

OPERATIONAL USE OF SECONDARY RADAR

INTRODUCTION

1. There are three prevailing sets of aircraft return characteristics still in use and decoders are designed to handle some or all of these sets:
 - a. IFF Mk 10 Basic. In this an aircraft which receives a valid interrogation replies with a single pulse normally and with a repeat for Identification and three repeats for Emergency.
 - b. IFF Mk 10 (SIF). This allows the use of code pulses between two framing pulses and an extra pulse position for Identification. Sixty four codes available in Mode 3/A including Emergency Select.
 - c. IFF Mk 10A. This is a refinement of IFF Mk 10 SIF in that the code content of Mode 3/A is increased to 4096 codes and the altitude reporting code (C) is added. There are a further two modes available (B & D), but not in common use.
 - d. SSR Civil versions of IFF Mk 10A and so without military Modes.

EQUIPMENT LIMITATIONS

2. Some Ground Equipments remain in use which are capable of detecting only 64 codes. The allocation of codes is such that these ground equipments are compatible with airborne transponders which have 4096 capability.
3. Mode C flight level information is usually transmitted in association with Mode 3/A but can, in most cases, be switched off if requested without affecting Mode 3/A responses. However, a number of aircraft are equipped with secondary radar control units which do not allow Mode C to be switched independently of Mode 3/A. Where the independent switching of Mode 3/A and Mode C is not possible and Mode C is outside tolerance (see para 12), pilots are to be instructed to switch off both Modes 3/A and C.

AUTOMATIC DECODING

4. In this sense 'automatic' decoding merely means that, independent of range and bearing, specific codes are looked for by the decoder. These are the aircraft replies, related to internationally agreed Emergencies. The principal ones are:
 - a. Emergency.
 - b. Communication Failure.
 - c. Unlawful Interference.

On detecting these replies, lights can be lit or bells rung to warn Supervisory positions that an emergency exists.

OPERATIONAL USE OF SECONDARY RADAR MODE 3/A (MATO ASI Sec III-8 p.9)

5. Depending on the ground equipment secondary radar Mode 3/A may be used to:
- Establish and maintain the identity of an aircraft. (See para 6)
 - Establish and maintain the position of an aircraft.
 - Facilitate the transfer of identity - eg radar handover.
 - Supplement primary radar information.
 - Provide navigational assistance when requested by a pilot.
 - Provide a radar service in the absence of primary radar under conditions specified by NATS/MATO. (See para 7)
 - Detect aircraft subject to Distress, Radio Failure and Unlawful Interference. (See para 9)

IDENTIFICATION BY USE OF SECONDARY RADAR MODE 3/A (MATO ASI Sec III 8 p.10)

6. Aircraft must be correctly identified before being provided with a radar service. When secondary radar is used, aircraft may be identified by one or more of the following methods:
- Observation of compliance with a four digit code setting instruction.
 - Observation of compliance with an instruction to operate the identification feature (SPI or I/P).
 - Recognition of an assigned individual (four digit) code.
 - Observation of compliance with an instruction to switch off and on Mode 3/A.

[Note: When no other SSR means of establishing identity is available, instructions may be given to switch off and on Mode 3/A, namely "Stop squawk 3/A - Squawk 3/A" provided that the aircraft concerned is operating in an area of proven SSR coverage. Extreme caution should be used when employing this method, since the same effect may be observed on the display as a result of:

(1) Temporary aerial shadowing caused by a change in attitude or another aircraft, or

(2) Simultaneous use of the same procedure by another radar controller operating within the same geographical area.]

CONDITIONS FOR THE USE OF MODE 3/A WITHOUT PRIMARY RADAR

7. Unless specifically authorised to the contrary by NATS/MATO, a secondary radar alone service is only to be provided:

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a. When primary radar fails until primary radar contingency plans are in force, or procedural separation temporarily established, provided that pilots of ac concerned are informed.

b. Within primary radar cover to overcome known deficiencies of a temporary or permanent nature, (eg clutter, ac reflecting characteristics) provided pilots are informed.

8. The separation minima to be applied when secondary radar is used without supporting primary radar will be specified unit by unit by NATS, taking into account the equipment type and performance available.

OPERATION OF AIRCRAFT SECONDARY RADAR TRANSPONDERS

9. Unless a pilot has been directed to squawk by an authorised control agency he should squawk conspicuity as laid down in the Planning document Sec 4 p.144 para 7e and f. In brief, he should squawk A4321 with Mode C when within the UK FIRs/UIRs unless he remains in an aerodrome traffic pattern below 3000 ft AGL or in the Military Low Flying System (MLFS). If he is in the MLFS he should squawk A4322 with Mode C when at or below 2000 ft Minimum Separation Distance (MSD). When he climbs above 2000 ft MSD he should retain A4322 if he requires a radar service or squawk A4321 if he does not. (Special rules apply to helicopters) The exceptions to this paragraph are:

a. Emergency. If the pilot of an aircraft encountering a state of emergency has previously been instructed to operate his secondary radar transponder on a specific mode/code setting this will normally be maintained unless he has decided or has been advised/instructed to do otherwise. In all other cases, pilots may be expected to operate their transponders with the Emergency code setting (7700). Military aircraft climbing out of Low Level into CAS should also squawk "Emergency".

b. Radio Failure. If their radio equipment is not working, pilots may be expected to operate their transponders on Mode 3/A Code 7600, and follow an appropriate established radio communication failure procedure. A controller suspecting an aircraft radio failure is to determine whether the aircraft radio receiver is working by instructing the pilot to operate the identification feature or to make a code change. If the aircraft radio receiver is working, these procedures may be adopted to obtain acknowledgement of ATC messages.

c. Unlawful Interference. Mode 3/A Code 7500 is allocated for pilots to indicate unlawful interference with the planned operation for their flight (hi-jacking).

d. Entering UK Airspace. When aircraft enter UK airspace from an adjacent FIR/UIR where transponder operation has not been required, pilots may be expected to operate the aircraft transponder on Mode 3/A Code 2000, with Mode C switched OFF, until instructed to do otherwise.

OPERATIONAL USE OF SECONDARY RADAR MODE C

10. The function of Mode C is to provide information to the controller on the vertical position of the aircraft in flight without the necessity for pilots' reports. The information at the instant of read-out, is expressed as Flight Level or Altitude dependent upon the type and capability of the ground equipment in use. The Mode C information transmitted from the aircraft is, with very rare exceptions, based on the Standard Pressure; the pressure datum cannot be altered in flight. The information is transmitted in a 3-digit form to the nearest 100 ft (ie A reading of 213 indicates that the aircraft is between 21,250 ft and 21,349 ft). Mode C information may be used to determine vertical displacement between aircraft and whether an aircraft has reached, is maintaining, has vacated or is passing a flight level.

VERIFICATION OF MODE C INFORMATION

11. Mode C information is subject to the following errors - 'Correspondence Difference' and 'Flight Technical'; basically the difference in indications on the ground and in the aircraft and aircraft deviations in flight profile. The combined values of these errors is accepted by ICAO to be ± 300 ft for the purpose of assessing the validity of Mode C transmissions.

12. Mode C transmissions are to be verified; the Mode C read out must indicate ± 200 ft (± 2 digits) of the reported level. This is the responsibility of each Mode C equipped ATS Unit contacted by the aircraft. Where there is a difference of ± 300 ft or more between the read-out and the reported flight level, the pilot is to be requested to confirm his flight level; if the read-out continues to indicate a difference of ± 300 ft or more, Mode C derived information is not to be used and the pilot is to be instructed to switch off Mode C (see para 3).

VERTICAL SEPARATION USING SECONDARY RADAR MODE C INFORMATION
(MATO ASI Sec III 8-B-1 p.4)

13. Verified Mode C information may be used by ATC within the UK FIR/UIR in the following circumstances to determine that vertical separation exists between aircraft, provided the read-out is continuously monitored to ensure that minimum vertical separation is maintained.

<u>Circumstances</u>	<u>Criteria</u>
a. When the intention of other aircraft is known, ie between aircraft for which the controller is responsible or between such aircraft and an observed aircraft whose behaviour and intention is known through co-ordination.	Standard vertical separation to be applied, ie 1000 ft below FL290 and 2000 ft at and above FL290.
b. When the intention of other aircraft is not known.	Vertical separation to be 5000 ft or more.

CRITERIA FOR ASSESSING FLIGHT LEVEL OCCUPANCY

14. The assessment of level occupancy, using verified Mode C, is to be based on the following criteria:

- a. In Level Flight. An aircraft may be considered to be at an assigned level provided that the Mode C readout indicates 200 ft or less from that level (± 2 digits).

- b. Vacating an Assigned Level. An aircraft which has been cleared to leave a level may be considered to have left the level when the Mode C readout indicates a change of 400 ft (4 digits) or more in the anticipated direction.
- c. Passing a Level. An aircraft climbing or descending may be considered to have passed through a level when the Mode C readout indicates that it has passed that level in the required direction by 400 ft (4 digits) or more.
- d. Reaching a Level. An aircraft may be considered to have reached an assigned level when 3 successive Mode C readouts indicate 200 ft (2 digits) or less from that level.

USE OF A4321*

15. As the intentions of a A4321 ac are not known and the Mode C is not verified, the ac must be avoided laterally. However, there are the following notable exceptions:

a. When the controllers ac is in the MRSA the A4321 ac is only to be told in, not avoided - unless there is reason to believe that the ac has strayed into the MRSA. (The same as non-squawking ac)

b. When the controlled ac is in CAS, provided: *eg airway.*

(1) The Mode C of the A4321 ac indicates that it is outside CAS and

(2) The controllers ac is 5000' above the lower limit of the CAS.

*

Controllers should note that, while the Mode C level of a A4321 ac must not be called, the Mode C may be used to indicate in which direction the pilot should look to sight the conflicting ac.

R/T PHRASEOLOGY

16. Examples of R/T phraseology used with secondary radar for ATC purposes are given in Annex A para 1.

GLOSSARY OF TERMS

17. A list of the common terms and slang phrases are given in Annex A para 2.

* and A0000, A4322.

** only A4321

NB. A2000 Mode C is unverified.

R/T PHRASEOLOGY AND GLOSSARY OF TERMS

1. R/T Phraseology

- "Squawk Alpha/~~Three~~ Code" - Select Mode and Code
- "Confirm you have Alpha/~~Three~~ Code... selected" - Check the equipment is on as the ground station cannot read the SSR.
- "Squawk Ident" - Operate ident feature (lasts 20-40 secs)
- "Squawk Mayday" - Select Emergency
- "Squawk Altimeter" - Switch on Mode C
- "Check altimeter setting and confirm level" - Pilot check that the correct pressure setting is on his altimeter
- "Stop altimeter squawk Mode C giving wrong indication" - De-select Mode C, incorrect level readout
- "Stop squawk Alpha/~~Three~~" - Switch off SSR transmissions

Note: "Squawk ^{Alpha}~~Three~~ Code, standby" is used by civilian ATC as part of a pre-take-off clearance. The pilot dials up the code and puts the SSR equipment on preheat.

2. Terms and Slang

- "Squawk Flash" - USAF term for "Squawk ident"
- Recycle squawk - A few ac have a recycle switch to ensure SSR transmissions are being made. The term is not used by ATC.
- Active decoder - A device enabling the controller to display the SSR readout for an indicated ac.
- Passive decoder - A device enabling the controller to display the SSR responses or labels of only the codes that he selects.
- Transponder Sierra
(*Not to be confused with "Mode Sierra"*) - Only 64 codes available (first 2 digits) read as -00.