DIST
D154a2
cd(rw)sp

UNCLASSIFIED
UK SECRET
UK EYES ONLY

Copy No 7 of copies

Unidentified Aerial Phenomena in the UK Air Defence Region: Volume 3

Miscellaneous Related Studies

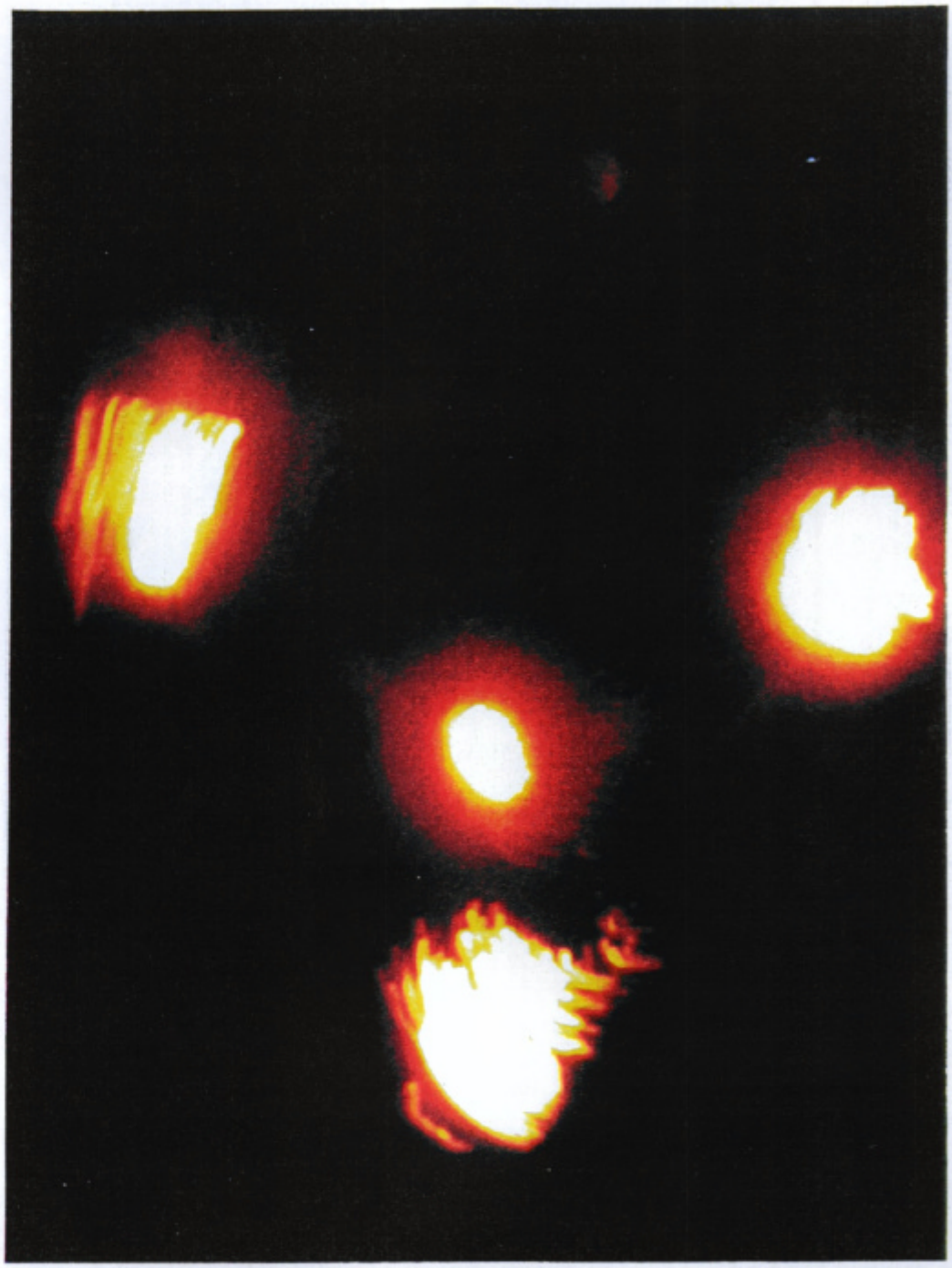
SCIENTIFIC & TECHNICAL MEMORANDUM - No. 55/2/00

DEFENCE INTELLIGENCE STAFF

December 2000 Defence Intelligence Analysis Staff

DIS

UNCLASSIFIED
UK EYES ONLY
UK SECRET



AN EXAMPLE UAP FORMATION OF THE TRIANGULAR TYPE

PREFACE

This is the third volume of a three-part report on the information held in DI55 on the subject of UAP. The material researched in this Volume is classified overall SECRET, only because it contains performance values of the UKADR radars Radar performance is directly relevant to whether unidentified aerial objects can enter and leave UK airspace and whether they constitute a threat. [redacted] S.26

In correlating certain other material in recent years and out of earlier DI55 interest in any reliable information connected with this topic and focusing upon the potential technologies involved and their possible future military uses, this Volume is also a convenient place-holder for several other related findings.(R)

Comments on this document, which has been produced by [redacted] are welcomed and should be addressed to MoD, DI(ST), DI55 [redacted], Room [redacted], Old War Office Building, Whitehall, London SW1A 2EU. Tel [redacted] (R) S.40 not relevant

February 2000

Issued by [redacted] DI55

UNIDENTIFIED AERIAL PHENOMENA IN THE UK AIR DEFENCE REGION

VOLUME 3

MISCELLANEOUS RELATED STUDIES

EXECUTIVE SUMMARY

1. This volume primarily deals with sensitive matters associated with the UAP study which could not be placed in the RESTRICTED Executive Summary. Much of the work reported in this third volume is an inevitable by-product of the main TORs. The main topics here are:

- **The potential `collision' threat**, posed by UAP events to aircraft flying in the UKADR
- XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX S.26
- Whether anything in the context of **potential current or future military interest** can be learned from an understanding of the phenomena. (C)

Collision Risk

2. Well over one hundred **unexplained RAF aircraft fatal accident reports** (covering the last 30 years), have been examined. Study findings, in the context of the sudden appearance of a UAP, causing a possible startling aircrew response when flying fast and low are:

- **The possibility of a collision with a `solid' object can almost certainly be discounted** [as shown in Volumes 1 & 2], as it is probable that the phenomena (mis-reporting of other objects excepted) is most likely formed by one of several atmospheric conditions, leading to the formation of plasmas.
- The **possibility of encountering a `UAP' suddenly at low altitude cannot be totally ignored, but the probability of doing so** (based on the current database information) **must be extremely low** and very much lower than the probability of a serious bird-strike.
- If a UAP is encountered suddenly, when flying fast and low, it could be postulated that a sudden and irrecoverable crew control input might result in a surface impact accident. **However, despite the fact that there are hundreds of reports of low altitude UAP activity, there is no firm evidence in the available reports that a RAF crew has ever encountered or evaded a low altitude UAP event.** (C)

3. Higher altitude events appear to occur mainly up to 20,000ft and have only been reported by civilian aircrew. Radially closing UAP events have been so fleeting that no evasive action could be taken in the time available and no damage, other than a fright to the crew has occurred. In particular, **there is evidence that civil airline crews are seeing far more than they are reporting for fear of ridicule or the potential effect on company business.** The airline crews seem to take the line that whatever they are seeing is apparently benign. Air traffic control is often informed and sometimes minor re-routing occurs. (U)

XXXXXXX

4. XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX S.26

XXXXXXXXX XXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

S.26

5. XXXXXXXXXXXXXXXXXXX It is believed that the majority of UAP targets are inherently variable in size, in radar terms. An analysis of the facts (reported at Volume 1) suggest that the majority, if not all, of the hitherto unexplained reports may well be due to atmospheric gaseous electrically charged buoyant plasmas.(S)

S.26

6. XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

S.26

7. XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

S.26

8. XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

S.26

Foreign Military Interest

9. Although the Study TOR's specify a UK focus, based on the reports held, UAPs are by no means confined to UK airspace. Other NATO nations, China, Russia and elsewhere frequently report the most extreme and puzzling incidents in the open press. DI55 does not have access to any other Government's classified reports, as there is no formal intelligence exchange on this topic. However, XXXXXXXXXXXXXXXXXXXXXX are known to have at least one member of staff active in this area. Similarly, at least two scientists are active in XXXXXXXXXXXXXXXXXX. Many other XXXX scientists have published papers on closely related subjects and the conclusions from studying these are of importance to the UK findings.(S)

S.27

S.27

10. Many other XXXX scientists have published papers on closely related subjects and the conclusions from studying these are of importance to the UK findings. Several governments have also been sufficiently concerned to set up Commissions and Institutes to examine the phenomena. A brief examination of some of the open-press information and

S.27

scientific papers of topics (such as plasmas) when associated with reported UAP characteristics has shown that:

- Russian, Former Soviet Republics and Chinese authorities have made a co-ordinated effort to understand the UAP topic. Several aircraft have been destroyed and at least four pilots have been killed 'chasing UFOs'. The importance of the topic has resulted in appointment of astronauts and senior pilots, as well as senior scientists to carry out investigations.

- Russian investigators have measured (or at least detected) 'fields', which are reported to have caused human effects when they are located close to the phenomena. **(U)**

11. [redacted] S.27

12. [redacted] S.26

Strategic Threats

13. Although postulated in some quarters that the frequency and location of UAP events might be higher in the vicinity of important national assets and strategic military establishments, **there is no evidence that this is the case for any reason other than a combination of the propensity of charged buoyant bodies to be atracted to mainly isolated assets, coupled with the presence of alert personnel at these sites . However, there appear to be good scientific reasons why higher numbers of UAP events occur (see also report Volumes 1 & 2). For example, they often occur where there are isolated electrically charged objects present, such as certain industrial and military buildings, power lines or cars in open countryside, or aircraft. (R)**

[redacted] S.26

CHAPER - 4 UAP WORK IN OTHER COUNTRIES

FORMER SOVIET UNION

1. It is clear that the Former Soviet Union has taken the study of UAPs seriously and that this may well be related to a programme of understanding and exploiting certain UAP-related natural phenomena, such as plasmas. A 'UFO' Commission was created under the USSR Union of Scientific and Engineering Societies in 1989; together in 1990 with an Inter-Industry Ufology Research Centre (SOYUZUFOSENTR) to co-ordinate records. This Centre had the rights of an Institute under the USSR Academy of Sciences, and was headed by V.G. AZAHAZHA (or AZHAZHA) an eminent researcher and former naval submariner. A school was set up with the Terms of Reference to study "ufology as a science of unidentified flying objects and their inter-relations with the universe and, in particular, with the biotechnosphere of the earth". The ten week course, reportedly studied, observation, characteristics, astronomy and psychophysical aspects of the problem. The russians use the acronym UFO in all their references, course names etc., and this is used here rather than UAP, while discussing their work(U)

2. V.V. ALEXANDROV and Y.N. GLAZOV, respectively Senior Project Engineer and Astronaut (Hero of Soviet Union) both of the Test Centre (Tsenatr Podgotovki Kosmonatov) at the Scientific Production Association (Geophysics), have been involved in research into UFO activity in 'abnormal zones' and landing places(!). A laboratory to support this work is reportedly located at AKHTUBISK (on the Volga). Glazov was Deputy Head of the Cosmonaut Training Centre in charge of science and testing.(U)

3. **Plasma Research.** Annex A summarises two russian scientific papers where, it appears, 20-30 scientists have pursued research for the prevention of air target detection. [redacted] S.26

4. **Former Soviet Union Ufology Commission** The Commission Head, Azhazha, was also a member of the USSR Union of Scientific and Engineering Societies Ufology Commission. The geographical features of zones in which UAP reports have been particularly frequent have been studied. Russian open reports attribute UFO activity as being 'purely terrestrial in origin', according to some theories. The Institute have reportedly developed light filters, instrumentation, IR and UV photography to pursue the topic. Unexplained imagery has reportedly been obtained including "peculiar spheres, humanoid figures (perceived as cylinders, circular objects and man-like beings in visible light). If the imagery exists, it has never been published. It seems more likely that images may have been **seen but not recorded.** Some theories, Azhazha reported, attribute these to "manifestations of some substance whose nature is little known at present. This substance may be capable of forming organic matter and temporarily becoming visible to the unaided eye". [COMMENT: The reader is referred to the unusual effects on humans apparently caused when in proximity to some aerial phenomena, reported at Volume 2 Working paper No 25.] [redacted] S.27

5. **Near Field Effects** In 1991 a group of Russian Researchers, having collected soil samples from an alleged UFO landing place noted an unusual field (NFI). V. KHZOPOV (a member of an Applied Biolocation Group), reported that other samples were obtained from other reported landing sites. In all cases a local field developed over a period of three hours. Impairment of human senses were reportedly observed in every person studied who had been **'in the field'**. The main effect was that the thought processes were degraded in some way, but that 'energy was also added'. The report published in 1991 states that the energetics of the upper human

energy centres increased. [Comment: In the absence of further information It can only be assumed that this may apply to brain or nerve centre activity. There is no indication as to the type of field involved. It is possible, and confirmed from some other data that russian scientists may have discovered some new field types. If this is the case the reports suggest that they have also developed a means of both detecting and measuring the field. See also Volume 2 Working Papers No. 1 and, again, paper No. 25, in particular]. The implication here is that the Russians are stating that UAP emanate some type of field - presumably of a nature known to man since apparently they were able to sense that a 'field' was present.(U)

6. In an interview with 'Pravda Ukrainy (24 April 1990), the Deputy Flight Director of the Centre for Control of Space Complexes, stated that UFO sightings in nuclear test and disaster areas were to be studied. One pilot possibly involved is (or was) Boris KOLOTOV. [Comment: It is of interest that both former nuclear test areas and disaster areas (presumably natural events, for example, earthquake, hurricane/tornado, etc.) are locations where an additional level of atmospherically-borne dust is likely to occur - see the Working Paper at Volume 2 on Charged Aerosols]. In 1990 the All Union Ufology Association was formed and headed by Major General of Aviation P. POPOVICH (Pilot Cosmonaut) at the Air Force Academy.(R)

7. Also in 1990 General of Aviation Igor MALTSEV, Chief of the Main Staff of Defence Forces, submitted documents and photographs for public release. These reports were from pilot and other expert observers. [Report held by DI55(R)]. Another Russian personality involved in the studies is Vsevolod TROITSKY (Russian Academy of Sciences) who chaired the Commission for the Study of Anomalous Propagation and Phenomena.(U)

8. **Former Soviet Union Aircraft Incidents** Sokolov reported. "We had 40 cases where pilots encountered UFOs. Initially they were commanded to chase, then shoot. When our pilots would engage the UFO it would speed- up, our aircraft would give chase, loose control and crash. That happened 3 times and twice the pilots died. After that the pilots we told to observe and change course and get out". "The pilots viewed UFOs as a definite threat". Sokolov says "the military were interested in UFOs including the belief that if the secrets of the UFO could be described they would be able to win the competition against prospective enemies by incorporating the technology". The incidence of 'Foo Fighters' or 'BOLS' (i.e. BOLIDES) is perhaps higher than reported. In Russia, airline crews, it has been suggested, are reluctant to call passenger's attention to these as it is bad for business! (U)

9. **FSU/Russian Experimental Vehicle** In 1980 Candidate of Technical Sciences (N. Abacharayev) submitted an invention 'of UFO-like shape' which was based on a super conducting storage rings, one vertically and one horizontally orientated. Electrodes, assembled into several sections, terminate outside the craft and create electrical discharges in the flying medium. The discharge current between the electrodes is controlled in some way by a current flows from a superconducting winding and thrust is produced. The vertical section of the electrodes is switched off for take-off and the horizontal sections are used for manoeuvring. Further USSR reports speak of seeing unknown aerial experimental vehicles UAPs (devices) which rotate around an axis and claim that the rotation of a plasma sheath create an additional magnetic field. Pulsating lights were obtained from the plasmas discharges. As the pulsating increased the velocity of the object increased - the higher the plasma discharges the higher the accelerations and speeds. XXXXXX S.27
XXXXXXXXXXXXXXXXXXXXXXXXXXXX

OTHER NATIONAL ACTIVITY

10. **CHINA** In the early 1990s China announced an interest in Unexplained Aerial Phenomena, and in May 1993 set up a 'Scientific Institute for the Study of UFOs. This Institute numbers more than 300 co-operating specialist members over 24 Industrial and Municipal Departments centred on Peking/Beijing and other large cities. The TORs are to determine whether UFOs represent unusual or unconventional astronomical phenomenon. Some articles have appeared in the Chinese News Media (in UKHAMI), together with UFO photography. The Chinese had contact with Russian officials on the topic of UAP in the setting-up of the organisation described briefly above, specifically Academicians Frolov, Kasmacheev and Pitrovich.[1][(U)

11. **SPAIN** The Spanish MoD have taken the 'UFO' phenomenon seriously. Sixty six files have reportedly been released to the public. DI 55 Staff have not seen these files.(U)

12. **USA & CANADA** The USA's widely-publicised activities were described and contrasted with the UK effort at the beginning of Volume 1 of this report. There is no intelligence exchange or access or collaboration of any sort on the topic of 'UFOs'. [redacted] S.27

13. The medical experiments which unexpectedly replicated 'UFO' effects on humans took place at the University of Ontario, Canada. No papers have been seen which directly relate these to an intention to replicate UFO effects obtained in Ontario,. (U)

14. Most responsible organisations distance themselves from the extreme positions taken by the media and the ever busy UFO publishing industry, which, in the last year has produced no less than 31 books for public consumption. Most of these originated in the USA. [redacted] S.27

[1] Comment: Source is translation of barely readable text on a document visible during a video interview

ANNEX A

CONTENTS

ANNEX A

GENERATION OF PLASMA FORMATIONS

INTRODUCTION

1. Avramenko [1] was working on plasma formations during the Cold War as a source of high power radiation, especially to produce 'long-lived' plasma formations. The properties developed were high density, low optical emission and retention of shape in an airflow up to 200ms^{-1}. These were supposedly analogues of ball lightning - but were clearly part of the Soviet Union HP microwave weapon programme. The colour of the plasma was light blue in air. In a water aerosol a **near spherical shape** was formed. Avramenko also showed, under laboratory conditions, that Energetic Plasma Formations (EPF) could pass through obstacles with holes in them. For example holes in rods, spheres, disks or plates. The EPF can pass through a much smaller hole than its dimensions, reforming on the other side without dividing into parts. This suggests that the plasma contains forces similar to surface tension or mutual attraction of the particles forming the medium. Experiments proved that pressures were possible up to ~25 torr before break-up. Strangely, the time taken for completion of the motion through the aperture apparently depends not only on the hole diameter and length (e.g. when passing through a tube), but also on the material. For example when the length of a glass tube was lengthened by a factor of ten, the transmit time was reduced by 40%. In diamagnetic material the time was reduced by ~25%. (U)

2. In the UAP context the implications are that (as often reported in practice by many witness) a UAP can 'enter' a room or even an aircraft though a small aperture relative to its size. It can achieve this either by puncturing a hole through a material or (frighteningly to a witness) entering through a door, chimney, keyhole, etc. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx S.26
xxxxxxxxxxxxxxxxxxxxxxxxxxx

3. **Signature Control** Experiments [2], have also been made into the 'cloaking' application of selective plasmas by modifying the plasma ionisation (i.e. it's density), so as either not to reflect the incident RF, or only partially to do so, and hence to prevent or reduce the probability of target detection. In diamagnetic material the time was reduced by ~25%. The propagation of these plasmas in a transverse magnetic ($H=1.2 \times 10^6 A.m^{-1}$) or electric ($E=10^6 V.m^{-1}$) fields was <u>not</u> accompanied by a noticeable deflection of the plasma in the experimental channel.(U)

4. In the experimental cases the energy distribution within the plasma was found to be axisymmetric and with rapid fall-off at the skirts. This may not, of course, be the case in the UAP context, where further variation may occur in single-core plasmas and complex plasma densities, and other probable E or H field distributions, may exist in multiple-cored formations (see colour imagery in front of Volume 1). Hence, the fields/fluxes from EPF's can be expected to be distributed not only as heat flux (of the order ~$5 \times 10^4 W.cm^{-2}$ where the core temperature can be 20,000 to 30,000^{0}K) but as visible and IR radiation. (R)

5. It is noted, and again especially relevant in the UAP context, that the overall plasma body density can be close to that of the surrounding air, even though the density of the charged particles themselves is high, as is the energy density. The particles exhibit an intensive mutual attraction, hence

the plasma mass is capable of autonomous existence for an anomalously long time; when compared with an ideal plasma. The charged particle density for 100^{0} EPF may be of the order 5×10^{16} cm^{-3}. The references indicate that at least 20-30 Russian scientists have been pursuing plasma research, its relevance to military activities, including ball lightning, and plasma research relative to air vehicles.(R)

6. In summary, the plasma density is such that, if formed (by whatever means) in the atmosphere, it is likely to:

- 'Float' or 'bob' (because of its close relative density to the surrounding air).
- Climb or descend slowly, unless acted upon by very strong external, potential differences seen in the 'darting' towards objects of different potential - often electrical or other earthed pylons, or their insulated or isolated conductors; or towards vehicles in open ground, especially on exposed high moorland or, for example, on mountain roads.
- Exhibit erratic motion caused by an interaction of total body charge with other surrounding magnetic and electrical fields.
- Be attracted towards areas where the electrical activity in the form of electrostatic charges may be modified by the presence of intense air-vehicle activity.

(U)

SPHERICAL FORMATIONS IN THE ATMOSPHERE

7. A 1995 Russian review states that spherical formations in the atmosphere originate mostly as a result of human activities. Examples of activities which can produce spherical shapes are:

- Launches of missiles, spacecraft and satellites.
- The burning up of used missile stages and defunct satellites in dense layers of the atmosphere.
- Atmospheric pollution (see also Working Paper 1 & 2 on Dusty Plasmas).
- The launching of stratostats and balloons (see Working Papers No.14 & 15)

8. Other spherical formations may be related to meteors, planets, the Aurora Borealis or other optical and natural weather phenoma, also covered in Volume 2. Many drifting luminous formations maintain their shape over long periods. Explanations have been sought, which include, chemical, optical and vortice models - which often do not explain the reported electrical properties of the formations. In contrast, the plasma models appear not to explain their stability and lifetime. At least one option[3] contends that such formations, including ball lightning, consist of electrostatically bi-polar charged shells comprising orderly orientated water molecules.(U)

9. While ball lightning diameters (see Working Paper No.2) are predominantly small, by comparison with many others reported, the common factors between all these are that they exhibit:

- Sudden appearance/emergence.
- Sudden disappearance.
- Erratic and other motion which enables them to be clearly distinguished from familiar objects.
- Forms of energy detectable - electrical field(s) present, magnetic field(s) present, heat, light, colours and sound.
- Similar shapes or shapes and, in general, those formed by rotations or distortions of a sphere.
- Shapes described as patterns by that bounded by several `marker lights' (or colours) - (e.g. rings of lights, triangles, oblongs).
- Shapes described as solid objects but often with lights (colours) at their sharp extremities, (is at their `corners').
- A propensity for spherical formations to form near sources of Methane, Iron and copper .

(U)

10. About 60% of ball lightning phenomena have a diameter of ~5m, with a probability of occurrence of 10^{-9} to 10^{-8} km^{-2} min^{-1}. In basic terms this is approximately 100 to 1000 incidents on earth every hour, many of which go unseen and therefore unreported. Apart from any visual sightings, the implication must be that these do not constantly present false alarms to radars. While the **theoretical** radar cross-section of the ideal reflective sphere, (given by $2\pi a/\lambda$, where 'a' is the radius), can be 50 square metres for a 5m diameter ball and ten for a 1m diameter ball, at D(L) Band; clearly this is not the case in practice. Plasma researchers quote diameters from centimetres to 10-15metres and RCS values from -60dB to 8 metres at the same RF. (U)

11. During the period of observation the phenomena may exhibit one or more of the following:

- Gradual growth.
- Splitting into two or more separate parts (but rarely more than five), accompanied sometimes by a change of pattern, spacing and shape.
- Dissolution/dissipation to invisibility (often instability reported as accelerating away rapidly; when in fact the diameter reduces and intensity fades).
- Merging of disparate `bright lights' (or colours) into larger formation (often reported as small craft joining the `mother ship' and thereafter forming a row of portholes!).

- Disappearance, accompanied by smell.

- Rotation, non linear motion.

- Weak thermal radiation.

- Translucence, haloes, blackness.

- Beamed light emissions, especially when near a conductive object (usually described by witnesses as beams, which, if they move or rotate become `scanning searchlights', or `beams searching for a landing site', especially if the formation is stationary at the time. It is, of course, inevitable that conductive objects will be found - depending on the location. A vehicle, for example, crossing moorland, may be the only conductive object for miles apart from a few telephone or power wires). They are, most likely, the discharge or leakage paths by which the plasma entity gradually loses its structure and weakens to a point of disappearance unless it is either attracted away or its buoancy state changes, allowing it to 'float off ' and seek another destination.

- Under some conditions invisibility to the human eye, while being visible to some forms of photography and contrarily, visible to the eye, but not seen on photographs taken at the time.

or White ball lightning (generally smaller in diameter) is usually spherical, hence the name; larger formations with other shapes are often reported as discoids, and have often three or four different colours, especially at the top or bottom.

(U)

12 **Proposed Theory** It is noted that the Russian perception is much the same as in The West. That there is a UAP connection is evident by the `beamed light emissions' and `landing site' mentioned above. In a strong electric (E) field, a stable structure can be formed of water molecules, where their dipole moment vectors are aligned with the force lines. This is possible because they possess polarity and hydrogen bands are capable of forming dense structures like ice or loose ones like snow. Among all known substances, water possesses the largest number of crystalline phases; which can be formed under various temperatures, pressures and water vapour condensation conditions. Certain types of ice, which originate at high pressure, can exist at temperatures exceeding 70°C. Only common ice is lighter than water. Due to ordered structures and high electric striction pressure, spherical formation balls can exist at high temperatures. Using the theory suggested [at Ref. 3], the shell stability and shell strength is determined by the local field, which keeps the shell of the spheroid in tension. The shell theory suggests that for such spherical formations, for example for a radius of ~10km, the delay period could be ~200s. When such shells disintegrate, molecules change state and stored energy is suddenly released, for example as a small explosion. The attractive force between a sphere and a conductive surface at distance ℓ, when the axis of the sphere is normal to the surface is given by:

$$F = 3p^2/32\pi\ell^4 \text{ at } p = 4\pi ER^3$$

At $R_2 = 10m$ (where R_2 is the sphere outer radius)

$E_1 = 3MV.m^{-1}$
$\ell = 42m$
$F = 123N$
or at $\ell = 10m$
$F = 40kN$

The magnitude of this attraction force, plus their low aerodynamic drag could explain how plasma balls have been seen to move against the wind. (U)

13. **Corona Discharge** The corona discharge from the surface of objects can ensure the stability of low density objects in the air. When the charged formation approaches a conducting object, the discharge of a bi-polarly charged shell would increase. This is normally accompanied by an electric wind which, in laboratory conditions can be shown to exceed $2m.s^{-1}$. The reactive effect produced by the electric wind is capable of balancing the mirror reflection and gravitation forces. (U)

14. **Shells** Spherical formations are shells that may be perceived differently by the eye, cameras, or radar. These shells cause an interference of light and radio waves. Ambient light falling on a thin shell will be partly reflected by the inner and partly by the outer surface. If the shell thickness happens to displace a light source by half a wavelength the waves would interfere, thus making the shell appear as a black (or solid) object or silhouette. (U)

15. Supercooled water vapour in the discharge space can enhance the amount of glow by up to 1000 times. In the UAP context, eyewitnesses frequently report convergent radiating star-shaped beams. (U)

SUMMARY

16. The foregoing theory cannot be entirely proved to be an exact model of a UAP, but the characteristics are strikingly similar, if not identical to many of the reports on the UK database. Undoubtedly, the postulated shells can be stable, can travel, have persistence and other UAP-like characteristics. S.27

[1] "Study of Plasma Formations in an Erosion Discharge"
Avramenko R. F., Bakhtin B.I. et al Sov. Tech Phys 35 (12) Dec 1990

[2] Kang W.I., Radar M & Alexoff. I "A Conceptual Study of Stealth Plasma Antenna" Plasma Science Laboratory, University of Tennessee

[3] A.I Mesenyashin "Spherical Formations in the Atmosphere as a Physical Phenomenon" Journal of Electrostatics No. 36,1995. Russian interest in UAPs is often evident in this short review, where 'shapes as solid objects' and triangles etc are mentioned. The similarlity of UAP characteristics are not normally connected in Western scientific papers on ball or bead lightning.

12. On the days of the above fatal accidents no major clusters of UAP reports occurred on any day but single reports were filed elsewhere in the UKADR indicating that the conditions over the UK allowed phenomena to occur. The possibility that a UAP event was present, although low, cannot be ruled out. Such crashes occur on the sparsely populated low flying routes. It is noted from the statistics of duration and motion that it is unlikely that a UAP would still be present after a crash, by the time any witnesses arrived.(R)

13. It is of interest that **all** seven accidents which were finally considered occurred in day light. Although this might be seen initially as mitigating **against** the causes being due to sudden aircrew reaction to UAP appearance:

- There is much less likelihood of seeing a UAP in daylight unless it is very close. [The overall incidence of all UAP reports in daylight is only 19% and many of these are momentary. It is believed that UAP's are probably equally present in both darkness and daylight when the conditions exist for their creation].

- Very few UAP are reported as the solid' variety, hence if an accident is due to a UAP, the probability of encountering a UAP with a 'solid' appearance 'head-on', would be very low indeed, and if this ever were to occur over land, there would surely be physical evidence in the form of easily seen artefacts, and unfamiliar collision debris.[It is shown elsewhere in the report that, almost certainly, the phenomena has a plasma basis, which on occasions can appear to be visually (optically) 'solid'] (R)

AIRMISSES

14. All aircraft near-miss reports, filed with the Joint (CAA & MoD) Airprox Section (JAS), at Uxbridge are rigorously investigated. On a small number of occasions the identity of one of the conflicting objects is never explained, despite exhaustive enquiries by a Working Group, with full access to all AIS(Mil) and CAA resources. These include careful track analysis, weather, other flight plans, radar contacts and cockpit/ATC voice recordings. Seven such events have occurred in the past 10 years. Table 2-1, based on inquiry reports, lists examples, from which the following observations are made:

- If an object is visually small, or not fully opaque, (e.g. in an indistinct form - even gaseous), it will not be seen in daylight until it is very close.

- The nature of close proximity misses at high closing speeds is that encounters are fleeting - a few seconds at the most.

- By the time the presence of an object is noted visually and a possible collision conflict is realised, indeed apparently imminent, it is too late for evasive manoeuvre.

- If an object is a plasma-type it may not be seen on civil aircraft radar.

- A non-transponding target, if detected, may be taken to be due to weather - and disregarded.

(R)

15. The descriptions of the unexplained objects at Table 2.1 by the civil aircrews are very similar to those typically received as UAP reports, both from the ground and from other airborne sightings which are not airmisses. In particular it should be noted that a coloured object is (naturally to aircrew in the absence of other information) reported as a 'navigation light' - on the assumption that all flying objects are manned aircraft. It is of interest to note that all are below 20,000ft and that despite good visibility, in all but one case, the sightings were always extremely close and closing fast. In all cases they were corroborated by at least two crew - and on occasions by other aircraft (i.e. a multi-independent witness scenario. Only on one occasion was a co-incident radar contact made, although for two of the scenarios, stationary radar contacts were observed. All of the colours seen are typical of UAP reports. If a two-colour object streaks past it is not unreasonable to describe it as having 'stripes'. If an object (for example, black) has a white part, it is not unreasonable to describe this as a white 'navigation light' (e.g. often reported as on the 'nose' or 'tail', even if the object is in fact spherical. The black 'lozenge' (Serial 4) and the 'wrinkled cylinder'(Serial 5), are again typical UAP shapes, described elsewhere in this report, at Volume 1, and in the supporting Working Papers at Volume 2.(U)

16. **UAP Event Correlation** The DI55 records were searched for correlation with the civil aircraft airmiss events listed at Table 2.1. No public or other reports were found for Serials 4, 5 or 6. Serial 2 was the only actual near miss report which had also been reported at the time as a UAP event and is held in the Departmental records. None of the other near-misses had resulted in a UAP report, which re-enforces the believe that many civil pilots have sightings but sdo not report them. However, June 7th was a busy UAP day, with 4 reports - from St Ives(Cornwall at 0010hrs), Sleaford (0013hrs), Manchester(1248hrs), and Hove(2350hrs). The Hove, St Ives and Sleaford reports all speak of multiple lights. The Royal Meteorological Society log reports extensive thunderstorms with hail and ball lightning reports on this date. (U)

17. On 14 January 1994 (Serial 3 at, Table 5), two separate reports were filed, respectively, from Glenrothes and Alness (Inverness), however, these were some eight hours after the airmiss report.(U)

18. Only one UAP report was received on the day of the remaining airmiss report (19 Jun. 1988). This was at 1740 hrs in the London area.(U)

19. It is impossible to correlate the airmiss and UAP reports because there is inadequate data. However, it should be noted that the weather reports at Table 2-1 are those at the scene of the respective sightings. Bearing in mind that on five of the seven occasions it is logged that dry hot and thundery weather was present (25-32 degrees C) in many areas of the UK on the days in question. It seems likely that the entities which were reported in good faith, on the assumption that they were 'solid' objects - were almost certainly various manifestations of atmospheric plasmas of one sort or another - including the optical phenomenon where the non-reflection of light can apparently give the appearance of black opaqueness. (U)

HAZARD SUMMARY

20. There are no Service unexplained fatal air accidents where a collision has occurred with a solid object, leaving behind some sort of tangible artefact. Only those unexplained accidents which are known or thought to be due to sudden inexplicable control inputs where the aircraft,

and the occupant(s) did not survive were investigated on the remote possibility that here might have been a potential UAP explanation. The key findings are as follows:

- About half the unexplained RAF accidents could not be correlated in location with UAP sightings, because many of the UAP records (1970-78 period) have been destroyed.

- The probability of the remaining accidents being caused by sudden aircrew reaction to avoid what they may have believed to be an apparently imminent collision is a possibility, although of the 11 events, four occurred on days on which atmospheric and electrical conditions may not have been conducive to UAP formation or UAP formed but were not reported.

- The frequency of UAP reports (not withstanding the likelihood that many UAP events are never reported) is such that the probability of an RAF (or Civil) aircraft encounter with a UAP, at any altitude must be very low. (C)

21. Because there are no reports of RAF aircraft intercepting UAPs, there is no first-hand experience of the difficulty which reportedly occurs. The Department has no access to official reports from other nations. However, all indications are that a UAP can reposition itself faster than any aircraft can manoeuvre. The reader is referred to Chapter 4, where it is clear that any attempted manoeuvre may result in over-stressing the aircraft. (R)

CONCLUSION

22. In conclusion, the possibility exists that a fatal accident[1] might have occurred in the past due to aircrew taking UAP avoiding action, when flying fast and low. However, the probability of an encounter is extremely low, even if this was the case for any of the seven unexplained occasions where this **potentially** might have occurred in the last 30 years.(C)

23. It is of interest that no RAF incidents of **subsequently unexplained** air misses have apparently been reported to the Joint Airprox Section at Uxbridge[2].(R)

24. Data was provided for seven incidents reported by civil aircrews where the cause of the events could **not** be explained by the subsequent official inquiry. It is clear that unexplained air misses are discussed among crews and there is likely to be much more to be learned by interview. However, they are understood to be unwilling to speak to anyone who might be sceptical or repeat the conversations elsewhere. It is believed that many more civil events due to UAP remain unreported. This is because, firstly, the airline crews have most probably decided that the UAP are benign, secondly they are concerned about their individual reputations as professionals and finally the effect any publicity this might have on airline business. The airline crews are concerned when airmiss reports remain unresolved. It is further noted that since Pope's book has been published airline crews are unlikely to wish to take the matter further with SEC(AS2), or with the civilian UFO organisations.(C)

[1] For the purpose of this study one RAF Squadron Leader was made aware that aircraft accident data was required as part of a UAP investigation.
[2] The precise purpose of the study was not made known to the Airprox Section, which understood the data to be needed as part of a radar investigation.

	Date	Time	FL	Visibility (km)	Weather	Colours/Shapes	Radar Contact	Aircraft Type	Location
1	7 Jun. 96	1800	90	10+ (VMC)	CuNb	Red/blue/white[6]	None	146[5]	STEVENAGE
2	6 Jan 95	1848	40	10+ (VMC)	Cu	Black/White[2][6]	None[1]	737[5]	MANCHESTER
3	14 Jan94	0834	30	10+ (VMC)	-	Sparks/Flames[3]	None	Helo[4]	ABERDEEN
4	15 Jul. 91	1745	140	40+ (VMC)	-	Black(Lozenge)	Yes	737[5]	CRAWLEY
5	6 Jun. 91	1438	80	50+ (VMC)	Inversion /Unstable	Yellow/Orange (Cylinder)	None	737[5]	BRACKNELL
6	17Oct. 88	2316	190	IMC	-	Green	None	VC9[7]	~DOVER
7	19Jun. 88	1953	80	5 (VMC)	Haze	Grey/White	None	BAC-111[5]	GATWICK

TABLE 5 REPORTED UNRESOLVED NEAR-MISS DATA.(R)

Notes: [1] But stationary intermittent radar contact seen before or after.
[2] 'Like a Christmas Tree'.
[3] Possible Meteorite/SOYUZ re-entry debris.
[4] Seen by 2 pilots of 2 other aircraft in vicinity..
[5] Seen by both pilots.
[6] 'Hawk' aircraft size.
[7] Seen by three flight deck crew of the VC9.

CHAPTER 3 - POTENTIAL FOR EXPLOITATION OF UAP-ASSOCIATED EFFECTS

1. One of the reasons for making an analysis of UAP reports was that of identifying any phenomena which could be robustly generated and provide a military advantage. [redacted] S.26

2. **Exotic Vehicles** In order to take an unbiased scientific approach the possibility of some sort of exotic vehicle, either terrestrial or from space could not be ruled out iuntil all available evidence had been examined. While it was clear that there are no artefacts on which any hands-on technical assessment can be made the possibility of technologies beyond the scope of human engineering and conception could not initially be ruled out. Even if it was discovered that such craft actually exist and were the product of other intelligence beings, any attempt to reproduce the exceptional performance achievements attributed to UAP could only be attempted using existing technology. Secondly, it seemed possible that other military applications might be found if the effects could be replicated in a controlled way. The problem then became one of identifying the precise physical effects and making a judgement as to whether there are credible roles in which they might be employed. The effects observed visually, on radar or through the apparent radiating field from UAP might be advantageous, for example as a countermeasure or decoy. Exceptionally, it was postulated that if the existence of some form of extra terrestrial technology was in fact proven, then (possibly) recommendations could be made as to the way ahead. For example, it would be necessary to focus on these capabilities in order to deduce and possibly, what sort of technologies might be necessary to achieve the reported almost instant accelerations, decelerations, manoeuvres and high velocities. At the level of human understanding this level of performance appears to imply the negation of inertia. Even if this was possible to achieve at some stage in the future in technological terms it would have to take place in an unmanned vehicle. Humans could not withstand (at least with our current our current knowledge of aviation medicine), the significant acceleration and deceleration forces which would be involved.(U)

3. Any attempt at the description of possible or probable technologies to construct a vehicle would be at the limits of current human understanding and involve technologies which may appear (one day) to be possible. They might include such ideas a propulsion by the use of anti-matter, gravitational or torsion fields or of particle phenomena and fields or waves which are not currently known in science or technology. One would have to concede that if extra terrestrial activity is involved, (the statistical analysis reported at Volume 1 makes this unlikely) not only would the originators of such vehicles have technologies developed over thousands of (earth) years – in any case they would have to travel very large distances to reach earth or other planets.(U)

4. The conventional scientific expectation, when searching for extra terrestrial life, is that this might be revealed by searching for oxygen, nitrogen or other specific spectral lines. Of course, this supposition is based possibly/probably erroneously on the assumption that there could only be biological life elsewhere in the form which we conventionally understand it. So far unsuccessfully, the USA have spent millions of dollars (in the SETI programme) in this search. Lateral thinking soon shows that any other 'inhabited' part of the universe may conceivably contain entities which bear no resemblance to ourselves whatsoever. Clearly, if they exist, they may not 'breathe' as humans or have any of the usual attributes - hence, one could argue, they could, perhaps naturally, withstand the enormous gravity forces involved in the manoeuvres described. The logic soon changes again when it is suggested that, in the limit, these entities may have no mass! Several UAP (UFO) researchers have concluded, for example, based on what they have taken to be reliable incident reports, that these entities must also have the ability to materialise and de-materialise. Further, the reported aerodynamic gymnastics implies that their technology of using, apparently, near drag-less, noise-less flight, can be achieved most of the time. All of these exceptional characteristics can be explained if te objects are gaseous buoyant charged plasmas (U)

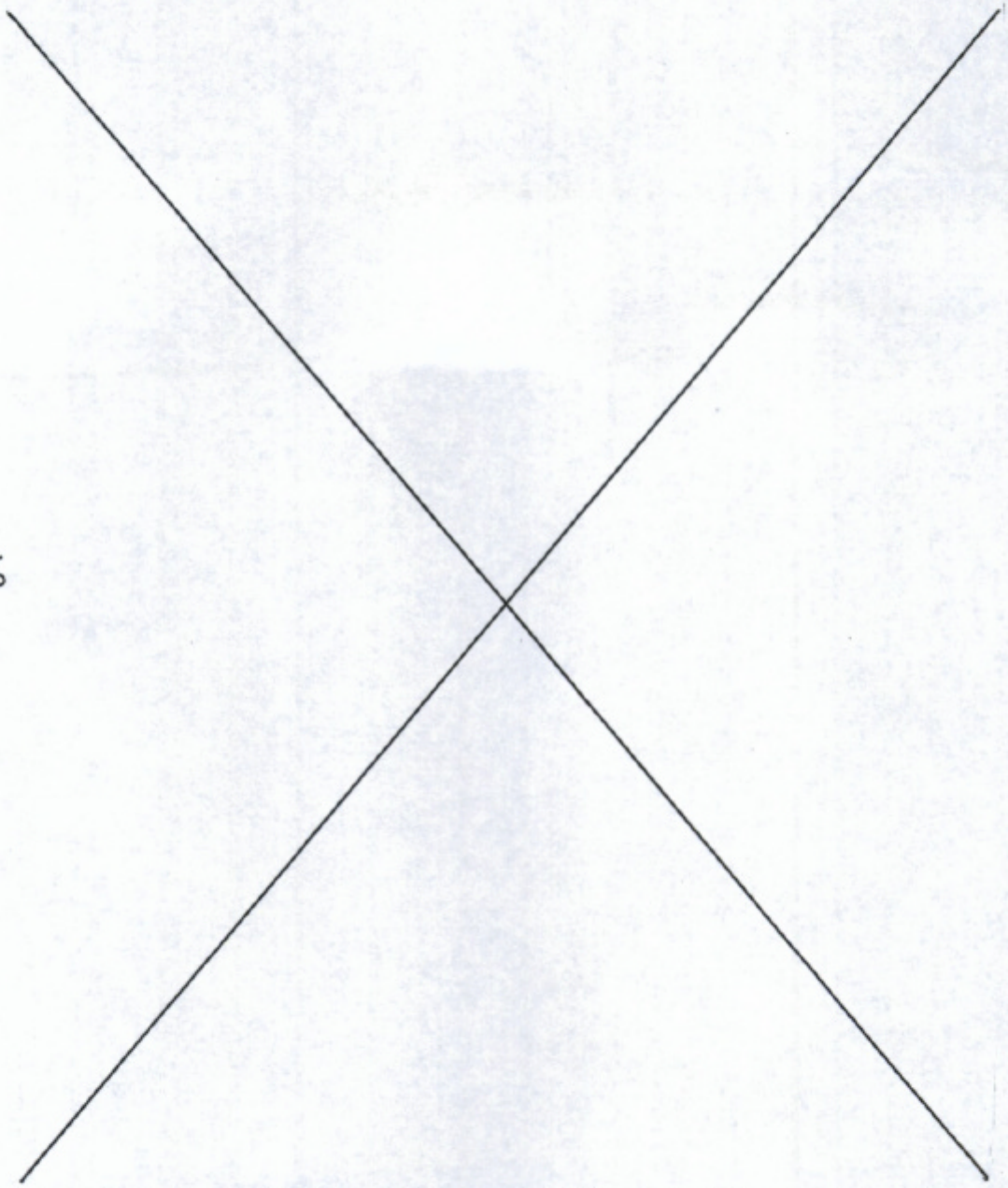
5. **Propulsion** UAP noise is only usually reported as a 'whine', 'hum', crackle or 'buzz' at 'take-off'. The method of propulsion of the objects does not, reportedly, produce the familiar noise which is made by air thrust, turbulence or motion by an aerofoil through the air, as we know it - despite the fact that the 'craft' size reports imply the presence of a significant mass given the enormous dimensions often described. If, however, as is believed, there are many reports which are of plasma/charged mass in characteristic, then they would be virtually inertia-less, and would therefore not push masses of air aside in order to move; while others are purely manifestations of visible light moving about. Further, allowing for variations in human descriptions, these sounds are those usually associated with electrical discharge and oscillation. If fields are present which cam cause neurological disturbance, as reported at Volume 2 Working Paper No 25, it is quite likely that other sounds will be sensed rather than heard acoustically. (U)

6. There is the question of the frequently reported merging and demerging of smaller craft with larger ones. These are usually triangular and sometimes 'oblong' or 'diamond'. In air operations we currently have at least some caution in linking up flying platforms for the comparatively simple task of air to air refuelling - and yet these smaller triangular UAPs seem to have little trouble in merging or seperating rapidly into or from their so called 'mother ship'. Finally, as these entities can also reportedly appear and disappear at will and have intelligence, one could surmise that they could also decide when and whether to be visible to humans or not. The classic reporting dilemma exists as to whether the witnesses are reporting what they are **actually** seeing or, alternatively reporting what they **think** they should be seeing. Finally, one must consider whther they are being affected in some way so as to distort their reporting.

7. In conclusion, from all the evidence examined in the UAP reports held in DI55, there is no indication that craft of extra-terrestrial origin exist. Any exploitation of technologies, resulting from this study, will clearly have to be based on those phenomena exposed and discussed at Volume 2. Those worth a brief examination are shown at Table 3.1. There are, as shown in the working papers, tens of natural and man made phenomena that can lead witnesses to believe that they have observed something quite extraordinary. The majority of the causes of known UAP sightings cannot be replicated and used for military purposes.(U)

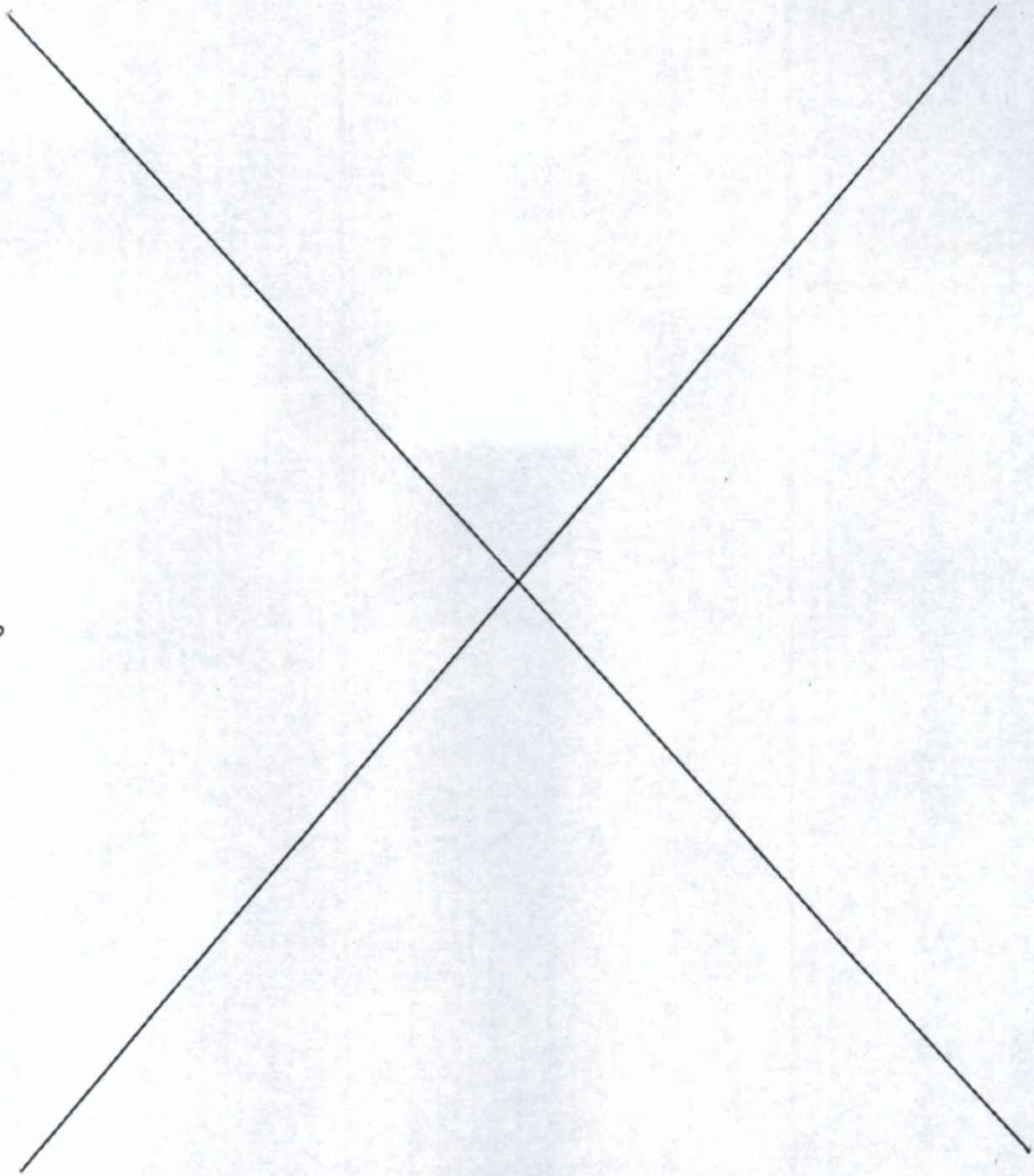
POTENTIAL APPLICATIONS

8. As a result of the UAP studies, the radar detection aspects have shown that there are three possible related potential applications:



5.26

9. **Earthlight Replication** While the production of light by fractured rocks is an interesting natural phenomena, no military applications can be seen, lightning itself does not, of course, reflect radar energy, and there is no other known effect discovered as a result of studying the UAP data available, that could be used advantageously.



S.26

Target Velocity (metres per second)	Scan Rate (Seconds)	Distance Travelled Between Scans (km)[1]	Dwell Time in 1.5 Degree Beam(Counter Direction)[2](sec)	Dwell Time in 1.5 Degree Beam(Same Direction)[3](sec)
250	10	2.5	0.04[4]	0.04[4]
1000	10	10.0	0.043	0.037
3000	10	30.0	0.052	0.033
6000	10	60.0	0.074	0.027
10,000	10	100.0	0.173	0.023
15,000	10	150.0	0.035*	0.018

TABLE 1-2: RADAR DISTANCE , TIME & DWELL (U)

Notes:

[1] Using the 10 second inspection rate of the UKADR radars.

[2] The number of pulses a radar receives is a function of the antenna beam-width, the PRF and the antenna scan rate. Hence, the scan rate is effectively reduced if the target speed causes it to stay in the beam for a longer period. In the limit both the target and the beam move at the same rate and the reflected pulses from a continuous dwell on-target are theoretically available. For example, at a target range of 20km., when scanning at an angular rate of 36 Degrees per second, equivalent to a linear beam movement rate of ~525m(subtended at 20km range) in millisec, this is equal to a linear beam velocity of ~13,000 metres per second. In this case the radar beam speed is only exceeded by the target speed by the final item* in the list above. Ignoring, the radar sampling algorithms which may be in use and any system limits on the maximum resultant tracking velocities of the system, the UAP detection probability could increase. Before the point of dwell is reached, assuming that the pulses are available for use, for example, when the UAP (moving at 7000 metres per second) is overtaken by the radar beam as it scans, the increased time-on-target would produce about 20 pulses for integration, instead of the designed 11 pulses which would be received (from an aircraft sized target) if the target was only moving at 250 metres per second. However, because of the huge UAP velocities which are possible, by the next inspection time, subject to the geometry, the object could easily move into the overhead dead-space, out of coverage range, have faded to a lower electron density or even disappeared (discharged) completely. Although the opportunities for detection might **apparently** be present (i.e. as would reasonably be expected if an object is within coverage) this alone is not sufficient as detection depends on a combination of factors which do not apply to normal targets.

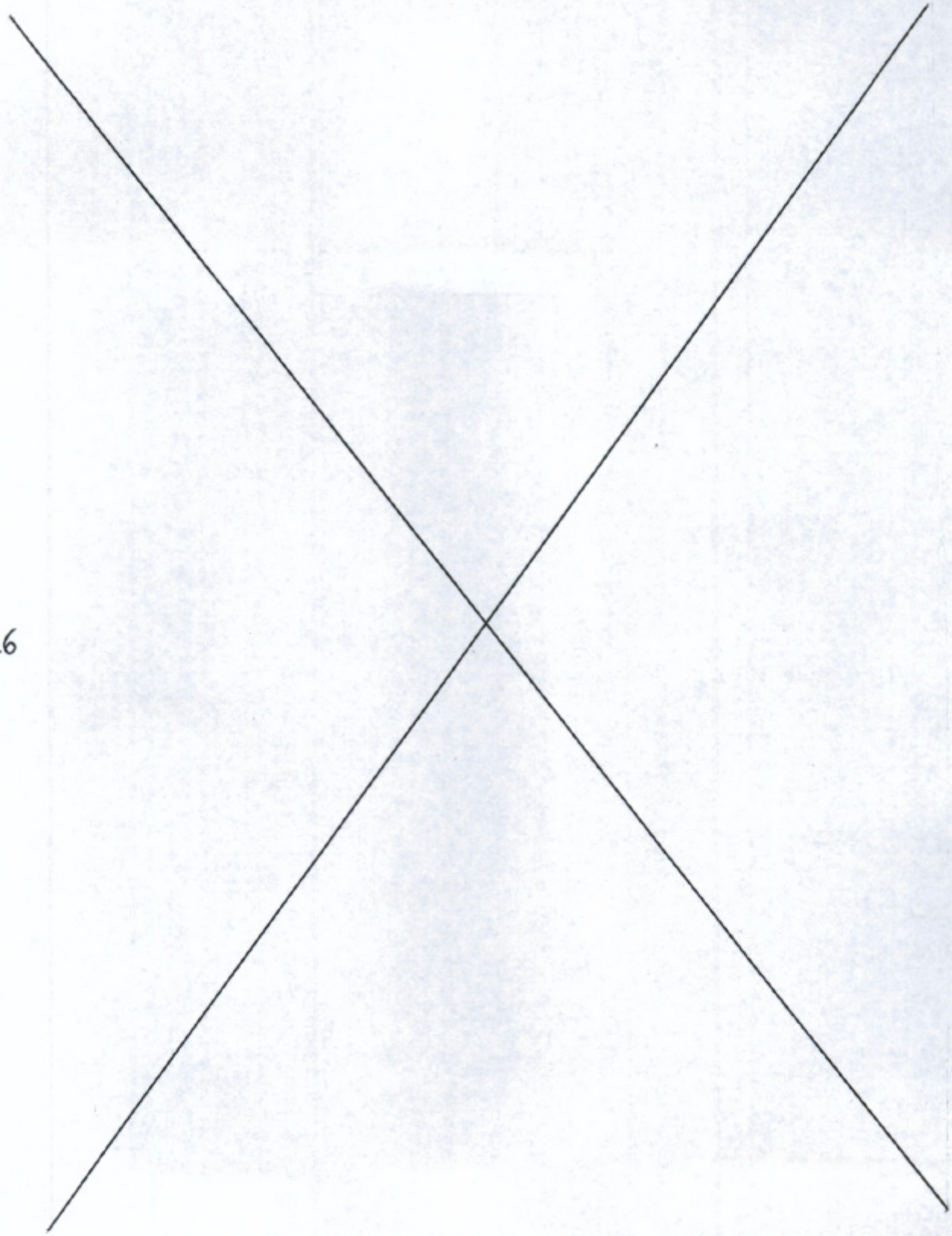
[3] At a target range of 20km but with the target flying across the azimuth beam in the opposite direction to it's rotation the effective scanning time is reduced. In this instance the beam-crossing target is spending progressively less time in the radar beam with increasing UAP velocity. As an example, at a UAP speed of 7000 metres per second the UAP passes through the beam at 20km range at an effective velocity of 20,000 metres per second. The time taken to cross a distance of 525m at this speed is ~0.026sec. and the number of pulses received by the radar would be reduced to 7. In turn, this will reduce the probability of detection, possibly to the point of not crossing the detection threshold. By the time the target velocity reaches 15,000 metres per second, there is only time for 5 pulses to be reflected.

[4] At a target velocity of 250 metres per second the dwell time does not vary significantly whether the target is going the same way as the beam is scanning. This is the normal situation for the speed range of typical manned aircraft.

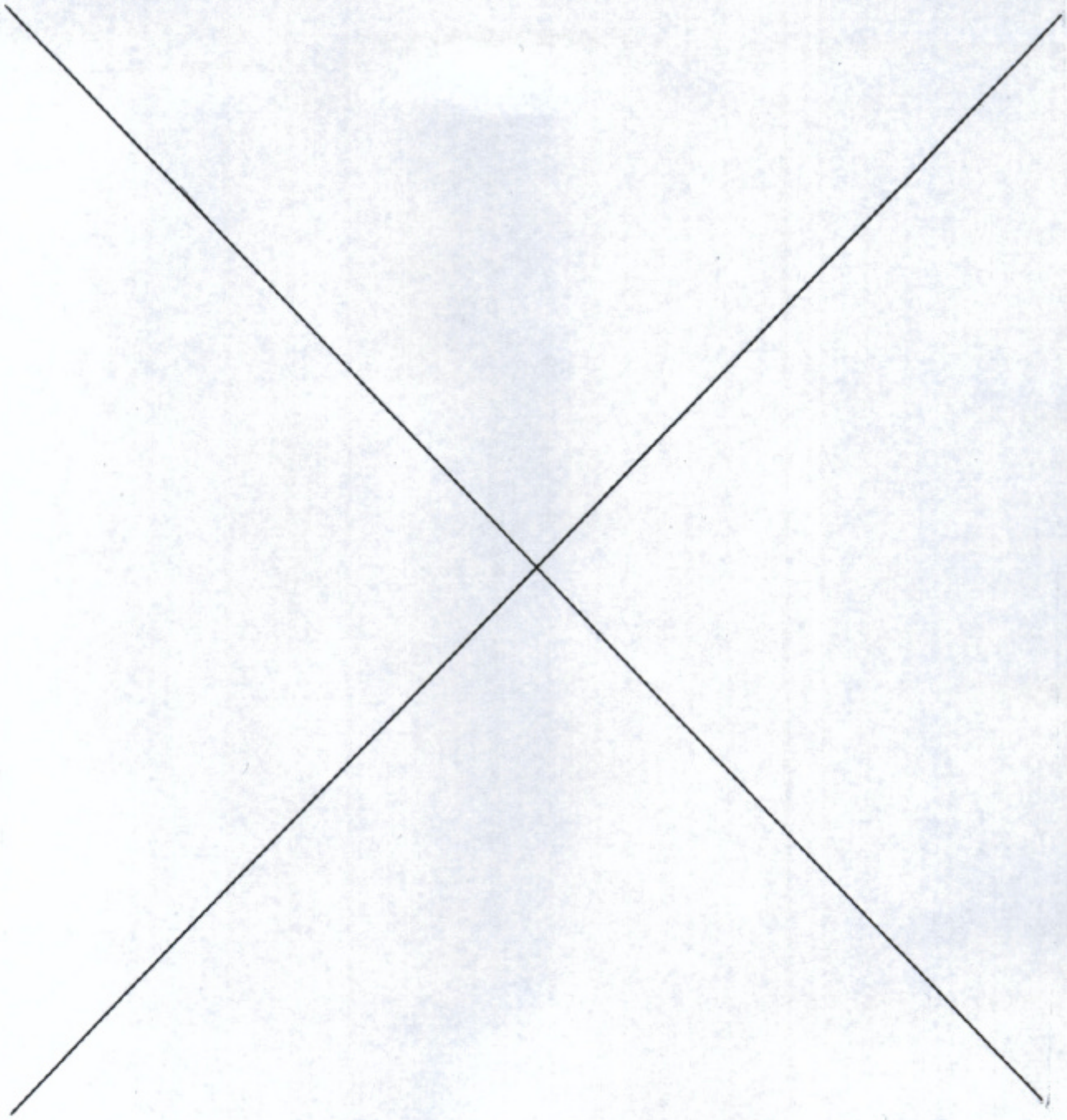
Moths	1	Wavelengths	10cm	(E/F Band)
Sparrow	15	Wavelengths	10cm	(E/F Band)
Sparrow	1.9	Wavelengths	3cm	(I Band)
Pigeon	80.0	Wavelengths	10cm	(E/F Band)
Pigeon	15	Wavelengths	3cm	(I Band)
Pigeon	11	Wavelengths	0.7m	(A/B Band)

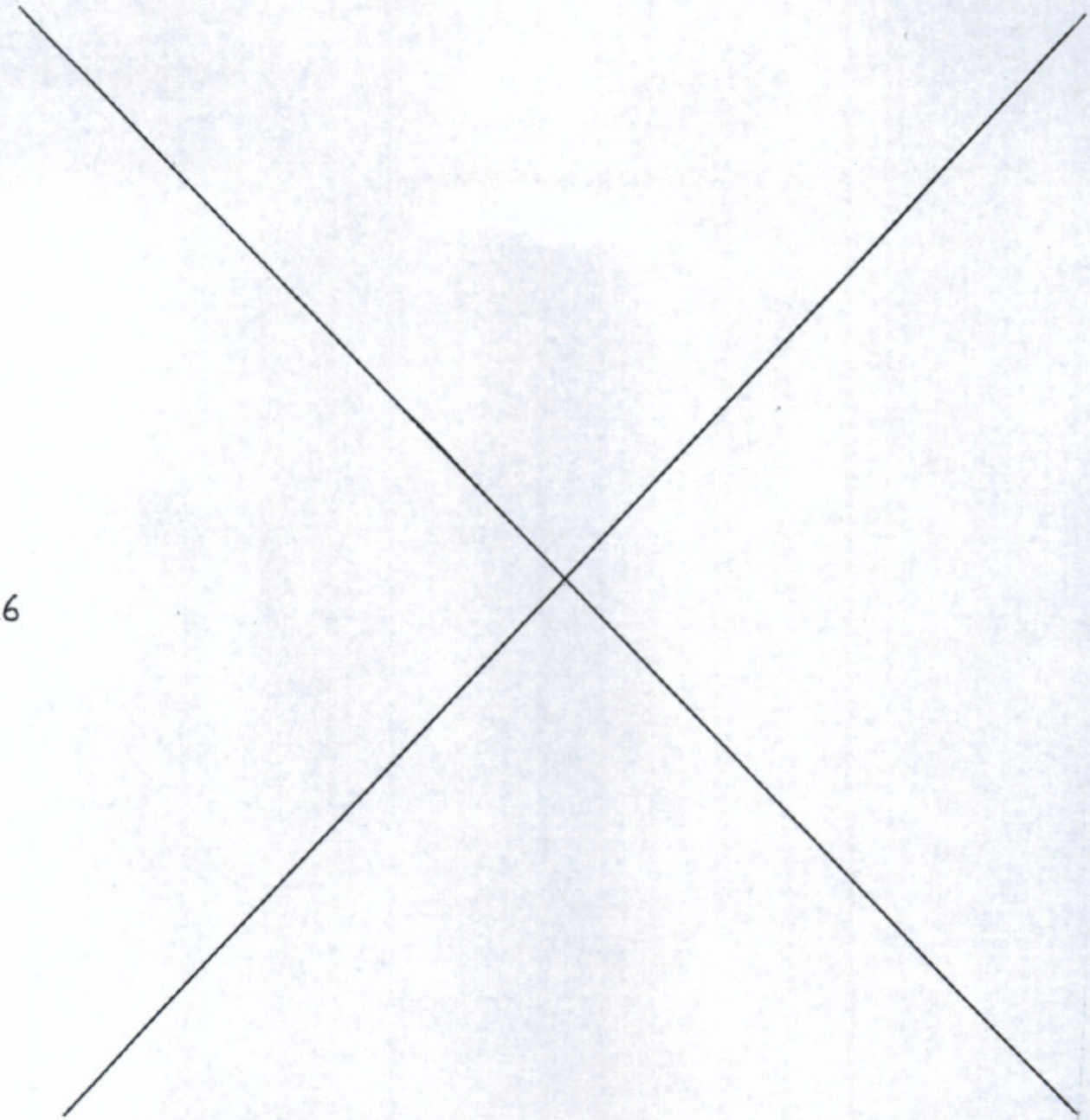
TABLE 1-3: BIRD & INSECT RCS (U)

S.26

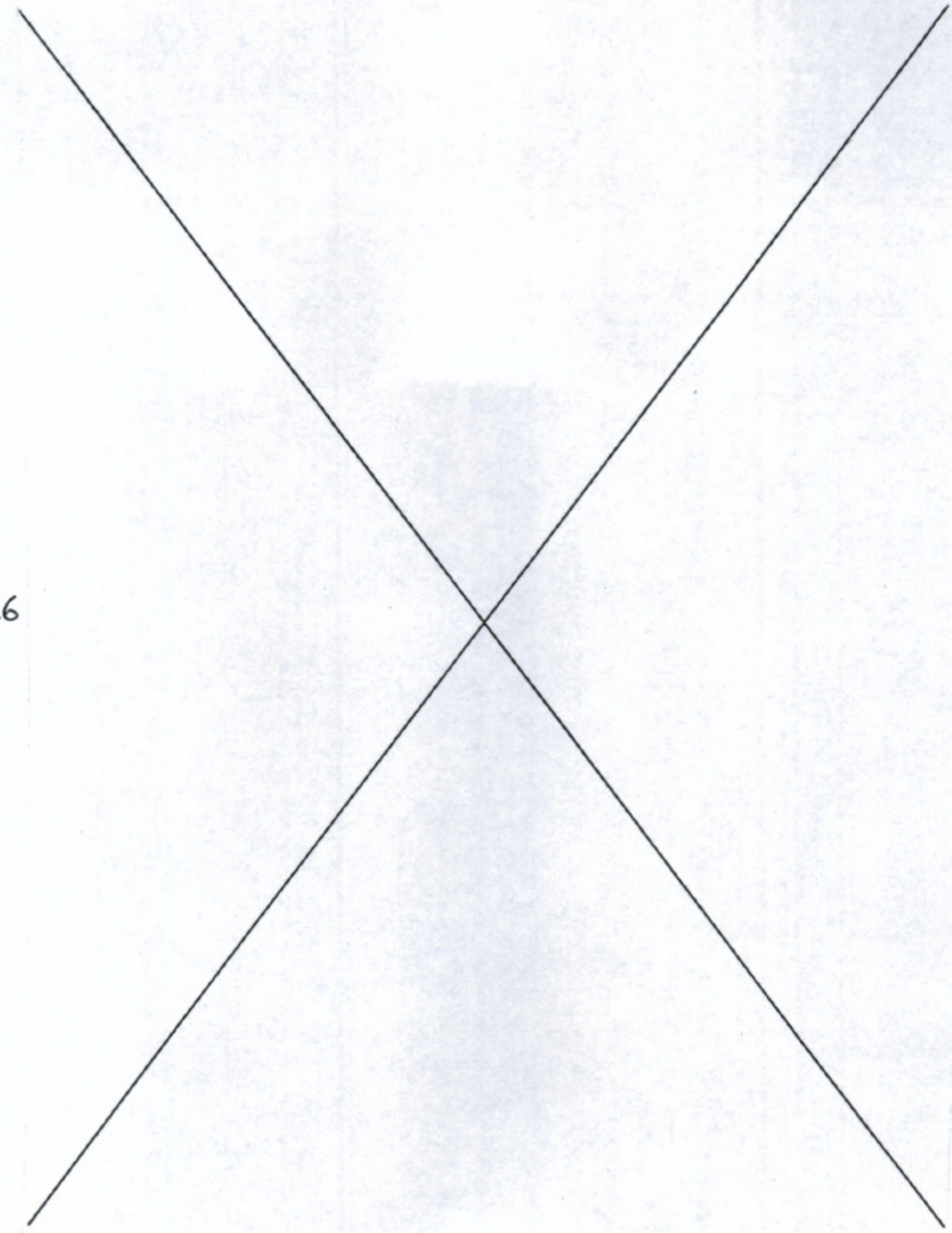


S.26

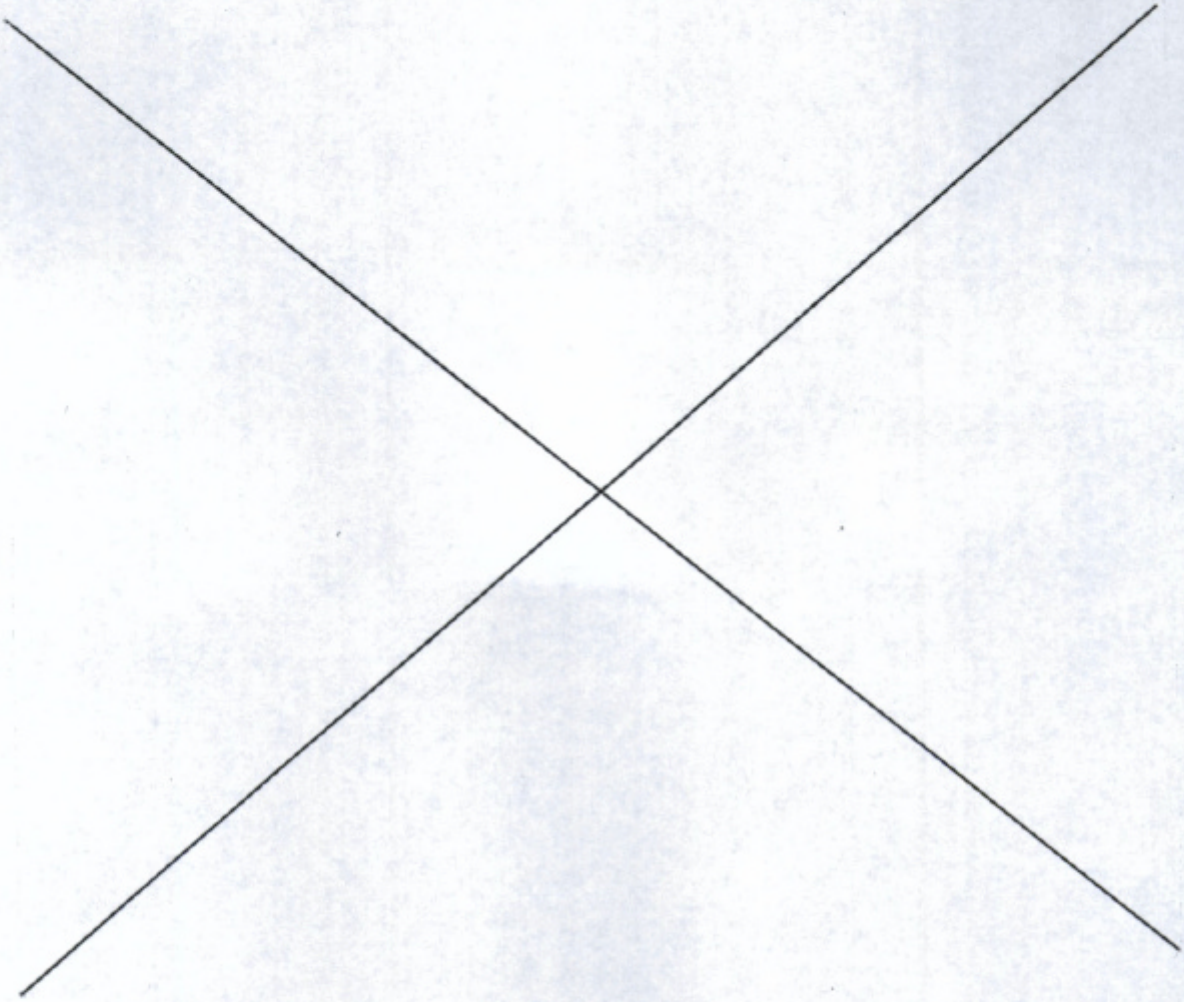




S.26



S.26



S.26

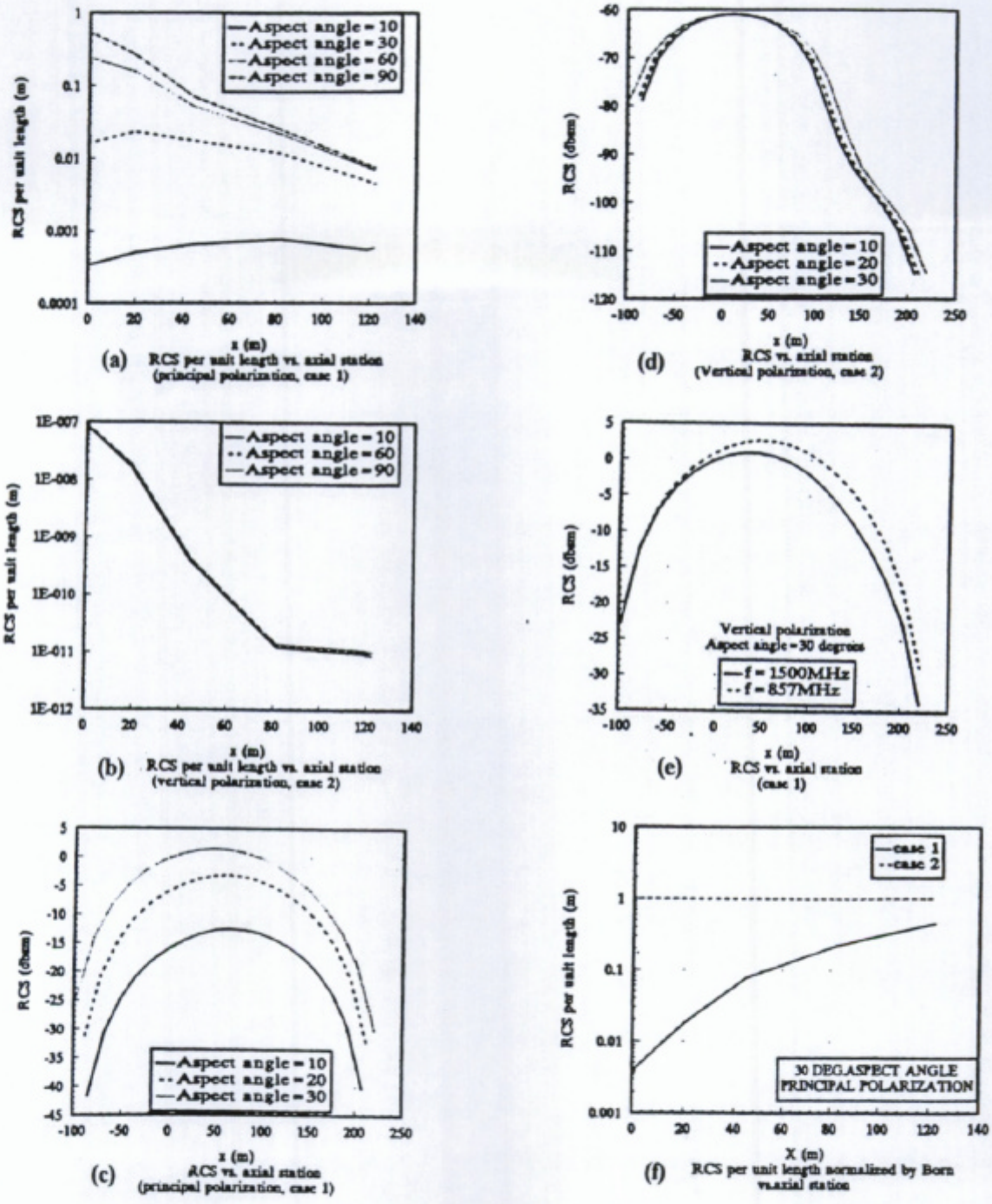


FIGURE 1-4 RADAR CROSS SECTION OF CYLINDRICAL PLASMAS(U)

CHAPTER 2 - POTENTIAL UAP HAZARDS TO AIRCRAFT

RATIONALE

1. A brief investigation has been made into the potential of UAP events as possible hazards. With assistance from the Inspectorate of Flight Safety (RAF Bentley Prior), all unexplained aircraft accidents on the RAF accident database were identified and then further filtered to isolate those which had apparently impacted the surface, due to what appeared to be sudden and inappropriate control inputs by the crew. Apart from isolated reported encounters (with what is apparently ball lightning) with both civil and some military aircraft, the investigation concentrated on the following scenarios:

- The possibility of aircrew suddenly being confronted with the phenomenon immediately ahead of the aircraft, especially when flying in Instrument Meteorological Conditions (IMC).

- The likely reaction of the pilot and the possibilities of distraction or disorientation.

- The possibility of this occurring at very low altitudes - leaving little margin for manoeuvre in proximity to the ground (or sea).

(R)

2. An examination of hundreds of UAP reports suggests that many occur (are reported) by witnesses at low altitudes and often in relatively low visibility. The UAP, in arriving near the surface, has undoubtedly descended from a higher altitude, whatever its origins. Although it is assumed that UAP may be encountered at any altitude, as shown by the infrequent reports from civil and military flight crews, there are no indications that any aircraft at high altitude has suffered an accident in UK airspace due to the presence of a UAP.(R)

3. In the absence of any reports of surviving aircraft crews having to take violent avoiding action, the investigation followed the logic that if violent manoeuvre has been carried out at low level by RAF aircraft, this could, potentially have caused fatal accidents. If these cases exist then there would be no crew report as to the cause of their sudden departure from the planned flight profile. However, none of the reports on file indicate a similar scenario for slow light aircraft or helicopters which one might assume could have time to recover after a sudden event. There is a dearth of sudden event reports from slow and low aircraft. However, many factors can be shown to possibly influence the behaviour of UAP, including, it is believed, the electrical charge on the aircraft. As charge is proportional to velocity and vehicle size, it may be the case that UAP are not generally seen in close proximity to small craft. This may explain the lack of reports. It should also be noted that many UAP events may be present of which crews are unaware because:

- They may not be visible in daylight.

- They may not occur in the Field of View (FOV) of the cockpit.

- They occur fleetingly and are not seen on a subsequent scan of the same spot.

- In IMC they may not be visible unless they are immediately ahead.

(U)

4. In sudden evasion at low altitude it is assumed that in mountain or hilly terrain the pilot would preferably try and fly over or under any object appearing suddenly ahead, rather than possibly turn into terrain. Hence, the possibilities of over-stress, out of envelope attitudes on pull-ups, and the possibility of wings level impact, if attempting to under-fly a UAP, all exist.(R)

5. Although it is fairly certain that at least some types of UAP emit either magnetic or electric fields, or both, it is assumed, in the absence of evidence to the contrary that aircraft systems are probably not adversely affected. Either they are adequately screened from the fields that a UAP may produce or will not remain within the field for sufficient time to have an effect. (see Working Paper No 25 Vol. 2).(R)

6. The rationale for the investigation was that a sudden appearance of fast - closing lights especially with, white green or red colours, or all three at once would almost certainly result in a sudden control input. In such a scenario it is easy to see that a collision with a solid object might be assumed imminent and evasive action would precede any radio call. It is often the case with UAP reports that red, green and white lights are reported, To an aircraft crew this would indicate the unexpected close presence of another aircraft. In undulating or rough terrain, when at very low altitude and high speed this involuntary response could be disastrous, especially if the turn was tightened as the object appeared to move in the same direction - which it could do if it was an electrically charged body (plasma), attracted by the aircraft's electrical charge.(R)

7. **Unexplained Accidents** Over the past 30 years, some 128 RAF aircraft accidents have not been completely explained. Those not occurring in the UKADR have been ignored. A careful examination has shown that many can be rejected from the UAP hypothesis because:

-There was adequate evidence to show that some form of mechanical event was the cause which was, nevertheless, not finally resolved.

- Some accidents occurred in close proximity to airfields where other observers should have noticed a UAP, if one was present.

- Some accidents happened away from base but when within visual range of other co-operating aircraft (e.g. on CAP or low altitude Fighter Affiliation exercises or near ships).

(C)

8. [redacted] S.26

9. After the initial filtering twenty one unexplained accidents remained. For these dates the available UAP data-base was examined for any reports which occurred on the same dates and in the same approximate locations where the accidents occurred. However, on ten of these occasions (between 1970 and 1978) no UAP records are available [as many of these earlier reports were destroyed before the current department assumed responsibility for UAP matters].(R)

10. On four occasions there were no UAP reports at all in the UKADR on the days of the air accidents. Two of these accidents occurred in 1987 Wales, which is one of the most fruitful areas for UAP reports. It must be noted, however, that UAP might have been present and gone unreported on these dates. The other 2 events occurred in the N. Sea and Cumbria, respectively in July and December 1982, where there were no other witnesses to the accidents.(C)

11. There were finally seven unexplained accidents:

Phantom 1400hrs 17 Dec. 1975 (ID 757231) Solway Firth, Cumbria. 1500ft Nearest (reported) UAP events were at Seven Trent 1840Z and South York's at 0905Z. [Accident Report: Loss of control but technical possibility]

Harrier 1215hrs 12 Feb. 1982 (ID 820629) 12nm NW Oswestry 8nm S Corwen. [Accident Report: probable distraction leading to disorientation] UAP reported at 0130Z with erratic motion at Redditch - not far in UAP terms from Oswestry.

Tornado 1204hrs 12 Dec. 1985 (ID 854334) Flamborough Head. Low flying. [Accident Report: No definite cause suggested] Reports of UAP activity were received from Andover. Increased UAP activity was noted in Northumberland on previous days up to 12 Dec.

Jaguar 1405hrs 27 Nov. 1986 (ID 863936) 11nm SW Hawick (5519N 00304W) 1500 ft. [Accident Report: Disorientation, inappropriate decision, Wings level, NIL weather, nose down into forest] No UAP activity reported on this day but reports from Reading on the previous day.

Tornado 1116hrs 1 Sep. 1994 (ID 942069) Glen Ogle, Killin Scotland 500 ft 480 Kt. [Accident Report: Inappropriate response to startling event]. Only one UAP report was received - from Northamptonshire at 2245 hrs.

Phantom 1445hrs 20 Apr. 1988 (ID 881174) 25nm 080° Leuchars. Low level CAP. [Accident Report: Probably sensory illusion in deceptive weather conditions]. Two UAP reports in England at Huddersfield, York, and Stockbury (M2 motorway).

Hercules 1530hrs 27 May 1993 (ID 931653) 8nm NW Blair Killecrankie, Scotland, Low flying. [Accident Report. Flew into ground]. No UKADR UAP reports anywhere on this date.

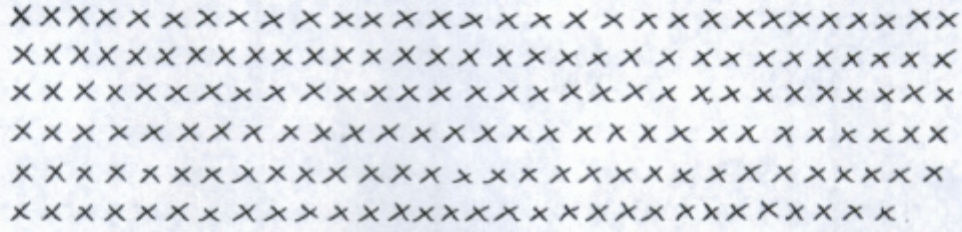
(UKR)

VOLUME 3 - MISCELLANEOUS RELATED STUDIES

CHAPTER 1 - RADAR DETECTION OF UAPs IN THE UKADR

RATIONALE

1. An understanding of the capabilities and limitations of modern radars indicates that apart from the well-known radar interference from, for example, precipitation and wind-blown chaff (both RF dependent) and unwanted surface returns (clutter) the following interfering signals may also be received and displayed:

- 

S.26

- **RFI/EMC** - Local electromagnetic effects can produce spurious returns. Some radars have filters to reject non-synchronous signals. The persistent types, which may, for example, affect fixed radar installations are usually identified and eliminated. Moving radars may encounter unexpected sources, while fixed stations may be affected by a moving interference source, only lasting a short period - hence, the possibility of producing what can appear to be a genuine target for a while. Moving plasma reflectors can produce realistic targets which can cross the detection threshold. The case of the spurious reflector located between the real target and the radar is particularly noted. The 'ghost' detection false velocities can be very high (compared with expected target speeds).

- **'Angels'** - although usually rejected, it is possible to receive and display far-distant surface returns due to the wave being partially reflected and partially refracted by atmospheric conditions. Temperature inversions cause thermal refractivity gradients (see also Working Paper at Volume 2, on optical 'mirages'). Similarly to the optical situation, the maximum confusion effect at radar frequencies is at very low elevation angles.

- **Birds** The radar echoing area (RCS) of birds and insects is of passing interest. It is only a few square centimetres and would normally fall well below the detection threshold of all but specialist radars; generic values are at Table 1-3.

(U)

2. **Anomalous Propagation** Radar signal propagation is normal in the UKADR for the majority of the time. It is possible, however to have atmospheric temperature lapse-rates where upward bending of the radar beam results in a reduction of the distance to the normal radar horizon. Dependent on the pressure-temperature gradient and partial pressure of water vapour, the extreme case is that of trapping the curved wavefronts to produce surface ducting. The mechanism of

ducting is somewhat different in tropical conditions than in temperate climates. For the purpose of evaluation of possible anomalous specular signals (which may be mistaken as UAPs), in the UKADR, inversion duct theory is used[1]. The effect can occur both in the radar's main beam and its vertical side-lobes. It is important to note that anomalous radar returns caused by the super-refraction form of this phenomena can take place in thunderstorm conditions - often also the scenario for 'ball' and 'bead' lightning and its consequent mis-identification as a UAP.(U)

3. [redacted] S.26

4. **Natural Conditions** The lower atmosphere is not a plasma under normal conditions. It contains 3×10^{25} electrically neutral molecules per cubic meter and only about 5×10^{8} ions. Ionising radiation accounts for ion pairs to be created all the time, balanced by the like number neutralised by re-combination. In fair weather, at sea level, there is an average downwards electric field force of about 130 $volt.m^{-1}$. An atmospheric layer at about 60km altitude is the lowest level in the atmosphere of uniform electrical potential (known as the 'electrosphere'). The potential of the electrosphere is ~300,000 volts positive with respect to the Earth's surface (i.e. the surface is the balancing negative charge).(U)

5. A current flows in the atmosphere because the air is not a perfect insulator. The charge balance (since the charge would otherwise leak away) is maintained by several hundred thousand lightning flashes per hour around the world. It is important to note that aircraft (flying at velocity (V) in the atmosphere), create their own electrostatic charge. They represent a conductor travelling in earth's magnetic field (β) and in fact generate a voltage between the extremities (e.g. for a Length L, Velocity V the potential is calculated from $E=\beta LV$). (U)

6. If the 'charged' aircraft encounters another charged body in the atmosphere it is assumed that the laws of electrostatics will apply and either an attraction or repulsion will occur. However, the aircraft will be moving at some velocity, whereas the 'UAP' can either be stationary or moving. Hence, there appear to be conditions where the charges do not come together, but reportedly parallel the aircraft course or follow it. When (conducting) flying vehicles enter a non-uniform field (E) a current dependent on $\partial E/\partial t$ arises in the vehicle. The balance of the charge with the UAP charge is believed to dictate the UAP subsequent motion. It is further reasonable to assume that the charged (phenomena) body may be either gaining or loosing energy hence it may dissipate and disappear.(U)

RADAR PERFORMANCE

7. Irrespectively of any other radar limitations, the ability to make an initial detection is fundamental. For radar reflections to occur from an atmospheric or any other type of plasma (as explained at Vol. 2 Working Papers Nos 21,19 & 5) requires the plasma to have a specific minimum electron density in the volume inspected by the radar beam. Reflection is dependent on the radar operating wavelength. [redacted] S.26

[1] Bean D.R. and Dutton E.J. "Radio Meteorology" US Govt. Printing Office, Washington

XXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXX XXXXXXXX XXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX S.26
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXX

8. The reflected power measured by a radar system is the average integrated power reflected from a finite illuminated area. If the reflecting area is smooth, with no irregularities, then the reflection will be entirely coherent and specular and a one-dimensional model can be adequate. However, if there are large spatial irregularities then the signal will be completely incoherent and diffuse. In between these extremes the reflected signal will contain both coherent and incoherent components, depending on the physical structure of the irregularities. In the context of the 'multi-cored' UAPs this seems likely to be the case. In the near field, from these diverse reflectors, there will be interference patterns and, potentially, considerable variability of reflected signal strength. The far-field value will be the residual signal resulting from the incoherent combinations.(R)

9. Since the plasma (or 'linked-plasmas' in a multi-core type UAP) will be, (according to witness reports of motion and colour change in the lights), in almost constant motion, it is reasonable to suggest that either regular or irregular field modulations could be present - not only in the self-radiation of the body, but in its radar-reflective properties. In basic terms, its RCS is likely to be fluctuating, probably for most of the time. This may not be the case where single-coloured ball lighting is reported which seems to be more stable than the multiple colour, multiple 'core' system that frequently form 'triangular', 'rectangular' or 'stacked' assemblies, often with an apparent shaped black coloured void between the bounding 'hot spots'. It may well be the case that quite apart from variable scatter from a large proportion of the total apparent reflecting area, that the variation of the reflectivity of the core itself may be below a particular radar's minimum detection capability.(R)

10. The scattering of EM waves from a variable surface has been long studied for more conventional radar targets. For a fluctuating plasma a number of variations will be evident dependent, for example, on the RMS coherent scattering coefficient, the RF in use, the ripple and curvature on the plasma surface, the electron density, correlation length, etc. Refraction effects, additionally, could cause smearing of the beam profile and absorption further weaken the radar returns, even if the electron density is theoretically adequate for the incident RF to be reflected under ideal conditions.(U)

11. XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX S.26
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXX

12. **Plasma Cylinders & Vortex Rings** Occasionally UAP reports describe a circular, cylindrical or 'boomerang' shape. These are sometimes oriented horizontally and sometimes vertically and various models are proposed. Entities are sometimes described as "a row of balls touching each other" or "a stack of discs one above the other"; the radius differs at various points along the 'cylinder' length. In some ways the resultant RCS can be expected to

be similar in format to a rocket plume. The distribution of the electrical properties (e.g. the electron density) are inhomogeneous both radially and axially.(U)

13. The modelling results [3] can only be an approximation, since the actual structure of the plasma UAP has never been measured. In the absence of any other information, it is assumed that a UAP (of the plasma type) comprises a plasma which obeys Maxwell's Equations. The important factors of a tubular-shaped plasma appear to be:

(a) In similarity to other radar targets the target response will vary with plasma 'cylinder' orientation and radar polarisation.

(b) The RCS varies with the incident radar's Radio Frequency.

(c) The RCS per unit length increases with the aspect angle, with the maximum RCS being reached near the cylinder centre.

(d) XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX S.26

14. For the purpose of the model, since total RCS is obtained by integrating lengthwise (in this case the length of the UAP); a radar range resolution of 100m is assumed. The numerical results were extracted (for the purpose of this DIS report) over a plasma cylinder radius of 0.4m and length of just over 1m up to a radius of 0.88 and length 122m.(U)

15. The set of results, shown at Figure 1-4, indicates a very small RCS per unit length, much less than $1m^2$, depending on aspect and polarisation. It is assumed that very similar effects may be present from elongated rotating vortex rings if they were illuminated by radar energy (U)

Aircraft as a Charged Body

16. The lower atmosphere is not a plasma under normal conditions. (3×10^{25} electrically neutral molecules per cubic meter and only about 5×10^{8} ions). Ionising radiation accounts for ion pairs to be created all the time, balanced by the like number neutralised by re-combination. In fair weather, at sea level, there is an average downwards electric field force of about 130 volt.m^{-1}. The earth's layer at about 60km altitude is the lowest level in the atmosphere of uniform electrical potential (known as the 'electrosphere'). The potential of the electrosphere is ~300,000 volts positive with respect to the earth's surface (i.e. the earth's surface is the balancing negative charge). A current flows because the air is not a perfect insulator. The charge balance (since the charge would otherwise leak away) is maintained by several hundred thousand lightning flashes per hour around the world. It is important to note that aircraft flying at velocity (V) create their own electrostatic charge; as they represent a conductor travelling in earth's magnetic field (β) (and in fact generate a voltage between the extremities (e.g. for a Length L, Velocity V ($E=\beta LV$). If the 'charged' aircraft encounters another charged body in the atmosphere it is assumed that the laws of electrostatics will apply and either an attraction or repression will occur. However,the aircraft will

[3] Shi Jiamming et al "Computation of the RCS of the Turbulent Plasma Cylinder" Inst. of Plasma Physics 43rd Inst. of State Ministry of Electronics PR China CIE Radar Conference 1996However, the aircraft will

be moving at some velocity, whereas the 'UAP' can either be stationary or moving. Hence, there appear to be conditions occurring where the charges do not come together but reportedly parallel the aircraft course or follow it. When (conducting) flying vehicles enter a non-uniform field (E) a current dependent on $\partial E/\partial t$ arises in the vehicle. The balance of the charge with the UAP charge dictates the UAP subsequent motion. It is further reasonable to assume that the charged (phenomena) body may be either gaining or loosing energy hence it may dissipate and disappear.(U)

17. [redacted] S.26

18. The reflected power measured by a radar system is the average integrated power reflected from a finite illuminated area. If the reflecting area is smooth, with no irregularities, then the reflection will be entirely coherent and specular and a one-dimensional model can be adequate. However, if there are large spatial irregularities then the signal will be completely incoherent and diffuse. In between these extremes the reflected signal will contain both coherent and incoherent components, depending on the physical structure of the irregularities. In the context of the 'multi-cored' UAPs this seems likely to be the case. (U)

19. In the near field, from these diverse reflectors, there will be interference patterns and, potentially, considerable variability of reflected signal strength. The far-field value will be the residual signal resulting from the incoherent combinations. Since the plasma (or 'linked-plasmas' in a multi-core type UAP) will be (according to witness reports of motion/colour change in the lights), in almost constant motion, it is reasonable to suggest that either regular or irregular modulations will be present - not only in the self-radiation of the body, but in it's radar-reflective properties. In basic terms, it's RCS is likely to be fluctuating, probably for most of the time. This may not be the case where single single-coloured ball lighting is reported which seems to be more stable than the multiple colour, multiple 'core' system that frequently form 'triangular', 'rectangular' or 'stacked' assemblies, -often with an apparent shaped void between the bounding 'hot spots'. It may well be the case that quite apart from variable scatter from a large proportion of the total apparent reflecting area, that the variation of the reflectivity of the core itself may be below a particular radar's minimum detection capability.(R)

20. The scattering of EM waves from a variable surface has been long studied for more conventional radar targets. For a fluctuating plasma a number of variations will be evident, dependent, for example, on the RMS coherent scattering coefficient, the RF in use, the ripple and curvature on the plasma surface, the electron density, correlation length, etc. Refraction effects, additionally, could cause smearing of the beam profile and absorption further weaken the radar returns even if the electron density is theoretically adequate for the incident RF to be reflected under ideal conditions.(U)

21. [redacted] S.26

SUMMARY OF UKADGE RADAR PERFORMANCE AGAINST UAPs

22. If, as seems quite likely, UAP phenomena is mainly caused by atmospheric plasmas (mis-reporting of man-made objects excepted), this phenomenon can be created by various natural causes for which examples are detailed in the Working Papers at Volume 2. The nature of plasmas has been studied in relation to their detectability by radar. S.26

23. **Target Characteristics** Plasma characteristics are widely explored in Vol. 2. In relation to radar response:

- The nature of plasma as a radar target is that of an amorphous electrically charged mass, which can appear as a sphere or other shape, a collection of spheres usually up to five in close formation, often forming a 'tube' or 'cylinder', either horizontally or vertically stacked; or (in plan) forming a pattern (triangle is the most prevalent, but oblongs, diamonds and star shapes can be seen). All would (according to witnesses' assessment of size) fall within a single radar resolution cell of most EW radars . They could possibly occupy adjacent range cells of Airborne Interception (AI) radar.

- Some plasmas can reflect radar energy, others cannot, dependent on the incident RF angle and the plasma electron density.

- Plasma life is limited. Weakening internal fields, temperatures, change in pressure, etc., internal electrical forces, rotation of the body, make the plasma an ever-changing target.

- According to russian research the maximum broadside RCS, i.e. at 90 degrees orientation, (Figure 1-4(a) to (f)), even with optimum polarisation, is only of the order of 0dB ($1m^2$) and changes in aspect-angle can quickly reduce to as low in value as - 40dB ($0.0001m^2$). As seen at Figure 1-4 (e), as the RF increased, the RCS decreased for most aspect angles. (U)

24. **Radar Characteristics** S.26

There are, however, several other key factors:

- [redacted] S.26

- **Radar Signature** Even though the RF conditions and plasma density conditions may be correct, the RCS of any given plasma may nevertheless be much too small to be detectable (see minimum detectable signal at Table 1-1) [redacted] S.26

  Further, it is not clear whether a UAP plasma has the same characteristic as a contained plasma in a laboratory. The radar response (including lack of response) could be quite different if the multi coloured plasmas rep[orted have more than one density core. For example the RCS may be dependent on a major reflector and several smaller ones or have the effect of a larger but unstable reflector fluctuation with random or predictable minor orientations. [redacted] S.26 Hence, it can be seen that together with the other factors below a plasma (which is inevitably gradually decaying towards extinction) may only produce a radar reflection for a limited period, if at all.

- [redacted] S.26

S.26

25. The search beam (with, say, an azimuth beam-width of 1.5 Deg.) takes ~40m.seconds to pass through the UAP target. However, the velocity of the target may be 10km per second, travelling some 400 metres in this scan time. If UAP travel is across the beam and the radar detection range, due to the small target size, is only, say, 20km, (at which range the beam is only ~525m wide), the actual beam velocity is also travelling (at that range) at over 13km per second. Hence, depending which way the target is moving, either the radar beam is chasing the target and just overtakes it or, if the target is moving in the opposite direction to the beam, the dwell time on the target is seriously curtailed, as the time-on-target could easily be halved. Either way a relatively small number of pulses hit the target. With a PRF of, say 265pps about 11 pulses are designed to hit the target in normal operation against aircraft. Against a UAP, not only is it a small target in all probability, it may only receive half the number of pulses which, integrated-up, may not reach a detection level.

S.26

Of course, this is taking a fast target as an example, with an assumed small RCS. Slower targets might be detected if their RCS and aspects were favourable.(R)

26. **Operator Procedures & Thresholds**

S.26

27. Several other factors are important:

-

S.26

- **Correlation**

S.26

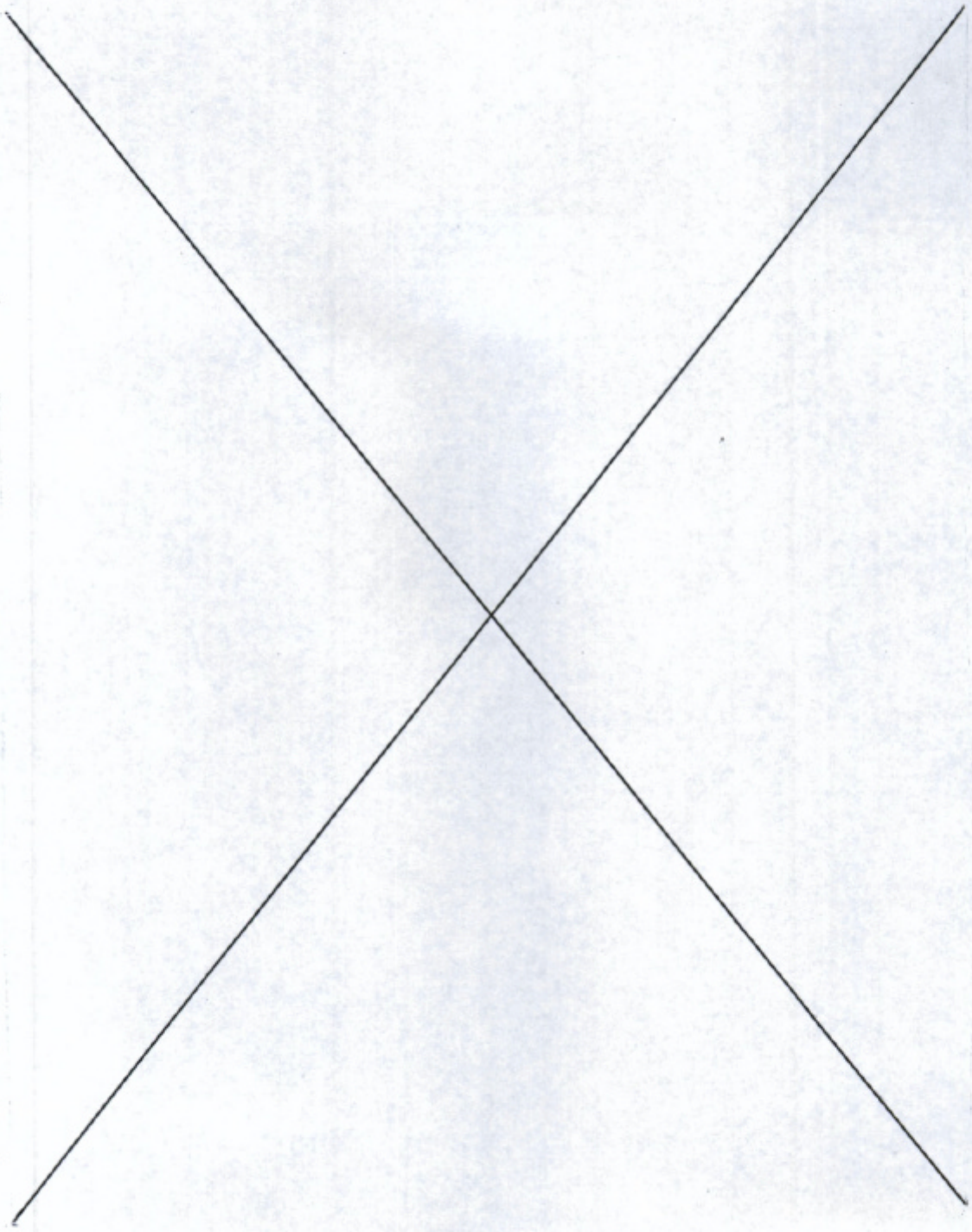
Frequently, when a UAP is spotted from an aircraft (often civil air-traffic) it cannot be seen on the controlling CAA radar. There is only one UK event on the DIS record where 3 radar's (2 RAF and one CAA) had simultaneous contact with a UAP, which eventually faded and disappeared.

(C)

SUMMARY

28. [redacted] S.26

[redacted] [The findings of this brief investigation into the reasons for the clear lack of radar reports on UAP activity - bearing in mind that hundreds of visual reports are currently received annually, can be compared with a Spanish Air Force UFO investigation, in which it is openly reported that between 1962 and 1990 only 20 cases were detected by radar, and only 7 of those lasted long enough to vector AD Fighters to the location. Spain had UAP peaks in the periods 1968-71, 1974-75 and 1979-81].(U)



S.26

S.26