**California State University, Long Beach, Department of Electrical Engineering**

**EE 400D Verification and Validation Test Plan, Spring 2017**

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# Introduction

This is the (Project Name) (Spring/Fall 20xx) Verification and Validation Test Plan

## Purpose

The purpose of this document is to provide a comprehensive Verification and Validation (V&V) Test Plan of the (Spring/Fall 20xx) (Project name), including the Project ConOps/Mission, Test Methodology, Verification and Validation Matricies, and Test Cases.

## Project ConOps/Mission

Provide an EXTREMELY DESCRIPTIVE TOP LEVEL OVERVIEW OF PROJECT MISSION AND CONOPS HERE. This will serve as driving force behind entire document’s verification/validation testing. YOUR TESTS ARE BEING CONDUCTED TO ENSURE THAT THE PROJECT MEETS THE OVERALL MISSION/CONOPS YOU HAVE DESCRIBED IN THIS SECTION.

## Document Overview

This document is organized as follows:

* Section 2 contains links to relevant and applicable project reference documents and presentations for this Test Plan.
* Section 3 contains a description of the Testing Methodology utilized in this Test Plan, including the Master Verification and Validation Matrix, a description of the 4 types of V&V testing performed, the Test Environment(s) description(s), and a Master Test Case List of all (number #) Test Cases for this project.

# Applicable Documents

This section contains a table of all relevant and applicable project reference documents and presentations for the (Project Name) (Spring/Fall 20xx) Verification and Validation Test Plan.

|  |  |  |
| --- | --- | --- |
| **Document Name** | **Document Description** | **Document Link** |
| Trade Study #x | Trade study involving xxxxxx | (Paste Google Drive Link here) |
| xxxxxx | xxxxxx | (Paste Google Drive Link here) |
| PDD | Preliminary Design Document. Contains xxxxxx | (Paste Google Drive Link here) |
| PDR | Preliminary Design Review Presentation. Contains L1 and L2 Requirements, System Block Diagram, Resource Allocation Reports, and xxxxxx | (Paste Google Drive Link here) |
| CDR | Critical Design Review Presentation. Contains xxxxxx | (Paste Google Drive Link here) |
| xxxxxx | xxxxxx | (Paste Google Drive Link here) |
| Final Project Code | Final Document of all MCU Firmware Code. | (Paste Google Drive Link here) |
| Final Project Summary | Final Presentation of completed Project. Contains xxxxxx | (Paste Google Drive Link here) |
| NASA Systems Engineering Handbook (2007) | Document containing Test Methodologies in Section 3 | <http://www.acq.osd.mil/se/docs/NASA-SP-2007-6105-Rev-1-Final-31Dec2007.pdf> |

# Testing Methodology

This section contains the Master Verification and Validation Matrix, as well as detailed descriptions of the various Test Methods and Test Cases utilized in this Test Plan.

## Master Verification and Validation (V&V) Matrix

This matrix provides complete traceability of every requirement. Specifically, every requirement is mapped to its description, success criteria, V&V testing designation and method, and Test Case(s) where the requirement will be tested. Note that some overlap between Test Cases’ requirements V&V is okay. **ALL REQUIREMENTS MUST BE MAPPED HERE AND ACCOUNTED FOR**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Requirement Number** | **Requirement Text** | **V&V Success Criteria** | **V&V Designation**(Verification, Validation?) | **V&V Method**(Analysis, Demonstration, Inspection, Test?) | **Test Case(s) where Requirement is Tested** |
|  |  |  |  |  |  |
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## Testing Types and Methods

This subsection contains the 4 types of Verification and Validation (V&V) testing, as derived from the NASA Systems Engineering Handbook referenced above in Section 2. Material is taken from Chapter 5 in the NASA Handbook, and replicated below.

**Verification** proves that a realized product for any system model within the system structure conforms to the build-to requirements (for software elements) or realize-to specifications and design descriptive documents (for hardware elements, manual procedures, or composite products of hardware, software, and manual procedures). In other words, Verification is requirements driven; verification shows proof of compliance with requirements; that the product can meet each “shall” statement as proven through performance of a test, analysis, inspection, or demonstration.

**Validation** is conducted under realistic conditions (or simulated conditions) on any end product for the purpose of determining the effectiveness and suitability of the product for use in mission operations by typical users; and the evaluation of the results of such tests. Testing is the detailed quantifying method of both verification and validation. However, testing is required to validate final end products to be produced and deployed. In other words, Validation is ConOps/Mission driven; validation shows that the product accomplishes the intended purpose in the intended environment; that product meets the expectations of the customer and other stakeholders as shown through performance of a test, analysis, inspection, or demonstration.

### Verification by Analysis

The use of mathematical modeling and analytical techniques to predict the suitability of a design to stakeholder expectations based on calculated data or data derived from lower system structure end product verifications. Analysis is generally used when a prototype; engineering model; or fabricated, assembled, and integrated product is not available. Analysis includes the use of modeling and simulation as analytical tools. A model is a mathematical representation of reality. A simulation is the manipulation of a model.

### Verification by Demonstration

Showing that the use of an end product achieves the individual specified requirement. It is generally a basic confirmation of performance capability, differentiated from testing by the lack of detailed data gathering. Demonstrations can involve the use of physical models or mockups; for example, a requirement that all controls shall be reachable by the pilot could be verified by having a pilot perform flight-related tasks in a cockpit mockup or simulator. A demonstration could also be the actual operation of the end product by highly qualified personnel, such as test pilots, who perform a one-time event that demonstrates a capability to operate at extreme limits of system performance, an operation not normally expected from a representative operational pilot.

### Verification by Inspection

The visual examination of a realized end product. Inspection is generally used to verify physical design features or specific manufacturer identification. For example, if there is a requirement that the safety arming pin has a red flag with the words “Remove Before Flight” stenciled on the flag in black letters, a visual inspection of the arming pin flag can be used to determine if this requirement was met.

### Verification by Test

The use of an end product to obtain detailed data needed to verify performance, or provide sufficient information to verify performance through further analysis. Testing can be conducted on final end products, breadboards, brass boards or prototypes. Testing produces data at discrete points for each specified requirement under controlled conditions and is the most resource-intensive verification/validation technique. As the saying goes, “Test as you fly, and fly as you test.” (See Subsection 5.3.2.5.).

### Validation by Analysis

The use of mathematical modeling and analytical techniques to predict the suitability of a design to stakeholder expectations based on calculated data or data derived from lower system structure end product validations. It is generally used when a prototype; engineering model; or fabricated, assembled, and integrated product is not available. Analysis includes the use of both modeling and simulation.

### Validation by Demonstration

The use of a realized end product to show that a set of stakeholder expectations can be achieved. It is generally used for a basic confirmation of performance capability and is differentiated from testing by the lack of detailed data gathering. Validation is done under realistic conditions for any end product within the system structure for the purpose of determining the effectiveness and suitability of the product for use in NASA missions or mission support by typical users and evaluating the results of such tests.

### Validation by Inspection

The visual examination of a realized end product. It is generally used to validate physical design features or specific manufacturer identification.

### Validation by Test

The use of a realized end product to obtain detailed data to validate performance or to provide sufficient information to validate performance through further analysis. Testing is the detailed quantifying method of both verification and validation but it is required in order to validate final end products to be produced and deployed.

## Master Test Case List

A **Test Case** can be described as *a scenario containing a sequence of detailed test steps, in order to perform verification/validation testing on multiple requirements that are similar in nature.*

For example, if a group has multiple requirements regarding starting up their robot project, they can group all these requirements to be verified/validated in a single test case. Similarly, if a group has multiple requirements that can be verified/validated via inspection, they can group all of them together in a single test case.

The purpose of this subsection is to provide a High-Level overview of all Test Cases utilized in this Test Plan. Each item in this subsection will contain the following: Test Case Number and Name, High Level Scenario Description, and Test Environment Description.

**The best way to approach Test Cases is to GROUP REQUIREMENTS THAT ARE SIMILAR IN NATURE FIRST, then write procedure steps for each Test Case.**

### TC-xx: xxxxxxx(Title)

Description: Provide high level description of Test Case; what is the overall point of this TC? Why did you group the requirements together? DO NOT GO INTO TOO MUCH DETAIL HERE.

Test Environment: Where is this TC taking place? Outside? Inside?

### TC-xx: xxxxxxx(Title)

Description: Provide high level description of Test Case; what is the overall point of this TC? Why did you group the requirements together? DO NOT GO INTO TOO MUCH DETAIL HERE.

Test Environment: Where is this TC taking place? Outside? Inside?

### TC-xx: xxxxxxx(Title)

Description: Provide high level description of Test Case; what is the overall point of this TC? Why did you group the requirements together? DO NOT GO INTO TOO MUCH DETAIL HERE.

Test Environment: Where is this TC taking place? Outside? Inside?

### TC-xx: xxxxxxx(Title)

Description: Provide high level description of Test Case; what is the overall point of this TC? Why did you group the requirements together? DO NOT GO INTO TOO MUCH DETAIL HERE.

Test Environment: Where is this TC taking place? Outside? Inside?

### TC-xx: xxxxxxx(Title)

Description: Provide high level description of Test Case; what is the overall point of this TC? Why did you group the requirements together? DO NOT GO INTO TOO MUCH DETAIL HERE.

Test Environment: Where is this TC taking place? Outside? Inside?

# Test Procedures

This section contains details of every Test Case utilized for V&V of project requirements. Each Test Case subsection within this section will contain the following: Test Case number and name, detailed scenario description, Test Case Traceability Matrix, detailed success criteria, detailed Test Environment description, Test Assumptions/Preconditions, Detailed Test Procedure Steps, and a Pass/Fail Matrix of success criteria per Test Case.

## TC-XX:xxxxxxx(Title)

### Detailed Description

Provide extremely detailed description of Test Case; what is the overall point of this TC? Why did you group the requirements together? Summarize Procedure Steps here, as summarizing those will give a detailed scenario description by default

### Test Case Traceability and Pass/Fail Matrix

This matrix shall show all requirements that are being tested in this test case. The Pass/Fail Column is populated after the Test Case has been run via the Procedure Steps.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Requirement Number** | **Requirement Text** | **V&V Success Criteria** | **V&V Designation**(Verification, Validation?) | **V&V Method**(Analysis, Demonstration, Inspection, Test?) | **Procedure Step(s) where Requirement is tested** | **Pass/Fail?** |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

### Detailed Success Criteria

Provide detailed description of what it will take to make this TC successful; what needs to go correctly in this TC to successfully V&V the requirements within it? Summarize Requirement V&V success criteria listed above here as summarizing those will give a detailed criteria description by default

### Test Environment

Where is this TC taking place? Outside? Inside? What is the classroom number? What is the location on campus? Give as many details as possible!

### Assumptions and Preconditions

**Use this space to list TC assumptions/preconditions in bullet form. Example below is for an Autonomous navigation TC.**

* The pathfinder is initialized correctly
* Solar Panel flaps are already open
* Waypoints have been predefined and set
* Pathfinder is starting at Waypoint 1
* Test Case begins in autonomous navigation mode
* There is adequate sunlight to power Pathfinder

### Procedure Steps

**MOST IMPORTANT PART OF THE TEST CASE. LIST** **detailed test steps, in order to perform verification/validation testing on multiple requirements documented above that are similar in nature.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Step Number** | **Step Description** | **Pass Criteria** | **Recorded Data** | **Requirement(s) Tested** | **Test Type** | **Test Method** |
| 1 | Turn on MCU | MCU turns on | (Write Yes/No, record number value, whatever you need to V&V Requirement) | L2-01 | Verification | Demonstration |
| 2 |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |

# Appendices

This section will contain any addition documentation needed to verify/validate requirements. For example, if a project has a cost constraint requirement, include the cost breakdown spreadsheet below as a subsection and reference the appendix subsection in the related Test Step in the Test Procedure. If another group needs to verify something by hand via calculation, include the calculations as a subsection below and reference the appendix subsection in the related Test Step in the Test Procedure.

## xxxxxxx

## xxxxxxx

## xxxxxxx

## xxxxxxx