Defense Systems
Information Analysis Center

DSIAC TECHNICAL INQUIRY (TI) RESPONSE REPORT

Solid Rocket Insensitive Munitions Testing Requirements for Thrust Vector Control Systems

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ABOUT DSIAC

The Defense Systems Information Analysis Center (DSIAC) is a U.S. Department of Defense information analysis center sponsored by the Defense Technical Information Center. DSIAC is operated by SURVICE Engineering Company under contract FA8075-14-D-0001.

DSIAC serves as the national clearinghouse for worldwide scientific and technical information for weapon systems; survivability and vulnerability; reliability, maintainability, quality, supportability, and interoperability; advanced materials; military sensing; autonomous systems; energetics; directed energy; and non-lethal weapons. We collect, analyze, synthesize, and disseminate related technical information and data for each of these focus areas.

A chief service of DSIAC is free technical inquiry (TI) research, limited to 4 research hours per inquiry. This TI response report summarizes the research findings of one such inquiry. For more information about DSIAC and our TI service, please visit www.DSIAC.org.

ABSTRACT

The Defense Systems Information Analysis Center (DSIAC) received a technical inquiry requesting information on the testing requirements for solid rocket insensitive munition testing and installation of the thrust vector control (TVC) system. A DSIAC subject matter expert provided guidance on testing requirements and potential impacts for use of the TVC during slow cookoff and fragment/bullet impact testing. Additionally, the need to perform modeling and analysis prior to testing was highlighted to help to further assess the impacts.

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1.0 TI Request

1.1 SUBJECT: Information Relating to Solid Rocket Insensitive Munitions Testing Requirements for Installation of the Thrust Vector Control (TVC) System

1.2 DESCRIPTION

The inquirer requested information on solid rocket insensitive munitions (IMs) testing. Specifically, the inquirer asked the question: During fragment or bullet impact or cookoff testing, does the test item need to have a functional TVC system installed to be properly scored?

2.0 TI Response

Defense Systems Information Analysis Center (DSIAC) subject matter expert (SME) Michael Fisher responded to the inquirer's request. Mr. Fisher is a senior staff engineer for DSIAC who specializes in propulsion, energetic materials, and weapons systems. During his 30-year career, he provided propulsion system design and program management support to a variety of Navy weapons programs, and managed propulsion and advanced materials research and development projects for a small business. Prior to joining the DSIAC team, Fisher supported the North Atlantic Treaty Organization (NATO) Munitions Safety Information Analysis Center (MSIAC) in Brussels and the Chemical Propulsion Information Analysis Center (CPIAC) as a technical specialist. He has presented numerous papers on propulsion design, IMs, and energetics at conferences and workshops in the U.S. and abroad.

2.1 SME RESPONSE

All IM tests are controlled by specific, standardized agreements (specifications) among NATO countries. References 1–4 include those specifications for bullet impact, fragment impact, slow heating, and fuel fire (fast heating) testing, respectively, as related to this inquiry. In each specification, the test article configuration is driven by the Threat Hazard Assessment (THA). An All-Up-Round (AUR) configuration with all flight hardware is preferred but can be supplemented by simulator components or hardware that do not detract from the mass, volume, or configuration of inert subcomponents. However, all tests must use the precise energetic materials to be tested in their actual configurations. Typically, the manufacturing agency/company and the user agree to define the preferred test article configuration that can most adequately achieve the necessary data to support grading munition response to various IM tests. A munition cannot be graded "for-score" without this prior agreement, and a test conducted without it would be considered an engineering test only.

Regulations and standards for IM testing procedures call for testing of munitions in the AUR configuration, and not as individual subsystems or components such as rocket motors. However, due to cost constraints, component-level tests are often conducted. Then, the likely response of an AUR configuration is determined based on analysis of component-level results.

In any test, some nonenergetic subcomponents may be replaced with inert simulants. Even in a component (motor or warhead) test, the rest of the missile mass should be simulated, at a minimum. For some tests, however, there are other considerations. For example, in fast cookoff or slow cookoff tests, the actual thermal path must be maintained.

If a solid mass simulant is used in place of the TVC, it may not expel fragments at the same velocity and direction (with the correct energy and distance) as the actual TVC. Therefore, the

replaced component's structure needs to be more realistically simulated. Additionally, the TVC may contain stored energy in the form of a battery or pressurized gas bottle, which would also need to be accounted for in a simulant.

In an impact test, the sightline for the fragment or bullet may need to pass through the TVC to impact the most sensitive part of the motor. A mass simulant might alter that path and energy. However, this scenario is unlikely unless the TVC surrounds the nozzle with an aft-mounted igniter.

Ultimately, all missile components need to be modeled and analyzed to determine how their simulation might affect the test result. It is usually safe to not include expensive electronics (unless they are in the fragment path), but there may still be issues.

If the test is for-score, a test plan, including the test article configuration, should be approved by the appropriate Service review board. If the test is an engineering assessment, more flexibility is typically granted regarding the test article configuration. However, there is a risk of obtaining a result not indicative of the actual for-score test in the future.

REFERENCES

[1] NATO Standardization Agency. “Bullet Impact, Munition Test Procedures.” STANAG-4241, ed. 2, 15 April 2003.

[2] NATO Standardization Agency. “Fragment Impact, Munition Test Procedures.” STANAG-4496, ed. 1, 13 December 2006.

[3] NATO Standardization Agency. “Slow Heating, Munition Test Procedures.” STANAG-4382, ed. 2, 15 April 2003.

[4] NATO Standardization Agency. “Liquid Fuel / External Fire, Munition Test Procedures.” STANAG-4240, ed. 2, 15 April 2003.