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NATO IFF TEST REQUIREMENTS – INTERROGATOR FLIGHT MARK XIIA AND MODE S

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NATO LETTER OF PROMULGATION

26 September 2019

1. The enclosed Allied Electronic Publication AEtP-12.9, Edition A, Version 1, NATO IFF TEST REQUIREMENTS - INTERROGATOR FLIGHT MARK XIIA AND MODE S, which has been approved by the nations in the Consultation Command and Control (C3) Board, is promulgated herewith. The recommendation of nations to use this publication is recorded in STANREC 5647.

2. AEtP-12.9, Edition A, Version 1, is effective upon receipt.

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4. This publication shall be handled in accordance with C-M(2002)60.

Zoltán GULYÁS
Brigadier General, HUNAF
Director, NATO Standardization Office

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RECORD OF RESERVATIONS

CHAPTER	RECORD OF RESERVATION BY NATIONS
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RECORD OF SPECIFIC RESERVATIONS

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1. General

1.1. Introduction

These test requirements have been prepared by the North Atlantic Treaty Organization (NATO) Identification Friend or Foe (IFF) Capability Team (CaT). These test requirements were developed in order to assist with flight test planning for installed interrogator systems in accordance with STANAG 4193 Edition 3.

1.2. Objective

The purpose of these test requirements is to evaluate interrogator system compliance with the the STANAG 4193 Edition 3 requirements specification at a platform level. Successful completion of these tests provides an acceptable confidence level of proper operation or identifies areas of needed improvement.

The tests will verify:

a. Mark XIIA system performance

b. Mode Select (Mode S) system performance

c. Automatic Dependent Surveillance-Broadcast (ADS-B) system performance (if necessary as ADS-B is not required in STANAG 4193 Edition 3)

1.3. Scope

Testing will be conducted to obtain interrogator data in the operational environment of the platform under test. The operational environment includes normal mission avionics, which will be enabled. One or more transponders will be interrogated in Selective Identification Feature (SIF), Mode 4, Mode 5 Level 1, and Mode S. Mode 5 Level 2 and ADS-B data will also be collected (if required).

The described methods in this document are only examples of performing the tests. The platform testing coordinator may develop other methods to obtain the required data.

1.4. Acronyms and Abbreviations

ADS-B	Automatic Dependent Surveillance-Broadcast
CaT	Capability Team
IFF	Identification Friend or Foe
LOS	Line Of Sight
Mode S	Mode Select
NATO	North Atlantic Treaty Organization
SIF	Selective Identification Feature
TSPI	Time, Space, and Position Information

1.5. References

1) STANAG 4193 Edition 3
   Technical Characteristics of the IFF Mk XIIA System

2. Test Preparation

2.1. Instrumentation

2.1.1. Transponder Target Platform

At a minimum, all dedicated airborne and/or surface transponder targets are required to be instrumented with Time, Space, and Position Information (TSPI) recording capability during all testing. During Mode 5 Level 2, Mode S, and ADS-B testing, recording of the parameters transmitted by the dedicated target transponder is required. It is recommended that interrogation and reply level data (Mode 5 at a minimum) is logged and time stamped by the target transponder.

2.1.2. Interrogator Platform

At a minimum, the interrogator platform under test is required to be instrumented with TSPI and time stamped target report recording capability. The target reports should contain transponder data, range, and azimuth. It is recommended that interrogation and reply level data (Mode 5 at a minimum) is logged and time stamped. It is highly recommended that the displays and fault monitoring also be recorded. A dedicated operator is required to monitor the displays during all testing.

If the required instrumentation is not available on the platform under test, an alternate interrogator platform may be used to confirm the performance of the interrogator under test for certain parameters. However, the alternate interrogator platform must cover the entire volume of the target's location during test and must be equipped with the required instrumentation.

2.2. Authorizations

It must be ensured that proper authorizations are received for the use of the airspace needed, radiation of the transponder, radiation of the interrogator, and radiation of any test equipment.

2.3. Key Usage

Care should be taken to ensure that only authorized Mode 4 and Mode 5 keys are loaded and radiated. Mode 4 and Mode 5 test keys shall be used for flight testing. Mode 5 operational key may be used only when specifically authorized, in accordance with the NATO Mk XIIA Mode 4 / Mode 5 Key Management Plan.

3 Test Events

Multiple test events may be combined into a single test. The test target maneuvers, altitudes, and areas of the test should be designed to maximize the amount of data collected while adhering to the constraints delineated in the authorizations to radiate. All airborne interrogator system testing should be conducted with the platform under test at operationally representative altitudes. Data collected during aircraft interrogator turns should not be used for performance evaluation. All test points, unless otherwise noted, should be conducted from minimum to maximum operational range of the interrogator system, with targets within Line Of Sight (LOS) of the interrogator platform. When defining the flight profile, ensure the test target(s) are above the horizon.

$$LOS\ (nmi) = 1.23(\sqrt{\text{interrogator height (ft)}} + \sqrt{\text{transponder height (ft)}}\ )$$

Targets of opportunity that are not instrumented are acceptable for some tests.

Air to surface demonstration is not required for airborne interrogator platforms that do not have a surface target tracking requirement.

3.1 Detection over the Operational Range

3.1.1 Data Needed

Data must be provided which demonstrates that the platform under test can produce an acceptable Probability of Detection from minimum to maximum ranges of the interrogator system under test. In order to asses Probability of Detection differences between modes, interrogator target report data should be collected to provide separate analysis for each mode (1, 2, 3/A, C, 4, Mode 5 Levels 1 and 2, Mode S, and ADS-B). Data should be collected using operational interrogation schemes/scans of the interrogator system. Successful and unsuccessful attempts should be presented in a range vs. time plot for all modes. Probability of Detection is to be calculated by dividing the number of target reports collected by the number of opportunities to receive valid transponder target replies, removing any period of time when detection is not expected (e.g., beyond LOS, beyond maximum range, less than minimum range, in a known multipath null, etc.). Any significant drop-outs must be investigated.

The probability of decoding the correct code(s) should also be evaluated against the system requirements.

3.1.2 Method of Test

An instrumented transponder target will proceed from the minimum range to the maximum range of the interrogator system, in reference to the interrogator platform, remaining within calculated LOS of the interrogator antenna. An airborne interrogator platform should fly at operationally representative altitudes and airspeeds. Surface interrogator platforms should be idle or cruising at operationally representative speeds. Multiple azimuth radials relative to the interrogator platform should be conducted by the transponder target platform. Multiple instrumented transponder targets are encouraged to participate to increase the amount of data collected during one test. Platforms which use supermode should verify performance with each possible response types (example: a

platform using a Mode 5 Level 2 / Mode 4 supermode should test with platforms responding in Mode 5 Level 2, Mode 5 Level 1, and Mode 4). This can be accomplished with multiple target platforms or by switching transponder capability during the flight.

For airborne platforms which are required to detect surface targets, a test transponder should be setup on the ground and data collected throughout the flight test. No specific ranges or maneuvers are required to analyze air to ground performance.

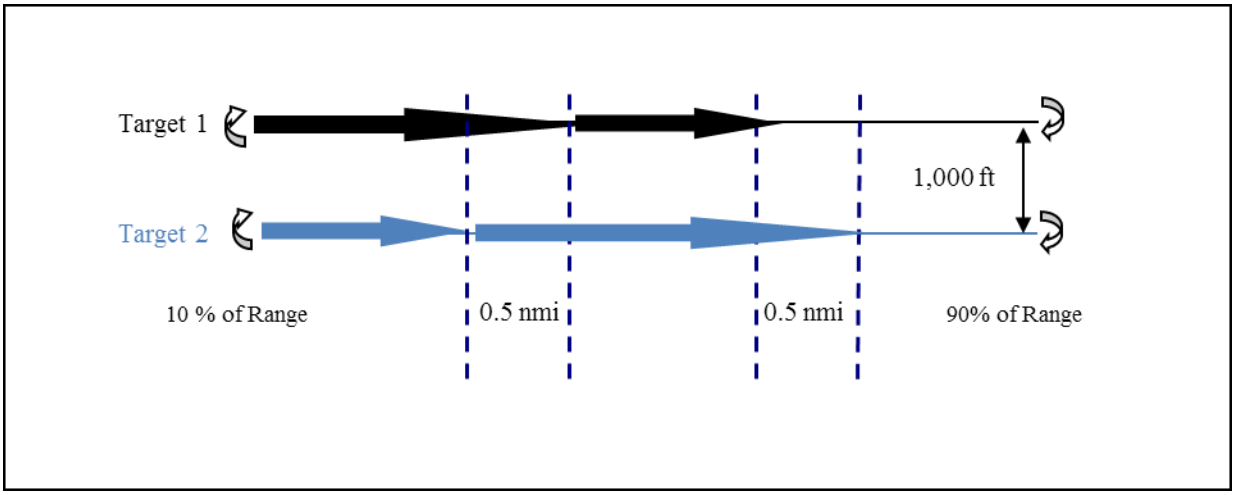
3.2 Range Resolution

3.2.1 Data Needed

Data must be provided to demonstrate that the platform under test can produce an acceptable range resolution. Interrogator target report data should be collected to provide separate analysis for SIF, Mode 4, Mode 5 Level 1, and Mode S. Data should be collected in all operational interrogation schemes/scans of the interrogator system. Range resolution is to be presented by calculating the range difference between two closely spaced targets in reference to the interrogator platform (as collected by TSPI), right before they are unable to be resolved by the interrogator. An analysis of false codes, code swapping, and target identification ambiguities should also be performed.

3.2.2 Method of Test

Two instrumented transponder targets will execute overtake maneuvers while staying well between the minimum and maximum range of the interrogator. The two aircraft will be separated by at least 1,000 ft in altitude. The trailing target will start each overtake at least 0.5 nmi in trail of the lead target, and perform the overtake until at least 0.5 nmi in the lead. The overtakes are to be performed at relatively slow speeds to ensure capture of the required data. The transponders in the test platforms should be configured in various ways (one or both with all modes enabled, Mark XII only, SIF only, etc.).



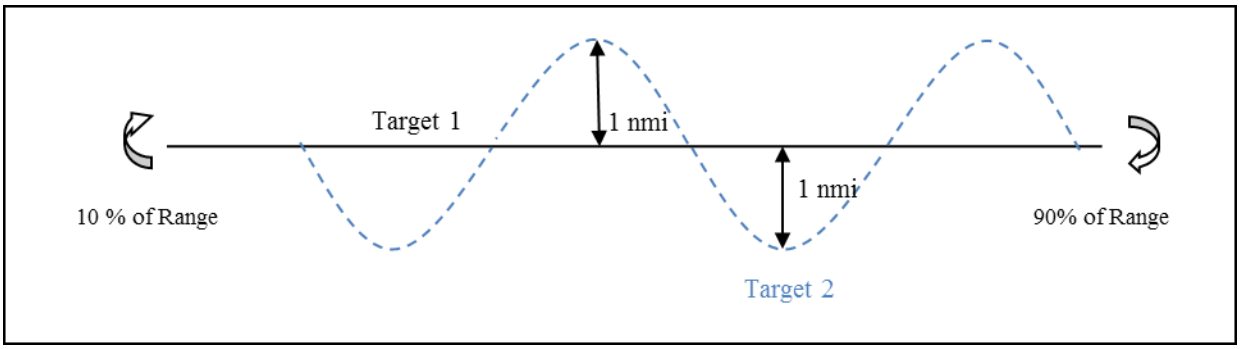
3.3 Azimuth Resolution

3.3.1 Data Needed

Data must be provided to demonstrate that the platform under test can produce an acceptable azimuth resolution. Interrogator target report data should be collected to provide separate analysis for SIF, Mode 4, Mode 5 Level 1, and Mode S. Data should be collected in all operational interrogation schemes/scans of the interrogator system. Azimuth resolution is to be presented by calculating the azimuth difference between two closely spaced targets in reference to the interrogator platform (as collected by TSPI), right before they are unable to be resolved by the interrogator. An analysis of false codes, code swapping, and target identification ambiguities should also be performed.

3.3.2 Method of Test

Two instrumented transponder targets will execute weave maneuvers while staying well between the minimum and maximum range of the interrogator. If aircraft are used, the two aircraft will be separated by at least 1,000 ft in altitude. The first target will maintain a straight path, while the second target will repeat weaves off course to create separations of approximately 1 nmi (or a different value needed to evaluate the azimuth resolution). The transponders in the test platforms should be configured in various ways (one or both with all modes enabled, Mark XII only, SIF only, etc.).



3.4 Range Accuracy

3.4.1 Data Needed

Data must be provided to demonstrate that the platform under test can produce acceptable range accuracy. Interrogator target report data should be collected to provide separate analysis for SIF, Mode 4, Mode 5 Level 1, and Mode S. Data should be collected in all operational interrogation schemes/scans of the interrogator system. Range accuracy is to be presented by calculating the range difference between the ranges reported in the target reports with the ranges calculated from TSPI in reference to the interrogator.

3.4.2 Method of Test

Specific maneuvers are not required for this test; the data can be collected in conjunction with all testing in which an instrumented transponder target is used.

3.5 Azimuth Accuracy

3.5.1 Data Needed

Data must be provided to demonstrate that the platform under test can produce acceptable azimuth accuracy. Interrogator target report data should be collected to provide separate analysis for SIF, Mode 4, Mode 5 Level 1, and Mode S. Data should be collected in all operational interrogation schemes/scans of the interrogator system. Azimuth accuracy is to be presented by calculating the difference in azimuth between the reported azimuth in the target reports and the azimuth calculated from TSPI, in reference to the interrogator. The performance shall be sufficient to meet the operational requirements of the platform. In the absence of a platform minimum requirement, the azimuth accuracy should be no greater than 25% of the 3 dB beamwidth of the antenna for at least 95% of targets.

3.5.2 Method of Test

Specific maneuvers are not required for this, and the data can be collected in conjunction with all testing in which an instrumented transponder target is used.

3.6 Antenna Coverage

3.6.1 Data Needed

Data must be provided to demonstrate that the platform under test can produce sufficient coverage in the scan volume. Data should be collected in all operational interrogation schemes/scans of the interrogator system. Antenna coverage should be presented by plotting the received target reports in an X-Y plot showing the range and altitude of the target as well as a polar plot showing the azimuth coverage. Targets should be tested throughout the required azimuth coverage; however, the required elevation coverage only needs to be tested at an operationally relevant sample.

3.6.2 Method of Test

Specific maneuvers are not required for this, and the data can be collected in conjunction with all testing. This test does not require dedicated instrumented targets, and target reports from targets of opportunity are encouraged to be used.

3.7 Mode 5 Lethal Interrogation Performance

3.7.1 Data Needed

Data must be provided to demonstrate that the interrogator platform can sufficiently conduct lethal interrogations in a dynamic environment. If integrated with a combat system, the Mode 5 lethal function must be demonstrated. Data is to be provided that shows the results of lethal interrogations when multiple targets are present.

3.7.2 Method of Test

This data can be collected in conjunction with the resolution profile. One target transponder should be placed in a civilian or unknown configuration (Modes 3/A, C, and S only or in Standby with Mode 5 disabled), and the second target transponder should be placed in Standby with Mode 5 enabled. Lethal interrogations should be conducted while the two targets cross.

3.8 Other Considerations

All anomalies observed during testing should be well documented. Items of interest include, but are not limited to:

- False targets, especially occurrences of the target of interest at an incorrect azimuth or range
- False caution indications or Built-in-test faults on the display
- Identification swaps during the resolution profiles
- Failure to correlate with other sensors
- Any anomalies associated with the testing transponder

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