NATO STANDARDIZATION OFFICE
BUREAU OTAN DE NORMALISATION

23 May 2016 NSO/0681(2016)C3/4193

STANAG 4193 C3 (EDITION 3) (PART III)- TECHNICAL CHARACTERISTICS OF THE IFF Mk XIIA SYSTEM PART III: INSTALLED SYSTEM CHARACTERISTICS

References:
a. NSO/1335(2015)C3B/4193 dated 21 October 2015 (Edition 3, Part III) (Ratification Draft 1)
b. STANAG 4193 Edition 1 & 2 PART I-VI

1. The enclosed NATO Standardization Agreement, which has been ratified by nations as reflected in the NATO Standardization Document Database (NSDD), is promulgated herewith.

2. The references listed above are to be destroyed in accordance with local document destruction procedures.

ACTION BY NATIONAL STAFFS

3. National staffs are requested to examine their ratification status of the STANAG and, if they have not already done so, advise the NSO, through their national delegation as appropriate of their intention regarding its ratification and implementation.

4. It should be noted that this standard entered development/ratification under AAP-03(I) and therefore is promulgated in its current format.

Edvardas MAŽEIKIS
Major General, LTUAF
Director, NATO Standardization Office

Enclosure:
STANAG 4193 (Edition 3)(Part II)

NATO Standardization Office – Bureau OTAN de normalisation
B-1110 Brussels, Belgium Internet site: http://nso.nato.int
E-mail: mazeikis.ervards@nso.nato.int – Tel 32.2.707.5555 – Fax 32.2.707.5718

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)

NATO STANDARDIZATION OFFICE
(NSO)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: TECHNICAL CHARACTERISTICS OF THE IFF Mk XIIA SYSTEM
PART III: INSTALLED SYSTEM CHARACTERISTICS

Promulgated on 23 May 2016

Edvardas MAŽEIKIS
Major General, LTUAF
Director, NATO Standardization Office

RECORD OF AMENDMENTS

No.	Reference/Date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This STANAG is promulgated by the Director NATO Standardization Office under the authority vested in him by the North Atlantic Council.

2. No departure may be made from the agreement without informing the tasking authority in the form of a reservation. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

4. Ratification, implementation and reservation details are available on request or through the NSO websites (internet http://nso.nato.int; NATO Secure WAN http://nso.hq.nato.int).

RESTRICTION TO REPRODUCTION

FEEDBACK

6. Any comments concerning this publication should be directed to NATO/NSO – Bvd Leopold III - 1110 Brussels - Belgium.

STANAG 4193 Part III
(Edition 3)

NAVY / ARMY / AIR

NATO STANDARDIZATION AGREEMENT
(STANAG)

TECHNICAL CHARACTERISTICS OF THE IFF Mk XIIA SYSTEM

PART III: INSTALLED SYSTEM CHARACTERISTICS

Annex: A: Installed System Characteristics

Related Documents:

(a) STANAG 4193 Part I - System Description and General Characteristics

(b) STANAG 4193 Part II - Classified System Characteristics

(c) STANAG 1241 - NATO Standard Identity Description Structure for Tactical Use

(d) Military Operational Requirement (MOR) for ID in NATO – MC 470 (Final) dated 5 June 2002

(e) Identification In The Alliance – AC/322(SC/7)D/1 dated 31.10.02

(f) AAP-28 – NATO Glossary of Identification (February 2002)

(g) ACP 160 - IFF/SIF Operational Procedures, and Supplements (where appropriate)

(h) AEtP-5 – The Merit of Individual System Performance Characteristics for IFF – Interoperability of IFF Systems (MISPEC (IFF)), Volume 4 – The Analysis of IFF System Performance Characteristics

(i) AEtP-6 – Standard methods of Measuring IFF System Performance (January 1987)

(j) AEtP-11 – Implementation Options and Guidance for Integrating IFF Mk XIIA Mode 5 on Military Platforms

(k) MC 88 - NATO Military Committee Policy for the Control of ATC Services

(l) IMSM-622-03 dated 22 Sept. 2003 “NATO Military Position on Mk XIIA IFF” and “NATO Military Concept of Operations for IFF Mk XIIA System Incorporating Mode 5”

(m) NATO Mk XIIA Identification Friend or Foe (IFF) Mode 4/5 Key Management Plan (KMP)

(n) NATO Identification Security Classification Guide (AC/322(SC/7)D(2007)003 + AS1)

(o) ICAO Annex 10 - International Standards and Recommended Practices for Aeronautical Telecommunications

(p) IMSM-971-00 dated 21 Dec. 2000 “Updated NATO Military Position on Mode S” and “NATO Military Concept of Operations (CONOPS) for Mode S”

(q) ICAO EUR Regional Supplementary Procedures (Doc. 7030/4)

(r) ICAO Document 9924-AN/474 – Aeronautical Surveillance Manual

(s) ICAO Document 9871-AN/464 – Technical Provisions for Mode S Services and Extended Squitter

(t) AC/302(SG/5)D/114 dated 21 Nov. 96: Report on Technical Options for Access to SSR Mode S Information by Military Forces

(u) EUROCONTROL Mode S CONOPS Ed. 2.0 dated 28 Nov. 1996

(v) EUROCONTROL Guidance for the Operational Introduction of SSR Mode S, Volume 1 – Elementary Surveillance

(w) EUROCONTROL Document Reference SUR/MODES/EMS/SPE-01: European Mode S Station (EMS) Functional Specification

(x) ARINC Characteristic No. 730 - Airborne Separation Assurance System

AIM

1. The aim of this agreement is to define and standardize essential technical characteristics which shall be incorporated in the design of the IFF Mk XIIA Interrogators and Transponders.

AGREEMENT

2. Participating nations agree to adopt the technical characteristics for the IFF Mk XIIA Interrogators and Transponders specified in Part I and Part II and agree to comply with the installed system characteristics specified in Part III.

DEFINITIONS

3. The definition of terms and abbreviations used in this Agreement are given in Annex L to Part I and Annex C to Part II.

GENERAL

4. This agreement replaces previous editions of STANAG 4193 for all IFF Mk XIIA Interrogators and Transponders. This agreement also replaces previous editions of STANAG 4193 for IFF Mk XA and IFF Mk XII Interrogators and Transponders developed to IFF Mk XIIA technical standards.

Note: Previous editions of STANAG 4193 Parts I, II, III and IV remain applicable to legacy IFF Mk XA and IFF Mk XIIA equipment.

DETAILS OF AGREEMENT

5. The details of the agreement are given as follows:

- in Part I: System Description and General Characteristics
- in Part II: Classified System Characteristics
- in Part III: Installed System Characteristics

each Part being published separately as STANAG 4193 (Part I), STANAG 4193 (Part II) and STANAG 4193 (Part III).

IMPLEMENTATION OF THE AGREEMENT

6. This STANAG is implemented by a nation when it has issued instructions that all future equipment procured or developed for its forces will be manufactured in accordance with the specifications detailed in this agreement.

STANAG 4193

TECHNICAL CHARACTERISTICS OF THE IFF Mk XIIA SYSTEM

PART III

INSTALLED SYSTEM CHARACTERISTICS

ANNEX A: INSTALLED SYSTEM CHARACTERISTICS

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1. INTRODUCTION (NU)

1.1 Scope (NU)

(NU) STANAG 4193, at Edition 3, defines the technical characteristics of the IFF Mk XIIA system. The IFF Mk XIIA system is a development of the previously implemented IFF Mk XA and IFF Mk XII systems, providing an enhanced Identification Friend or Foe (IFF) capability whilst maintaining interoperability with civil Secondary Surveillance Radar (SSR).

(NU) STANAG 4193 (Part III) defines the installed characteristics of the IFF Mk XIIA system. The requirements applicable to any specific category of equipment are referenced by STANAG 4193 (Part I), which describes the IFF Mk XIIA system and defines general system characteristics. Classified characteristics of the IFF Mk XIIA system are defined in STANAG 4193 (Part II).

(NU) This Annex to STANAG 4193 (Part III) defines relevant functional and performance requirements applicable to both interrogator and transponder installations. The requirements specified are those considered to be the minimum necessary to ensure adequate overall IFF system performance.

1.2 Implementation (NU)

(NU) IFF Mk XIIA installations designed subsequent to the approval of this STANAG shall meet the requirements specified in this document.

Notes:

1. IFF Mk XA and IFF Mk XII installations designed subsequent to the approval of this STANAG should meet the requirements specified in this document, excluding those requirements specific to any Mode 5 capability.

2. Previous editions of STANAG 4193 Parts I, II and III remain applicable to legacy IFF Mk XA and IFF Mk XII installations.

(NU) The requirements defined in this Annex shall be met for each supported capability, where these are determined by equipment application as specified in STANAG 4193 (Part I).

(NU) All parameters quoted in this document are absolute values: appropriate allowance shall be made for test equipment tolerance when any parameter is subject to measurement.

2. INTERROGATOR CHARACTERISTICS (NU)

2.1 Introduction (NU)

(NU) IFF system performance is characterised by the ability of an installed interrogator to identify friendly platforms to an adequate confidence level, as defined by the simultaneous probabilities of friend rejection (P_{FR}) and enemy acceptance (P_{EA}), within some defined environment. Irrespective of whether an interrogator is installed for the purposes of general surveillance or target specific identification, the installation must ensure that adequate performance is maintained without compromising the operational effectiveness of the host platform. It cannot be over emphasised that incorrect or poor installations can result in the engagement of friendly forces.

(NU) An interrogator installation comprises the interrogator equipment (which may comprise one or more units, dependent upon the level of integration of signal processing, cryptographic and command / control facilities) and the interrogator antenna subsystem, together with all necessary inter-unit and host platform interfacing.

(NU) The general and platform specific installed characteristics defined herein are those considered to be the minimum necessary to ensure adequate IFF system performance. The specified requirements shall apply over all service conditions within the operational envelope of the host platform.

2.2 General Installed Characteristics (NU)

2.2.1 Antenna Subsystem Characteristics (NU)

(NU) The interrogator antenna subsystem shall comprise those components in the interrogator installation connected either directly or indirectly to the antenna ports of the interrogator equipment, including, but not limited to, radiating elements, transmission lines and any associated connectors, filters, matching devices and protection devices.

(NU) The antenna characteristics defined herein shall apply to all defined operational configurations of the platform, taking account of alternative external stores fits and alternative equipment fits impacting upon the electromagnetic environment.

2.2.1.1 Configuration (NU)

(NU) The interrogator antenna system shall comprise one or more “main” antennas (or antenna arrays), as necessary to provide the “main beam” characteristics defined in paragraph 2.2.1.4, together with one or more corresponding “control” antennas (or antenna arrays), as necessary to provide the “control beam” characteristics defined in paragraph 2.2.1.4, with each antenna connected to an interrogator antenna port via a suitable transmission network comprising all necessary cables, connectors and ancillary devices required to meet the characteristics defined in paragraphs 2.2.1.2 to 2.2.1.9.

(NU) The separation between each supported main antenna and its corresponding control antenna(s) shall be minimised such as to meet the differential path delay requirements defined in paragraph 2.2.1.6.

Notes:

1. Each antenna and associated transmission network are components of one “channel” of an interrogator installation. Multiple channels are required for the transmission of main and control components of interrogations, the reception of replies and, optionally, the monopulse processing, and / or Receiver Side Lobe Suppression (RSLS) processing, of replies.

2. A typical installation may comprise a single main antenna (the “sum” channel) and a single control antenna (the “difference” channel), whereby the sum channel is used for the transmission / reception of the main beam components of interrogations / replies and the difference channel is used both for interrogation control transmissions and for reply monopulse / RSLS processing. Other installations may comprise a single main antenna (the sum channel) and two control channels (the difference channel and the “omni-directional” channel), whereby the difference channel is retained for reply monopulse processing, while the omni-directional channel is used for interrogation control transmissions and reply RSLS processing.

3. A single main antenna, together with corresponding control antenna(s), is typical of “stared” or mechanical scan (m-scan) systems whereby the required coverage can be achieved using fixed radiation patterns. A single main antenna, together with corresponding control

antenna(s), is also typical of electronic scan (e-scan) systems whereby the required coverage can be achieved solely by means of electronic beam steering through the selection of alternative antenna radiation patterns. Multiple, switched antennas may be used where the required coverage cannot be met using a single antenna implementation.

4. Corresponding main and control antenna(s) should, wherever feasible, be co-located. The referenced differential path delay requirements are maximum values necessary to assure correct Interrogation Sidelobe Suppression (ISLS) operation.

2.2.1.2 Operating Frequencies (NU)

(NU) Each transmission channel of the antenna subsystem shall be designed to transmit RF energy in a frequency band, nominally centred on 1030 MHz, that is consistent with the interrogation encoding and transmitter requirements defined, or referenced by, paragraph 3.4 of Annex A to Part I.

(NU) Each reception channel of the antenna subsystem shall be designed to receive RF energy in a frequency band, nominally centred on 1090 MHz, that is consistent with the receiver and reply decoding requirements defined, or referenced by, paragraph 3.5 of Annex A to Part I.

2.2.1.3 Polarisation (NU)

(NU) Each antenna (/ antenna array) shall be mounted such that polarisation is predominantly vertical relative to the horizontal plane of the host platform, as defined in paragraph 2.2.1.4.

2.2.1.4 Radiation Patterns and Coverage (NU)

(NU) The coverage of the interrogator installation shall be consistent with the coverage requirements of the host platform and any associated primary sensor(s), referenced to the coordinate system shown in Figure A-1, whereby:

(a) Angles of azimuth φ are defined in the range 0° to 360°, where 0° is defined to be directly ahead of the platform and angles increase in a clockwise sense as viewed from above.

(b) Angles of elevation θ are defined in the range -90° to 90°, where -90° is defined to be directly below the platform and 90° directly above.

(c) The horizontal plane of the platform is the plane of 0° elevation when the platform is straight and level.

Notes:

1. Coverage is defined as a volume within which some defined performance criteria are to be met. Consistency of coverage requires the installed interrogator coverage to approximate that of each associated primary sensor.

2. The azimuthal and elevation coverage of the interrogator installation is a function of the radiation patterns of each antenna, combined with the characteristics of any antenna scanning facilities. The range coverage of the interrogator installation is a function of the gain of each antenna, combined with the signal path losses, transmitter power levels and receiver sensitivities associated with each antenna channel.

3. Most interrogator installations operate in conjunction with one or more primary sensors (whether, for example, a primary radar, or simply the use of a sight for manual (visual) detection). Some installations may however be used independently where only a surveillance capability is required.

(NU) The radiation pattern of the main antenna(s) shall:

(a) Be directional in azimuth, with a half-power beamwidth that is simultaneously:

    (i) Sufficiently wide as to meet the installed interrogator's required performance criteria.

    (ii) Minimised, both to meet any installed interrogator target azimuth resolution requirements and to limit system interference.

(b) Have sufficient beamwidth in elevation to meet the installed interrogator's elevation coverage requirements while being minimised, or shaped, to limit system interference.

(c) Have minimised sidelobe and backlobe levels.

Notes:

1. For interrogator installations comprising multiple main antennas, the coverage requirements of each antenna may be a subset of the overall installed interrogator coverage requirements.

2. Radiation patterns are typically compromise solutions. Reduced beamwidths correspond to higher directional antenna gain, thus reducing the transmitter power and receiver sensitivity requirements associated with any desired operational range. Available gain is however generally limited by antenna aperture constraints, while too narrow a beamwidth may result in pattern alignment issues and / or impose unacceptable limitations on scan rates (where applicable).

3. Absolute limits on sidelobe and backlobe levels are constrained by ISLS requirements, as reflected by the effective radiated power requirements defined in paragraphs 2.2.2.1 / 2.2.2.2 and RSLS requirements, as reflected by the effective sensitivity requirements defined in paragraphs 2.2.3.1 / 2.2.3.2.

(NU) The radiation pattern of any control antenna used for interrogation control transmissions shall be consistent with ISLS requirements, as reflected by the effective radiated power requirements defined in paragraph 2.2.2.2.

Notes:

1. ISLS performance is predicated on the relative effective radiated power of the main beam and control beam components of an interrogation at any given azimuth and elevation angle. For those azimuth and elevation angles corresponding to the main lobe of the main antenna, the power of the main beam component is required to exceed that of the control beam component, whereas at all other angles the power of the control

beam component should equal, or exceed, that of the main beam component.

2. ISLS may be used in combination with RSLS for the purposes of synchronous sidelobe response elimination.

(NU) The radiation pattern of any control antenna(s) used for RSLS processing shall be consistent with RSLS requirements applicable to the installed interrogator.

Notes:

1. RSLS performance is predicated on the relative effective sensitivity of the main beam and control beam channels for reply signals received at any given azimuth and elevation angle.

2. RSLS operation may utilise the combined radiation patterns of multiple control antennas to achieve the required level of performance.

(NU) The radiation pattern of any control antenna(s) used for monopulse processing shall be consistent with the target azimuth accuracy requirements applicable to the installed interrogator.

Note:

1. Monopulse performance is predicated on the relative effective sensitivity of the main beam and control beam channels for reply signals received at any given azimuth and elevation angle within the main lobe of the main antenna.

(NU) For those installations in which there is a requirement to align the radiation patterns of the interrogator and any associated primary sensor, the boresight of the interrogator main antenna pattern should be aligned with that of the primary to an accuracy of within ± 10% of the half power beamwidth of the interrogator main antenna pattern.

Note:

1. This recommendation is only applicable to those installations for which automatic association of targets detected by primary and IFF sensors is assumed.

2.2.1.5 Signal Path Losses (NU)

(NU) The total loss between each interrogator antenna port and its corresponding antenna(s) should be minimised and shall be consistent with the power budgets used for the determination of interrogator peak power and interrogator minimum sensitivity, as defined in paragraphs 2.2.2.3 and 2.2.3.3 respectively.

Note:

1. The total loss includes insertion and mismatch losses for every component in the transmission path.

(NU) The differential loss between antenna channels used for the transmission of main beam and control beam components of any interrogation should be minimised and shall be consistent with ISLS requirements, as reflected by the effective radiated power requirements defined in paragraphs 2.2.2.1 / 2.2.2.2.

(NU) The differential loss between antenna channels used for any RSLS processing of replies should be minimised and shall be consistent with RSLS requirements, as reflected by the effective sensitivity requirements defined in paragraph 2.2.3.1 / 2.2.3.2.

(NU) The differential loss between antenna channels used for any monopulse processing of replies should be minimised and shall be consistent with the target azimuth accuracy requirements applicable to the installed interrogator.

2.2.1.6 Signal Path Delays (NU)

(NU) For each channel of the antenna subsystem, the total signal path delay between the interrogator antenna port and its corresponding antenna(s) should be minimised.

(NU) For any interrogator installation requiring a Mode S ISLS capability (refer to paragraph 2.3.1 of Annex A to Part I and to paragraph 2.2.5.1 of Annex D to Part I), the differential signal path delay between antenna channels used for the transmission of the main beam and control beam components of any interrogation shall be such that the timing offset of main beam and control beam signals received at any location relative to the host platform does not exceed ± 50 ns.

Notes:

1. This requirement assures correct ISLS operation for all modes including Mode S.

2. This requirement implies a maximum differential delay of (50 – (D + (T x 10^9)) ns, where D allows for the maximum differential delay of main and control beam components at the interrogator antenna ports (ns) and where T is the maximum free space signal delay due to antenna separation (i.e. T = d / c, where T is the time difference (s), d is the antenna separation (m) and c is the speed of light (ms^{-1})). This in turn implies a maximum antenna separation of nominally 50 feet assuming no differential delay between main and control beam components at the interrogator antenna ports.

(NU) For any interrogator installation not requiring a Mode S ISLS capability, the differential signal path delay between antenna channels used for the transmission of the main beam and control beam components of any interrogation shall be such that the timing offset of main beam and control beam signals received at any location relative to the host platform does not exceed ± 100 ns.

Notes:

1. This requirement is derived from Mode 4 pulse position tolerance requirements and assures correct ISLS operation for all modes excluding Mode S.

2. This requirement implies a maximum differential delay of (100 – (D + (T x 10^9)) ns, where D allows for the maximum differential delay of main and control beam components at the interrogator antenna ports and where T is the maximum free space signal delay due to antenna separation (i.e. T = d / c, where T is the time difference (s), d is the antenna separation (m) and c is the speed of light (ms^{-1})). This in turn implies a maximum antenna separation of nominally 100 feet assuming no differential delay between main and control beam components at the interrogator antenna ports.

(NU) The differential signal path delay between antenna channels used for any RSLS and monopulse processing of replies should be minimised and shall be consistent with the RSLS and target accuracy requirements applicable to the installed interrogator.

2.2.1.7 Inter-channel Isolation (NU)

(NU) The isolation between antenna channels used for the transmission of the main and control beam components of any interrogation should be maximised and shall be consistent with ISLS requirements, as reflected by the effective radiated power requirements defined in paragraphs 2.2.2.1 / 2.2.2.2.

(NU) The isolation between antenna channels used for any RSLS processing of replies should be maximised and shall be consistent with the RSLS requirements applicable to the installed interrogator.

2.2.1.8 Power Handling (NU)

(NU) The antenna subsystem should withstand peak power levels of (P + 3 dB) W on each antenna channel without voltage flashover, where P is the maximum peak power level of the main beam or control component of any interrogation signal present at any interrogator antenna port.

(NU) The antenna subsystem should be designed to radiate mean signal power levels of (P + 3dB) x D/100 W on each antenna channel, where P is the maximum peak power level of the main beam or control component of any interrogation signal present at any interrogator antenna port and D is the maximum long term transmitter duty cycle expressed as a percentage.

2.2.1.9 VSWR Characteristics (NU)

(NU) Not defined.

Note:

1. Interrogator antenna subsystem VSWR characteristics will typically be constrained by the installation. There is no specific requirement.

2.2.2 Transmitter Output Power (NU)

(NU) Transmission power requirements are a function of the required installed system coverage. The objective is to ensure that an adequate power budget exists between the interrogator and any transponder within coverage, as applicable over the most adverse of operational conditions, such as to maintain reliable communications while also avoiding the use of excessive transmission power (which would result in increased interference levels and thus degrade overall system performance).

(NU) To achieve this objective:

(a) The effective radiated power required on the boresight of the main antenna radiation pattern is established, based upon the assumed receiver characteristics of an installed transponder, the predicted propagation losses applicable to any applicable operational environment and an allowance made for gain loss across the effective beamwidth of the antenna.

(b) The peak power of the main beam component of interrogations required at the relevant interrogator antenna port is established, based upon the required effective radiated power on boresight, the gain of the main antenna and the total signal path losses in the main antenna transmission path.

(c) The peak power of the control beam component of interrogations required at the relevant interrogator antenna port is established, based upon the required peak power of the main beam component, ISLS requirements defined in respect of the relative effective radiated power requirements of main and control antennas, together with differential losses in the main and control antenna transmission paths.

(NU) The required main antenna effective radiated power shall be established on the basis of maximum range requirements (refer to paragraph 2.2.2.1).

(NU) For interrogator installations that have a required main antenna effective radiated power requirement greater than 82.5 dBm, a facility to permit the effective radiated power to be limited to a level that is $\leq$ 82.5 dBm shall be provided.

(NU) For interrogator installations that may be employed in applications with varying maximum range applications, a facility to permit the effective radiated power to be limited to a level to that required by the specific application shall be provided.

Note:

1. It is recommended that all interrogator installations, including those intended to operate over a fixed range, include facilities to permit adjustment of effective radiated power. Such facilities may facilitate the licensing / authorisation of interrogation transmission within operating environments in which system interference is considered to be an issue.

2.2.2.1 Effective Radiated Power: Main Antenna (NU)

(NU) The effective radiated power required on the boresight of the main antenna shall be established by full analysis of link power budgets, on the basis of the required coverage and the applicable operational environments, in accordance with AEtP-5, Volume 4 (MISPEC: The Analysis of IFF System Performance Characteristics).

(NU) Analysis of link power budgets shall be made using the following link budget equation:

$$P_{IE} = T_S + L_P + M_L + L_S \quad \text{dBm}$$

where:

P_{IE}	=	Interrogator effective radiated power
Ts	=	Transponder effective sensitivity
L_P	=	Propagation losses
M_L	=	Link Margin
L_S	=	Interrogator antenna pattern / scan loss

(NU) The transponder effective sensitivity shall be derived from the following equation:

$$T_S = MTL + L_T + L_A - G_T \quad \text{dBm}$$

where:

MTL	=	Transponder sensitivity (dBm)
L_T	=	Transponder feeder losses (dB)
L_A	=	Transponder antenna pattern loss (dB)

G_T = Transponder antenna gain (dBi)

(NU) The propagation losses shall be derived from the following equation:

$$L_P = L_{FS} + L_{AT} + L_{PR} \quad \text{dB}$$

where:

L_{FS} = Free space path loss (dB), given by $(93 + 20 \log_{10} R)$, where R is the required range in km

L_{AT} = Atmospheric losses (dB)

L_{PR} = Propagation loss due to multipath antenna lobing (dB)

(NU) The link margin shall be derived from the following equation:

$$M_L = M + M_M \quad \text{dB}$$

where:

M = A margin that allows for tolerances and computational accuracy (dB)

M_M = A mode specific link margin that compensates for differential transponder sensitivities in different modes of operation (dB)

(NU) The following fixed parameter values shall be assumed when establishing the required effective radiated power on the boresight of the main antenna:

MTL (excluding Mode 5)	=	-74 dBm
MTL (Mode 5)	=	-80 dBm
L_T	=	3 dB
L_A	=	3 dB
G_T	=	0 dBi

(NU) The following maximum parameter values shall be assumed when establishing the required effective radiated power on the boresight of the main antenna:

L_{AT}	$\leq$	1.3 dB
L_{PR}	$\leq$	3 dB
M	$\leq$	3 dB

Notes:

1. The antenna pattern / scan loss, L_S (dB), accounts for antenna radiation pattern loss across the effective antenna beamwidth. This is the difference between the maximum gain on the antenna boresight and the minimum gain over the beamwidth in which system performance is defined.

2. The parameter M_M is not described within AEtP-5. This margin is introduced to maintain a fixed transmission power, irrespective of the mode of operation. Refer to paragraph 3.4.2.1 of Annexes B, C, D and E to Part I.

3. Example calculations and further explanatory notes are provided within AEtP-11.

2.2.2.2 Effective Radiated Power: Control Antenna (NU)

(NU) The effective radiated power of the control beam component of any interrogation:

(a) Shall be below that of the main beam component by at least 9 dB at any azimuth and elevation within the desired sector of interrogation.

(b) Should be equal to, or greater than, that of the main beam component at any azimuth and elevation within the desired sector of suppression, but also be limited such as not to cause unnecessary levels of system interference.

Notes:

1. Relative main beam / control beam radiated power levels are established by both main and control antenna radiation patterns and, where independent power control

is provided for the main and control beam components of interrogations, by differential peak power levels.

2. The desired sector of interrogation corresponds to the effective beamwidth of the main-lobe of the main antenna. Between this sector and the desired sector(s) of suppression is an "ISLS grey region" within which transponder replies may, or may not, be suppressed.

3. For any interrogator installation that provides control over transmitted power levels, these requirements apply for all power level settings.

4. For any interrogator installation that provides control over antenna configuration, for example antenna selection and / or electronic beam-steering, these requirements apply for all antenna configurations.

5. Ideally, the effective radiated power of the control beam would exceed that of the main beam throughout the desired sector of suppression, however this is not generally necessary where the radiated power level of main beam sidelobes / backlobes is more than 40 dB below the peak main beam radiated power level.

2.2.2.3 Interrogator Peak Power (NU)

(NU) The peak power of the main beam component of interrogations, as required at the relevant interrogator antenna port, shall be determined from the required main antenna effective radiated power, as calculated in paragraph 2.2.2.1, using the following equation:

$$P_{IM} = P_{IE} + L_{IM} - G_{IM} \quad \text{dBm}$$

where:

P_{IM} = Interrogator peak power, main beam component

P_{IE} = Interrogator effective radiated power, main antenna (dBm)

L_{IM} = Total interrogator antenna subsystem signal path losses, main antenna transmission channel (dB)

G_{IM} = Interrogator antenna gain on boresight, main antenna (dBi)

Note:

1. Example calculations are provided within AEtP-11.

(NU) The peak power of the control beam component of interrogations, as required at the relevant interrogator antenna port, shall be selected to assure compliance with the control antenna effective radiated power requirements defined in paragraph 2.2.2.2, taking into account the peak power of the main beam component of interrogations together with any differential signal path losses in main and control antenna transmission paths.

Notes:

1. For interrogator installations using a single transmitter in conjunction with external signal path switching to provide both main and control beam components of interrogations, control of relative effective radiated power will be limited to appropriate selection of antenna patterns and transmission channel signal path losses.

2. Interrogator equipment may provide facilities to adjust the relative power of main beam and control beam components of interrogations to provide control over the desired sector of interrogation using “beam-sharpening” techniques. Similar facilities may be provided in the receiver using RSLS techniques.

3. For any interrogator installation that provides control over antenna configuration, the required peak power of the control beam component of interrogations may differ for differing antenna configurations.

2.2.3 Receiver Sensitivity (NU)

(NU) Receiver sensitivity requirements are a function of the required installed system coverage. The objective is to ensure that an adequate power budget exists between the interrogator and any transponder within coverage, as applicable over the most adverse of operational conditions, such as to maintain reliable communications while also avoiding excessive sensitivity (which could result in degraded installed interrogator performance).

(NU) To achieve this objective:

(a) The effective sensitivity required on the boresight of the main antenna radiation pattern is established, based upon the assumed transmitter characteristics of an installed transponder, the predicted propagation losses applicable to any applicable operational environment and an allowance made for gain loss across the effective beamwidth of the antenna.

(b) The minimum sensitivity required at the relevant interrogator antenna port is established, based upon the required effective sensitivity on boresight, the gain of the main antenna and the total signal path losses in the main antenna transmission path.

(c) The sensitivity levels required in respect of any control channels provided for the purposes of RSLS and / or monopulse processing of replies at the relevant interrogator antenna ports are established, based upon the relative effective sensitivity of main and control antennas across all azimuth and elevation angles, differential losses in the main and control antenna transmission paths, together with RSLS and target accuracy requirements applicable to the installed interrogator.

Note:

1. Receiver sensitivity levels are established on the basis of maximum range requirements. Sensitivity control facilities may be provided within the interrogator to reduce sensitivity when operating at reduced ranges.

2.2.3.1 Effective Sensitivity: Main Antenna (NU)

(NU) The effective sensitivity required on the boresight of the main antenna shall be established by full analysis of link power budgets, on the basis of the required coverage and the applicable operational environments, in accordance with AEtP-5, Volume 4 (MISPEC: The Analysis of IFF System Performance Characteristics).

(NU) Analysis of link power budgets shall be made using the following link budget equation:

$$S = T_P - (L_P + M_L + L_S) \quad \text{dBm}$$

where:

S = Interrogator effective sensitivity

T_P	=	Transponder effective radiated power
L_P	=	Propagation losses
M_L	=	Link Margin
L_S	=	Interrogator antenna pattern / scan loss

(NU) The transponder effective radiated power shall be derived from the following equation:

$$T_P = P_T + G_T - (L_T + L_A) \quad \text{dBm}$$

where:

P_T	=	Minimum transponder peak power (dBm)
L_T	=	Transponder feeder losses (dB)
L_A	=	Transponder antenna pattern loss (dB)
G_T	=	Transponder antenna gain (dBi)

(NU) The propagation losses shall be derived from the following equation:

$$L_P = (L_{FS} + L_{AT} + L_{PR}) \quad \text{dB}$$

where:

L_{FS}	=	Free space path loss (dB), given by ($93 + 20 \log_{10}R$), where R is the required range in km
L_{AT}	=	Atmospheric losses (dB)
L_{PR}	=	Propagation loss due to multipath antenna lobing (dB)

(NU) The link margin shall be derived from the following equation:

$$M_L = M + M_M \quad \text{dB}$$

where:

M	=	A margin that allows for tolerances and computational accuracy (dB)

M_M = A mode specific link margin that allows for differential interrogator sensitivities in different modes of operation. This compensates for an equivalent factor in the transmission link power budget, as defined in paragraph 2.2.2.1 (dB)

Notes:

1. The antenna pattern / scan loss, L_S (dB), accounts for antenna radiation pattern loss across the effective antenna beamwidth. This is the difference between the maximum gain on the antenna boresight and the minimum gain over the beamwidth in which system performance is defined.

2. The parameter M_M is not described within AEtP-5. This compensating margin maintains balanced transmission and reception path link budgets in each supported mode of operation. Refer to paragraph 3.5.5.1 of Annexes B, C, D and E to Part I.

3. Example calculations are provided within AEtP-11.

2.2.3.2 Control Antenna (NU)

(NU) The effective sensitivity required in respect of each control antenna used in the processing of replies shall be consistent with any applicable RSLS and azimuth accuracy requirements.

Note:

1. There are no generally applicable control antenna sensitivity requirements as both RSLS and azimuth accuracy performance have no direct impact on system interoperability.

2.2.3.3 Interrogator Minimum Sensitivity (NU)

(NU) The minimum sensitivity required at the relevant interrogator antenna port is mode specific and should be derived from the required main antenna effective sensitivity in that mode, as calculated in paragraph 2.2.3.1, using the following equation:

$$S_I = S + G_{IM} - L_{IM} \quad \text{dBm}$$

where:

S_I = Interrogator minimum sensitivity

S = Interrogator effective sensitivity (dBm)

G_{IM} = Interrogator antenna gain on boresight, main antenna (dBi)

L_{IM} = Total interrogator antenna subsystem signal path losses, main antenna transmission channel (dB)

Note:

1. Example calculations are provided within AEtP-11.

2.2.4 Platform Integration (NU)

2.2.4.1 Functional Partitioning (NU)

(NU) The functionality of the equipment component of the interrogator installation may be integrated or distributed, with individual functions implemented using either dedicated units and / or functional elements within non-dedicated systems. Irrespective of the method of partitioning, the requirements defined in respect of both equipment and installed characteristics within Parts I, II ands III of this STANAG shall be met.

Notes:

1. Some interrogator installations may, for example, permit modes of operation and interrogation scheduling to be controlled via centralised Command and Control (C2) facilities. Within such installations, the C2 system is responsible for ensuring compliance with limits defined in respect of interrogation rates if no equivalent facility is provided elsewhere within the installation.

2. Some interrogator installations may, for example, require control and display functions to be provided via centralised facilities or to be provided via some combination of dedicated and centralised facilities. Within such installations, any use of centralised

facilities must be consistent with the functional requirements defined in Part I.

2.2.4.2 System Compatibility (NU)

(NU) The implementation and operation of the interrogator installation shall be compatible with the implementation and operation of other host platform facilities, including any associated sensor system(s).

Notes:

1. Compatibility requirements in respect of coverage matching are specified in paragraph 2.2.1.4.

2. The interrogator installation may be required to operate independently of, or synchronised with, other systems. Synchronised operation may be required in respect of the control of antenna bearing and / or in respect of signal transmission and reception timing.

2.2.4.3 Co-site Interoperability (NU)

(NU) The interrogator installation shall comply with all functional and performance requirements when operating in the presence of other (co-sited) platform systems.

Note:

1. Mutual interference between systems is generally mitigated by adequate antenna separation together with appropriate filtering of out of band signals within transmitter and / or receiver paths. Mutual external suppression may be necessary for systems operating in the same frequency band(s) both to inhibit mutual interference and to protect against damage.

2.2.4.4 External Suppression (NU)

(NU) Any interrogator installation used in conjunction with co-sited systems operating in the same frequency band(s) should include external suppression output and external suppression input facilities.

(NU) For those interrogator installations that include external suppression output facilities, suppression periods shall be the minimum necessary to ensure co-sited system interoperability.

Note:

1. The use of extended suppression periods can potentially be used to suppress own platform transponder responses to multipath reflections of own interrogations, however this will compromise transponder performance and thus may place the host platform at an increased risk of engagement. Reference should be made to AEtP-11 in respect of guidance for the use of external suppression.

(NU) For those interrogator installations that include external suppression input facilities, it should be ensured that the combined suppression periods attributable to co-sited systems do not unduly degrade interrogator performance.

Notes:

1. Requirements applicable to other systems are assumed to limit suppression periods to the minimum necessary to ensure co-sited system interoperability.

2. Where appropriate, an interrogator should defer the transmission of any scheduled interrogation during any suppression period and mitigate against suppression conditions whereby identification performance may be degraded (e.g. by means of re-interrogation or the provision of a warning indication).

2.2.4.5 External Data Links (NU)

(NU) For those interrogator installations interfacing to external systems by means of data links, open networking standards and protocols should be used wherever possible.

Notes:

1. For interrogator installations comprising one element of an integrated surveillance environment (e.g. a ground system linked to the NATO Air Command and Control System (ACCS)), or operating remotely through the use of data links, the preferred standard for data exchange is the Eurocontrol ASTERIX standard.

2. Interrogator installations may be connected to civil data networks for the purposes of importing data (e.g. to assist in the compilation of recognised air pictures).

2.2.4.6 Access (NU)

(NU) The interrogator installation shall provide adequate access to those facilities and functions required for operational and maintenance purposes, as appropriate to the platform and its deployment.

Notes:

1. Operational and maintenance access may include provisions for the identification and protection of cryptographic assets, the loading of key and mission data and safety interlocks.

2. Where there is a requirement for remote key loading, the associated facilities are to be considered as a component of the interrogator installation. Any such facilities are subject to the approval of the relevant national agencies.

2.2.5 Installation Test (NU)

(NU) Means shall be provided to verify the operational status of the interrogator installation.

Note:

1. Where appropriate, verification of operational status may be carried out in conjunction with a reference transponder.

2.3 Air Platforms (NU)

2.3.1 Antenna Radiation Patterns and Coverage (NU)

(NU) Antenna coverage requirements for air platform installations shall be consistent with the generic requirements specified in paragraph 2.2.1.4.

2.3.2 Platform Configuration (NU)

(NU) Air platform interrogator installations shall be configured such that only those modes of operation and those interrogation formats assigned to the designated operational application are available for use.

Note:

1. Interrogation formats associated with SHORAD applications or assigned for “Lethal” use are only to be used in accordance with

the limitations of use defined in Part I and in accordance with operational procedures defined in ACP 160.

(NU) Guidance for the implementation and integration of air platform interrogator installations is provided in AEtP-11.

2.4 Surface Platforms (NU)

2.4.1 Antenna Radiation Patterns and Coverage (NU)

(NU) Antenna coverage requirements for surface platforms shall be consistent with the generic requirements specified in paragraph 2.2.1.4.

2.4.2 Platform Configuration (NU)

(NU) Surface platform interrogator installations shall be configured such that only those modes of operation and those interrogation formats assigned to the designated operational application are available for use.

Note:

1. Interrogation formats associated with SHORAD applications or assigned for “Lethal” use are only to be used in accordance with the limitations of use defined in Part I and in accordance with operational procedures defined in ACP 160.

(NU) Guidance for the implementation and integration of surface platform interrogator installations is provided in AEtP-11.

2.5 Ground Platforms (NU)

2.5.1 Antenna Radiation Patterns and Coverage (NU)

(NU) Antenna coverage requirements for ground platform installations shall be consistent with the generic requirements specified in paragraph 2.2.1.4.

2.5.2 Platform Configuration (NU)

(NU) Ground platform interrogator installations shall be configured such that only those modes of operation and those interrogation formats assigned to the designated operational application are available for use.

Note:

1. Interrogation formats associated with SHORAD applications or assigned for “Lethal” use are only to be used in accordance with

the limitations of use defined in Part I and in accordance with operational procedures defined in ACP 160.

(NU) Guidance for the implementation and integration of ground platform interrogator installations is provided in AEtP-11.

3. TRANSPONDER CHARACTERISTICS (NU)

3.1 Introduction (NU)

(NU) IFF system performance is dependent upon the concept of an installed transponder being the "constant element" of the system. A transponder is installed on a platform to ensure its protection against attack from own forces, thus the installation must ensure that adequate performance is maintained without compromising the operational effectiveness of the host platform. It cannot be over emphasised that incorrect or poor installations will place the host platform at risk of engagement.

(NU) A transponder installation comprises the transponder equipment (which may comprise one or more units, dependent upon the level of integration of cryptographic and control / display facilities) and the transponder antenna subsystem, together with all necessary inter-unit and host platform interfacing.

(NU) The general and platform specific installed characteristics defined herein are those considered to be the minimum necessary to ensure adequate IFF system performance. The specified requirements shall apply over all service conditions within the operational envelope of the host platform.

3.2 General Installed Characteristics (NU)

3.2.1 Antenna Subsystem Characteristics (NU)

(NU) The transponder antenna subsystem shall comprise those components in the transponder installation connected either directly or indirectly to the antenna ports of the transponder equipment, including, but not limited to, radiating elements, transmission lines and any associated connectors, filters, matching devices and protection devices.

(NU) The antenna characteristics defined herein shall apply to all defined operational configurations of the platform, taking account of alternative external stores fits and alternative equipment fits impacting upon the electromagnetic environment.

3.2.1.1 Configuration (NU)

(NU) The transponder antenna subsystem shall comprise either one or two antennas (or antenna arrays), as necessary to provide the coverage referenced by paragraph 3.2.1.4, with each antenna connected to a transponder antenna port via a suitable transmission network comprising all necessary cables, connectors and ancillary devices required to meet the characteristics defined in paragraphs 3.2.1.2 to 3.2.1.9.

(NU) For those antenna subsystems comprising two antennas (or antenna arrays), the separation between each antenna:

(a) Shall be minimised such as to meet the differential path delay requirements defined in paragraph 3.2.1.6.

(b) Should not exceed 25 feet in the horizontal plane of the host platform, as defined in paragraph 3.2.1.4.

Notes:

1. Each antenna and associated transmission network are components of one "channel" of a transponder installation providing a spatial diversity capability.

2. A typical installation will comprise two diversity channels, although a single channel may suffice for some platforms.

3.2.1.2 Operating Frequencies (NU)

(NU) Each channel of the antenna subsystem shall be designed to:

(a) Receive RF energy in the 1030 ± 10 MHz frequency band.

(b) Transmit RF energy in the 1090 ± 10 MHz frequency band.

3.2.1.3 Polarisation (NU)

(NU) Each antenna (/ antenna array) shall be mounted such that polarisation is predominantly vertical relative to the horizontal plane of the host platform, as defined in paragraph 3.2.1.4.

3.2.1.4 Radiation Patterns and Coverage (NU)

(NU) The azimuthal and elevation coverage of the antenna subsystem, as defined by the combined radiation patterns of each antenna, shall comply with the relevant platform specific requirements detailed in paragraphs 3.3.1 and 3.4.1 for air and surface platforms respectively, referenced to the coordinate system shown in Figure A-1, whereby:

(a) Angles of azimuth φ are defined in the range 0° to 360°, where 0° is defined to be directly ahead of the platform and angles increase in a clockwise sense as viewed from above.

(b) Angles of elevation θ are defined in the range -90° to 90°, where -90° is defined to be directly below the platform and 90° directly above.

(c) The horizontal plane of the platform is the plane of 0° elevation when the platform is straight and level.

3.2.1.5 Signal Path Losses (NU)

(NU) For each diversity channel of the antenna subsystem, the total loss between the transponder antenna port and its corresponding antenna should be minimised and shall meet the limits specified in paragraphs 3.3.1 and 3.4.1 for air and surface platforms respectively.

(NU) The differential total loss between each diversity channel of the antenna subsystem should not exceed 1 dB.

Notes:

1. The total loss includes insertion and mismatch losses for every component in the transmission path.

2. The differential loss recommendation assures adequate diversity performance taking into account the additional differences that will exist between diversity channels in respect of both antenna gains and signal path losses within the transponder equipment.

3.2.1.6 Signal Path Delays (NU)

(NU) For each diversity channel of the antenna subsystem, the total signal path delay between the transponder antenna port and its corresponding antenna should be minimised.

(NU) The differential signal path delay between each diversity channel of the antenna subsystem shall be such that, for replies transmitted in response to standard interrogation signals received at the transponder inputs at any RF level in the range MTL + 3 dB to -22 dBm, the difference in the mean reply delay between diversity channels, for an interrogator at any arbitrary location, does not exceed 0.13 μs.

Note:

1. The permitted differential signal path delay between each diversity channel of the antenna subsystem is constrained by antenna separation and the differential reply delay of the transponder in each supported mode of operation. The maximum variation in mean reply delay due to antenna separation for antennas with the recommended maximum (horizontal) separation of 25 feet is 0.05 μs (two-way transmission delay in space). The maximum permitted differential transponder reply delay in any mode is 0.05 μs.

3.2.1.7 Inter-channel Isolation (NU)

(NU) The isolation between each diversity channel of the antenna subsystem, excluding losses due to signal coupling between radiating elements, shall be not less than 40 dB.

Note:

1. Some minimum level of isolation between radiating elements may additionally be required to protect the transponder receiver of one diversity channel against potential damage during the transmission of signals on the other diversity channel (if alternative protection facilities are not provided within the transponder equipment).

3.2.1.8 Power Handling (NU)

(NU) The antenna subsystem shall be designed to radiate mean signal power levels of 15 W on each diversity channel.

3.2.1.9 VSWR Characteristics (NU)

(NU) The maximum VSWR of the antenna subsystem, as measured at each transponder antenna port, shall not, except where precluded by installation limitations, exceed 1.5:1 for all frequencies in the ranges 1020 MHz – 1040 MHz and 1080 MHz – 1100 MHz under all phase conditions.

Note:

1. It is recognised that a maximum VSWR of 1.5:1 may not be feasible for all antenna installations. For these installations, the maximum VSWR should be minimised with a value not exceeding 2:1. VSWR characteristics must be consistent with signal path loss requirements, as defined in paragraph 3.2.1.5, and be allowed for by any VSWR monitoring facilities.

3.2.2 Platform Integration (NU)

3.2.2.1 Functional Partitioning (NU)

(NU) The functionality of the equipment component of the transponder installation may be integrated or distributed, with individual functions implemented using either dedicated units and / or functional elements within non-dedicated systems. Irrespective of the method of partitioning, the requirements defined in respect of both equipment and installed characteristics within Parts I, II ands III of this STANAG shall be met.

Note:

1. Some transponder installations may, for example, require control and display functions to be provided via centralised facilities or to be provided via some combination of dedicated and centralised facilities. Within such installations, any use of centralised facilities must be consistent with the functional requirements defined in Part I.

3.2.2.2 System Compatibility (NU)

(NU) The implementation and operation of the transponder installation shall be compatible with the implementation and operation of other associated host platform facilities.

Note:

1. The transponder installation will typically be required to operate in conjunction with host platform navigation systems and, in certain applications, in conjunction with an Airborne Collision Avoidance System (ACAS).

3.2.2.3 Co-site Interoperability (NU)

(NU) The transponder installation shall comply with all functional and performance requirements when operating in the presence of other (co-sited) platform systems.

Note:

1. Mutual interference between systems is generally assured by adequate antenna separation together with appropriate filtering of out of band signals within transmitter and / or receiver paths. Mutual external suppression may be necessary for systems operating in the same frequency band(s) both to inhibit mutual interference and to protect against damage.

3.2.2.4 External Suppression (NU)

(NU) Any transponder installation used in conjunction with co-sited systems operating in the same frequency band(s) should include external suppression input and external suppression output facilities.

(NU) For those transponder installations that include external suppression input facilities, it should be ensured that the combined suppression periods attributable to co-sited systems do not unduly degrade transponder performance.

Note:

1. Requirements applicable to other systems are assumed to limit suppression periods to the minimum necessary to ensure co-sited system interoperability. Reference should be made to AEtP-11 in respect of guidance for the use of external suppression.

3.2.2.5 External Data Links (NU)

(NU) For those transponder installations interfacing to external systems by means of data links, open networking standards and protocols should be used wherever possible.

3.2.2.6 Access (NU)

(NU) The transponder installation shall provide adequate access to those facilities and functions required for operational and maintenance purposes, as appropriate to the platform and its deployment.

Notes:

1. Operational and maintenance access may include provisions for the identification and protection of cryptographic assets, the loading of key and mission data and safety interlocks.

2. Where there is a requirement for remote key loading, the associated facilities are to be considered as a component of the transponder installation. Any such facilities are subject to the approval of the relevant national agencies.

3.2.3 Installation Test (NU)

(NU) Means shall be provided to verify the operational status of the transponder installation, including the antenna subsystem.

Note:

1. Integrity monitoring, without the use of external equipment, is required in accordance with the monitoring and test requirements defined in Annex A to Part I. Full operational verification will require the use of external test facilities, e.g. a “flight-line” test facility or equivalent, to verify the use of valid key variables and valid time.

3.3 Air Platforms (NU)

3.3.1 Antenna Radiation Patterns and Coverage (NU)

(NU) Antenna radiation patterns for air platform installations shall provide for essentially omni-directional coverage in azimuth, together with at least ± 30° coverage in elevation, relative to the horizontal plane of the platform (refer to paragraph 3.2.1.4).

(NU) The total antenna subsystem gain within the coverage volume defined by an azimuth range of 0° to 360° and elevation range of -30° to +30° shall be greater than -4dBi over 50% of the volume, -6 dBi over 80% of the volume and -8.5 dBi over 95% of the volume.

Notes:

1. The antenna subsystem comprises all components connected either directly or indirectly to the antenna ports of the

transponder equipment, as defined in paragraph 3.2.1. Signal path losses between any antenna port and its corresponding antenna element should not exceed 4 dB.

2. The required coverage is provided by either one or two antennas, as defined in paragraph 3.2.1.1.

3.3.2 Platform Configuration (NU)

(NU) Air platform transponder installations shall be configured such that only those modes of operation and those interrogation / reply formats assigned to the designated operational application are available for use.

Notes:

1. All modes of operation are potentially applicable to air platform applications.

2. Mode and format applicability is, beyond that specified by minimum interoperability requirements, dependent upon supported capabilities (e.g. the level of operation in Mode 5 and any ACAS capability).

(NU) Air platform transponder installations should be configured to accept default values of the Mode S Address, PIN and National Origin assigned to the host platform (refer to paragraph 4.8.6.1 of Annex D to Part I and to paragraphs 4.8.6.1 and 4.8.6.2 of Annex E to Part I).

(NU) Guidance for the implementation and integration of transponder installations is provided in AEtP-11.

3.4 Surface Platforms (NU)

3.4.1 Antenna Radiation Patterns and Coverage (NU)

(NU) Antenna radiation patterns for surface platform installations shall provide for essentially omni-directional coverage in azimuth, together with at least ± 30° coverage in elevation, relative to the horizontal plane of the platform (refer to paragraph 3.2.1.4).

(NU) The total antenna subsystem gain within the coverage volume defined by an azimuth range of 0° to 360° and elevation range of -30° to +30° shall, for platforms other than submarines, be greater than -4dBi over 50% of the volume, -6 dBi over 80% of the volume and -8.5 dBi over 95% of the volume.

Notes:

1. The antenna subsystem comprises all components connected either directly or indirectly to the antenna ports of the transponder equipment, as defined in paragraph 3.2.1. Signal path losses between any antenna port and its corresponding antenna element should not exceed 4 dB.

2. The required coverage is provided by either one or two antennas, as defined in paragraph 3.2.1.1. Negative elevation coverage requirements allow for platform pitch / roll.

3. For submarine platforms, the aim should be to achieve the coverage defined for other platforms, whilst allowing for a relaxation of up to 6 dB on any requirement, based upon the assumption of signal path losses not exceeding 10 dB.

3.4.2 Platform Configuration (NU)

(NU) Surface platform transponder installations shall be configured such that only those modes of operation and those interrogation / reply formats assigned to the designated operational application are available for use.

Notes:

1. All modes of operation are potentially applicable to surface platform applications. Mode C and Mode S are not intended for use by surface platforms, however these may be used (e.g. for the purposes of "back-to-back" testing in conjunction with an interrogator) provided that appropriate measures, as defined herein, are taken to preclude interference with civil ATC and ACAS.

2. Mode and format applicability is, beyond that specified by minimum interoperability requirements, dependent upon supported capabilities (e.g. the level of operation in Mode 5).

(NU) For those surface platform transponder installations that provide a Mode C and / or Mode S capability, the installation shall be configured in accordance with the requirements defined for surface platforms in paragraph 2.3.3 of Annex A to Part I.

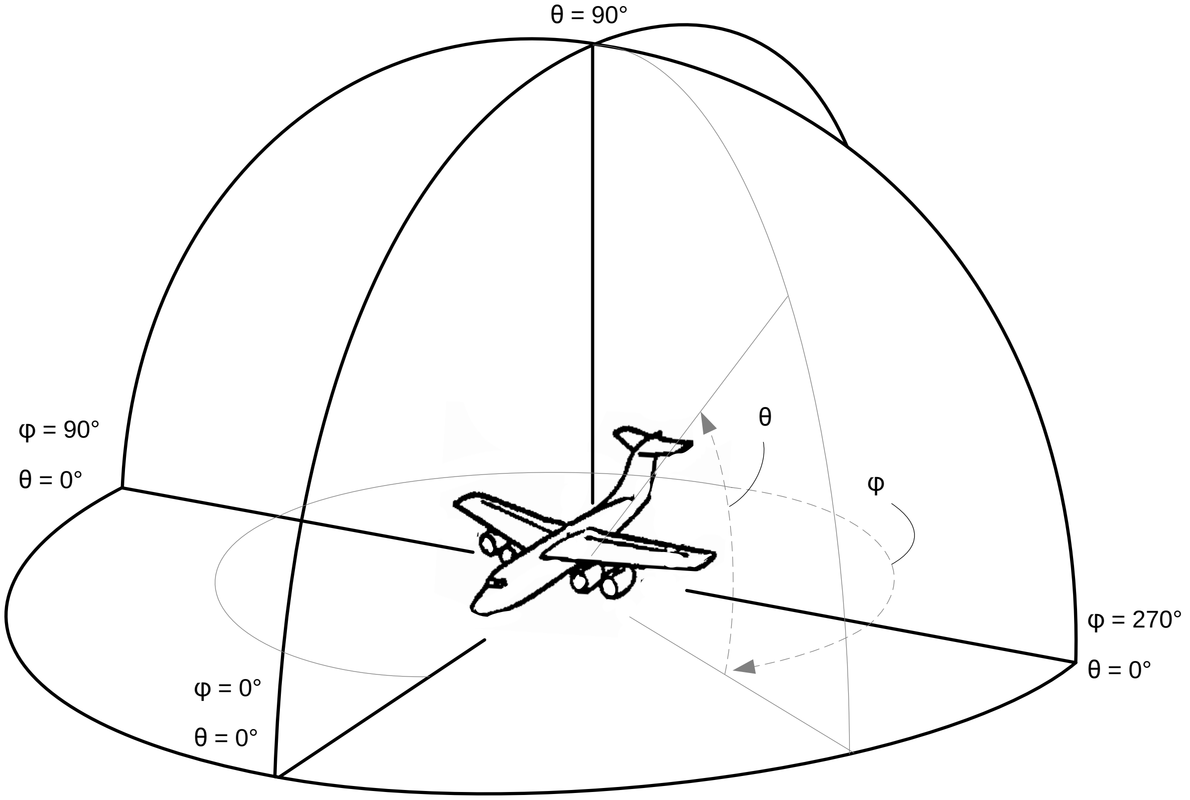
(NU) Surface platform transponder installations should be configured to accept default values of the Mode S Address (if applicable), PIN and National Origin assigned to the host platform (refer to paragraph

4.8.6.1 of Annex D to Part I and to paragraphs 4.8.6.1 and 4.8.6.2 of Annex E to Part I).

(NU) Guidance for the implementation and integration of transponder installations is provided in AEtP-11.

3.5 Ground Platforms (NU)

(NU) [Reserved]



Applicable to all platform types

Figure A-1 Radiation Pattern Co-ordinate Systems