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PERFORMANCE CRITERIA FOR MOD TERMINAL AIR TRAFFIC CONTROL PRIMARY SURVEILLANCE RADAR (WATCHMAN)

1. As chairman of the recently formed MOD Air Traffic Management Performance Criteria Working Group (ATMPC WG), our first major task has been to produce a set of Performance Criteria for MOD Terminal ATC radar (Watchman). Although the main focus of the WG is to look at the future MOD ATM capability requirements, this initial work has been generated by the need to assist industry in developing mitigation solutions for the effects of wind turbines on ATC radars. Currently, the MOD objects to numerous Windfarm developments due to the adverse impact on military flying operations caused by unwanted returns on ATC radar displays. In order for industry to develop appropriate solutions, it has been necessary to produce a document that sets out our existing radar capability standards; I should make clear that the criteria set out in this document are for MOD Terminal ATC radars and not Area Radar where ATC services are provided using National Air Traffic Services (NATS) radars under contract.

2. This document is released to the Department for Energy and Climate Change (DECC) who, as co-ordinator for the pan-Government MOU for developing aviation mitigation for Windfarms, will be inviting industry to tender (through the Aviation Management Board) for release of funding that will allow further development work of potential mitigation solutions. From an MOD perspective, the Performance Criteria contained in this document is key to ensuring solutions are developed to the required standard.

3. The technical information contained within the document has been developed with expert advice from the Air Defence and Air Traffic System (ADATS) Delivery Team, HQ AIR Command ATC staff and 56(R) Sqn Operational Evaluation Unit with assistance of the Military Flying Test Regulator department. Any questions on the attached should be addressed to myself in the first instance; alternatively, you can contact Wg Cdr Mike Coleman on 01494 494572 or by e-mail Michael.Coleman752@mod.uk.

<Signed Electronically>

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DEFENCE AIRSPACE AND AIR TRAFFIC MANAGEMENT (DAATM)

PERFORMANCE CRITERIA FOR MOD TERMINAL AIR TRAFFIC CONTROL PRIMARY SURVEILLANCE RADAR (WATCHMAN)

MOD TERMINAL AIR TRAFFIC CONTROL PRIMARY SURVEILLANCE RADAR

INTRODUCTION

1. The MOD has been providing Air Traffic Control (ATC) radar services in one form or another for over 50 years. These services are provided in the UK and overseas, in order that military operations and training can take place safely in all weathers and in increasingly congested and constrained airspace. More recently, increased development of Windfarms across the UK has degraded the performance of ATC radars, both military and civilian, as wind turbines produce unwanted 'clutter' on ATC radar displays; furthermore, recent proliferation of Windfarm developments means that this degradation is now reaching unacceptable levels. The effects of wind turbines occur when Windfarms are developed in line of sight to ATC radars where obscuration of aircraft returns are such that it is not possible to differentiate between actual aircraft and wind turbines; it is also possible for Windfarms to produce radar 'dark areas' which make detection of aircraft impossible. Given the MOD's reliance on operating within Class G airspace, if nothing is done to mitigate against the effects to Primary Surveillance Radar (PSR), there is a significant risk to the safety of military and civilian aircraft who rely on military air traffic controllers to maintain appropriate separation between aircraft in 'uncontrolled airspace'.

2. MOD ATC has historically objected to Windfarm developments for Flight Safety reasons with objections based on the assessed impact to ATC radars. However, the UK Government has increased pressure to reduce the number objections to Windfarm planning proposals and the MOD is now a co-signatory to a pan-Government Memorandum of Understanding (MOU), to work closely with potential developers in order to find mutually agreeable mitigation solutions. In order for industry to develop mitigation solutions for MOD Terminal ATC radars, it is necessary to provide the technical performance data so development work can be carried out to the required standard. Unfortunately, current MOD ATC radars (such as Watchman) have been in service for several decades and were procured to legacy capability requirements without specific Performance Criteria being published.

AIM

3. The aim of this document is to articulate a set of Performance Criteria for legacy MOD ATC Terminal surveillance radar capability, Watchman, in order to inform industry's development of Windfarm mitigation solutions. To that end, historical Performance Criteria for Watchman Radar are included at Annex A; however, in order to understand the context in which Watchman Radar is employed, it is important to have an overview of UK Air Traffic Services (ATS), the airspace in which ATS are provided, the impact of wind turbines on ATC radars and the future Terminal ATC requirement.

TERMINAL ATC RADAR SERVICES

4. Terminal ATC radar services are provided iaw Civil Aviation Publication 774 (UK Flight Information Services), full details of which can be found at www.caa.co.uk. For the

purposes of Windfarm mitigation work, the ATS most affected by the presence of wind turbine 'clutter' are as follows:

a. **Traffic Service**. A Traffic Service is where a controller provides specific surveillance derived traffic information to assist pilots in avoiding other traffic.

b. **Deconfliction Service**. Deconfliction Service is a surveillance-based ATS where the controller provides specific surveillance derived information and issues headings and/or levels aimed at achieving planned deconfliction minima against all aircraft in Class F/G airspace, or for positioning and/or sequencing.

Military controllers can be expected to provide radar services across a range of differing types of airspace both in the UK and overseas.

UK AIRSPACE

5. UK airspace is subdivided into various classes and functional areas in order to meet national or international airspace management requirements. For the purposes of international standardization, certain of these subdivisions are classified according to an International Civil Aviation Organisation (ICAO) system within which minimum ATS are specified. The 7 airspace classifications (Classes A to G) agreed within ICAO are adopted by the UK and are further categorized as Controlled Airspace (Classes A to E) and Uncontrolled Airspace (Classes F and G).

a. **Controlled Airspace**. Controlled Airspace (CAS) is a generic term used to describe airspace which is 'notified' as such in the UK Air Information Publication (UK AIP); within this airspace, all pilots (civil and military) are required to comply with ATC and other regulations forming part of the UK Air Navigation Order (ANO) and Rules of the Air Regulations. In essence, CAS comprises different types of control zone and control area to which are assigned one of the ICAO Airspace Classifications A to E as follows:

(1) **Class A**. In the UK, Class A airspace comprises all airways below FL195 (except where they pass through a Terminal Control Area (CTA) or Control Zone (CTR) of lower status), the London Terminal Manoeuvring Area (TMA), the Manchester TMA, the Daventry, Cotswold and Worthing Control Areas and the London CTR.

(2) **Class B**. Not allocated in the UK.

(3) **Class C**. Within the London and Scottish Flight and Upper Information Regions (FIR/UIR), Class C airspace extends from FL195 to FL660. The UIR contains the Hebrides Upper Transition Area (HUTA) and a network of domestic and international routes for use by General Air Traffic (GAT). Military upper airspace routes, based on TACAN beacons, are available to Operational Air Traffic operating above FL245.

(4) **Class D**. Class D CAS comprises CTAs and/or CTRs surrounding notified aerodromes, including some military aerodromes, together with part of the Scottish TMA.

(5) **Class E**. Class E CAS comprises the Scottish TMA at and below 6000ft AMSL and the Belfast TMA.

b. **Uncontrolled Airspace**. In Uncontrolled Airspace, it is not mandatory for pilots to receive an ATS; furthermore, the carriage of Secondary Surveillance Radar (SSR) transponders, which permit easy identification of aircraft, is not mandated. Uncontrolled Airspace can, by its nature, contain a multitude of aircraft including civilian aircraft (private and commercial), gliders, and military fast-jets and training aircraft flying at all altitudes and conducting aerobatic manoeuvres. This creates an 'unknown' traffic environment where the identity, intentions and height of numerous aircraft may not be available to radar controllers. As wind turbine 'clutter' is presented in the same manner as aircraft returns, controllers are required to provide advice to pilots to avoid such radar returns. Equally, if wind turbine 'clutter' produces 'dark areas', it is impossible for controllers to track the aircraft that is receiving a service or to see aircraft which are potentially conflicting. In marginal weather conditions, or when flying in cloud, pilots often request Traffic or Deconfliction services in order to ensure that they maintain separation from other airspace users; this is particularly the case for military aircraft where the nature of the flying task creates a high cockpit workload. In these circumstances, provision of effective ATS is crucial to ensuring the safety of aircraft and contributing to the success of their sorties. Operations within Class F and G are unpredictable and controllers must maintain awareness of the developing air picture. The radar equipment used must therefore be able to detect all aircraft likely to be operating within the required coverage. Uncontrolled airspace comprises Classes F and G as follows:

(1) **Class F**. Class F airspace consists of Advisory Routes (ADRs) along which a civil air traffic advisory service is available to participating aircraft. ADRs in the FIR may pass through, originate from or terminate in CAS.

(2) **Class G**. The remainder of UK airspace falls within Class G. This includes Military Aerodrome Traffic Zones (MATZs) which are established to provide added protection for military aircraft operating in/out of military aerodromes; however, civil aircraft are not mandated to recognize MATZs and may enter a MATZ without requesting an ATS.

In general, MOD Terminal radar controllers can be expected to provide radar services within Class A, C, D, F and G airspace.

6. While ICAO exists to regulate the purely civilian aspects of international aviation, it promulgates standards and recommended practices which member states agree to observe whenever possible. Although the MOD has no direct link with ICAO, it aims to conform with ICAO standards and practices provided there are no conflicting military requirements.

ASSESSMENT OF IMPACT OF WIND TURBINES ON TERMINAL ATC RADAR

7. The potential impact that a Windfarms will have on a Terminal ATC radar unit varies considerably depending on the differences in radar performance at various radar sites. Local topography can mask turbines thereby negating any impact on the radar; however, the local terrain may be such that turbines are clearly visible on radar and influence the performance of the entire radar system. Not only are wind turbines displayed to the controller as returns that need to be 'avoided' (under Deconfliction Service) or 'called' (under Traffic Service) but the performance of the radar can be degraded such that aircraft operating in their vicinity may not be displayed at all.

8. Protection of radar coverage in airspace used for an aerodrome traffic patterns and procedures remains the MOD's primary concern. Furthermore, it is particularly concerning that the proliferation of Windfarm planning proposals will lead to unacceptable levels of wind turbine 'clutter' on ATC radars making it impossible to provide effective Deconfliction/ Traffic Services; equally, this 'cumulative effect' that will be created should the current number of proposed Windfarms be developed will see a marked degradation of radar coverage as a whole. This proliferation is likely to have considerable impact not only on Flight Safety when providing ATS to aircraft flying published patterns and procedures but also in providing ATS to aircraft transiting across UK airspace**.**

FUTURE MOD TERMINAL ATC REQUIREMENT

9. Future MOD ATC equipment will be procured using principles consistent with the Defence Equipment and Support (DE&S) Project Oriented Safety Management System (POSMS). Legacy Air Traffic Management (ATM) equipment will be replaced by a Joint Military Air Traffic Management System (JMATS) for which contract award is set for 2013. JMATS equipment will be delivered to a set standard that will take into account NATO/ICAO/EuroControl guidelines and appropriate European regulations. JMATS Performance Criteria are currently being devised by MOD technical staff and industry partners will be required to consider Windfarm mitigation in the development of replacement equipment for Watchman.

MOD INTEGRATION PROCESS FOR WINDFARM MITIGATION SOLUTIONS

10. Ideally, JMATS should deliver a Windfarm-resilient PSR capability within the given constraints of available proven safe technology and within acceptable risk. Given that Watchman capability will not be replaced until the JMATS era, mitigation solutions for Windfarm effects require investigation as a matter of priority to enable the MOD to safely support the proliferation of Windfarm developments. However, implementation of a mitigation solution is predicated on the understanding that Windfarm developers will need to fund and resource any likely solution. Although work is currently ongoing within MOD DE&S to identify the process that needs to be followed, it is highly likely that the process will contain much of the following:

a. Funding for any technical analysis or taking forward a proposed mitigation solution should be wholly funded by the Windfarm developer(s).

b. Funding for any contracted activity would need to be received from any developer before any contract is placed with industry.

c. Funding to cover all of MOD’s internal costs necessary to facilitate analysis, risk mitigation and subsequent implementation of technical solutions to be provided by the Windfarm developer(s).

d. Copyright and Intellectual Property Rights would be owned by the MOD.

e. Through-life costs of a solution would need to be borne by the Windfarm developer(s) as there is no current MOD requirement for this integration and, therefore, no available budget.

HISTORICAL WATCHMAN PROCUREMENT AND SPECIFICATION INFORMATION

1.0	**CAVEATS**
1.1	The data below is a reflection of Performance Level for Watchman, baselined by MoD Procurement Executive in 1979 and may not reflect the existing Watchman performance or Requirement in 2009 and the future.
1.2	The detail below does not consider the entire end-to-end Surveillance System, which will be assessed for performance and Safety Performance in the 2009 environment.
1.3	The detail below only partially considers Sea Channel Requirement for Royal Naval Air Stations.
1.4	The detail below does not consider Secondary Surveillance systems.
1.5	The detail below does not consider Navigation Aids or other systems.
1.6	The detail below does not consider the use of Other Primary Surveillance Systems.
1.7	The detail below does not consider the Statutory and Regulatory Safety Requirements in 2009 and is unlikely to meet the future proposed Military Equipment Standards.
1.8	Any trials baselining performance against the standards below may be erroneous unless they are considered across all Azimuth bearings and on a system that is configured for operational use.
1.9	Any trials baselining performance against the standards below would be unlikely to meet future Statutory and Safety Regulatory Requirements in future.
1.10	The detail below is not endorsed by the MoD Flight Test Regulator as representing the Surveillance System Performance Requirement in future.
2.0	**Operational Requirement for Replacement of AR1, AR15/2 and ACR430 Radars (circa Dec 1979). D/DD Ops(Nav)(RAF)/6/2**
2.1	Operational Availability:
	2.1.1 Provide 2-D Primary Radar Information within the stated coverage envelope.
	2.1.2 98.5% for one Tx/Rx and 2 displays.
2.2	Reliability and Maintainability:
	2.2.1 MTBF of a single Tx/Rx system must exceed 500 hours.
	2.2.2 Depth B repair time should be under 30 mins.

2.3	Basic Radar Performance:	
	2.3.1	Target Size – $3m^2$ Swerling Case 1.
	2.3.2	Radar Rotation Rate – 15 rpm.
	2.3.3	Probability of Detection – 80% Pd in clear conditions.
	2.3.4	Probability of False Alarm shall be less than $1x10^{-6}$
	2.3.5	Coverage Envelope - 360° Azimuth, 0.5nm to 50nm and 5000 30000ft. 300ft above runway threshold to a range of 15nm. 3000ft at 35nm for LARS. Portland and Cambridge operate out to 75nm. Culdrose to 60nm. Sea Channel Coverage down to 40ft for dunking exercises required for RN.
	2.3.6	Data Update Rate shall be 15 times per minute. RN MTI Requirement.
	2.3.7	Zenithal Gap shall not extend to below 30° w.r.t Horizontal.
	2.3.8	Resolution Cell – 1.5° Azimuth or 0.5nm (or 0.25) Range with a probability of 95%.
	2.3.9	Clutter Performance. Must have Wx and PE suppression facilities. ***Use of Anti-Clutter Facilities shall not degrade the stated performance of the system.*** Blind Speed fading shall not occur from 25-600kts.
	2.3.10	Wx Penetration. Performance shall be attainable with up to 5mm rainfall.
	2.3.11	Video Map. Must allow 2 discrete maps to be displayed. On/Off and Gain controls.
	2.3.12	Power Supplies. Compatible with existing PSU's. 415 3Phase, 240V Single Phase, 220V single phase, 380V three phase.
	2.3.13	Processing and Displays. Can feed six operational displays and process two separate sensor feeds.
	2.3.14	Display Characteristics: 2.3.14.1 Range Selections 5, 10, 20, 40 and 60nm Required. 2.3.14.2 Range Markers at 1, 2, 5, 10 and 20nm intervals. 2.3.14.3 Offset Capability should be possible for displayed position. 2.3.14.4 Screen Persistence. Permits at least 4 but no more than 8 strikes of track history from Primary returns. SSR information shall have no afterglow.

	2.3.14.5 Range/Bearing Line shall be provided. 2.3.14.6 Compass Rose shall be fitted and illuminated. 2.3.14.7 Switch Illumination shall be provided. 2.3.14.8 Additional Controls.
2.4	ECCM Facilities:
	2.4.1 These are not reproduced in this document.
2.5	Physical Characteristics:
	2.5.1 Transportability. 3 units are to be fully transportable. 2.5.2 Windspeed Limits. Shall be able to turn in up to 70kt and survive 120kt winds. 2.5.3 Ice Loading. 60kt wind with ¼” thick ice load shall be attainable. 2.5.4 Temperature/Humidity. -40°C to +55°C. 0-100% Humidity from -40°C to +35°C and 0-60% Humidity from +35°C to +55°C. 2.5.5 Display dimensions. 400-450mm diameter. Length under 1033mm, width under 488mm, height under 730mm. 2.5.6 Blast protection. Minimise effect of rapid air pressure variations from blast. 2.5.7 Battle Damage Repair. Designed for rapid replacement of sub assemblies. 2.5.8 TouchDown Markers. To be provided with each unit.
3.0 Plessey Procurement Specification RSL 2610-211(1)	
3.1	System Features and Performance:
	3.1.1 Radar Coverage on $3m^2$ Target at 80% Pd, coverage extends to 76nm in range and 38000ft in height. 3.1.2 Maximum Display Range is 60nm is determined by PRF (1100pps). 3.1.3 Antenna Rotation Rate is 15rpm. 3.1.4 Pd falls to 50% when rain and ground clutter coincide. 3.1.5 No Blind speeds below 2000kts. 3.1.6 MTBF of 729 hours.

3.2	Standard Watchman System Data Summary:
	3.2.1 Radar Parameters: 3.2.1.1 Range 0.5nm to 60nm. 3.2.1.2 Range Accuracy 1%. 3.2.1.3 Azimuth 360°. 3.2.1.4 Azimuth Accuracy 0.5°. 3.2.1.5 Height up to 60000ft. 3.2.1.6 Update Rate – every 4s. 3.2.1.7 Frequency Band – 2750 to 3050MHz.
	3.2.2 Display Capabilities: 3.2.2.1 Two Digital or Analogue video Channels. 3.2.2.2 200 plots with 50 labels per revolution. 3.2.2.3 5 maps, 500 vectors and 100 symbols. 3.2.2.4 CCDS can be linked in. 3.2.2.5 5, 10, 20, 40 or 60nm Range Selection. 3.2.2.6 2, 5, 10nm Rangemark Selection.
	3.2.3 Technical Summary: 3.2.3.1 Max. Range 60nm. 3.2.3.2 Min. Range 0.25nm. 3.2.3.3 Frequency 2750 to 3050MHz. 3.2.3.4 PRF – 1100pp. 3.2.3.5 Aerial – Two beam horn fed double curve reflector. 3.2.3.6 Ae Gain – 34dB. 3.2.3.7 Azimuth Beamwidth – 1.5°. 3.2.3.8 Azimuth Sidelobes 25-30dB. 3.2.3.9 Circular Polarization. 3.2.3.10 Rotation Rate 15rpm.

	3.2.3.11 AMTD with 40dB Ground Clutter and 38dB moving clutter suppression. 3.2.3.12 Expected Life 20yrs. 3.2.3.13 MTBF 729hrs; increasing to 1500hrs in recommended operating environment. 3.2.3.14 MTTR 24mins. 3.2.3.15 Availability 99.78%.
	3.2.4 Clutter Map Performance: 3.2.4.1 512K storage locations available. Say 2048 Range and 256 Azimuth Cells (note Azimuth Beamwidth is 1.5°). 3.2.4.2 Signal-to-Clutter Ratio needs to be around 18dB to ensure 80% Pd with Swerling 1.