RAF Fylingdales Upgrade to Early Warning Radar

Environmental and Land Use Report

16 June 2003

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Executive Summary

1. This report was commissioned by Defence Estates to advise on the implications of the request from the United States government to upgrade the RAF Fylingdales early warning radar for missile defence purposes. The report was commissioned in January 2003.

2. The report was commissioned to assess all potential environmental, sustainability and land use planning implications of the upgrade, and to consider them in the context of UK planning legislation and guidelines, and other relevant environmental legislation and guidelines. Particular recognition has been afforded to the location of RAF Fylingdales within the North York Moors National Park.

3. An outline design specification for the upgraded radar has been recently issued by the US. In addition, the US has provided information about the nature of the installation work required at the station. This information has been assessed in detail with a view to determining what changes, if any, will occur as a result of the upgrade and what impacts this will produce.

4. The report notes that:

    a. for the vast bulk of the time, the radar will continue to operate as it does at present,

    b. when operated in a missile defence mode, the upgraded radar will not produce increased levels of radio frequency exposure to humans, animals or plants, and

    c. the radio frequency environment remains safe and many times lower than the relevant safety guidelines, with no adverse effects on the locality.

5. The report concludes that there will be:

    a. no material change in the appearance of the site,

    b. no material change in the nature of the radar emissions,

    c. no temporary measures required that would involve planning consultation, and

    d. no material change of use of the facility that would require any clearance under the planning acts.

6. Previously, MOD had asked for current radar emissions to be measured and assessed by TuV Product Services during 2002 to confirm that the current operation of the facility conformed with relevant guidelines and also to provide an

information base against which any potential future changes could be assessed. This assessment confirms that:

a. Measurement and calculation of the radio frequency (RF) exposure of the general public shows that it is well below the National Radiological Protection Board (NRPB) guidelines.

b. There is no potential for RF ignition of flammable vapours or electro-explosive devices in areas accessed by the general public and no safety issues arise (Annex E).

c. The potential for electromagnetic interference with apparatus or transport remains unchanged.

7. In the light of the above, the report concludes that there should be no requirement for formal consultation on either planning or National Parks policy grounds.

1.0 Background

1.1 RAF Fylingdales has operated since 1963 as one of the radars which provides early warning of ballistic missile launches against UK, Western Europe and the US.

1.2 Information received from the RAF Fylingdales radar is used alongside data gathered from a network of other similar facilities in Clear (Alaska), Thule (Greenland), Beale (California) and Cape Cod (Massachusetts) to provide an Integrated Tactical Warning and Attack Assessment for both the UK and the US.

1.3 The facilities at RAF Fylingdales have been upgraded over the years in order to keep up with developments in ballistic missiles and the space track mission. The most notable of these upgrades was made during the late 1980s when the three "golf ball" radars were replaced by the current phased array radar, which takes the form of a truncated pyramid.

1.4 In addition to the physical replacement and upgrading of the structure of the radar, there have been periodic improvements in computer technology, which have led to improvements in missile warning and space object tracking functions of the station.

1.5 Similarly, periodic repairs have been undertaken at the facility. A Service Life Extension Programme is currently underway at the facility that replaces older equipment with newer, more reliable equipment to maintain the current early warning and space object tracking capabilities. No formal consultation was required in relation to the Service Life Extension Programme, however informal discussions were held with the North York Moors National Park Authority.

1.6 On 17th December 2002 the Secretary of State for Defence informed the House of Commons that a request had been received from the US Government to upgrade the existing Early Warning Radar as part of its missile defence programme.

1.7 This upgrade will enable the existing radar to track incoming threat objects more accurately and reliably, so that it may perform missile defence functions. Further details of the nature of this upgrade are set out in this report. It should be noted that the upgrade entails the replacement of internal computer hardware and software that are housed within the existing radar accommodation. The upgrade will not involve the replacement or modification of the radar itself, merely the equipment which controls its use and analyses its output.

1.8 As part of the upgrade, satellite communications equipment will be replaced in order to provide necessary secure and improved data links to US communications systems. The new equipment can be housed within the existing building, and the satellite communications will continue to operate on the same frequencies as at present.

1.9 The existing radome protecting the satellite communications building is showing signs of wear. A replacement is therefore needed in any event, and is not

associated with the upgrade of the radar. It may be opportune to replace it at the same time as the communications equipment. In the light of the location of the radome within a National Park setting, MOD has indicated that it will enter into discussions with the Local Planning Authority to explore the potential to improve its appearance and render it less intrusive in its landscape.

1.10 Over the past few months there has been a public and parliamentary debate on the subject of missile defence. This included the publication of a Discussion Paper on 9th November 2002, a visit to the North Yorkshire area by the Secretary of State, an Inquiry and Report by the House of Commons Defence Committee (HCDC), and discussion in both Houses of Parliament.

1.11 The HCDC produced a report on 29th January 2003 addressing the US request to upgrade the BMEWS station at RAF Fylingdales for missile defence purposes. In concluding that the Government should agree the US request, the Committee noted that:

> "We do not believe that the UK, or the Fylingdales area, would face any material additional risks (including health risks) from the upgrade, in terms either of health risks from radiation or an increased likelihood of potential attackers identifying Fylingdales as a target.".

It also observed that:

> "We see no reason to believe that agreeing to the upgrade will lead inevitably to further development or deployment at Fylingdales itself, or indeed elsewhere in the UK."

1.12 In a written parliamentary statement on the 5th February 2003 the Secretary of State announced:

> *"…we have been able to clarify that:*
>
> *the upgrade essentially comprises computer and software modification and involves no new development or change to the external appearance or power output of the radar,*
>
> *the radar will continue to fulfil its long-established Ballistic Missile Early Warning System role,*
>
> *it will continue to be operated and staffed by the Royal Air Force and we will continue to enjoy full access to its data, and*
>
> *the upgrade does not of itself commit the UK Government to any greater participation in the US missile defence programme.*
>
> *"It does however keep open the prospect of acquiring missile defence capabilities for the UK, should we desire such protection at some point in the future.*

"We will continue discussions with the local planning authorities on the detail of the upgrade work.

"I am satisfied that we have been able to take fully into account the views of all interested parties in coming to a decision. I am therefore today replying to the United States Secretary of Defense, Donald Rumsfeld, conveying the Government's agreement to the US request."

1.13 The purpose of this report is to outline the land use planning, sustainable development and environmental issues and any potential impacts on the policy affecting National Parks that are raised by the upgrade of the RAF Fylingdales facility. The report does not address routine repair and maintenance operations, which will continue to be required at the Station.

1.14 The report provides details on all aspects of the upgrade and concludes that there will be no significant or material environmental impacts arising from the upgrade, and that it does not constitute "development" as defined by the Planning Acts.

2.0 Context

Location

2.1 RAF Fylingdales is located approximately 10 miles north of Pickering, on the southern edge of the North York Moors National Park. The site context is illustrated at Figure 1. The site owned by the MOD covers an area of approximately 800 hectares, which is about 0.03% of the total area of the North York Moors National Park.

2.2 The radar itself is located approximately 850 metres to the east of the A169.

2.3 Open moorland surrounds the station. A small coniferous forestry plantation that was situated to the south east of the station has recently been removed on the advice of English Nature and with the co-operation of the National Park Authority.

2.4 This area of woodland comprised typical “Forestry Commission” coniferous planting which was not native to the natural environment of the National Park. The plantation was recently acquired by the MOD, has been cleared and is in the process of being restored to moorland. This clearance was not connected to the upgrade and is part of the continuing process of works services at the station. The clearing of the woodland was undertaken in consultation with the National Park Authority, English Nature and other interested groups. All parties were supportive of the clearance and moorland restoration.

2.5 The access road to the site leads from a signed junction with the A169 to a security gate and on to the main compound.

Site History

2.6 The station has been in continuous use as an early warning radar facility since 1963. Prior to that date the site was in use by the Ministry of Defence as an artillery range at least as far back as the First World War. The site, along with a substantially wider area of moorland, continued to be used as a firing range up until the 1950s.

2.7 As noted, the radar facility at the site previously took the form of three Radomes (which were colloquially referred to as “golf balls”) which measured approximately 140 feet in diameter. A further small radome was mounted on top of a tower and was known as “the lollipop”.

2.8 These radar facilities were replaced during a modernisation of the facility between 1989 and 1992 when the Radomes were replaced by the current Solid State Phased Array Radar (SSPAR) which takes the form of a truncated pyramid structure. Illustrations of the replacement facilities are set out at Appendix A.

2.9 The site of the original radomes has now been restored to moorland habitat. This restoration was undertaken in consultation with the North York Moors National Park Authority and other interested agencies.

2.10 In addition to the radar facility, there are a range of other ancillary buildings on site, including offices and living accommodation for staff, and utility buildings such as power house and communication facilities.

2.11 A security fence surrounds the site and inhibits unauthorised access. An additional internal fence restricts access to the secure area immediately around the radar itself for health and safety and security reasons.

2.12 The MOD ownership extends outside of the secure area and includes areas of open countryside. The extent of ownership and alignment of security fences are illustrated at Figure 2.

The Surrounding Area

2.13 The RAF Fylingdales site is located at a height of 260 metres above ordnance datum. The radar is located at a high point in the undulating moorland countryside, and ground levels fall away in all directions. Illustrations of the topography of the RAF Fylingdales Site are set out at Figure 3.

2.14 The A169 is the closest public road to the radar (approximately 850 metres to the west) and further west still, the North York Moors Railway passes within approximately 1,400 metres of the radar.

2.15 The closest inhabited buildings are Nab Farm and Barr Farm to the south. These are located approximately 1.8km and 2.2 km to the south of the radar respectively.

2.16 The environment surrounding RAF Fylingdales comprises a mixture of dry heath land with areas of wet bog. To the east of the site is a substantial area of Forestry Commission coniferous woodland which is in the process of being cleared and restored to open moorland.

2.17 There is public access across much of the surrounding area. A number of formal and informal public footpaths cross MOD land and are illustrated at Figure 4. The various routes are described below:

a. A Public Bridleway known as the Robin Hoods Bay Road originally crossed the site but was stopped up on 25th September 1962 under Section 49 of the Town and Country Planning Act 1947. An alternative alignment was provided to the south of the site. A small segment of the original bridleway remains, running east from the main road to the boundary of the secure site;

b. A Public Footpath crosses the extreme south west corner of the MOD owned land (outside the secured site);

c. The Lyke Wake Walk crosses MOD land to the north of the secure area. At its closest point, this route runs approximately 1.4 km from the radar. This is not a Public Right of Way though the MOD does not object to its use and it has become well established as a long distance footpath. The location of the route is illustrated at Figure 4.

3.0 Planning and Policy Context

3.1 The planning policy framework within which development proposals at RAF Fylingdales would be assessed is defined by:

a. the Planning Acts and other national legislation

b. national Planning Policy Guidance Notes,

c. Government policy on development in National Parks, and the associated guidance notes (Circular 12/96),

d. the North Yorkshire Structure Plan, and

e. the North York Moors Local Plan.

3.2 The site lies within the North York Moors National Park and the North York Moors National Park Authority is the Local Planning Authority. Ryedale District Council is the Environmental Health Authority.

3.3 The importance of the landscape setting of the site is reflected in the National Park designation. Development plans are in place, which seek to maintain and enhance the character of this landscape and ensure that it is managed in a way which is compatible with its ecological value and recreational use.

North York Moors National Park

3.4 The RAF Fylingdales site lies within the North York Moors National Park. The government has accepted that defence uses will continue in National Parks for the foreseeable future, but has reinforced its commitment to consult with the local planning authorities on development proposals within the Parks themselves.

3.5 Circular 12/96 recognises that "defence use of National Parks makes a major contribution to the country's defence capabilities and provides essential facilities which cannot be easily replicated elsewhere. It can also be an important factor in contributing to the local economic and social well-being of the Park communities".

3.6 The stated policy aim of the Strategy for the Defence Estate "In Trust and On Trust" (2000) is to "*safeguard and improve the valued landscape character of its estate*" and to "*promote the objectives of statutorily designated areas (e.g. National Parks and AONB) wherever possible*".

3.7 Specifically, the policy also seeks to "*take all reasonable measures to mitigate the impacts of any development proposals on landscape character in order to avoid undertaking damaging developments*".

3.8 We do not consider that the proposed upgrade is in conflict with or will impact upon this strategy.

North York Moors Site of Special Scientific Interest (SSSI) /
Potential Special Protection Area (pSPA) /
Candidate Special Area of Conservation cSAC

3.9 The area around RAF Fylingdales including land within MOD ownership is of important ecological interest and is designated as a Site of Special Scientific Interest (SSSI), a potential Special Protection Area (pSPA) and a Candidate Special Area of Conservation (cSAC).

3.10 Sites of Special Scientific Interest are UK sites of national ecological importance. The boundary of the SSSI is illustrated at Figure 5.

3.11 SACs and SPAs are classified under a European Union Directive. Expressed in simple terms, the pSPA designation reflects the importance of the site as an area which supports a population of rare birds, and the cSAC designation reflects the importance of the habitat in itself.

3.12 The SPA designation requires the UK Government to take the necessary steps to protect and maintain a sufficient diversity of habitats for wild birds. In this case, the ecological importance of the moorland habitat is as an integrated ecosystem, providing a habitat for ground nesting birds including the Merlin and Golden Plover. The boundary of the cSAC and the boundary of the pSPA is illustrated at Figure 5.

3.13 The majority of the SSSI / pSPA is dry heath land although there are stands of wet heath, a significant area of blanket bog on Loose Howe Rigg and areas of flush and mire communities adjacent to water courses. There are also stands of bracken along the beck and acidic grassland occurs in local areas – particularly adjacent to the main road.

3.14 The SSSI/ pSPA supports a range of breeding moorland bird species, including Merlin; Golden Plover; Snipe; Curlew; Redshank; Lapwing; Winchat; Ring Ouzel; Wheatear; Red Grouse; Peregrine; Hen Harrier; and Short Eared Owl. Of these birds, the populations of Merlin and Golden Plover are of international importance.

3.15 English Nature's main objective in relation to the SSSI / pSPA is to maintain and enhance the nature conservation interest of the area by:

a. Maintaining and enhancing areas of heather moorland including the range of dwarf shrub species and, where appropriate, a proportion of old growth heather.

b. Maintaining, and wherever possible restoring, blanket mire, wet heath and flush areas.

c. Maintaining and enhancing woodlands, and where appropriate increasing small areas of native trees and shrubs.

d. Maintaining and enhancing the populations of breeding birds, in particular the internationally important populations of Merlin and Golden Plover.

e. Preventing any increase in areas of acidic grassland at the expense of other moorland habitats.

3.16 These considerations are relevant to the way in which the station is managed today, and will continue to apply after the upgrade is completed. The UEWR will not affect the SSSI or pSPA in any way.

DOE Circular 12/96 – Environment Act 1995, Part III National Parks

3.17 This circular reconfirms the twin purposes of National Parks as:

a. to conserve and enhance the natural beauty, wildlife and cultural heritage of the National Parks, and

b. to promote opportunities for the understanding and enjoyment of the special qualities of the Parks by the public.

3.18 The circular notes the importance of National Parks as:

a. places of exceptional beauty,

b. areas containing important wildlife habitats,

c. living and working landscapes,

d. areas of cultural importance, and

e. areas which contain wide-open spaces, wilderness and tranquillity.

3.19 The circular sets out the role of National Park Authorities in terms of the long-term management of the Parks and in mediating between potentially conflicting recreational and conservation objectives. The theme of sustainable development is considered within the circular, and highlights the potential for National Parks to provide models for the sustainable management of the countryside, and to achieve well-being of local communities whilst aiding conservation and enhancing biodiversity.

3.20 Under Section 62 of the 1995 Act, a general duty is placed upon all relevant authorities (including the MOD and Defence Estates) to have regard to the purposes of National Parks when coming to decisions or carrying out their activities relating to or affecting land within the Parks and to be able to demonstrate that they have fulfilled this duty.

3.21 The circular confirms that National Park Authorities Act as the relevant Local Planning Authority within their respective areas. The importance of preparing and maintaining an up to date Development Plan is considered and duties in respect of development control are outlined.

3.22 In relation to "major development" the circular states that:

a. "Major development should not take place in these areas save in exceptional circumstances. Because of the serious impact that major developments may have on their natural beauty, applications for such developments must be subject to the most rigorous examination and should be demonstrated to be in the public interest before being allowed to proceed. Consideration of such applications should therefore normally include an assessment of:

i. "The need for development, in terms of national considerations, and the impact of permitting it or refusing it upon the local economy;

ii. "The cost of and scope for developing elsewhere outside the area, or meeting the need for it in some other way; and

iii. "Any detrimental effect on the environment and the landscape, and the extent to which it should be moderated."

3.23 The Circular specifically considers the use of National Park for defence purposes and states that:

a. "While the Government accepts that these existing uses will continue into the foreseeable future, it is nevertheless committed to ensuring that new, renewed or intensified use of land in the National Parks for defence purposes should be subject to formal consultation with the National Park Authorities and the Countryside Agency and to an environmental impact assessment, and should be tested against any provisions set out in planning policy guidance.

b. "It acknowledges however, that there can be conflicts between defence use and Park purposes, but believes that these will be best resolved through co-operation with the National Park Authorities. The Ministry of Defence will continue to give a high priority to conservation.

c. "Defence use of National Parks makes a major contribution to the country's defence capability, and provides essential facilities which could not be easily replicated elsewhere. It can also be an important factor in contributing to the local economic and social well-being of Park Communities."

3.24 The Government has accepted that defence uses in National Parks will continue into the foreseeable future and at the same time has reinforced its commitment to consultation with Local Planning Authorities on new developments in Parks.

3.25 Through the history of the Fylingdales site, there have been a number of major developments which have been the subject of formal consultation – for example

when the "golf ball" radomes were replaced by the current truncated pyramid structure.

3.26 As this report demonstrates, the upgrade of the existing radar will not have any material impact upon the National Park, its residents, visitors, flora or fauna. As such the use of the site, its appearance, radar emissions and all other relevant considerations will be unaffected. In terms of its impact on the environment and character of the National Park, it is clear that there will be no perceivable change. Since the radar will continue to be used for early warning and space surveillance missions, and would be irrespective of any upgrade, there is no new or renewed land use of the site. There is also no change in staffing levels or permanent infrastructure at the site, and therefore no intensified land use.

DOE Circular 18/84 – Crown Land and Crown Development

3.27 This Circular provides advice on the management and disposal of Crown Land.

3.28 Part IV of the Circular considers development by Government Departments and describes the arrangements by which consultation should be undertaken with Local Planning Authorities.

3.29 The Circular states that:

> "Development by the Crown does not require planning permission. But Government Departments will consult with local planning authorities before proceeding with development (including material changes of use) which would otherwise require planning permission."

3.30 In this instance, a detailed review of the proposal has been undertaken and the conclusion has been reached that the upgrade does not constitute built development or a material change of use and as such formal consultation is not required (see Section 7).

3.31 The Circular goes on to state that:

> "Departments have agreed to also bear in mind that in any event, whether or not consultation or notification is required, an early preliminary approach to the Local Planning Authority will often be useful particularly in the case of development likely to be of special local concern to the public or the local planning authority."

3.32 Considering the profile and public interest in the RAF Fylingdales site, the decision was taken by the MOD at an early stage that the Local Planning Authority should be approached and provided with all necessary information regarding the upgrade and its implications in terms of land use, sustainability and environmental impact. This report sets out these considerations in detail.

Planning Status of Existing Radar

3.33 As noted above, the original early warning radar facility at RAF Fylingdales was constructed in 1963 and since then there have been a series of upgrades and new developments, resulting in the facility which is on site today.

3.34 In instances where upgrades constitute "development" as defined in the Planning Acts, the Secretary of State formally consults with the North York Moors National Park (as the Local Planning Authority) under the Notice of Proposed Development (NoPD) procedure set out in Department of the Environment (DoE) Circular 18/84.

3.35 The most significant NoPD consultation was undertaken during the modernisation of the facility in the late 1980s that entailed the replacement of the "golf balls" with the current facility. That upgrade involved a major development at the site, with the removal of the three "golf balls" and the erection of the current truncated pyramid radar structure. The current upgrade does not involve any material change to the external appearance of the site or buildings located on it.

3.36 The 1980s upgrade was allowed to proceed without objection from the planning authority on the basis set out below. There is therefore an extant planning permission for the operation of the radar at Fylingdales and its associated support services.

3.37 In raising no objection to the MOD's NOPD, the North York Moors National Park Authority asked for an assurance from the Secretary of State for the Environment that he was satisfied beyond all doubt that there was no possible alternative site to Fylingdales. This assurance was given in a letter dated 13th August 1987, which stated that "there are overwhelming reasons of national interest not to relocate the facility". Although one ground for this conclusion, namely the 1972 ABM Treaty, has since been removed, there were also significant cost and environmental reasons for not relocating the radar.

3.38 Subject to that assurance, the NYMNPA also asked for eight specific requirements to be met. Six of these concerned activities specifically related to the modernisation work and thus have no current relevance. One requirement sought an assurance that in the event of any future modernisation being necessary the Government should seek to relocate BMEWS outside the National Park on environmental grounds. The letter, referenced above, stated that the Government was not in a position to give any assurance on this point. Indeed, there is a modernisation programme currently in hand (the "Service Life Extension Programme") which is intended to preserve the operational capability of the BMEWS radar. NYMNPA advised that the proposal did not constitute development under the definition set out in the Planning Acts and formal consultation under DOE Circular 18/84 was not required. The eighth requirement was accepted by the Government in the following terms:

> "The MOD undertakes to remove all buildings and structures when the station is no longer required for its present purposes".

3.39 It is stated MOD policy that the current roles of the station will continue for the foreseeable future (this includes its BMEWS and space surveillance roles), and therefore this requirement cannot yet be met. The use of the radar in a missile defence mode does not affect this position, as this mission does not extend beyond the required lifetime of the early warning mission.

Structure Plan and Local Plan

3.40 The Environment Secretary approved the North Yorkshire Structure Plan in 1980.

3.41 The North York Moors Local Plan is in the advanced stages of revision. The plan has been through a Public Local Inquiry and been the subject of an Inspector's Report. The local authority has considered the Inspector's Report and advertised subsequent modifications to its plan. In early April, the Council advertised its intention to adopt the plan formally, and providing there are no challenges, it intends to adopt the plan in mid to late May.

3.42 The Structure and Local Plans set out the policy context within which development proposals would be assessed.

3.43 The Structure and Local Plans set out a very strong presumption against new development within the National Park. The policy framework requires that new development which is to be allowed must be necessary in that location and must protect the quality and character of the landscape, important buildings and other heritage or ecological features.

3.44 The appraisal of the proposed upgrade has been undertaken with respect to the range of issues identified within the Structure and Local Plan policy context. It should be noted, however, that the upgrade proposal does not represent a "development" as defined in the Town and Country Planning Acts.

4.0 Description of the existing site, including the Early Warning Radar

The Site

4.1 The layout of the existing RAF Fylingdales site is illustrated at Figure 6.

4.2 The figure illustrates the locations of the radar itself, along with ancillary facilities such as the security facilities, power house, accommodation units, staff mess, communication equipment etc.

4.3 Approximately 409 staff are employed at the station, making it a significant source of local employment which are broken down as follows:

a. 81 RAF personnel

b. 43 MOD Civilian staff (including MOD Fire Service and Guard Service)

c. 85 MOD Police

d. Approximately 189 Contractors

e. 1 USAF Major and 10 US Contractors (Communications)

4.4 The precise numbers of staff can fluctuate, depending upon recruitment and deployment within the RAF, but it is unlikely to be of any significance.

4.5 In addition to the permanent staff, contractors also frequently work at the facility. There will be a temporary, slight increase in the number of contractors working at the site during the implementation of the upgrade, however these will not be significant in the context of existing transport flows to the site and on the surrounding road network. Typically there would be approximately 20 additional contractors working at the site during the upgrade.

The Radar

4.6 The existing Early Warning Radar is a surveillance and tracking radar system, which is operated by the RAF to serve UK and US strategic defence purposes. The primary purpose of the radar is to detect, track and provide early warning of intercontinental ballistic missiles and sea-launched ballistic missiles.

4.7 The existing Early Warning Radar is housed in a 32 metre high “pyramid like” building. The building is approximately 30 x 45 metres at its base.

4.8 The radar transmits pulsed radio frequency signals into space. These signals are reflected by objects back to the radar. The signals are then analysed to determine the distance, speed and location of detected objects.

4.9 The flat arrays of individual radiating elements transmit and receive radio frequency signals generated by the radar. The equipment that generates and analyses the radio frequency signals is housed inside the radar building.

4.10 Further details of the radar are set out at Appendix B.

5.0 The Upgrade

5.1 As part of the announced test bed for their Missile Defence programme, the US require the existing Early Warning Radar at RAF Fylingdales to be upgraded by the installation of new electronic hardware and software which will be housed within existing buildings and structures on site.

5.2 The Upgrade of the RAF Fylingdales' radar to become an "Upgraded Early Warning Radar" (UEWR) is the latest of many modifications that have been made at the site during its forty years lifetime. Unlike some of the previous upgrades, most notably when the three old radars became unsupportable and had to be replaced by the modern Solid State Phased Array Radar (SSPAR), this new change will make no material change to the external appearance. The overwhelming majority of the changes necessary will be internal to the SSPAR building and also to a satellite communications building on the site. The changes and their purpose are described below.

5.3 A number of modifications are required to the radar and its supporting services to implement the new requirements. The major change envisaged is to replace the existing computers at the radar. The principal reason is to provide computers, which are faster and more capable. The change of computers will meet the need to be able to track objects more accurately than the current radar. The current radar was designed to meet the needs of the Cold War when attacks by many hundreds of missiles were anticipated. In such a situation, these missiles had only to be tracked with sufficient accuracy to determine whether and roughly where they were going to impact on the US or the UK. The missile defence requirement is to locate relatively few objects very precisely in space so that intercepting missiles may be directed accurately to strike them.

5.4 Associated with this modification is the need to make an accurate measurement of the local weather conditions in order to determine very accurately how the atmosphere affects the radar beam. In order to achieve this, new sensors need to be fitted on the roof of the radar, on the same poles that will carry the GPS equipment (see below), and these will be undetectable from the ground.

5.5 The new computer systems will also improve the radar's ability to distinguish missile warheads from all the other paraphernalia associated with a missile launch such as booster tanks, associated objects and possibly decoys. This process is called discrimination and the new computers will be required to analyse the radar data to be able to carry out this function.

5.6 It is also necessary to improve the communications links between the radar and US command centres involved in missile defence. The aim of this change is to reduce the time it will take for information from the radar to reach the US where it can be acted upon. The improved communications will also be able to provide the radar with "cues" which will tell the radar where to look for attacking missiles using

information provided by early warning satellites. To meet this requirement the existing satellite communications equipment must be replaced. The major part of this modification will be internal to the existing satellite communications building located in the most easterly part of the site. Further work will be required inside the associated radome to modify the satellite communications antenna. This modification will be invisible externally. However, consideration is being given to whether the radome itself, which is showing signs of wear, should be replaced at the same time.

5.7 Finally, although the radar is already reliable, it must be made even more so. If the radar were to fail in its current mission, the UK and US could receive limited warning of incoming missiles from other sources, such as early warning satellites. However, if the upgraded radar is to provide accurate tracking data for the US to be able to launch an interceptor missile, changes are needed to improve reliability even further. One such change is the requirement to provide the radar with a very reliable means of co-ordinating time measurements across the US missile defence network. It is proposed to achieve this using the US Global Positioning System (GPS) navigation satellites. In order to receive signals from the satellite, GPS antennas will be fitted on the roof of the radar, adjacent to, and below the roofline of, the existing air conditioning housings. These antennas are so small that for all practical purposes they are invisible from the ground. Mock ups of the antennas are available to demonstrate this.

5.8 The enhanced capabilities of the Upgraded Early Warning Radar are provided by technological improvements to the electronic hardware and computer software, which enable better detection, tracking and identification of missiles. The improved effectiveness that would result from the upgrade does not require the power of the radar to be increased.

5.9 The hardware modifications which are required to upgrade the radar consist of replacing:

a. transmitter/receiver equipment. The new equipment will not transmit higher power than the existing equipment but it will allow a wider range of pulse lengths and bandwidths,

b. existing signal and data processors with new computers,

c. old operator displays with modern equipment,

d. old timing equipment with a new system which will allow the radar to be synchronised with the whole network using time derived from the Global Positioning Satellite (GPS) system. This new timing equipment will require the installation of two small GPS antennae on the roof of the radar,

e. radar receiver equipment which will allow more accurate estimation of target position,

f. old communications equipment with new, which will allow the radar to

provide its information to other elements of the system with minimum delay. This modification will also require equipment within the existing satellite communications building to be modernised.

5.10 Expressed in simple terms, the proposal is comparable with the installation of a new computer system within an existing office to improve service delivery.

5.11 In addition to the hardware upgrade, the software that operates the radar would be rewritten to incorporate missile defence functionality, to allow identification, tracking and classification of smaller objects.

5.12 Beyond those internal hardware and software upgrades identified above, there will be no upgrade or change to the radar equipment itself (eg radiating elements, power, frequency etc).

5.13 Existing satellite communication equipment will be replaced as part of the upgrade. The new equipment will provide the necessary data carrying capability to meet the missile defence communications requirements.

5.14 No additional radome installations will be required to accommodate this equipment. MOD has indicated that discussions will be held with officers from the North York Moors National Park to consider whether the communications radome could be more sensitively coloured as part of the equipment replacement programme.

5.15 Particular points, which are worthy of emphasis here, are:

a. The existing radar building will remain unchanged.

a. There will be no material change to its external appearance.

b. The radar will continue to operate at frequencies of between 420 and 450 MHz.

c. The number of radiating elements (2560) within each face of the radar will be unaltered.

d. The antenna beam width will be unaffected.

e. The power and duty factor of the radar will remain the same. (note: the duty factor or duty cycle is defined as the amount of time a radar is transmitting energy over a certain period, usually expressed as a percentage)

6.0 Appraisal of Potential Environmental and Sustainability Impacts

6.1 This section of the report considers the scope of potential effects arising from the RAF Fylingdales upgrade and considers whether these effects may result in specific impacts upon the local and wider environment.

6.2 The appraisal considers the range of potential issues that could be assessed within a formal Environmental Impact Assessment. The appraisal also reviews the upgrade in the light of issues raised by the MOD's own commitment to Sustainable Development and specifically its Appraisal Handbook for Sustainability and the Environment.

Sustainability and the Environment Handbook

6.3 In July 2000, the Secretary of State for Defence issued a policy statement committing the MOD to consider the environmental implications of new policies and equipment acquisition programmes, development projects and training activities. In some instances this may include the production of a formal Environmental Statement as required by the Town and Country Planning Acts. In other instances a less 'formal' appraisal may be undertaken, although the scope of issues to be considered should remain comprehensive.

6.4 In 2002 an Appraisal Handbook was produced which outlined the scope of assessments which should be undertaken. The scope of issues that should be considered includes environmental issues and also wider social and economic matters to provide a broad "Sustainability Appraisal".

6.5 The following appraisal of the environmental implications of the upgrade has been undertaken with reference to the Appraisal Handbook and current practices in the field of environmental assessment.

Impacts

6.6 The Effect of Physical Development

a. The upgrade will not result in the construction of buildings on any part of the site, and as such will not have any visual impacts or lead to any impacts upon flora or fauna.

b. The works that are required to implement the upgrade relate to the replacement of internal hardware and software. The only external change which is required as part of the upgrade is the installation of two small GPS

(Global Positioning System) antennae on the roof of the radar, adjoining and below the height of the existing ventilation housing. The two antennae are fixed on 3 metre x 100 mm diameter poles and are illustrated at Appendix G As noted, this equipment is very small within the context of the overall radar facility and will have no visual impact when viewed from the surrounding area.

c. As noted previously, equipment within a satellite communication radome will also be replaced at the same time as the upgrade is implemented. Although the replacement equipment can be physically installed within the existing radome, it is proposed that as the existing radome is around 10 years old and showing signs of dilapidation, it would be cost effective to replace it at the same time as the upgrade. MOD has indicated that discussions will be held with the National Park Authority to explore the potential for the replacement radome to be coloured in such a way as to reduce its visual impact within the landscape.

d. The external visual appearance of the facility will therefore remain unaltered as a result of the upgrade.

e. In addition to considering the permanent effects of physical development associated with the upgrade, temporary effects experienced during the implementation of the upgrade have also been considered.

f. There will be no requirement for temporary on site accommodation to be constructed during the implementation of the upgrade and the nature of the upgrade will not give rise to appreciably higher levels of road traffic or staff levels. Any increase in construction traffic will not be discernible from the day to day fluctuations in vehicle movements, which occur at present.

g. There will be no requirement for additional temporary or permanent storage facilities or accommodation associated with the upgrade.

6.7 Security, public access, and terrorism

a. Before, during and after the upgrade, appropriate levels of security will be maintained, and all areas and routes that are open to the public will remain unaffected. The upgrade is not assessed as likely to raise the profile of the site as a target for terrorists.

6.8 Socio-economic Issues

a. The facility will continue to be operated and staffed by the Royal Air Force. There will continue to be a limited number of US personnel working at the station (see paragraph 4.3).

b. RAF Fylingdales provides employment for around 409 staff, and as such it represents a significant feature within the local economy.

c. The implementation of the upgrade will not give rise to a change in the number of staff permanently based at the station (ie around 409 staff including contractors, with some day to day fluctuation). In total there may be in the order of 75 to 100 contractors involved in the upgrade, although typically there may be around 20 contractors on site at any one time.

d. The temporary increase in activity which will be experienced during the implementation of the upgrade will not represent an appreciable increase in activity, and will not give rise to any issues of capacity or congestion on local transportation networks.

e. There will therefore be no socio-economic impact in terms of permanent local jobs and opportunities. Current economic and social benefits that the station brings will continue for the foreseeable future, including the level of employment generated. For the two year period of the upgrade work, there is likely to be a limited increase in spending on local services, food, and other goods by contractors' staff (ie hotels, pubs, restaurants, cinemas etc). However the scale of this benefit is such that it will not give rise to the need for additional facilities to be developed. It is too early to assess the extent to which US contractors for the upgrade will use UK or local companies as subcontractors.

6.9 Land Use

a. Since 1963 the site has operated as an early warning radar facility – surveying and tracking missiles and other space objects.

b. The land use of the site for this purpose will not change as a result of the upgrade of the facility.

6.10 Transport

a. Numbers of permanent staff working at the site will not be materially increased as a result of the upgrade (see paragraph 4.3).

b. There will be a limited temporary increase in movements to the site as a result of the upgrade, although this will not be a significant increase over the existing vehicle numbers visiting the site.

6.11 Noise / Vibration

a. There will be no change in noise levels or vibrations as a result of either the implementation of the upgrade or its future operation, other than very minor effects during the upgrade itself. This minor temporary increase in noise and vibration during the implementation of the upgrade will not be perceivable outside of the site itself.

6.12 Emissions

a. The operation of the radar does not produce emissions that cause pollution to the air, water or ground.

b. The upgrade will not result in increased levels of noise and vibration.

c. The level of power usage by the facility will not be affected as a result of the upgrade and there will therefore be no impacts in terms of additional air, water or ground pollution at the point of generation.

d. Obsolete hardware will be removed from site and disposed of in accordance with relevant regulations.

e. Other effects that are of relevance to the radar relate to radio frequency emissions, electromagnetic compatibility and radio frequency hazard. These issues were raised specifically during public discussion regarding missile defence, and are of particular concern in relation to potential impacts upon human health. In view of the technical nature of these issues and the nature of the concerns raised, a detailed appraisal of these issues is set out in Appendices B – G.

f. The basic conclusion of this report is, however, that the radar currently operates well within existing guidelines and that the power levels, frequency range, wavelength and other characteristics will not be materially affected by the upgrade.

6.13 Radio Frequency Environment

a. A detailed assessment has been undertaken of the Radio Frequency Environment around the RAF Fylingdales station. The findings of this assessment are set out at Appendix D.

b. Radio frequency exposures of the existing radar and the upgraded facility have been assessed and are all many times below the radio frequency exposure guidelines issued by the National Radiological Protection Board (NRPB). This indicates that there is no evidence of a non-ionising radiation

hazard to the general public at the present time or in the future. Measures are put in place to protect personnel and working on or visiting the site itself.

c. As part of its normal health and safety procedures, MOD will continue to monitor exposure levels around the station.

6.14 Radio Frequency Ignition of Flammable Vapours and Electro-Explosive Devices

a. The potential for the radar facility to trigger or ignite flammable or electro-explosive devices has been assessed and the findings of this study are set out at Appendix E. The potential for ignition or detonation are dependent upon the peak power and the energy in the pulse and the substance involved.

b. The peak transmitted power of the upgraded radar will be unchanged, and therefore the resultant potential for RF ignition of flammable vapours or electro-explosive devices remains unchanged and non-hazardous for the general public.

6.15 Regulation of Radio Frequency Transmission

a. The frequencies at which the radar operates will continue to operate within the same frequency spectrum (420-450 MHz) and will only vary within that range. MOD is licensed to use this range and works with the Radiocommunications Agency (RA) on accommodating both military and civil use where possible of this frequency band.

b. Current radar operations at RAF Fylingdales are affected to some degree by interference from other users of the frequency spectrum, and MOD has been examining with the Radiocommunications Agency ways and means of mitigating this interference. The upgrade of the radar may put an additional premium on finding ways to reduce the interference, particularly at the lower end of the radar's operating band, and work is in hand with the RA to establish what further mitigation might be required.

6.16 Electro Magnetic Compatibility

a. Peak electric field strengths due to the radar will be unchanged. The measured field strengths, which are set out at Appendix F, will therefore remain valid and there will be no additional interference hazard associated with the upgrade.

6.17 Human Radio Frequency Exposure

a. As there are no changes to power transmitted by the radar and, as noted above, there will be no new impacts upon humans arising from the upgraded radar. The radar will continue to operate within safety standards, there will be no risk to health or safety and there will be no change to existing public access arrangements around the station. The assessment of RF exposure is set out in Appendix D.

6.18 Flora

a. As there is no construction associated with the upgrade (other than the internal replacement of equipment and the installation of two small GPS antennae upon an existing facility) there will be no loss or impact upon flora as a result of building operations.

b. As radar emissions will remain materially unchanged as a result of the upgrade, there will be no increased RF exposure effect upon plant life within and around the site.

c. The felling of the coniferous woodland adjacent to the site, which has been noted in the interest of completeness, is not related to the upgrade project. It should also be noted that the felling of this non-native woodland will provide positive benefits in terms of moorland restoration, which has the support of English Nature, the Countryside Agency, and the National Park Authority.

6.19 Fauna

a. As there are no material changes to radar emissions, as noted above, there will be no impacts upon fauna resulting from the upgraded radar. The proposal will not result in any impacts upon fauna living within or around the radar site. As noted above, as the absence of physical development, and the lack of changes in terms of radar emissions have led to the conclusion that there will be no environmental changes which could lead to impacts upon fauna.

6.20 Visual / Landscape

a. It is recognised that the quality of the landscape within the National Park is a critical concern. The existing radar forms a landmark within the landscape of the park, and it is recognised that it is highly prominent over a wide area. The visual impact of the radar will remain, irrespective of whether its performance is upgraded, since the current functions of the radar will continue for the foreseeable future.

b. The only external change that will result from the upgrade is the installation of the GPS antennae on top of the existing radar facility, and this itself will have no material visual impact.

c. Within the context of the overall radar installation, the installation of these small antennae is considered to be de minimis in terms of its impact.

d. It is therefore concluded that the upgrade will not give rise to any material impact in terms of the landscape or visual character of the site and its surrounding environment.

6.21 Built Heritage and Archaeology

a. The existing radar is not listed and does not affect the setting of a listed building. It does not lie within a conservation area or an area of acknowledged archaeological interest.

b. The “built heritage” value of the site lies in its prominence as a landmark and its cultural importance as a part of the country’s military infrastructure.

c. The upgrade does not involve construction work or external changes to buildings, thus the built heritage and any archaeological interest will not be affected by the upgrade.

6.22 Climatic

a. At ground level, the power densities resulting from the operation of the radar are so small as to have no discernible effects in terms of climate or temperature. And, as noted above, there will be no change in the power densities as a result of the upgrade.

b. There are no external elements of the upgrade that will give rise to other micro-climatic impacts (for example due to turbulence or over shadowing).

6.23 Traffic, transport, access and rights of way

a. As noted there will be a slight, temporary increase in the number of vehicles travelling to the site during the implementation of the upgrade, although this will not be significant within the context of the existing flows to and from the site.

b. Areas and routes where public access is permitted will not be altered or restricted as a result of the upgrade.

c. The effects of the radar (in terms of the ground level radio frequency environment etc) will not be materially changed in these areas.

6.24 Geology and Hydrology

There will be no geological or hydrological impacts resulting from the upgrade.

6.25 Summary

a. The full range of potential impacts that could arise as a result of the upgrade of the RAF Fylingdales facility has been explored.

b. In addition to the more frequently assessed land use planning considerations such as visual impact, transport and effects upon flora and fauna, particular emphasis has been paid to the consideration of radar related issues. These have included a rigorous assessment of such issues as radio frequency exposure, radio frequency ignition of flammable vapours and electro-explosive devices, radio frequency transmission and electromagnetic compatibility.

c. The upgrade has been assessed in the light of the requirements of UK planning and environmental legislation and also the MOD's commitment to Sustainability.

d. The only impacts which will result from the upgrade are a slight temporary increase in activity at the station whilst the upgrade is implemented, and a "de minimis" impact resulting from the installation of two small GPS antennae.

e. The rigorous assessment that has been undertaken has not identified any material impacts that will result from the upgrade.

7.0 Planning Considerations

7.1 The Crown is granted an exemption from the requirement to secure planning permission for development. In place of submitting a planning application, the Crown undertakes a parallel process, which entails the submission of a Notice of Proposed Development, which facilitates consultation with the Local Planning Authority and other relevant parties.

7.2 In determining whether a Notice of Proposed Development would be required under Department of the Environment (DoE) Circular 18/84 for the upgrade of the RAF Fylingdales Early Warning Radar, two key issues need to be considered:

a. Would the physical works necessary to upgrade the Early Warning Radar constitute building operations, engineering, mining or other operations?

b. Would the upgrade result in a material change of use?

Definition of Development

7.3 The Town and Country Planning Act 1990 (Part III) defines development as:

"the carrying out of building operations, engineering, mining or other operations in, on, over or under land, or the making of any material change in the use of any buildings or other land".

7.4 The definition goes on to state that:

"the following operations or uses of land shall not be taken for the purposes of this Act to involve development of land-

i. the carrying out of maintenance, improvement or other alteration to any building of works which:

affect only the interior of the building, or

do not materially affect the external appearance of the building."

7.5 Details of the works that would be required to upgrade the Early Warning Radar are set out at Section 5 of this report.

7.6 The upgrade of the Early Warning Radar at RAF Fylingdales largely entails works which only affect the interior of buildings. The only exceptions to this are the installation of GPS (Global Positioning System) satellite antennae, which, because of their size, external appearance and proposed location, are considered to be de-minimis and the replacement of satellite communications equipment, which will not materially affect its external appearance.

Change of Use

7.7 The use of the Early Warning Radar will not be altered as a result of the upgrade, on account of the following:

a. The function of the radar (for surveillance and tracking) will remain unaltered: an additional missile defence mission would be added, but this does not materially affect the way in which the radar is operated.

b. The peak and average field strengths and power densities resulting from the upgrade will be unaltered and also will remain substantially below UK guidelines.

c. The area affected by illumination from the radar will remain unaltered.

d. The number of staff will remain within current normal levels, subject to minor fluctuations during the implementation of the upgrade.

e. Public access to and enjoyment of the North York Moors will be unaffected.

f. There will be no requirement for additional utility services to be provided to the site.

g. The proposal will not give rise to an increase in traffic generation at the site or a need for additional parking.

8.0 Conclusions

8.1 This report has been prepared to advise MOD on any environmental impacts resulting from the upgrade and accordingly, whether there is a requirement for formal consultation with the Local Planning Authority.

8.2 In respect of the issues identified above, the conclusions of this report are that:

a. The upgrade of the RAF Fylingdales Early Warning Radar:

i. will not involve building operations, engineering, mining or other operations other than those which affect only the interior of the building, and

ii. will not result in any material change of use of any building or other land.

8.3 The upgrade will therefore not represent “development” as defined in the Town and Country Planning Act 1990.

8.4 There is therefore no requirement to undertake a Circular 18/84 consultation in the form of a Notice of Proposed Development.

8.5 This Report also concludes that the radar facility operates, and will continue to operate, within relevant safety guidelines.

Appendix A

Photographs of Existing Radar

Appendix B

Radar Description

Introduction

1. The array faces are 31 metres wide and tilted back at 20^{o} from the vertical. The active portion of the array is located within a circle which is 25.6 metres wide at the centre of each face of the radar. Each face of the array comprises 2560 radiating modules. Each radiating element is connected to a solid-state transmit/receive module that provides a nominal peak power of 340 watts and a low-noise receiver to amplify the returning radar signals.

2. The radar operates at ultra high frequencies. The radar operates at frequencies between 420 to 450 MHz and will continue to operate within this frequency range following the upgrade. The radar selects certain frequency bands within this overall range to transmit radar pulses, and receives signals back in wider frequency bands within the overall range.

How does the radar operate?

3. The Early Warning Radar undertakes two principal kinds of activities – surveillance and tracking. The radar undertakes both activities simultaneously.

Surveillance

4. The activity of surveillance is intended to detect intercontinental ballistic missiles and sea launched ballistic missiles and satellites that penetrate its field of view. Once an object has been detected, it is tracked and its trajectory estimated, along with the trajectory of any object that separates from it.

5. The radar currently looks for missiles (and satellites) as they appear just above the horizon. In principle, this process is very simple: a beam is transmitted towards just above the horizon, and the radar waits for any echoes to be received from that direction before making another transmission. That process is repeated, always to just above the horizon, but each time on a different bearing until the whole 360 degrees has been surveyed. This sequence produces what is called the “surveillance fence” and the sequence has to be repeated sufficiently often so that no missile can fly through the fence undetected.

6. Objects are detected as they pass through this “surveillance fence” and may then be the subject of more detailed tracking and analysis.

7. In surveillance mode, all three faces of the radar are active simultaneously providing 360^0 coverage.

Tracking

8. A second function of the radar is to track objects that have been identified within the surveillance fence.

9. When the radar is upgraded it will become a part of the US Ground-Based Midcourse Defence System (GMDS). This system is intended to detect, track and intercept ballistic missiles in what is called their "midcourse" phase of flight: that is after the rocket has burned out and before the warhead(s) re-enter the atmosphere

10. Missile defence missions will only take place if an attack by ballistic missile, which is trackable by this radar, is launched against the US. In this situation, the radar will only operate for brief periods of time while it tracks a missile, bearing in mind that the typical flight time would be approximately 17 minutes.

11. In addition, there will be occasions when the UEWR is used in missile defence mode for training and proving purposes. To this end, crews will be trained to conduct their standard operational procedures. These procedures will span the current early warning mission, satellite tracking and, following the upgrade, the missile defence function. The first part of crew training will be carried out using a simulator, which will be located within an existing building at the site. Only after crews have performed satisfactorily using the simulator would they be "checked out" using the live radar.

12. At this time it is not possible to be certain exactly how long the radar will operate in training mode, but it needs to be emphasised that, even in full Missile Defence mode, there will be no additional radar power emissions over and above the present radar.

13. The radar does not transmit continuously, either now nor after the upgrade. It transmits discrete and very short interval pulses for analysis by the computer systems, and would never transmit for more than one third of the time.

How are signals transmitted from the radar?

14. The radio frequency signals transmitted from each array form one narrow beam, with a width of 1.8^o. Most of the energy (around 90%) is contained in the main beam.

15. Rather than a rotating dish shaped antenna, the radar consists of three flat antenna arrays, measuring 25.6 metres in diameter and containing 2560 radiating elements and 609 non-radiating elements.

16. Each of the radiating elements is driven by a solid state transmitter / receiver module in strict phase relation with other elements. The spreading and merging of

the fields from all the elements creates the radar beam. The individual electric and magnetic fields can be thought of as waves emanating from each module of the array. Just like a pool of water, when they encounter other waves, the effect is to produce regions where the wave heights become larger, and other regions where the wave heights get cancelled out. This is essentially how the radar beam is formed. The main beam is located where the heights add together coherently.

17. Outside the main beam, the waves do not completely reinforce each other and produce a smaller radio frequency field known as sidelobes, which is a small fraction of the strength of the main beam (for example, one percent for the first sidelobe).

18. When operating, each antenna array forms its own electromagnetic radar beam that can be electronically scanned right, left, up and down, whilst the face of the radar remains stationary. The beam is steered by changing the relative electric phase angle of the individual elements. This is controlled by individual phase shifters located in each element.

19. The radar beam consists of a series of electromagnetic pulses, with varying pulse length and frequency depending upon the nature of the task being undertaken.

20. If a target of interest is detected during the operation of the surveillance fence, time is allotted to target tracking beams directed towards the object to establish its characteristics in terms of trajectory, speed etc.

21. When the topography of the surrounding terrain is taken into account, the elevation of the main beam is substantially above ground level.

22. Each of the three faces of the radar covers an azimuth, or bearing angle of 120^{o} – giving 360^{o} coverage in all. The arrays of the RAF Fylingdales radar are orientated so that a beam sent out at perpendicular to the face of the array would be directed on bearings of 7, 127 and 247^{o}. These 'perpendicular' beams would be projected upwards at an angle of 20^{o} above the horizontal since the face of the radar array is angled back 20^{o} from the vertical.

23. The beam generated by each of the three radar antennae can be steered left and right by up to 60^{o}. This allows full 360^{o} coverage in the horizontal plane.

24. Steering in the vertical plane is restricted (by both hardware and software) so that the radar can only be directed between 3 and 85^{o} above horizontal. Allowing for the 1.8^{o} width of the main beam, this restriction ensures that nobody on the ground or in buildings can be exposed to radio frequency emissions from the main beam.

How is an individual radar signal transmitted and received?

25. During normal operation, the radar first repositions the direction of the main beam, it then emits a pulse, and then listens for echoes from that pulse before moving on to its next co-ordinate.

26. The repositioning of the radar beam occurs very rapidly. The beam is moved from one orientation in the horizontal and vertical axis to another in a few millionths of a second. A pulse is then emitted with a maximum pulse length of 16ms after which the receive period would last for another 39.5ms.

27. The beam is then directed to another horizontal and vertical bearing according to a predetermined sequence.

28. The overall "Resource Period" is around 0.0555 second (55.5 milliseconds), irrespective of whether the radar is in surveillance or tracking mode. Within this period, the radar will transmit and receive one or more pulses and then communicate with the radar software.

How long does the radar transmit for in each location?

29. Waveform is a term that is used to describe the temporal characteristics of the transmitted radiation. Different radar functions, such as searching or tracking functions, require different waveforms.

30. The process of transmitting a beam is as follows:

    a. the radar first selects a frequency,

    b. the radar sets the phase shifters which determine the direction of the beam,

    c. the radar transmits one or more pulses of radio frequency energy, separated by listening periods (power is fully on during transmission and fully off during listening periods), and finally

    d. the radar listens for target echoes between pulse transmissions.

31. The duration of each pulse is called a "pulsewidth" and lasts between 0.25 and 16 milliseconds.

32. During the pulsewidth, the frequency of the signal is varied between 5 MHz for track beams to 0.3 MHz for surveillance fence beams. This variation in the frequency (or "Chirp") is used to allow the radar to detect small objects whilst at the same time obtaining good range resolution. The upgraded radar will utilise a 10 MHz chirp pulse which will have a lower transmitted power level per unit frequency than the present 5 MHz pulse and therefore will continue to have no environmental effects.

What sequence of search patterns are used?

33. The radar schedules a surveillance fence that ensures that all horizontal bearings are covered. The last surveillance beam positions of each face are revisited more frequently than other surveillance positions in order to compensate for the broadening of the beam at these extremes and hence ensure that 360^{o} coverage is provided.

34. The lowest elevation of the radar beam is 3^{o} above the horizontal. In assessing the impact of the radar upon the ground level radio frequency environment, power density calculations are undertaken on the basis of a 3^{o} minimum radar beam elevation in order to determine the ground level power densities. The main radar beam therefore never touches the ground at any point. There are areas of reduced radio frequency emission around the main beam that can reach the ground. These are known as sidelobes.

35. The Fylingdales radar performs both short-range and long-range surveillance, each of which needs separate beams. Both types of surveillance are done concurrently by alternating between short- and long-range beam transmission. Short-range beams have a considerably shorter pulsewidth, and as a consequence have much less power - around $1/20^{th}$ of a long-range beam.

Is radio frequency energy transmitted outside of the main beam?

36. Smaller amounts of energy are emitted by the radar outside the main beam. These energy patterns are called sidelobes. These are regions outside the main beam where the transmitted waves do not completely cancel each other out, because of the physics of the focusing process.

37. By convention, sidelobes are given numbered designations, with the lower numbers being closer to the main beam. The energy contained in these sidelobes progressively decreases with distance from the main beam and distance from the radar.

38. The first sidelobe takes the form of a concentric circle around the main beam. This beam has around 1% of the power of the main beam.

39. The second and higher order sidelobes take the form of irregular shaped peaks distributed in a “pseudo-random” fashion around the main beam. The power density of these higher order sidelobes is approximately 0.1% of the main beam power density.

40. The pattern and distribution of sidelobes will vary depending upon the horizontal and vertical angles of the main beam.

How do these activities affect the power density at ground level?

41. The vast majority of the energy from the radar is directed upward, where it can be used to detect potential targets. As the main beam cannot be aimed lower than an elevation of 3^{o} above horizontal, it can never intercept the ground. The first sidelobe is at an angle of 2.9^{o} to the main beam and is also therefore above the horizontal.

42. Since second order and above sidelobes are all around the main beam, in some instances, they do point lower than the horizontal, and therefore direct energy towards the ground. For example, the second sidelobe intersects the ground at distances of 713m or greater from the radar. The power levels of these sidelobes are, as indicated above, very low at this distance (less than 0.1% of the main beam power), and many times within the relevant safety limits.

43. An assessment of the RF radiation effects from the existing early warning radar and the upgraded early warning radar is given in Appendix D.

Appendix C

The Nature of Radio Frequency (RF) Radiation from the Early Warning Radar

1. The first objective of this section is to review the impact of the existing Ballistic Missile Early Warning System (BMEWS) installation on the radio frequency (RF) environment and show that adequate controls are in place to ensure that the RF environment is safe and has no adverse effects on the locality. The second objective is to demonstrate that the upgraded early warning radar (UEWR) does not introduce any additional contribution to the RF environment and therefore to confirm that the UEWR RF environment remains safe and has no adverse effects on the locality.

2. In order to consider the environmental effects due to the transmitted RF radiation from the UEWR, we need to list the known types of RF radiation effects, assess their magnitude and their consequences.

RF Radiation Effects

3. The effects of RF radiation can be summarised as follows and will be addressed in more detail in the Appendices shown:

   a. RF exposure of humans, plants and animals (Appendix D)

   b. RF ignition of flammable vapours and electro-explosive devices (Appendix E)

   c. Electromagnetic Compatibility (EMC) including Electromagnetic Interference (EMI, also known as Radio Frequency Interference (RFI)), and its impact on the susceptibility of electrical and electronic equipment or transport (e.g. vehicles and aircraft). The ability of equipment to operate in a particular RF environment is known as electromagnetic compatibility (EMC). (Appendix F)

      Note: 'Susceptibility' is a term used to describe the malfunction or failure of an electrical system when subjected to particular levels of radiated interference or conducted interference.

Magnitude of the RF Effect

4. A number of factors determine the magnitude of the RF effect. These include which part of the radar beam that is illuminating a location, the distance from the radar and whether there is intervening terrain or obstacles.

5. The most significant potential hazard is due to the main beam of the radar, since the main beam is designed to contain the maximum level of RF radiation. The design of the BMEWS and UEWR described in Appendix B, ensures that the minimum elevation of the main beam is 3 degrees so that there are no locations at ground level illuminated by the main beam.

6. The radar beam pattern has sidelobes in directions outside of the main beam that contain a small percentage of the total RF power. These sidelobes may illuminate locations at ground level. Their power levels are less than 1/1000 of the main beam power (see Appendices B and D).

7. There are a number of ways of expressing RF levels and a number of different measurement units used. Power density is usually expressed in terms of Watts per square metre (W/m^2) but also, milliwatts per square centimetre (mW/cm^2) and microwatts per square centimetre ($\mu W/cm^2$). These are related as follows, $1W/m^2 = 0.1mW/cm^2 = 100\mu W/cm^2$. The power density is formed by two components, electric field strength expressed in Volts per metre (V/m) and magnetic field strength expressed in Amps per metre (A/m). All of these quantities can be measured in terms of their peak value (instantaneous maximum) or average value (over a specified time period).

Consequences of RF Effects

8. The consequences of radar effects at any point are determined by what may be present there i.e. people, animals, vehicles, electrical equipment etc. The consequence can then be assessed by considering health and safety responsibilities and assessing compliance with national standards. The following types of standards are relevant for each RF effect:

RF Effect	Standards or Controls
RF exposure of humans	National Radiological Protection Board (NRPB) Statement Vol.4 No.5 (UK)
RF ignition of flammable vapours and electro-explosive devices	▪ BS6657 Prevention of inadvertent initiation of electro-explosive devices by radio-frequency radiation ▪ BS6656 Guide to the prevention of inadvertent ignition of flammable atmospheres by radio frequency radiation ▪ MOD Ordnance Board Pillar Proceeding 101, Principles of design and use for electrical circuits incorporating explosive components
Regulation of RF transmissions and their impact on other users of the RF spectrum	▪ National Frequency Planning Group (NFPG)
Electromagnetic Compatibility (EMC, RFI)	▪ UK Statutory Instruments (SI) concerning European Union (EU) Directives ▪ Civil Aviation Authority, Directorate of Airspace Policy ▪ MOD HIRTA (High intensity radio frequency transmitting area)

Table 1 – RF Effects, Standards and Controls

Appendix D

Radio Frequency (RF) Exposure

RF Exposure of Humans

1. Electromagnetic fields can affect people through heating of the body, shocks, burns or biological effects. Electromagnetic fields can also affect people indirectly if they wear implantable devices such as heart pacemakers and this aspect is dealt with under electromagnetic compatibility (Appendix F).

2. Over the frequency range of the radar of 420MHz to 450MHz the known RF effects are thermal (i.e. they cause a rise in temperature) due to absorption of RF energy in the tissue. To prevent people from being exposed to hazardous fields, basic restrictions are placed on certain quantities such as Specific Absorption Rate (SAR) that are described further below. As these quantities are difficult to measure directly since they occur inside the body, they are linked to measurable external quantities such as electric field strength or power density. Various committees and bodies have set investigation or reference levels for these measurable quantities.

3. There is no current explicit legislation in the UK requiring compliance with any exposure limits. However, the guidelines from the UK National Radiological Protection Board (NRPB) are widely adopted and are enabled through UK Health & Safety law, e.g. the requirement to perform a risk assessment and duty of care. The Directorate of Safety Environment and Fire Policy (D SEF Pol) implements these requirements within the MOD.

4. The current UK public exposure guidelines are set out below: NRBP guidelines are periodically monitored and revised. It is noted that the guidelines are currently under review in the NRPB Consultation Document “Proposals for limiting exposure to electromagnetic fields (0 – 300GHz), 1 May 2003”.

Document Extract	Specific Absorption Rate (W/kg)	Electric Field Strength (V/m)	Power Density (W/m^2)	Power Density (mW/cm^2)	Power Density ($\mu W/cm^2$)
NRPB Investigation Levels * (UK Guidelines)	0.4	100	26	2.6	2600

* Note: Investigation levels are not limits on exposure. The investigation levels are values of electric field strength and power density for investigating whether compliance with basic restrictions is achieved. If the measured values are greater than the relevant investigation levels, it does not necessarily follow that the basic restrictions are exceeded. If the field to which a person is exposed exceeds the relevant investigation level then it is necessary to investigate compliance with basic restrictions. Factors that might be considered in such an assessment include, for example, the efficiency of the coupling of the person to the field, the

Table 2 – General Public RF Exposure Guidelines, 420 to 450MHz

5. The term, Specific Absorption Rate (SAR) is the rate of energy absorption by living tissue expressed in watts per unit mass of tissue, usually in units of watts per kilogram (W/kg).

6. The (human) RF exposure guidelines take account of the size and weight range of adults and children. This is because the size of the person contributes to the SAR due to resonance. A typical adult has a resonant frequency of 68MHz while a child has a resonant frequency of approximately 240MHz. The RF exposure guidelines for power density exposure therefore vary with frequency to account for this resonant effect. There are a number of safety factors built into the RF exposure guidelines. The levels of SAR considered by the RF exposure guidelines are:

   a. Thermal effects known to occur at levels of 4W/kg

   b. Basic restriction set at 0.4W/kg (safety factor of 10)

7. For the purposes of calculating or measuring the exposure levels the measurable quantities of electric field strength or power density are used. From Table 2, the power density specified in the NRPB guidelines is $26W/m^2$. Note that in accordance with the guideline documents this is the average level over any 15 minute period. This average power density corresponds to an average electric field strength value 100V/m.

Assessment of Radio Frequency (RF) Exposure for Current BMEWS Operation

8. In order to assess the RF exposure levels to electromagnetic fields around the radar the power density and electric fields from the radar have been calculated using computer calculations and the existing power density and electric fields from the current BMEWS operational radar have been measured during field surveys.

9. These two sets of results, one calculated and one measured, have then been compared to the RF exposure guidelines to demonstrate that levels are well within prescribed safety limits in relation to both current and future operation.

10. The values calculated or measured in this study take account of the fact that the exposed individuals are on the ground (height up to 2m). Note that the minimum main beam elevation angle of 3^o ensures that no individual on the ground is exposed to the main beam. The electromagnetic field from the radar is therefore the result of sidelobes in the antenna pattern. This is further reduced by path loss related to the distance from the radar.

11. An important aspect of the radar operation is that the radar transmission is pulsed and is also continuously scanning electronically. This has the effect of reducing the

spatial distribution of the field across the volume of space occupied by the person and the duration of exposure.

amount of energy present at any particular location over a period of time. This is important because all the NRPB guideline document requires is the average amount of energy to be compared to the reference or investigation levels over a defined period of time of 15 minutes.

12. For some of the measurement surveys, the peak levels were initially measured and the average levels were calculated. The reason for this was that the locations were not accessible by road, and therefore small handheld test instrumentation was used.

13. Three RF surveys have been conducted,

    a. Royal Airforce Signals Engineering Establishment (RAFSEE) 1991/1992, Reference Theoretical Assessment and Measurement Survey of the Electromagnetic Radiation Hazard Levels around the Solid State Phased Array Radar at RAF Fylingdales, Technical Note 92127, May 1993, Issue 0.1

    b. TuV PS August 2000, Reference Measurement Survey of the Electromagnetic Radiation Around the Solid State Phased Array Radar at RAF Fylingdales, NP607358, 23 August 2000. This survey revisited the 1991 / 1992 RAFSEE survey points to confirm that there had been no change in emissions over time.

    c. TuV PS February 2002, Reference Radio Frequency Exposure Survey for the Solid State Phased Array Radar at RAF Fylingdales, LK607358/5, March 2002. This survey extended the range of measurement points to include footpaths, areas of high ground and roads in the surrounding area.

14. Two RF calculation exercises have been performed,

    a. IITRI (Illinois Institute of Technology –Research Institute) calculations using PALPAM programme, 3 May 2001

    b. MITRE Technical Report, RF Power Density Exposure at Ground Level Due to Fylingdales radar, August 7, 2001

15. The RAFSEE 1991/1992 Electromagnetic Radiation Hazard Survey showed that the radio frequency levels, at normal places of work around the site, were below the maximum permissible levels given in NRPB Guidance as to restrictions on exposure to time varying electromagnetic fields and the 1988 recommendations of the International Non-Ionizing Radiation Committee. 90 locations were measured both within the RAF Fylingdales site and in the surrounding area.

16. The TuV PS August 2000 survey took a subset of five locations from the RAFSEE 1991/1992 report which were accessible to the general public and exhibited the maximum RF exposure levels and remeasured them. The report concluded that over the intervening years between 1991/92 and 2000, the overall RF levels surrounding RAF Fylingdales had not changed.

17. The TuV PS February 2002 survey was performed to provide validation of the IITRI and MITRE computer modelling calculations particularly at locations which had not been previously surveyed, see Figure 7. The report concluded that there were no RF exposure results in excess of the Guidelines issued by the National Radiological Protection Board (NRPB).

18. Table 3 shows a summary of the maximum calculated and measured levels. The values shown are expressed as average power densities to enable comparison to the RF exposure guideline that is also shown in the table. Where results were in terms on peak power density or peak electric field strength these have been converted to average power density. The factor used is the worst case conversion factor from peak to average power for the radar of 0.012 that accounts for the reduction in averaged levels due to the radar duty cycle and radar beam scanning.

19. A single scheme of location reference letters has been used in this report as shown in Table 3 since the previous studies have used differing numbering schemes to identify locations.

20. Based on the available data, the measured RF exposure from the RAF Fylingdales radar is below or within measurement uncertainty of the calculated RF exposure.

21. The measured and calculated RF exposures are all below the RF exposure guidelines issued by the NRPB. This indicates that there is no evidence of a non-ionising radiation hazard to the general public on the ground from the Early Warning Radar at RAF Fylingdales in its current operation.

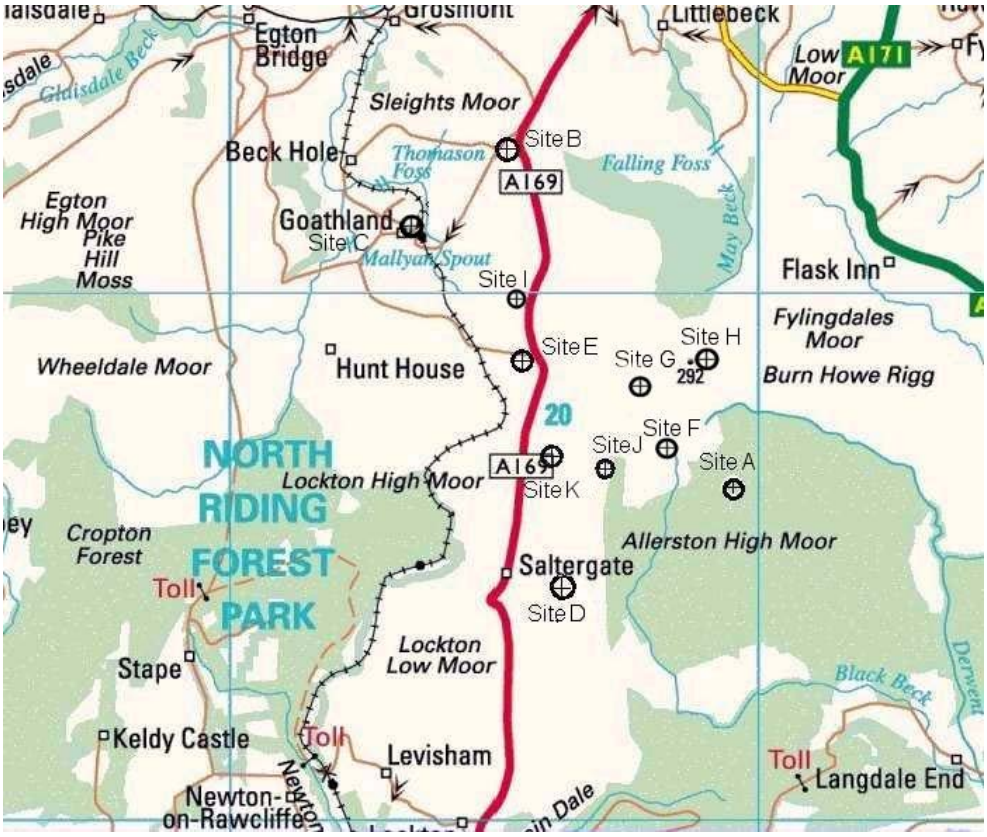

Figure 7 – 2002 RF Exposure Survey Locations

Location Reference	Location of Site	May 2001 Calculations (IITRI) W/m^2	August 2001 Calculations (MITRE) W/m^2	1991 Survey (RAFSEE) W/m^2	August 2000 Survey (TuV PS) W/m^2	February 2002 Survey (TuV PS) W/m^2	Maximum RF Exposure Guideline W/m^2
A	Allerston High Moor, near Low Woof Howe	0.0018 (Site 7)	<0.012	n/a	n/a	0.0024 (Site 7)	26
B	A169, near Breckon Howe	0.00054 (Site 4)	<0.012	n/a	n/a	0.001 (Site 4)	26
C	Goathland, near railway station	0.00049 (Goathland)	<0.0012	n/a	n/a	n/a	26
D	Near Whinney Nab, Saltergate	0.0042 (Site 10)	<0.012	n/a	n/a	0.014 (Site 10)	26
E	Near RASFSEE points 58/59, Car park 76m or Lay-by 236m from A169 along Moorgate Road	0.0026 (Site 2)	<0.012	0.0049 (*Loc. 59*)	0.0012 *(Loc. 58*)	0.0017 (Site 2)	26
F	On moorland track to Northeast of site in front of face C	n/a	<0.0012	0.02 (Loc. 29)	0.000008 (Loc 29)	n/a	26
G	On moorland track to Northeast of site near boresite tower	n/a	<0.012	0.04 (Loc. 30)	0.0013 (Loc. 30)	n/a	26

Location Reference	Location of Site	May 2001 Calculations (IITRI) W/m^2	August 2001 Calculations (MITRE) W/m^2	1991 Survey (RAFSEE) W/m^2	August 2000 Survey (TuV PS) W/m^2	February 2002 Survey (TuV PS) W/m^2	Maximum RF Exposure Guideline W/m^2
H	On moorland track Northeast of site near ordnance marker	n/a	<0.012	0.007 (Loc. 31)	0.00067 (Loc. 31)	n/a	26
I	Hilltop, 3km north on A169 from site main entrance. This is the highest ground along the A169 with a view of radar	n/a	<0.012	0.00039 (Loc. 55)	0.0001 (Loc. 55)	n/a	26
J	Forestry track adjoining security fence on SE of site (near RAFSEE points 24 & 54 inside fence)	n/a	>0.012	0.05 *(c.f. Loc. 24)* *(inside fence, not public access)*	n/a	0.031 (Site 12)	26
K	Half way along Site Access Road (approximately 500m east of RAFSEE point 27)	n/a	>0.012	0.0013 (*c.f. Loc. 27*)	n/a	0.0015 (Site 11)	26

Table 3 – Summary Table of Calculated and Measured Average Power Densities

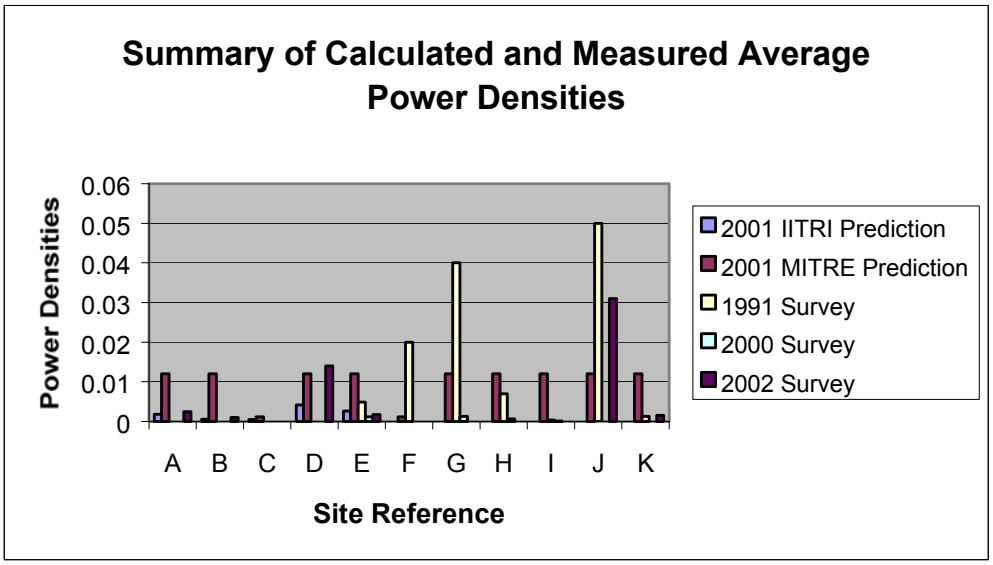

Table 4: Graph Illustrating Maximum Calculated and Measured Power Density

Note: The highest calculated or measured power density is 0.05 W/m^2 which is 1/520th of the Maximum Exposure Guideline of 26 W/m^2.

RF Exposure of Plants and Animals

22. When considering plants and animals, there are no specific documented guidelines published. Birds in flight may be affected in a localised area near the radar but this is unlikely to be hazardous due to the short duration of time taken to traverse the area. There is no evidence of adverse effects on plants or animals over the 40 years that the radar has been operating.

Assessment of RF Exposure Due to the Upgrade of the EWR

23. In order to assess whether there is any change in RF exposure due to the upgraded early warning radar it is necessary to examine those radar parameters that contribute to RF exposure.

24. The physical radar arrays and RF solid-state modules will remain unchanged.

25. The design frequency range will remain unchanged at 420MHz to 450MHz although not the entire frequency band is used.

26. The total transmitted power during a pulse will be unchanged at 870kW peak (794 after losses).

27. The maximum antenna gain will be unchanged at 39.9dB.

28. The main beam and sidelobe pattern will be unchanged.

29. The radar antenna polarisation will be unchanged and will be circularly polarised.

30. The minimum beam elevation will be unchanged at 3 degrees above the horizontal.

31. The main beam beam-width will remain within 1.8 and 5 degrees as at present.

32. The radar functions will not change even though the data gathered may be put to different purposes. The functions are surveillance, search and track.

33. The basic concept of the radar waveform timing will not change. The radar waveform will use various pulse widths (the time that the radar is transmitting) and frequency modulation of the radar pulse (chirp) to achieve the different functions of surveillance, search and track. Different functions will be scheduled together in an optimal manner within the time periods for which the radar is transmitting; these time periods will remain unchanged.

34. The number of pulses transmitted, and how often will be constrained by the radar duty factor, which will be unchanged. The duty factor or duty cycle is defined as the percentage of time over which a radar face is transmitting energy over a period of time. Duty factor constraints arise from the design of the radar solid-state modules, and this aspect of the radar design will not change.

35. The basic concept of a continuously scanning radar beam will not change. The directions of the radar beam will be scheduled according to the purpose of the pulse being transmitted, i.e. whether it is for surveillance, search or track. Early warning surveillance will consist of long range, medium range and short range surveillance “fences” that steer the beam in a predetermined sequence to provide 360-degree coverage from the three radar faces. A “search” will be an augmentation of this standard surveillance fence, and will be used to locate objects. A “track” will be used for accurately tracking the paths of unknown objects, satellites and re-entry vehicles. All these functions are interleaved so that the overall effect is a continuously scanning radar beam.

36. The UEWR surveillance fences will be built using single beams fixed in elevation. The revisit rate to any particular azimuth will vary as a function of beamwidth to produce the effect that the probability of detection is uniform across each of the faces. The effect "on the ground" will be to make the illumination much more uniform than it is now and the average power at any one location will be the average for the face and therefore unchanged compared to the RF assessments for the existing radar.

37. In summary there are no changes as a result of the UEWR that will increase RF exposure to humans. This conclusion would be further substantiated by RF exposure measurement surveys of the UEWR.

Appendix E

Radio Frequency Ignition of Flammable Vapours and Electro-Explosive Devices (EED)

1. A RF field of sufficient strength can cause sparking between conductors and the spark could subsequently cause fire or explosion if there are flammable vapours. Additionally items such as detonators and electro-explosive devices (EED) require additional precautions against RF fields.

2. The likelihood of ignition increases with peak power and the energy in the pulse and the substance involved.

3. A detailed methodology for dealing with flammable vapours and gases is given in BS6656, “Guide to the prevention of inadvertent ignition of flammable atmospheres by radio frequency radiation”.

4. A detailed methodology for dealing with commercial detonators is given in BS6657, “Prevention of inadvertent initiation of electro-explosive devices by radio-frequency radiation”.

5. The main radio frequency hazard (RADHAZ) is within the RAF Fylingdales secured site rather than to the general public. Appropriate health and safety measures are employed on site to prevent incidents. In particular:

    a. Previous assessments of fuels and gases have been made by RAFSEE in 1991/1992 and RADHAZ boundaries exist and are maintained within the RAF Fylingdales site.

    b. Currently RAF Fylingdales is not licensed to store explosives and therefore no EED hazard exists within the site.

6. With respect to hazards outside the perimeter fence, the requirements of BS6656 can be applied. The BS6656 gives threshold power levels for different groups of gases as shown in Table 5. These power levels can be converted to peak electric field strengths using the formulae in BS6656. The maximum peak field strengths measured during the surveys are included for comparison. Further details of these surveys are given in Appendix D. Additionally the RAFSEE 1991/1992 report provides safe distances calculated from BS6656 of which the second sidelobe data is relevant as this can illuminate ground level.

Gas Group (see BS6656)	Threshold Power (from BS6656)	Equivalent Threshold Electric Field at 420MHz (Note 1) (from BS6656)	Maximum Result for Public Access	Calculated Safe Distance
I & IIA e.g. methane (includes petrol & diesel)	8W over 100uS period	69.1V/m	31.3V/m	294m
IIB e.g. Ethylene	4W over 100uS period	48.8V/m	31.3V/m	417m
IIC e.g. Hydrogen	2W over 20uS period	34.5V/m	31.3V/m	589m

Note 1: The lowest radar frequency gives the worst case

Table 5 – Inadvertent Ignition of Flammable Atmospheres

7. From Table 5, it can be seen that the measured and calculated peak electric field results for general public access are safe with respect to the threshold for inadvertent ignition of any Gas Group.

8. For the general public the major concern could be the (emergency) refuelling of vehicles, however, as the closest approach of a public road (the A169) is 850m at its closest point, this is not a concern. This can be seen to be safe with respect to the safe distance for all the gas groups as illustrated above. Controls are put in place to ensure that ignition of flammable materials are not a hazard within the site itself.

9. The use of EEDs (detonators) by the general public is subject to licensing and would need to take account of the radar if licensed for use in its vicinity. Considering safety in transit, e.g. vehicles using the A169, BS6657 specifies a maximum field strength of 100V/m, 100MHz to 1GHz. Considering this level is not exceeded anywhere with public access. The maximum being 31.3V/m (forestry track) and 12.4V/m on the A169.

10. The regular safe use of the RAF Fylingdales site and locality by road vehicles demonstrates that there is no hazard to EEDs used in vehicle air bags. Manufacturers have to ensure that the air bag systems are immune to all RF environments encountered.

Assessment of RF Ignition of Flammable Vapours and EED due to the Upgraded EWR

11. The peak transmitted power of the UEWR will be unchanged, therefore the peak electric field strengths due to the radar beam and its sidelobes will also be unchanged. The measured field strengths shown in Table 5 will therefore be equally valid and therefore there will be no additional hazard due to the UEWR.

Appendix F

Electromagnetic Compatibility (EMC)

1. Electromagnetic compatibility is concerned with electromagnetic interference (EMI, often called radio frequency interference or RFI) and is any unwanted signal that adversely affects the operation of a device, electrical or electronic equipment or system, referred to as an 'apparatus'. This definition excludes compatibility with other transmitting radio communication systems as spectrum compatibility is dealt with by the Radiocommunications Agency. It does include compatibility with broadcast receivers (radio and television).

2. The radar beam is an intentional signal but where it illuminates other equipment it may act as an interference signal and cause the apparatus to malfunction or fail. This situation is known as susceptibility. The degree of protection offered by an apparatus is known as its immunity. With regard to the radar beam the coupling mechanism of the susceptibility is due to the radiated electric field, therefore the relevant immunity parameter is radiated field immunity that is expressed in Volts per metre (V/m). The peak electric field strength is relevant when considering immunity.

3. In order to assess whether there is a potential electromagnetic compatibility issue for ground based apparatus, the radar has been assessed by calculation and measurement. Table 6 shows a summary of the maximum calculated and measured levels. Further details of these assessments are given in Appendix D. The values shown are expressed as peak electric field strengths to enable comparison to the RADHAZ and EMC standards.

Location Reference	**Location of Site**	**Peak Electric Field Strength V/m** (Highest measurement or calculation in bold)	**Distance from Radar km**
A (Site 7)	Allerston High Moor, near Low Woof Howe	**8.6 (TUV PS Survey)** 7.57 (IITRI Calculation)	2.55
B (Site 4)	A169, near Breckon Howe	**5.6 (TUV PS Survey)** 4.12 (IITRI Calculation)	6.5
C	Goathland, near railway station	**3.92 (IITRI Calculation**)	5.2
D (Site 10)	Near Whinney Nab, Saltergate	**20.7 (TUV PS Survey)**	2.2

		11.54 (IITRI Calculation)	
E (Site 2)	Near RASFSEE points 58/59, Car park 76m or Layby 236m from A169 along Moorgate Road	**12.4 (RAFSEE Survey)** 7.2 (TUV PS Survey)	2.05
F (Loc 29)	On moorland track to north east of radar in front of face C	**22.39 (RAFSEE Survey)** 2.51 (TUV PS Survey)	1.55
G (Loc 30)	On moorland track to north east of radar near boresite tower	**28.18 (RAFSEE Survey)** 6.31 (TUV PS Survey)	1.75
H (Loc 31)	On moorland track to north east of radar near ordnance marker	**15.85 (RAFSEE Survey)** 5.01 (TUV PS Survey)	3.2
I (Loc 55)	Hilltop, 3km north on A169 from site main entrance. This is the highest ground along the A169 with a view of radar	**3.48 (RAFSEE Survey)** 2.51 (TUV PS Survey)	3.05
J (Site 12)	Forestry track adjoining security fence on SE of site (near RAFSEE points 24 & 54 inside fence)	**31.3 (TUV PS Survey)**	0.65
K (Site 11)	Half way along Site Access Road (approximately 500m east of RAFSEE point 27)	6.8 (TUV PS Survey)	0.61

Table 6 – Summary of Calculated and Measured Peak Electric Fields

4. Due to the wide range of apparatus it is not possible to provide a single value of the immunity characteristic. The following categories are therefore considered to help with the assessment:

   a. Interference with fixed apparatus and portable or personal apparatus

   b. Interference with vehicle electrical systems

   c. Interference with railway rolling stock and infrastructure

   d. Interference with aircraft electrical systems

5. The immunity performance of apparatus is regulated within the European Union (EU) by EU Directives implemented by Statutory Instruments (SI) in the UK. In

addition there are technical standards or EuroNorm (EN) which detail test methods and limits applicable to an apparatus to demonstrate conformity to a Directive. The following paragraphs review the directives and standards in more detail.

Fixed and Portable Apparatus

6. In the first category, most apparatus (electrical or electronic equipment) has to conform to the requirements of the European Electromagnetic Compatibility (EMC) Directives 89/336/EEC, (as amended by 92/31/EEC and 93/68/EEC) which is implemented by UK Statutory Instrument, The Electromagnetic Compatibility Regulations 1992 (S.I. No. 2372). Within these regulations are essential requirements for apparatus not to cause electromagnetic disturbances (i.e. interference) and to have an adequate level of immunity to electromagnetic disturbances. (Note that radio communications equipment is not within the scope of the EMC Directive, and therefore the radar itself is not subject to this Directive).

7. Required levels of immunity are specified in various standards depending on product type, product family or environment. The immunity to electric field radiated interference generally falls into two severities for non-safety related equipment:

   a. Domestic and light industrial environment requires an immunity of 3V/m (80MHz to 1000MHz)

   b. Industrial environment requires an immunity of 10V/m (80MHz to 1000MHz)

8. The minimum level of immunity in the various standards is 3V/m with the exception of sound and television broadcast receivers. The standard EN55020 specifies radiated immunity up to 150MHz at a level not exceeding 1.78V/m for this equipment. This requirement does not therefore address the radar frequencies of 420MHz to 450MHz. The immunity performance of sound and television broadcast receivers is therefore not assessed for compliance with the European EMC directive over this frequency band. Any reported incidence of sound and television broadcast interference would be examined on a case-by-case basis by the Radiocommunications Agency.

9. The EMC Directive specifically excludes safety issues and therefore other EU Directives concerned with safety related apparatus include a safety argument approach to all EMC issues. This means that there are not necessarily specified immunity levels available but manufacturers must consider their apparatus and its RF environment. EU Directives that could relate to safety related apparatus include:

   a. Low Voltage

   b. Gas Appliances

   c. Construction Products

d. General Product Safety

e. Machinery

f. Personal Protective Equipment

g. Health and Safety at Work

h. Toy Safety

i. Medical Devices

j. Radio and Telecommunication Terminal

10. Of particular relevance are medical devices as these could be worn by the general public when walking in the vicinity of the radar. Medical equipment is covered by one of three product-specific directives:

    a. The Medical Devices Directive (MDD) 93/42/EEC; in force since 1998

    b. The Active Implantable Medical Devices Directive (AIMD) 90/385/EEC; in force since 1995

    c. The In Vitro Diagnostic Directive (IVDD) 98/79/EEC, 1998

11. There are EMC standards for external active medical devices and implantable medical devices, e.g. pacemakers or defibrillators. Pacemakers are typically immune to fields of 200V/m or more.

12. For portable or personal apparatus used by the general public, the maximum field strength from Table 6 is 31.3V/m near the security fence on the South East of the RAF Fylingdales site (Site J). Although this level exceeds the minimum required immunity levels for some apparatus, this does not automatically mean that an interference problem would ensue. There would need to be an apparatus present at this location and in use that had only the minimum immunity performance at the frequencies of the radar operation. Most interference would be of a nuisance value such as audible noise for example on personal entertainment systems such as on a radio receiver, cassette or CD player. At increasing distance from the radar site, the field strength reduces.

13. Safety related apparatus such as heart pacemakers are protected against the maximum measured or calculated levels.

14. For apparatus installed inside buildings, the building will provide a degree of shielding (reduction in the field strength) depending on the construction, therefore the field strengths will be further reduced.

Vehicles

15. There are several EU Directives relevant to vehicles, including road, agricultural, earth moving and construction vehicles.

16. From 1 January 1996, all new road vehicle types have had to comply with the European Automotive EMC Directive 95/54/EC. Existing vehicles, which comply with older Directives 72/245/EEC (or with 72/306/EEC for diesel engine types), must comply with the new Directive by 1 October 2002. The Automotive EMC Directive contains a complete technical specification. It applies to vehicles covered by the Vehicle Framework Directive (70/156/EEC as amended by 92/53/EEC): broadly speaking this means cars, vans, coaches, trucks, motorcaravans and caravans. Motorcycles need to comply with the Motorcycle Directive 97/24/EC, which contains EMC requirements identical to those of the Automotive EMC Directive. The Automotive EMC Directive applies to whole vehicles and electrical subassemblies (ESA) including accessories for aftermarket fitment.

17. The Automotive EMC Directive specifies a field of 30V/m from 20MHz to 1GHz with amplitude modulation at 1kHz to a depth of 80%. These tests can be applied to whole vehicles or ESAs.

18. Other vehicles including forestry and agricultural tractors, earth-moving machinery and construction equipment have their own Directive 75/322/EEC. The EMC requirements are the same as the Automotive EMC Directive.

19. For vehicles using public roads the maximum field strength assessed during the measurement surveys and calculations is 12.4V/m as shown in Table 6. This is within the minimum vehicle immunity standards of 30V/m and therefore no hazard exists for vehicles on the public road.

20. For vehicles travelling off road, including forestry and agricultural equipment, the maximum field strength from Table 6 is 31.3V/m near to the security fence. This is marginally above the minimum vehicle immunity standards of 30V/m but vehicle manufacturers ensure that their vehicles are immune to levels well in excess of the minimum required and therefore a hazard is unlikely to exist.

Railways

21. The EU Directive on EMC and rail company standards controls railway EMC. Radiated immunity of rolling stock and infrastructure is typically 20V/m.

22. The nearest main line railway (through York) is some 45km away from the radar site and is not illuminated by the radar beam.

23. The North York Moors single-track railway is 1.4km away from the radar site at closest approach. The majority of the line in the vicinity is in a natural cutting and not illuminated by the radar. A section of the track near Moorgates has sight of the radar for a short distance. The railway is a preserved steam railway and as such

the rolling stock and infrastructure do not use electronic safety systems and are therefore inherently immune to radiated interference. The signals are mechanically operated.

24. There is therefore no EMC hazard for railways in the vicinity associated with the radar.

Aircraft

25. The RF effect of the main beam is limited to airborne objects, for example aircraft. In order to ensure that aircraft safety systems do not malfunction due to radio frequency interference from transmitters such as radars, exclusion zones are established on aeronautical maps. Beyond this exclusion zone the RF radiation levels are at a safe level. This exclusion zone applies to all aircraft including gliders, microlites, hangliders, balloons, and parachutists. Military aircraft are subject to an additional control known as HIRTA (High Intensity Radio Frequency Transmission Area). All airborne activity is therefore excluded from the exclusion zone.

26. The Civil Aviation Authority (CAA) Directorate of Airspace Policy (DAP) is responsible for the planning and regulation of all UK airspace including the navigation and communications infrastructure to support safe and efficient operations. DAP is staffed by civilian and military experts with experience of commercial, business, recreational and military aviation.

27. The High Intensity Radio Frequency Transmitting Area (HIRTA) scheme was developed to prevent aircraft during low flying manoeuvres from entering areas of high intensity electromagnetic radiation where their systems may inadvertently operate or malfunction because of that radiation. A HIRTA is a virtual upright cylinder, described by its radius in nautical miles and its height in feet. The actual shape of the radiation pattern of the antenna is not considered. Outside of this cylinder aircraft may be considered safe; inside this volume they are at risk.

28. The HIRTA scheme has two main elements:

    a. Aircraft System Susceptibility. The susceptibility of an aircraft is assessed to determine the safe field strength/power density its systems and weapons can be exposed to when subjected to the electromagnetic environment. This information is contained within the aircraft release to service documents. Aircraft susceptibility is then assessed within four frequency bands, which are further sub-divided into 4 sensitivities to provide a HIRTA code.

    b. HIRTA Information. The second element is a list of transmitters containing descriptions of their location by reference number, place name, grid reference, lat/long, their frequency band, and lists of the radii and heights within which the sensitivity grades are exceeded.

29. The HIRTA Scheme also enables the identification of other avoidance distances for classified areas allowing a pilot with knowledge of his aircraft susceptibility to determine a safe flight path during flight planning for low level exercises or in a few cases total avoidance from very high power transmitters.

30. The EMC hazard to aircraft is therefore carefully controlled by use of exclusion zones.

Assessment of Electromagnetic Compatibility issues associated with the UEWR

31. The peak transmitted power of the UEWR will be unchanged, therefore the peak electric field strengths due to the radar beam and its sidelobes will also be unchanged. The measured field strengths shown in Table 6 will therefore be equally valid and therefore there will be no additional hazard due to the UEWR.

Appendix G

Images of GPS Antennae