Specifying STAT Requirements In Defense Contracts Revision 2

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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.

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Revision 1, 30 Sep 2018, Formatting and minor typographical/grammatical edits.
Revision 2, 1 Nov 2018, Added Defense Business Systems Appendix

Executive Summary

Test and evaluation (T&E) activities are intended to evaluate system performance against requirements and uncover risks. To improve the efficiency and effectiveness of T&E, DOD Instruction 5000.02 includes a requirement for the incorporation of scientific test and analysis techniques (STAT) into all acquisition test programs but it is primarily directed at government testing. Rigorous and informed contractor tests (CT) reveal and reduce risks earlier in the program and identify improvement options when they are less costly to implement. Injecting STAT in CT means clearly articulating STAT goals so the contractor understands the level of rigor the government requires. The current reference for incorporating T&E into contract language states the government's T&E rigor goals clearly, but does not provide specific deliverable language. This paper provides specific language for data item descriptions (DID) and for proposal evaluation criteria. The verbiage defines an expected level of rigor and analytical output capability without specifying how the contractor should conduct the testing.

Keywords: contractor testing, rigor, design of experiments, statistics, analysis, STAT

Introduction

Test and evaluation (T&E) activities are intended to evaluate system performance against requirements and uncover risks. To improve the efficiency and effectiveness of T&E, DOD Instruction 5000.02 (DUSD AT&L, 2017) includes a requirement for the incorporation of scientific test and analysis techniques (STAT) into all acquisition test programs but it is primarily directed at government testing. To impact contractual language, the defense department included STAT in the T&E contracts guide (DASD(DT&E), 2011). This excerpt adequately describe the goals (emphasis added):

> Paragraph 2.7.1. Statement of Objectives (SOO)
> "The Government desires an ***efficient and integrated experimental design and analysis*** (i.e., DOE) approach linking the contractor's design process, proposed M&S efforts, hardware-in-the-loop (HWIL) utilization, and any planned ground or flight test associated with this effort. Selected test points should be tested in the HWIL as part of formal qualification testing. The Government expects efficient and effective tests with ***statistically significant results*** over a ***broad range of operational conditions***. Test plans should ***cite the statistical risks*** implied by the proposed test programs. Specifically, tests should be designed to obtain data that: (1) ***support design space trades*** as part of the development process, (2) ***assess performance***, and (3) ***predict performance over the system's operational space***. The Government expects that the contractor will implement this experimental design and analysis approach to take advantage of the greater understanding of product physics, identify sensitivities to the parameters of interest, and ***utilize relevant statistics to reduce schedule and costs while lowering overall program risk***."

However the guide provides no specific contract data requirements list (CDRL) language for the contractor to act upon or criteria for government proposal review. This leaves room for a fairly broad interpretation of these desires with no guarantee the results will meet the expressed needs of the government. This is not to say some contractors do not already produce rigorous analytical products. Rather, this is to require and more adequately define output for those who are not already producing rigorous analytical products.

Also, it is recognized that contractual requirements must define desired outcomes and not specify solutions. Therefore, the following section provides specific language for inclusion in data item descriptions (DID) and for proposal evaluation criteria. The purpose of these STAT requirements is to define an expected level of rigor and analytical output capability without specifying how the testing is to be done by the contractor. These requirements can be applied to any type of contract and at all levels of acquisition.

STAT Requirements Language

The government is interested in both how the contractor chooses to explore the system operating region and what methods are selected. The level of STAT rigor delivered is directly related to the level of STAT rigor required by the contract. Clearly, rigor can be added to both processes and analysis. Improved processes for strategy development and test planning are necessary components of effective test designs. Quantitative analytical requirements ensure specific methods are described and rigor is reinforced in developing test strategies. The STAT requirements described below follow the process and order documented in the STAT Center of Excellence (COE) Test Planning Guide (STAT COE, 2017). The requirements are not specific to a particular method (e.g., DOE), but are written to be broadly applicable while requiring specific detail about the solution selected by the contractor. These requirements ensure a level of rigor from the contractor and documentation for program assessment.

These statements can be incorporated into the DIDs, proposal evaluation criteria, or other applicable sections. They cover the whole STAT test planning process and should be included in their entirety.

1. Identify any clarifications or assumptions made associated with the requirements.
2. Describe the test strategy employed.
3. Detail any system/function decomposition used to support the test strategy.
4. List test objectives ensuring they are unbiased, specific, measurable, and of practical consequence (Montgomery, 2017).
5. Explain the response variables and any amplifying information (e.g., how does this response support assessing the requirement).
6. List and describe all factors to be used in testing. If applicable, identify which ones are hard to change, held constant, recorded, or nuisance variables.
7. Identify any constraints (e.g., factor, range, schedule, budget constraints) that impact the choice of test design, quality of data collection, or analysis.

8. Describe the test design selection process.
9. Document any assumptions that impact the choice of test design.
10. Provide rationale for the type of test design selected, sample size, and/or the location and organization of the test points.
11. Provide rationale for the level of statistical merit associated with the selected design (e.g. confidence, power, correlation, orthogonality, etc.).
12. Describe the post-test analytical methods to be employed.
13. Define what software will be used, especially if custom coding is going to be developed (e.g. R for Bayesian analysis).
14. Provide data and analytical products in native formats (not PDF) so government analysis and review can be accomplished using the same software tools.

Context Notes

- Include the TEMP in the RFP/SOW/contract so government objectives are clearly articulated.
- CDRLs must require government approval.
- Timelines for CDRL approval must include a period for government review so that updates can be incorporated without delaying events.
- These criteria are especially important for systems where the contractor accomplishes a large portion of testing. Space systems are a prime example because the contractor may not transfer ownership to the government until a substantial amount of overall testing is already complete.

Frequently Asked Questions Related To STAT in Contracts

STAT COE experience with DoD programs since 2012 uncovered a number of frequently asked questions that inform the structure and rationale of STAT in contracts. These are covered below along with their justifications.

Where Is This Language To Be Implemented?

The STAT requirements can be included as general instructions to the contractor or in specific CDRL details. These requirements can also be used as evaluation criteria for competitive awards.

Why Is Additional Work Being Required Of The Contractor?

CT provides the first insight into system performance and informs risk early in the program. The STAT requirements ensure the contractor's test planning processes and level of rigor are documented and available for review. This is not additional work because we already expect a high quality product from the contractors. This simply requires them to document their processes more completely and allow government acceptance and/or updates before execution. Detailing the STAT requirements also supports more insightful evaluation of the proposal by the government team.

Is This Expecting Too Much Detail Before Any Development Has Been Done?

At program initiation it is understandable that many details are not clear before actual design and engineering work begins. The level of STAT detail should be consistent with the level of design and

planning work required to develop a proposal cost estimate. Early in the acquisition life cycle, this information may rely more on design planning details, whereas later proposals should reflect actual development progress already accomplished. Information is gained as more is learned throughout the T&E continuum and sequential learning will inform test plans as progress is made. Any and all assumptions should be documented that inform or bound the level of rigor.

How Will The Program Evaluators Assess The Adequacy Of The Proposal?

The program will evaluate the quality and sufficiency of the stated details similar to other stated requirements leveraged through the acquisition contracting process. Requiring this level of detail implies the program can interpret and understand the technical details. Team members must be skilled in interpreting the technical language and rationale provided in the proposal. Specific STAT-skilled resources may be required during the evaluation process. These resources should be secured early in the process and help with the authoring of the requirements as well as in the proposal review.

Conclusion

The government wants T&E to be efficient and effective beginning with CT to include the employment of STAT. Rigorous and informed CT serves to reveal and reduce risks earlier in the program but STAT goals must be explicitly incorporated into the contract to ensure government desires are met. Specific STAT language can be included in the contract without specifying how the contractor should conduct the testing. Quality STAT content in contract deliverables is a direct product of the detail required by the government. Finally, the government contract review team must be skilled in STAT and ready to provide feedback on deliverables so the products meet the stated requirements. The STAT COE can support the development of contract language, evaluation of proposals, and review of deliverables and can be contacted at COE@AFIT.edu.

References

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Appendix A: STAT for Defense Business System Performance Work Statement

This appendix contains additional information specific to the inclusion of STAT in Defense Business Systems. The following language should be added and/or tailored to meet program-unique requirements.

The contractor shall employ Scientific Test and Analysis Techniques (STAT) in the test program (https://www.afit.edu/STAT/). The Government expects efficient and effective tests with statistically significant results over a broad range of operational conditions. Test plans should cite the statistical risks implied by the proposed test programs. Specifically, tests should be designed to obtain data that: (1) support design space trades as part of the development process, (2) assess performance, and (3) predict performance over the system's operational space. The Government expects that the contractor will implement this experimental design and analysis approach to take advantage of the greater understanding of the system, identify sensitivities to the parameters of interest, and utilize relevant statistics to reduce schedule and costs while lowering overall program risk.

The contractor shall:

- Assist in prioritizing and scoping test activities using a capabilities risk-based approach (e.g. Multiple Attribute Decision Analysis). The contractor shall separately analyze the XXX Program business processes and interfaces to determine:
    a. Business criticality
    b. Relative likelihood of failure based upon level of maturity, technical complexity, developmental risk, and prior test results
- Utilize either the Government-provided NIST Automated Combinatorial Testing System (ACTS) tool or a similar tool to generate an efficient list of test cases using up to six parameters for each XXX Program-unique business process and interface. The appropriate t-way coverage should be based on the desired risk level
- Use ACTS (or equivalent) to support scope system regression testing
- Use STAT in the process of planning, designing, executing and analyzing the testing of selected requirements documented in the System Requirement Specification (SRS). STAT-applicable requirements are associated with XXX Program physical processes that have random variables as responses/outputs, such as response times, download times, and tasks performed. Typically statistical Design of Experiments, a specific STAT technique, is applied to these types of requirements in Defense Business Systems
- Incorporate STAT related info in the T&E CDRLS (e.g. Software Test Plan, Software Test Description, Software Test Report).