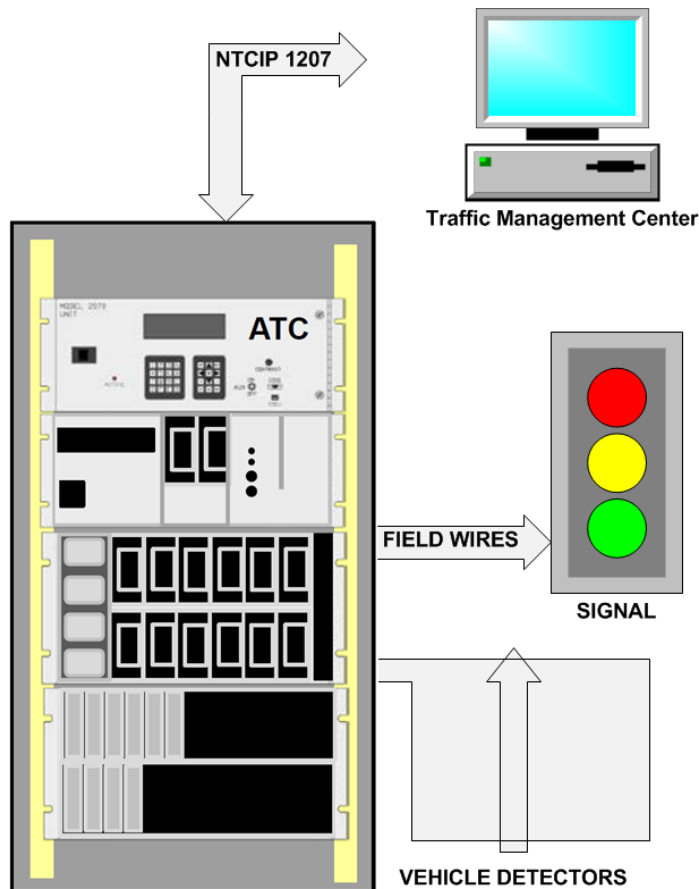
Requirement		Test Case	
ID	Title	ID	Title
1.	Metered Lane Main Configuration		
1.1	Maximum Number of Metered Lanes		
		TC1.1	Test the Boundaries
1.2	Number of Metered Lanes		
		TC1.2	Test the Combinations
1.3	Metered Lane Configuration Table		
		TC2.1	Test the Min Meter Time
		TC2.2	Test the Min Red
		TC2.3	Test the Min Green



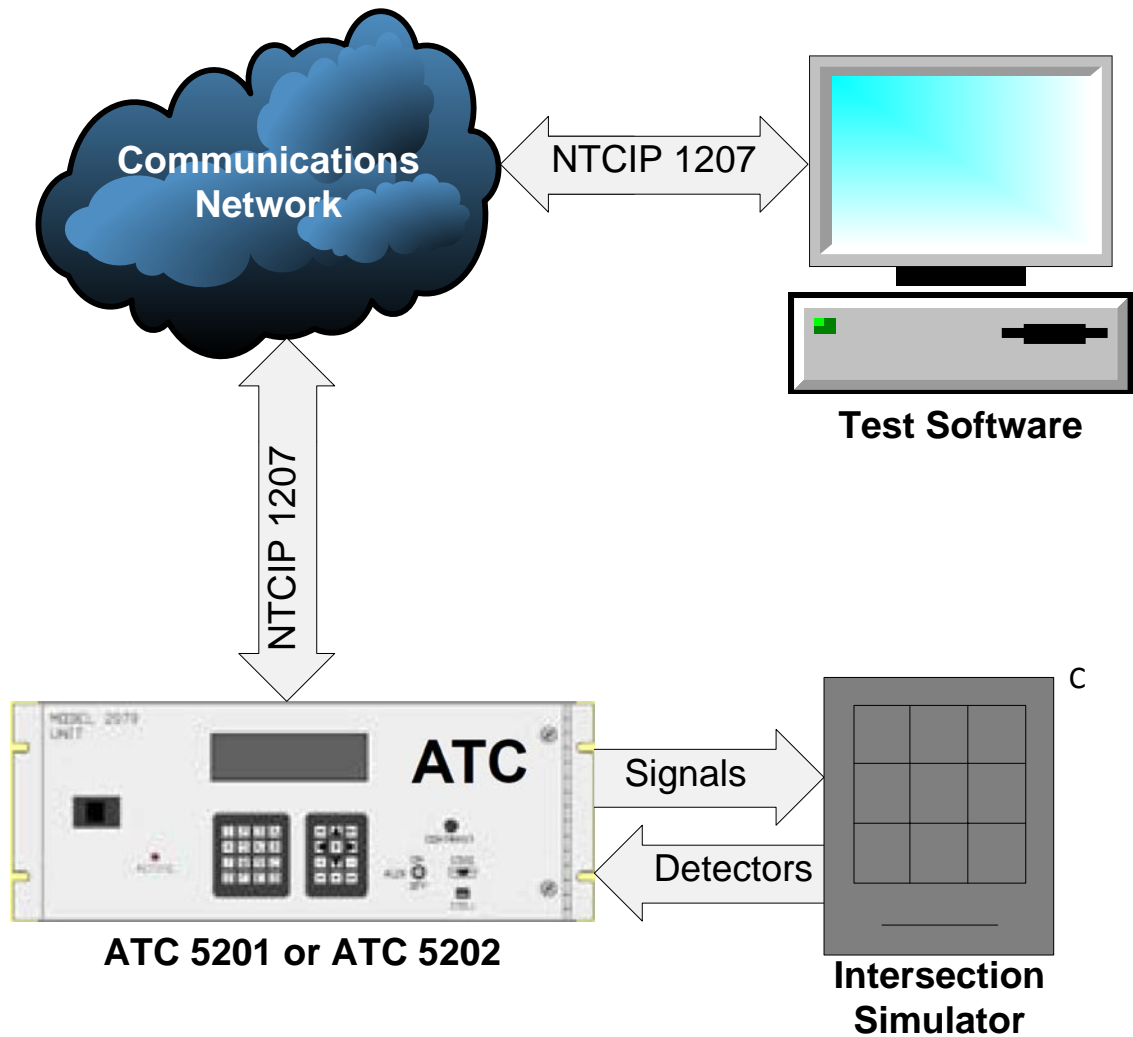
Ramp Meter Test Documentation includes one or more Test Cases per Test Procedure:



Key elements of a ramp meter installed at the roadside:



Ramp meter unit level test environment:



Examples of ramp meter controller conformance groups, which are sets of managed objects:

Ref	Conformance Group	Clause of Profile	Status	Support
B.5	Metered Lane Conformance Group	NTCIP 1207 3.3	M	Yes
B.12	Configuration Conformance Group	NTCIP 1207 2.2	M	Yes
B.10	Physical I/O Conformance Group	NTCIP 1207 3.7	O	Yes / No
	- Metered Lane Output	NTCIP 1207 3.7	O	Yes / No
	- Dependency Group Output	NTCIP 1207 3.7	O	Yes / No





Example of ramp meter controller requirements traceability matrix:

Requirement		Test Case	
ID	Title	ID	Title
1.	Metered Lane Main Configuration		
1.1	Maximum Number of Metered Lanes		
		TC1.1	Test the Boundaries
1.2	Number of Metered Lanes		
		TC1.2	Test the Combinations
1.3	Metered Lane Configuration Table		
		TC2.1	Test the Min Meter Time
		TC2.2	Test the Min Red
		TC2.3	Test the Min Green

Example of ramp meter controller requirements test case traceability matrix:

Requirement		Test Case	
ID	Title	ID	Title
1.	Metered Lane Configuration		
1.1	Set maximum # of metered lanes	TC1.1	Test the Boundaries
1.2	Set number of metered lanes	TC1.2	Test the Combinations

Example of ramp meter controller test case:

Test Case:	Title:	Test the Boundaries	
TC1.1	Description	This test case verifies the maximum number of metered lanes that can be SET by the central station. The test is conducted just below, just above, and exactly at the boundary	
	Variables	Max Lanes	From project requirements
		Max Lanes - 1	From the test plan
		Max Lanes +1	From the test plan
Pass/Fail Criteria	1. The DUT shall accept data at Max Lanes 2. The DUT shall accept data at Max Lanes -1 3. The DUT shall return an error at Max Lanes +1		





Example of ramp meter controller test procedure:

Step	Test Procedure	Results
1	Configure: SET the Max Lanes = 2, record the DUT response	
2	SET the number of Metered Lanes = 1, record the DUT response	
3	SET the number of Metered Lanes = 2, record the DUT response	
4	SET the number of Metered Lanes = 3, record the DUT response	

### 3. Reference to Other Standards

- *IEEE Std 829-2008 - IEEE Standard for Software and System Test Documentation*
- *NTCIP 1207 Version v02.06 National Transportation Communications for ITS Protocol, Object Definitions for Ramp Meter Control (RMC), ([www.ntcip.org](http://www.ntcip.org))*
- *NTCIP 1201 Version v03.13a, National Transportation Communications for ITS Protocol, Global Object Definitions ([www.ntcip.org](http://www.ntcip.org))*
- *NTCIP 8007 Version 1.21, National Transportation Communications for ITS Protocol, Testing and CA Documentation within NTCIP Standards ([www.ntcip.org](http://www.ntcip.org))*
- *NTCIP 9001 Version v04, National Transportation Communications for ITS Protocol, The NTCIP Guide ([www.ntcip.org](http://www.ntcip.org))*
- *Institute of Transportation Engineers, ATC 5201 Advanced Transportation Controller (ATC) Standard Version 06, ATC Joint Committee, 30 July 2012*
- *Institute of Transportation Engineers, ATC 5202 Model 2070 Controller Standard Version 03, ATC Joint Committee, 28 December 2012*

### 4. Case Studies

- M-0446 Ramp Metering Feasibility Study for Durham and Wake Counties, National Research Final Report, version 6.0, February 15, 2013. Study includes data from Atlanta, GA, Minneapolis/St. Paul, MN, Washington State, Louisiana, Kansas City, MO, Nevada, and the United Kingdom.
- Twin Cities Ramp Meter Evaluation Executive Summary for Minnesota Department of Transportation, February 1, 2001
- Georgia Milepost, “Georgia Activates Ramp Meters”, Georgia.gov, Summer – Fall 2008

### 5. Glossary

Term	Definition
Agency Specification	A document that has been prepared by an agency to define requirements for a subject item or process when procured by the agency.
ATC	Advanced Transportation Controller
Compliance	A condition that exists when an item meets all of the requirements of an



Term	Definition
	agency specification.
Concept of Operations	A document that describes the purpose for a system project, including a description of the current and proposed system, as well as key user needs that the new system is required to address.
Conformance	A condition that exists when an item meets all of the mandatory requirements as defined by a standard. It can be measured on the standard as a whole, which means that it meets all mandatory (and applicable conditional) requirements of the standard or on a feature level (e.g., it conforms to feature 3 as defined in section 1.2.3), which means that it meets all mandatory (and applicable conditional) requirements of the feature.
CG	Conformance Group
DUT	Device Under Test
ITS	Intelligent Transportation Systems
LTP	Level Test Plan
MTP	Master Test Plan
PRL	Protocol Requirements List
RMC	Ramp Meter Control
RTCTM	Requirements Test Case Traceability Matrix
RTM	Requirements Traceability Matrix
TMC	Traffic Management Center

## 6. References

- *Systems Engineering Guidebook for Intelligent Transportation Systems Version 3.0 Systems Engineering Model* ([ops.fhwa.dot.gov/publications/seitsguide/seguide.pdf](https://ops.fhwa.dot.gov/publications/seitsguide/seguide.pdf))
- *T202: Overview of Test Design Specifications, Test Cases and Test Procedures*
- *T203 Part 1 of 2: How to Develop Test Cases for an ITS Standards-based Test Plan, Part 1 of 2*
- *T203 Part 2 of 2: How to Develop Test Cases for an ITS Standards-based Test Plan, Part 2 of 2*
- *T204 Part 1 of 2: How to Develop Test Procedures for an ITS Standards-based Test Plan, Part 1 of 2*
- *T204 Part 2 of 2: How to Develop Test Procedures for an ITS Standards-based Test Plan, Part 2 of 2*

## 7. Study Questions

1. Which of the below is not a reason to test an RMC unit?
  - a) Satisfy system requirements
  - b) Testing is part of the NTCIP 1207 Standard v02



- c) Solve the right problem
  - d) Satisfy user needs
2. Which is not a testing process within the life cycle?
- a) Test planning
  - b) Preparation of test documentation
  - c) Test execution and reporting
  - d) Identification of system requirement
3. Which is not a reason to use the IEEE 829 Standard?
- a) IEEE 829 is part of NTCIP 1207 Standard v02
  - b) Provides familiar documents
  - c) Standard definition of terms
  - d) Reuse in later projects
4. Which is not a part of a Level Test Plan?
- a) Introduction
  - b) Test details
  - c) Planning for multiple levels of test
  - d) Test management
5. When is the test documentation completed?
- a) Before the test is executed
  - b) Only during the test execution
  - c) Only after the test is executed
  - d) During and after the test execution
6. What is the primary purpose of the RTCTM?
- a) Sets the testing workflow sequences
  - b) Correlates User Needs to Requirements
  - c) Describes the Optional Objects needed to fulfill Requirements
  - d) Correlates each RMC Requirement to Test Case

