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NOTE 3

RADAR EQUIPMENTS

PRESENT EQUIPMENTS

1. The radar equipments in use are listed below:

UNIT	SITE	EQUIPMENT
BNATSU	Brize Norton Clee Hill Heathrow	AR 15 SSR 700 SSR5G
Border	Boulmer Boulmer Boulmer	T84 T85 SSR 750
Eastern	Watton Watton Neatishead Neatishead Neatishead	T82 SSR TPX 46 T84 T85 SSR 750
Highland	Buchan Buchan Buchan	T80 TPS 34 SSR 750
LATCC(Mil)	Ash Burrington Clee Hill Heathrow Mt Gabriel St Annes Ventnor Neatishead	S264 + SSR5G AR5 + SSR 700 AR5 + SSR 700 2 x S264 + SSR5G 2 x SSR 700 S264 + SSR5G S264 + SSR5G T84, T85 + SSR
Midland	North Luffenham North Luffenham ~~Watton~~ Neatishead Staxton Wold	T82 SSR TPX 46 ~~T82 + SSR~~ T84, T85 + SSR T84, T85 + SSR
ScATCC(Mil)	Aberdeen Aberdeen Bishops Court Glasgow Lowther Hill St Annes Stornoway Sumburgh	S264 SSR5G (available 1984) T84 + SSR S264 S264 + SSR5G S264 + SSR5G SSR 700 SSR 4032
Shetland	Saxa Vord Saxa Vord	S649 SSR 750
Yeovilton	Yeovilton Yeovilton	S264 SSR 700

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2. T80 Radar. The T80 primary radar was designed in the fifties as a replacement for wartime and immediate postwar air defence radars. Operating on 10 cm wavelength it features very narrow beamwidth, long range but slow rate of rotation.

3. T82 Radar. Designed as a tracking radar for the Bloodhound Mk1 SAM system, this 10 cm radar system has been in use since 1958. Built as a complete radar system in itself, the radar has been modified for ATCRU use; the rate of rotation has been reduced to 8 rpm, modified SSR and better weather suppresion circuitry have been added. A noteworthy feature of this equipment is the fact that it is a 3D radar.

4. T84 Radar. This is a long range 23 cm air defence primary radar available for ATC use through digital link. It features a very slow rate of rotation.

5. T85 Radar. T85 is a high powered, long range air defence primary radar operating on the 10 cm wavelength made available for ATC use through digital link. As with T84, the rate of rotation is very slow.

6. S264 Radar. This is a development by Marconi of a long range shipborne radar system and was designed specifically for ATC purposes. Its 50 cm wavelength makes it virtually weather free, but its wide beamwidth produces large primary radar returns. However this is compensated for in most installations by on-site processing before feeding to a remote digital display.

7. AR 5. A purpose built ATC radar designed by Plessey, operating on 23 cm wavelength. Its long range, relatively high rate of rotation and narrow beam width make it ideal for area work. Both installations are processed on site and fed to LATCC via digital link.

8. AR 15. Operating on 10 cm wavelength, this is an update of the AR 1 by Plessey. Its fast rate of rotation and comparatively short range do not make it particularly suitable for area work. However when coupled to an automated SSR system, such as Marconi PPS200, its value is much enhanced.

9. Summary

TYPE	W/LENGTH	BEAMWIDTH	RPM	RANGE
T80	10cm	0.3°	4	180+
T82	10cm	Tx 1.0° Rx 1.7°	8	120
T84	23cm	Restricted	4	180+
T85	10cm	Restricted	4	180+
S264	50cm	2.25°	10	160
AR5	23cm	1.2°	7	200
AR15	10cm	1.4°	15	80
S649	10 & 23cm	Restricted	4	Restricted
SSR5G	N/A	2°	Slaved to Primary	250
SSR 700	N/A	2°	3-15	200

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FUTURE DEVELOPMENTS

10. It will be seen from the preceding notes that the radar equipment used by area radar controllers is a mixture of air defence (AD) and purpose-built ATC radars. The UK Air Defence Ground Environment (UKADGE) is in the process of major re-equipment plan associated with NATO developments. This will preclude the use of AD radars for ATC use. At the same time NATS is expanding its own radar network with the aim of complete independence from AD radars. This is a major programme which will be the subject of a comprehensive briefing later in the Course. Suffice it to say, at this juncture, that the replacement equipment will involve new primary and secondary radars at 5 sites - Heathrow, Pease - Pottage, Debden a site near the Wash and one in North Yorkshire.

11. SRE-M5 Primary Radar. This is a 23 cm solid state radar combining antenna and turning gear by AEG Telefunken with transmitter, receiver and plot extractor units by Hollandse Signaalapparaten. The radar features a very large antenna - 14.5m x 9m (almost 80% larger than similar comparable antennae); this offers better signal gain hence stronger responses and the width of the antenna will offer narrow, well defined returns with a very clean base to the beams. 2 beams are employed - one like a fan beam, the other resembling a pencil beam. The fan-shaped beam offers more energy at higher angles of elevation, the pencil beam concentrating the power to give longer range. The total power transmitted can be varied between the 2 beams to suit the particular location, thus the transmitter can be configured for short range, very long range or an acceptable combination in between. Additionally the use of 3 separate front end receivers offers very good short range (down to 300 metres) with no loss to long range performance (200 nms).

12. Cossor SSR 950. The NATS modification programme also includes 22 Cossor SSR 950 Interrogator/Receivers for both new and existing sites. The SSR 950 has full monopulse capability and has been designed for future adaptation to ADSEL (Address Selectivity) SSR application.

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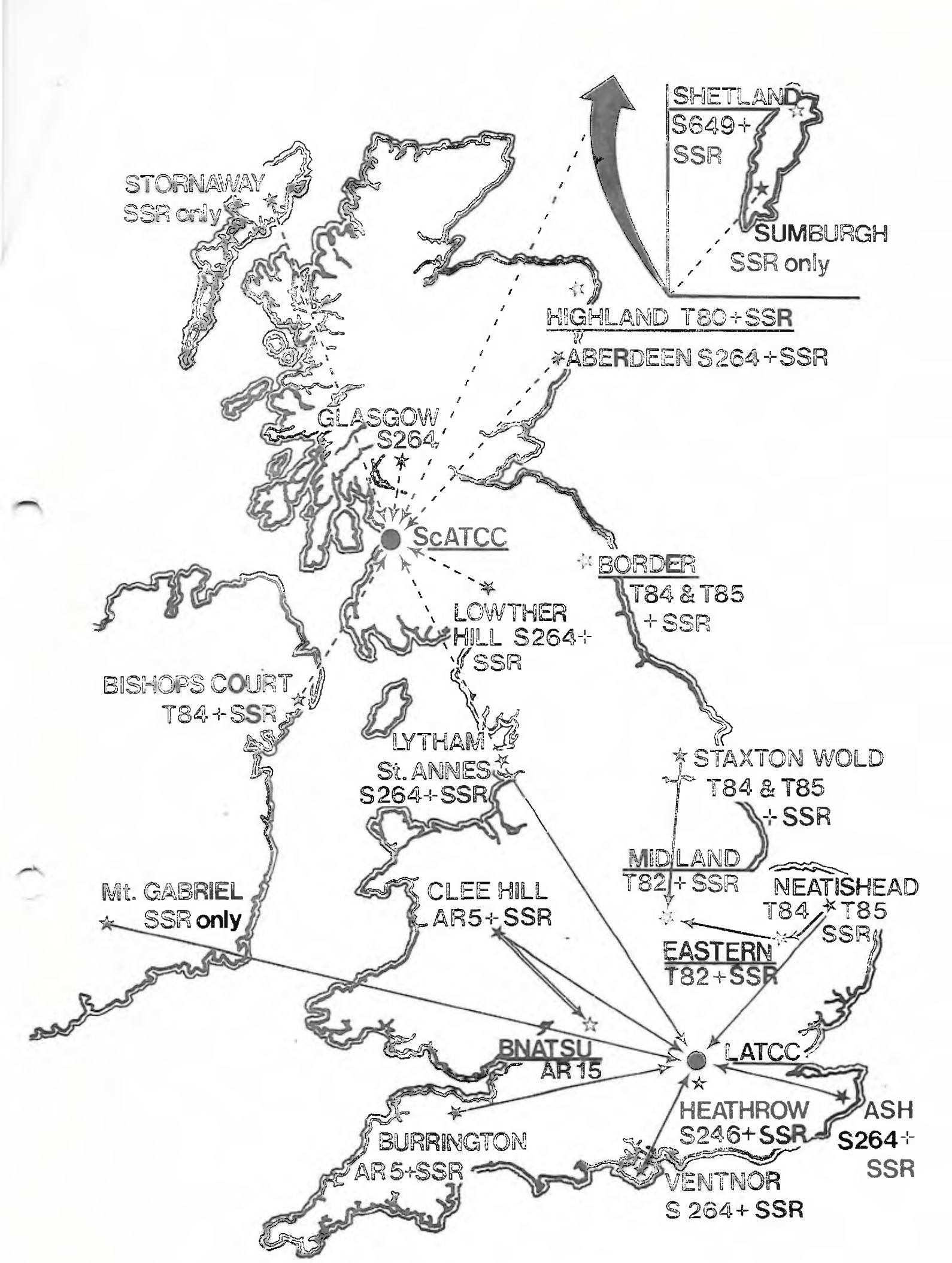
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S649+
SSR
SUMBURGH
SSR only
STORNAWAY
SSR only
HIGHLAND T80+SSR
ABERDEEN S264+SSR
GLASGOW
S264
ScATCC
BORDER
T84 & T85
+SSR
LOWTHER
HILL S264+
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BISHOPS COURT
T84+SSR
LYTHAM
St. ANNES
S264+SSR
STAXTON WOLD
T84 & T85
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MIDLAND
T82+SSR
NEATISHEAD
T84 T85
SSR
Mt. GABRIEL
SSR only
CLEE HILL
AR5+SSR
EASTERN
T82+SSR
BNATSU
AR15
LATCC
HEATHROW
S246+SSR
ASH
S264+
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BURRINGTON
AR5+SSR
VENTNOR
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NOTE 4

FACTORS AFFECTING THE PERFORMANCE OF GROUND RADAR

INTRODUCTION

1. The performance of all ground radars is affected to some extent by natural phenomena (clutter), or man-made intentional or unintentional interference. Some radars are more susceptible than others and generally speaking the degree of interference is related to the frequency/wavelength or radiated power of the radar.

TYPES OF INTERFERENCE

2. The common types of interference are as follows: WASPJAR

a. Weather.

b. Anomolous Propagation.

c. Suppressors.

d. Permanent Echoes.

e. Jamming.

f. Angels.

g. Radar Interference.

WEATHER

3. One of the most common forms of clutter is that produced by weather. Rain, snow, storms and dense cloud affect all radars in one form or another. Interference will be in the form of one or more of the following:

a. Variation of the moisture content of the atmosphere affects the absorption rate of the radiated power, and hence the range performance of all radars.

b. Metric radars depend on the reflecting properties of the site. Damp or wet ground vary these conditions and hence performance and radar cover.

c. With high frequency radar the water content of clouds and heavy rain act as reflecting surfaces and these appear as cloud clutter on centimetric or high frequency displays. Use is made of this phenomena by meteorological radar. Aircraft returns are often obliterated and returns from aircraft beyond the cloud are weakened by absorption.

4. The effect of bad weather conditions from the display point of view can be improved by electronic means such as Logarithmic receivers, MTI, short time constants, variable swept gain, rain plates, etc.

5. 23 and 50 cms radars are less liable to interference from cloud and rain than centimetric radars, and because of this, they are often classed or termed "All Weather Radars". It should be noted, however, that the more extreme weather conditions will cause interference even on 50 cms displays.

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ANOMOLOUS PROPAGATION (ANAPROP)

6. Under normal atmospheric conditions radar propagation is quasioptical, but abnormal atmospheric conditions such as temperature inversion and concentration of moisture content near the Earth's surface cause bending or refraction of the radio waves emanating from the aerial array at low angles - normally in the order of about 1^{o} and within a height band of about 5,000 to 10,000 feet. The effect is that objects such as high ground and distant coastlines not normally visible appear on the PPI displays in a form of ground clutter at the appropriate range of the object. Furthermore conditions which produce Anaprop will increase the risk of interference from other high powered ground radars.

7. There is another form of Anaprop known as second or third trace returns in which objects normally well beyond the normal range of the radar appear within the range of the equipment and are displayed on the PPI trace. This type of interference is more common in semi-tropical or tropical regions and on low frequency radars.

8. Regretfully there is nothing that we can do to reduce the effect of Anaprop.

SUPPRESSORS

9. Suppressors are devices designed into radar equipment to reduce clutter or interference. They range from the simple circular polarisation to the more complex and extremely powerful ECCM systems available on high performance air defence radars. In all instances because they suppress the received signal there is a resultant loss of performance. Moreover individual suppression circuits often have serious disadvantages of which you as the operator should be well aware eg:

Suppression Circuit		Disadvantages
MTI	-	Blind speeds and tangential fade.
Logarithmic Rx	-	Overall reduction in performance.
Circular polarisation	-	Marked reduction in performance.
Swept gain	-	Some AD swept gain settings are excessive.
FTC/STC	-	Still leaves leading edge cutter.
Doppler square	-	Not permitted because of blind speeds.
Manual gain	-	Must not be used.

PERMANENT ECHOES

10. There are ground returns which are present with all types of primary radar. They are directly connected with the siting of equipment and are simply responses received from permanent objects within the area of coverage of the radar transmissions. The extent to which they appear on the display is governed by the site and topography of the surrounding area, the tilt of the radar aerial, the power of the radar and the scatter of the transmissions governed by the design of the radar aerial.

11. With modern radar and new techniques the problem of PEs is not serious. If PEs affect the operational function they can be reduced or eliminated, by electronic devices such at MTI, logarithmic receivers, swept gain, gating circuits etc.

JAMMING

12. In peacetime most forms of jamming are unintentional except when created for special exercises or trials. The effect of jamming varies with wavelength and size of the aerial - metric radars within a wide beamwidth are more susceptible than narrow beam centimetric radars, except for spot frequency or lock-on jammers.

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13. Depending on the type of transmissions and the frequency concerned, radio transmission jamming or "MUSIC" can be recognized when, as a weak signal, it appears as a single spoke originating from the centre of the PPI and extending to the extremity of the trace on the bearing of the jamming signal. As the signal is increased in intensity, the spoke widens and subsidiary spokes appear until the whole face of the display is covered. At maximum intensity, when the radar receiver and display equipment becomes saturated, a black-out, or blanking off on the bearing of the jamming facility can occur. Other types of transmission can cause areas of bright pinpoints, background or noise brilliance over a sector, a sector of brightening or bright moving spiral bands, or pulsating sector brightening.

14. Various forms of anti-jamming or ECCM devices are available on AD radars controlled through the Radar Office, these mitigate the effect of jamming. If, jamming remains a nuisance the supervisor will arrange for cease jamming either through the exercise cease jamming authority or by arrangment with Air Force Operations Room (MOD AFOR).

15. When jamming is caused by dropping chaff, or "WINDOW", from aircraft, it appears as a cloud formation or irregular pattern of clutter on the screen. If small quantities are used, it can look like a formation of slow moving aircraft. The jamming effect is very dependent on the scatter resulting from the amount discharged from the aircraft, the height from which it is released and the windspeed. Additionally, "WINDOW" will normally only cause interference on radars operating on the wave-length proportionate to the length of the metallic strips being used.

16. This form of jamming is not normally a problem as it disperses slowly down-wind.

ANGELS

17. Angels are a relatively new form of interference that appeared with the advent of high power centimetric radars. They appear on displays as slow moving small dots out to a range of up to about 100 miles. The intensity varies with conditions and range, diminishing as the range increases. The cause of angels is not known but they appear to be associated with frontal weather variations and to some extent are seasonal. The latter led to the theory that they were migrating birds, but it is thought that they might be returns from the upper atmosphere.

18. Nothing can be done to reduce the effect of Angels, but they are relatively rare.

RADAR INTERFERENCE

19. Interference will often be caused unintentionally by other radar equipment either ground, ship or airborne. Particularly troublesome is the interference caused by AEW or ground mapping radars, but even Rebecca and DME may cause some interference in the form of slowly moving spiral of dots or "running rabbits".

20. Interference can be reduced by changing frequency or by judicious use of a correlator where one is available. Alternatively the source of the interference, if it can be located, should be switched off or removed.