

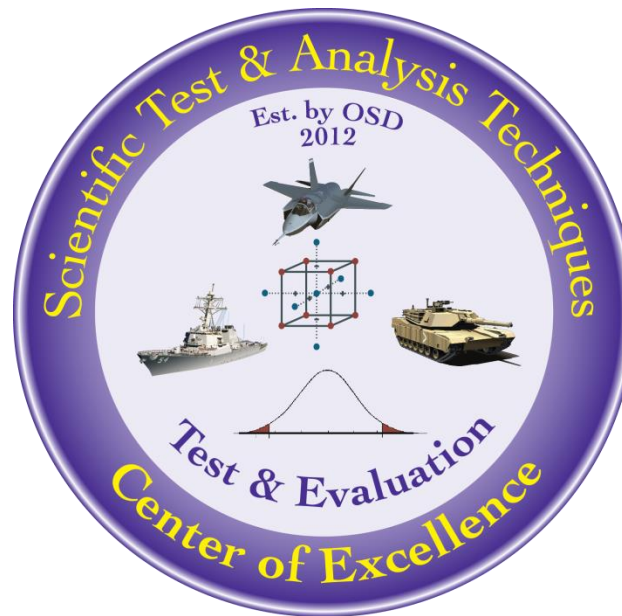
# Understanding Requirements for Effective Test Planning

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**The goal of the STAT COE is to assist in developing rigorous, defensible test strategies to more effectively quantify and characterize system performance and provide information that reduces risk. This and other COE products are available at [www.AFIT.edu/STAT](http://www.AFIT.edu/STAT).**

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## Executive Summary

Requirements are the starting and ending point for test and evaluation. Planning starts with mapping out a path to report on the requirement. Many choices will be made along the way to address concerns like operating conditions, resource constraints, and range limitations. These choices help focus the process towards the test design and execution methods so the analysis will provide the right information to make a decision about the requirement. If the requirement is not understood clearly at the beginning of the process the test team may find that it has planned a test that will not produce the data needed to address the requirement. Understanding what is written, what is missing, or what needs to be clarified in the requirement is the first step in effective planning.

**Keywords:** Requirements, test planning, best practice, STAT

## Introduction

The test planning process begins with the requirement. A test must be designed and conducted to gather data that will enable evaluation of the requirement and support a decision about the product it describes. Testers have a tendency to jump to the parts of the process that are tangible and easy to document like factor descriptions, scenarios, and decomposing the mission. New mandates from DOD leadership to implement scientific test and analysis techniques (STAT) into our designs may shift the focus more towards analysis and away from the requirements. This puts the process at risk because without a solid understanding of the requirement, what conditions it pertains to, how it factors into the mission, and how it can and should be tested and evaluated, the process is unguided. The planning team must pause to ask critical questions about the requirement. This crucial first step will drive the development of test objectives, responses, factors, designs, and analysis plans. The amount of detail (or lack thereof) associated with a requirement will directly impact the amount, type, and quality of the data collected.

## Examples of Requirements

This is a list of actual, albeit sanitized, DOD requirements:

- Rate of fire of X rounds per minute (rpm) and a maximum rate of fire of Y rpm.
- Radar range for detection at least X nm for patrol boat
- Respond to a fire mission with first round fired within X seconds Y% of the time.
- Electro-Optics Infrared (EO/IR) countermeasures (CM) are required to actively damage or disrupt EO/IR missile seekers to prevent a successful engagement during X percent of engagements by the specified CDD threshold threats.
- The vehicle shall be able to disengage and successfully escape from X percent of EO/IR and Y percent of radio frequency (RF) penetrations (to two thirds of the maximum lethal radius) into enroute mobile threshold threats specified in the CDD.

- Laser detection capability is required to detect X percent aggregate of the CDD threshold threats.
- Probability of detection of X % in a mission duration of Y hours
- A combat configured vehicle shall have an unrefueled combat mission radius of X nm at Y feet pressure altitude, Hot Day conditions.
- At all times during the mission, using no more than maximum continuous power, the vehicle shall be capable of maintaining X KTAS Y' PA, Hot Day conditions while combat configured and fuel load sufficient to meet Combat Radius KSA.
- The vehicle shall be capable of transporting X tons over the threshold range in the threshold temperature operating range and threshold sea state.

How well are these requirements written? Consider these questions:

1. Is there anything specifying performance or conditions?
2. Is there a percentage of the time it must pass?
3. Is there an operational region or specific points called out?
4. Is the evaluation to be based on the overall average performance?

## An Examination of Content

### Silent Requirements

***Rate of fire of X rounds per minute (rpm) and a maximum rate of fire of Y rpm.***

What accuracy is required and is it the same both day and night? What if the number of operators is varied or the target changes? When the requirement is silent about conditions, it implies that the system must demonstrate passing performance across the whole operational space. Is this likely? Certainly one would not expect a car to get highway gas mileage in the city so why would anyone expect a system to perform equally across the entire spectrum? A requirement without some caveats or conditions is difficult to address because testing must be able to characterize performance adequately in order to prove robustness or provide pointed direction for improvements should it not perform under certain conditions.

### Percentile Requirements

***Respond to a fire mission with first round fired within X seconds Y% of the time.***

Some requirements dictate that performance above the threshold is required in some percentage of the operational region, say 90%. Anything above the threshold is passing but how should the failing 10% be evaluated? Are there critical conditions where failing cannot be allowed? Should we expect failing performance to be just below the threshold or miserably bad and is either acceptable? How rapidly does performance degrade once it goes below the threshold? Also, from a statistical perspective, this

assumes that performance is aggregated into a single performance distribution which runs counter to the efforts of STAT to break out significant factors and characterize performance.

## Regional Specifications

***The vehicle shall be capable of transporting X tons over the threshold range in the threshold temperature operating range and threshold sea state.***

Some requirements specify a region or certain points to be evaluated. Certainly, the operators we work with can address whether these scenarios are broad enough to cover their expectations. If they are not, how will the rest of the space be evaluated? Demonstrations might seem like the easy answer; prove the stated requirement statistically and sample from the rest of the space. But how can the results of the demonstrations be proven with some level of assurance if they are one-off events? STAT is mandated to better inform decision makers, and single passing events are not wholly informative, nor are single failing events.

## The Average

***Radar range for detection at least X nm for patrol boat***

Finally, the age-old assumption is that the overall performance average must be above the threshold. While this is easy to compute it begs the question “which points will inform the average?” There is a joke about a statistician at the firing range who misses 2 feet to the left and then 2 feet to the right and claims that, on average, he hit the bullseye. Using the average does not meet STAT requirements to characterize performance across the space, does not detail risk areas, and can be misleading.

## How Does This Impact Test Planning?

Are requirements really written this poorly and are they really this hard to understand? The previous examples illustrate some of what is discussed here. Someone may say that this discussion is moot since The Director, Operational Test and Evaluation (DOT&E) wants the whole operational space to be evaluated anyway. No matter what your position, tests designed for good system characterization will address all these questions. A clear understanding by all stakeholders early in the process will inform a planning process resulting in the right data. Defining factors/levels well will support a thorough evaluation. More importantly, remember that many systems do not meet requirements at the outset and the program manager is looking for information about the deficiencies so he can direct resources to correct them. Testers are that feedback loop in the system engineering process to help address performance issues and make improvements. Solid test data is needed to focus that effort.

## Communication Is the Key

A well functioning WIPT facilitates communications and understanding. In some cases, a requirement clarification letter is required to formalize the evaluation plan. And early integration of DT and OT

planners will help with agreement on factors and levels. Take time to discuss and understand what the requirement says and how it must be evaluated.

Questions to ask:

- What remains to be clarified in the requirement?
- What is my test objective to address the requirement?
- Can I effectively characterize the system?
- If not, where are the risk (un-testable) regions?

These questions will lead the test team into the design process and help with strategy development and resource planning. Ultimately, the test design must produce the data that allows the analysis to address the requirement. It all starts with understanding the requirement.