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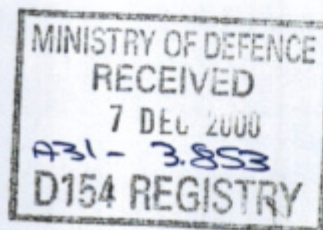
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Unidentified Aerial Phenomena in the UK Air Defence Region: Volume 2

Information on Associated Natural & Man-Made Phenomena

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



December 2000

Defence Intelligence Analysis Staff



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INFORMATION ON ASSOCIATED NATURAL AND MAN-MADE PHENOMENA

VOLUME 2

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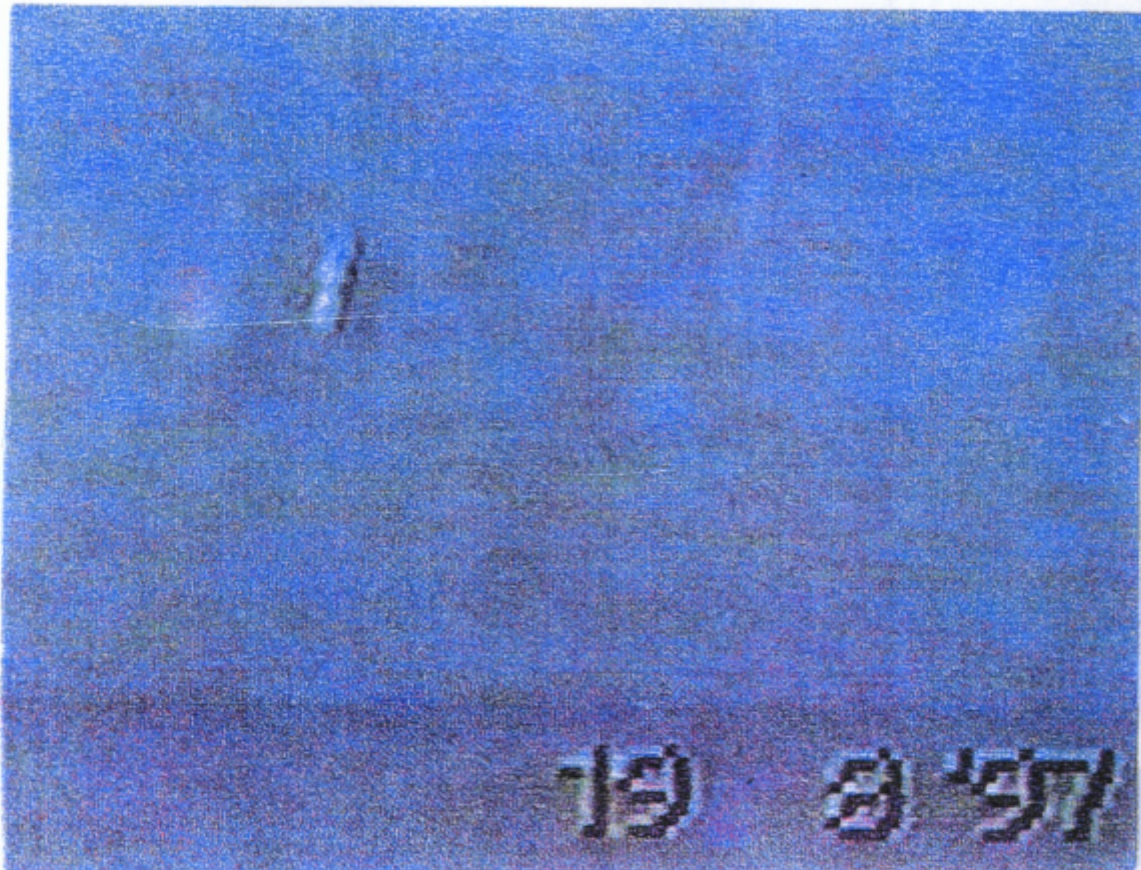
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PREFACE

1. This is Volume 2 of a three-volume 'Report on Unidentified Aerial Phenomena (UAP) in the UK Air Defence Region'. A complete index for all three volumes is at Volume 1. Volume 2 contains working papers, in no particular priority order, resulting from information collected and conclusions drawn from a wide variety of phenomena which have been applied to the study of UAP. (R)
2. This wide spread of background information is required in order to understand the relationship between UAP sightings and their probable explanations. While the majority of UAP reports can easily be explained as aircraft, satellites, clouds etc., it has been necessary to investigate some phenomenal aspects in much more detail. A significant, but rare phenomenon, for example, particularly in the study of alleged UAP effects on humans, potentially causing them to see (and possibly to hear) exceptional events due to UAP field effects and the reported degradation of vehicle electrics and electronics, is that no actual UAP electromagnetic or other field measurements exist. (R)
3. The aim of the attached papers was to act as a reference source during UAP report analysis, interpretation and identification. In many cases much more information is available on most of these topics. That which is included is judged to be sufficient for an understanding in the UAP context. (U)
4. The copyright of reference material used is given wherever this is known..(U)

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3
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CONTENTS

- 1 UAP Effects on Humans, Electrical/Electronic Equipments and Objects
- 2 Ball and Bead Lightning
- 3 Potential Reasons for Higher Densities of UAP Sightings
- 4 After Images as a Result of Flashes of Light
- 5 Detection of UAPs by Radar
- 6 Exotic Technologies
- 7 Sightline Rates of Flying Objects & Meteorites
- 8 Rarity of UAP Sound Reports
- 9 Black and other Aircraft Programmes as UAP Events
- 10 Ley Lines, 'EARTH LIGHTS' and UK Earth Fault Lines
- 11 Collected Imagery and Classification of UAP Shapes
- 12 Earth's Magnetic Field in the UKADR
- 13 Visual Meteorological and other Natural Phenomena
- 14 Meteorological Balloons
- 15 Air Ships and Hot Air Balloons
- 16 Sunspot, Aurora and Seismic Correlation
- 17 Visual Observation of Satellites
- 18 Projected Shapes/Shadows, Fluorescence & Luminescence
- 19 Charged Dust Aerosols
- 20 Optical Mirages
- 21 Ionospheric Plasma
- 22 Artefacts
- 23 Linked Vortex Rings
- 24 Sprites, Elves and Blue Jets
- 25 Overview of Magnetic Field Effects on Humans

WORKING PAPER NO. 1

UAP EFFECTS ON HUMANS, ELECTRICAL/ELECTRONIC EQUIPMENT AND
OBJECTS

	Para. No	Page
SENSING THE PRESENCE OF A UAP	1	1-1
Animals	2	1-1
ELECTRO-MAGNETIC FIELD LEVELS	4	1-1
Magnetic Fields	(a)	1-1
Electric Fields	(b)	1-1
Electromagnetic (EM) Fields	(c)	1-2
MAGNETIC FIELD EFFECTS	5	1-2
ANNEXES:		
A SOUND		
B ODOURS		
C TASTE		
D EM EFFECTS ON EQUIPMENT & OBJECTS		
E DIRECT THERMAL EFFECTS		
F NON-IONISING EM EFFECTS ON HUMANS		

February 1, 2000

i

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UAP EFFECTS ON HUMANS, ELECTRICAL/ELECTRONIC EQUIPMENT AND OBJECTS

SENSING THE PRESENCE OF A UAP

1. The ACCESS Database tables generated for the UAP study encompass all the sensing methods and descriptions, of which humans are capable, except touch. This paper provides an initial overview. Some of the topics are considered in further detail in following working papers. The sensing methods are:

- Aided or unaided visual sight (including colours, shapes etc.)
- Sound (Annex A)
- Heat (Annex E)
- Smell (Annex B)
- Feeling (excluding actual touch), for example sensing air pressure, electrical fields (static effect on skin/hair, burning of skins) - Direct Thermal Effects (Annex D)
- Taste (Annex C)
- Description of the Sighting Location and Environment
- Non-Ionising Electromagnetic Effects. (Annex F)

2. **Animals** Several of the effects are also found to extend, in some parameters, to other animals such as farm and domestic animals.

3. The following sections and subsequent working papers consider each of these effects briefly, as an aid to future analysis of UK sightings. The following review is not in any specific order of priority. Although it is very rare for the initial contact not to be by a visual sighting. The combination of more than one sensing effect, (at para. 1, above) is present on only some occasions.

ELECTRO-MAGNETIC FIELD LEVELS

4. On the assumption that some sort of field emanates from a UAP, though not necessarily on all occasions, and is apparently only influential on humans when at close range; there are three field options, using the most familiar types of field to consider. These are:

- (a) **Magnetic Fields** A magnetic (H) field can be either natural (e.g. Earth's natural field), generated, or stored (permanent). Familiar magnetised ferrous-based materials form permanent magnetics, while solenoids generate fixed or varying magnetic fields. In the UAP context this would either mean the presence of large (and heavy) field generators on a substantial and solid 'craft', or a magnetic field being generated in a UAP comprised of, perhaps, a plasma. As is well-known a magnetic field is polarised, with lines of force (flux) travelling towards the opposite polarity either on the same source or towards the earth's surface. A magnetic flux can be modulated, although the rate and shape of the resulting energy time distribution is affected by the presence of inductance, capacitance and resistance.
- (b) **Electric Fields** Electric (Electrostatic) fields are set up between objects of opposite electrical potential. Familiar manifestations of the presence of an E field is hair standing on end/bristling. For an E field to exist a non-conducting (free space, dielectric/gas) material must be between the charged entities. In the UAP context the E field, (for human effect) would conceptually pass between the UAP 'body' and earth, with the human in between. The human may be 'earthed' (i.e. standing on the surface), depending on the scenario.

- (c) **Electromagnetic (EM) Fields** These are often described generically as Radio Frequency (RF) fields as they are widely used for radio/radar emissions although the EM spectrum extends over a much wider range in practice, including IR, UV and the visible bands. An EM field is taken to comprise both E and H (Electric and Magnetic) components, which are separately detectable and measurable. Close to their origin (normally known as the source or transmitter) their relative amplitudes and phase are usually complex, but after a short distance the resultant wavefront becomes stable. In the UAP context the main interest is in whether a UAP body radiates EM waves, other than those in the visible part of the spectrum - which are present anyway, as the means by which a UAP is most often seen. The polarisation of an EM field is defined by the orientation of its E field to the horizon, but since an EM wavefront might be rotated, then both elliptical and circular emissions can occur.

Currently, the field characteristics of a UAP are unknown but it is a corroborated fact that, in addition to light (and sometimes heat), some

sort of field is emanated which has adverse effects on some people when they are close to the source. A search was therefore made to identify possible effects on people exposed to all three of the main options (a) to (c) above, both physical and mental. The following information is included because of its applicability to the subject, to assist in future analysis and elimination, and especially because of the discoveries at Working Paper No. 25.

Annex D considers EM effects on Equipment and Objects and Annex F non-ionising effects on humans.

MAGNETIC FIELD EFFECTS

5. The findings due to purely magnetic effects are considered to be of prime importance in the UAP content because of the response of the human brain and the similarity to UAP reporting. This has warranted the separate Working Paper No. 25.

A first general effects summary chart for electromagnetic (microwave) effects on humans is at Table F-1.

SOUND

1. Sounds which are sometimes reported accompanying sightings are not unusual in nature (see para 3, below), but the reasons for hearing (or not hearing) an airborne object can be complex. Further, there is wide scope for mis-reporting of those sounds which are heard. (Working Paper No. 8 considers this aspect further). They range from the violent roar or even explosion, to the low hum. The more violent can clearly come from the explosion which sometimes occurs when ball lightning disappears. However, there are reports that objects which seem to emit other sounds (e.g. whistling) or may glow very brightly, can also cause an explosive (i.e. shock-wave effect) as they 'leave the ground' or 'take-off'. These events are apparently sometimes accompanied by the formation of a mist. If an object changes its temperature or surface pressure, condensation can occur if the air is moist.

2. If microwave fields are also involved, the formation of mists may be as the result of water molecule absorption wavelengths forming resonances. (These occur at $\lambda = 0.017\text{m}$ and at four other values when $\lambda < 0.001\text{m}$). However, it is not clear how, or if, this causes the sounds which are reported.

3. The most likely reported sounds, described as normal acoustic waves, are humming, buzzing, whistling, beeping or pulsing; and they are either low or high-pitched. Observers use their own perception of sound and a wide range of descriptions are therefore used.

4. Whistling sounds are reported to be equal or louder in intensity than those of jet aircraft, even to the point of being heard inside an aircraft. Changes in pitch have been noted - not as a familiar Doppler effect, but abruptly, suggesting very high sightline (i.e. observer crossing) rates or abrupt changes of direction.

5. Animals can be 20-30% more

sensitive than humans. Frequent reports suggest extreme animal reaction to unexplained sightings. Human audio upper cut-off frequency is at 20kHz. The cut off, for example, for cats, is 60kHz and the microwave density for sound to be induced in cats is about one quarter of that for humans.

6. It is well established that microwaves can be sensed, i.e. 'heard', as well as normal acoustics. Experiments show that this is likely to occur at RFs between 200 and 3000MHz. ($\lambda = 1.5\text{m}$ to $\lambda = 0.10\text{m}$), with peak power densities of 300m.W.cm^{-2} . Hence PRFs of 50-100Hz can be heard as humming.

7. An entirely different audio mechanism can occur where human biological tissue absorbs energy, which, in turn, increases temperature, causes expansion and pressure - which then propagates as vibration and cause sounds to be heard by the auditory nerve.

8. Sound effects caused by microwaves are dependent on head size (and clearly vary from person to person and animal type). The microwave density levels for humans to receive sound effects is several hundred times the current microwave safety limits. Subjects receiving these extreme levels often describe them as producing very highly pitched whistles.

SUMMARY

9. In summary, there are two mechanisms which can produce sounds which humans have described when in close proximity to unexplained phenomena. For weak intensities and low prfs (or CW) the low audio acoustic range is the normal human reception mechanism. However, when microwaves are present, if the mechanism of tissue vibration is caused, then the noise heard is described as having a much higher pitch. About 6% (of over 300 humans tested experimentally) could hear S(E/F Band) EM emissions as 'buzzing'.

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ANNEX B

ODOURS

1. Some cases have occurred where peculiar odours have been reported. These seem to be produced by microwaves or high energy electrical fields.
2. These effects are well understood and can be replicated in the laboratory. Normally the smell is described as 'sulphurous', 'electrical burning' or ozone-like.
3. During electrical discharges in the atmosphere many electrical compounds are formed. Nitric oxide, for example, reacts with other atmospheric gases to form nitro-benzene, which smells like bitter almonds.
4. The slow decay of activated nitrogen can exhibit a white glow and may be the reason for white trails (or 'tails') sometimes described by witnesses, whether or not the witness has smelled the chemical reaction.
5. Reports have been received where a 'strange odour' hangs in the air for some time after an event.

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TASTE

1. This effect is usually described as the taste one can experience when placing a low voltage (e.g. dry battery) electrode on the tongue. It is often described as 'metallic' and 'tingling'. The effect is created, for example if dissimilar metals are placed on the tongue, creating a battery, with an extremely low (μA) current flow. However, the presence of 'taste' in the vicinity of UAPs occurs without touch.

2. The taste is immediate but the decay

much longer. It is reported that this effect can occur by pulsing and by alternating currents up to $\sim 1000\text{Hz}$. The affect is attributed to the breakdown of the chemicals in saliva. Since the human body is conductive, it is believed that bursts of EM energy could cause the 'taste' effect. Estimates are that a current of $>100\mu\text{A}$ (DC or AC) is required. Less than 1% of a 300+ sample of humans could 'taste' the presence of microwave energy. This may well be modified by the presence/absence of metallic teeth fillings.

EFFECTS ON EQUIPMENT AND OBJECTS

1. The reported effects, which seem to be due to electrical charges, magnetic and microwave energy are known to have caused:

- Overheating of car batteries.
- Metallic objects rising in temperature.
- Magnetisation, which is sometimes retained.

MAGNETIC EFFECTS

2. Objects close to reported UAP sightings have been subject to:

- Permanent magnetism (fences, flag poles). This seems to imply DC or very slowly varying magnetic fields.
- Radio interference. Radios can appear to off-tune (or go off their stations, since, presumably, they move to a non-receiving wavelength). This is possibly due to the magnetisation of the ferrites used as the antenna cores (i.e. part of the tuning loop) in modern communications/radio receivers.
- Interference with magnetic compasses.

3. In the latter case compass rotation rates have been noted. The effect (and speed) can be replicated by exposing the compass to an appropriate pulsed or varying magnetic field.

4. France is known to have measured magnetic field strengths in the vicinity of sightings as early as the 1950s when an extensive field measurement system (network of sensors) was set up for nuclear effects and the earth's geomagnetic field. Measurements to 1 part in 1000 established the change in field (in the presence of a UAP) and extraordinarily-high magnetic fields were sensed. When this level was translated (i.e. scaled) to a reported distance of a few hundred metres between UAPs and radio receivers, from other reports elsewhere, the magnetic flux was consistent with the levels needed to cause the radio receiver effects reported.

5. High frequency magnetic fields, presumably from nearby UAPs, are reported as causing battery acid heating (conducting medium), and other conductors to warm-up, while non-conductors, e.g. rubbers, plastics have reportedly remained cold to the touch.

6. French reports suggest that the slowly varying magnetic fields suspected do not appear to noticeably cause any body-currents in humans. The effects of EM fields on humans is covered at Annex F.

7. A report from Finland in 1977, which involved 170 troops on the Finnish border reported RF equipment 'jammed' and no telephones.

DIRECT THERMAL EFFECTS

1. Short-range observations, in almost every reported instance, have been accompanied by a sensation of heat, ranging from mild warmth to severe burning. Normally (but not exclusively) these appear to be line-of-sight effects.

2. If an object is surrounded by a plasma (usually described as 'a glow'), it can radiate broad-band energy well beyond the visible spectrum. If an object is without plasma (i.e. seen to have a 'metal' surface), it can radiate IR radiation from any gases or body heat which may be present, or energy at UV wavelengths.

3. Reports of 'sunburn', severe sunburn, and even eye-pain and loss of vision have been reported. In one event the witness, a policeman, suffered arm-burns through a long-sleeved uniform. But his body was otherwise protected by the car door, behind which he was standing.

4. All indications are that the phenomena at paragraph 3 above could not be IR or UV but must have been microwave penetration at very (ultra) high frequency(s), where even for

humans 'skin effect' (i.e. surface rather than absorption microwave heating) can occur.

5. In the 1950s several reports were received (France and South America) of combined vehicle failure and mild shocks or 'tingling' in proximity to 'hovering' objects.

6. At the time of vehicle failure several reports (Canada) have resulted in apparent temporary paralysis of humans until the nearby object moved away. It is possible that some muscular control (motor-control) nerves can be affected by electrical potential. This can be replicated by medical scientists. One explanation is that either constant or pulsed microwave, coupling into the nervous systems may cause this affect. Pulsed interference with the human system is possible because of the 500 milliseconds muscle relaxation delay.

7. At least one fatal incident is reported, following what was believed to be radiation-induced from one or more energy levels, including the possibility of x-rays, or protons. Effects, ranging from minor skin burns (i.e. sunburn - like) to the level of blisters have also been reported (USA).

	Para. No
NON-IONISING EM EFFECTS ON HUMANS	
EM FIELD FROM A PLASMA	1
Near Fields	2
UAP Near Fields	3
Variation with RF	7
Athermal Effects	8
Modulations	10
Near Field Coupling	11
Radiation Pattern	12
POTENTIAL NEUROLOGICAL EFFECTS	13
APPLICABILITY TO UAP EVENTS	18
SUMMARY	20

NON-IONISING EM EFFECTS ON HUMANS

EM FIELD FROM A PLASMA

1. The EM field from a radiating plasma is assumed to be present in three forms:

- The Radiation field which diminishes with range at $\frac{1}{R^2}$.
- Induction components which diminish at $\frac{1}{R^2}$.
- A Quasi-Static field which reduces at $\frac{1}{R^3}$.

2. **Near Fields** The induction and quasi-static fields are near field components, only of significance close to the source and thus of particular interest in the study of those UAPs which might be caused by plasmas or electrically charged bodies. Assuming that the dimension D (effective linear 'aperture') of the plasma is large compared with the wavelength (λ), then the near field is taken to extend to a distance $2D^2/\lambda$ from the source. The Radiation Field (far-field) is not of interest in this study. In the normal case of an EM source (for example, antenna emission) the radiation field beyond the near field stabilises with spatially uniform distributions of the E and H field components, which are at right angles to each other and transverse to the direction of propagation, they are in phase and have a constant amplitude relationship.

3. **UAP Near Fields** Assuming that EM radiation may be present in at least some of the UAP sources (e.g. ball lightning, bead lightning, 'earth lights' and other charged air-masses, it is possible to calculate, as shown at Table F-2, some expected near-field distances.

4. For effects on humans calculations are made to determine power flux-density (watts/m²). In the near field this value is determined from the vector product of the E and H fields, making calculation more complex than the familiar terms ($S = P/Gi/4\pi R^2$) used, for

example, for radar calculations. For the near-field there is an arbitrary phase and amplitude relationship between E and H which must be taken into account for every point in the near-field region if power flux-density values are required. To simplify calculations for the near-field a 'plane-wave equivalent' value is sometimes used. If the E field or H fields are known, power density is evaluated respectively from E^2/Z_0 or H^2/Z_0 . Z_0 is the familiar characteristic wave impedance of free space 377Ω .

5. It is not clear whether single, multiple or broad-band radiation frequencies are emitted from the airborne sources of interest (UAPs). Unfortunately there are no electric or magnetic field strength measurements taken, the majority of UAP events only being present for a few seconds.

6. Standard radiation hazard calculations assume that at MF/HF the frequencies are below whole human body resonance frequencies and direct hazard effects can be high. Most of the work concerning radiation levels concentrates on the specific absorption rates (SAR) in biological tissues (for thermal reasons). The maximum amount the body absorbs depends on the rate between body length and the free-space wavelength of 0.4. For the human body a significant absorption maximum therefore occurs at ~80MHz ($\lambda = 3.75m$), varies with adults and children and is dependent on whether the subject is in contact with a conductive ground or in free space.

7. **Variation with RF** Below an RF of ~30kHz, thermal effects can be neglected in comparison to stimulation effects on nerve and tissue cells. In the RF range from ~100kHz to 1MHz the thermal and stimulation effects are of the same order. Figure F-1 shows the combined experimental results for RFs up to 100kHz. For the study of possible radiation

from UAPs the following zones on the shaded diagram are of interest. Lines A and B (Figure F-1(d) & (e)) are the value of electric current densities occurring in tissue. The information at Figure F-1 is converted into incident E and H fields at Figures F-2 and F-3. Since, for this study it seems likely that UAP radiation affects the human temporal lobes, a sphere is used as the model at Figures F-3 and F-4, with the same current densities as at Figure F-1.

8. The source of these values¹ recognises that the maximum current densities may be in error by up to an order. Hence, they can only be used with caution. In general, from 3 to 300MHz power densities $<1\text{mW.cm}^{-2}$ are considered 'weak' fields.

9. **Athermal Effects** Very little agreed scientific knowledge exists about athermal effects other than stimulating effects. Localised absorption is known to occur, for example at 3MHz around the ankles and head, indicating a higher likelihood of higher current distributions (see Figure F-1) in the body area where brain stimulation may be affected. This is not to imply that adverse effects are certain - because no biophysical action model exists to produce reliable information on which to base a firm hypothesis. It is not known whether UAP emissions produce mixed frequency effects.

10. **Modulations** Effects on humans are also concerned with any modulation which may be present and this clearly affects total received energy and may therefore affect human brains in different ways, depending on the coupling mechanism.

11. **Near-Field Coupling** Due to complicated near-field structures, with temporal phase differences between the E and H fields, a considerable variation can occur in polarisation. Very few investigations have been made to determine near-field coupling and absorption. Optimum coupling into a body can only take place when its orientation (polarization characteristic) is identical to the incident wave at that point. It is clear from this

that it might be possible for a human to be close to a UAP radiation, in fact within its near-field with little effect, while a short distance away the coupling conditions may cause another human to receive stimulation resulting in quite different description of what is being seen. The generalised values deemed to be acceptable radiation hazard levels do not necessarily apply in the case of UAPs, where it is suggested that very low levels of radiation in the near-field (and possibly containing unknown modulations) may couple with the human brain. There is also some evidence that some humans are more susceptible than others to this phenomena. This may well account for the fact that often the same person repeatedly 'observes' UAP events while others do not.

12. **Radiation Pattern** Although it may be assumed that the (idealised) shape of the radiating UAP is spherical and that its radiation pattern is uniformly omni-directional, in practice this may not be the case. Frequent reports suggest that the (assumed plasmas) take up a variety of shapes and have 'hot spots' which are visible. Conventional logic is that the inhomogeneity and shape variation will lead to a non-uniform radiation distribution. Hence, there may well be 'hot spots' of radiation emanating along some axes - which the close observer may or may not be exposed to. Further, the objects of interest are often observed/approached by witnesses travelling in cars which will provide some screening. On other occasions the screening is supplied because witnesses are in aircraft. Finally, there are cases where people have left their cars and suffered both immediate and after-effects.

¹ "RF Hazards Exposure Limits". European Union Geneva 1995 Tech. 3278-E

POTENTIAL MENTAL EFFECTS ON HUMANS

13. Neurological, rather than biological effects may be the clue to some human behaviour after exposure in the near field of UAP radiation. Particularly sensitive are the temporal lobe areas of the brain. Unlike other parts of the brain, the temporal cortex can be rendered electrically unstable. The connection between RF fields and brain activity was confirmed by the 1980s. In the last 20 years much of the work has been concerned, on the one hand with protection of humans against RF hazards and secondly to understand the viability of microwave weapons. The amount of scientific papers on human interaction with RF fields is prodigious - 4500 papers alone between 1978 and 1984! The linking of brain activity to UAP events, where the witness is presumably within the near field influences, is currently only partially understood, since assumptions must be made (in the absence of real values) as to the type of fields being encountered. Within the UKADR these close encounters occur only a very few times each year. The well-reported Rendlesham Forest/Bentwaters event is an example where it might be postulated that several observers were probably exposed to UAP radiation for longer than normal UAP sighting periods. There may be other cases which remain unreported. It is clear that the recipients of these effects are not aware that their behaviour/perception of what they are observing is being modified. The E field strengths which are known to affect the brain are of the order 50 multivolts per centimetre at between 1 and 100MHz and experiments have shown that effects can be produced at levels of 10^{-7} to 10^{-8} volts per centimetre.

14. An important fact is that the reported effect of (presumed) UAP radiation on humans is that it is quick-acting and remembered - although, curiously, following the event there is little or no recall of events as a continuum. In short, the witness often reports an apparent 'gaps' or 'lost time' - often not accounting for up to several hours. It is described as though the exposure causes a temporary memory

erasure. Experiments (on animals) have shown that low (3mW.cm^{-1} at 450MHz) exposures affect brain calcium ions and that these are known to play an important role in the transmission of nerve impulses. Various modulations (e.g. 5Hz, 16Hz) were imposed on the radiation. However, whereas earlier experiments went on for tens of minutes - or even for hours: as such they were not (and not intended to be) representative of the very short UAP exposure times of a few seconds. In 1981 it was discovered that E fields (at ELF) of 10-50 or V.cm^{-2} at a modulation of 5Hz for only 5 to 10 seconds could increase the excitability of nerves for hours.

15. It is concluded therefore that if some UAPs, as is believed and correlated by actual reports (collateral effects on, for example, car electrical equipment) produce EM radiation then there is a high probability that they can affect the human brain.

16. It would seem that this effect can occur when close to a UAP, either outdoors or indoors. This causes the brain to interact in an unusual way with the imagination 'library', causing reports of visual activity which are not in fact a true representation of the facts. It is of particular interest that a perusal of a limited number of old UAP reports (pre- 20th century), while often similar or even identical to modern reports, does not produce evidence of 'spacecraft' aliens (grey or green), 'portholes' or 'searchlight' beams!

APPLICABILITY TO UAP EVENTS

17. As there are few, if any, measurements of UAP radiation anywhere in the world, one option is to eliminate those RFs, modulations and radiation values which are known **not** to affect the human brain. For example, research has been done in this area in programmes which try to identify human susceptibility to mobile phones. In particular, operating at 160, 350 and 915MHz; and the new RF for mobiles at 1700MHz. Of course any pursuit of this process of identification or elimination is pointless if it turns out that UAP radiation is

other than EM radiation as we currently understand it.

18. For experimental purposes RF energy has been launched using resonant dipole antennas in both E and H orientation². The amount absorbed was greatest at lower RFs (longer wavelengths) and at E field polarisation. However, it is recognised [for the UAP Study of Effects] that it may not be the **amount** of energy absorbed which causes unexpected brain responses to close encounters with a UAP, but possibly some sort of modulations at much lower energy levels.

19. A wealth of other international experimental measurements (in 18,000 research papers) have been taken using devices which radiate at most RFs, including ELF (e.g. 50Hz). Much of this work is based upon the necessity to understand hazards from, mobiles, AC mains and equipment such as VDUs, broadcast stations, etc. It is of interest, in the UAP context, that maximum absorption (and logically the maximum effect) is in the human head irrespective of wavelength. See Figure F-1. This also appears to be the case irrespective of human orientation (i.e. facing or side-on to the source). Near-field exposure deposits a far greater rate of absorption in the head than when in the far-field. It is also clear that time-varying electric fields, acting on nerve axons, can give rise to sensory stimulation. Further, the effect will not be the same on every person. Unfortunately, the stress on experimental measurements has always been human (or animal) biological changes, rather than possible neurological effects. It is of interest that at some RFs (e.g. at 900 and 1700MHz) some field focusing occurs in the head and it must be considered that while this may occur at other RFs; it may be some focusing effects or even the occurrence of several interacting frequencies from a UAP which cause the reported effects.

SUMMARY

20. Because few persons are exposed to the postulated UAP radiation, the following points are pertinent:

- There is no history of after-effects of 'UAP exposure' reported beyond 'feeling unwell for a few hours'.
- Unlike other EM radiation sources no cumulative effects are reported or studied.
- It is not certain that the radiation/fields are conventional and electromagnetic in nature.
- No other known (even repeated) exposures to EM radiation (with conventional modulations) causes the 'loss of time' syndrome reported by many (close encounter) witnesses worldwide.

² "RF Energy, Deposition in a Heterogeneous Model of Man: Near Field Exposures M.A. Stuchey et al. IEEE Trans. Biomed. Eng. Dec 1987

		Microwave	Microwave Threshold (mW.cm ⁻²)	Radio Frequency (MHz)	PRF (Hz)	Pulse Duration (µsec)
Heard as:	Shockwaves	YES	?	>60,000	?	?
	Low Pitch	YES	12	200-3000	50-100	1-100
	High Pitch	YES	~2000	Any	Any	Any
Smell		YES	?	Any	[3]	Any
Taste ^[4]		YES	<13.1	Any	<1000	Any
Felt as:	Heat ^[5]	YES	~8.4	30,000	Any	Any
	Shock ^[2]	YES	?	Any	Any	Any
	Burns	YES	?	30,000	Any	Any
	Internal Burns	YES	?	<3,000	Any	Any
	Paralysis	YES	?	~3,000 ^[1]	>500	Any

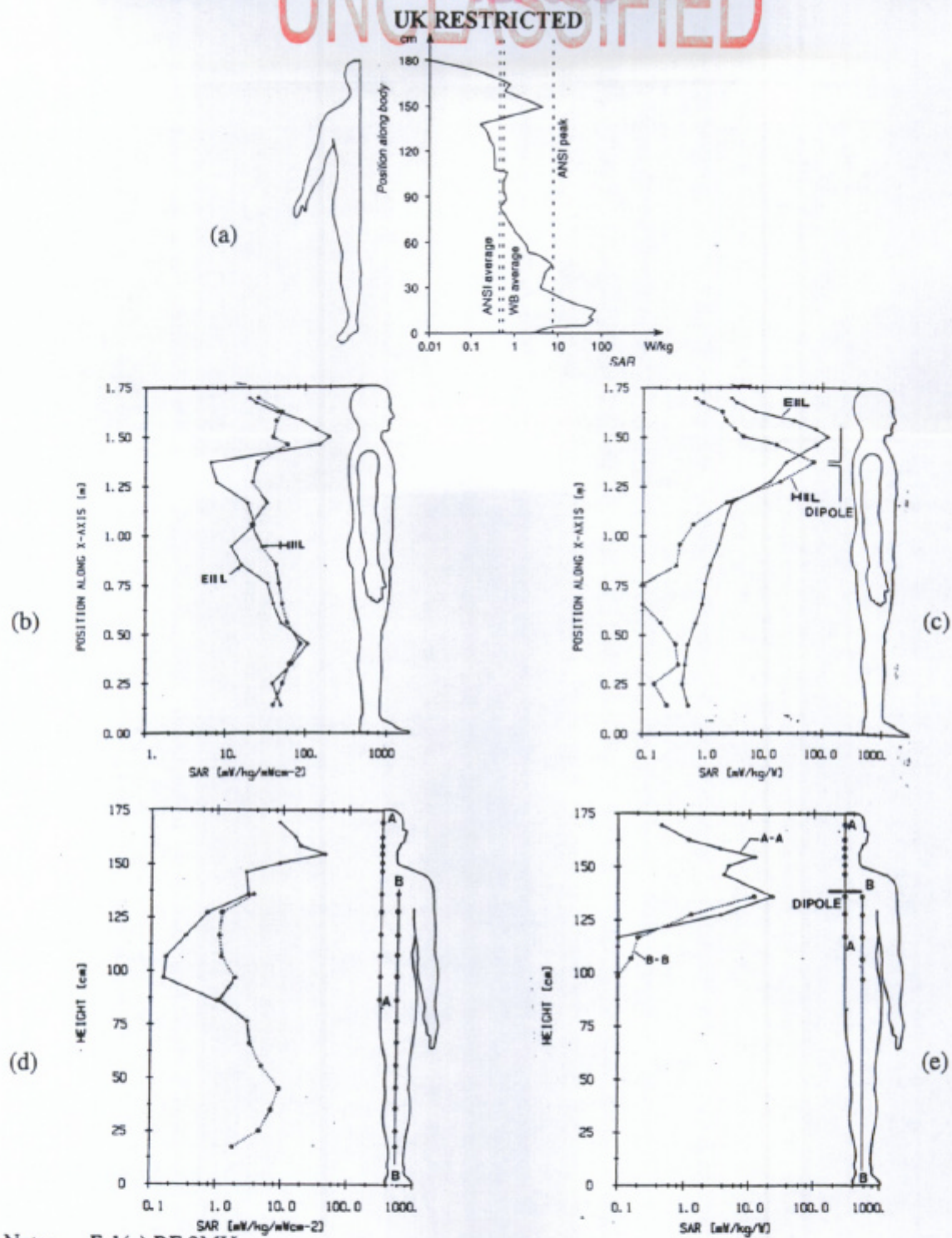
Table F-1 HUMAN EFFECTS THRESHOLD (U)

- Notes**
- [1] Reportedly enhanced if >500Hz
 - [2] Electrical shock
 - [3] Reportedly enhances smell
 - [4] >100µ Amp
 - [5] Added to those microwave heating effects can be the effects of IR

Object (UAP) ^[1] Diameter (m)	$\lambda(m)\{f(MHz)\}^{[2]}$				
	100{3}	10{30}	1{300}	0.10{3,000}	0.01{30,000}
0.5	0.005	0.05	0.5	5.0	5.0
1.0	0.020	0.20	2.0	20	200
1.5	0.045	0.45	4.5	45	450
3.0	0.180	1.80	18.0	180	1800
10.0	2.000	20.0	200	2000	20,000
20.0	8.000	80.0	800	8000	80,000

TABLE F-2: NEAR FIELD DISTANCES[3] (m)

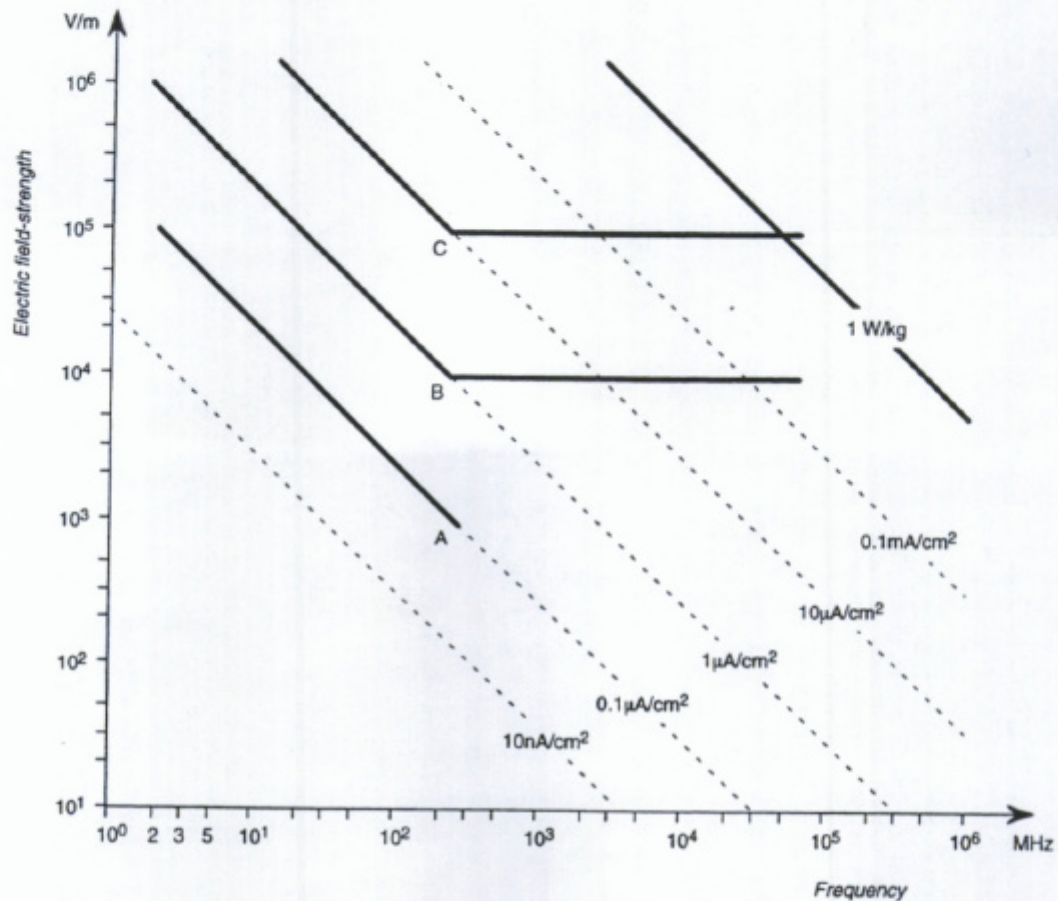
- Notes: [1] Assumes that UAP is a radiation plasma or charged mass source with effective aperture shown. The recorded appearance of plasma balls exceptionally reaches the largest value shown. However, this should not be confused with the large triangles, rectangles and other large shapes reported. These possibly have radiating peaks (e.g. at the 'corners' but, as they do not appear to be (visually) homogeneous seem unlikely to represent a total radiation aperture.
- [2] It is not known whether UAPs radiate narrow or wide-band RFs.
- [3] The standard near-field criteria is used ($2D^2/\lambda$).



Notes

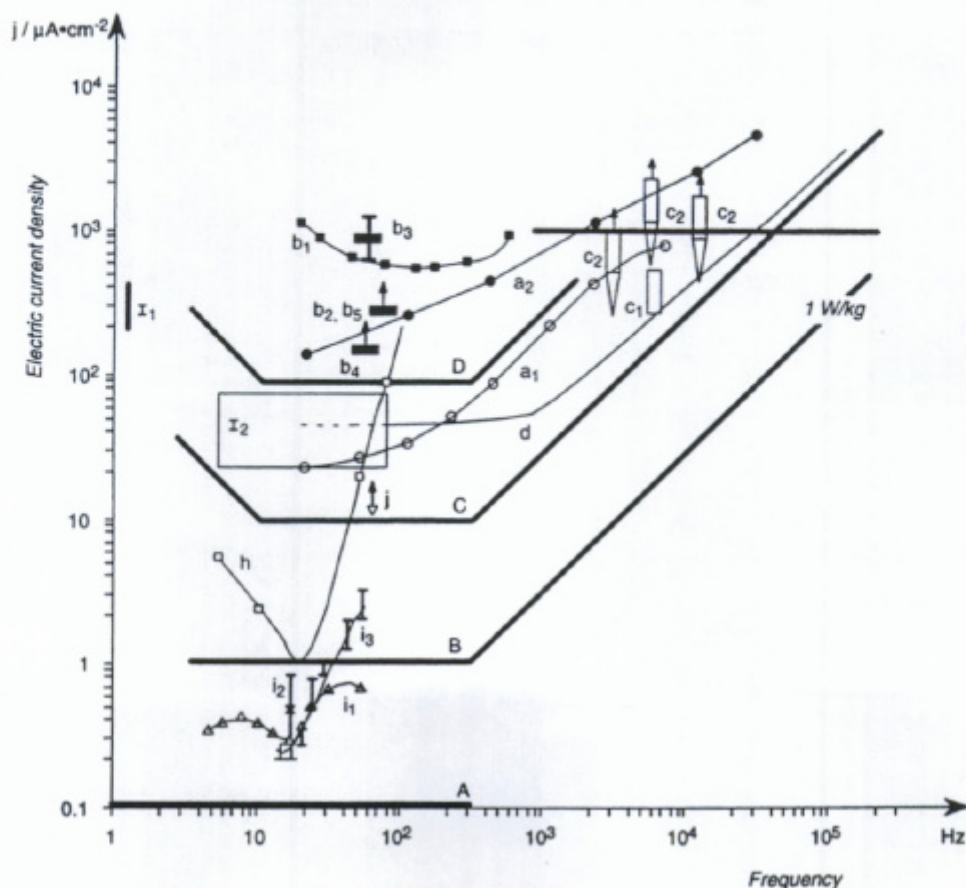
- F-1(a) RF 3MHz
- Figure F-1(b) RF 350MHz Far Field (1mW.cm²)
- Figure F-1(c) RF 350MHz Near Field for same far field
- Figure F-1(d) RF 915MHz Far Field
- Figure F-1(e) RF915MHz Near Field

FIGURE F-1: DISTRIBUTION OF ABSORBED RADIATION



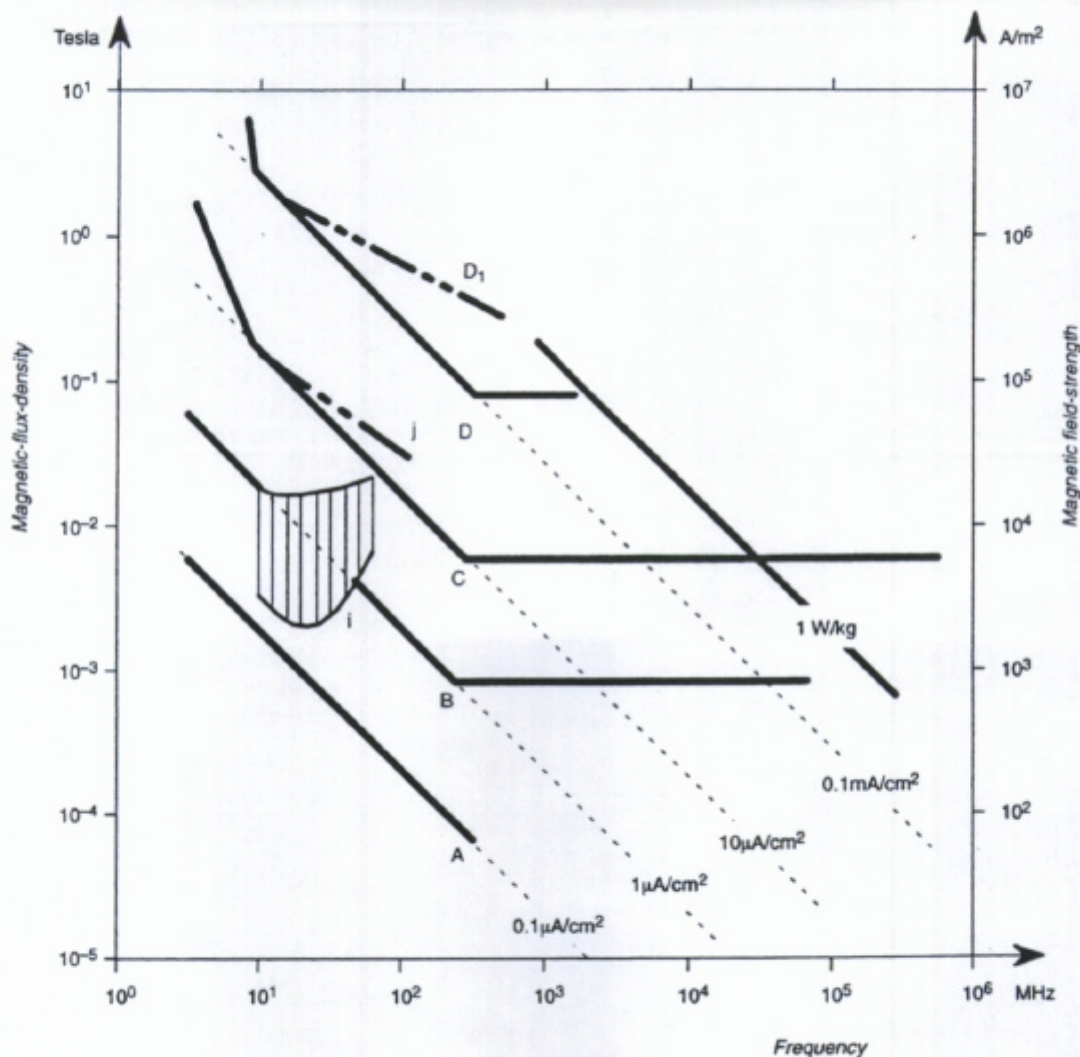
- Notes:
1. The longitudinal axis of the man is parallel to the orientation of the field.
 2. Numerical RMS values apply to the undisturbed field.
 3. In other parts of the body (e.g. wrists or ankles), depending on the exposure conditions, current-density values up to tenfold greater are possible.
 4. For curves A, B and C, see the notes given in Figure F-3.

FIGURE F-2: ELECTRIC FIELD-STRENGTHS WHICH INDUCE APPROXIMATELY THE INDICATED CURRENT DENSITIES IN THE HEAD AND IN THE CARDIAC REGION OF A MAN



- Key:
- a₁, a₂ Stimulation of sensory receptors immediately underneath surface electrodes (Geddes et al., 1969).
 - b₁ - b₅ Ventricular fibrillation thresholds for stimulation times of 1 sec or longer (b₁: Imich et al., 1974; b₂: Roy et al., 1976; b₃: Jacobsen et al., 1974; b₄: Osypka, 1963; b₅: Watson et al., 1973).
 - D "Envelope" threshold curve for extrasystole elicitation and ventricular fibrillation; stimulation, 1 sec or longer (injury threshold).
 - c₁, c₂ Extra-cellular stimulation thresholds of single cells (c₁: Roberts and Smith, 1973; c₂: Ranck, 1975).
 - d Frequency dependence of stimulation thresholds for nerve/muscle systems (modified from Schaefer, 1940). This curve may be used as a lower "envelope" curve for excitation thresholds for single unidirectional pulses or pulse sequences.
 - I₁ Threshold for modulation among different neurons (Chan and Nicholson, 1986).
 - I₂ Modulation of neuronal excitability in rat hippocampal slices (Bawin et al., 1984).
 - C "Envelope" threshold value curve for stimulating effects (possibly hazardous).
 - h, i, j, B Calculated current densities for the threshold values of electrophosphores (h: Adrian, 1977) magnetophosphores (calculated current densities; i₁: Silny, 1981; i₂ and i₃: Bernhardt, 1985) and variations of optically-generated reaction potentials (j: Silny, 1981). B shows the range over which biological effects are expected and observed.
 - A Average value of naturally-flowing current density in the body tissue; the values of the current densities due to the electrical events in the brain or in the heart are usually much larger at a microscopic level. Below this current density, absence of detectable effects is assumed.
 - 1 W/kg The current density range above which additional thermal effects have to be considered.

FIGURE F-3: THRESHOLD VALUES OF ELECTRIC CURRENT DENSITY FOR DIFFERENT BIOLOGICAL EFFECTS



- Key:
- i Threshold values for magnetophosphenes; the upper curve corresponds to magnetic fields where phosphenes were observed as patterns.
 - j Changes in visually-produced potentials (from Silney, 1981).
 - D₁ Experimental values for cardiac stimulations, calculated for humans from experiments conducted on animals (from Silney, 1986).

For curves A, B, C and D, see the notes given in Fig. 16.

- Notes:
1. The magnetic field is varying sinusoidally.
 2. Due to larger conductivities and current loops at a local level, induced body-current densities may exist at levels which are higher by one order of magnitude than those indicated.

FIGURE F-4: MAGNETIC FLUX DENSITIES WHICH INDUCE APPROXIMATELY THE INDICATED CURRENT DENSITIES IN THE BRAIN AND THE HEART OF A MAN

WORKING PAPER NO. 2

BALL AND BEAD LIGHTNING

	Para.	Page
INTRODUCTION	1	2-2
Ball Lightning	2	2-1
Bead Lightning	3	2-2
SHAPES, SIZES AND STRUCTURES	7	2-2
MOTION	10	2-3
Velocity	11	2-3
SOUNDS	12	2-3
DURATION	13	2-4
RADIATION-HEAT AND LIGHT	14	2-4
Light	15	2-4
Heat	16	2-4
EM Radiation	17	2-4
ODOURS	19	2-5
EFFECTS ON HUMANS	20	2-5
EFFECTS ON ENVIRONMENT	21	2-5
EFFECTS ON EQUIPMENT	22	2-5
SUPPORTING THEORIES	23	2-6
LABORATORY PRODUCED BALL LIGHTNING	31	2-7
PLASMOID	38	2-8

February 1, 2000

- i -

XXXXXXXXXXXX S.40

	Para.	Page
AURORAL LOOPS	39	2-8
Ball Light Ozone Spheres	39	2-8
Power Intensive Plasma Formations (PPFs)	40	2-8
BALL LIGHTNING AND AIRCRAFT	41	2-8
PLASMA SHAPE CHANGES AND SIZE	46	2-10
SURVEY OF COLOURS	47	2-10
OPTICAL 'THICKNESS' OF BLACK RADIATORS	48	2-11
THERMO-CHEMICAL REFRIGERATION	49	2-11
SUMMARY OF BALL LIGHTNING CHARACTERISTICS	50	2-11
Near-Terrestrial Events	51	2-11
In-Structure Phenomena	52	2-12
Demise	53	2-12
SUMMARY - RELEVANCE OF BALL & BEAD LIGHTNING TO UAP REPORTS	54	2-12

THE CHARACTERISTICS OF BALL AND BEAD LIGHTNING

INTRODUCTION

1. A review of the nature of Ball and Bead Lightning has been made, because of the possibility of this being reported:

- As a visual unexplained UAP sighting - since this phenomena can exist up to two hours after a storm and the luminous globe can be retained on the human eye (as an after image on the retina) and reported as an object.
- As a potential UAP phenomena which can occur in all weather situations - even in a clear sky.
- The sounds and colours which can be produced by ball lightning are frequently similar to those which appear on UK UAP reports.

Lightning, as a topic, has only been seriously (scientifically) investigated for the last 200-300 years. Reports go back to at least 'Globes Igneous', (St. Gregory of Tours 6th Century AD), Aristotle 4th Century BC and others in the First Century BC. On occasions the Ball variety of lightning is known as a 'solid' or simply 'fireball'. The phenomenon of Ball Lightning is assessed to involve the disciplines of chemistry, meteorology, physics, electrostatics and electromagnetics. Chemical, optical and various electrical models and explanations have been proposed. These are only investigated here to a depth to show the consistency of characteristics as an aid to the identification of many UAP events as ball lightning or its similar relation phenomenon 'Earth Lights'. Of the numerous explanations there is generally at least one important aspect that is not totally fulfilled and a variety of theories are put forward to explain the missing

link. Either lifetime (duration) is explained and stability not, or for example, colour does not match expected temperatures. For other theories, for example the vortex explanation, does not explain electrical properties. Apart from Ball Lightning and Earth Lights, many such occurrences are known simply as 'atmospheric spherical formations'. While the probability of the occurrence of ball lightning somewhere on earth has been calculated as between 10^{-9} and 10^{-8} per square kilometre per minute (equating to about 100 to 1000 balls world-wide per hour); it can only be seen at close range and many events must be unrecorded. Some, of course, are black, others translucent, both have weak thermal radiation. Reportedly bright spots or 'beams of light' are likely to occur when the phenomenon approaches a conducting object. [Comment: This is important in the context of reports, often by car owners who report supposed 'extra terrestrial' objects with illuminated 'portholes']. The 'beams' often converge unlike, for example, searchlights and this appears to be due to lens effects caused by the high electric field intensity of the surface, or 'shell' of the ball (or other shape seen)

2. **Ball Lightning** A study of Ball Lightning can be classified under the following headings:

- Conditions and locations for occurrence.
- Shapes, sizes and structures
- Motion (Velocity and Trajectory)
- Sounds
- Duration
- Radiation (Heat and Light)

- Effect on Humans
- Effect on the Environment
- Effect on Equipment
- Odours
- Electrical/Chemical theory

Ball Lightning decays in a variety of ways - see Sounds/Colours, below.

3. **Ball Lightning** is believed to be formed from an 'ordinary' flash of lightning - for which the familiar 'electrical' storms are a generator. However, it can also occur without the presence of a storm or of visible/conventional lightning. Apart from these conditions, once present, the 'balls' or 'beads' can last for a few seconds up to minutes. Ball lightning can enter rooms (usually through apertures (e.g. chimneys, doors, windows) and can either leave by the same method or dissipate within the enclosed space. Instances have been reported where ball lightning has entered aircraft (BOAC 1938 and TWA 1948 Easter Airlines 1963, USAF KC-97 in 1960 and in Russia). In Europe 65% of all reports identified as ball lightning occur in the summer months. 95% are reported in the hours 1300-2359 hours and mostly clustered in the period 1600-2000 hours. It has even been seen in snow. Frequently the effect has been reported in the vicinity of marshes, volcanoes (lee-side) and during earthquakes. The balls/globes appear in rain, in clear skies, in still conditions or wind, move against the wind, can be vortex associated, in snow, near the ground and at altitude. Undoubtedly the largest occurrence is during storms/cyclonic conditions. Conditions for ball lightning formation appear to be:

- Charge particle connected
- Frictional action of dust (hence Volcanic links)
- Dependent on the presence of very high electrical charges and fields
- Possibly dependent on the formation of natural EM radiation

- Emitted from a 'bend' in conventional lightning
- Drop from clouds (initially)

On occasions ball lightning has no apparent connection with a storm. It can also leave a meteor-like trail.

4. **Bead Lightning** Bead lightning (5-15%) is much less prevalent than ball lightning (85-95%) and is the residue of cloud-to-cloud or cloud to surface lightning strokes where a row of balls are seen separated by darker regions in a string-like form. Bead lightning is generally observed at a distance, in contrast to ball lightning which is observed nearby. As for ball lightning, the incidence of the occurrence of bead lightning is quite low. One survey found only 1600 reports between 1850 and 1978! Bead lightning is also sometimes called 'pearl' lightning. Some 'strings' have been reported as quasi-sinusoidal in form, while elongation of the beads (or balls) suggests sausage or cigar-shapes [often a feature of UAP reports].

5. Most reports of ball and bead lightning occur at low altitude - most probably because that is the location of most observers; hence this limitation may not be true in practice (see para. 22 below). Insufficient evidence exists to be certain of all the conditions for ball and bead lightning formation. No single theory appears to satisfy all the criteria. The ball is sometimes seen with a halo.

6. Ball lightning is sometimes mistakenly reported as St. Elmo's fire.

SHAPES, SIZES AND STRUCTURES

7. On some occasions bead lightning, often described as a 'string of sausages' (i.e. elongated beads), converts or 'breaks off' into a single glowing ball as the pinching effect which separates the components disappears, leaving a single glowing ball (or balls). Shapes are invariably described as globes. Sometimes flames seem to be revolving inside the globe. On rare occasions, two balls have been reported linked together (a metre or two apart), while on others oval, or pear-shaped forms are reported. On even rarer occasions 'torus' and

'rod-shaped' systems have been seen, and also 'hollow' spheres.

8. Ball dimension reported vary from a few centimetres to 12-15m in diameter. Some examples had ball diameters of 22cm (inside eastern Airlines Aircraft, 30cm, 50cm, 60cm, 8.5m, 12.8m, and a 38cm (rod). A summary of the scientific factors which control plasma sizing is at paragraph 30, below. Optical illusion effects can clearly change the perception of size. It is important to note that an increase of light intensity can be perceived as an increase/change in size or shape. The balls are sometimes hazy in outline and may not be truly spherical (when not one of the other shapes).

9. Within the bounds of the shapes, described above, there appear to be three structural types:

- (a) Balls with a solid appearance with a dull or reflecting surface, or with a solid core in a translucent envelope (often 30-50cm in diameter).
- (b) A rotating structure.
- (c) A burning appearance (often <40cm diameter).

Reports suggest that single balls can break up into smaller ones (or disperse - see para. 12 below).

MOTION

10. The motion attributes reported are, firstly direction/profile, where the phenomena is reported as moving in one or more of the following directions or types of movement:

- Cloud-to-cloud
- Earth-to-cloud
- Cloud-to-earth
- In a horizontal path (55% of occasions and usually of the 'burning' type)
- Climbing and bouncing/rebounding
- Changing course
- Movement opposite to wind direction

- Very rapidly point to point (jumping or darting)
- Attracted to enclosures (e.g. indoors/in vehicles/aircraft)
- Rolling (on earth's surface, wet or dry)
- Emerge from Lake
- Turning sharply/abruptly
- Executing parabolic curves
- Spinning or spiralling
- Floating
- Motionless/hovering
- Diving (at high speed)
- Apparently moving at windspeed
- Jumping (to a few metres in height)
- Darting to a conductor (especially water, fences etc.)
- Attaching (to an object) or 'pushing' at an object
- Detracting (and floating away from an object)
- In complex trajectory (20% of reports)
- Vortex-associated
- Float ('squeeze') through a small hole and then expand to a large ball-shape.

11. **Velocity** Secondly the ball lightning often has velocity in one or more of the following categories.

- Often low velocity (including zero)
- Estimated 100-1200ms⁻¹.

Frequently the speed is reported (when near the ground) as that of a man walking or running. The spiral or rotational form, which is often vortex-associated, appears to take the form of a hydrodynamic or plasma vortex.

SOUNDS

12. Many sightings have been made when the ball makes no sound, while others have:

- Hissed (hence confusion with St. Elmo's fire)

- Exploded (after which they disappear either with a pop, a mild bang or a significant explosion)
- Possibly imploded
- Buzzed or 'fluttered'
- Sparked (when colliding with foliage, objects)
- Cracked.

These sounds occur quite separately from thunder or precipitation - in fact there may be no storm present. Termination often occurs after a colour change (see para. 15 below). Sometimes a residue is left after an explosion (no further information).

DURATION

13. The duration of ball lightning varies from a few seconds to several minutes. However, most seem to last for up to five seconds, with the longest on record as 15 minutes.

RADIATION - HEAT AND LIGHT

14. Almost all ball lightning reports are visual in the first instance. After they have disappeared (either peacefully or explosively), the observers recall the added features of sound (paragraph 12, above) and any damage caused, which is dealt with below at paras 20 to 22.

15. **Light** Attention is drawn to the phenomena visually, and although there are variations, most sightings fall into the categories of:

- Blue or blue/green
- Red (or pink/rose-pink)
- Red changing to white
- Violet changing to white
- Yellow
- Yellow changing to white
- White to red (observation on one occasion for 65 seconds)

Most sightings fall in the red or red/yellow category. They often disappear noisily after a

colour change. Some structures seem to favour certain colours. The main attributes are:

- Rod structures are often purple/violet
- Solid types (see para. 9) often appear as green/violet
- Rotating types can have a combination of colours
- Burning types are mostly red or red/yellow in appearance
- Colours described and classed as atmospheric luminescence
- Hovering or horizontal motion types are often red or red/yellow
- Predominantly red if 'floating'
- Blue or blue/white occurs on only 5% of reports
- Red or yellow types occur on 60% of reports, sometimes reported as being in a bluish envelope
- Less than 1% change colour
- Can emit sparks, fireworks-like
- Can leave behind smoke-colour trail
- Emit, on occasions, bright flashes
- Reported blue or white 'hollow'
- Leave behind a mist (seen as direct light) or blue or white (in reflected light) in moist air
- Smelly types leave behind a brown mist
- Colours may be pulsating.

16. **Heat** Reports both of intense heat and of no apparent heat can be found. The attributes reported are:

- Apparent colour on the surface and a hot core
- "Ball fell into water tank and boiled the water"
- Absence of heat, despite intense light
- ~1% (of those closer than 15m) were reported to emit heat

- Temperature emitted burns humans (see paragraph 20, below).

17. **EM Radiation** An intense E field, set up during storm conditions can charge sharp protrusions. This is thought to account for the attraction (often erratic darting movements) of globes/balls to sharp edges, pylons, fence etc. The presence of these fields causes sparking, incandescent traces (and radio interference/static). The electrical potential is quoted as $3-400\text{kVm}^{-1}$. Pyrotechnic 'streamers', like a fireworks 'burst', accompany the high potentials. EM radiation (E plus H fields) are present, but little magnetic (H field) measurement has been made. Radiation (measured as RF) in storms can be at 6kHz to 450MHz. When lightning is present the radiation is very wideband 100Hz-4000MHz, vertically polarised. The power present is reported to fall off as $1/r^2$. The logic for the radiation is considered at paragraph 23, below.

18. There is no indication of gamma radiation from either ball or bead lightning.

ODOURS

19. Odours are frequently present. Most are reported as:

- Sharp
- Repugnant
- Ozone-like
- Sulphurous
- Nitric oxide/dioxide
- Methane
- Burning.

It is known that an increased nitrogen level persists for long periods after passage of a lightning ball.

EFFECT ON HUMANS

20. Serious burns and other effects are reported. [It is of particular interest that many of these are similar to those reported by UAP observers]:

- Humans burned on hands, feet and arms etc. (This seems to be unpredictable/inconsistent as sometimes no heat is reported).
- Startling and fright (specially with noisy/explosive types of ball-lightning). Some effects of fright are reported in animals. Hairs bristle, dogs/cats cower, farm animals stampede in fields.
- Humans knocked over.

Potential electromagnetic mental effects on humans, separate from these other, more tangible physical effects, are considered at Working Paper No. 1 Annex F.

EFFECTS ON ENVIRONMENT

21 The following effects have been reported:

- Holes in the ground (reportedly up to 1m in diameter and over 1m deep)
- Furrows in the earth
- Trees uprooted
- Granite boulders broken/cracked
- Water boiled (see 'heat' above (para. 16) and discussion at para. 26 below)
- Electrically-excited atomic/molecular species, causing single and multiple atmospheric discharges and micro-discharges
- Charging of atmospheric dust particles
- Luminosity from water droplets
- Bio-luminescence and chemical luminescence/due to chemical reactions (not due to thermal sources)
- Production of visible light at room temperatures (and at other temperatures)
- Atmospheric trails/traces (usually terminating at the ball, or persisting afterwards). Pyrotechnic in appearance.

EFFECTS ON EQUIPMENTS

22 Apart from the reported 'static' on receiving equipment (see also EM Radiation (para. 17 above), example effects are:

- Attachment to power lines/electrical wires/pylons (but no effect on the system reported)
- Entry of 'balls' of various diameters into aircraft cabins
- Stopped (Russian) aircraft engine (1956)
- Military fighter destroyed (1948)
- Moved ahead of aircraft (Russian 1956)
- Russia (1959) caused 100° compass error.

The aircraft incidents above were at altitudes from 2500m to 3400m. Some general EM effects on equipment (not necessarily ball lightning) are also discussed at Working Paper No. 1 Annex D.

SUPPORTING THEORIES

23. No single theory seems to support all the criteria. The phenomena appears to be sighted only when one or more of the following are present:

- Charged particles or droplets
- High electrical charges in the atmosphere (not necessarily caused by lightning)
- When dust particles are generated (e.g. during volcanic activity)
- When high concentrations of nitrogen and ozone are created
- When marsh gas (methane) is given off
- Vortices (incandescent gas vortices).

24. Luminosity is observed from water droplets of opposite charges. The plasma (plasmoid) appears to be a mass of charged luminous material with sizes, structures and shapes as described, (at para. 27-30 below).

25. It is known that ball lightning is a natural electromagnetic radiation formation. However, it has been impossible to produce in the laboratory, unless the object has some sort of containment and, once formed, does not rely on external field(s) to maintain equilibrium.

26. There are several unusual features and questions:

- If the body is hot, why does it not rise?
- What constraints could be keeping it at level altitude (floating type)
- Is the plasma rotating? If so is this the means of storing it's energy?
- Is the spiral action (seen in vortices) due to the Earth's E and H fields.

27. The energy stored (E) must be proportional to volume, and E must be proportional to the cube of the cloud dimension. Similarly the light emitted is proportional to the surface area. Hence, the light is proportional to the square of a dimension. Plasma theory shows that a 10cm diameter ball could glow for 0.01 sec. The maximum energy which, in theory, could be stored in a ball appears to be less than could sustain it. In theory if the ball is lighter or heavier than air, then it should, respectively rise or fall. For equilibrium (hover or 'float') the ball density must be $1.29 \times 10^{-3} \text{ gm. cm.}^{-3}$.

28. To achieve colours, one associates this with temperatures:

Yellow	$\lambda = 5800 \text{ \AA} =$	5000°K
Red	$\lambda = 6300 \text{ \AA} =$	4600°K
Blue	$\lambda = 4700 \text{ \AA} =$	6200°K
White	-	10,000°K to 14000°K

This, of course, does not accord with the perception of colours reported when no heat is reported. It may be, of course, that, although present, no heat was felt/sensed for various reasons (e.g. long range, cooling wind, etc.)

29. The logic is that to glow for longer than the 0.01sec (at para. 27 above) energy must be received from somewhere.

30. The diameter of a spherical ionic plasma is determined by the resonance of the ball with the EM oscillations of the external wave at which energy absorption is most efficient. Resonance occurs when (for a sphere), the λ of the external radiation is 3.65 times the sphere diameter. To get typical ball

sizes reported, λ would have to be 35-100cm. Hence, the upper limit would be $3 \times 10^8 / 1 = 300\text{MHz}$ (whereas 30 and 50MHz are reported from microcharges). It should be noted that rarely are there any measurements from real ball lightning; any measurements quoted are from experiments attempting to simulate the phenomenon.

LABORATORY-PRODUCED BALL LIGHTNING

31. Many attempts have been made to produce ball lightning under laboratory conditions and it is reported¹ that (in the USA) it is routinely possible to produce a specific type of this phenomenon. Golka also claims that plasmoids can be produced by combustion inside a 'microwave oven'. However, it is not proposed that the ball lightning generated accounts for all types. In the experiments the fireballs lasted from two to five seconds but with only diameters of ~1cm. This has been achieved by short-circuiting 60Hz currents as low as 1200A across copper and aluminium electrodes under ~2cm of water. Another researcher (Silberg, unreferenced) describes how this phenomenon, produced green fireballs in a submarine engine room, using 260 Volts and 156,000 Amperes. Ball diameter was 6 to 10cm. For a 10cm diameter ball (volume 515cm^3) there are 1.4×10^{23} molecules. When the medium (used in the switching contacts) is nitrogen and an ionisation energy of 15eV per ion pair for the single ionisation, it can be calculated that there must be 3.4×10^4 Joules contained in the ball. The ball quickly disperses unless a source of replenishment energy is present.

32. The fireballs produced rise to the surface and remain until exhausted, 1-2KJ of energy having been deposited. The type of lightning balls produced are reported to be similar to those observed in aircraft during flight and, strangely, in submarines during WWII. With higher power the 'ball' can be made to travel higher from the surface and 'bounce' and 'dance'. It is postulated that the

more power applied, the larger the diameter which may be produced. Hence, the phenomenon might be scaleable.

33. Other characteristics clearly depend on the materials and size of the electrodes and their burning temperature when a tremendous energy level is applied to a very small surface area. For aluminium this is of the order 4400°F. As might be expected, as the fireballs surface they sizzle and hiss, some leave the surface and produce spiralling smoke trails, leading to the supposition that the fireballs are spinning (see below). Different electrode types produce more or less smoke. Those remaining on the water exhibit random motion until they decay.

34. Experiments were only made with the electrodes under water because this method enabled measurements to be made before the fireballs darted off in all directions, making measurements difficult. Whereas previous researchers had expected high voltages to be a prime requirement, these experiments were made at 40-50 volts. Even so, enough energy overall was deposited on occasions to make the balls leave the surface of the experimental tank and leap onto the floor.

35. Aluminium electrodes produce white fireballs, while iron-to-iron electrodes produce yellow. Either the outer surface or the kernel appears to be spinning. As soon as the ball stops emitting light, it shrinks to sugar-grain size. If over water these particles sink.

36. It is postulated that if the sphere is spinning a boundary layer phenomena will be set up, retarding thermal radiation in the same way that the filament of an incandescent lamp forms sheath layers which keep the filament at a higher temperature.

37. As a result of these experiments the author suggests that, as ball lightning has only very rarely been reported inside pressurised aircraft, that the product of the balls was due to natural lightning attachment to the aircraft skin forming a small hole (at 4400°F) with consequent formation of a plasma ball on the inside of the aircraft.

¹ "Laboratory-Produced Ball Lightning"

R.K. Golka, Journal of Geophysical Research Vol. 99 No. D5 May 20 1994.

PLASMOID

38. A plasmoid is postulated as formed by a small volume of plasma (small as compared with $\frac{\pi d^2}{6}$), where d is the diameter of the final ball. The energy is formed by RF at $\lambda/3.65d$, and ionisation grows - but eventually becomes stabilised and expands but eventually deviates from resonance and cools and returns to $d=\lambda/3.65$. A weak shock is formed on collapse when the RF energy is cut off suddenly - but if the RF field reduces gradually the extinction progress becomes smooth and noiseless. It is reported that spherical plasmoid shapes can be sustained by RF energy at low pressure, and the concept of a phase-locked loop of EM radiation at a wavelength stable to the circumstances previously has also been suggested. It is suggested, in this instance, that the stable standing wave excites the ambient gases to glow and that the colour is dependent on the constituents, such as dust etc. in suspension. In some cases it is claimed that ball lightning has the ability to absorb light, hence it can be grey or black in appearance.

- Ball Lightning
- sometimes has glowing tentacles
 - rapid rotation of sphere despite slow linear path motion
 - light given off can which is ascribed to electronic excitation

It is theorised (Ashby and Whitehead, Aldermaston 1971), following the collection of remotely sensed signals during thunderstorms, that because gamma-ray levels soared dramatically (X50), on several occasions (for several seconds) that more complex explanations than hitherto might be responsible for the plasma production - perhaps involving minute particles of anti-matter (micrometeorites). However, it is not clear how the plasmas remain in suspension or even enter aircraft on occasions - a well documented occurrence by multiple witnesses.

AURORAL LOOPS

39. **Ball Light Ozone Spheres** The gravitational force on a sphere of ozone a metre in diameter is 430g and it would descend. A 0.5m diameter sphere would experience a force of 54g. If the sphere was visible ozone, on sudden expansion when conversion occurs to oxygen (20 litres for a 50cm sphere of ozone), it produces explosive energy. Ozone is the only gas denser than air produced in quantity under stress in air, as distinct from production from a streaming spark discharge. The earth's surface and ozone spheres are both generally negatively charged. Although blue in colour, if nitrogen is present the explosion colour is yellow.

40. **Power Intensive Plasma Formations (PPFs)** In the search for the key characteristics of ball (and bead) lightning PPFs, a related phenomenon appeared to show some further similarities to UAP reports; of which the most relevant are:

- PPF dimensions extend to tens of cm.
- They can disappear in one point of space and simultaneously appear in another.
- Sound propagation speeds in PPF are much higher than the speed of sound in gas and may reach 1600 ms^{-1} .
- The plasma temperature inside is $<1000^\circ\text{K}$.
- PPFs can burn metals leaving holes (but not affect dielectric material).
- PPFs do not disturb the gases they pass through in movement.

Large PPFs (e.g. 1m diameter) are known as METEOXTRONES. Working papers 19, 21 and 24 describe other types of atmospheric plasmas.

BALL LIGHTNING AND AIRCRAFT

41. The reported incidences of ball lightning 'flying' ahead or behind aircraft have brought about some investigations into the expected characteristics of ball in the aircraft airstream. It seems likely that the incidence of sightings of 'foo fighters' (as they became known in World War 2) would increase, purely

because of the huge numbers of aircraft flying - certainly much more night flying than had been carried out in the short history of manned flight.

42. It is stated that large radius ball lightning (similar plasma bodies) can 'chase' aircraft while maintaining shape and more or less constant distance from the aircraft. The 'ball' is able to do so because it is not solid (otherwise a thrust force of thousands of Kg would be needed)! It is postulated that the layer of air adjacent to the surface of the ball loses its viscous properties. The ball follows the aircraft even in manoeuvres. Observations of ball lightning show that its characteristics do not change appreciably during its lifetime. When it is in the airstream of an aircraft it is postulated that it behaves as a non-deformable solid sphere in the airflow which holds its position due to the electrical/magnetic charges, described elsewhere in this Working Paper. The main reason for interest in close encounters of aircraft with ball lightning is one of flight safety. It is reported that large balls can be comparable with body diameter of large aircraft and can be 'captured' by the exhaust from engines and 'chase' the aircraft at a velocity of $150-200\text{m.s}^{-1}$ (278-370kts), maintaining an apparent constant range from the tail assembly.

43. One (TU134) pilot reported that at an altitude of 10,000ft and flying at a velocity of 800km hr^{-1} ($\sim 220\text{ms}^{-1}$), the ball (in this case green) "appeared as though tethered behind the aircraft". Another (Russian) crew report, when flying at 7500ft altitude were 'followed' by a huge ball which was still in 'pursuit' after a fast descent to 4500ft. It refused to leave despite manoeuvre - which was limited for an airliner.

44. If the moving object were solid it would take the force of many Newtons to make it follow an aircraft. Clearly the ball is sensibly weightless (apart from the mass of the gases it contains). It is believed that the electrical charge of the ball diminishes as ionisation of the air-layer in contact with its surface occurs. The USSR treated the ball lightning phenomenon as very important and

Gaidukov [3] reported after modelling the interaction that:

- All efforts should be made to avoid lightning seen ahead (before a ball is formed).
- To avoid the chance of an encounter with a ball, pilots should 'encircle around a vertical line passing through the centre of the lightning'.
- Pendulum-like undulations in altitude may be seen (by balls ahead), and every effort should be made to place the ball astern, where it will assume a stable position.
- The balls cannot 'catch up' the aircraft once the pilot has ensured that the ball is astern.
- The ball will dissipate. Reports of 10km (tail chase!) are not unusual.

45. Several comments can be made:

- (a) The instances of phenomena of ball lightning ahead of, or behind, aircraft is relatively rare, but the Russian research suggests, apart from initial lightning avoidance, that the aircraft would be safe with the ball astern.
- (b) Reports of balls above aircraft 'pushing or forcing' an aircraft to descend are of concern, even if the ball does not cause physical damage its presence is clearly menacing to the uninitiated - especially as it occurs suddenly.
- (c) A 'collision' from astern is not considered likely.
- (d) A 'collision' head-on is possible and its imminence might cause violent pilot (control) reaction even though the contact may not (at the last moment) have actually occurred.

The 'stand off' of the ball lightning from an aircraft seems to be very much like the situation encountered in several scenarios where pilots have been scrambled to investigate 'UFO' sightings. A scenario where this occurs not only involves the 'stand-off' described here

but also the 'black' centre described, below, at para. 48

PLASMA SHAPE CHANGES AND SIZE

46 It can be argued that the buoyancy of the plasma is balanced by charged ion droplet mass, with the actual shape make-up dependent on the distribution of forces within the ball. Although some have suggested that the oval shapes occasionally reported are due, not to the mass of the droplets/particles (which gravity may pull into a pear shape, individually), but to the presence of a strong D.C. field, elongating the ball in the field direction. It is believed that the production of nitric acid (note the section on nitrous smells) leads to an inflow of air which aids ball stability. The size of the ball seems to be determined at its creation[4] and it is believed the cycle of change in electric field, of ion production, of water demand, and then evaporation might change the temperature gradient in the ball but not its size. In the many attempts to develop a theory to explain ball lightning (and by so doing possibly understanding the 'earthlights' phenomenon), it is always postulated that a source of energy is essential within the phenomenon for it to exist and be sustained. It has been difficult to apply recognised theory, although at the turn of the century it was recognised that Maxwell's equations could be generalised to include magnetic charge and current as the mirror-partners to electric charge and electric current. Since then 'new physics', has postulated the 'magnetic photon' as a corollary to the more widely known conventional optical photon. Hence, some theories concerning the ball lightning phenomenon have developed using the 'magnetic photon' and 'magnetic charge'. 'Vortons', in turn, are postulated to occur in pairs and create a rotating magnetic field. [Comment: This is of particular significance when related to the discovery that humans exposed to rotating magnetic fields can produce responses strikingly similar to those reported from close encounters with a UAP].

SURVEY OF COLOURS

47. Smirnov² analysed over 4100 ball/bead reports (indicating that the Former Soviet Union must have a considerable database on UAP-type topics). The total power radiated by a black body obeys the Stephen-Boltzmann Law of proportionality to the fourth power of temperature and in 4112 samples the temperatures produced the following statistical colour distribution:

White	20.4%
Red/Pink	17.7%
Orange	23.1%
Yellow	20.2%
Green	1.4%
Blue/Violet	11.4%
Mixed Colours	5.3%

From this it can be seen that for the atmospheric luminous phenomenon seen as a ball, there is around an 80% likelihood of the ball (or bead) colour being either white, Red/Pink, Orange or Yellow and around a 20% chance of it being one of these four options, rather than green, blue or mixed.

An apparent paradox in the understanding of the intensity (and hence colours) has been that the calculated radiant power (using colour temperature to determine intensity) has resulted in intensities that seem to be far too large to be in agreement with actual observations of heat and light. One of the later theories resolves this by suggesting that the vortons (see para. 46 above), moving as a gas, exhibit positive Doppler shifts of the radiant black-body energy to a higher colour temperature (moving towards the observer) and to a lower colour temperature for movement away. Variable cloud shapes other than balls can occur, it is claimed, if a ferromagnetic-like interaction of the dipole forces of the individual vortons occurs.

² Smirnov B.M. Sov. Phys. USP 35 650 (1992) and Phys Rep No. 224 151 (1993)

OPTICAL 'THICKNESS' OF BLACK BODY RADIATORS

48. A supportable theory suggests that some balls have a coherent core which is too cool to radiate in the optical visible spectrum - hence such a volume would appear totally black. The visible appearance of the phenomenon depends on optical 'thickness', where:

- If the body (of gases/particles??) is hot enough to radiate, then its intensity is uniform over the surface; independent of the angle the surface makes with the sightline of the observer.
- When the radiator is too cold to radiate a significant amount of energy in the optical region, it will completely absorb any optical radiation which falls on it and hence would be 'seen' as a totally black object.

NOTE: This later statement would seem to have a significant read-across to frequent UAP sightings where a black shape (often rectangular or triangular) is seen between visible lights at the extremities. Although, Black and grey-body radiators are, respectively, 'thick' and 'thin' optical sources.

THERMO-CHEMICAL REFRIGERATION

49. Considerable evidence exists to show that the incidence of ball lightning, especially with a longer lifetime, is higher when conditions of high humidity are present. Further, because of rapid ion motion and a higher temperature than the surrounding air, ions escaping from the plasma become hydrated and this action adds heat to the system; keeping the hydration zone (boundary) fairly hot. However, if the ions survive long enough to become hydrated by ~5 water molecules it is postulated that cooling occurs. To this thermochemical action is attributed the characteristics of the reported harmlessness of occasional human brushing contact with a ball and the reason for the cloudiness/indistinct appearance of the edges of the ball.

SUMMARY OF BALL LIGHTNING CHARACTERISTICS

50. A survey of literature on ball and bead lightning and its relevance to UAP reports, has shown that:

- There is a near constant brightness, size and shape, which can exist from a few seconds to minutes.
- The balls/beads have considerable mobility.
- It is possible for an electronically-charged body (possibly including ball lightning) to 'attach itself' to an aircraft in flight; where, apparently due to a balance of fields (electrostatic/magnetic or EM), it can remain in close proximity (formation abreast or astern).
- Ball lightning can enter houses and structures including aircraft and can actually exist within closed metal structures
- Sounds and smells are present on rare occasions. These are both often described, respectively, as 'electrical' (e.g. buzzing sounds, or explosions) and smells witnesses associate with electrical equipment, such as insulators overheating or rotten eggs.

51. **Near Terrestrial Events** There is a tendency for ball lightning not to rise - most sightings remain at low level near the earth in a near horizontal path. This is explained, in theory, in the reasonable expectation that the balance of charges between the ball in its environment (either indoors or outdoors) is such that the postulated radially-moving negative ions form a static charge on nearby surfaces which tend to repel the negative body of the ball; keeping it at a distance. This, it is argued, is the most likely reason for the balls to reportedly try to pass through any aperture (i.e. window, door, chimney). In short, as it moves it creates a field which tends to hold the ball in position (e.g. at constant altitude outdoors, or across the centre of a room. Further, since no charge builds on the aperture, the ball can proceed - presumably sending a positive charge somewhere ahead. This may also account for

the propensity of balls to 'dart' towards power cables or any object where the radial does not exceed the local positive value.

52. In-Structure Phenomena The fact that the plasma phenomena can reportedly exist in closed metal structures suggests that, contrary to expectations, the existence of the ball is apparently not dependent on an external source but must retain its own electric or magnetic field in order to exist and, once formed, is self-sustaining until its demise. Within the past year some researchers have suggested that atmospheric plasmas may owe their duration to a combination of both vertical and horizontal (i.e. orthogonal) magnetic looped fields which contain and sustain the phenomena. If this is the case the process may be applicable to any atmospheric plasma - however formed, if the field are strong enough. It has been proposed [6] that the stability of a volume (ball) of air at 16,000 to 30,000 degrees Kelvin might be contained within linked magnetic lines. Discharge arcs (e.g. lightning) advance along narrow tracks 50-100µm in diameter in air. These streamers would only occupy a small volume of the ball. It is postulated that some of these form short circuits, resulting in circulating currents, each loop acting as a coil. the physical appearance of the charge-contained ball would be shining and diffused. It can be shown by Maxwell's equations that a 'magnetic knot' is feasible and this has now been observed under laboratory conditions. The conducted energy cannot be stationary and is postulated to produce a slowly-varying magnetic field. The magnetic energy is a function of the ball radius, the vacuum magnetic permeability, the number of magnetic lines which are linked and a field normalising function. It is not within the scope of this study to pursue this important phenomenon further, other than to emphasise the likely connection between this, the formation of plasmas by meteors and the effects of varying magnetic fields on humans (Working Paper No 25), in the UAP context.

53. Demise For those balls/beads visible to humans it is reported that the silent demise is normally a simple fade in brightness and diameter, while the explosive demise is sometimes preceded by an increase in brightness and a colour change. Similarly,

plasmas of other origins than ball or bead lightning may also decay in the same way. Hence, in the UAP sighting reports it is almost impossible to determine the origin of a particular UAP because, it is believed, the behaviour is very similar. Further, if the premise that meteors (see Working Papers and statistical results at Volume 1) also cause the formation of UAP, then a UAP could be formed during a thunderstorm (as well as from ball or bead lightning) and similarly persist afterwards.

SUMMARY - RELEVANCE TO UAP

54. An examination of a wide range of research into ball and bead lightning has shown that it is certainly connected with a proportion of the UAP reports received from within the UK airspace. Descriptions of these particular forms of lightning correlate in time, colour and motion with qualitative description often given by reliable UAP witnesses. Because those UAP which are formed and then reported as a result of lightning are, of course, transitory in nature and their form is apparently changing as they head towards demise, it is reasonable that the colour descriptions vary, that they exhibit strongly influential electrical field characteristics, exceptional motion and pyrotechnic displays. All of which are unfamiliar to the majority of the population.

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WORKING PAPER NO. 3

POTENTIAL REASONS FOR HIGHER DENSITIES OF UAP SIGHTINGS

	Para	Page
INTRODUCTION	1	3-1
POPULATION DENSITY	4	3-1
WEATHER/VISIBILITY	5	3-1
TIME OF YEAR	6	3-1
TIME OF DAY	7	3-2
LOCATION	8	3-2
AVAILABILITY AND COMPETENCY OF WITNESSES	9	3-3
HIGH INCIDENCE LOCATIONS	12	3-3
AIR CONTAMINATION	15	3-4

POTENTIAL REASONS FOR HIGHER DENSITIES OF UAP SIGHTINGS

February 1, 2000

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POTENTIAL REASONS FOR HIGHER DENSITIES OF UAP SIGHTINGS

INTRODUCTION

1. In the current database analysis it has been important not to misinterpret the reasons for UAP occurrences, by drawing the wrong inferences from a statistical analysis. One of the first analyses was to ascertain the density of UAP sightings across UK aerospace to look for high incidence areas - in the hope/possibility that this may shed some light on the nature of the phenomena, lead to more focused scientific work and possibly to obtain more data when sightings occur (e.g. correlation of visual sightings with coincident radar coverage). As the unknown is being investigated, preconceptions are no part of initial assumptions.

2. Taking the extreme case - that UAP are more than natural occurrences - it cannot be assumed that locations where the objects occur will necessarily be of obvious importance to humans. Further, it cannot be ruled out that these appearances may only take place at certain intervals and be entirely unrelated to our concept of time. They may even be related to the relative disposition of the gravitational fields of various bodies in space, or even of other fields of which we may have scant or even no knowledge at present.

3. On the initial assumption that the phenomena of a UAP sighting can occur anywhere, then the presence of larger numbers of sightings in a particular part of UK will be dependent, at first sight, upon:

- (a) The population density
- (b) The weather/visibility
- (c) The time of year
- (d) The time of day
- (e) The location
- (f) Availability and competence of witnesses.

POPULATION DENSITY

4. It would seem logical that if there are a greater number of potential observers, and on the assumption of an equal probability (i.e. equal distribution of UAPs in the UK air space), then sighting clusters could be expected to occur in more highly populated areas. However, in areas of greater population there is also a much higher night-time background lighting level, making observation of flying objects much less likely to be seen (as evidenced by astronomical observatories, which have been forced to move away from lit-up areas). The contrary situation is that more sparsely populated areas have fewer potential observers, but little or no interference from ambient surface lighting. It is thus difficult to immediately connect the number of potential observers available in a geographical area against the likelihood of expectation of UAP sightings, since other factors are present. As an initial guide Table 1 shows the population distribution for the UKADR¹.

WEATHER/VISIBILITY

5. A brief analysis to determine the relative prevalence of sightings in cyclonic and anti-cyclonic conditions has been made. There was no clear evidence of correlation with temperature, dew point, wind, etc. However, the continued prevalence of UAP reports whether thunder (i.e. Lightning, as a prerequisite - see Working Paper No 2) was present or not on the same day in the same area was of particular importance in an attempt to discover whether atmospheric conditions are key to the formation of UAP. However, adequately clear visibility for viewing low and

¹ Oceania World Index Johan van der Heijden
1996

medium altitude UAPs can exist in both weather patterns; although the high pressure clear conditions, rather than the misty conditions in high pressure are likely to provide the best viewing conditions. There is, nevertheless, a possibility that UAP sightings might be connected to weather patterns.

TIME OF YEAR

6. It is instinctive to imagine a larger number of reported sightings during dusk and darkness - simply because the greatest number of reports are ones where 'lights' are seen - and this is rarely the case reported in daylight. Of course, this does not necessarily mean that there are fewer UAPs present during daylight (assuming that their occurrence is indifferent to the presence or absence of light). [Since we do not know what they are we cannot assume any attributes]. In addition to weather, it may be shown that the electrostatic and electromagnetic nature of the atmosphere correlates with sightings (see Working Papers No. 1, 2 and 10). It is known that sightings occur in the vicinity of volcanic activity - possibly connected with the presence of electrical charges caused by particle friction in the dust which is present and its velocity. The potential connection between UAP and ball lightning are summarised at Working Paper No 2.

TIME OF DAY

7. Although a time-of-day connection with UAP reports is inevitable because of the relative daylight and darkness viewing conditions for 'lights' in the sky, the actual occurrence of the total of these phenomena, within the atmosphere at any given time may not be time-dependent. One must not fall into the trap of assuming that the presence of unexplained objects in the atmosphere (or in near space) is necessarily connected to our world measurement cycle of time or that the rate of occurrence is somehow connected to the routine of life. As this study only involves sightings within the UK's airspace, this investigation will not be in a position to

correlate UK sightings with successive sightings (if they were reported or even if they were present) in Europe or over Ireland, in the Atlantic, North Sea or Bay of Biscay. However, if there is shown to be a cycle of sightings, we shall have no other option than to measure it in terms of time as we know it. If, for example, this (to our eyes) appears to recur at regular intervals, the problem will then be to fit this time period to a meaningful pattern, perhaps sidereal. It may, of course, be shown not to fit any known pattern (e.g. celestial, seasonal, etc).

LOCATION

8. It is sometimes claimed that UAP sightings are more likely to occur in some locations than others. Apart from the volcanic connection, claimed by some observers (clearly not applicable to UKADGE), it has been suggested that the location list at the database (Table UAP-2, Volume 1) may be connected with sightings. Before useful statistical work can be done on locations, the following must be considered for a rigorous analysis to be made:

- (a) The location of a sighting is often given crudely. A 'place name', 'near a place', 'between two places', 'out to sea off xxxx', 'on holiday near xxxx'. The address of the witness may not be the location of the sighting.
- (b) Lat/Long co-ordinates and Grid References are rare (but could be generated approximately from most of the witness reports).
- (c) Post codes might be a good method.
- (d) Plots (maps) of the following are required in electronic form:
 - National Grid/Local Power lines down to main sub-station level
 - Airfields - Civil
 - Airfields - Military/Experimental Establishments
 - Air corridors

- Low Flying Routes for Military Aircraft
- National strategic sites
- Power Stations (including nuclear)
- Locations of ancient monuments/fault lines (to investigate the claim of heightened probability of UAP sightings electromagnetic/gravity/earth's field changes claimed at these sites).

AVAILABILITY AND COMPETENCY OF WITNESSES

9. Clearly only a proportion of UAP phenomena is reported. There is no way of ascertaining what proportion this may be. It can only happen where people are present, therefore there may be large areas of the UK, with high UAP activity, but never seen or reported. The phenomenon of the lack of radar correlations is considered at Working Paper No. 10 and at Volume 3 for specific in-service systems.

10. The decision to report activity depends on the witness. The more 'responsible' are likely to do so because the UAP sighting is a unique event in most cases: it has caused fright or concern and there is a 'need' to tell someone in authority. Because the sighting is 'airborne' the preferred reporting option is the nearest RAF Station, followed by the coastguard or the police. Dating of reports compared with sighting dates clearly indicates that some witnesses often wait a day before making a report. [As for all delayed reports there is always the possibility of forgetfulness on detail or embellishment!]. Many witnesses delay because of concern about their credibility. A comprehensive report is not usually obtained from the very basic UAP (UFO) reporting form - and the accuracy and detail obtained from a witness depend significantly on the attitude and care taken by the police or other reporting authority. Hence, there is no reliable consistency of reporting - even from the ATC/CAA sources.

11. It is wrong to separate so-called competent/reliable witnesses from others because every scrap of evidence has the potential of being important. For example several single-witness crude sightings can complement a 'reliable' sighting, since these extra sightings:

- Allow multiple angle/aspects to be registered
- Allow object velocities, colours, altitudes and sizes to be established independently
- Allow geometry to be used to eliminate heavenly bodies (i.e. planet sightings)
- Allow both silhouette as well as reflected-light viewing
- Allow multi-aspect viewing to ascertain shape, colour and flight profile
- Eliminate the retained after-image sighting of single witnesses - so establishing true sighting times
- Confirmed UAP geometries and spacings independently.
- Eliminate single-human events (e.g. occult, drugs, psychological etc.)
- Usually eliminate the hoax option
- Reinforce credibility of each others reports from a group of independent witnesses
- Allows multiple photography/video to be taken.

HIGH INCIDENCE LOCATIONS

12. Within the UKADR it is reported by researchers that the greatest incidence of UAP events are centred on:

- Lothian (Scotland)
- Luce Bay (Scotland)
- South Wales
- Warminster (S. England)
- Pennine Hills

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13. Elsewhere in the world concentrations of events occur at 20 prime general locations. These, include France, Belgium and Scandinavia - all which have airspace adjacent to the UKADR

14. Hence, reports are sometimes received of UAPs entering from, or leaving towards, these nations. Only NE Italy and Spain are among the other NATO nations reporting large numbers of sightings (although these are not shared or reported through official channels to UK MOD).

AIR CONTAMINATION

15. It is postulated by some plasma and other atmospheric researchers that the presence of

particles (from whatever sources), as well as the introduction of various industrial gases, will affect the conditions for the formation of atmospheric plasmas. This is considered further in the relevant Working Papers, principally Number 19. It is noted, in passing, that those nations with higher atmospheric dust-producing conditions (e.g. Volcanic and Earthquake Regions), reportedly have a high incidence of UAP reports. Further, if this theory is true, one would expect to find more UK reports at, or close to, centres of the older smoke or gas producing industries and possibly nearer to areas such as airports where exhaust particles of various types are likely to be in higher concentration.

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FIGURE 1: HIGH INCIDENCE UAP LOCATIONS (J. RANGLES)

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		area in km ²	population census 1991
Avon	Bristol	1,346	920,000
Bedfordshire	Bedford	1,235	514,000
Berkshire	Reading	1,259	717,000
Buckinghamshire	Aylesbury	1,883	620,000
Cambridgeshire	Cambridge	3,409	641,000
Cheshire	Chester	2,329	937,000
Cleveland	Middlesbrough	583	541,000
Cornwall	Truro	3,564	469,000
Cumbria	Carlisle	6,810	487,000
Derbyshire	Matlock	2,631	915,000
Devon	Exeter	6,711	998,000
Dorset	Dorchester	2,654	645,000
Durham	Durham	2,436	590,000
East Sussex	Lewes	1,795	671,000
Essex	Chelmsford	3,672	1,496,000
Gloucestershire	Gloucester	2,643	521,000
Greater London	London	1,579	6,378,000
Greater Manchester	Manchester	1,287	2,456,000
Hampshire	Winchester	3,777	1,512,000
Hereford & Worcester	Worcester	3,927	668,000
Hertfordshire	Hertford	1,634	952,000
Humberside	Hull	3,512	835,000
Isle of Wight	Newport	381	127,000
Kent	Maidstone	3,731	1,485,000
Lancashire	Preston	3,064	1,365,000
Leicestershire	Leicester	2,553	861,000
Lincolnshire	Lincoln	5,915	574,000
Merseyside	Liverpool	652	1,377,000
Norfolk	Norwich	5,368	736,000
Northamptonshire	Northampton	2,367	573,000
Tyne & Wear	Newcastle	5,032	301,000

TABLE 1(A): POPULATION DISTRIBUTION UKADR

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Southend on Sea	153,700
Peterborough	148,800
Blackpool	144,500
Colchester	141,100
Brighton	133,400
Blackburn	132,800
Poole	130,900
Newport	129,900
Preston	126,200
Reading	122,600
Torbay (Torquay)	122,500
Saint Albans	122,400
Norwich	121,100
Ipswich	115,500
Oxford	109,000
Exeter	101,100
York	100,600

North Yorkshire	Northallerton	8,309	699,000
Nottinghamshire	Nottingham	2,164	981,000
Oxfordshire	Oxford	2,608	554,000
Shropshire	Shrewsbury	3,490	402,000
Somerset	Taunton	3,451	459,000
South Yorkshire	Barnsley	1,560	1,249,000
Staffordshire	Stafford	2,716	1,020,000
Suffolk	Ipswich	3,797	630,000
Surrey	Kingston	1,679	998,000
Tyne and Wear	Newcastle	540	1,087,000
Warwickshire	Warwick	1,981	477,000
West Midlands	Birmingham	899	2,499,000
West Sussex	Chichester	1,989	693,000
West Yorkshire	Wakefield	2,039	1,985,000
Wiltshire	Trowbridge	3,480	553,000
Total England	London	130,439	46,168,000

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cities	population 1991
London	6,803,100
Birmingham	934,900
Leeds	674,400
Glasgow	654,542
Sheffield	500,500
Bradford	449,100
Liverpool	448,300
Manchester	432,600
Edinburgh	421,213
Bristol	370,300
Huddersfield	367,600
Dudley	300,400
Coventry	292,600
Sunderland	286,800
Belfast	279,237
Cardiff	272,600
Leicester	270,600
Newcastle	263,000
Nottingham	261,500
Walsall	255,600
Bolton	253,300
Kingston upon Hull	252,200
Rotherham	247,100
Stoke on Trent	244,800
Wolverhampton	239,800
Plymouth	238,800
Derby	214,000
Aberdeen	201,099
Southampton	194,400
Swansea	182,100
Northampton	178,200
Saint Helens	175,300
Portsmouth	174,700
Luton	167,300
Dundee	165,548
Bournemouth	154,400

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Borders	Newtown St.Boswells	4,698	103,000
Central	Stirling	2,700	268,000
Dumfries and Galloway	Dumfries	6,425	147,000
Fife	Glenrothes	1,319	339,000
Grampian	Aberdeen	8,752	493,000
Highland	Inverness	26,137	209,000
Lothian	Edinburgh	1,770	724,000
Strathclyde	Glasgow	13,773	2,218,000
Tayside	Dundee	7,643	385,000
Island Areas	-	5,566	71,000
Total Scotland	Edinburgh	78,783	4,957,000

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DIS SCIENTIFIC & TECHNICAL MEMORANDUM 55/2/00

WORKING PAPER NO. 4

AFTER-IMAGES AS A RESULT OF FLASHES OF LIGHT

	Para	Page
BACKGROUND	1	4-1
Primary Sensation	3	4-1
Results of Experiments	4	4-1
Flash Duration Dependency	6	4-2
Observer Variability	8	4-2
SUMMARY	9	4-2
RELEVANCE TO UAP SIGHTINGS	10	4-2

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AFTER-IMAGES AS A RESULT OF FLASHES OF LIGHT

BACKGROUND

1. Illusions observed in darkness or low light conditions, after exposure of one or more eyes to a bright light are known as 'positive after-images' and are often similar in colour to the inducing light. Those illusions seen in moderate illumination are called 'negative after images' and are often of the approximation to complementary colours. In practice the actual appearance of after-images is complex and likely to depend on many factors. However, adaptation from dark to light takes much less time than from light to dark - hence there is an awareness of the appearance of a light in dark conditions much more quickly than the appearance of a shadow in lighter conditions. Excessive eye stimulation, as is well known, produces blindness in the limit.

2. Within the eye the sequence of changes which occur in reception after light is absorbed differs between rods and cones, classes of cones, and suffers further adaptation by the nerve cells of the retina and of the brain. However, the result is the persistence of the sensation of light after the stimulus has been removed.

3. **Primary Sensation** Human eye response is from $\lambda = 0.4$ to $\lambda = 0.7\mu\text{m}$ with an unaided peak at $0.55\mu\text{m}$; and a detectability from $10^{-6} \text{ cd.m}^{-2}$ to 5000 cd.m^{-2} . There is a range of conditions over which the primary sensation produced by a flash of light depends on its luminance-time product (i.e. in general, the integration of luminance with respect to time). This is independent of temporal distribution. This was proved experimentally by regularly repeated flashes as long as 150 years ago and confirmed this century using extremely short flash durations now possible. The practice holds for flash values down to $\sim 4 \times 10^{-7} \text{ sec}$ and is considered valid for high intensities. For longer duration flashes the measurements are less researched. Hence, the integration of flashes is less reliable as a guide

at an illumination intensity of 0.5 cd.m^{-2} at which pulse durations of 27 millisecon may be the eye integration limit (3° fovea fov). The time duration may be greater than 27 millisecon for dimmer flashes and shorter in period for those which are brighter.

4. **Results of Experiments** Preliminary experiments [1] to investigate after-image conditions for eye stimuli of different lengths produced the following results:

- Stimuli ~ 2 sec maximum. The whole course of the (positive or negative) after image, excluding its first 15 sec, was dependent on total light in the stimulus and not on the light's intensity distribution in time.
- Stimuli 2-5 sec. The result only differed slightly from the 2 sec stimuli length above, but with some time distribution differences. In particular, there were some differences between positive (dark background) and negative (bright background) after-images.
- In the after-image observation time $t=10$ to $t=30$ it is believed that the retinal illumination decays exponentially (from white light stimuli), but the after-images caused by other colours may decay at other rates. The actual detection threshold is inversely proportional to flash duration.

5. The human eye can nevertheless distinguish between extremely short spaces between flashes (pulses of light). Experiments have shown that 4 millisecon intervals can be distinguished from intervals as little as 0.28 millisecon. Hence, in the context of UAP observations, pulsed (i.e. modulated) lights should be distinguishable by observers, even with very short durations - and should not get mis-reported as steady lights. This is

important, for example, in the context of lights which are 'chopped' by helicopter blades (~50Hz for a main rotor four-bladed Helo).

6. **Flash Duration Dependency** An important finding is that a given amount of light produces the same after-image (except for the first 15 sec), irrespective of whether it is delivered within 15.7 millisecond or spread over 1.68 sec. This, is consistent with the hypothesis that the after-images of a brief stimulus from the 15th second until its disappearance at $t=100$ to 300 seconds later, depends upon photochemical effects. It does not depend upon adaptation or neural mechanisms in the retina or brain (as a result of the activity it is presumed the brain undertakes immediately after an eye stimulus).

7. It is probable, from the evidence available, that, after the first 15 seconds, neural effects contribute to the perception of the image seen. Up to five seconds after a stimulus (flash) it is nevertheless believed that neural as well as retinal (chemical) image perceptions are formed particularly if the event is from an unexpected source. At $t=10$ seconds the after-images are nearly alike (when using the alternatives used for experimentation). By 15 seconds they are seen as alike.

8. **Observer Variability** Observer contrast, for 50% probability of detection (against a plain background), is a function of object luminance, size of illuminated field, object size, edge sharpness, shape, time seen, position in field of view, colour, motion and experience. Detection thresholds are largely independent of shape up to an expected ratio of 7:1.

SUMMARY OF RESULTS

9. Based on the limited data available; to a first order level:

- After-images in the eye are based on the total amount of light available, independent of time.

- The persistence depends on the chemical consequences in the eye's receptors, not in (5-10 sec case) the adaptation of the image by the nerves/brain response.
- For very short flashes (e.g. less than 4 millisecond) high intensities have more effect than lower intensity stimuli when viewed against either bright or dim backgrounds.
- Colours observed following a flash of a particular colour are dependent on the viewing background thereafter.

RELEVANCE TO UAP SIGHTINGS

10. A large number of UAP reports are of very intense lights of diverse colours, some of which are only reported as being of very short duration. Some of these could be the after-images of even briefer flashes. Longer duration reports apparently (see para. 6) of up to five minutes in duration, could be attributed to flash stimuli, followed by an after-image. It would appear that sightings are unlikely to be caused by after images for longer than five minutes. After 10-15 seconds the human involved will be interpreting and adapting what is seen well beyond what is actually registered chemically, due to the flash, within the retina.

11. There is, of course, the possibility of the after-image being 'replenished' by successive intense flashes. However, many flashes are separate (i.e. single) events, e.g. lighting, unexpected (i.e. non-continuous) electrical flash-over from (national grid) power lines or overhead train power lines.

12. It seems unlikely that, on the occasion of multiple witnesses of UAPs, that they will all receive the same phenomena (after-image); since apart from human observer variability in eyesight, it is unlikely that they would all receive the same stimulus at the same time unless they were located very close together.

[1] "Discrimination of After-Images" G.S. Brindley, J. Physiology 147 (1959).

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- [2] "Further Studies of the Positive Visual
After-Image C.A. Padgham Opt. Acta
Vol. 4 1959.

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WORKING PAPER NO. 5

DETECTION OF UAPs BY RADAR

	Para	Page
DETECTION OF UAPs BY RADAR	1	5-1
Possible Explanations	3	5-1
Current Detection Minima	4	5-2
RADAR REFLECTIONS FROM PLASMA	5	5-2
BALL LIGHTNING AS A RADAR REFLECTOR	10	5-3
Radar Echoing Area	12	5-3
DUSTY PLASMAS AS RADAR REFLECTORS	13	5-3
DETECTION BY UK-BASED RADARS	19	5-4
RADAR SIGHTING REPORTS	21	5-4

DETECTION OF UAPs BY RADAR

3. **Possible Explanations** A number of explanations are possible. The conditions at

[illegible]

$$\omega_0 = 5.64 \times 10^{-4} \sqrt{N_c}$$

8. Calculations show that to reflect 10 GHz microwaves a plasma should be at least 1-2 cm in thickness and less than -20dB through-transmission. It is possible for very high RF energies to be reflected (although the case here is much attenuated by the arrival of a radar pulse having suffered propagation attenuation $\propto 1/R^2$ (which will be repeated on the reverse journey for a monostatic radar inspection)).

9. XXXXX
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$$4\pi\epsilon^2 / m\omega_0^2 = 1$$

11. As stated at Working Paper No. 2, ball and bead lightning (which do not always

12. **Radar Echoing Areas** The radar echoing area of ball lightning would be expected to be of the order calculated from its physical size. A transition between a strongly reflecting target and an almost completely absorbing target occurs. The possible RCS values for plasma spheres are different from that of metallic spheres (whose RCS is a function of sphere radius and radar wavelength), with the radar echoing area of plasma spheres dependent also on ionisation level. An 'overdense' plasma sphere (or other shape) may be treated as a perfect reflector. However other plasmas depend, for their RCS, upon interference effects between the backscattered wave and tightly bound surface waves. This gives the plasma the properties of a dielectric, even when it is overdense. For example, a collisionless homogeneous plasma sphere with low electron density may have a RCS value of -60dB, peaking between 1 to 8m^2 as the density increases, but falling to 1m^2 as the density increases yet further. These values are for D/E(L) Band assessments.

13. It is argued that 'dust' particles, possibly of ice, form noctilucent clouds. (These are of the type, see Working Paper No. 13, which are sometimes reported as UAPs) A more recent understanding of dusty plasmas is at Working Paper No 19 'Charged Dust Aerosols'). It can be postulated that the plasmas containing these particles comprises two ionic components (one single charged atomic or molecular ion and a positive, or negative, multiple charged dust particle). Due to the tendency of the plasma to charge neutrally, a kind of charged cloud forms

For backscatter $\varphi(\Omega)$ equates to 1. The full derivation is at^[1].

17. Anomalous radar scatter has been received at RFs of 50, 224 and 933MHz, using experimental radars. The plasma is not fully ionised.

18. Strong backscatter from this cause occurs principally at high latitudes, in the summer and at considerable altitude ($\sim 80\text{km}$).

15. It is beyond the scope of this brief paper to pursue the detail of the scattering, other than to note that for radar-wave scattering to be enhanced there must be no interaction between the dust particles.

16. The intensity of the scattering, as a function of the incident radiation λ_{co} , equals $2\pi/k_{\text{co}}$, where k_{co} is the wave vector number. There are two regimes with little intensity for long wavelengths ($2k_{\text{co}}\lambda_{\text{D}}^2 \leq 1$) and a regime at shorter wavelengths ($2k_{\text{co}}\lambda_{\text{D}}^2 \geq 1$). The radar scattering is caused by fluctuations of electron density. The scattered power per unit volume of illuminated plasma within an interval of solid angle, within a frequency interval $d\omega$ and at wave vector k can be calculated from the Thomson electron cross section:

$$\sigma_T = r_e^2 = 7.95 \times 10^{-30} \text{ m}^2.$$

where $r_e = 2.82 \times 10^{-15} \text{ m}$ is the classical electron radius, E_0 is the incident (E field) amplitude and $\phi(\Omega)$ is a polarisation factor defined as:

$$\varphi(\Omega) = \left| \frac{k_s(k_s E_0)}{k^2 E_0} \right|^2$$

19. Backscatter from 'dusty' plasma at an altitude of, say, 80km could theoretically be obtained at a slant range of ~190km from a radar with a maximum elevation angle of ~25°. Those radars with a height-finding capability would soon reject the returns because the range/angle/altitude combination would place the target at an impossible altitude for manned aircraft.

20. The detection of phenomena other than mesosphere plasmas is also considered at Volume 3 and is necessarily classified SECRET as it involves the current detection performance of military operational systems.

RADAR SIGHTING REPORTS

21. In an attempt to correlate simultaneous or sequential radar sightings with radar types, only limited UK information is available. In December 1989, 5 NATO radars, part of ACCS, were within coverage range of a UAP report. Three radars had detections but two did not. Unfortunately, the radars have since been replaced and records of their parameters,

[1] LaHoz.C "Radar Scattering from Dusty Plasmas" Physica Scripta 45. Univ. Of Tromso, Norway 1991.

in use at the time, are no longer available. In the 1960s, Preston Air Traffic radar had unexplained detections and, over various years, the F-16 Air Interception radar has occasionally made UAP detections. More recently, RAF Neatishead, RAF Waddington Airfield Approach Radar and the CAA radar at Claxby, apparently had simultaneous detections. In all these cases the electron density of the target must have been high enough for the RF in use to produce reflections.

22. Clearly, UAP response to radar is variable, otherwise all the radars would see all the objects which entered their respective coverage zones all the time. The implication of this would seem to be that at least the surface offered to a radar wavefront by a UAP target is not a consistent solid object. This variability may be due to aspect or orientation, material composition or both. If UAPs are plasmas, their intensity would probably be diminishing as their physical life decays.

23. In the absence of firm radar cross-correlation the number of occasions where velocity could be deduced from actual measurements (compared, for example with purely 'eyeball' estimates of speeds obtained from some members of the public) are few. On one event a triangular (visual) formation was tracked on radar with an acceleration from 100 to 980kts in two seconds and an altitude change from 7000 to 3000ft in 1 second. This, of course, is feasible if the entities are charged bodies which are moving under the forces of electromagnetic or electrostatic fields. The Hessdalen lights, in Norway, for example, were reportedly tracked at a velocity of $\sim 8.5 \text{ km.s}^{-1}$.

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APPENDIX A5

DETECTABILITY OF PLASMA TARGETS

1. If it is assumed that, in the first instance the target is a spherical plasma body, the following conditions could exist:

- The sphere could be large in dimension compared with the radar wavelength
- The radar echoing area of the simple sphere is a function of its ratio of circumference to the illuminating wavelength [$2\pi a/\lambda$ (where a is the sphere radius)]
- For large values of $2\pi a/\lambda$, the RCS approaches the optical RCS (σ_{opt})
- The sphere, if homogeneous and perfect would be aspect-insensitive. (U)

2. In theory it is seen, therefore, that if a UAP was a stable plasma sphere of adequate electron density, a metre in diameter and comprised of entirely reflecting gaseous material, then its maximum radar echoing area for all practical purposes, when illuminated by a E/F Band (0.10m) radar, could be about ~16 square metres. For D/E(L) Band radars the value computes to ~five square metres. However, there may be several other factors of importance for a plasma UAP which could significantly affect its detectability; and in practice (as mentioned at page 5-3, paragraph 12), the real values (L Band) are estimated as falling somewhere between -60dB (0.000001m²) and +8m². Any surface absorption of the radar signal, which, in theory, should have little effect when the wavelength is large compared to the target dimensions, is not necessarily the case here, as it is by no means certain that the UAP plasma (inside it's outer shell, or surface) can be considered a resonant body. Or, indeed, that it's surface remains a consistent and constant reflector, especially as many UAP reports indicate that the body is constantly changing colour and often varying slightly in shape. The response of the body as a reflector when compared against the characteristics of the radar is clearly a key factor. (R)

3. **Target Characteristics** Target RCS fluctuation plays a significant role in the detection performance of all radars. In general, radars, (apart from Weapon Control/Tracking Radars, which may dwell for relatively long periods on their chosen target) inspect their targets at repeated and sometimes regular intervals in the form of dwells or scans, and by illuminating them with bursts of pulses. If it is reasonably assumed that a plasma UAP is a cloud of swirling ionised gases with variable electron density (possibly interspersed with periods of greater plasma stability), then for much of the time the radar reflectivity may vary rapidly, possibly uniquely from pulse-to-pulse (Swerling Case 2), rather than from scan-to-scan (Swerling Case 1). Further, the fluctuations may vary continuously from scan-to-scan (Case 3); or finally, so rapidly as to vary from pulse-to-pulse (case 4). (U)

4. If the plasma entity has several, possibly variable-density cores (as sometimes visible and reported as variable colour centres within a single buoyant body, and as always the case where a UAP comprises a grouping of multiple bodies (e.g. 'Triangle', 'Oblong', or Balls either 'in a row', or 'stacked'), this further adds to the complexity and variability of any radar reflecting characteristics the

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object might have. The steady (non-fluctuating case), sometimes called Case 5, is extremely rare in normal radar practise, due to the inherent nature of flying targets.(R)

5. Practical Effects The detection capability of a radar depends upon the signal (wanted) to noise (unwanted) ratio. The practical effect of RCS fluctuations, applicable to the UAP scenario, is most simply illustrated by one example. For a typical radar with a requirement of probability of detection of 0.95, against a steady target, a signal/noise ratio of 4 (~6dB) is required. If the target is fluctuating according to Case 1, above, a ratio of ~48 (16.8dB) would be necessary. In radar range terms this turns out to be a range performance reduction by a factor of 3.28. This effect can be mitigated somewhat by illuminating the target with a larger number of pulses and averaging them out. However, there is a limit to the number of pulses emitted, and which impinge on a target from an early warning-type radar during its typical continuous-scan mode of operation. For targets which exhibit Case 3 and Case 4 fluctuations the situation is even worse - and it is believed that this is the case for most, if not all, of the plasma UAP events. Hence, the factors which account for the intermittent detection of most UAP events on the radars, can be well justified in engineering and scientific terms. The precise limitations on the UKADR radars are discussed at Volume 3.(U)

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WORKING PAPER NO. 6

EXOTIC TECHNOLOGIES

	Para	Page
INTRODUCTION	1	6-1
Exotic Solutions	2	6-1
UAPs AS PROPELLED VEHICLES	4	6-1
ANTI-MATTER (ANTI-PROTON) PROPULSION	8	6-2
Material Storage	9	6-2
NATIONAL CAPABILITY		
USA	10	6-2
UK	11	6-2
Former Soviet Union	12	6-2
France & Italy	13	6-2
Rest of The World	14	6-2
ELECTRIC PROPULSION TECHNOLOGIES	15	6-2
Arcjets	16	6-3
Stationary Plasma Thrust (SPT)	17	6-3
Ion Thrusters (ISP)	18	6-3
Field Emission Propulsion (FEP)	19	6-3
PROJECTED ENERGY	23	6-3
TORSION, GRAVITY AND LASER FIELDS		6-4
Torsion Fields: Definition and Properties	24	6-4
Laser Propulsion	27	6-4
MICROWAVE PROPULSION	28	6-4
Summary	31	6-5
OVERALL SUMMARY	32	6-6

EXOTIC TECHNOLOGIES

INTRODUCTION

1. UAP reports usually describe objects seen at a distance and these reports can only provide, at best, approximate angular speed and size (and often a very vague diameter). For this reason, in the absence of mass or linear velocities the information is almost useless when trying to apply the laws of physics controlling the ability of a 'craft' to land (or hover) and take off again.

The thrust of any object must be slightly less than the body mass on landing and twice its weight for an acceleration on lift-off of 1g. If an object of say 5 or 20 metres diameter were to lift off, using (conventionally understood) thrust then a significant blast and scorching effect must be expected on the surface. No such after-effects are reported in the thousands of UAP reports held in MOD.

2. **Exotic Solutions** Exotic solutions may be postulated but these often lead to the necessity for some form of force beyond human understanding and contrary to the laws of physics as we understand them. This leads to such ideas as:

- Gravity Cancellation
- Teleportation
- Propulsion without reaction
- Force Fields

3. Intergalactic travel requires ~four million years for a return trip (travelling at just less than the speed of light), or three years, even to a nearby planet at a velocity of 20Km sec⁻¹ - a planet on which we can determine no sign of life in the form which would indicate 'beings' and their technology.

UAPs AS PROPELLED VEHICLES

4. The majority of UAP sightings can be attributed as relatively easily explainable natural or human phenomena - explainable, for

example, as one of the many options explored at the database auxiliary tables. There are, however, the remaining, relatively few events which are not so easily explainable. One of the extreme postulations is that these 'residual' UAPs are, in fact, genuine constructed air vehicles, which use potential scientific and engineering principles which are beyond currently applied knowledge. Thus they must have some sort of propulsion systems which would provide the extraordinary range of velocities and accelerations (and presumably both endo- and exo-atmospheric capabilities) frequently reported. It is only possible to explore the propulsion possibilities which fall within the human realms of conceptual thinking. It must therefore be recognised that there is a limit to real engineering (as within the current limits of understood technologies) and that, if the postulation is true, that methods of propulsion may, in fact, be possible beyond our current understanding in the UK.

5. Several side-issues in which current aeronautical engineering may progress and which may be relevant may also be explored. These include:

- The use of plasmas to reduce airframe drag.
- Plasma 'coatings' as a method of RCS reduction.
- Combined chemical and electric nuclear propulsion.
- Magnetic propulsion.
- Hypersonics.

6. It is surmised that the requirement would be to propel the object at ~> Mach 8 or more and that alternatives (as understood within currently accepted engineering capabilities) would be capable of exceeding scramjet or conventional rocket velocities. Research and development on hypersonic technology is expanding, principally in the

technology is expanding, principally in the USA. The projected (USAF) priority plan is to produce unpiloted air-breathing aircraft with a Mach 8-12 capability and transatmospheric vehicles which can operate between the upper-air-breathing and sub-orbital flight regimes, as well as highly supersonic vehicles at Mach 4 to 6.

7. It is assumed that the fuel options are intrinsic (fuel carried internally), partially extrinsic (some part of the fuel is obtained externally e.g. from the atmosphere) or the propulsion energy is entirely extrinsic (e.g. from some sort of external field). The foregoing examples are understood as, respectively, chemical or electric or nuclear (e.g. rocket), air-breathing (e.g. jet engine), or a system which uses a field (e.g. magnetic field) - of which the only vehicular example is terrestrial (e.g. levitated train).

ANTI-MATTER (ANTI-PROTON PROPULSION)

8. A variety of conceptual engine types are potentially feasible. The following performance capability would be possible, using just one gram of the anti-matter:

- 100Kg payload accelerated to a velocity of the order 1000 Km s^{-1} (Rocket)
- Launch a 1000 Ton payload into a Mars mission (Rocket)
- Payload/gross weight ratio improvements by a factor of three to five (Air-breather). This would involve the use of anti-matter to amplify the SI of standard cycle engines.
- Possibility of 'fusion engine'.

The rocket (i.e. exo-atmospheric mission) potential is encompassed by the relation $M(\Delta)^2 \sim 10^5$, where M is the mission mass (metric tons) and ΔV the velocity increment (measured in km.s^{-1}). It is believed that the application of anti-matter can be developed for solid core, gas core, plasma core and beam core rocket motors

with adaptations for the air-breathers. Parametric studies have been made to this effect in the USA.

9. **Material Storage** Cooling is among the most serious problems to be solved. Portable storage for containing the 'anti-matter', in the form of rings and ion traps, would be necessary. The particles are typically confined within a plasma volume (e.g. 200cm (long) by 5cm (dia) with a vacuum $<10^{-12}$ Torr and a magnetic field of 10T). This could all fit into a large truck, including all support equipment and provide ~30 to >100 days of storage time. The dimensions given might store $\sim 10^{13}$ anti-protons at 20-50KeV and is considered to be a factor of 100 down on the limit. According to authoritative sources a few milligrams of anti-matter might be produced annually by a nation with the resources to do so.

NATIONAL CAPABILITY

10. **USA** In 1987 it was stated that the US could construct an intense source of low-energy anti-protons in three to four years and thereafter deliver (store) 10^{14} low energy protons annually. It was hinted that a five to seven year programme might be started (or already had been). This information, given in a 1987 closed seminar, was given public-release in 1994. One of the prime applications envisaged is for air-vehicle propulsion. The cost of a R&D programme would be ~\$400M, over a ten year period. In addition to propulsion, non-propulsion applications of anti-matter have been proposed in medical (tomographical imaging), therapy and biomedical detectors.

11. **UK** That anti-matter is a key topic of interest is confirmed by a series of papers, and, in particular reports of CERN activities in which UK participate. A recent review paper (P T Greenland, Imperial College London) relates Newton's search for a cause of gravity and the relationship between gravitational mass and inertial mass. Anti-hydrogen has been produced at CERN, but the trapping and control of the anti-hydrogen is not yet achieved to enable instrumentation and measurement to

be obtained, for example for a comparison with conventional hydrogen. The approach is to produce traps to contain, separately, anti-protons and positrons both at liquid helium temperatures. Anti-hydrogen is then obtained by the combination. The work so far has used the highest energies achievable by the Low Energy Anti-proton Ring (LEAR). No anti-hydrogen has yet been trapped at low temperature. There are no indications of any current experiments or early developments of future potential applications of anti-matter for propulsion purposes.

12. Former Soviet Union Scientific papers report the conceptual design of anti-matter storage devices, for example, positron storage rings. These, including the 'IREN' project are at the design experimental and very early development stages. In particular, important work is proceeding on the use of Gamma-Ray Lasing in the matter and anti-matter research fields.

13. France & Italy French aspirations seem to be significantly aimed at whether some stars (and even some entire galaxies) may exist which are made up of anti-matter. The possibility of this scenario will, in theory, be proved if anti-matter (single anti-helium nucleus in cosmic ray flux) are detected in cosmic rays. Results are awaited from the a current Shuttle project. Further work is being funded by NATO and the EU. In 1996, two scientists at the Italian National Nuclear Physics Institute reviewed anti-matter as an area of future research and proposed future experimental projects. They pointed out that the possible existence of anti-matter was first postulated in 1928, and that recent exo-atmospheric experiments were delayed following the Shuttle disaster. As a result four balloon-borne experiments had occurred and the planned work (Italy-Russia) will also examine anti-matter components of cosmic rays. The possible existence of cosmological ant-matter, with a symmetric universe and matter and anti-matter separated into domains remains a fundamental question.

14. ROW Nations There is no evidence that any ROW nation has scientific or engineering capability, leading to real developments in the field of anti-matter.

ELECTRIC PROPULSION TECHNOLOGIES

15. Chemical propulsion requires large propellant mass compared with electrical methods. Hence, assuming that a UAP of undetermined origin could somehow enter and leave earth's atmosphere, (with the capability of some unknown propulsion method) the remaining journey (from wherever it came from and returned to) could presumably use one of the 'electric' propulsion methods for which the technologies are currently understood. However, these produce low thrust levels (mN), as shown at Table 1.

16. Arcjets produce an arc typically in the exhaust nozzle of a chemical thruster. For electric propulsion (EP) although their thrust is higher than other EP methods, there is the mass penalty of the chemical propellant required.

17. Stationary Plasma Thrust (SPT) produces ionised xenon, which draws in electrons from a cathode after the xenon propellant passes through electric and magnetic fields in a discharge chamber.

18. Ion thrusters (IPS) also use ionised xenon propellant.

19. Field Emission Propulsion (FEP) is a future concept assessed to produce a higher specific impulse (Isp) but at low thrust levels.

20. None of the methods at Table 1 were conceived as primary methods of spacecraft propulsion.

21. On board power requirements (for a 18mN UK IPS design with an Isp of 3466) is ~600W, worst case. The thruster exhaust velocity is ~40,000m.s⁻¹. For satellite position-keeping, 40Kg of propellant held in a titanium storage tank (mass ~10Kg), would provide a planned life of ten years. Even a small thrust,

Projections and modelling claim a Mach 5 capability, to 100,000ft altitude. The laser provides thermal energy (collected from the beam) and used to produce air-breathing thrust. At altitude, conventional rocket fuels would be used to boost to escape velocity.

MICROWAVE PROPULSION

28. Low frequency microwave beams are not suitable for on-board energy collection. The problems are those of diffraction, and the requirement for large antennas on board the vehicle. Also, the low breakdown threshold of the atmosphere limits the received power density. The selection of high frequencies is limited by the EM atmospheric windows (e.g. 34, 94, 140 or 220GHz). Atmospheric attenuation also increases with increased RFs. It is assessed¹ that a 15m diameter craft could logically use a 35GHz system with the high power rectifying antenna ('rectenna'), which is a solid state converter. Within the atmospheric propagation breakdown limits (4KWcm^{-2}) this antenna could receive $\sim 5.6\text{GW}$. At an RF of 200 GHz Benford and Myrabo², suggest an array of focused 10KW gyrotrons could provide a launch station. With the overall power assessed at 30MW a huge 550m diameter array would be required to ensure adequate energy (10MW on a one meter diameter receive antenna), reaches the vehicle at the extremity of the atmosphere because of the extinction loss en-route (even using the 220GHz atmospheric 'window'). Conceptually, a space-based, (LEO) passive relay station could be used to pass the EM energy beamed from a terrestrial station onto the vehicle in space, where the energy would be converted this time for use in an ion thruster engine.

29. It is beyond the scope of this report to include fine details of the design of such a craft other than to list the key features which might have a bearing on the potential UAP

connections in answering the enigmatic question - "Can a craft capable of extra terrestrial travel with the reported characteristics be conceived within the limits of 'earthbound' capabilities"? The key features follow with UAP-related comments in square brackets

- (a) **Size** The microwave craft proposed has a 15m diameter. [This falls within some reported UAP diameters].
- (b) **Mass** A launch mass of 1400Kg is proposed (surface area loading 7.9Kg.m^2). This is an aerodynamic (e.g. wing) loading similar to that of ultralight aircraft. This leads to the conclusion that every conceivable means must be used to lighten the mass even to the point of carrying no propellant - hence the idea of using a microwave-induced 'air spike' and beamed energy sources. The point that immediately diminishes the UAP connection here is that energy conversion is used and atmospheric thrust is produced. Hence, there will always be, as far as can be deduced, some type of acoustic effect. [In other words an observer will hear very loud sounds, contrary to UAP reports] However, if it is possible to place all the electromagnetic air acceleration technology on the outside of the body this may not be the case.
- (c) **Materials** Thin film materials with adequate tensile and compressive strength could, conceivably, be made. Silicon Carbide based materials (exotic fibres) have been suggested. The thin film materials might be microwave-reflective, acting simultaneously as the rectenna. Any collected spare power could be used, for example, to power the air-spike.

- (d) **Propulsion** Several propulsion configurations have been proposed. The first is the pulsed detonation engine (PDE), or 'microwave-thermal

¹ "Hyper Energetic Manned Aerospacecraft Propelled by Intense Pulsed Microwave Beam" L.K. Myrabo. SPIE Vol. 2557 1995

² "Propulsion of Small Launch Vehicles using Millimetric Waves" SPIE Vol. 2154 1994

air breathing engine'. The PDE uses microwave-supported detonation to heat the air working fluid and is based on what, in principle, is the air-breathing ramjet. A combined cycle engine (i.e. air-breathing and rocket) might be envisaged for a transatmospheric role. Clearly this would only operate in the atmosphere and velocities of Mach 5-6 are claimed to be possible without an air spike. [Hence, to return to the possible 'UAP' similarities this type of craft could not be extra-terrestrial unless it used another type of propulsion outside the atmosphere] Another endo-atmospheric option is the Magneto-Hydro Dynamic Fanjet (MHDF), where powerful Lorentz body forces are exerted on external air working fluid. In effect the active microwave-powered 'armature' accelerate the passive 'field coil' - which is the air channel used for momentum exchange.

- (e) **Rectenna** For microwave on-board collection an off-board source must exist. [In the UAP context there has been no detectable source on earth or from space which, using conventional EM-waves at any wavelength someone on earth would have surely intercepted; especially in view of the huge power requirements].
30. There are several other key factors in the completion of the design, for example the production of a heatshield (if re-entry is required), artificial gravity, aerodynamic stability and control, plasma radiation shield (hazardous radiations), life support, and communications. [It is, however, seen that even this vehicle, if possible with today's technology, would be unlikely to achieve the characteristics attributed to UAP events]. It is of interest that the conceptual body shapes tend to be saucer-like. This is probably pure co-incidence - as many

UAP events reported are, in fact, not necessarily 'saucer shaped'!!

SUMMARY -PROPULSION OPTIONS

31. Propulsion mode is the key factor in considering whether it would:

- (a) Be possible to construct a vehicle with reported UAP attributes and potentially (until proved otherwise) with an extra-terrestrial capability, using existing 'earth' technology.
- (b) Be possible to conceive such a craft which can move with zero or near-zero sound and change the direction of movement almost instantly.

CONCLUSIONS

32. In attempting to explore the potential technologies which would be essential in order to construct a craft with the exceptional characteristics, attributed to UAP it is important to note that:

- No reliable report exists of a landing and take-off of an object known to contain 'beings'.
- No spacecraft or occupants can be seen anywhere on earth and not even small artifacts have been left on earth to confirm the existence of a 'spacecraft' in the form of metals or other materials. None have apparently ever crashed, despite sighting reports for thousands of years.
- There is no evidence of attempts at communication between the alleged occupants of the 'craft' and humans - or messages/items left behind as a form of communication. There is no evidence that any nation has a current capability to produce and trap anti-matter for propulsion purposes.

33. Hence, there are no new technologies or methods which could be exploited beyond those already known or being researched. There have been no

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opportunities for accurate size or shape measurements, no examinations of unknown or special materials or of any types of devices which could aid in the determination of what the phenomena comprise or be used in order to replicate the UAP as an air-vehicle as a result of the presence of UAP in the UKADR. In the absence of measurable artifacts, the best estimate of the nature of UAP can only be assessed by a careful analysis of all the available reported characteristics and the hope of correlating not only reports from diverse sources but the frequency of reports with other measurable events, such as weather, meteors, etc.

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	Thrust (N)	Isp (S)	Uses
CSP	1-500	<320	Extensive
ARCJET	<1	550	Wide
SPT	0.04-0.20	1600	Limited
IPS	0.062-0.25	3000	Experimental
FEED	<0.001	4000	Future

TABLE 1: ELECTRIC PROPULSION OPTIONS

WORKING PAPER NO. 7

SIGHTLINE RATES OF FLYING OBJECTS

&

METEORITES

	Para	Page
INTRODUCTION	1	7-1
SIGHTLINE RATE GEOMETRY	2	7-1
PARAMETERS	5	7-1
INTERPRETATION	6	7-2
EXO-ATMOSPHERIC OBJECTS	9	7-2
Meteorites	9	7-2
Satellites	13	7-3
PLASMAS, CHARGED AEROSOLS AND SPRITES	17	7-3
THE ILLUSION OF OBJECT MOTION	18	7-3
VELOCITY ILLUSION	19	7-4

February 1, 2000

XXXXXXXXXXXX S.40

- i -

SIGHTLINE RATES OF FLYING OBJECTS

INTRODUCTION

1. This brief paper is intended to relate to frequent UAP reports where objects cross through the observer's field of view at what are often, reportedly, extra-ordinarily high velocities. Typical examples are those of satellites and meteorites.

SIGHTLINE RATE GEOMETRY

2. The basic geometry assumption is that, from the initial visual contact, the object continues in a straight line until it goes out of sight due to some local obscuration or reaches the observer's visual horizon. The largest angle through which an object can pass is from horizon to horizon. Usually the angular sector crossed (or at least seen by the observer) is much less. The angle crossed is usually viewed either in azimuth or elevation. On occasions the object is diving and often disappears during the process - and these are usually explainable as burning-up meteorites or space debris. The greatest tangential velocity occurs when either the object is passing exactly overhead or when at a 90° azimuth offset. Velocities always appear to be greater when objects are closer to the observer, even though they are identical to those at greater range which pass through the same enclosed angle but take longer because the distance subtended is greater. The human perception of speed is often distorted by any accompanying sound. Many UAPs are reported as 'silent'. However, it is borne in mind that if any sound is present it can give added perception of speed (see Working Paper Nos. 1 and 8).

3. On the spur of the moment, accounting for surprise and even incredulity, later embellishment, misunderstanding and over or under estimation; it is clear that the time and velocity figures given by a UAP witness can be wildly inaccurate. Further, more than one witness at the same event may provide

conflicting evidence. Often, events are reported as duration of 'about ten seconds' or 'two to five seconds' and through small angles. Further, those not regularly concerned with aircraft can only be expected to give very approximate altitudes (ranges). However, the evidence cannot be ignored, as taken together with other information from the same sighting and with other witnesses, which may come from nearby. --Crude target track construction can be made - hence a process of elimination of options is assisted. Further, untrained observers regularly have difficulties with range assessments and grossly misrepresent objects as being "beyond the moon", or "about 2 fields away".

4. The Field of View(FOV) available is clearly much larger when the observer is in an advantageous position, e.g. open countryside, on a hill, or (without obscuration) viewing over the sea or, finally, in the air. Even so, for often inexplicable reasons, and with clear FOVs, objects are sometimes only seen fleetingly. Velocity discrimination/estimation is much more difficult - even for aircrew in this case, unless in a parallel course or catch-up/overtake/being overtaken scenario.

PARAMETERS

5. The attached plots at Figures 1 and 2, although accurate, are intended as a guide in the analysis of a UAP sighting, where the witness provides one or more of the following.

- Start (elevation angle) and finish (elevation angle)
- Time of observation together with some idea of the angle passed-through
- Time and altitude of an objects' passage.

The plots are for objects 'flying' at constant altitudes. If an object is either climbing or diving then a different calculation is needed.

INTERPRETATION

6 Figure 2 (for both endo-and-exo-atmospheric targets) enables a target speed to be approximated, based on witness assessments of angle traversed (az or el), range and time of observation:

$$v = \frac{R\phi}{t}$$

where ϕ = Angle traversed (radians) =
Deg/57.29

R = Witness estimate of target range

t = Witness estimate of duration of sighting

7. The same approximation applies to space-based objects. In this case it is assumed that exo-atmospheric objects can be at any altitude above the earth.

8. It is important to note that the method used is based on the assumption that moving objects travel tangentially through the estimated angle, with respect to the observer's position. Any movement at other angles with respect to the observer would increase the track-length flown and thus, in a given time, increase the object's velocity.

EXO-ATMOSPHERIC OBJECTS

9. **Meteorites** Diving objects (e.g. often shown to be meteorites/meteors) are frequently reported. These are high velocity ionised trails caused by meteor-body friction with air molecules, which then ionises; usually with a fiery tail/trail, lasting only a few seconds. RF reflection from trails (utilised for scatter HF communications purposes), occurs in the (approximate) 30 to 120MHz range. Meteor-trail duration is measured in hundreds of milliseconds. Two categories describe the rate

at which meteors strike the earth's atmosphere. The **periodic** group (known as meteor 'showers'), which have a yearly cycle and the **sporadic** group which are, though more random, occur year-round. In the context of UAP sightings:

- 'Showers' occur for periods from hours to days at a rate of the order 20 to 50 per hour.¹ These are often present, though not necessarily visible, due to the interference of moonlight. The forthcoming occurrence of showers can be predicted, because both the earth's (and the meteor stream's orbits) are known - hence the intersection can be calculated. What is not known is the shower density. There is a shower density cycle repeating every 33 years. There is no connection between meteorite activity and sun spots or solar flares.
- 'Sporadics' exhibit a Poisson distribution but with a diurnal variation.
- In addition to the familiar largest fire-ball-producing meteors there are tiny grains not visible to the human observer. Radio and radar methods allow the latter to be detected. As the meteorite rate may have a bearing on the production and presence of some types of 'UAP', attempts will be made to correlate meteorite density against the trend of UAP reports.

10. This latter condition reflects the fact that at dawn (local time) a meteor will cut the longest path in the atmosphere, while at mid-day the meteor will appear to strike the atmosphere vertically. As the size of meteors varies between smaller than a grain of sand to those that survive and impact the earth's surface, the initial mass varies inversely with its probability of arrival. Consequently, smaller meteors make up a significant proportion of all meteors arriving and are not large enough to be seen visually.

¹ Lovell A.C.B. Meteor Astronomy UP 1954 P248.

11. Associated with the size is the electron line density (ELD). These are classed as either 'over' or 'under' dense: Under-dense ELD is $<2 \times 10^{14}$ electrons per metre. Over-dense trails are considered to be a tubular plasma cloud (hence the links with other phenomena of interest to this study). The duration of over-dense trails is generally longer than that of under-dense trails. Trails can be manipulated by the effects of both wind-shear and high altitude winds, which distort their tracks. A brief examination of recent UK meteorite velocity measurements shows velocities from about 11km per second minimum to 72km per second maximum, with a mean of around 40km per second. The International Meteor Organisation produce a Meteor Shower Calendar, which is used elsewhere in this report as the basis for some statistical analysis against the UAP report rate. (see Volume 1 Annex F)

12. The probability of observing meteor trails visually is low and apparently not equally distributed over the earth. For communications purposes it has been found that the best trails occur according to the distribution at Figure 1, and it might be supposed that this density also reflects the most likely locations where higher visual opportunities occur. This changes according to geographical latitude. The meteor scenario, in relation to reported UAP events is an enigma. Firstly, it is important to note the increased presence of more UAP reports in coincidence with periods of high (or higher) meteorite activity. This does not necessarily mean that observers are only seeing meteors. Further, it does not mean that UAP reports are always caused by meteors. There are bound to be reports generated by a host of other causes. On the other hand it could mean that some UAP are formed by meteors as the residual effect of the meteors enormous energy. These postulations are examined further, statistically, at Volume 1 Annex F, where it is clear that this is the case.

13. **Satellites** Other, frequently reported objects, almost always described as 'steady lights' are probably satellites in low earth orbit (LEO) (see Working Paper No. 17). The

sightline rate of these is clearly dependent on orbital altitude and speed.

14. Observation curves are at WP No17, and assume an observer is stationary on the earth's surface. Geo-stationary satellites can be ignored, as by definition they have no sightline rate. Low earth orbit satellites have a practical maximum altitude of ~1000Km and orbit at a velocity of $\sim 7\text{Km sec}^{-1}$. This equates to an angle-rate of about 4° per minute.

15. If an observer spotted a satellite from rise to set (most unlikely) covering a full 180° (45 minutes), or even for 15 minutes, current public knowledge is such that it would be identified as such and not reported as a UAP, or even reported at all.

16. In UK latitudes the satellite orbit would have to be at an inclination $>50^\circ$. Viewing conditions must also be correct to observe a satellite:

- It is unlikely in daylight.
- Its size must be large (small debris is not seen).
- The light falling on the satellite, which is then reflected must be adequate. Other data concerning the observation of satellites and hence the probability of being mis-reported as UAPs, is at Working Paper No. 17.

PLASMAS, CHARGED AEROSOLS AND SPRITES

17. It is evident that when plasmas, particularly sprites and any higher altitude phenomena, which depend on luminosity due to electrical charges, that sightline rates can be extremely high. These phenomena, often described as 'nocturnal lights' are described at Working Papers Nos. 2, 5, 19, 21, and 24. They frequently appear as having significant angular size and, because of their high speeds (despite being at altitudes from a few kilometres to tens of kilometres), are often

perceived and reported as flying much lower than they actually are.

THE ILLUSION OF OBJECT MOTION

18. It is important to note that (other types of actual flying objects excepted), with those visual phenomena which are due to certain atmospheric effects, little of substantial physical substance actually moves. It is the light seen by the observer that moves from place to place and it becomes visible in those places because the atmospheric conditions (electrical, particle etc.), allow it to become visible. Hence, the observed variation in colours seen, the duration for which an object is seen, and the time for which a sightline rate is discernible. The visualisation (wavelength) of a UAP, from an electrical charge source, also depends upon air pressure.

VELOCITY ILLUSION

19. The illusion of velocity in receding objects is particularly important in UAP reports, where, as they are often in the dark, leave the observer with no surface references with which to relate speed. This is especially the case when the sky background does not offer a simultaneous view of any aircraft, with which to compare sightline motion. Similarly, in bright sunlight the velocity of a small receding spherical object is particularly difficult to assess. This is dependent on whether the object being viewed is just a spherical (i.e. 'round') light, (which may be bright or dim) or whether it is being viewed as a silhouette. The surface area of a receding sphere is seen purely as the area of a circle (πr^2) and the enclosed angle resulting (i.e. subtended) from its diameter, as range increases, will reduce linearly as the ratio of its diameter to range. However, its area appears to the observer to have shrunk according to the square law. The important feature here is that a sphere comprising plasma, which might not be accelerating away (or even be moving away at linear speed) but is in fact shrinking in size (as its, often brief, lifetime comes to an end as the electrical forces holding it stable collapse), can

appear, from the observer's viewpoint, to be receding; whereas, it is actually an illusion and the object may hardly have moved in range.

It is easily seen, therefore, that a reported 'receding light', may in fact be a light which is reducing in intensity but remaining in exactly the same spot. Similarly a 'rotating' light may be a fluctuating light, which is the same light giving the impression of rotation.

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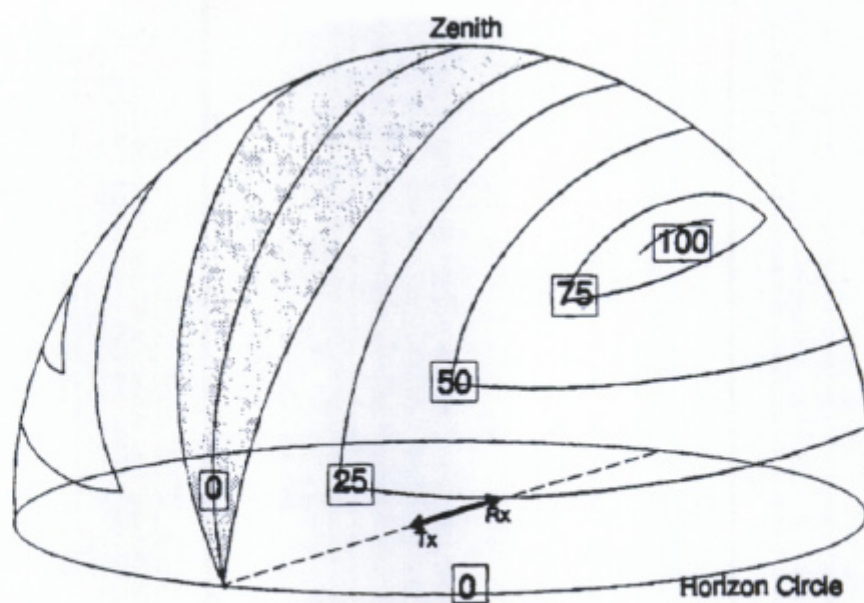


FIGURE 1: METEORITE TRAIL DISTRIBUTION (U)

7-5
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Velocity
(m/sec)

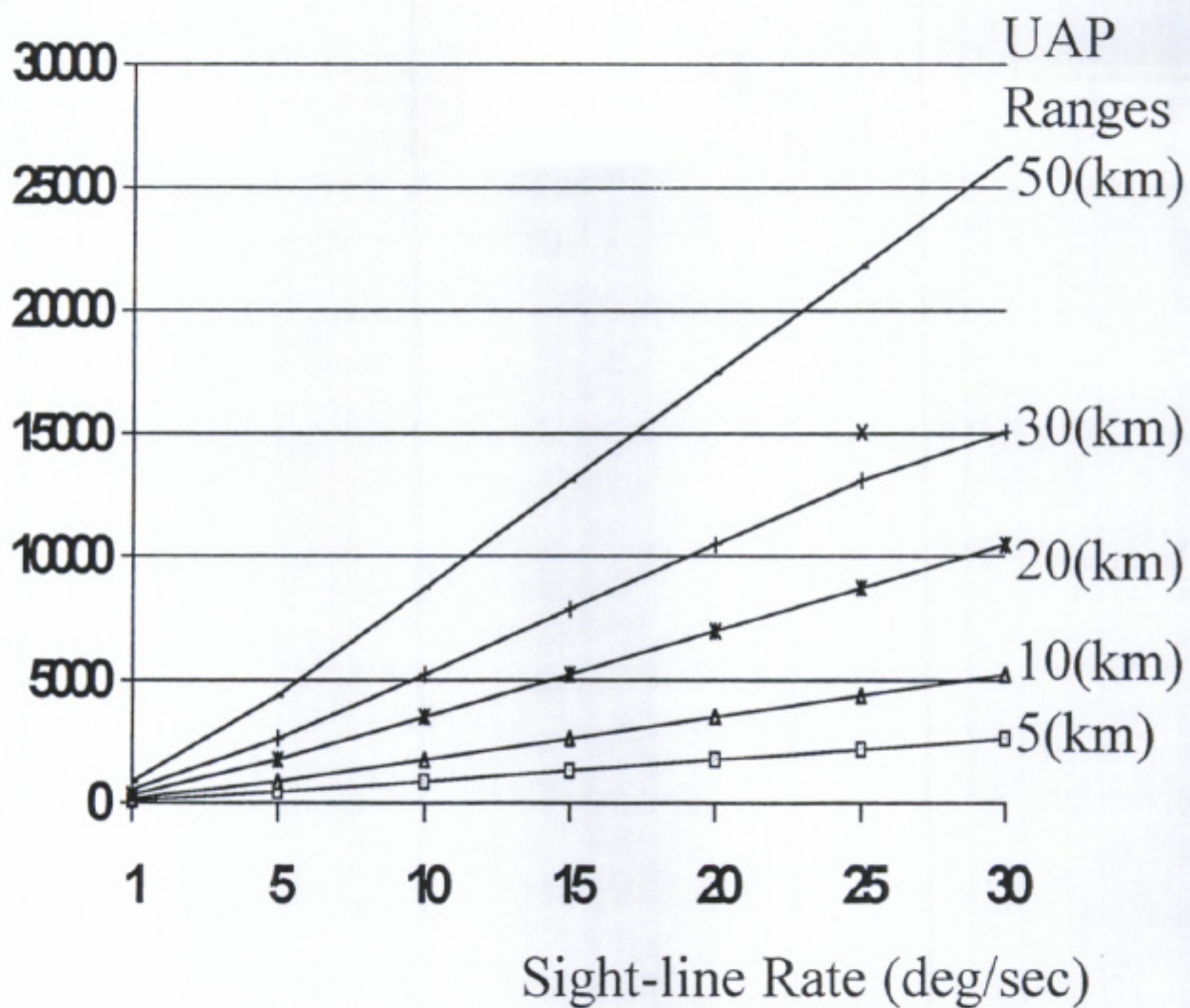


FIGURE 2 SIGHT-LINE RATES(U)

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WORKING PAPER NO. 8

RARITY OF UAP SOUND

REPORTS

	Para	Page
INTRODUCTION	1	8-1
Anomalies	2	8-1
Discussion	3	8-1
Geometry	4	8-1
Future systems	5	8-1
Mis-reported sounds	6	8-1
SUMMARY	7	8-1

February 1, 2000

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- i -

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RARITY OF UAP SOUND REPORTS

INTRODUCTION

1. An initial overview on UAP sound is at Working Paper No. 1. This paper further sound in the context that there appears to be a contradiction between the occasional report of sounds, the frequent lack of sound when high UAP velocities are reported when, unusually there are no corresponding reports of 'sonic booms' nearby. Normally, sound is either generated and then emitted by a stationary body due to some inherent mechanical or electrical vibrating, oscillating or rotating device mounted internally or on its surface. A moving body produces sound due to bulk or frictional displacement of air. Sound may also be caused by electrical discharge or chemical action.

2. **Anomalies** When an object is in the air and, however erroneously is considered to be a 'vehicle', a witness normally expects to hear some sort of noise. The faster a UAP is perceived as travelling, then the greater is the expectation of sound. The lack of sound at the witness location may be due to:

- An over-estimate of the object's actual velocity.
- The presence of some atmospheric conditions (e.g. wind absorbing cloud) that suppressed the sound to an inaudible level.
- The probability that, while reported as being in the atmosphere, the object is in fact in space.
- The object - though travelling sometimes at high speed, has not actually disturbed the atmosphere through which it has clearly seemed to pass.
- The fact that the 'object' seen may have no mass, or negligible mass, compared with its surrounding atmosphere (i.e. it is a 'visible mass' only, caused by reflections from its ionised gases or an internally-generated colour temperature).

3. **Discussion** The first effect above is not unexpected as most UAP witnesses are untrained. The second can occur when the

sonic shock wave is distorted and the conical pattern of the shock front does not reach the ground. It is also noted that the classic bow and tail shocks may not both be heard as they are at different intensities. Hence, as the public are aware (and may recognise a double shock as a supersonic aircraft), a single shock 'bump' may not be recognised as coming from a genuine aircraft. Further, the lateral extent of a supersonic shock wave causes a variation in intensity. This effect coupled with windspeed can either reinforce or weaken the sound heard.

4. **Geometry** Unless the observer is along the track of the target, $\pm$ a few kilometres, the double (or even single) 'boom' may not be heard. Airframe aerodynamic design can reduce shock wave effects, though not eliminate them.

5. **Future Systems** It is of interest, here in the UAP context, that the first experiments to modify airflow using electromagnetic fields (and plasmas) took place in the 1960s, and is a topic of current interest with its 'read-across' to target signature control (i.e. RCS reduction). It is not clear, at present, how much the reduction of drag will affect the overall audio noise generated. Intuitively the majority of noise heard on the ground is generated by the engine thrust, relatively little being generated by the airflow over a smooth vehicle body.

6. **Mis-reported Sounds** Finally, one must consider that sounds may be mis-reported (e.g. mistaken description of the noise itself) or are a figment of the imagination engendered and embellished with the rest of the alleged phenomena. For example, it is as easy to imagine a charged mass to have a dome and portholes as it is to attribute a whine when it 'takes off'. Sound reports, as with other attributes, suffer from not having a first-hand debrief immediately after the event and before reports become forgotten or the information of interest is lost.

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SUMMARY

7. It seems most likely that the reasons for few reports of sound (for those sightings in which nearby aircraft can be eliminated) are that many objects are beyond the range at which sound would be heard, are mis-reported in range, they are satellites; or are 'charged' air masses of various sorts which emit little or no sound. (e.g. Charged aerosols or plasmas, etc.)

8-2
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WORKING PAPER NO.9

'BLACK' AND OTHER AIRCRAFT

AS UAP EVENTS

	Para	Page
WESTERN PROGRAMMES	1	9-1
SR-71 programme	2	9-1
s.27 XXXXXXX	3	9-1
XXXXXXX	6	9-1
RUSSIA	7	9-1
UAVs	9	9-2
GLIDERS	10	9-2
PARAWINGS, HANG-GLIDERS & MICROLIGHTS	11	9-2
MIXED AIR ASSETS	12	9-2
HELICOPTERS	13	9-2
AIRCRAFT LOW FLYING ROUTES	14	9-2
VISIBILITY FOR LOW FLYING	15	9-3
AIRCRAFT LOW FLYING AT NIGHT	16	9-3
AIRCRAFT IN FORMATIONS	17	9-3
SPEED WHEN LOW FLYING	18	9-3
USE OF RE-HEAT OR AFTERBURNER	19	9-3
FREE-FALL PARACHUTING	20	9-3

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SECRET
NATO RESTRICTED

OBSTRUCTIONS & POWER LINES 21 9-3

PROHIBITED & AVOIDANCE AREAS 22 9-3

SPECIAL NOTE:

This working paper contains NATO RESTRICTED information on the UK low Flying Zone, for use in UAP report filtering and analysis, which must not be divulged to the public.

ii
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'BLACK' AND OTHER AIRCRAFT AS UAP EVENTS

WESTERN PROGRAMMES

1. It is acknowledged that some UAP reports can be attributed to covert aircraft programmes – in which unusual air vehicles may be seen, either at the experimental stage or in service. UAP reports often describe the shapes that are shown at Figures 1 to 9. It is noted that certain viewing aspects of these vehicles may be described as 'saucer like' – hence they are not ignored by observers – as more conventional and familiar aircraft shapes would be, but are frequently reported as UAPs.

2 **SR-71 Programme** Figure 1 shows an SR-71. Flights have been conducted since the 1960s. It is known that this was a US supersonic (M3+) reconnaissance aircraft that operated over the UK. This aircraft was also known as 'SENIOR CROWN'.

3.  S.27

4. Figures 7 and 9 show head-on silhouettes of the F117 and B2 'Stealth' aircraft and of other aircraft, the body/fuselage shape of which can be reported respectively as 'saucer or arc/boomerang shaped' under certain silhouette and lighting conditions. These aircraft types are

unfamiliar as they are rarely spotted in UK airspace.

5. It is important to note that since these aircraft cannot hover then accelerate, they cannot be the cause of reports where these phenomena occur.

6.  S.27

RUSSIA

7. In 1992 Russia announced a new flying machine, called a thermoplane, constructed by designers of the Moscow Aviation Institute, according to Moskovskaya Pravda newspaper. This unusual airship, outwardly resembling a **flying saucer**, is intended to be used for ecologically sound highly effective technologies in the field of superblock construction; control and remote exploration of the environment; and large scale life-saving operations.

8. According to experts the fuel and economic efficiency of the thermoplane will exceed that of an aeroplane by five to seven times, two to three 2-3 times for an automobile and can be compared with seagoing vessels up to 20 thousand tonnes displacement. Tests on the thermoplane are being conducted in Ulyanovski Aviation Industrial Complex (Volga region). The diameter is ~40m and depth 16m.

UAVs

9. There is a significant UAV programme in the USA and Israel and to a lesser extent in the European NATO Nations. It is possible that experimental versions may be flown principally over coastal or sparsely inhabited regions of the UKADR in the future. Some of these may be reported as UAP.

GLIDERS

10. Gliding objects are of particular interest in the UAP context, as they make very little sound. Further para-wings and hang-gliders often appear to an observer to hover, move, climb and descend. On occasions, depending on livery, a glider has briefly reflected light and has been reported as a UAP, insufficient of the rest of the machine being seen to permit the observer to recognise the sighting as a glider. Both freeflight and powered gliders fall in this category.

PARA-WINGS, HANG-GLIDERS & MICROLIGHTS

11. There is an increase in the use of sport para-wings and hang-gliders, both unpowered and powered. The small size (and often similar span to length ratio), make these more likely to be misreported as a UAP than ignored, as would be the case for a more conventional aircraft. Hang-glider avoidance areas are specified, therefore the possibility of an erroneous UAP report can be minimised by referring to Figure 10 and Figures 15 to 33. These types do not normally fly after dark.

MIXED AIR ASSETS

12. Except for towing aircraft for gliders, other fixed wing aircraft, especially fast low jet aircraft, are prohibited from glider and hang-glider sites. Hence, within those areas, a useful filter is that UAP events cannot be

misinterpreted as other military or civil operations. UAP reports from within these areas are therefore due to either gliders or hang-gliders, or other natural or man-made objects, which may enter the airspace, (e.g. birds, balloons); or 'genuine' UAP events. Note should be taken of the fact that these sport aircraft, though in use at all times during daylight, when weather conditions allow are more likely to appear at weekends and holidays.

HELICOPTERS

13. Although helicopters can be seen anywhere and under certain conditions (rotor disc illuminated from above or below) are reported as a disc-type UAP event, this is more likely to occur within the UK helicopter routes shown in Figures 11 to 14.

AIRCRAFT LOW FLYING ROUTES

14. Although, in principle, the whole of the UKADR is available for low flying (down to an altitude of 250ft), in practice, and excluding the prohibited and restricted areas, such as danger areas, major conurbations and other specified areas, low flying is limited to the designated low flying areas. In three areas aircraft can fly down to 100ft. Although they are theoretically available for 24hrs per day, low flying is prohibited **over land areas**, between 2300 and 0700hrs, with few exceptions for non-jet aircraft. This is rare enough to warrant special permission and then only for Monday to Friday. Weekend and Public Holiday flying is only permitted for small-scale, pre-arranged exercises, and only from 0800 to 1900, with the exception of some aircraft used for parachute training. An obvious exception is that of Search and Rescue operations and helicopter training over sea at weekends and on Public Holidays. Use of the UK Low Flying System is exclusively for UK aircraft, UK aircraft based in Germany and NATO aircraft on approved

flights. Special approval is required for other (non-NATO) nations, who must not fly below 2000ft AGL. Exceptionally UK light fixed wing aircraft may fly down to 50ft.

VISIBILITY FOR LOW FLYING

15. Strict rules apply to visibility for low flying. This is of interest in the UAP context, as clearly this filters out all manned aircraft if certain conditions exist:

- For low flying aircraft (in excess of 140kts), there must be a forward visibility of at least 5km and 150ft horizontal and 500ft vertical separation from cloud.
- Light aircraft must have a forward visibility of at least 2km, be clear of cloud and sight of the surface
- Helicopters, (flying at 140kts, or less) must either be clear of cloud and in sight of the surface, or apply the same rules as for low flying aircraft above.

AIRCRAFT LOW FLYING AT NIGHT

16. The UK Night Low Flying System (UKNLFS) is a source of potential UAP erroneous reports. Restrictions apply as shown at Table 1, with timing that can be taken into account for UAP event analysis. Normally, low flying night flights will show navigation lights.

AIRCRAFT IN FORMATIONS

17. In the UK Low Flying System a formation is not normally to exceed four aircraft, but North of 54 degrees North formations of up to 8 aircraft may be flown permitted for various operational activities.

Special permission is required to exceed these rules and the incidence of larger formations is very rare.

SPEED WHEN LOW-FLYING

18. The maximum speed (all aircraft types) is 520kts.

USE OF RE-HEAT OR AFTERBURNER

19.A characteristic of some UAP reports is that of glowing objects in the sky. Except for emergencies, it is unlikely that after-burners will be used overland at low altitude at less than 1000ft for most aircraft. The Jaguar is an exception (500ft)

FREE-FALL PARACHUTING

20.A brief glimpse of a parachute can be sufficient to produce a UAP report. Manned aircraft are prohibited from the designated parachuting areas. Normally, parachuting only takes place in daylight.

OBSTRUCTIONS & POWER LINES

21. During analysis it should be noted that while a UAP (e.g. Ball Lightning) may be observed near to tall structures, aircraft, the crews of which will be aware of these, can be eliminated, as they will not fly close by. UK towers below a height of 500ft are not lit. Slow inspection aircraft can be expected in the vicinity of electrical power lines.

PROHIBITED & AVOIDANCE AREAS

22. For the purpose of evaluation of UAP reports it is possible to filter out fixed wing aircraft (not withstanding any infringement), where sufficient UAP evidence exists to determine that its altitude was observed below the avoidance area minimum altitude (2000ft AGL)

MONTH	START	END
JAN	1630	0800
FEB	1730	0700
MAR	1830	0600
APR	1930	0430
MAY	2000	0330
JUN	2100	0300
JUL	2030	0330
AUG	1930	0430
SEP	1830	0530
OCT	1730	0600
NOV	1630	0700
DEC	1600	0800

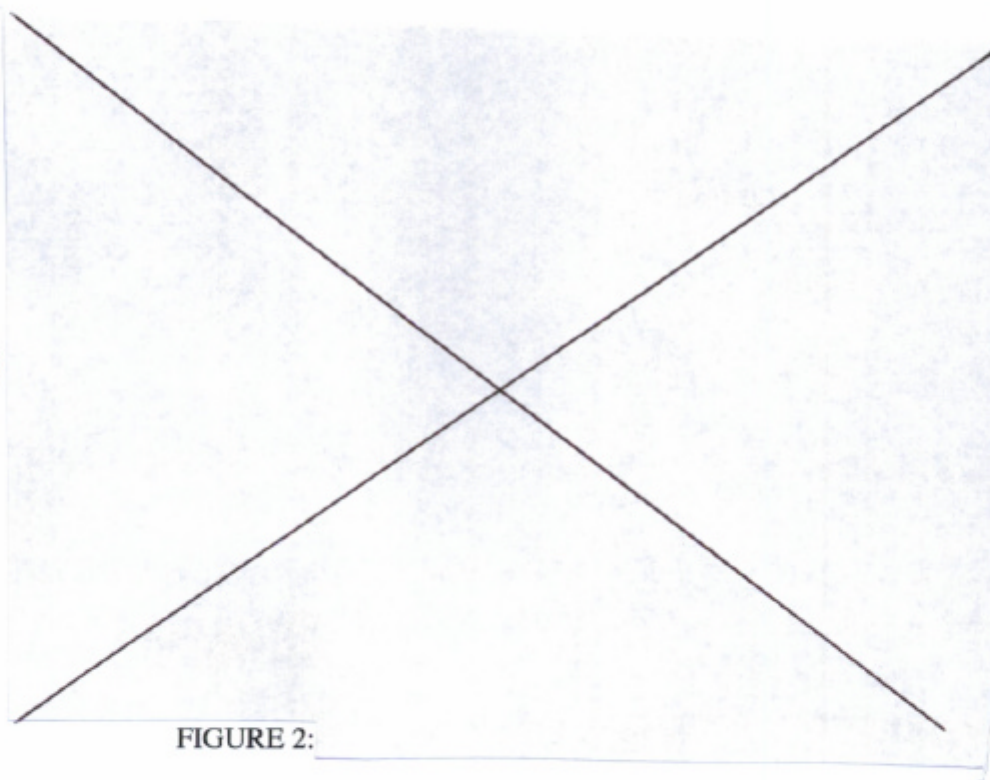
NOTE: All times Zulu

TABLE 1 LOW FLYING NIGHT-TIME PERIODS

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FIGURE 1: SR-71 IN FLIGHT (NASA PHOTO)



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FIGURE 2:

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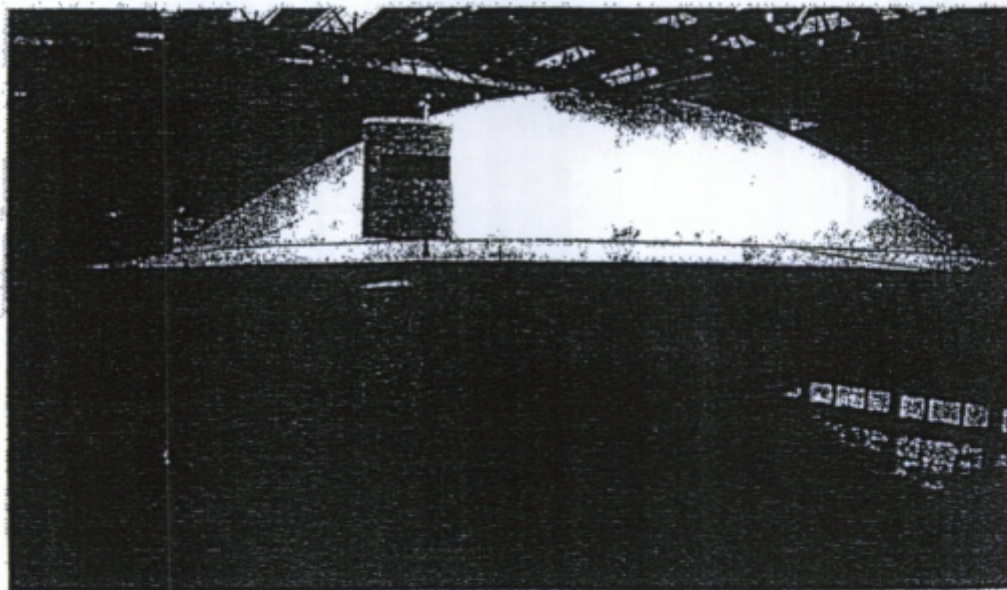
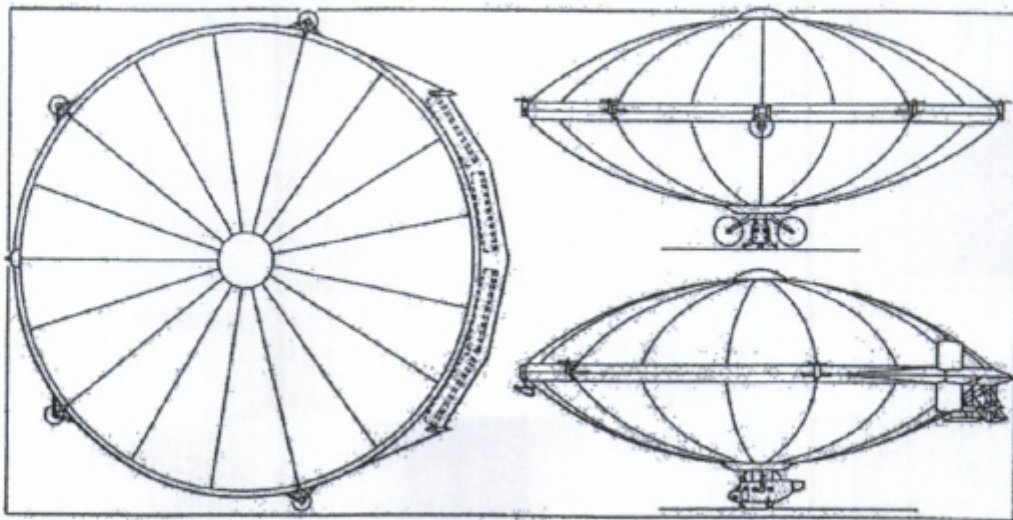
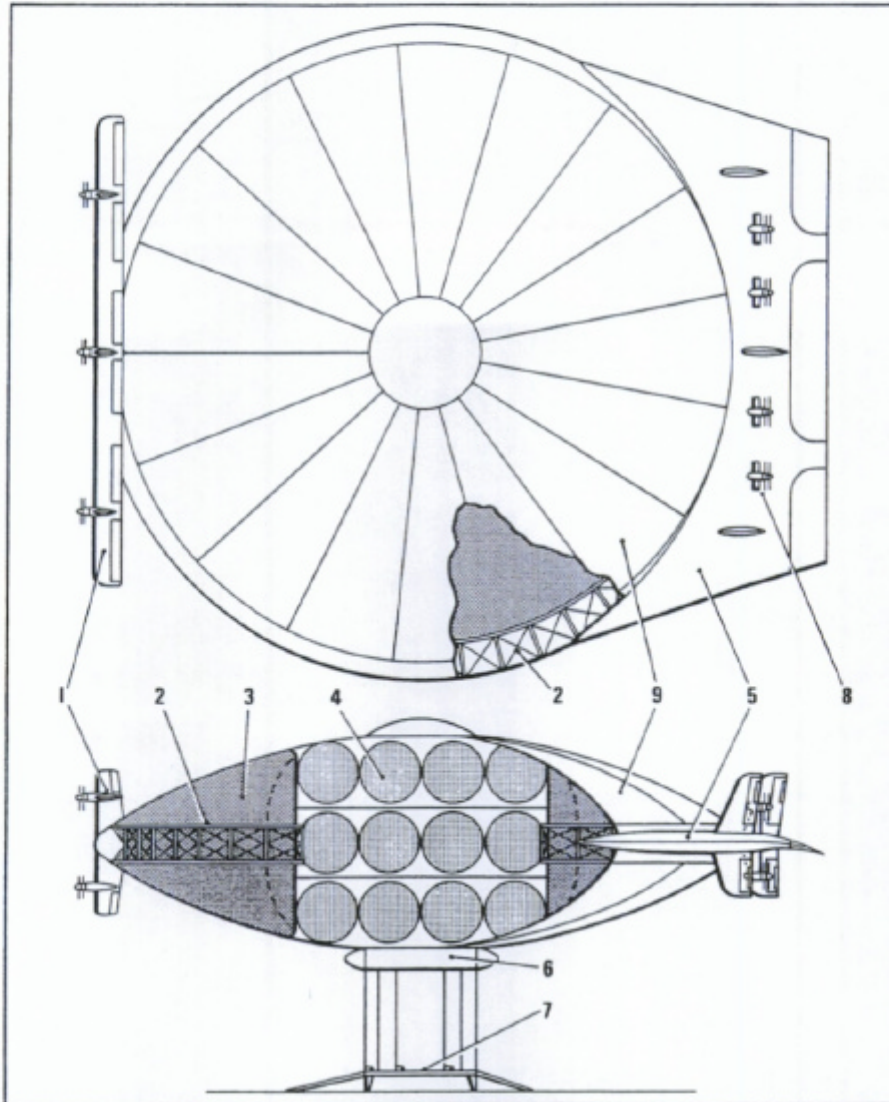


FIGURE 3: THE ALA-40 PROOF OF CONCEPT THERMOPLANE UNDER TEST AT ULYANKOVSK IN MID-1992 (P. DUFF)

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Structural details of the ThermoPlane ALA-600:

- | | |
|--|--------------------|
| 1. Front vertical and horizontal stabilisers | 6. Fuselage module |
| 2. Internal hull construction | 7. Cargo platform |
| 3. Hot air/natural gas volume | 8. Engines |
| 4. Hydrogen or helium spheres | 9. Hull skin |
| 5. Rear stabiliser | |

FIGURE 4: ALA-600 THERMOPLANE (RUSSIA)

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FIGURE 5:

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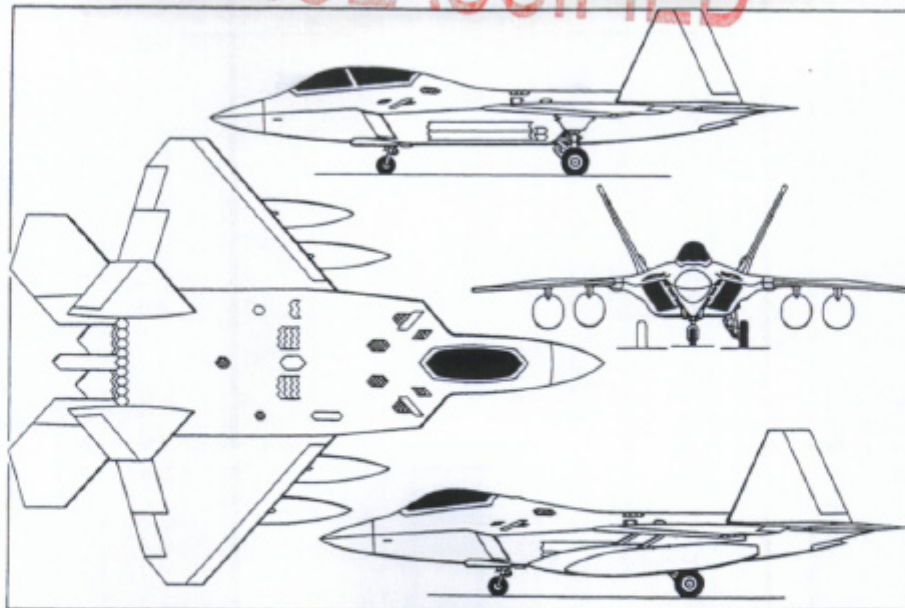


FIGURE 6: PRODUCTION CONFIGURATION OF LOCKHEED F-22A WITH
ADDITIONAL SIDE VIEW (TOP) OF TWO-SEAT F-22B (JANES)

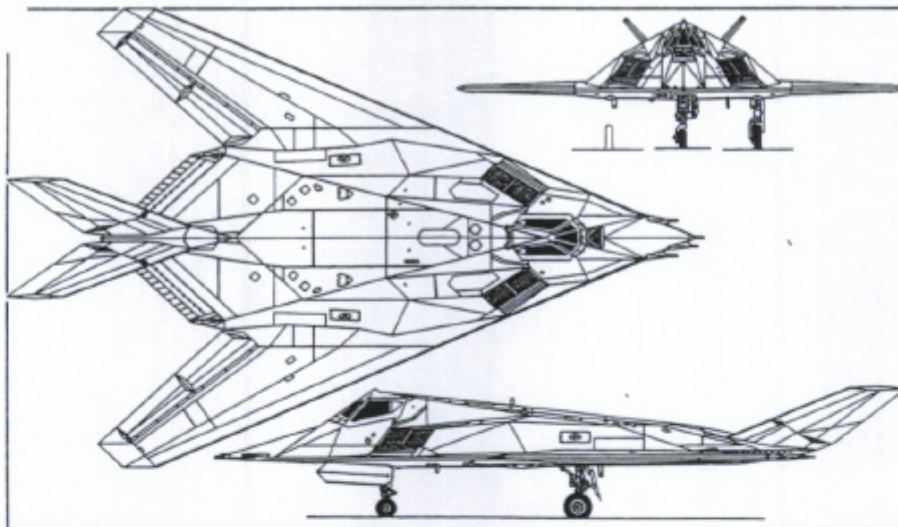


FIGURE 7: LOCKHEED F-117A STEALTH ATTACK AIRCRAFT (JANES)

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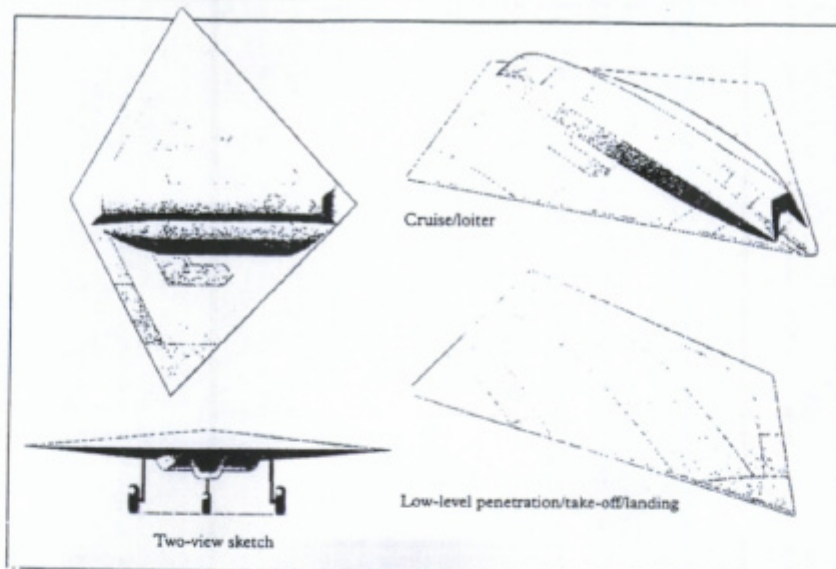


FIGURE 8: A STEALTHY UCAV CONCEPT DEPICTING THE 'ROLL-OVER' TECHNIQUE FOR REDUCING RADAR CROSS SECTION (TOP RIGHT) (JANES)

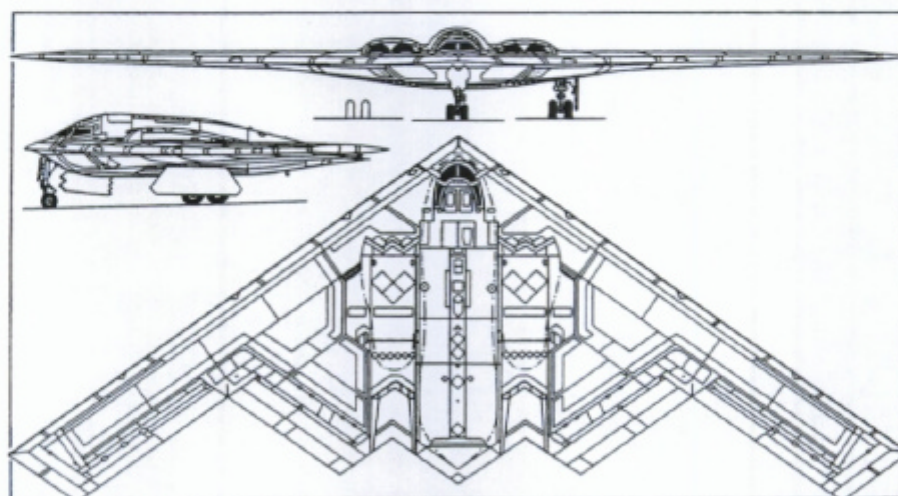


FIGURE 9: B-2 'SPIRIT' STEALTH BOMBER (USA)

(JANES)

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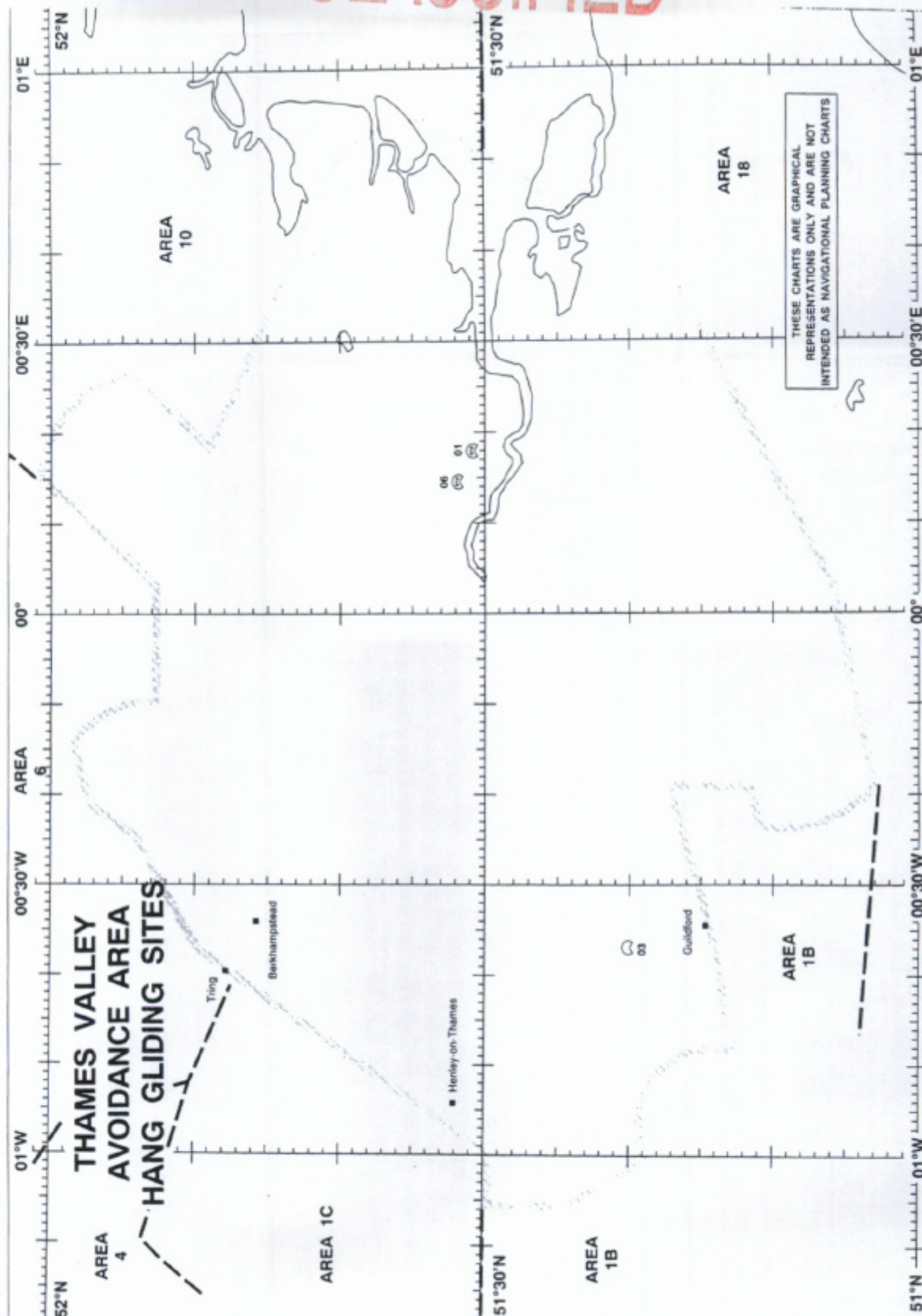


FIGURE 10

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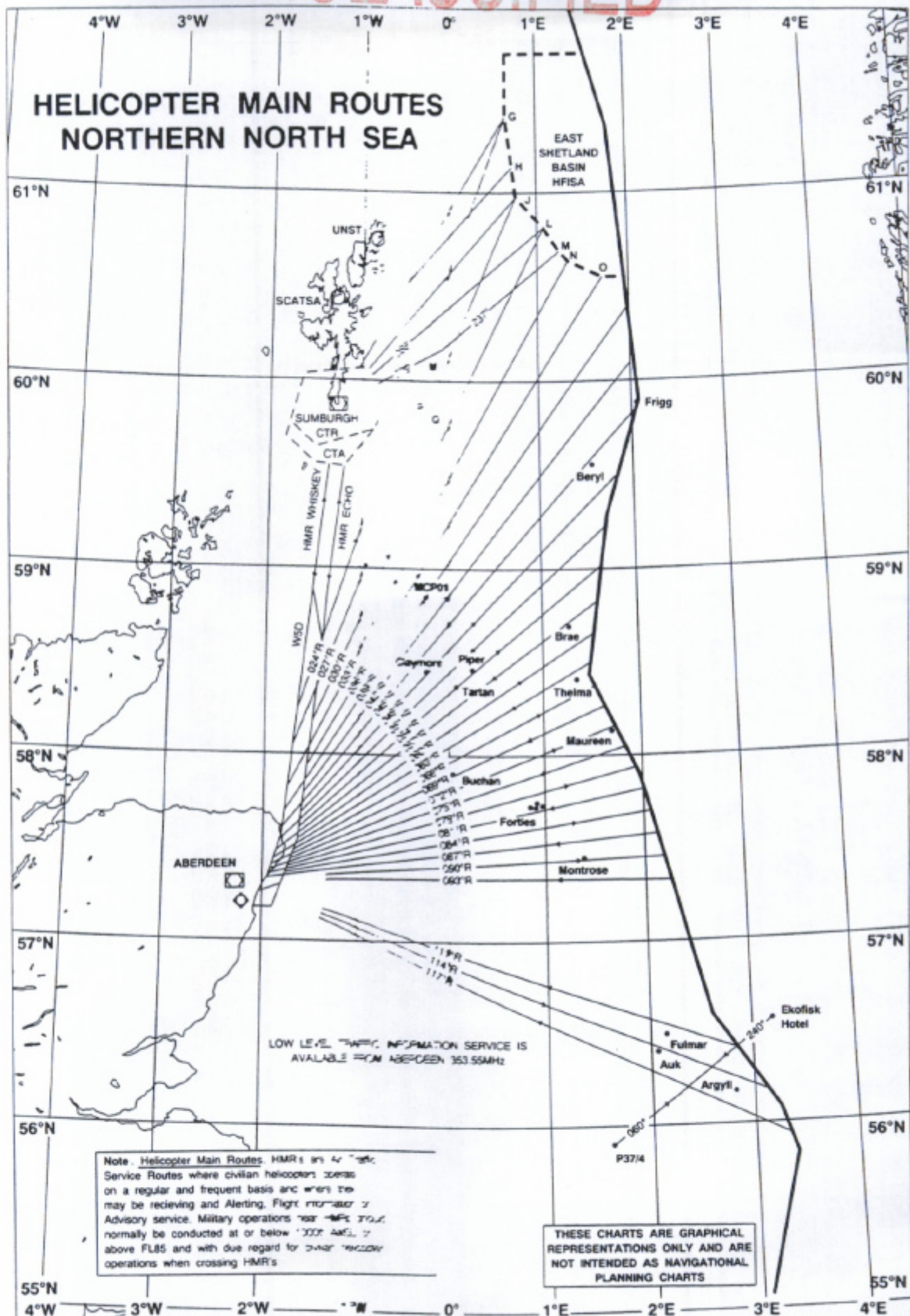


FIGURE 12

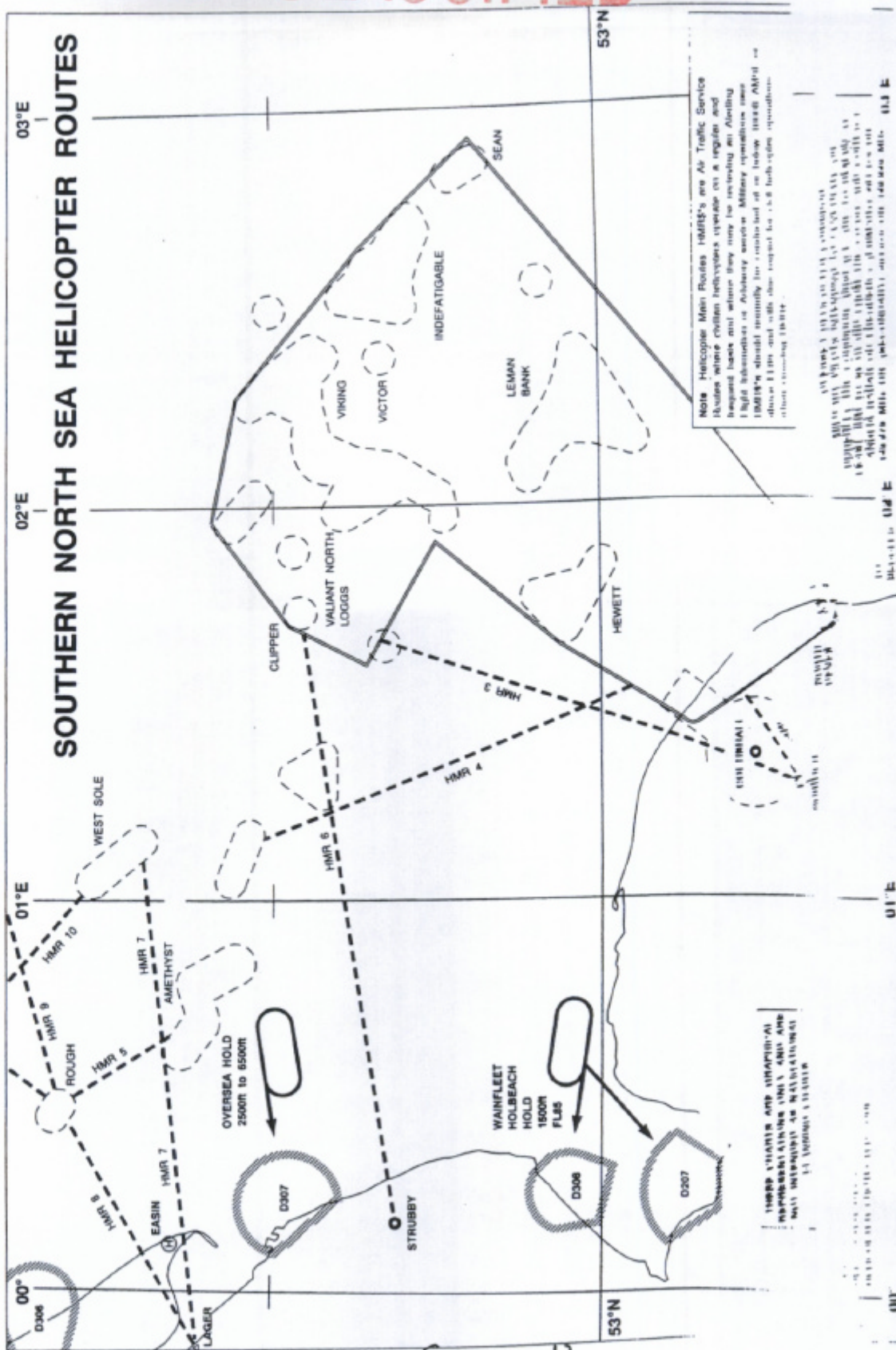


FIGURE 13

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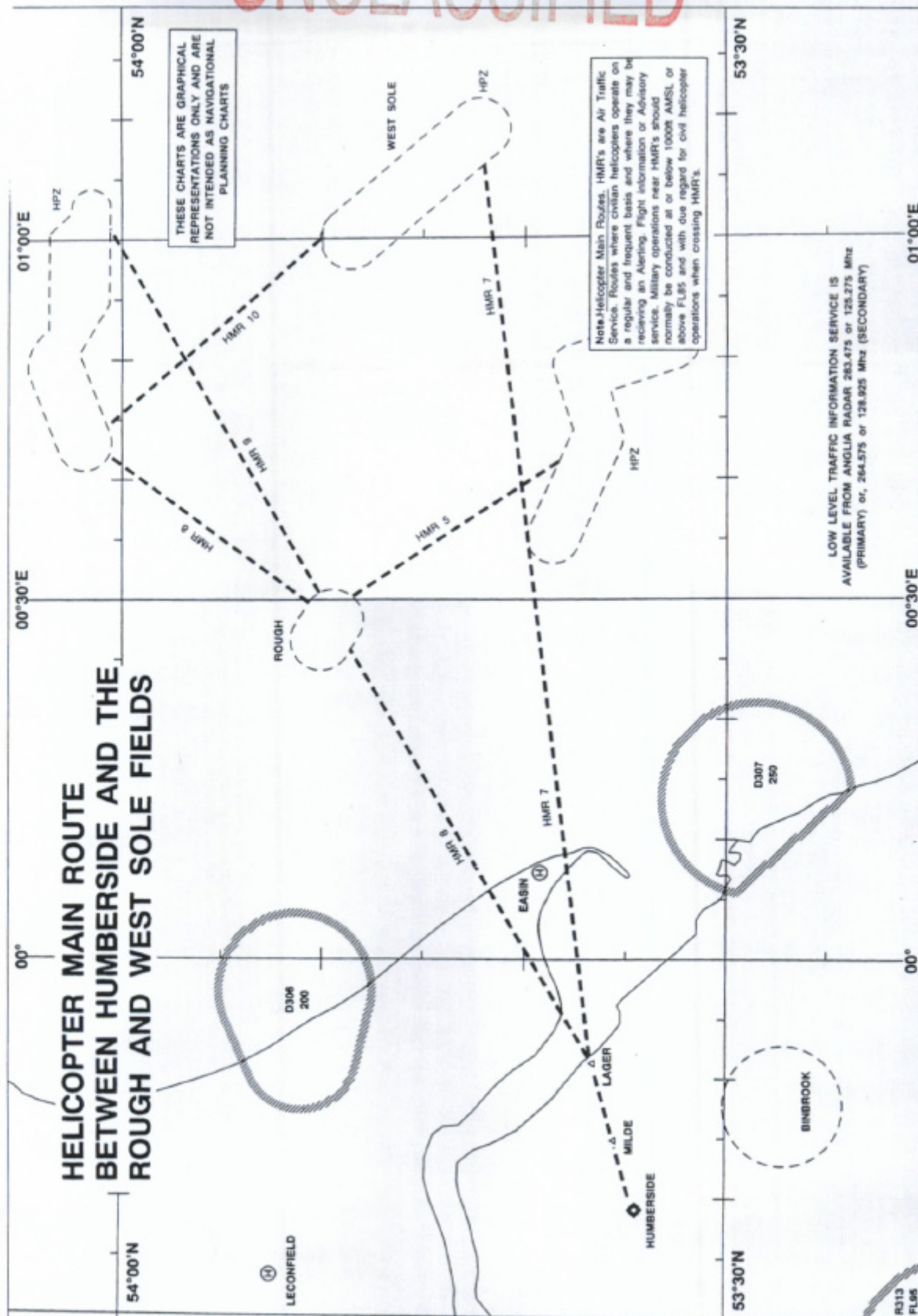


FIGURE 14

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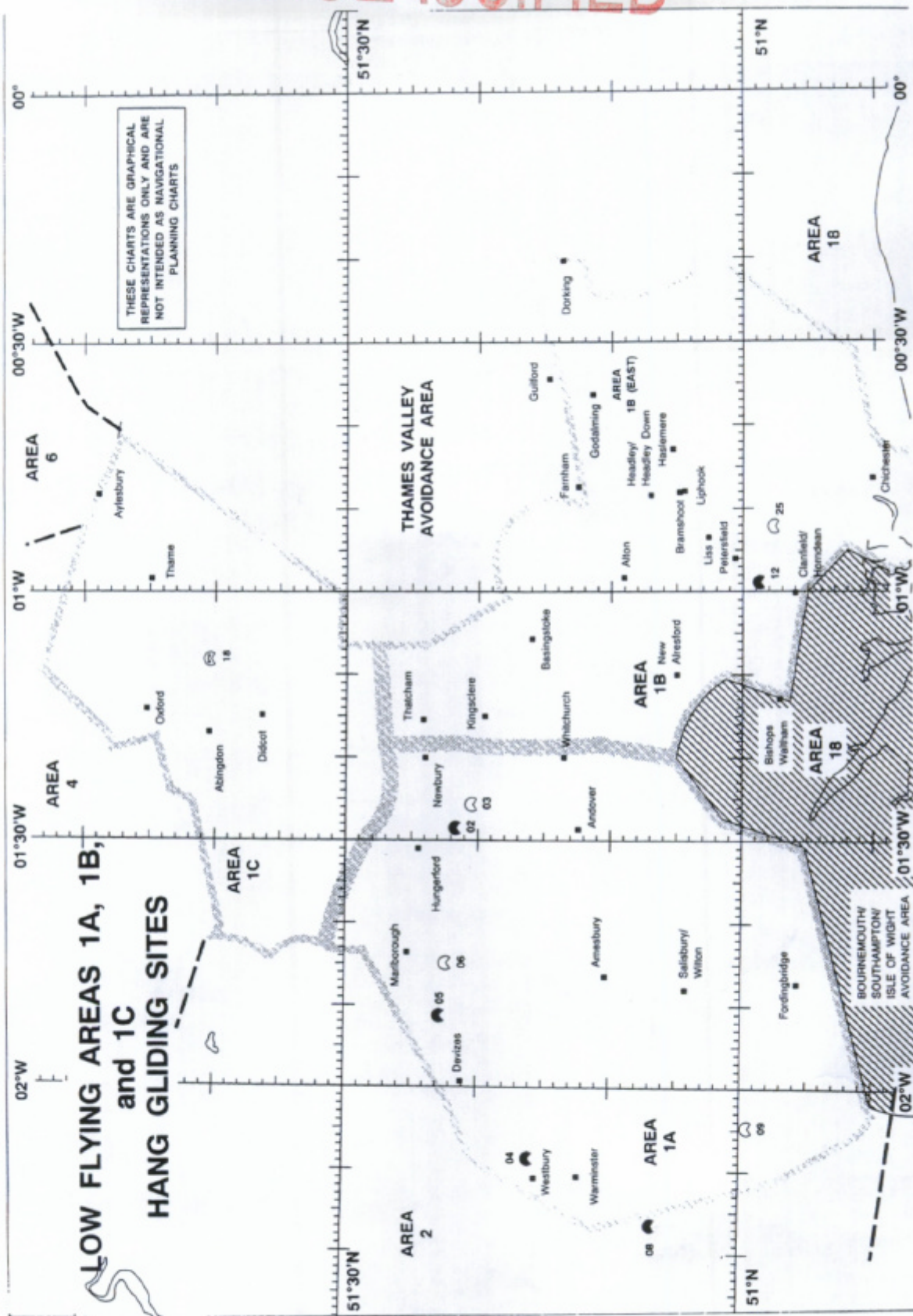


FIGURE 15

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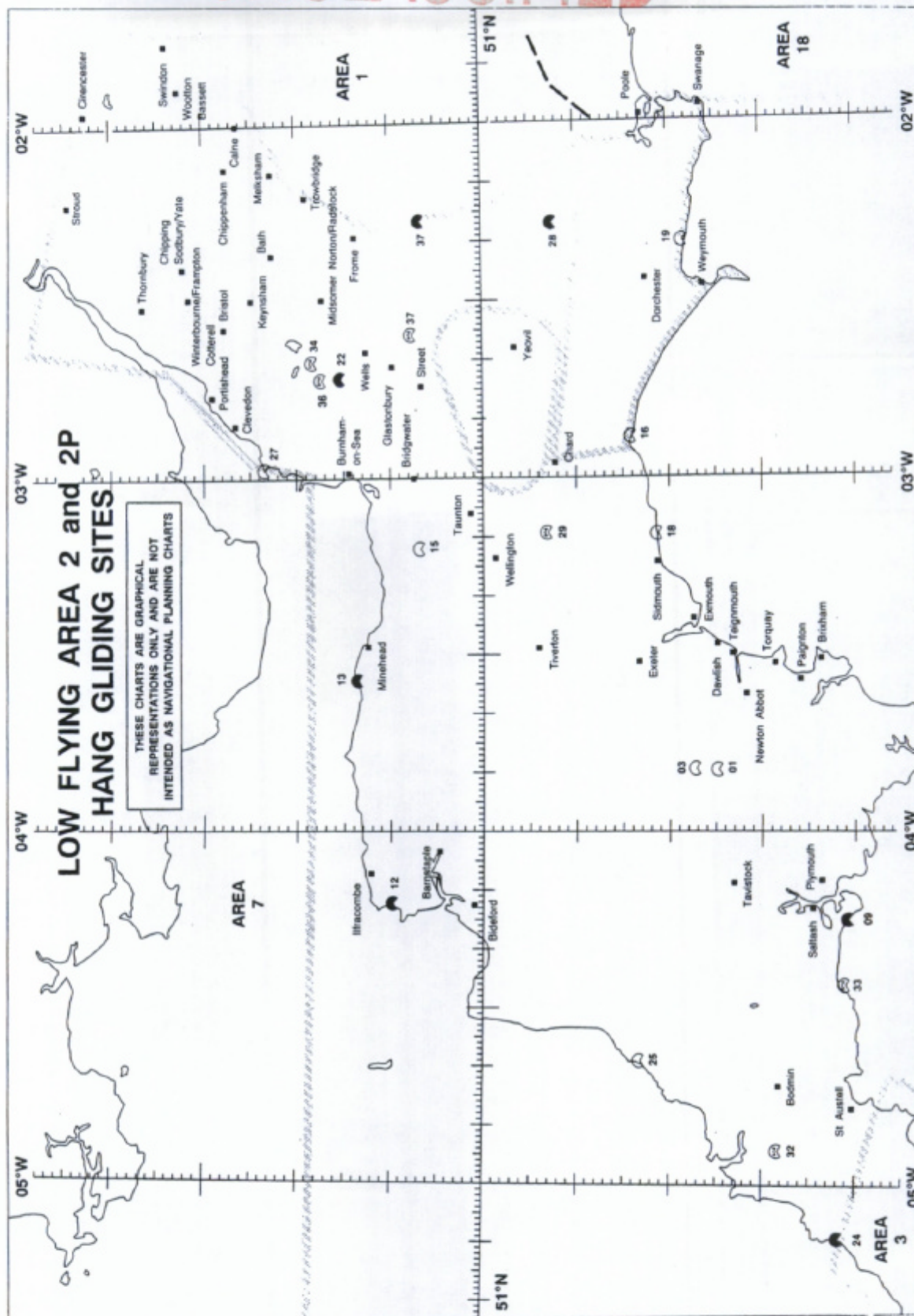


FIGURE 16

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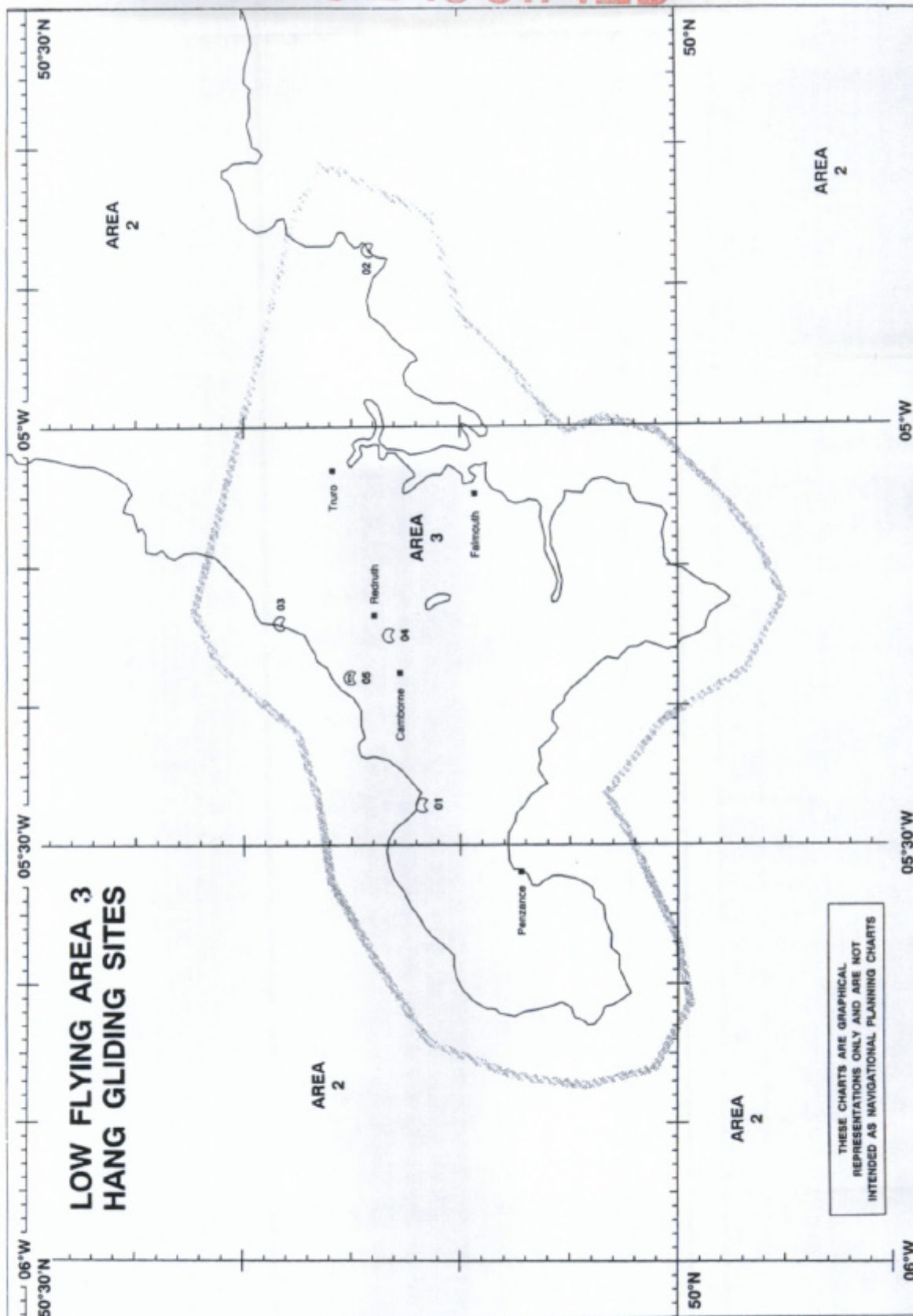


FIGURE 17

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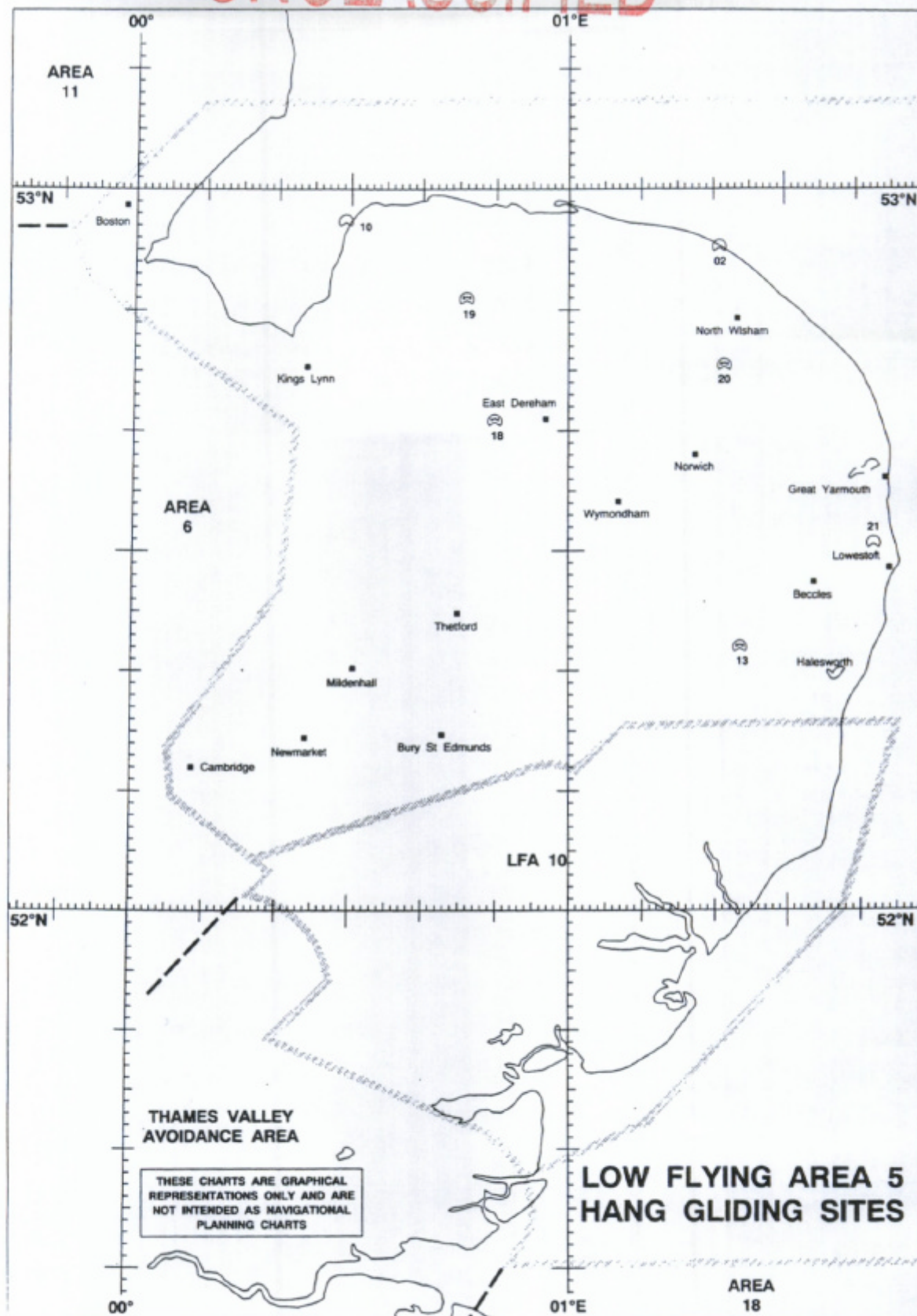


FIGURE 19

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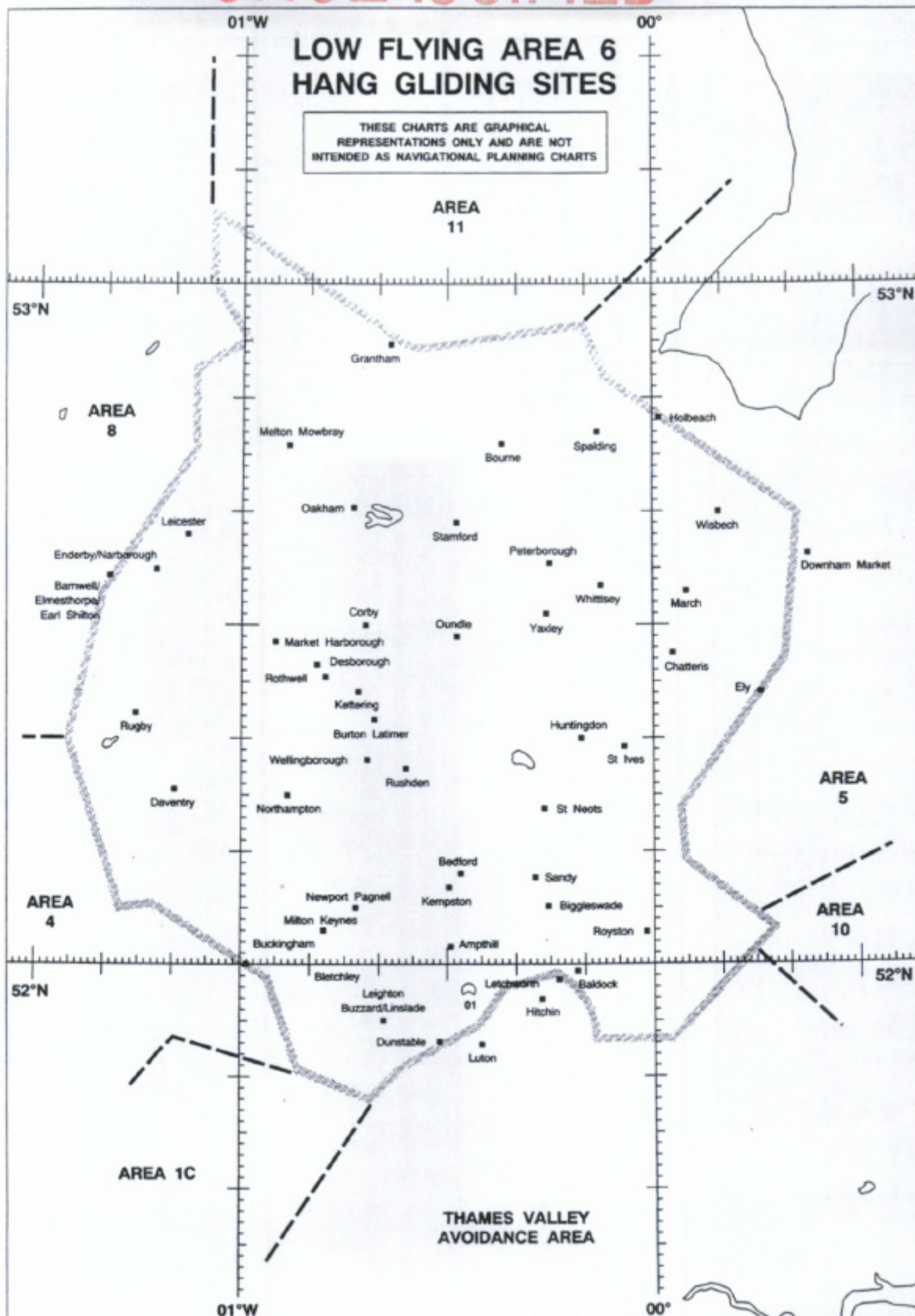


FIGURE 20

9-21

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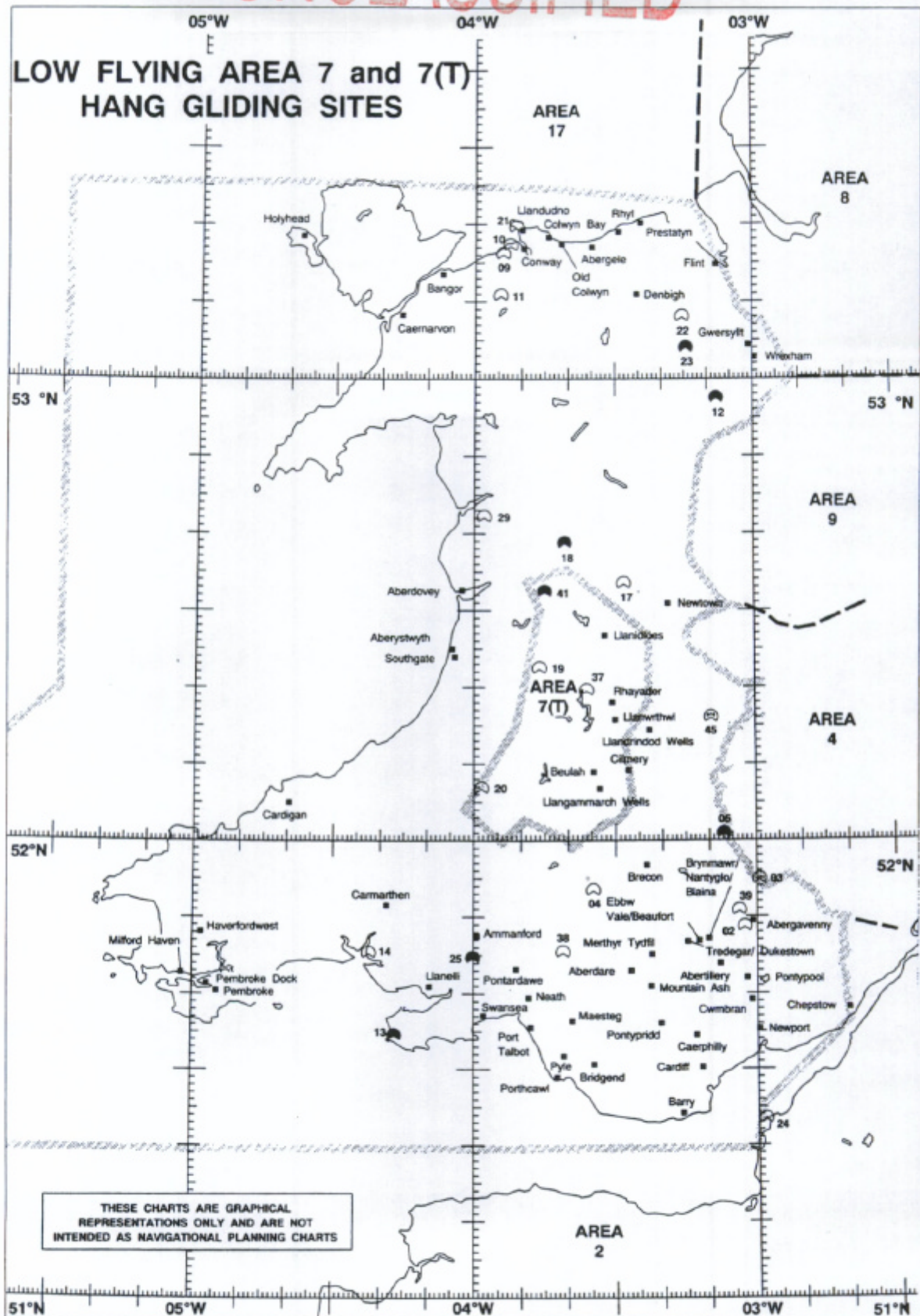


FIGURE 21

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THESE CHARTS ARE GRAPHICAL
REPRESENTATIONS ONLY AND ARE NOT
INTENDED AS NAVIGATIONAL PLANNING CHARTS

FIGURE 22

9-23

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9-23
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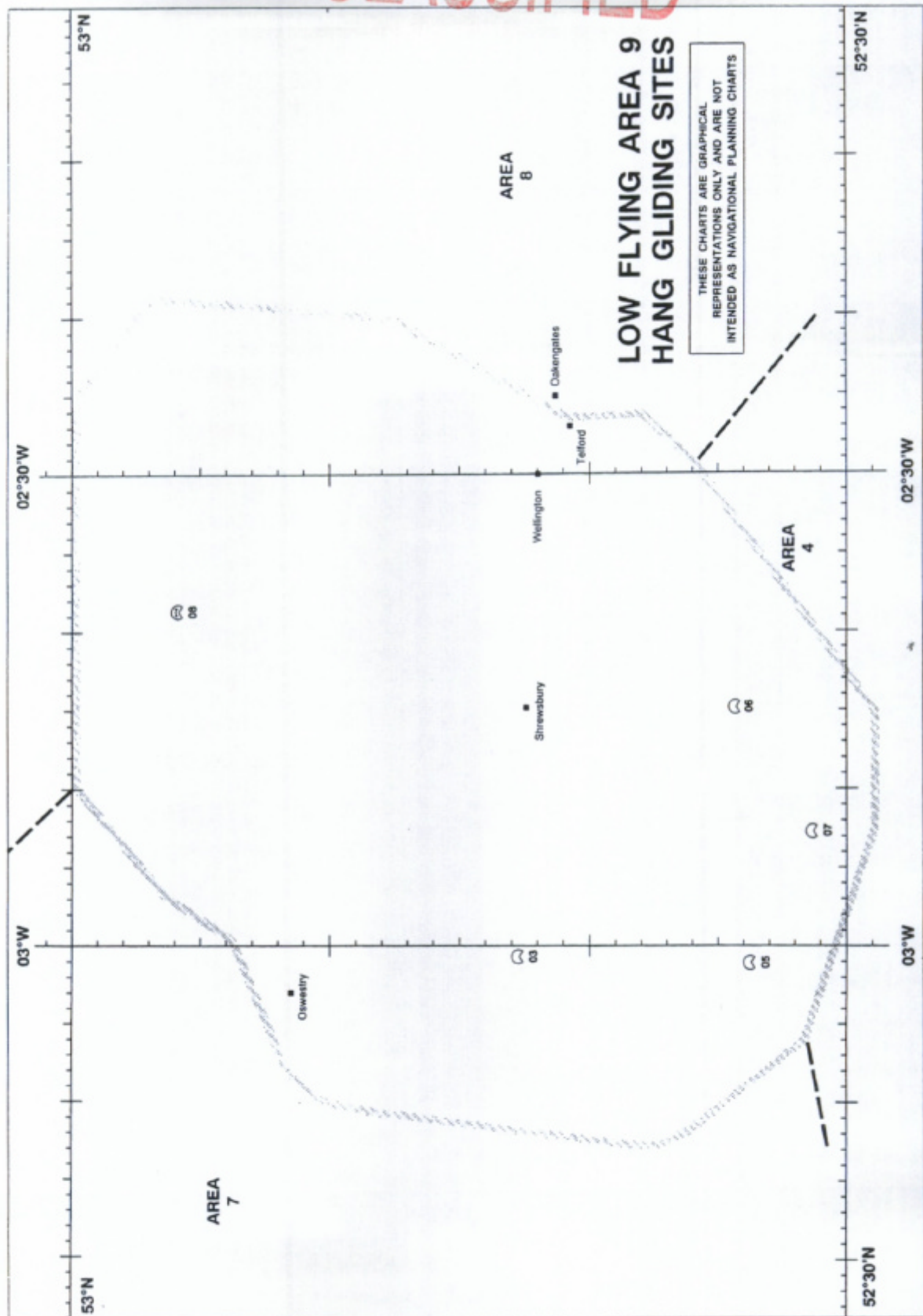


FIGURE 23

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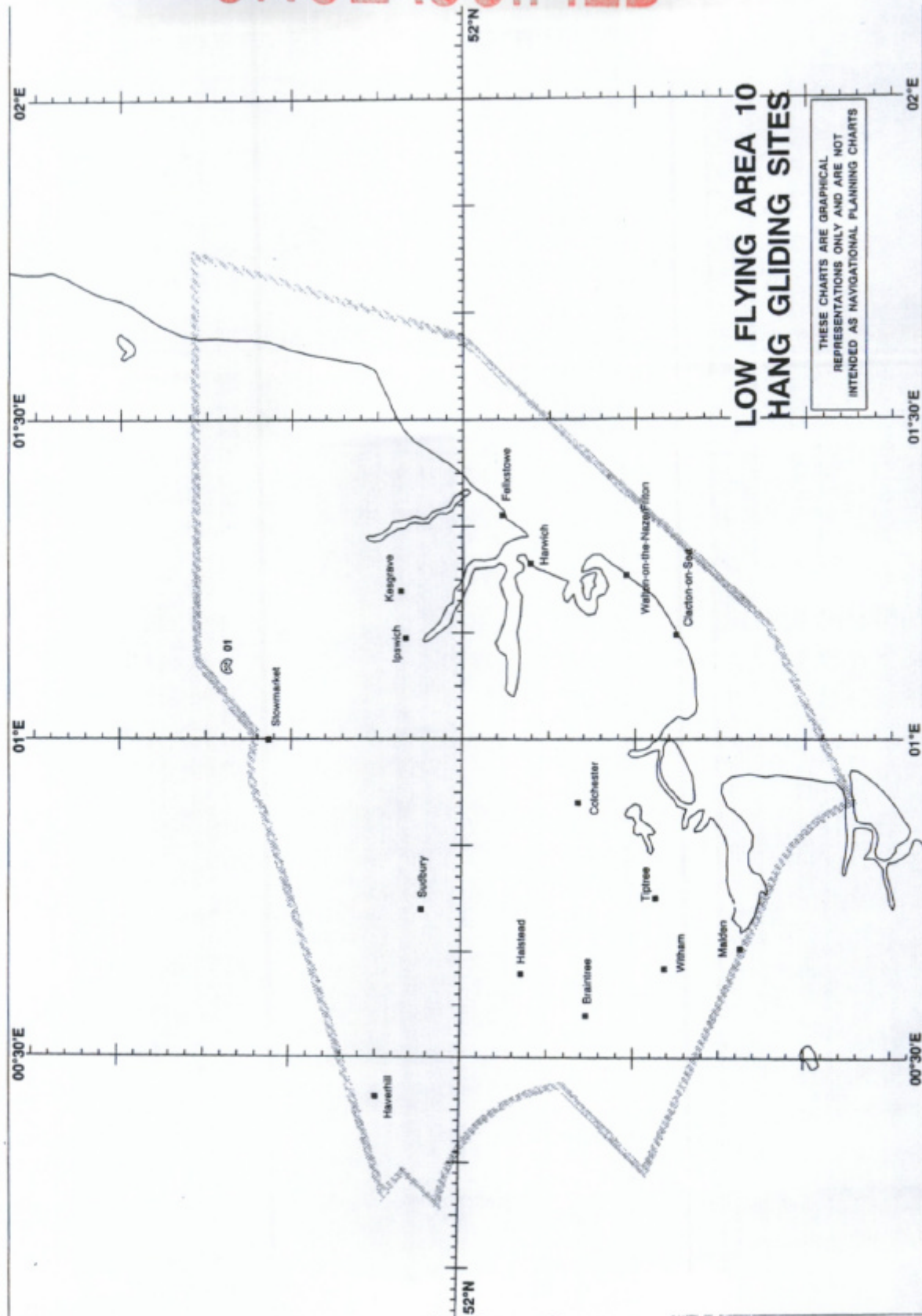


FIGURE 24

9-25

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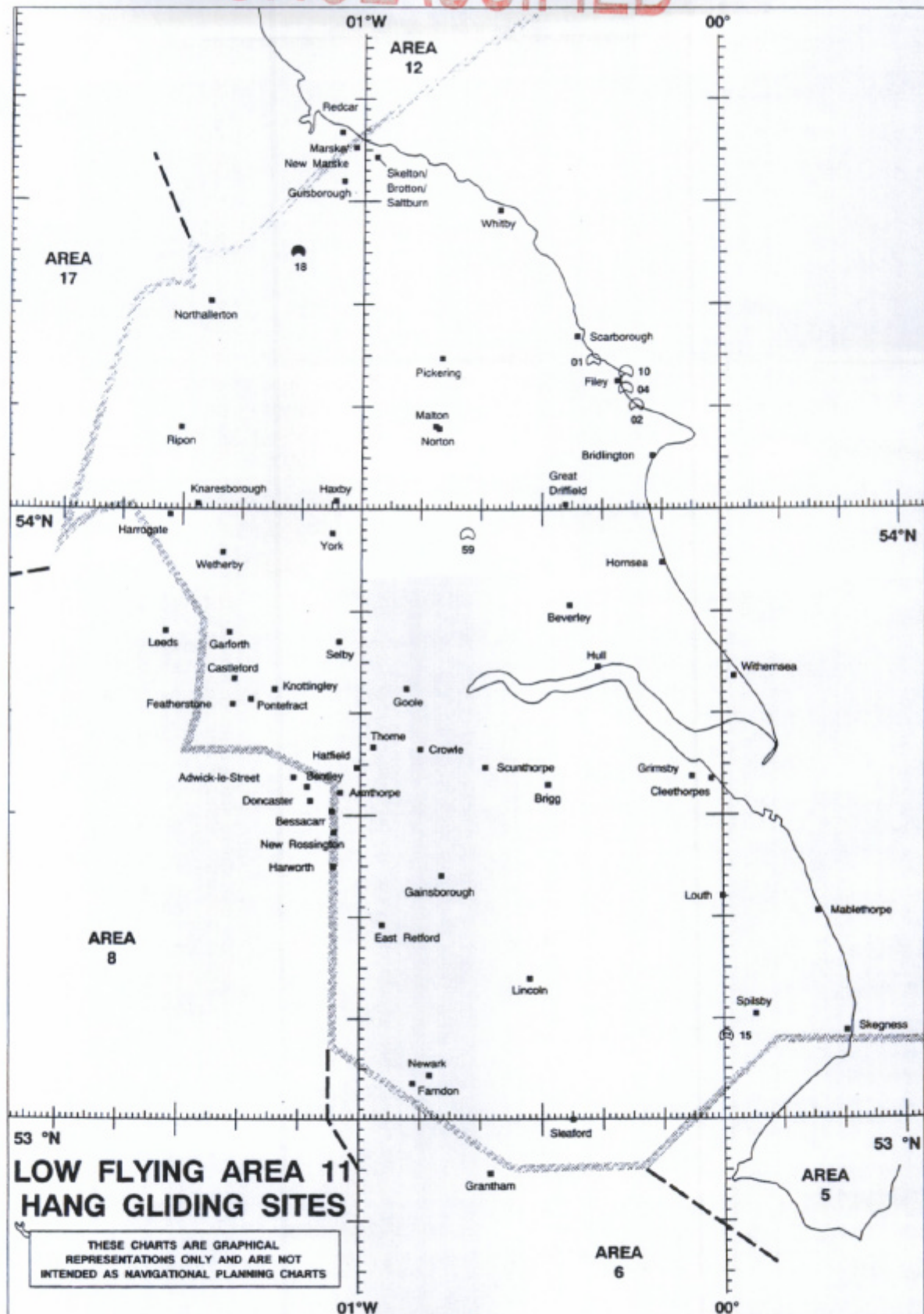


FIGURE 25

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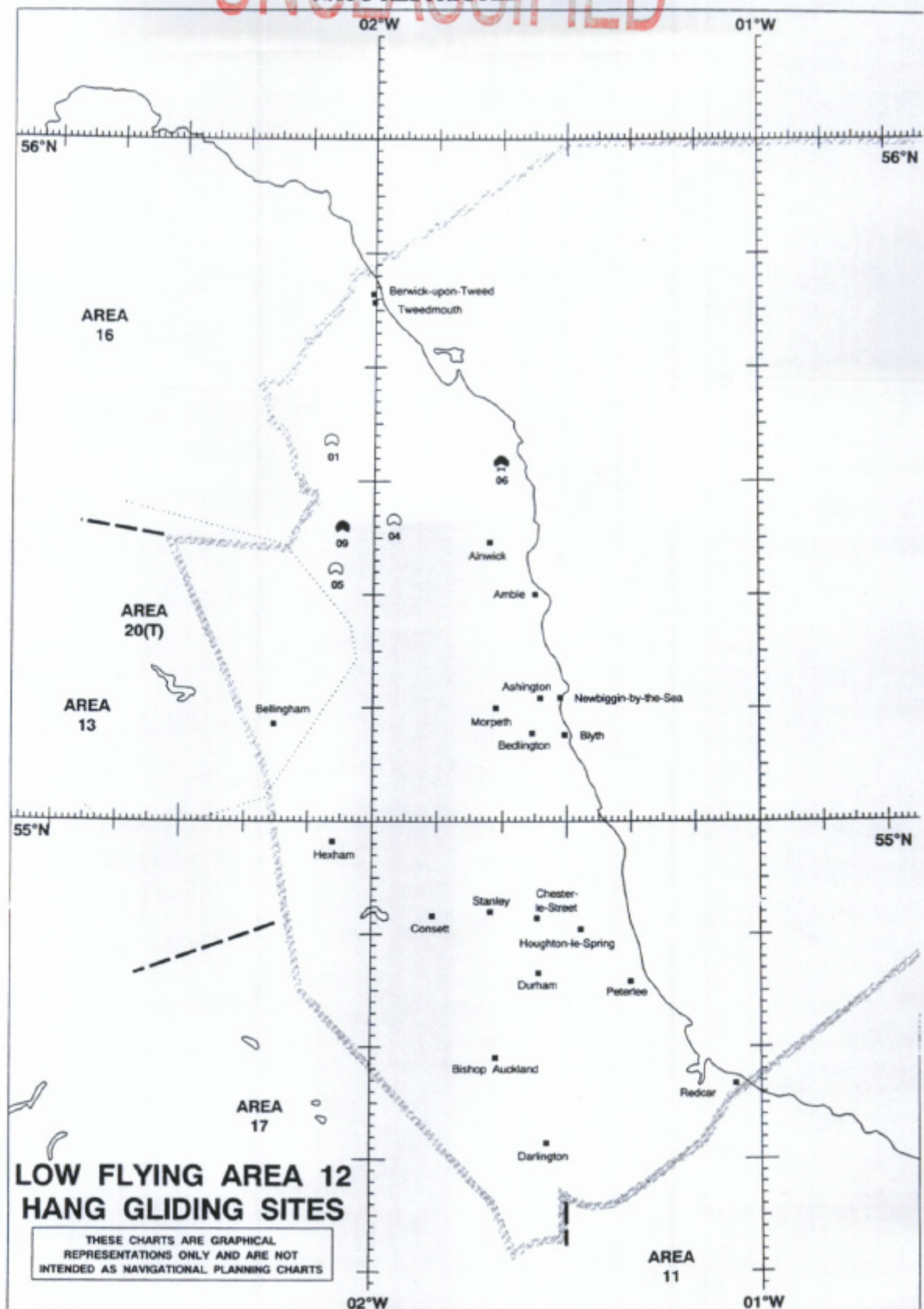


FIGURE 26

9-27
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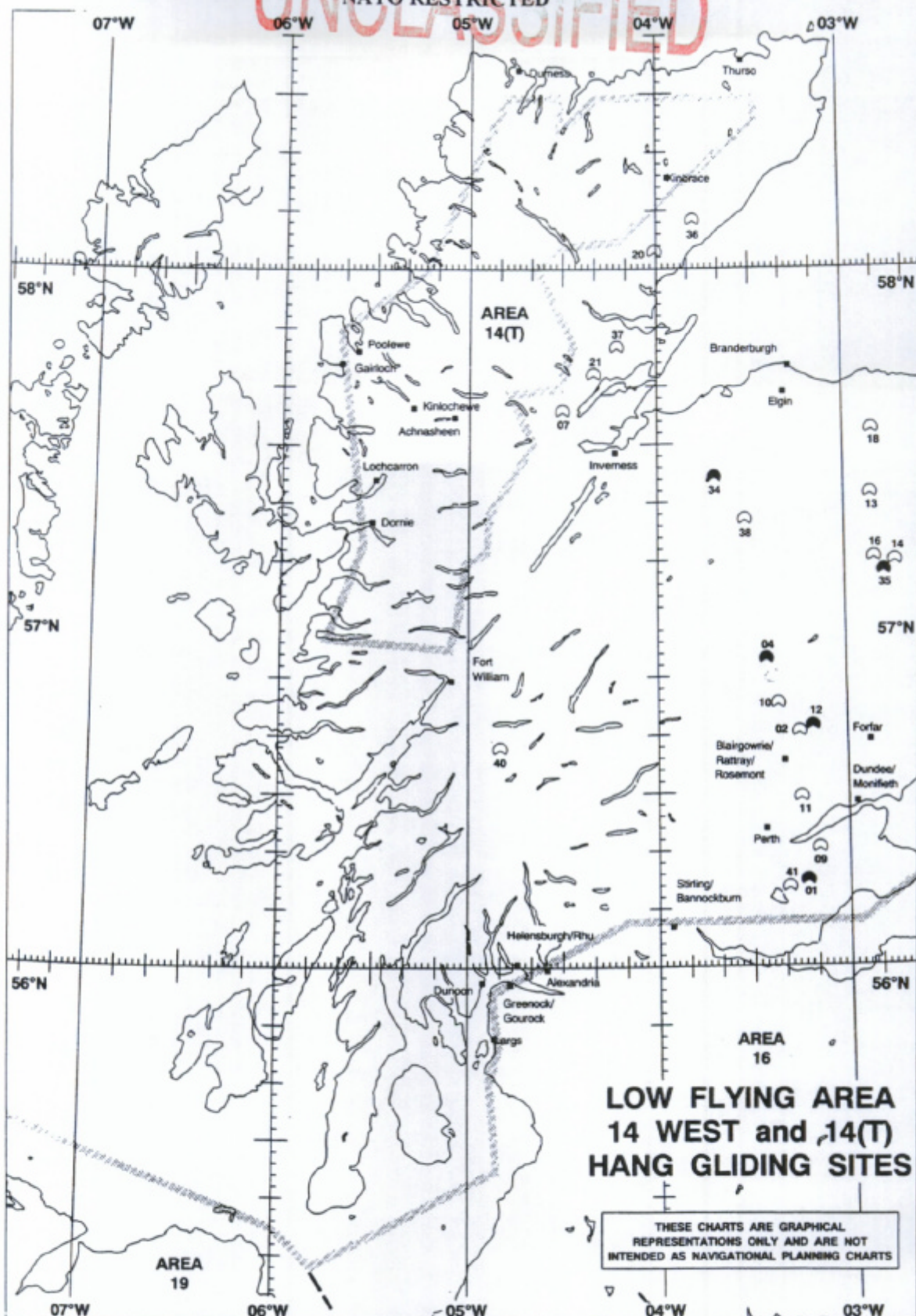


FIGURE 27

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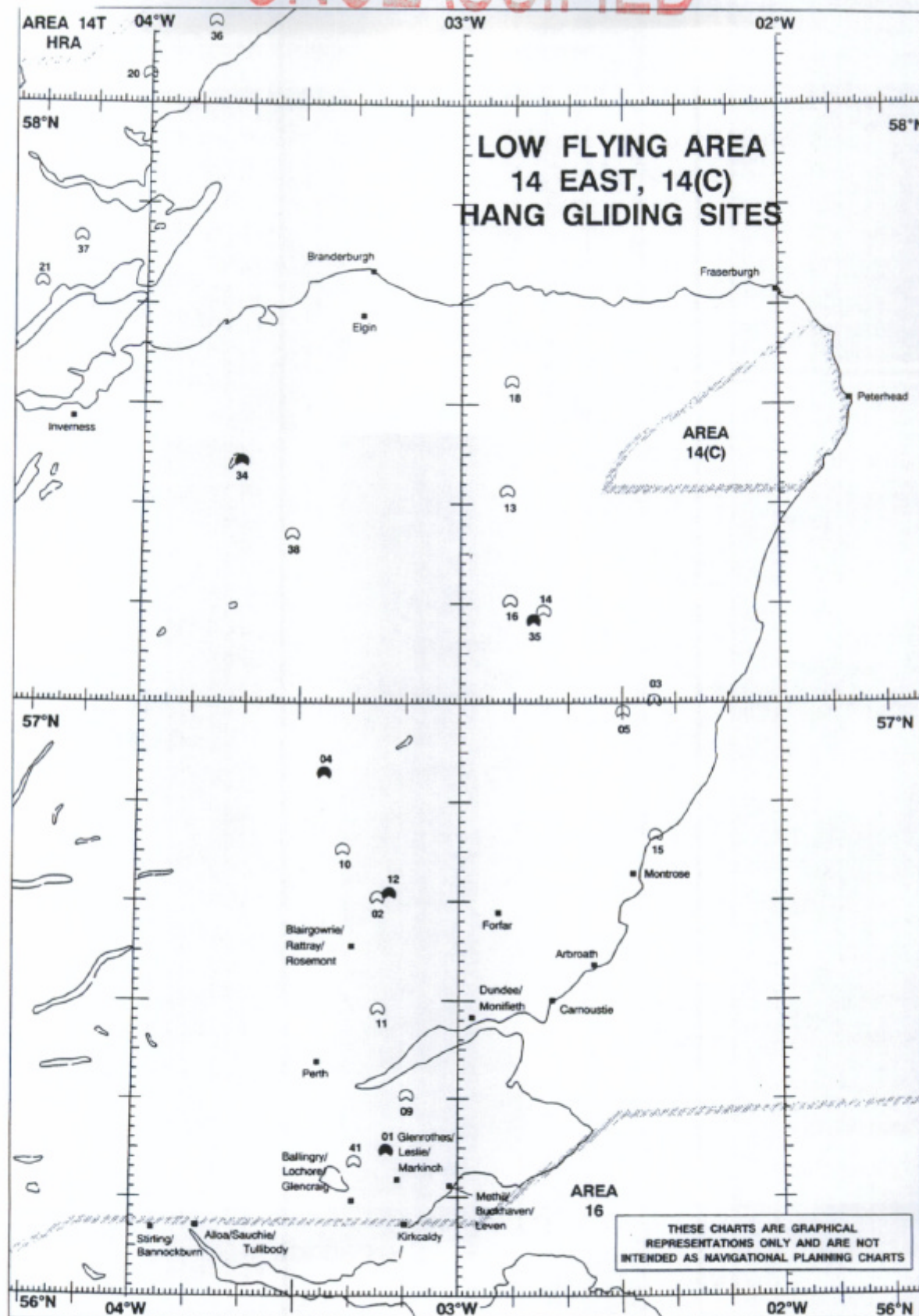


FIGURE 28

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NATO RESTRICTED

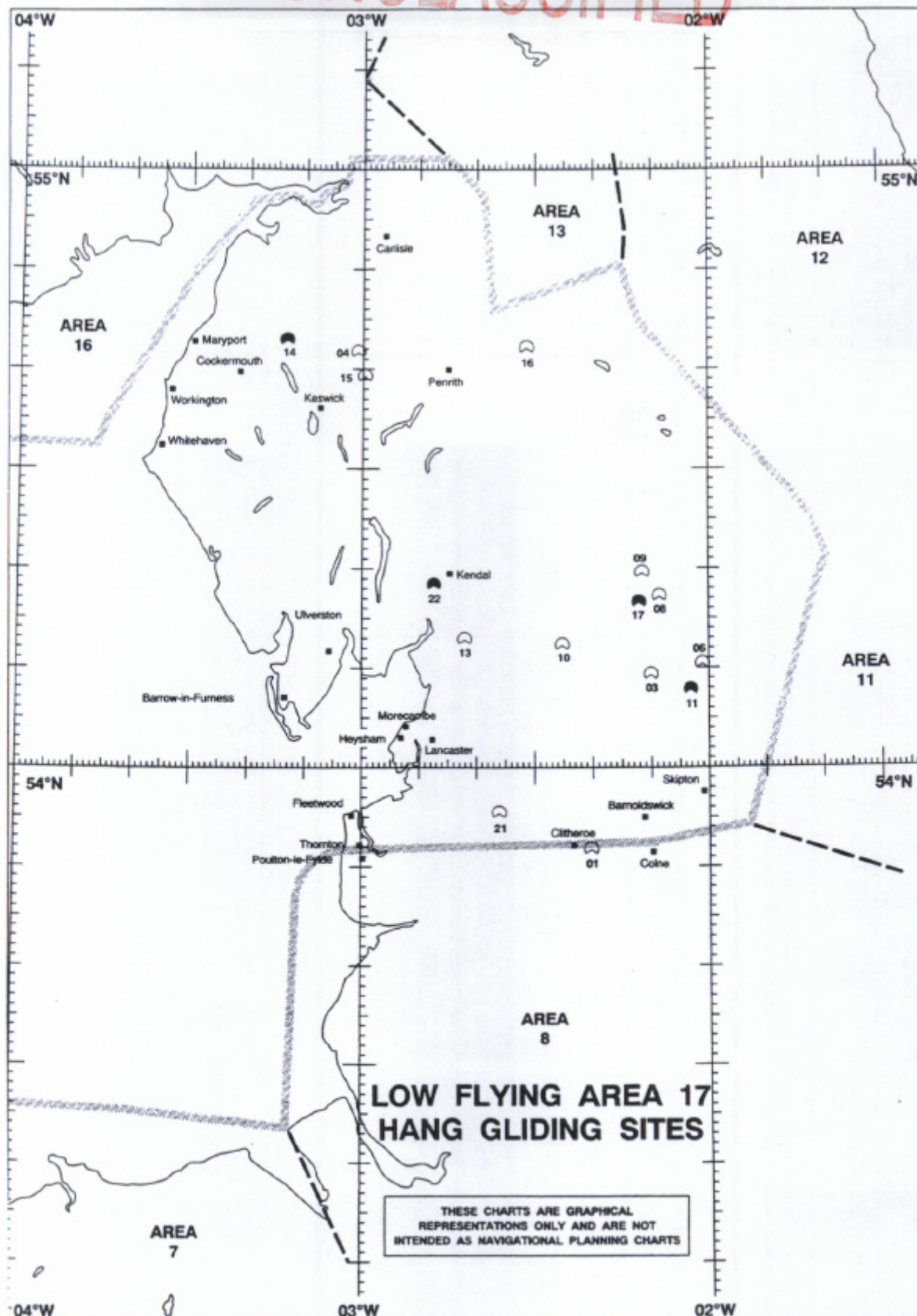


FIGURE 30

9-31

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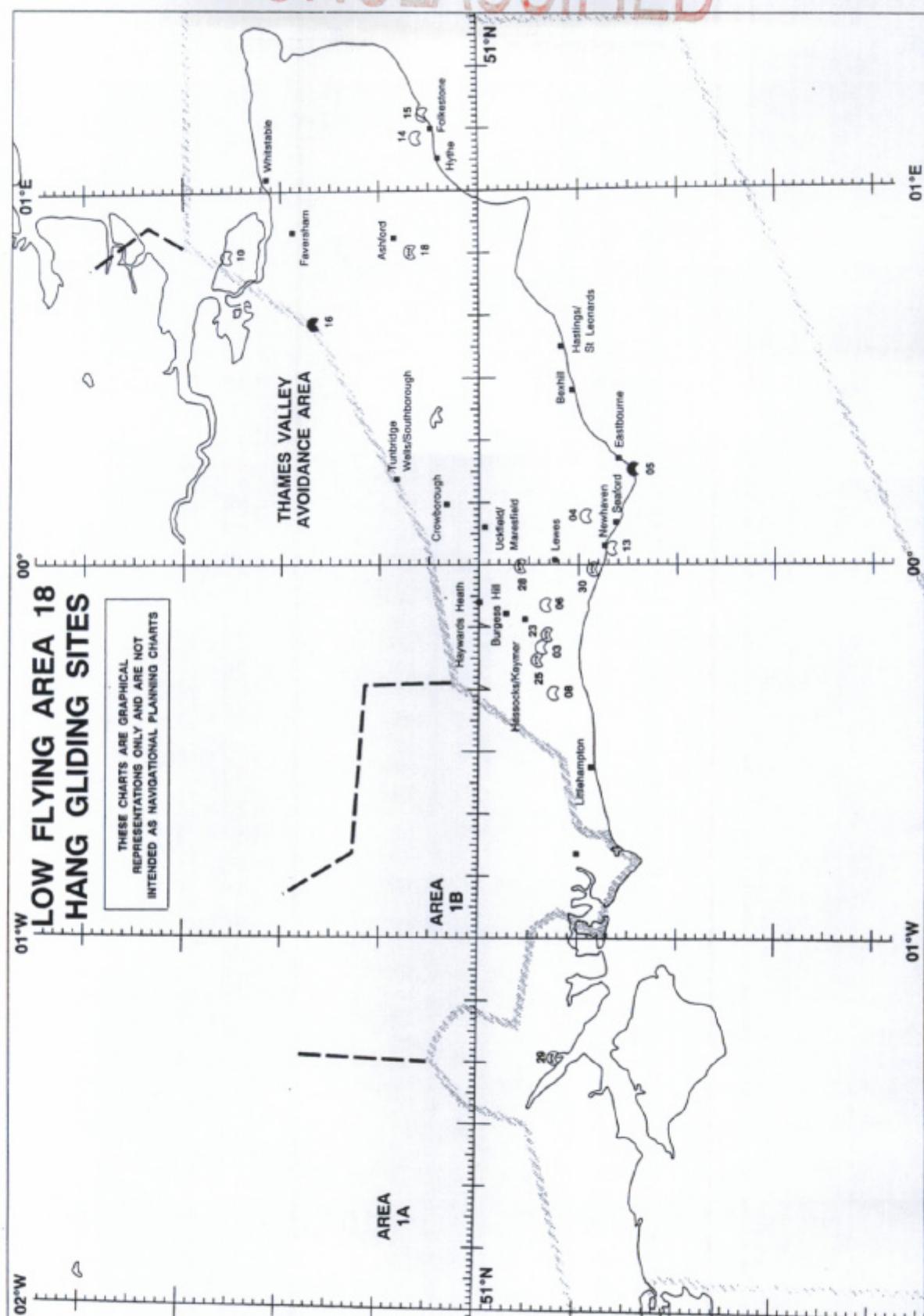


FIGURE 31

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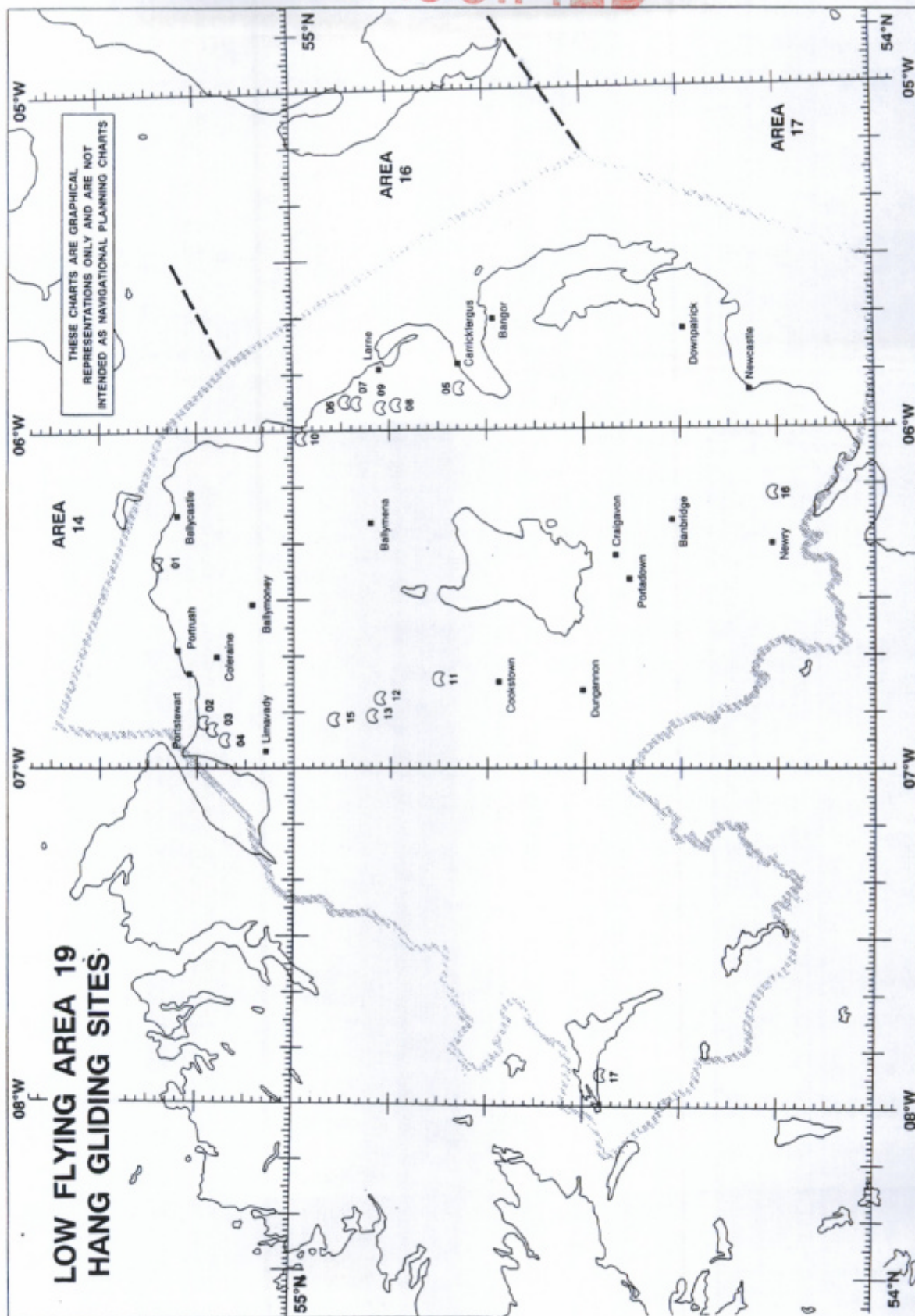
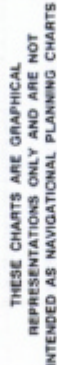


FIGURE 32

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DIS SCIENTIFIC & TECHNICAL MEMORANDUM 55/2/00

WORKING PAPER NO. 10

LEY LINES, EARTHLIGHTS AND UK EARTH FAULT LINES

	Para	Page
LEY LINES	1	10-1
Study Objective	7	10-2
ELECTRO, THERMO AND TRIBOLUMINESCENCE	10	10-3
EARTHLIGHTS	13	10-3
Summary	14	10-5
EARTHLIGHT REACTION	15	10-6
HISTORICAL	16	10-6
GEOLOGICAL	17	10-6

January 26, 2000

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LEY LINES, EARTHLIGHTS AND UK EARTH FAULT LINES

LEY LINES

1. This aspect is briefly investigated because of the suggestion that the location of 'LEY LINES' and UAP sightings may be linked in some way and even in coincidence. The name 'LEY LINES' was coined in 1921 from the old terminology the 'lay' or 'lie' of the land.

2. The suggestion of a UAP connection seems to have originated from a French investigator who postulated that there was a 'tendency for UFO sightings to appear in straight lines'[1] These were then called 'orthotenes'.

3. Further investigators ([2] and [3]) respectively linked archaeological and astronomical interests to the theory.

4. A Ley Line is stated to be a straight (or nearly straight) line which some have connected with ancient sites. These comprise hill forts, stone circles, earthworks (e.g. long burrows, mounds), stone markers, ancient abbeys and churches built on old pagan locations. The postulation is that these are found to be in alignment or near-alignment. There is other evidence that they often occur over water-bearing underground fissures. They are also supposedly associated with 'magnetic currents (or some type of unknown 'current' or 'force') which allow, for example, water to be located by some, while seeming to have physical effects on others. On occasions a plan of several ley line groups has (reportedly) shown replica astronomical patterns (e.g. BEAR). Numerous plots of these 'ley lines' can be made by simple

reference to ancient sites and markers etc. found on Ordnance Survey Maps.

5. The work was further followed-up by researchers who conducted considerable investigation into the geometry and alignment of ancient sites, such as stone circles, the results of which have suggested that these were accurately constructed (and that ancient civilisations must have had knowledge beyond expectation). In the UK much of this is based on 'accurate' measurements of standing artefacts (which often turn out to be spaced at multiples of ~2.72 feet - the so called 'megalithic yard' - a human pace!)

6. In the research briefly explored the alignment of three such sites is statistically invalid. Four-point ley lines are also rejected as inadmissible on the grounds of probability. However, 'ley lines' of many objects spread over many kilometres in length can be found.

7. **Rationale** The only significance in including LEY LINES in this UAP study was to note that (should clusters of sightings or lines of sightings appear) in the analysis, ley lines may be a factor, since some of the locations which form ley lines involve rocky formations. Hence, there may be a tenuous connection with tribo-or chemi-luminescence, where certain archaeological formations are said to produce visual effects when they fracture. There may also turn out to be some sort of connection with the earth's geomagnetic field. The action of rocks fracturing to produce light has been proven in laboratory experiments. One particular Norwegian location where this has occurred consistently, with similar rock formations to parts of the UK.

8. Hessdalen is a small valley in the middle part of Norway, South East of Trondheim. In that valley strange unknown lights first showed up hundreds of times between 1981 and 1985. It was given the name "The Hessdalen Phenomenon" and the project was linked with the Norwegian Defence Research Establishment.

9. In June 1983 "Project Hessdalen" started, the main purpose of which was to collect as much scientific data as possible. During the autumn a research programme was established, and the work in the field started 21 January 1984 and ended 26 February 1984. A research station was set up in Hessdalen, with eight different kinds of instruments:

- **Camera with grating**
Three pictures showed a continuous spectrum but no spectral-lines were seen.
- **IR-viewer**
This instrument was used too little to draw any conclusions.
- **Spectrum-analyser**
Sometimes there were electromagnetic signals with harmonics of about 80MHz.
- **Seismograph**
No local seismographic activity was detected. [This, of course is contrary to the expectation of the effect being initiated by normally detectable seismic activity].
- **Magnetograph**
The magnetic field did sometimes change when the lights showed up. There also seemed to be a correlation with the magnetic pulsation.
- **Radar**
The lights could be seen on the radar. The speed varied

all the way from 0 to 30,000 km/hour. Sometimes the radar saw something moving at a low speed, but no lights were seen by eye. Clearly, something was there, but only the radar could detect it.

- **Laser**

A laser-beam was directed toward the light and the behaviour of the light reportedly changed. Out of nine occasions the light changed on eight attempts, and reportedly reverted to the original state when the laser was switched off. There could, of course be several interpretations placed on this phenomena [the most bizarre of which is that known as a 'Close Encounter of the 5th kind' - see Volume 1 of this report]. A more realistic explanation may be that the laser light, being coherent, interacted with the light/energy supplied by the 'earthlight' to produce a different colour for the human observer - which would then clearly revert to its original colour unless some other more permanent or ongoing change was taking place anyway - for example a decay in the energy of the airborne mass.

- **Geiger-counter**

No radioactivity was detected. But the source was 1km away when this instrument was used. Sometimes the lights at Hessdalen lasted for more than two hours in one place before they moved. Literally hundreds of instances have

been reported, six to seven times a week and two to three times a day.

Despite all the blanks drawn during the investigation some 20 scientists researched the phenomenon during 1994 and their reports were either not completed or not available at the time this MoD study was made.

ELECTRO THERMO AND TRIBO-LUMINESCENCE FROM ROCK FORMATIONS/EARTH FAULTS

10. Statistical studies have shown [1] that geology and UAP events seem to be linked. Research [2] in 1977 confirmed that (French) events reported over 25 years correlated with locations of rock formations and a similar study in Leicestershire (1972-1977) gave almost the same statistical results. In 1981 the US Bureau of Mines carried out experiments in which granite core was crushed under darkened test conditions in which recordings were made and a line was established between anomalous aerial lights and geological sites.

11. Although these luminous effects were earlier attributed to piezo-electric action several other scientific explanations have been proposed, including natural radioactivity, cosmic rays and light from thermo or tribo-luminescence. The latter would involve reactive electrons moving between conduction and valence bands in three-dimensional lattices and which contain defects. Some connection with tribo-luminescence is also reported - a simple example of which would be the electrical charging of materials by friction - which can be manifested as static discharge. Tribo-luminescence is the emission of visible radiation due to frictional forces - in effect 'cold light emission'.

12. Example fault lines where 'Earthlights' have been seen are shown at Figure .5. It is clear from other sources [3] that sightings are often directional rather (as

might be expected) omni-directional, that the observer must normally be within a few hundred metres of the phenomena and that the lights appear within a few hundred metres of the local earth fault-line. Overseas, particularly in the USA, there is evidence of increased UAP sightings in areas of tectonic volatility - for example in the Cascade Mountain Range in Washington State. The description of these correlates with light seen in Leicestershire, first prior to the 1957 UK earthquake.

EARTHLIGHTS

13. The phenomenon of 'earthlights' is based on the fact that physical and electrical forces accumulate in areas of seismic activity, possibly over weeks or months, and the resultant stresses in rock formations finally result in rock fractures. At the moment of fracture (and proved by laboratory experiments) these produce electrically charged particles before bursting, which is manifested as light when the fracture occurs. Whereas an earthquake releases energy in a major form, pre- and post-earthquake stresses are the likeliest time for earthlights to be reported. It is claimed that this anomalous light phenomenon occurs:

- (a) Along the earth's faultlines.
- (b) At ± 2 km from the faultline (although usually within 30m and exceptionally 20km from an epicentre).
- (c) At land or sea (underwater faultlines, for example, Loch Ness, Loch Tay) overwater the lights have sometimes been described as green and globe shapes have been said to change to triangles.

- | | |
|--|---|
| (d) When exceptional meteorological conditions are present. | - Discoids |
| (e) When increased man-made pollution (air particles capable of holding a charge) are present. | - Spheres (Globes, Boloids and Orbs) (see also (c) above) |
| | - Tadpoles (square front with tail). |

- (f) When there is a gaseous presence or chemiluminescent (i.e. rock to rock friction) also occurs.

These can all flash, 'flutter', 'flicker' or 'flip' in motion. Occasionally they are described as 'basketball' size, but diameters of 8 to 100m have been reported.

The key characteristics are:

- | | |
|---|--|
| (a) Balls, streaks, sparkles or phosphorescent arcs, v-shaped formations or 'boomerangs'. | (h) More than one light can move together, leading to the supposition: |
| (b) Lights that change shape, fly, occur near the surface or at height and are often described as 'danced', 'chased' or 'merged'. | - That they are on each extremity of a solid object. |
| (c) Mostly reports are likely at night, even though the phenomena occur in daylight. | - That they have some sort of field present which regulates their spacing. |
| (d) An (apparently) ionised shape is formed. | (i) Lights can merge or split, giving, according to some reports, the impression that they are 'intelligent' (see also para 15 below). |
| (e) Sounds are sometimes heard. | (j) Between lights in a cluster there is the appearance of blackness in outline. Three lights, for example, give the appearance of a solid triangle and four a rectangle. The outline of the shape can be clearly seen as 'blackier' than the background (i.e. absolute absence of light). |
| (f) An emission of EM waves (or other unknown energy fields) are present. | |
| (g) Shapes appear and disappear and normally take the form of: | (k) Lights may move towards a witness when approached. |
| - Triangles 'with rounded corners' | |

(l) Lights seem to be attracted (frequency of occurrence is apparently higher) near to:

- Mountain peaks, quarries, rock ridges, caves and mines. (20 years of sightings in the 1920's era in Chipping Norton area of Oxfordshire and in Ironstone quarries of Banbury e.g. 1923).
- Power lines, transmitter towers.
- Water.
- Areas of mineral deposits.

(m) In daylight they appear as 'metallised' discs, hazy glows or haloes or 'cloudy cigar shapes', but colours have been reported, mainly as amber-yellow and white; with rapid colour changes. When red is reported the core is often described as red. A well reported example appeared on the Fakenham-Norwich road in 1908, lasted 20 minutes, had a red core and was 50-60ft high.

(n) Low-level seismic activity is apparently necessary.

(o) The phenomenon appears to be 'weightless'.

(p) Some can be seen on radar - others not. (see Working Paper 5 & Volume 3)

SUMMARY

14. Some comments can be made about the long list of earthlight attributes above.

(a) Electroluminescence is understood to be the release of luminous energy from rock when electrons move from higher to lower energy levels due to friction.

(b) Fault lines and 'ley lines' often coincide, as do the ancient buildings (stone circles, religious sites (often Christian churches, built over former Satanic worship sites, etc.).

EARTHLIGHT REACTION

15. It is noted (at para 8-Hessdalen) that the earthlights reacted when remotely irradiated with a laser. (No further information is available, as the Hessdalen report is still in the process of being published. It is of interest, however, that a Ship's Captain (in the Baltic Sea) claimed (in 1951) that earthlights were triggered 'on' by his ship's radar. The lights "took the form of phosphorescent arcs which gyrated clockwise and anti-clockwise". Working paper No. 24 on 'SPRITES' considers this phenomenon further.

HISTORICAL

16. It is of interest that the phenomena of earthlights has been observed for, perhaps, thousands of years. In medieval and Victorian times these were variously described as 'Spook Lights', 'Luminous Vapours', 'Fairy Lights' (Ireland), 'Fireball Spirits', 'Kitty Candlestick', 'Ignis Fatuus', 'Jack-o-Lantern', 'Boggarts', 'Dragons', 'Will-o-the-Wisp', 'Corpse Candles' and 'Orbs' (Windsor Castle early 1990s). It seems likely that what is seen becomes matched to the understanding of the day. What was once a simple type of

misunderstood apparition, becomes a spacecraft or similar 20th Century-related technology entity. They were frequently connected with swampy or marshy conditions on the one hand and described as having a yellow core, violet edge and sometimes red. More recently some have been attributed as being methane-based (CH_4) with a trigger of P_2H_2 (hydrogen phosphide).

17. As a sample of the pedigree of what is reported today, much further back (AD 584) brilliant rays of light which seemed to collide were reported and (in AD 585) 'rays' or 'domes' were observed in France. On 3 August, AD 989, three brilliant round objects were seen to join together. A fire breathing dragon came out of the sea. In Japan a 'spinning ball of fire like a red wheel hovered' - with many witnesses. While from the terrace of Windsor Castle on 18 August 1783 four eminent scientists (including Fellows of the Royal Society) observed and reported (Philosophical Trans. Royal Soc. 1784) an object which hovered, moved, changed luminosity and changed shape, brightened and finally, exploded. [This, in fact was probably ball lightning rather than an earthlight]. Other historical earthlight areas (which will be relevant when a database analysis is done for the present day) are:

- Llambert, Barmouth and Harlech (see Ley Line/Fault Line map) and Llangolan. (40 mile wide strip).
- Haverfordwest, St. Brides Bay, Milford Haven, 'Stack Rocks'.
- Colwyn Bay to Shotton (24km wide extension inland).
- Denbigh (e.g. 1979 and 1984).

18. During the Second World War what were (now understood) clearly earthlights were reported by Commander-in-Chief Devonport. In 1915 Naval Intelligence investigated phenomena (feared to be of German origin) both in the Warminster and Dartmoor areas and further displays are recorded in 1981 at the Standing Stones of Drizzlecombe. Similar phenomena are reported in the USA. These are often reported for several days, weeks, or months in a particular area - after which they are not seen again, perhaps for years.

19. It appears that there may be more than one type earthlight since medieval miners were well aware that their interest in the phenomena was the proximity of earthlights to copper and iron ore.

GEOLOGICAL

20. As an aid to the statistical analysis of locations of UAP reports, Figure 8 shows the geological structure of the UK. This may be required if it becomes necessary to:

- Isolate what are believed to be earthlights to specific geographic and geological locations and types of rock formation.
- Further correlate (and thus eliminate those UAPs) with rock types known to produce earthlights when under seismic stress, (as it is suggested that low magnitude seismic disturbance may be sufficient to provide the conditions for light phenomena).

21. **Fault Systems** There are several Earth Fault-Systems which cross the United Kingdom. The location of these is shown for the whole country (known as the DENT Fault System) at Figure 9.

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BIBLIOGRAPHY

- [1] "Flying Saucers & the Straight Line
Mystery Criterion" Michel Aime
1958.
- [2] "Ley Lines in Question" Williamson &
Bellamy ISBN 0437-19205-9.
- [3] "The View over Atlantis" J. Mitchell
SAGO Press 1969.

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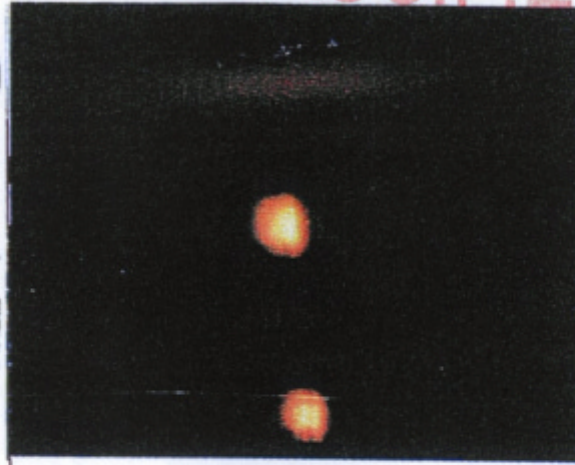


FIGURE 1: UK EARTHLIGHTS (OR POSSIBLY BALL LIGHTNING)

NOTE: Location Carleton Moor, Skipton, Yorks, police photograph (copyright Sgt. Anthony Dodd)



FIGURE 2: PROBABLE UK EARTHLIGHT (OR PLASMA/AEROSOL OR CHARGED PARTICLE VORTICE)

NOTE: location Rossendale, Lancs. (copyright David Milner)

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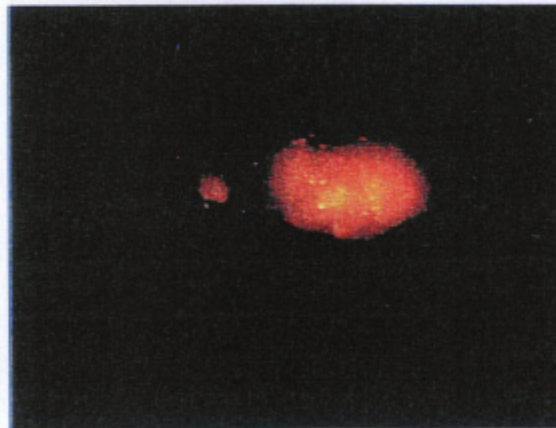


FIGURE 3: TRIBOLUMINESCENCE

NOTE: Laboratory-produce as a result of rock crystal fracture (copyright P. Devereux)

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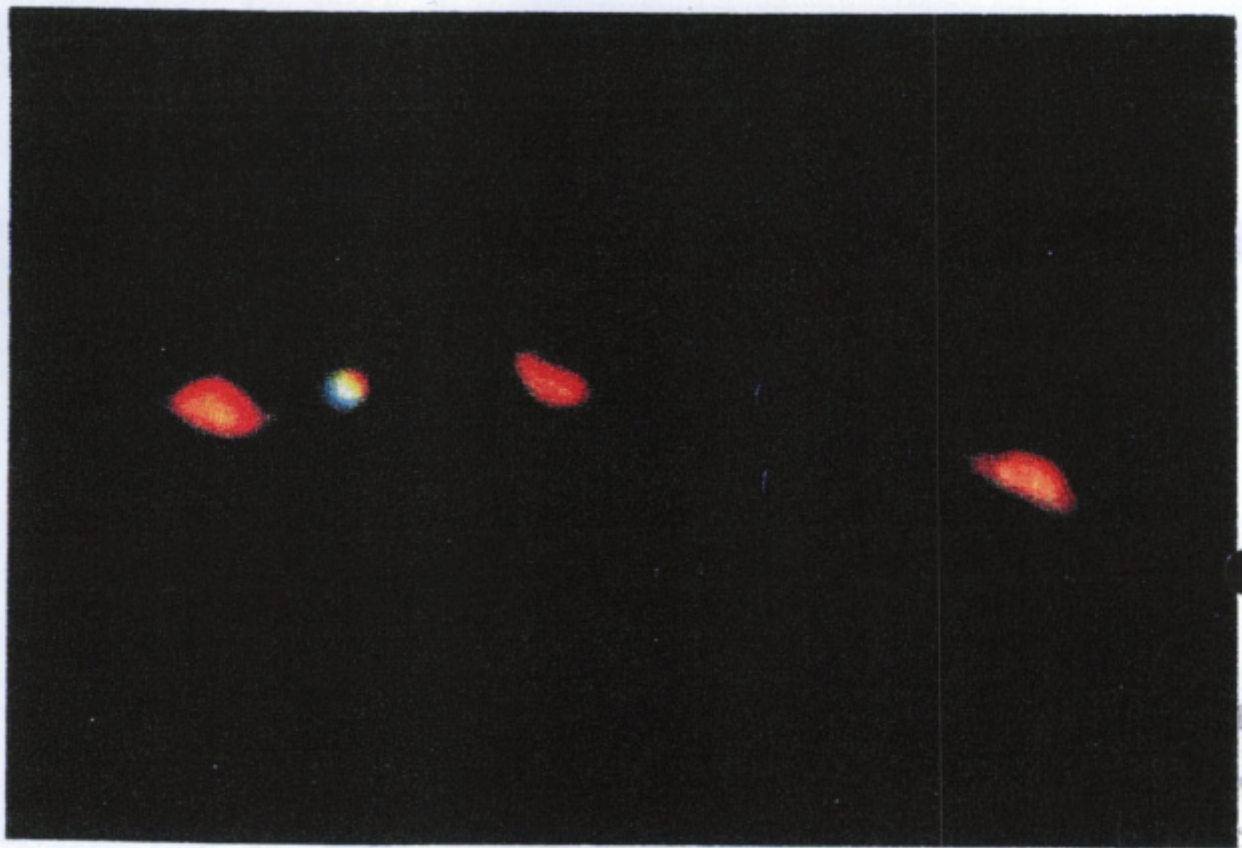


FIGURE 4: EARTHLIGHTS

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FIGURE 5: UK EARTHLIGHTS LOCATIONS (P. DEVEREUX)

NOTE: Frequent earthlight reporting areas shown as stars. Larger stars indicates greater frequency of sightings.

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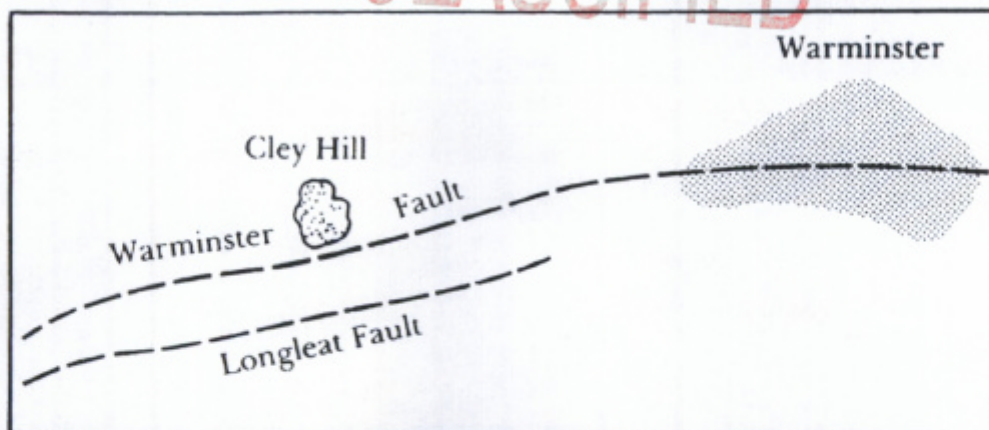


FIGURE 6(a): CLEY HILL FAULT-LINE (NEAR WARMINSTER) (P. DEVEREUX)

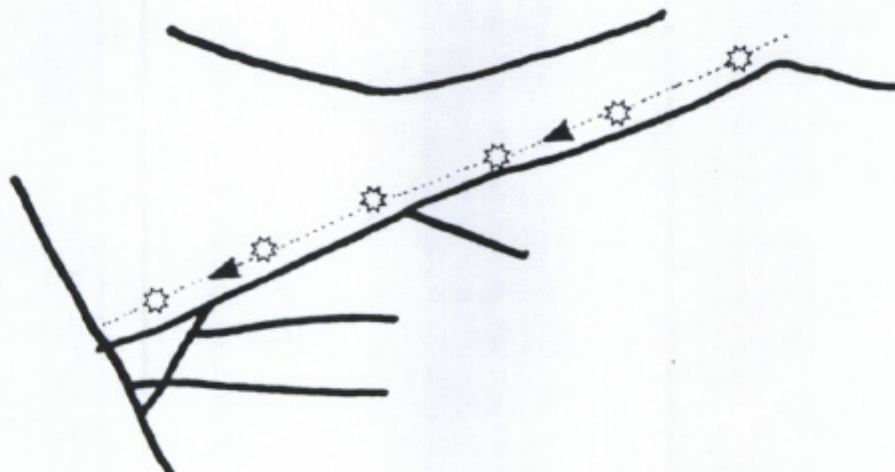


FIGURE 6(b): EARTHLIGHT 'BALL'/BALL LIGHTING COURSE (P. DEVEREUX)

NOTE: 1984 Wrose to Thackley (near Shipley). faultlines solid, phenomena track dotted.

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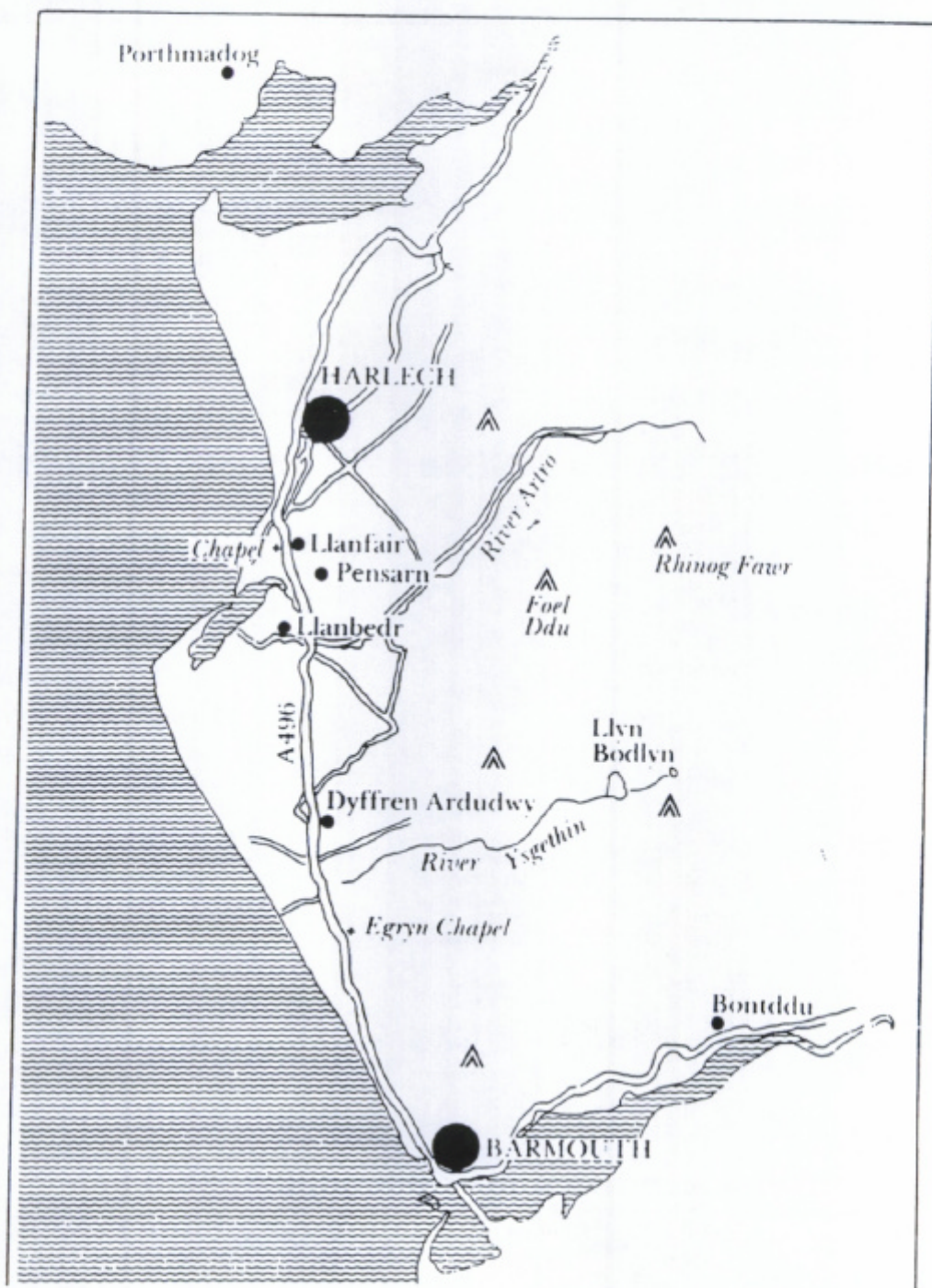


FIGURE 6(c): FAULTLINE BARMOUTH-HARLECH, WALES

NOTE: Particular earthlight activity 1904-5 and since.

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FIGURE 7: 'PROJECT PENNINE' EARTHLIGHT LOCATIONS

NOTE: A simplified sketch map of the area of the Pennines found by Project Pennine to harbour zones of repeated earthlight activity.

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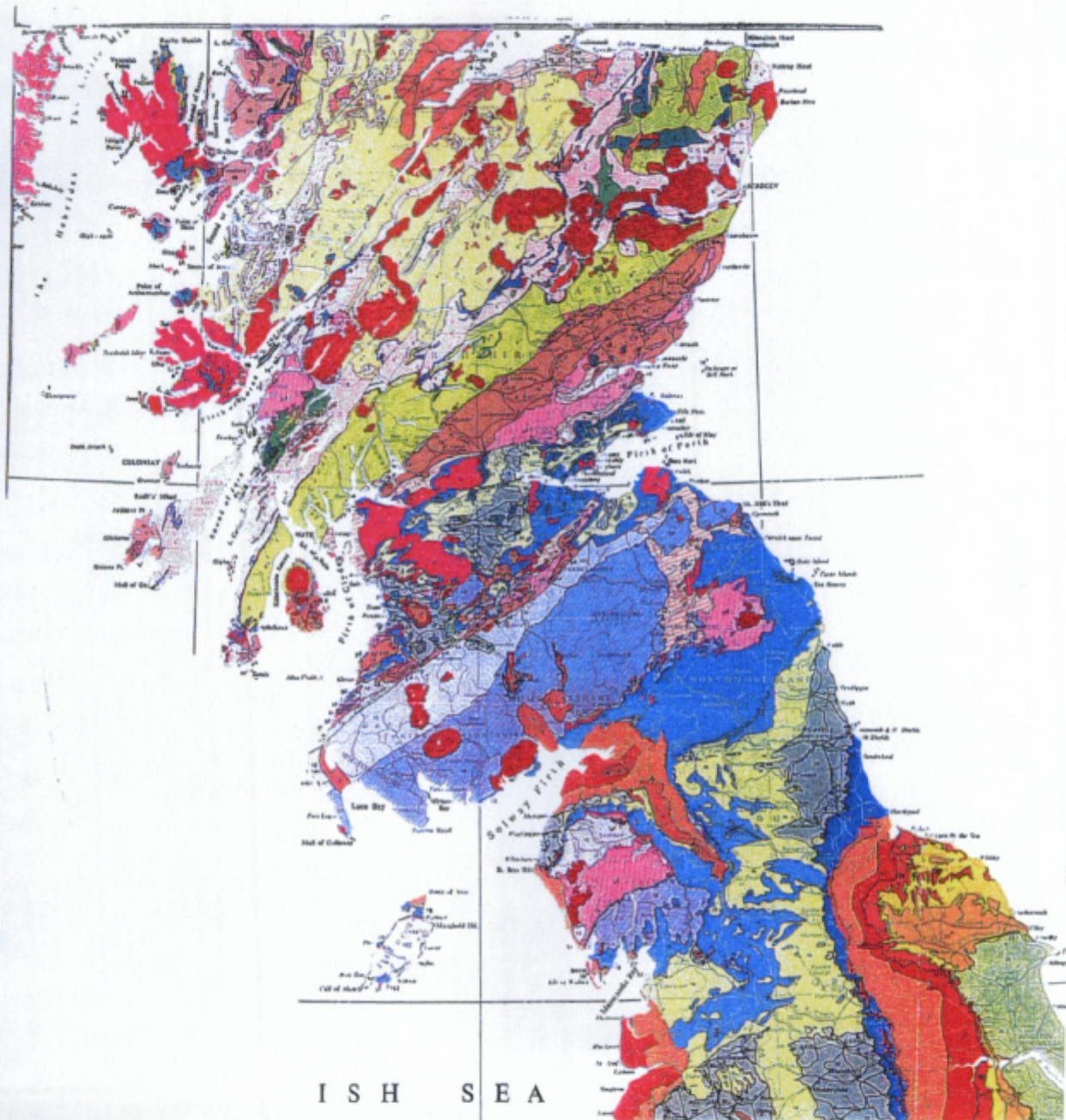
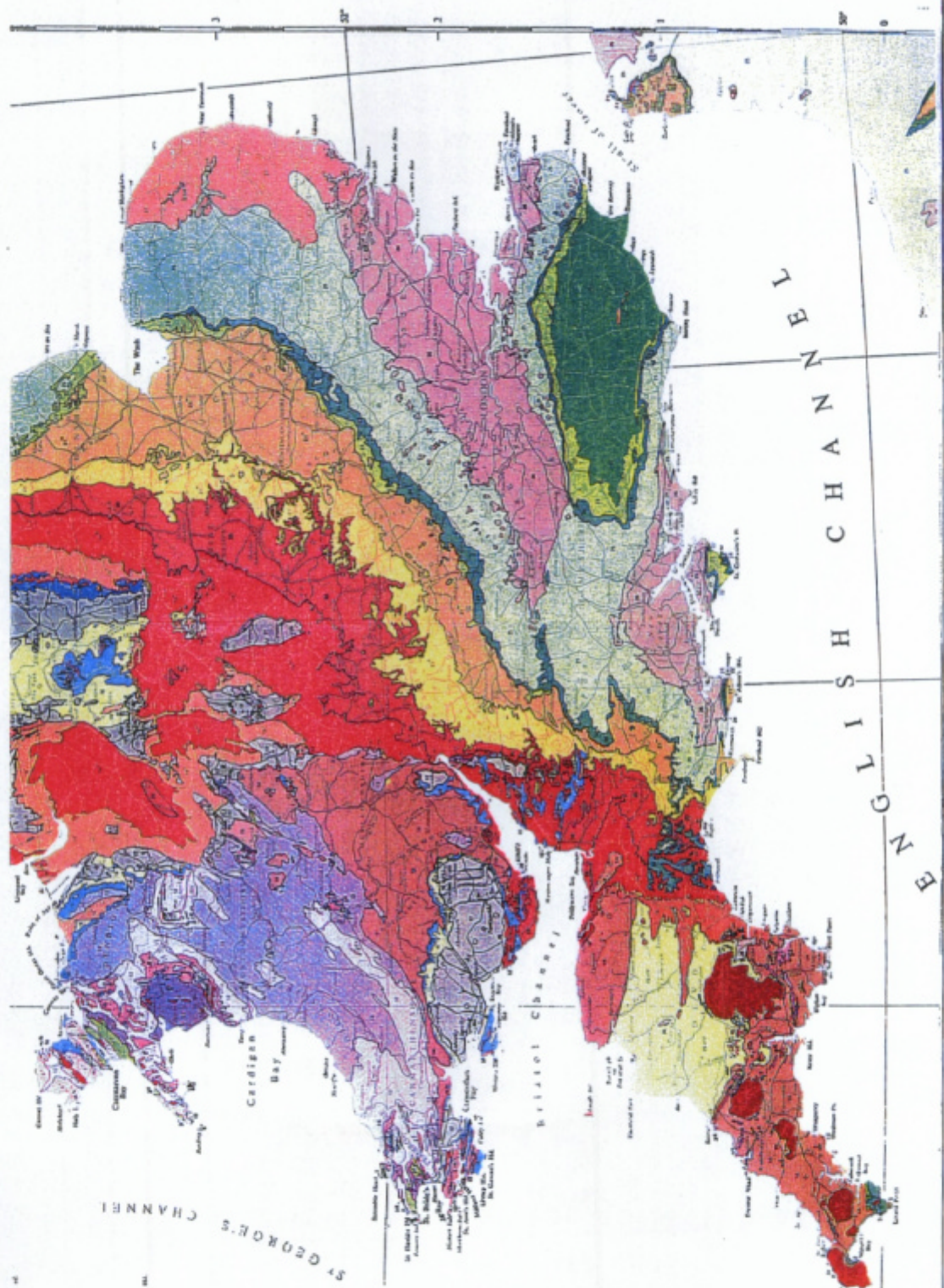


FIGURE 8: Geological Structure of UK

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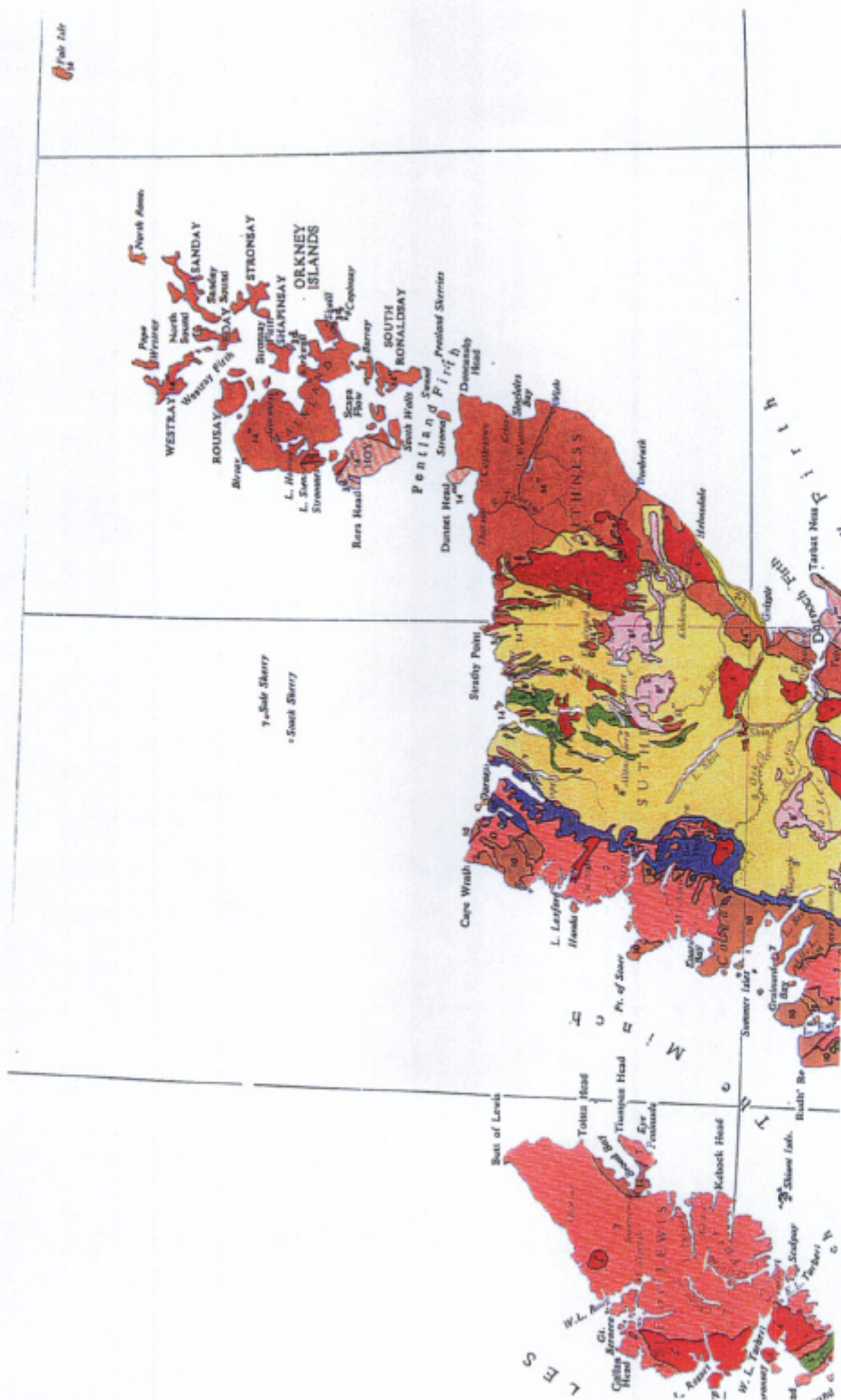
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INDEX

CENOZOIC, TERTIARY AND QUATERNARY	MESOZOIC	75	Pliocene (marine) and Pliocene	Shelly soft sand and clay
		76	Oligocene and Eocene	Sand and clay, loam, limestone bands, shell-beds and pebbles
		77	Chalk	Variable limestone with soft and hard beds, flint and marl; all hard and non-fractile in N. Ireland
		78	Upper Greensand and Gault	Diff. blue-grey clay partly overlain by fine-grained green sand or sandstone
		79	Lower Greensand and Speeton Series	Variable coarse sand and clay, with limestone
		80	Wensley	Alternations of clay and fine-grained sandstone
		81	Oolite	Mainly clay with limestone and sandstone
		82		
		83	Liasite and Rhaetic	Clay and subordinate sandstone
		84	Keuper Marl and Sandstone	Red and grey marl, sandstone and coquina
UPPER PALAEOZOIC	TRIASSIC	85	Bunter Sandstone	Coarse and fine-grained sandstone with some pebble beds
		86	Permian Marl and Permian-Triassic Sandstone	Marl, sandstone, conglomerate, breccia and volcanic rock (partly Carboniferous)
		87	Magnesian Limestone	Dolomitic limestone and red marl
		88	Coal Measures	Sandstone, shale, variegated and coal
		89	Milstone Grit Series	Massive grit, sandstone, shale and coal
		90	Carboniferous Limestone Series	Grey limestone, shale, dolomite, sandstone and coal
		91	Upper Old Red Sandstone	Conglomerate and sandstone; also, shale, sandstone and volcanic rock
		92	Middle Old Red Sandstone	Sandstone, flagstone, conglomerate; also, shale, limestone and volcanic rock
		93	Lower Old Red Sandstone and Devonian	Red and green marl and sandstone; flagstone, grit, conglomerate; also, shale, sandstone and grey, volcanic rock
		94	Silurian	Shale, siltstone, sandstone and impure limestone
LOWER PALAEOZOIC	DEVONIAN AND BRACHYONIAN	95	Ordovician	Shale, shale, grit, chert and volcanic rock
		96	Cambrian	Shale, shale, sandstone and quartzite; dolomite of N. W. Ireland (partly Ordovician)
		97	Terrigenous; Chert; Langunian	Sandstone, grit, flagstone, shale, conglomerate, breccia; also, limestone and volcanic rock; shale, flagstone and grit
		98	Devonian	Siltstone, grit, shale, mica-schist; (probably Lower Palaeozoic)
		99	Malin	Massive quartzite-siltstone
		100	Levittian	Massive mica-schist and 'striped schist'
		101	Pre-Cambrian	Massive acid gneiss with some basic gneiss, quartzite-siltstone, mica-schist and limestone
		102	Ultrabasic age	Mica-schist, quartzite-siltstone, mica-schist, quartzite, phyllite, gneiss, etc.
		103	Calonian	Granite-schist, amphibolite, etc.
		104	Levittian	Granite-gneiss
METAMORPHIC ROCKS	IGNEOUS ROCKS	105	Tertiary	Volcanic Rocks: Basalt, Andesite, etc.
		106	Permian and Carboniferous	Volcanic Rocks: Basalt, Andesite, etc.
		107	Devonian	Volcanic Rocks: Basalt, Andesite, etc.
		108	Lower Palaeozoic	Volcanic Rocks: Basalt, Andesite, etc.
		109	Pre-Cambrian	Volcanic Rocks: Basalt, Andesite, etc.
		110	Granite, Gneiss, Schist, etc.	Acid
		111	Basalt, Gneiss, Schist, etc.	Basic
		112	Granite, Gneiss, Schist, etc.	Acid
		113	Granite, Gneiss, Schist, etc.	Acid
		114	Granite, Gneiss, Schist, etc.	Acid

Bealish clay and other superficial deposits are omitted. Some major faults are shown.

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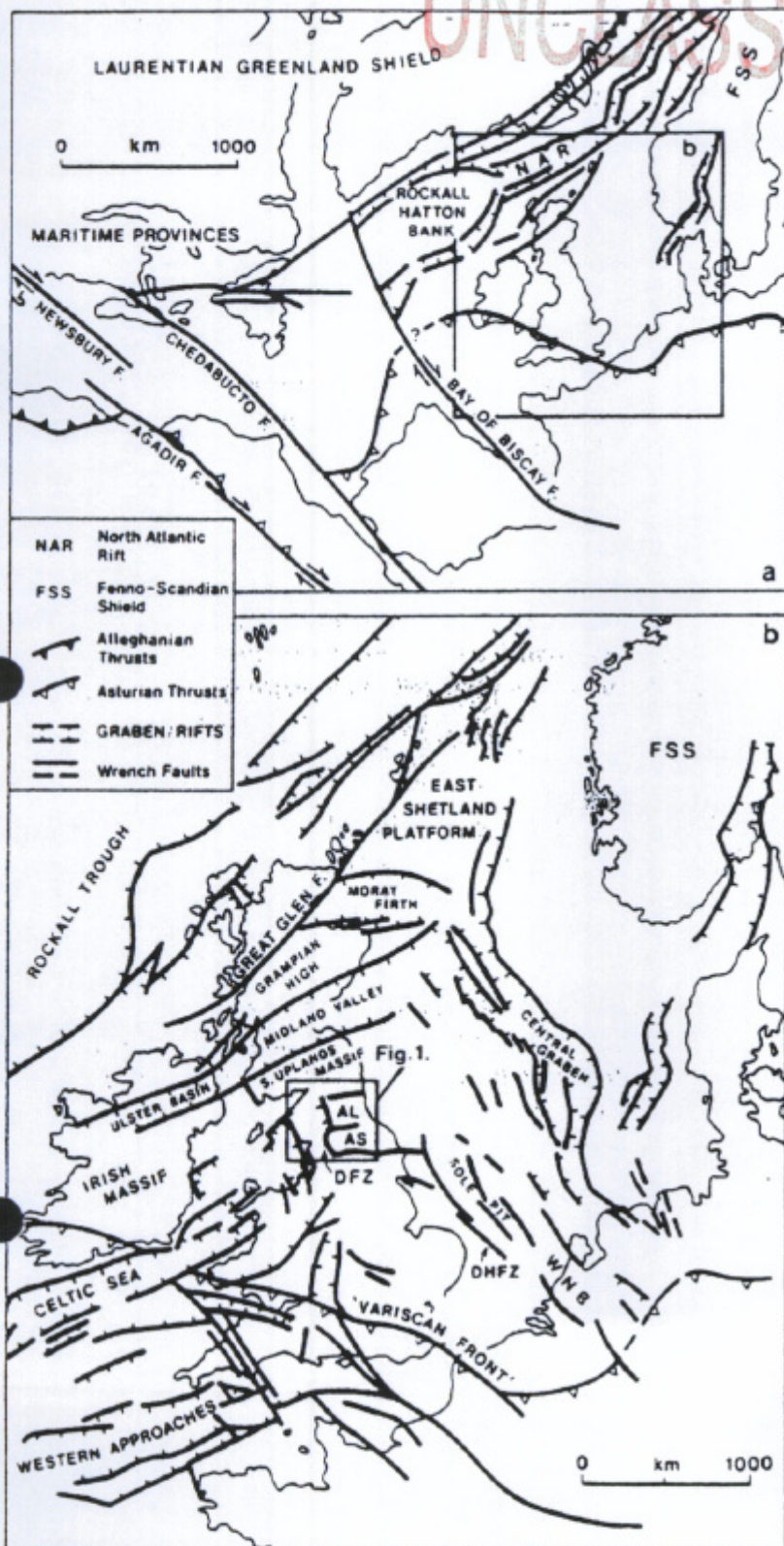


FIGURE 9

KEY

AL- ALSTON BLOCK

AS -ASTRIGG BLOCK

DFZ- DENT FAULT ZONE

DHFZ - DOWSING HEWITT

FAULT ZONE

WNB -WEST
NETHERLANDS BASIN

FRACTURES

LIGHTS

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DIS SCIENTIFIC & TECHNICAL MEMORANDUM 55/2/00

WORKING PAPER NO. 11

COLLECTED IMAGERY AND CLASSIFICATION OF UAP SHAPES

January 26, 2000

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COLLECTED IMAGERY AND CLASSIFICATION OF UAP SHAPES

CONTENTS

1. The material in this section has been collected from a number of sources - news reports, photography and video records. The sources are not limited to UK reports, as the intention is to use the material as a reference/correlation catalogue and to hopefully use the material as a filter to separate the explainable from the inexplicable, if possible. In some cases - particularly since the advent of personal video cameras - the original material is in colour. Shape and lights (colours) are invariably the trigger which attracts the eye and results in incident reports. Shapes have been generically categorised as follows:

- | | | |
|--|--|------------------|
| - SPHERES | (Includes 'BOLS' and multiple spherical lights) | Figures 1 - 7 |
| - DISCS | (Only circular in plan - and thus, on frequent occasions from different aspects, the same events are described by other witnesses as 'balls' or spheres) | Figures 8 to 28. |
| - CIGAR | These have a larger mid-chord than discs and tend towards 'long airship' shapes, with much less 'sharp' ends than discs | Figure 29 |
| - STAR/POINT | Seen as balls of light, with the star effect due to atmospheric optics | - |
| - OVAL | Described as a variant of 'discs', but with a wider mid-chord and without the elongation of 'cigars' | |
| - TRIANGLE/PYRAMID/CONE/
RECTANGLE/CYLINDER | The outline shape is formed, not by a solid object, although at times it appears so - see Working Papers) but by three or more coloured lights at the extremities, forming the 'corners'. A cylinder is often described which is, in fact, formed by a row of lights (balls). A vertically oriented cylinder is sometimes seen - see Working Papers No 23 and 24 | Figures 30 to 35 |

- RECTANGLE/DIAMOND As for Figures 30 - 35, but where the viewing angle changes the spacing to form diamond/rhomboid patterns As for Figures 30-35
- BOOMERANG/ARC Figure 36

As can be seen (Vol. 1 Tables 1 and 2) certain combinations of shapes and lights can be attributed to definite causes. Shapes and lights are the **initial** key to filtering the known from the inexplicable. Little is gained in analysis of purely descriptive unknown shapes and lights reports unless further information, such as imagery, correlation from multiple witnesses, or data from which to obtain angles, sizes, sounds, smells, or velocities is available.

For the purposes of the database it was necessary to identify the whole range of shapes frequently reported. It is of course inevitable that these are due to a whole range of different underlying phenomena, described in the other working papers in this Volume.

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SPHERES

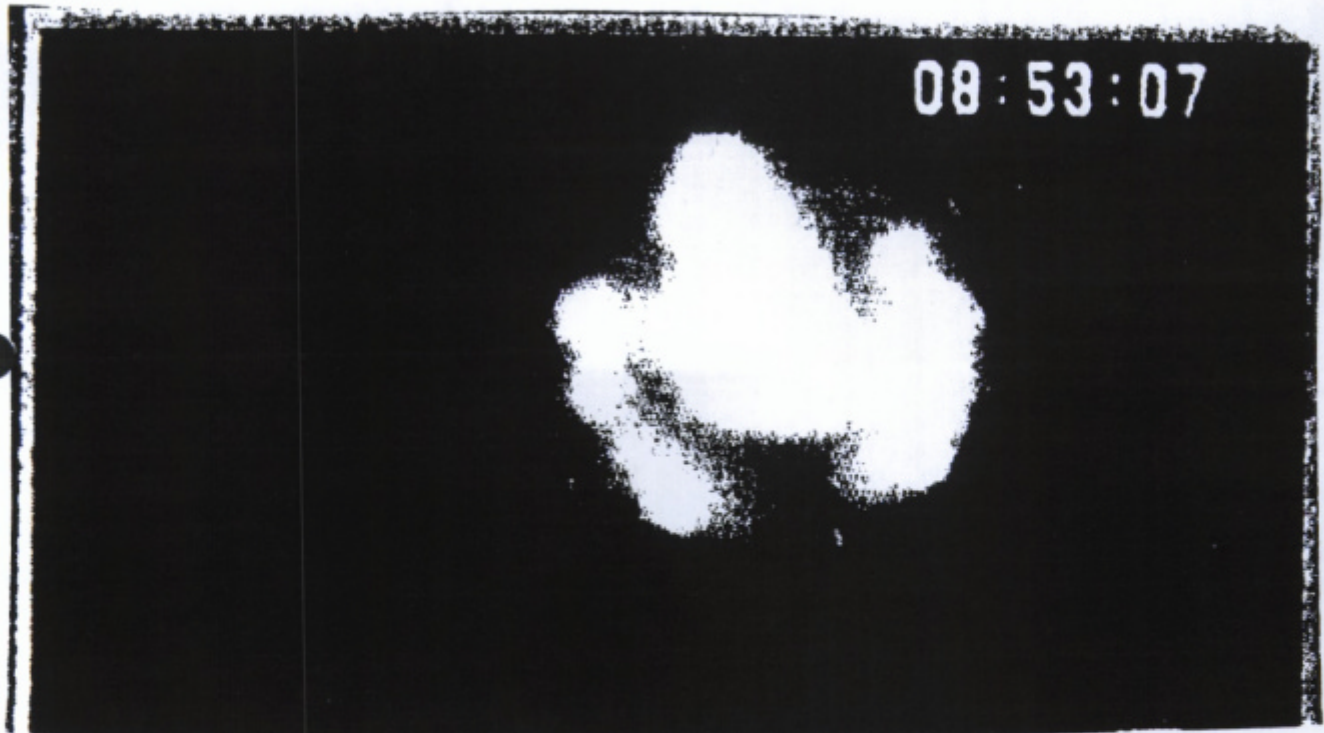


FIGURE 1: SPHERES

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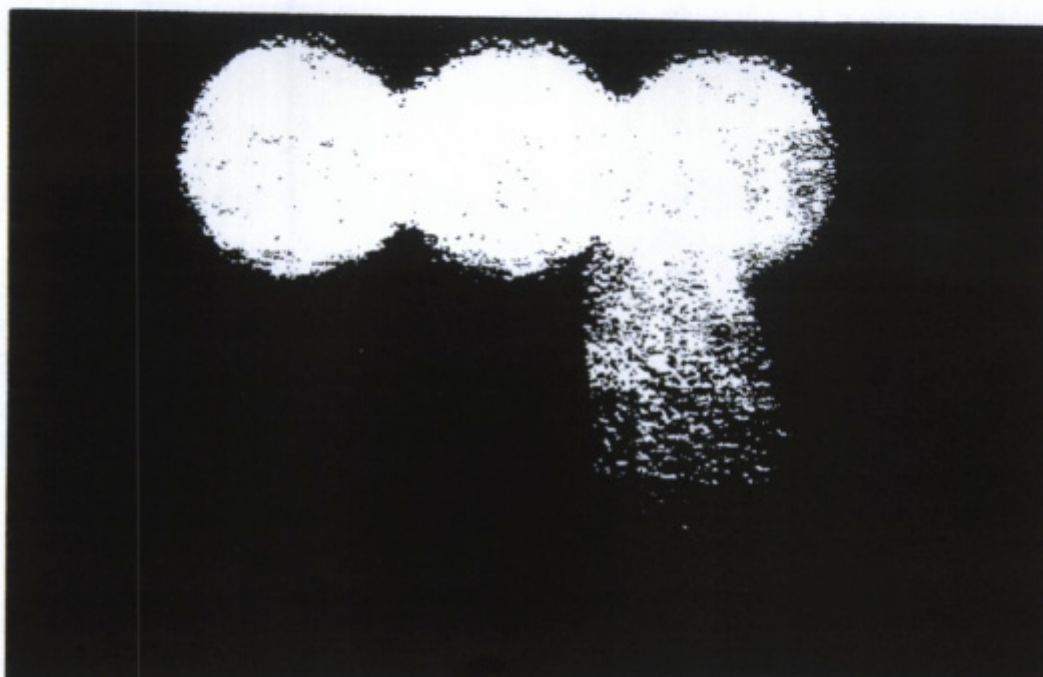


FIGURE 2: KENT UK, SEPTEMBER 17-20 1993

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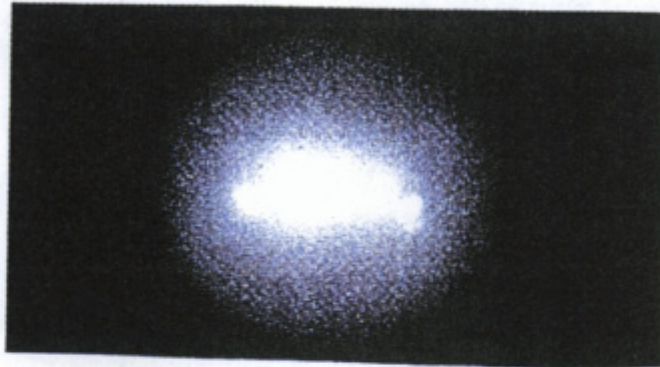


FIGURE 3: MEXICO POLICE PHOTOGRAPH ^[1] (JULY 1991)

Note [1] Four police officers at range ~50 yards. Some lens distortion.

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FIGURE 4: LOWESTOFT 1997

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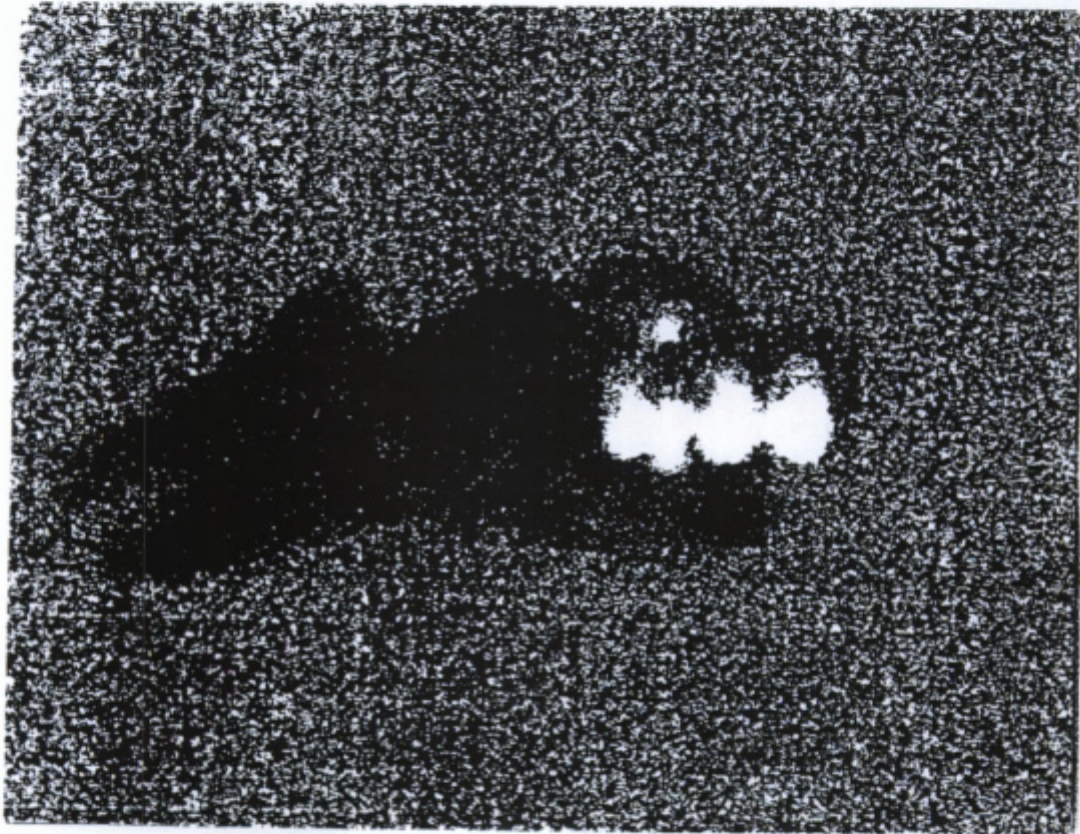


FIGURE 5: GULF OF MEXICO (DARK SHAPE IS THE ACCOMPANYING F15 AIRCRAFT)

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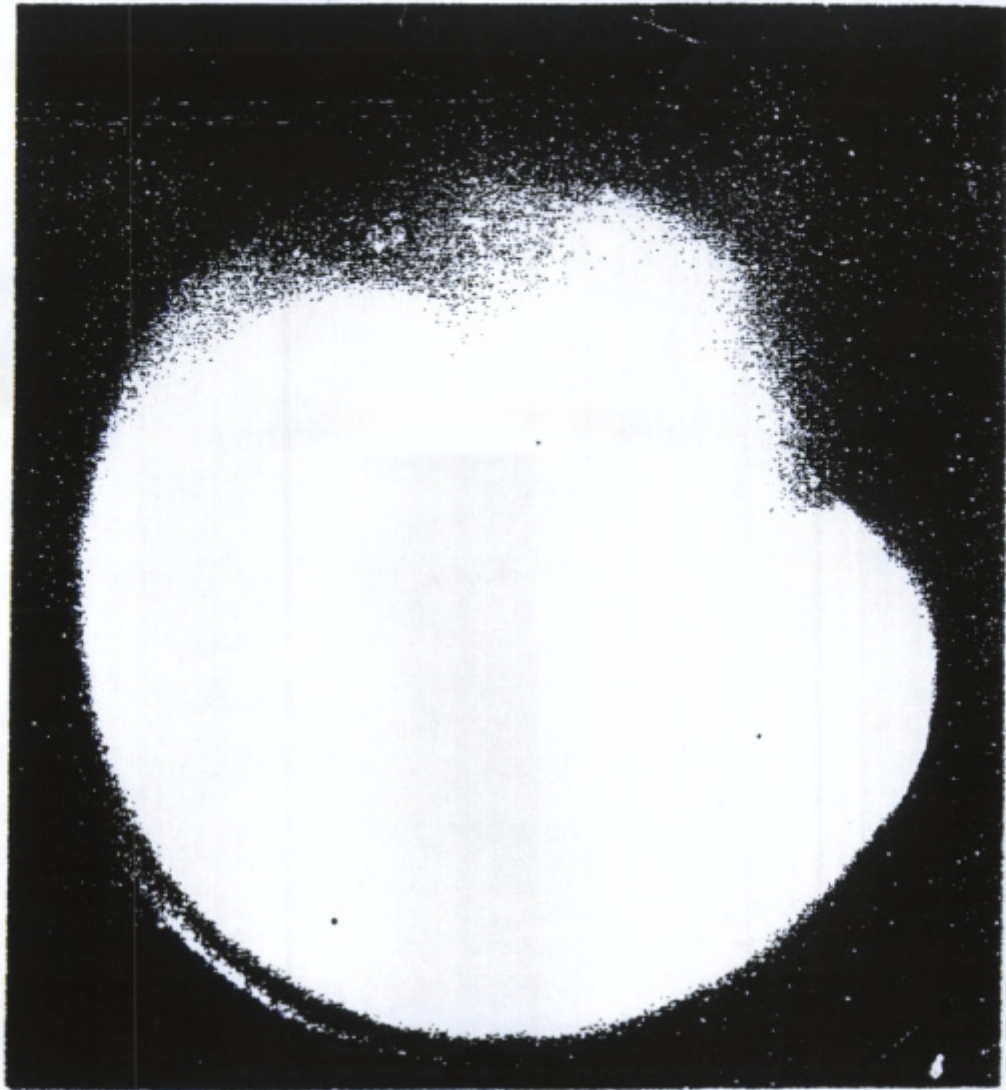


FIGURE 6: FRANCE 1974

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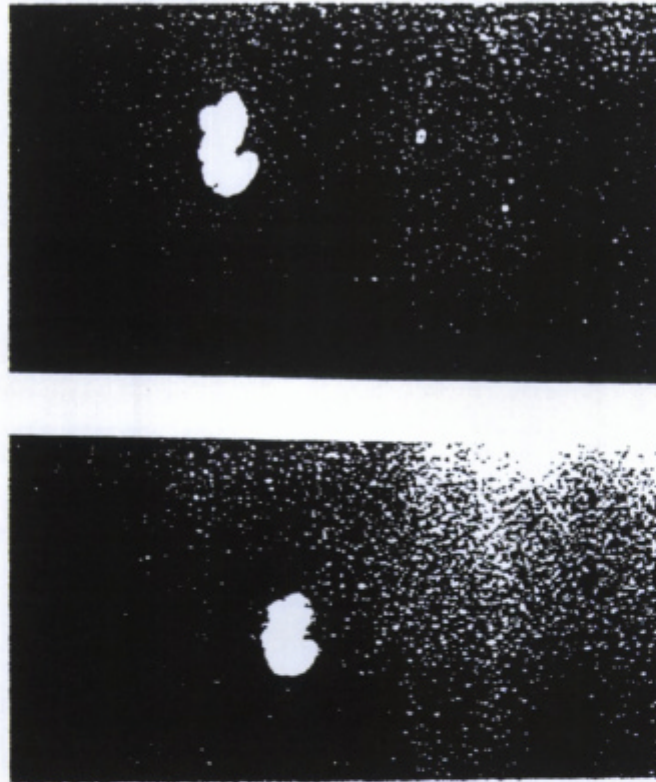


FIGURE 7: AIR-TO-AIR UAP

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DISCS



FIGURE 8: LAKE CONISTON ENGLAND 1954

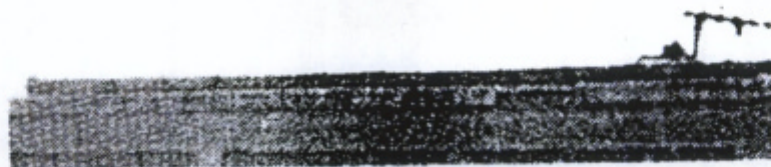


FIGURE 9: JAPAN 1958

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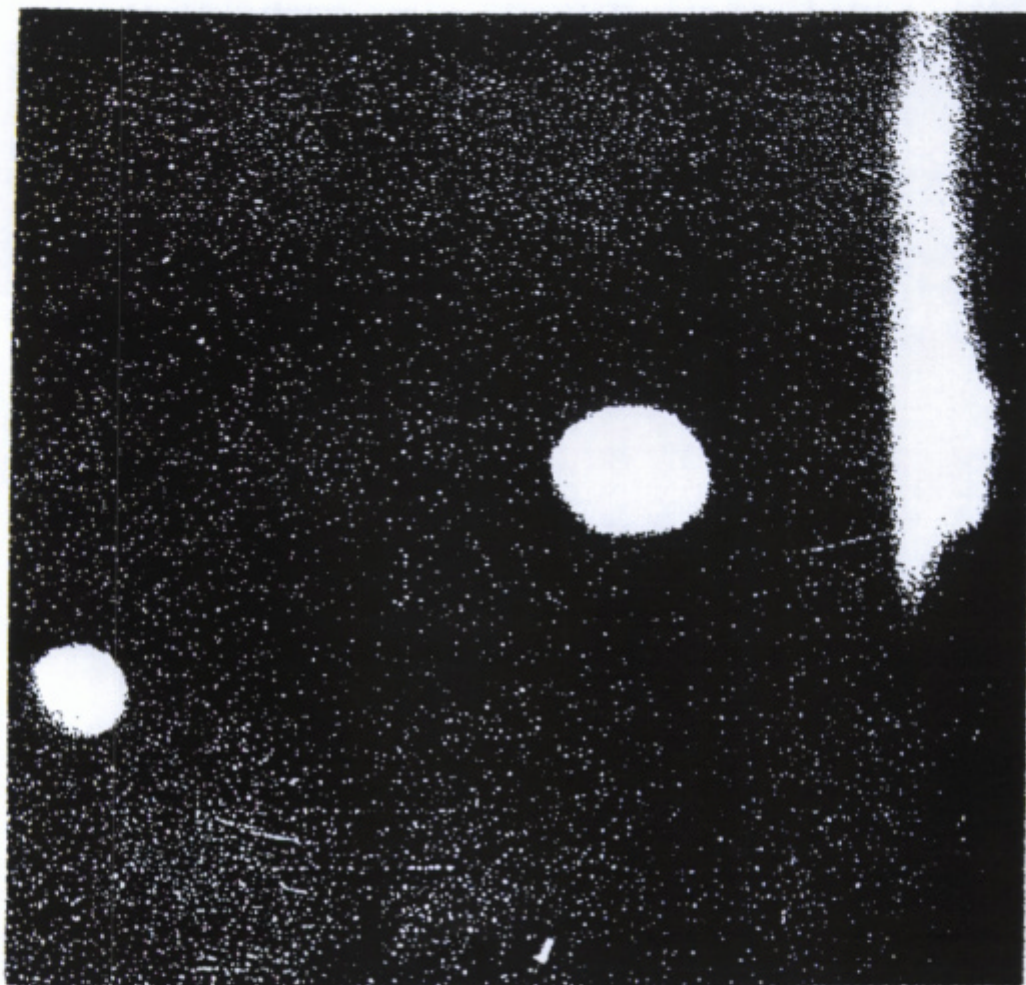


FIGURE 9: AUSTRALIA 1972

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FIGURE 10: AUSTRIA 1971

FIGURE 11: OREGON USA 1950

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FIGURE 12: 1958 SOUTH ATLANTIC (BRAZILIAN NAVY)



FIGURE 13: USA 1952

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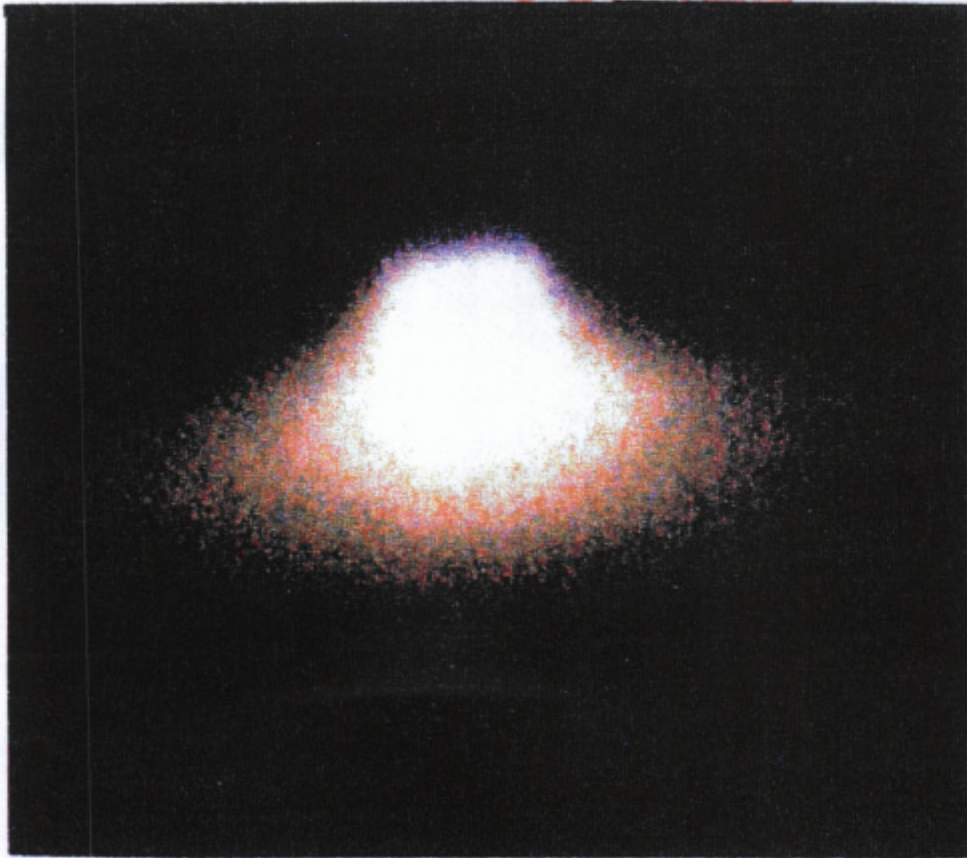


FIGURE 14:



FIGURE 15:

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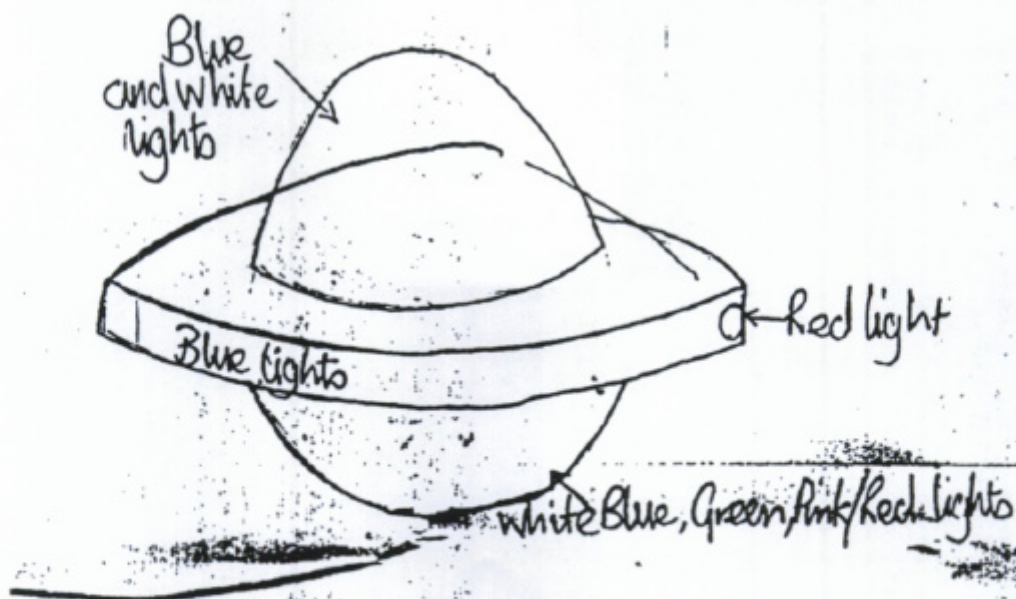


FIGURE 16: POLICE SKETCH 26 APRIL 1984 UK

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FIGURE 17: SILVER DISC (20-30 FEET DIAMETER) 1993



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FIGURE 18: PERU

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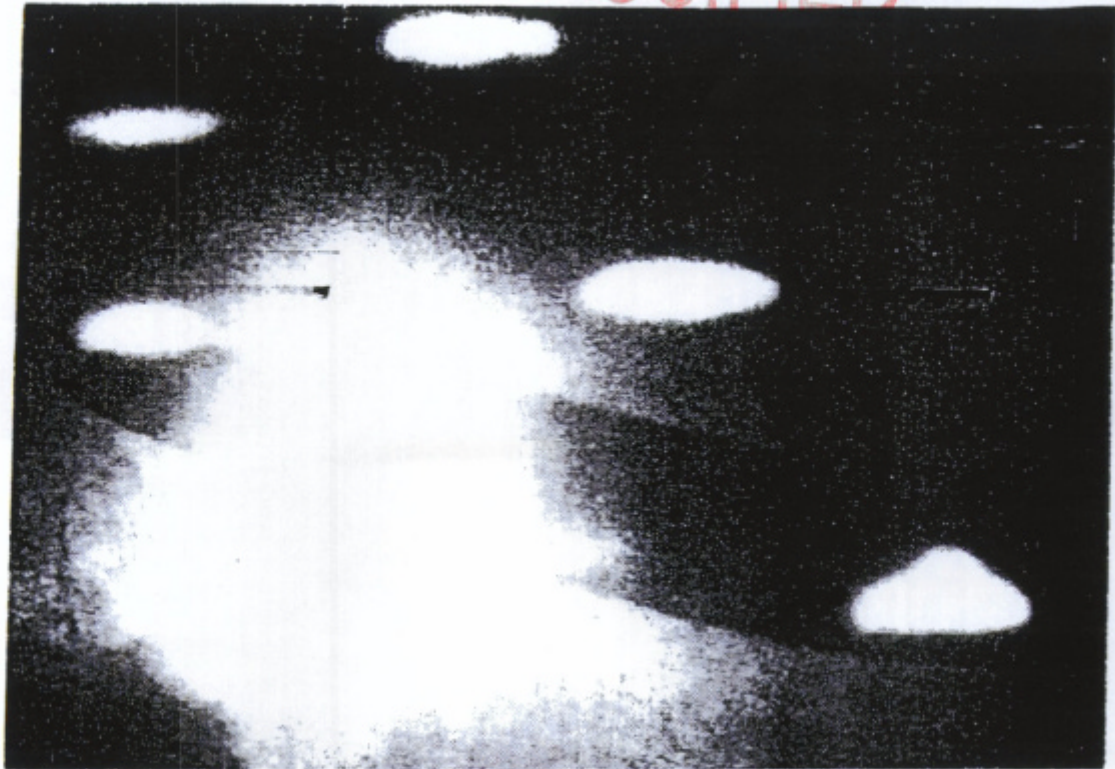


FIGURE 19(a): OPEN SKIES - CLOSED MINDS [N. POPE]

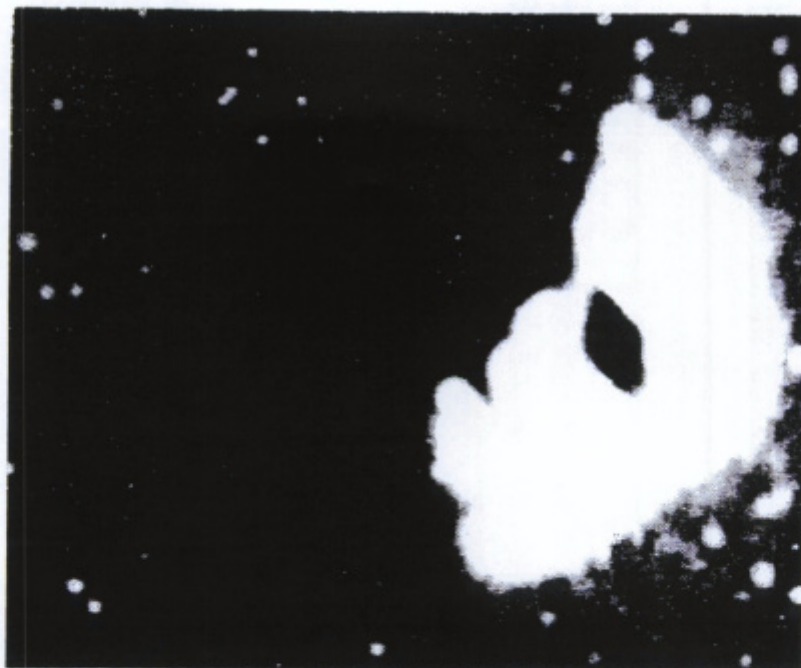


FIGURE 19(b): OPEN SKIES - CLOSED MINDS [N. POPE]

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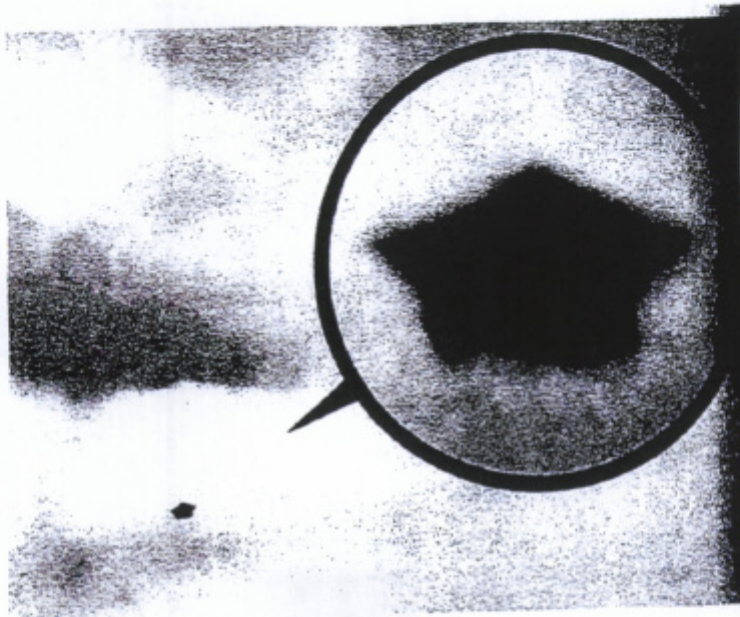


FIGURE 20: JAPAN (TOKYO) SEPTEMBER 1986^[1]

Note [1] Sixteen witness event for 25 minutes 180 miles North of Tokyo. Appeared to rotate.

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FIGURE 21: ARGENTINA - LAKE BARILOCHE (~1978)

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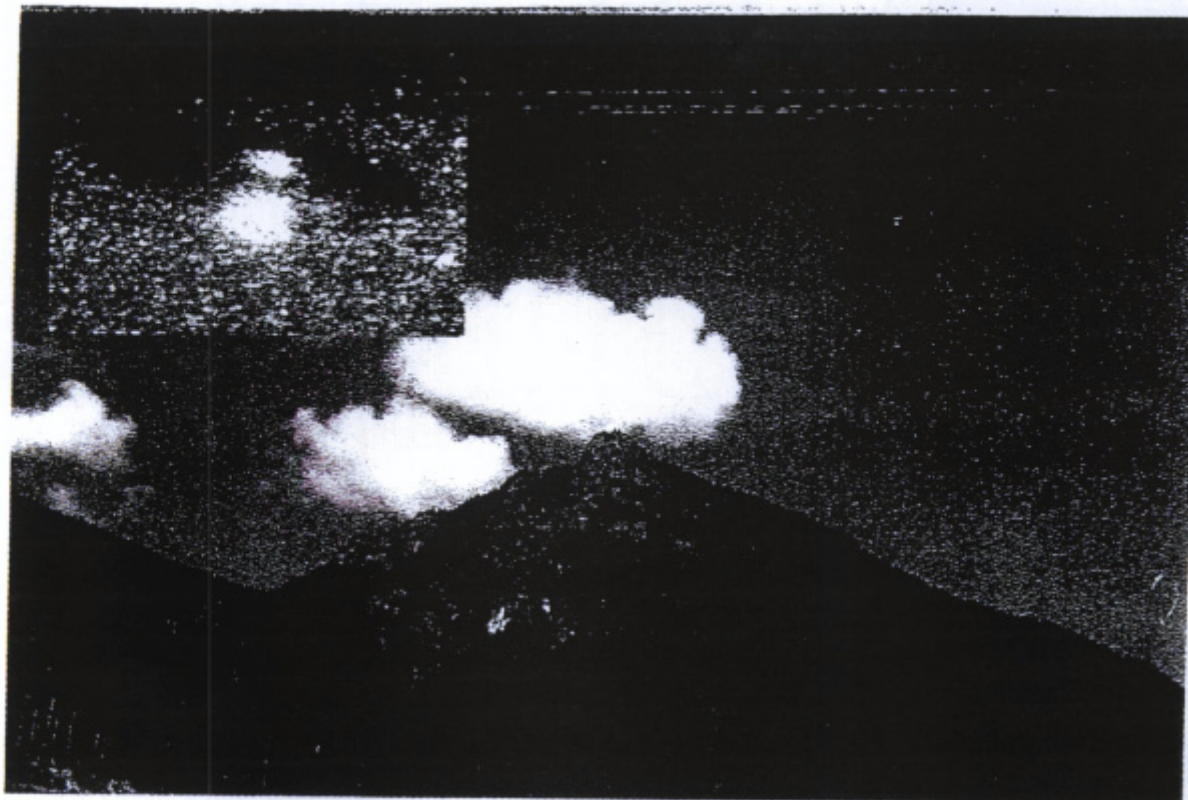


FIGURE 22: CANADA - VANCOUVER ISLAND 1981

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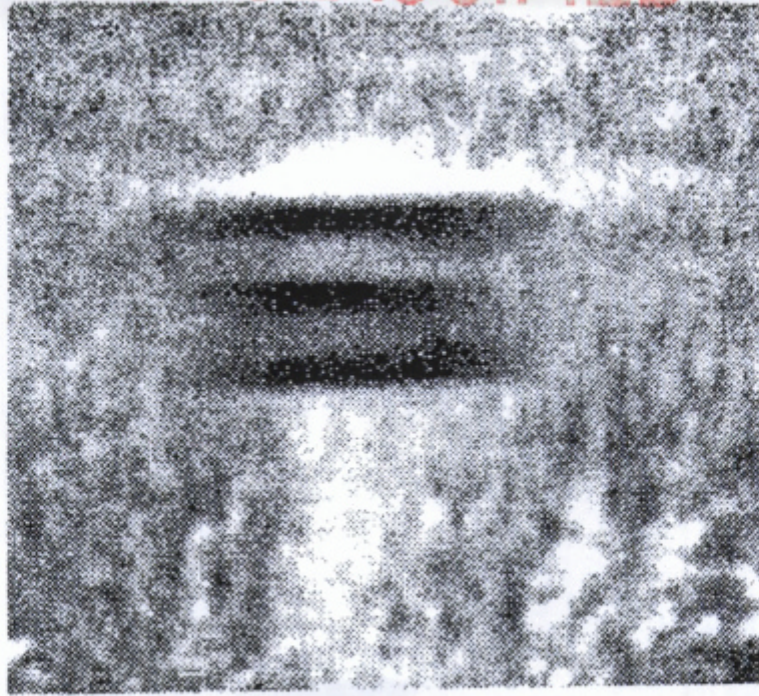


FIGURE 23: OREGON 1966

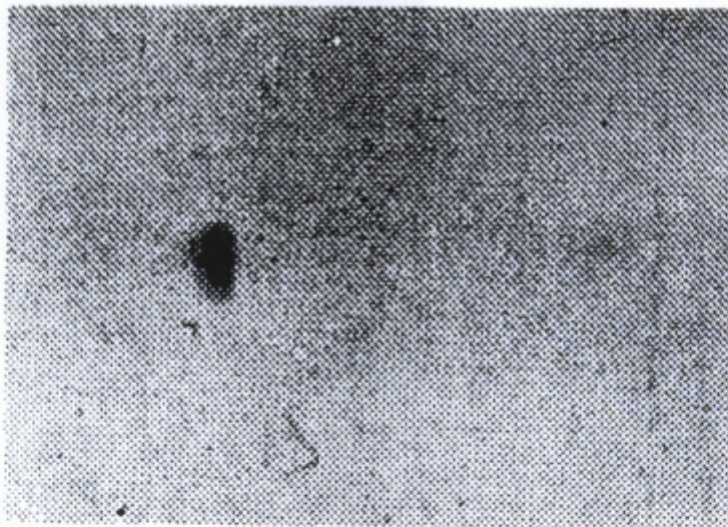


FIGURE 24: MALAYSIA 1966

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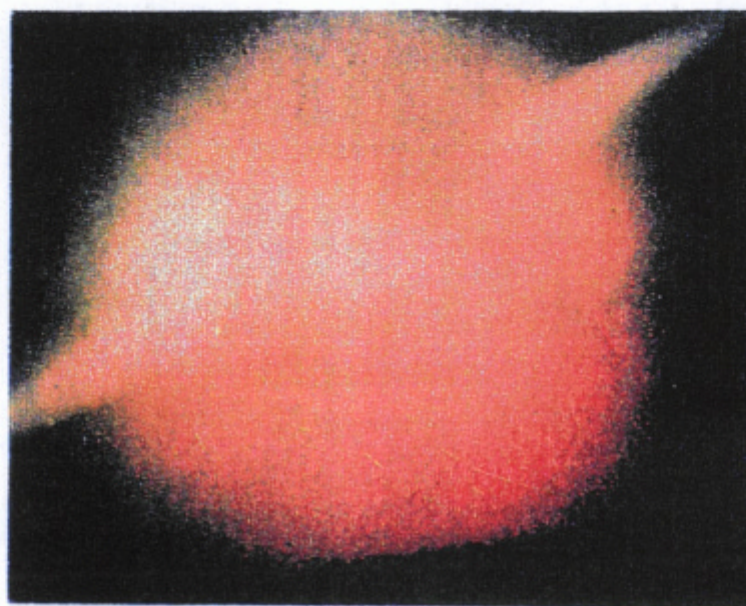


FIGURE 25: SPANISH AIR FORCE 1976

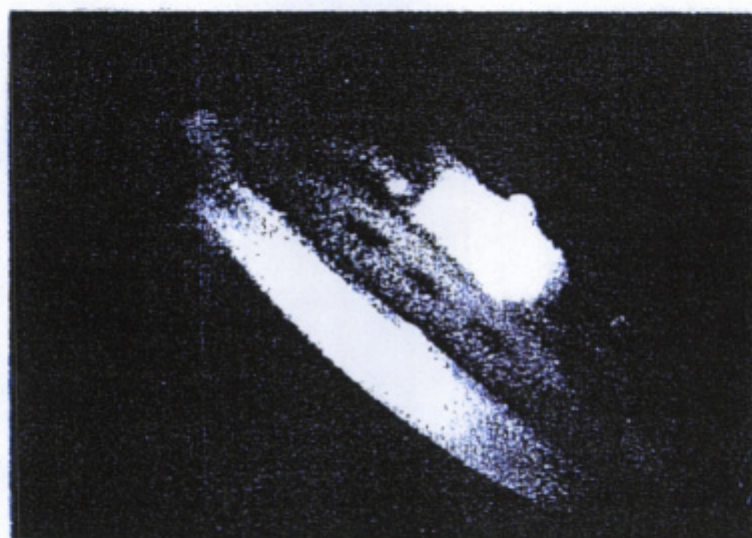


FIGURE 26: DENMARK 1974

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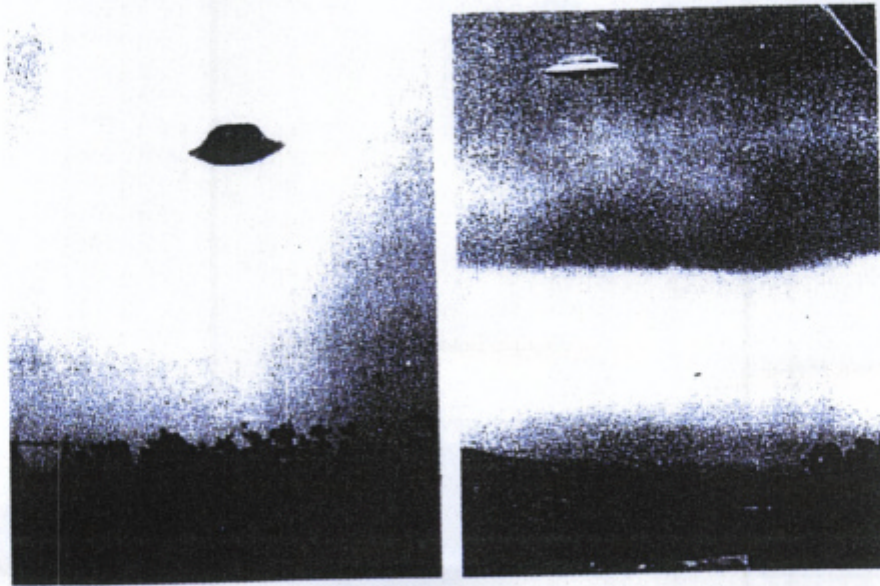


FIGURE 27: MEXICO (RESPECTIVELY MARCH AND JUNE 1992)

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FIGURE 28: ROCHDALE LANCS., 1975

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'CIGAR' TYPES

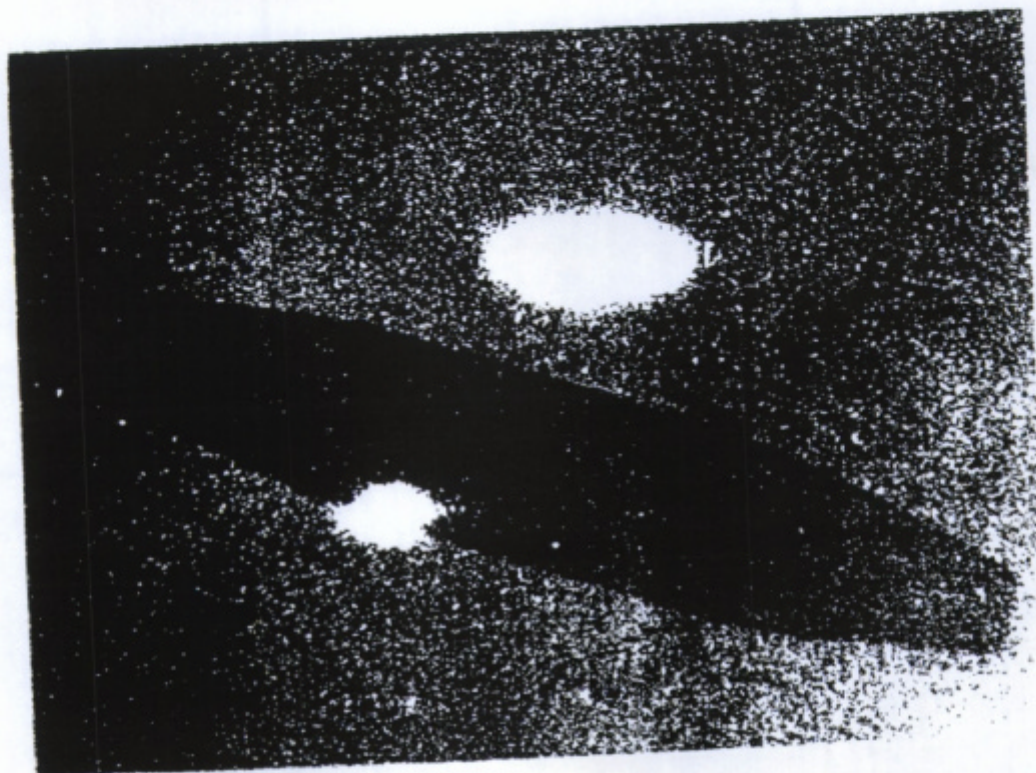


FIGURE 29: 'CIGAR' TYPE

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TRIANGLES

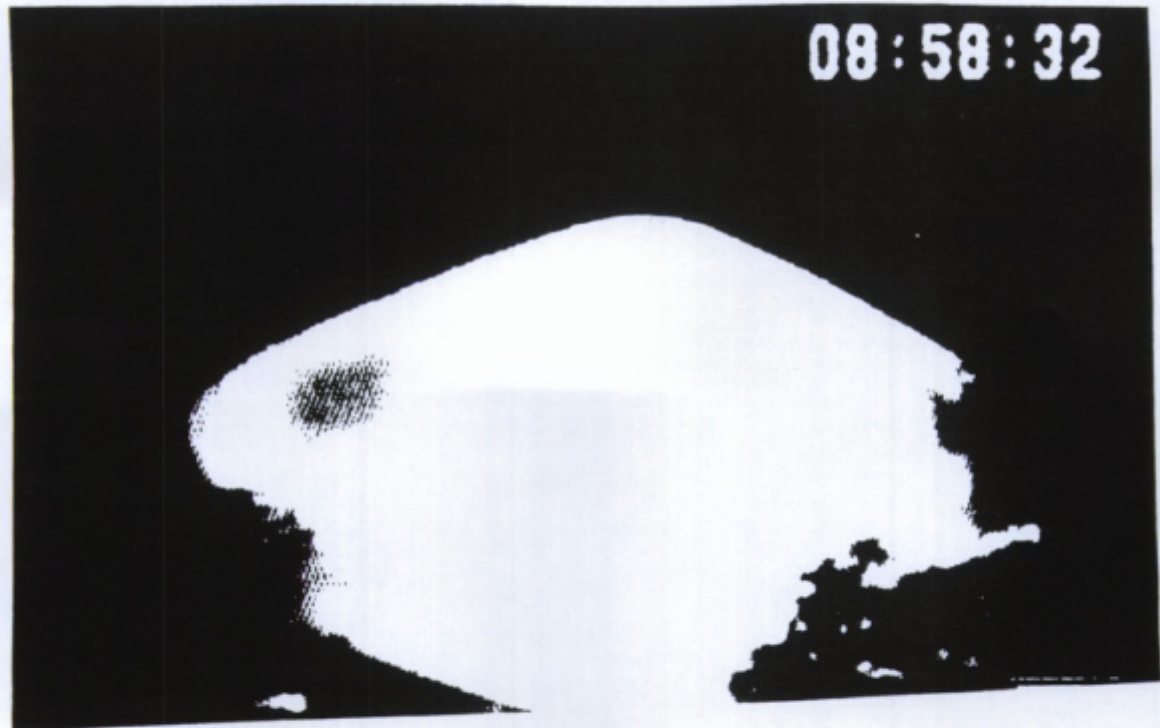


FIGURE 30: TRIANGLES/PYRAMID/CONES

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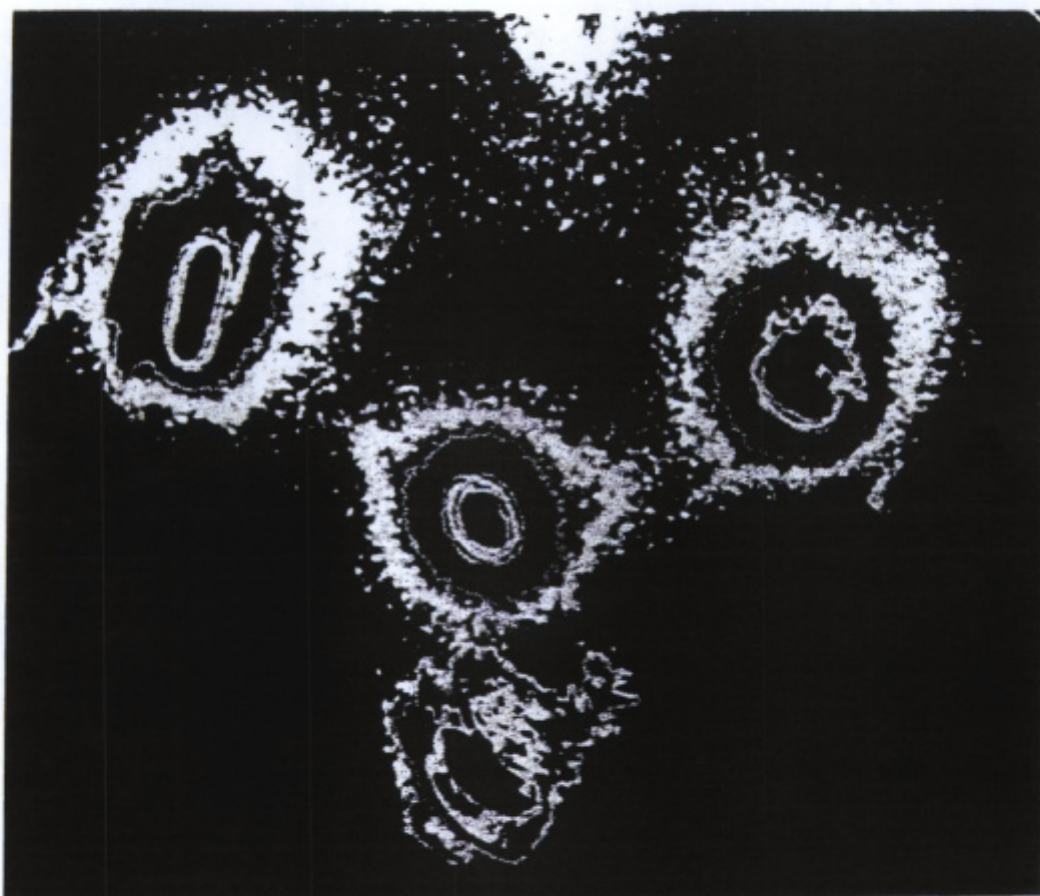


FIGURE 31: BELGIUM LOCATION EUPEN (2 SECOND AT ZOOM SETTING 100-150MM AT F4) 30-31 MARCH 1970

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FIGURE 32: BELGIUM (AS FIGURE.. ABOVE. BLUE FILTER ENHANCEMENT
REVEALED UNDERLYING TRIANGULAR SHAPE (ALL OF WHICH IS VISIBLE
ON ORIGINAL)

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**FIGURE 33: SOVIET UNION - LOCATION ZAGRESK MARCH 1990 (NOTE
UNDERLYING EQUILATERAL TRIANGLE)**

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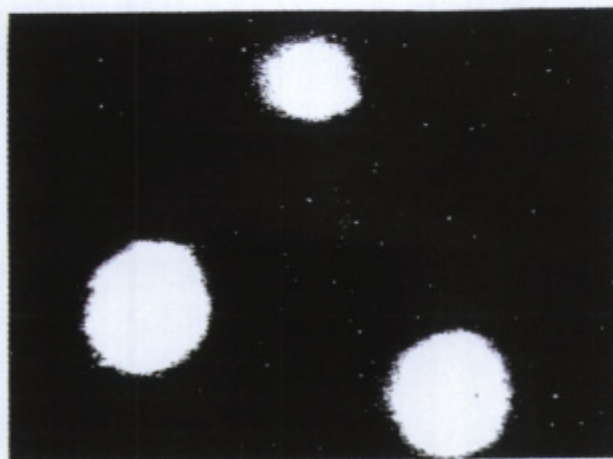


FIGURE 34: VIDEO FRAME - BELGIUM 31 MARCH 1990

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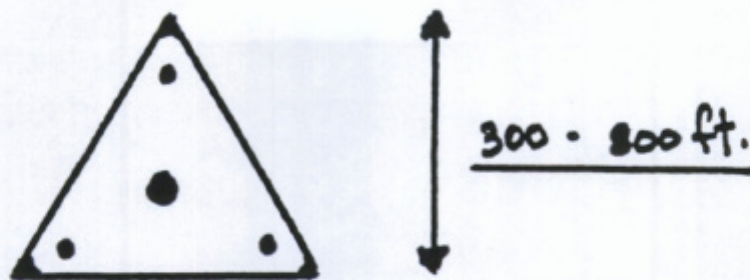


FIGURE 35: SHAPE UK, RUSSIA, BELGIUM

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BOOMERANG/ARC

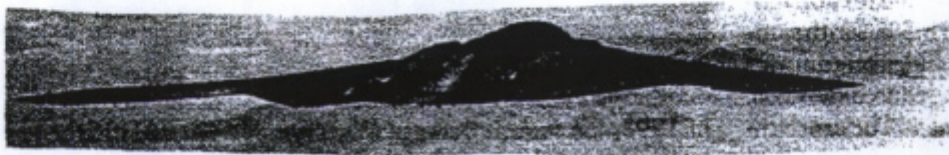


FIGURE 36:

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WORKING PAPER NO. 12

EARTH'S MAGNETIC FIELD IN THE UKADR

	Para	Page
INTRODUCTION	1	12-1
FIELD MEASUREMENTS	2	12-1
Field Intensity	3	12-1
Field Angles	4	12-1
Local Variations	6	12-1
UNITED KINGDOM MAGNETIC SURVEY	7	12-1
COMPARISON WITH MEDICAL EXPERIMENTS	8	12-2

EARTH'S MAGNETIC FIELD IN THE UKADR

INTRODUCTION

1. Earth's magnetic field has been briefly researched because of:

- The possible connection of field strength with UAP events.
- As a comparison with the magnetic field strengths used during the magnetic field experiments reported at Working Paper No 25.

FIELD MEASUREMENTS

2. Over the period 1987-95 eight international stations, comprising a Sub-Auroral Magnetometer Network (SAMNET) monitored the changes every five seconds. Earth's internal magnetic field changes only slowly in direction and magnitude, but there are also magnetic effects due to the flow of charged particles in the upper reaches of the atmosphere (the ionosphere) and in space. Day plots have been taken every 1 second, since 1995. Each station records the magnetic field in three orthogonal directions. The stations cover the UK, Sweden, Norway, Finland and the Faroe Islands.

3. **Field Intensity** The magnetic field is calculated (in Nano Teslas) from the International Geomagnetic Reference Field (IGRF). The total intensity in the UK is 49,000 to 50,000 nT ($1\text{nT} \approx 18$). Changes in intensity are $\sim 30\text{nT}$ per year. The horizontal component of the field is about 20,000 nT in Southern UK and 15,000 nT in Northern UK.

4. **Field Angles** The field inclination angle is $\sim 70^\circ$ with typical changes of one to two minutes (of angle) per year. For epoch 1970 the declination angle is between -6 and -12 degrees, with changes of ~ 6 minutes of angle per year.

5. The North magnetic pole is migrating NW by 9km per year (79.1°N 28.9°E). For the chart shown at Figure 1, $18 = 10^{-5}$ Gauss. $= 10^{-9}\text{T} = 1\text{nT}$. The plotted readings show no sudden or unexplained variations but rather a steady decline in magnetic intensity level over the 50 to 60°N lines of latitude straddling most of the UKADR.

6. **Local Variations** No information is available on small variations which may occur in specific locations. Particularly, no field peculiarities are present in the main plots to indicate the possibility of influencing geographical clustering of UAP reports.

UNITED KINGDOM MAGNETIC SURVEY

7. Data gathered nationally by a network of 51 stations (survey points), established between 1985 and 1988, allow local (crustal) magnetic variations to be monitored^[1]. Global models accurately represent the main part of the geomagnetic field, originating in the earth's core. At the surface there are perturbations caused by magnetised rocks and electric currents in the ionosphere and

atmosphere. While there are errors which are superimposed on the global model, in the UAP context it is just possible that the high density measurements of field strengths in certain areas may contribute either singly or in combination with other factors to produce UAP. The associated solar phenomena (solar flux and sun-spots) are considered at Working Paper No 16.

[1] British Geological Survey, Edinburgh

[2] Persinger is Referenced at Working Paper No 25, together with the results of his experiments on the human response to modulated magnetic fields, which are of prime importance to the overall findings of this study.

COMPARISON WITH MEDICAL EXPERIMENTS

8. A comparison of the national UK earth magnetic values at Working Paper No. 25 with those used by Persinger and others, in their medical experiments, has shown that the key difference between the experimental field which produces human responses and descriptions of experiences surprisingly like those of close encounter UFO/UAP reports; are those of modulation. It is noted that the modulated experimental amplitude values used by Persinger, and which cause the surprising effects on humans, are only approx. 1/500 of the steady field level experienced daily in the UK.

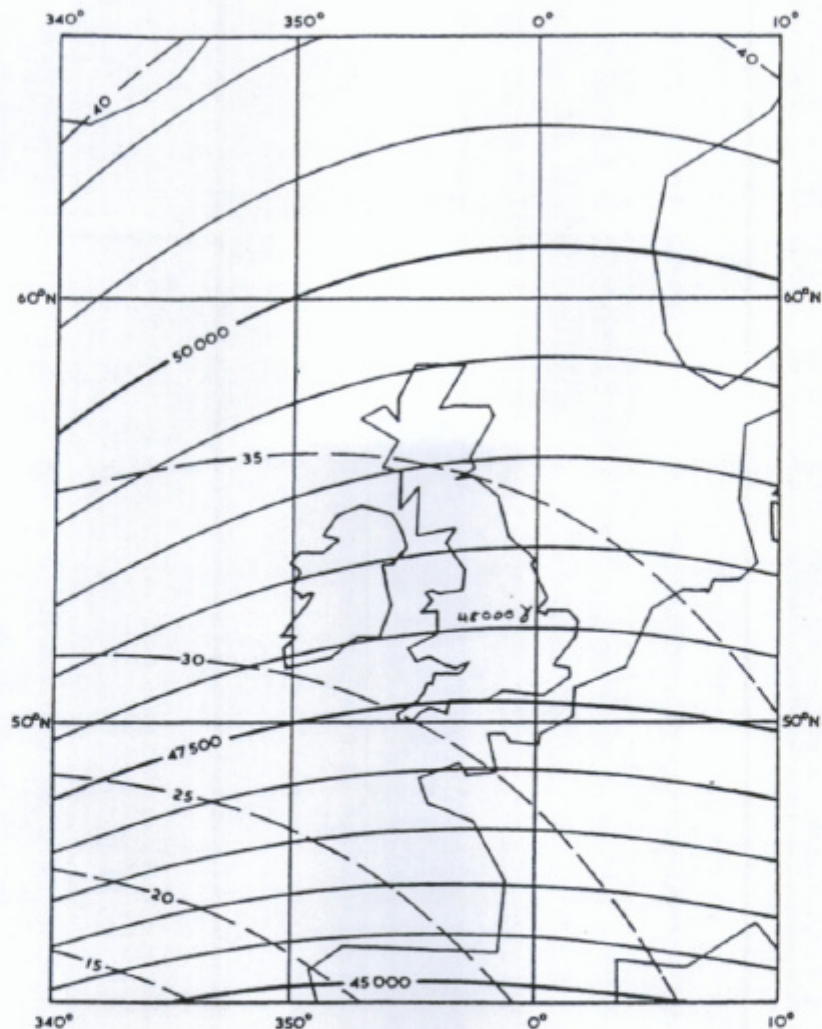


FIGURE 1: INTERNATIONAL GEOMAGNETIC REFERENCE FIELD FOR UKADR

- Notes:
- Solid lines are total intensity (in Gammas, where $1\delta = 1\text{nT}$)
 - Dashed lines are secular changes (gammas per year).

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DIS SCIENTIFIC & TECHNICAL MEMORANDUM 55/2/00

WORKING PAPER NO. 13

VISUAL METEOROLOGICAL AND OTHER NATURAL ATMOSPHERIC
PHENOMENA

	Para	Page
LENTICULAR CLOUDS	2	13-1
MAMMA	6	13-1
NOCTILUCENT CLOUDS	7	13-1
MOTHER OF PEARL CLOUDS	8	13-2
DUST DEVILS, TORNADOES & WATER SPOUTS	9	13-2
CONDENSATION AND DISSIPATION TRAILS	10	13-3
GLORY/CORONAS	11	13-3
HALOS & ARCS	12	13-3
SUN DOGS	13	13-4
ST. ELMO'S FIRE	14	13-4
BIRDS	15	13-4
MOTHS	16	13-5
SOLAR RADIATION	17	13-5
SUN PILLARS & LIGHT PILLARS	20	13-5

February 1, 2000

i

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VISUAL METEOROLOGICAL AND OTHER NATURAL ATMOSPHERIC PHENOMENA

1. This paper briefly investigates a number of additional atmospheric visual phenomena, mainly meteorological, which can give rise to UAP reports because they are unfamiliar to most witnesses:

- Lenticular clouds
- Dust Devils
- Moon and Sun
'Dogs'
- Aurora
- Twisters
- Ice Clouds
- Glory/Corona
- Condensation Trails
and Distrails
- Halos
- Mother of Pearl
Clouds
- Mamma
- Noctilucent clouds

LENTICULAR CLOUDS

2. Examples of laminated, disc-like (Lenticularis) clouds are shown at Figures 1 to 9. These are clouds which are oval or lens-shaped. No further explanation is required to see that these can easily be visually mistaken - and, with a little embellishment - be turned into convincing 'UFOs'. Key factors in the filtering process must be:

- They are usually visible using reflected light (e.g. ambient daylight/sunlight or moonlight), but on some occasions they may be seen in silhouette as disc shapes.
- Lenticular clouds have no inherent glow (other than natural external illumination).
- They will either appear to be stationary (dependent on geometry) or move slowly (at wind rate).
- They will not manoeuvre.
- Conditions to climb are rare unless 'forced ascent' (i.e. external agency) conditions are present.

4. Lenticular clouds often form:

- Over hills.

- At the top of cumulus clouds to form a 'cap-cloud' (pileous cloud).
- With a 'metallic grey' colour.

4. If cumulus cloud below a cap-cloud evaporates or disperses the lenticular cap can descend (sink). They can remain poised or slowly wavering above hills. Lenticular effects can form with several basic cloud types, e.g. Altocumulus Lenticularis, Cumulus Pileus, Strato-Cumulus Lenticularis etc.

5. Some photographs (for example, at Figure 2) show that lenticularis clouds (or 'wave clouds') can appear as billows (i.e. ovals/lens-shaped discs with a hole in the centre) and also with laminated appearance. Pileous laminations occur when humid layers are sandwiched between dry air layers. At Figure 5 little imagination is required to describe 'a dome on top'. When the top of a wave-cloud is 'bow-shaped' and smooth, this usually indicates that the air above is stable and dry. The size of lenticularis clouds may extend for kilometres. However, small ones seen edge-on may give the impression of much smaller discs. These formations often appear to the leeward side of high ground. The typical reported altitude might be 3000-6500 metres.

MAMMA

6. These protuberances occur when small-scale convection changes cause portions of cloud to sink in clear air below a cloud formation. The sinking elements mix with the clear air and usually evaporate. However, if they contain rain or snow crystals, the shapes shown at Figure 6 can occur. These particularly occur beneath the

thick clouds associated with thunderstorms. Mamma can also occur at the lower ends of cirrus cloud formations.

NOCTILUCENT CLOUDS

7. Noctilucent clouds have the appearance of decayed cirrus but are typically at 80Km altitude in the stratosphere. They can shine for an hour or so after sunset but they are not seen if the sun is above the horizon. If the sun is more than $\sim 16^\circ$ below the horizon noctilucent effects cannot be seen. Normally noctilucent clouds appear between May and August at latitudes 50° - 70° N. (This includes UKADR latitudes). It is reported that these may be caused by dust particles which catch the lower stratosphere during volcanic eruptions, or due to dust produced in the solar system by collisions among minor planets. Noctilucent effects can also be caused by terrestrial-based light sources shining on the underside of disc-shaped or laminar clouds. Noctilucent clouds are the highest clouds in the atmosphere.

MOTHER OF PEARL CLOUDS

8. 'Mother of Pearl' formations (Figure 9) are rare but can be seen in Scotland occasionally between November and March. They have iridescent bands of colour, lit by sunlight in a twilight sky (limiting the time of occurrence). They occur only at altitudes of the order 22-30Km and probably comprise super-cooled droplets with ice crystals.

DUST DEVILS, TORNADOES & WATER SPOUTS

9. These occur in unstable layers of dry air over hot ground. They are visible because of the dust (which may rotate in

either direction) and often have a hollow centre. Water spouts occur similarly at sea. Tornadoes are predominantly cyclonic in rotation. All three phenomena move at prevailing wind-speed.

CONDENSATION & DISSIPATION TRAILS

10. 'Contrails' and 'Distrails' are well known visual effects in the sky. Drawn into aerodynamic vortices (i.e. wing-tip vortices), these can fragment to provide unusual visual phenomena. Distrails are formed when an aircraft flies in relatively dry air just above a thin layer of cloud such that the down-wash penetrates the layer. This can produce a series of 'holes'. Pendulous blobs (with the probable appearance of spheres) can occur.

GLORY & CORONAS

11. Coronas are colourful concentric rings centred on bright light sources. They are caused by water droplets or ice crystals of relatively uniform size. However, observers in both Texas and Finland have reported coronas caused by pollen particles. Coronas can be distinguished from halos in that they commonly have a radius angle of 22 degrees, although the extremes reported for halos have boundaries of 4 to 46 degrees. The key filter to use in UAP identification is that coronas are always centred on a bright object. Figure 7(a) shows the shadow of a crucial peak thrown onto mist. The observer (on the peak) is surrounded by a multicoloured 'Glory' of corona rings. In fact until the advent of aircraft only mountaineers could observe the effect. This is due to the refraction and diffraction of light by the mist droplets. This effect can also be seen from aircraft when their shadow falls on droplet clouds. On the ground it is especially noticeable in

hilly country, when air close to the ground cools and flows into valleys overnight. Some of the ice particles in cirrus wave clouds at temperatures of -40 to -50 degrees C, apparently form faceted uni-axial polyhedral crystals, while others resemble spheres. It is well known that 'Glory' results from the interference of light rays back-scattered from internally reflected and circumferential ray paths (the latter is unique to spheres).

12. As seen at Figure 7(b), the incident ray couples to a sphere as a surface wave, is critically refracted into the sphere, reflects, and is critically refracted back to the surface, spends a short period as a surface wave and is directed back towards the original source. A curved wavefront is formed by exciting the rays to the right and left of the glory ray. Rotating this curved wavefront (Figure 7(c)), through an angle (Π), as directed by spherical geometry, reveals that a wavefront shape associated with the Glory is a toroid. Propagation of this wavefront to a far field gives rise to a strong axial focusing, because the infinite number of rays from the ring around the flat part of the wavefront all go in the same direction. As soon as the observer moves off the exact back-scattered axis, only two rays contribute to the scattering and it is the interference between the left and right rays of the toroidal wavefront that produces the 'Glory'.

HALOS & ARCS

13. A halo is observed when looking at the sun through high altitude cirro-stratus (which is several thousand feet deep and composed of non-spherical ice crystals - which have also recently been suspected of producing 'Glories'. It is a cloud type which readily forms aircraft condensation trails). The halo angular radius (i.e. half

angle) is said to be 22° . Halos from the sun can be either above or below the horizon. Halo activity is persistent and is known to many of the public, however it results in some UAP reports. Over a 40 year period (Netherlands) it was noted that average halo conditions existed for 227 days of the year, peaking in 1972, when 300 days were recorded.

13. On other days conditions existed for other parhelian and circumzenithal events. Halo Arcs occur at low solar elevations and are caused by pyramidal crystals and occur when they fall through the air with certain axes vertically orientated. Halo rings of unusual radii can be produced when their faces are not in random orientation. From those in random orientation six concentric odd-radii halos should result at 9, 18.3, 19.9, 22.9, and 23.8 degrees. Each of these six halo types has been imaged this century, but most of the 12 (yet undiscovered) forms are, at most solar elevations, completely below the horizon and thus only visible from airborne platforms in cool climates. The 12 halos divide into 32 individual arcs in the sky, of which only ten, so far, have been photographed. Halos still escape a complete understanding. In particular, ice particles with pyramidal ends are suspected of producing bright arcs of dimension of odd radius halos. It should be noted that some effects can be related to the polarisation of observers' sun-glasses!

Although the photograph at Figure 13 is artificially produced by light passing through a single vertically orientated hexagonal ice crystal (the parhelic spots shown are the actual projection on a wall), it is noted that these shapes are markedly similar to some UAP reports where 'multiple balls' are described.

SUN DOGS

14. A 'sun dog' (parhelian) is a mock sun, a parhalion. (See also para.20 and Figure 14)

St. ELMO's FIRE

15. This is commonly mis-identified as ball (or bead) lighting. It has been reported for thousands of years and is a corona discharge from a 'grounded' point in a strong electric field, hence, it is usually observed as a glowing object hovering over an earthed object before or during a thunderstorm. It is commonly blue or blue-white in appearance and about the size of a large orange. However, much larger diameters - up to 30cm - have been seen. It decays silently, sometimes slowly and sometimes suddenly, with a lifetime of (usually) many seconds, which may extend to minutes. A characteristic distinction between St. Elmo's Fire and Ball/Bead lighting is that the latter has motion. The exception is when St. Elmo's Fire moves along a conductor.

BIRDS

15. Small flocks of birds (e.g. gulls) can be reported at night as UAPs. Their reflective under-bellies can be seen in triangular formation. Because no sound may be heard this increases the likelihood of an unwary observer, who may only see the birds for a few seconds as they wheel; producing a brief visual reflection. In bright sunlight seagulls have high reflectivity. The specular reflection from the body reported as 'bluish white' observes the fact that it is a bird as the bright flash obscures the wings. Clusters of sightings tend to occur in areas of 'greatest watchfulness' - for example near airfields and population centres. The radar echoing area (i.e. RCS) of birds is

briefly considered at Volume 3 as a source of radar false alarms in the UAP context. Certain areas of the UKADR¹ (e.g. breeding areas) are prone to the presence of birds concentrations, shown at Figures 10 to 13, and are therefore more likely to be areas where UAP are mis-reported.

MOTHS

16. Clouds of large moths, usually in some country areas, can briefly reflect light and appear as a 'vehicle'. Swarms of spruce budworm moths are said to be luminous.

SOLAR RADIATION

17. LAZAREV,² writing in the Journal of Optical Technology, explains the 'outbreak in Flying Saucers' (in Brazil and S. Africa) by "atmospheric optical phenomena which manifest themselves especially distinctively at twilight, near the visible horizon of the earth".

18. It is claimed that this is associated with the increase of optically active air mass, coincident with sharp reduction of the brightness of the atmosphere combined with the enhanced contrast of the phenomenon against the twilight background. In particular (in the locations mentioned above) these formations were observed over volcanic areas and faded after a time. This is attributed to Fresnel reflection from clouds of heated gases (air, CO₂, water vapour, volcanic sulphurous gases, aerosols etc.). Sometimes these ring-like formations were observed for several minutes.

19. Lazarev has also reported the entry of a snowball core (of a minicomet) into the atmosphere (26 September, 1990) and possibly again on 20 June, 1992 (at the

MIR orbital complex). The frequency of occurrence of cores of minicomets into the earth's atmosphere (observed from space-station MIR) is assessed at ~20 per minute.

SUN PILLARS & LIGHT PILLARS

20. A vertical column of light can sometimes be seen either below or above the sun, usually when the sun is at low elevation angles. Sun pillars are produced when correctly orientated ice crystals reflect sunlight or when hexagonal columnar ice crystals fall through the air with their long axes orientated horizontally. Example Sun Pillars and Sun Dogs are shown at Figures 14 to 16. Light Pillars are similarly formed from strong light sources other than the sun. It is possible to observe Light Pillars which do not reach to the ground - another source of UAP activity with 'searchlights' beaming downwards.

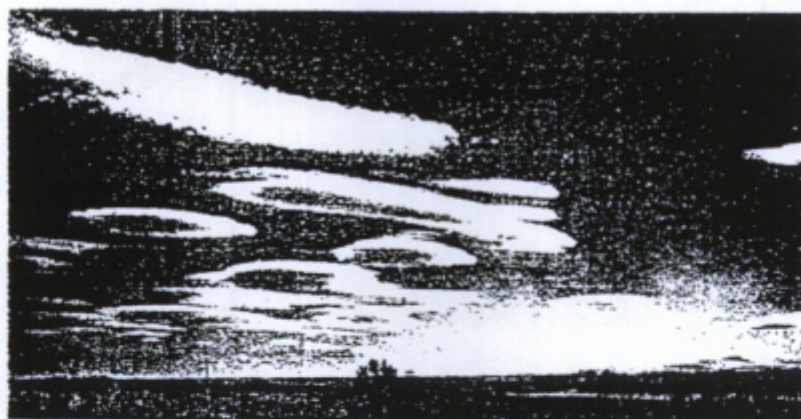
¹ UK Military Low Flying Handbook (NATO Restricted) Edition 82 Dec, 1997.

² A I Lazarev, State Optical Institute, All Russia Scientific Centre, St Petersburg. 1997.



Australian National Antarctic Research Expedition

FIGURE 1: LAMINATED CLOUD [1]



L. Larsson

FIGURE 2: LENTICULAR CLOUD [1]

[1] "Cloud Study". Ludlam and Scorer, Muray 1960

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FIGURE 3: LENTICULAR CLOUD



FIGURE 4: LENTICULAR CLOUD

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FIGURE 5: PILEOUS LAMINATED CLOUD [1]

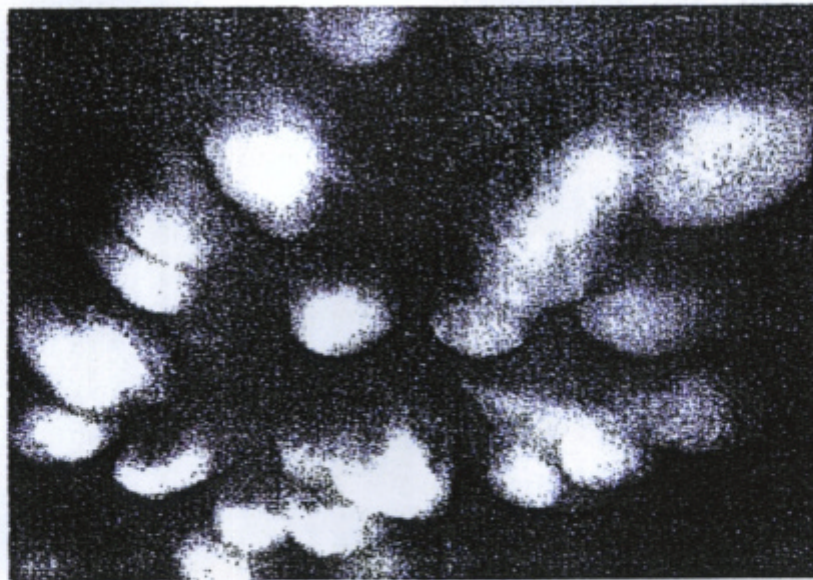
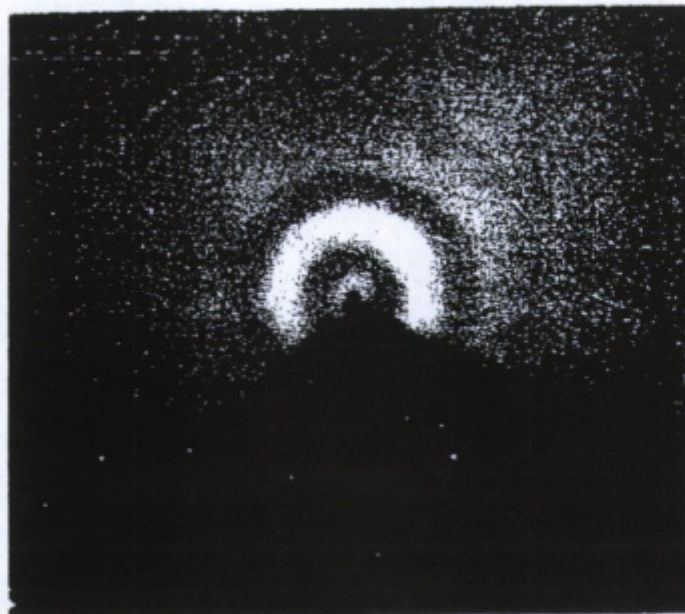


FIGURE 6: MAMMA [1]

R. S. Scorer

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J. E. Tinkler

FIGURE 7(a): GLORY [1]

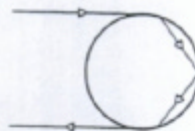


FIGURE 7 (b): LIGHT PATH



FIGURE 7(c): TOROID

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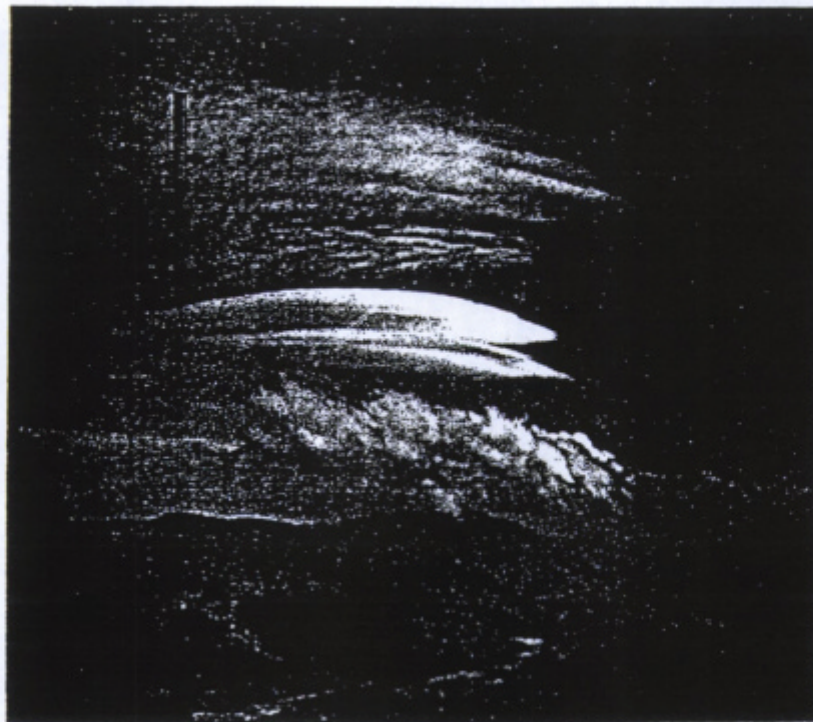


FIGURE 8: ROTOR CLOUD UK [1]



FIGURE 9: 'MOTHER OF PEARL'

Carl Störmer

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FIGURE 10: BIRD CONCENTRATION AREAS(Aug-Feb)

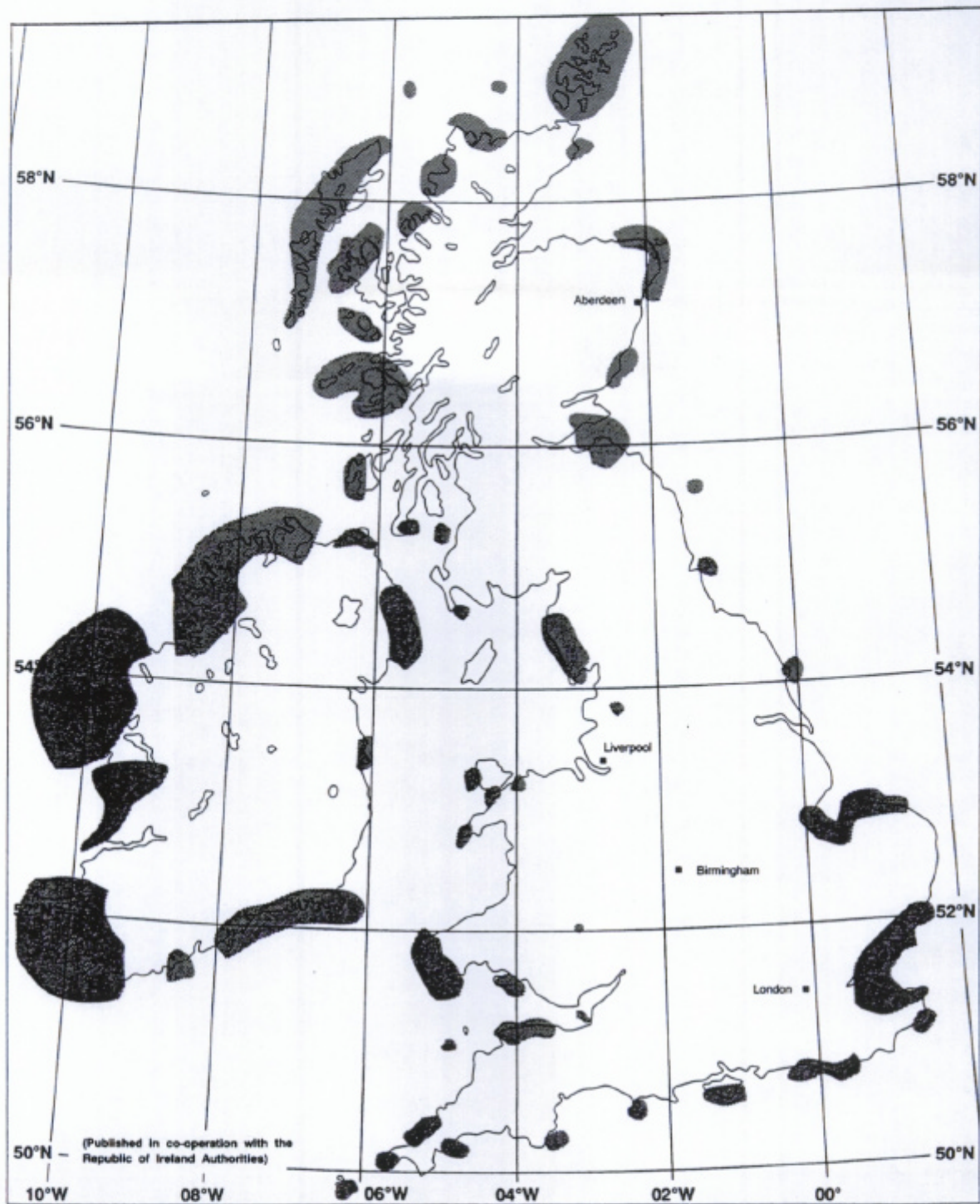


FIGURE 11: BIRD CONCENTRATION AREAS (Mar-Jul)



FIGURE 12: MAJOR SEABIRD AREAS -SCOTLAND

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FIGURE 13: SEVEN SOLAR IMAGES FROM ICE CRYSTAL



FIGURE 14: SUN PILLAR & SUN DOG (R GREENLER)

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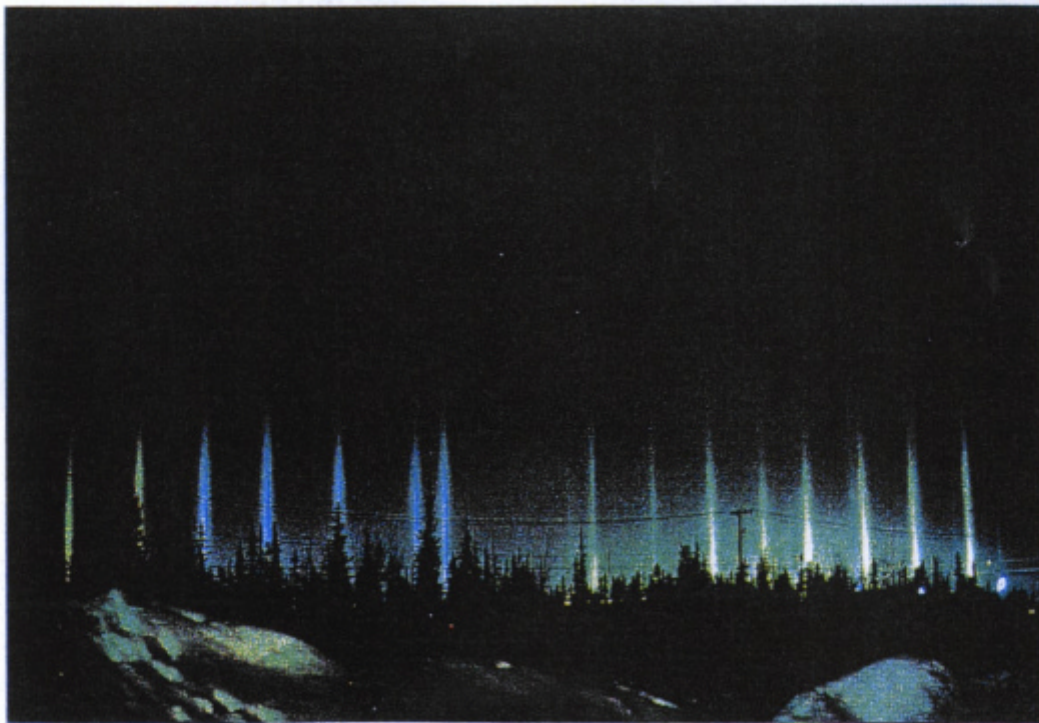


FIGURE 15: MULTIPLE LIGHT PILLAR DISPLAY (W TAPE)



FIGURE 16: LIGHT PILLAR (P PARVIAINEN)

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DIS SCIENTIFIC & TECHNICAL MEMORANDUM 55/2/00

WORKING PAPER NO. 14

METEOROLOGICAL BALLOONS

	Para	Page
Radiosonde Launch Sites	2	14.1
Size and Shape	3	14.1
Location	4	14.1

January 26, 2000

- i -

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METEOROLOGICAL BALLOONS

1. A probable cause of UAP reports which must be considered is that of radiosondes and their lifting balloons.

2. **Radiosonde Launch Sites** There are eight operational upper air stations in the United Kingdom, just part of a world wide network of some 900. The stations in the UK release helium- or hydrogen-filled balloons four times a day at midnight, midday, six o'clock in the morning and evening. The transmitter, (the proper name is a radiosonde), sends back information about the temperature, pressure and the water content of the upper atmosphere. Wind speed and direction may also determine, either by using a NAVAID system or in some cases, the balloon and radiosonde are followed by radar. The distance the balloons travel away from the launch site is dependent on the wind strength, but they will quite readily reach a height of up to 15 miles (about 80,000ft) above the ground before they burst. The equipment descends on a small parachute.

3. **Size and Shape** The Meteorological Office currently use balloons which are spherical and 1.5 to 2m in diameter at launch. The actual radiosonde is suspended some 30m beneath the balloon and, for visual purposes, can be ignored.

4. **Location** The location of radiosondes, on their lifting balloons, is known from LORAN C; and could be used to eliminate suspected UAP mis-reporting.

5. The location of the release points in the United Kingdom are shown at Figure 1. The incidence of mis-reported radiosondes as 'UAPs' is likely to be higher in the vicinity of these launch sites.

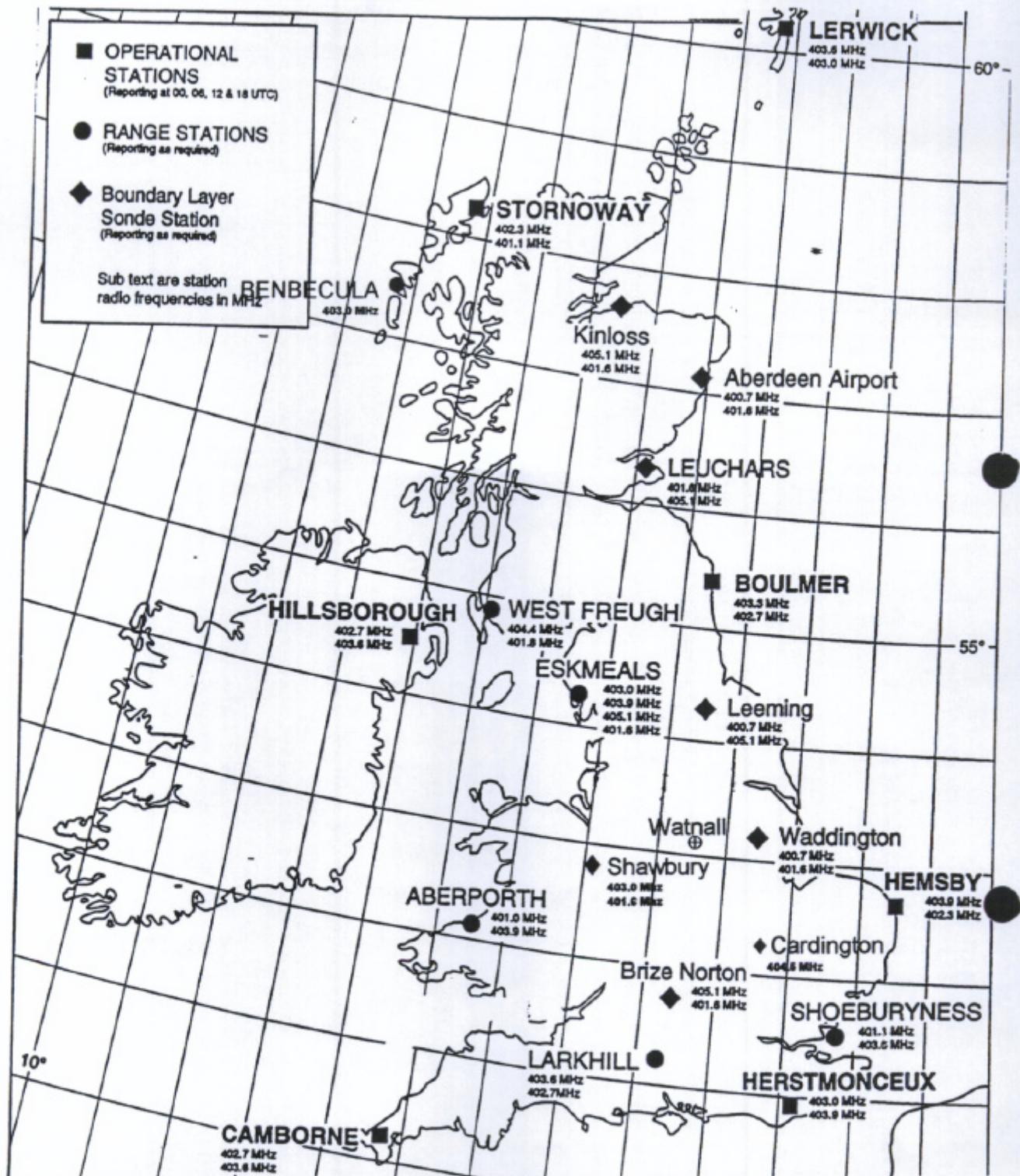


FIGURE 14-1 RADIOSONDE LAUNCH SITES

WORKING PAPER NO. 15

AIRSHIPS , HOT AIR & TETHERED BALLOONS

	Page	Para
Object Sizes	15-1	1
Report Incidence	15-1	2
Meteorological Balloons	15-1	3
Tethered Balloons	15-1	4

AIRSHIPS AND HOT AIR BALLOONS

1. **Object Sizes** Airships and hot air balloons are frequently mis-reported as UAPs, probably because their appearance in the UKADR is still relatively rare in some parts of the country, and the fact that they are at low altitude. However, ballooning is a growing sport and an increase in false alarms from this source can be expected. Both UK-produced and imported balloons can be expected in UK airspace, including balloons of novel shapes (e.g. cylindrical). The situation is enhanced by the fact that balloons are often silent for long periods, and airship engines are relatively quiet. Table 1 shows a selection of typical parameters for airships. Balloon diameters are typically 22m with a height of 26m. The use of gas burners at night is a particular source of reports of 'glowing spheres', particularly in Southern England.

2. **Report Incidence** If a number of design proposals proceed, the incidence of both cargo and passenger airships can be expected to increase; however, their appearance will still be relatively rare to most observers, compared with other familiar air-objects such as aircraft and gliders.

3. **Meteorological Balloons** These are described at Working Paper No 14.

4. **Tethered Balloons** While tethered balloons are less likely to be mis-identified as a UAP, by stationary observers, an observer in a moving vehicle may catch a glimpse of a tethered balloon in the appropriate weather and lighting conditions and submit an event report. In the UK, tethered balloons of up to 20ft in diameter may fly up to 200ft AGL, without tether streamers (the presence of streamers

would almost certainly have eliminated many false reports).

5. It should, however, be noted that the presence of a tethered balloon may, in fact, attract an atmospheric UAP which is seeking an attracting electrical potential, since a charged mass of air may be attracted to the balloon or it's tether.

6. Tethered balloons may remain in one position for up to 10 days.

	Length (m)	Diameter (m)	Height (m) ^[1]
Skyship P600	59	16	20
USA	17	5.5	6.77
USA	39	10	-
USA	25	8	-
USA	67.5	16.7	20.2
COLT	34	12.5	-
UK	30	11	-
GERMANY	68	14	-

TABLE 1 EXAMPLE BALLOON DIMENSIONS

Note [1] Including Gondola

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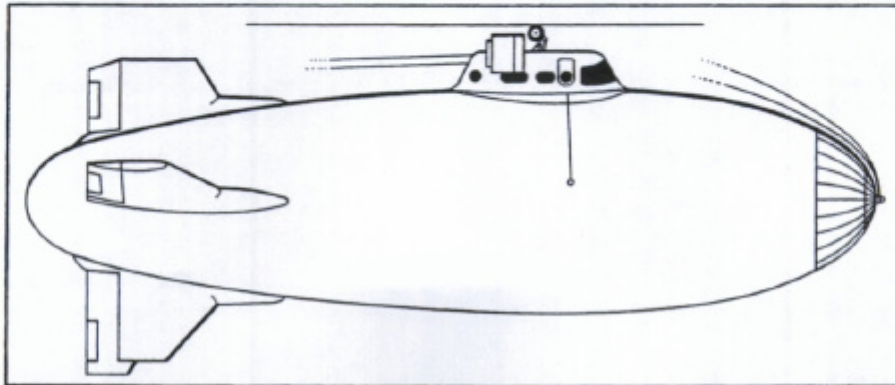


Figure 1 Design Drawing for the DKBA-800 Passenger/Cargo Airship

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WORKING PAPER NO. 16

SUNSPOT, AURORA AND SEISMIC CORRELATION

	Para	Page
SUNSPOT, AURORA AND SEISMIC CORRELATION		
Solar Cycle	1	16-1
Auroral Phenomena	5	16-1
CORRELATION OF UAP EVENTS WITH SEISMIC ACTIVITY	6	16-2
TECTONIC ELEMENTS OF THE UK	8	16-2

SUNSPOT, AURORA AND SEISMIC CORRELATION

1. **Solar Cycle** At the commencement of the UAP study it was recognised that the UAP enigma, which has apparently been present in some form for recorded history, might be due to a simple natural explanation. However, it is only in the last 50 years that an increasingly large number of UAP sightings have been recorded. While it was recognised that the phenomenon may eventually be shown to be due to a combination of natural events, rather than a single cause, the solar cycle is one of the more obvious candidates for investigation. The frequency of occurrence of UAP reports against known earth phenomena, such as solar activity, has been checked. However, as this transient solar phenomenon repeats in an eleven (~11.4) year cycle, long-term statistical comparison will not be possible unless a very large spread of UAP events are entered into the database and, clearly, it would not be viable, purely in the interests of Defence Intelligence, to do so. Investigations, reported in Volume 1 of the Study, were necessarily limited to monthly comparisons taken over a year. No direct correlation was found for solar flux or sunspot number. This does not mean that, in the future, there will not be shown to be some weak correlation, connection or contribution, when taken together with other natural effects

2. One of the reasons for considering sunspot correlation is because the cycle seems to derive from a more fundamental 23 year magnetic periodicity on the sun and, it has been suggested, in some quarters, that UAP and magnetic activity are connected in some way on the earth. The solar magnetic cycle has a period approximately twice that of sunspot (flare) activity. The electromagnetic emissions from the sun vary in power, penetrating power, degree of fluctuation and intensity distribution over the earth. The direct effects of electromagnetic radiation are confined to the sun-lit hemisphere of the earth. During each new 11 year cycle the

polarity of the pattern of magnetic activity reverses.

3. Within the 11/23 year cycle, solar surges appear (solar flares) which produce complex magnetic fields. Therefore, even to make correlations between the frequency of UAP reports and spurious magnetic activity will require at least several years of reports in the UAP database - or ideally, a filter to remove identifiable distractors, such as aircraft. Figures 2 to 4^[1] show portion of the solar cycles 21-23. Cycle 21 started in June 1976, Cycle 22 in September 1986 and Cycle 23 (the current Cycle) in May 1996. It is clear that to carry out any meaningful statistical analysis a the dat for a lengthy period of UAP sighting reports is required. As an initial sample the daily measurements were obtained for the period 1986-1996 and used for correlation studies reported at Volume 1.

4. Proof of the postulated UAP-solar connection may be difficult to confirm even if all the statistics were available because it must be remembered that UAP statistics will have been significantly skewed in the more recent decades by the addition of airships, aircraft, satellites, etc. to the reasons for sightings (i.e. man-made events).

5. **Auroral Phenomena** Magnetic and auroral phenomena (M-Region disturbance) occur at 27 day intervals over months or even years (Figure 1). These recurrent effects are most prevalent during the last three to four years of the 11 year cycle - unexpectedly when normal sunspot activity is low. The terrestrial effects are much less vigorous than the effects caused by flares, but they can last several days, reaching a peak when the earth is at its greatest distance above or below the plane of the sun's equator.

CORRELATION OF UAP EVENTS WITH SEISMIC ACTIVITY

6. On the assumption that major luminous events are also connected with seismic activity, it should be possible to correlate this coincidence if enough UAP event evidence is available to compare with seismic records. The rationale for supposing that seismic (structural) strain causes luminescences is described (Working Paper No. 10). If this were a reliable guide then the onset of a set of UAP events could possibly be predicted! There are, however, several problem areas:

- The number of UAP events which are clearly luminous/earthlight-related, must first be separated from all other UAP sightings.
- The UK land-mass suffers serious seismic activity only at a low rate but hundreds of low-magnitude events occur which must influence rock-stress conditions from day to day.
- The UK distribution of probable 'earthlights' cannot be expected to be evenly spread because of the variability of the geological structure and sporadic reporting; as many of the rocky areas of the UK are in sparsely populated areas.

7. Persinger^[3] has analysed luminosity events across Europe (Six nations) using reports taken over a 100 year period (1820-1920), where it is shown that the years of peak earthquake activity were also the same years of maximum UFO reporting. While this type of analysis could be made for the period for which the Department hold UAP reports (1967-1997), some of the early reports are limited in number and sparse in detail, and a more realistic approach is to take a ten year sample (1987-1997), where the statistical value will be higher. Distinct UAP-Earthquake to Fault-line

links were found with UAP, in a French investigation as long ago as 1960. It has already been established elsewhere in this study that UAP events may be due to many different effects, no possible cause must be ignored.

TECTONIC ELEMENTS OF THE UK

8. As an aid to possible future analysis of UAP events, the UK earth-fault system has been briefly investigated. The most useful reference for this purpose is at [4]. A full database should enable UAP location correlations to be made with this fault map if seismic activity is the cause. It is assumed that if earthlights are formed at or near fault positions they may travel some distance (e.g. 10km or more) before dissipating. Under some circumstances (e.g. attachment to a charged body such as an aircraft), they may travel much further, depending on air target velocity.

9. The total annual release of energy in the world's earthquakes corresponds to up to 10^6 kW and although the largest earthquakes account for most of the seismic release it is assessed that ~20,000 small quakes occur. A moderate earthquake generates $\sim 10^5$ watts per square metre and a fault rupture $\sim 10^{14}$ watts. No trigger mechanism has been discovered to predict earthquakes reliably (in which case this might also act as a warning for expected UAP reports due to earthlights (see Working Paper No. 10)). Many events exhibit the property of 'dilantancy', for example, (i.e. an increase in volume during deformation). This, in turn, causes an increase in frictional forces and a change in resistivity/electrical conductivity, which, in turn, must affect the production of early, but small, seismic movements (said to be detected by animals in advance of human detection systems/instruments and a precursor to earthlights).

10. Commercial data is available (at a small cost) to support further investigations, if required.

[1] SIDC Brussels at www.dxlc.com/spolar. J Alvested. 1988

[2] British Geological Survey,
Edinburgh

[3] Persinger M.A.
"Geographical Variables and
Behaviour" Laurentian
University Canada (1983)

[4] Underhill J. R. et al " The
Dent Fault System....." Journal
of the Geographical Society,
London Vol 145,(1988)

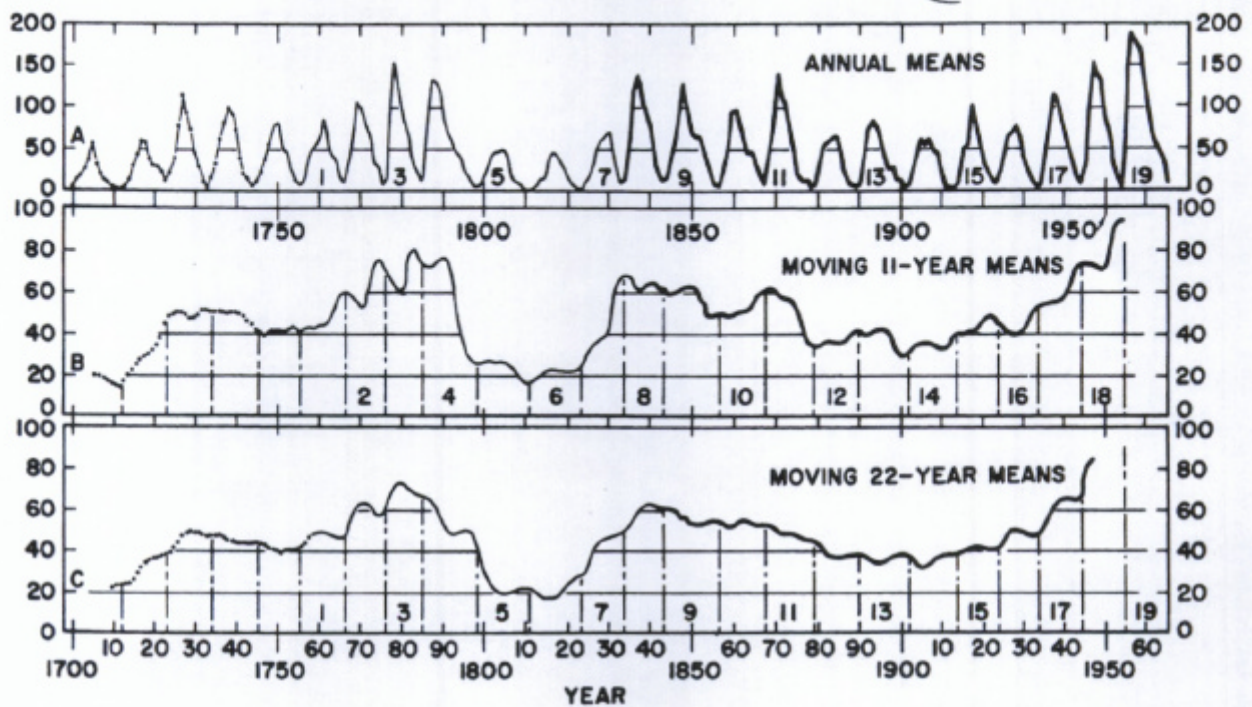


FIGURE 1: MEANS OF RELATIVE SUNSPOT NUMBERS, 1700 TO 1960¹

¹ HANDBOOK of Geophysics and Space Environments Air Force Cambridge Research Laboratories.

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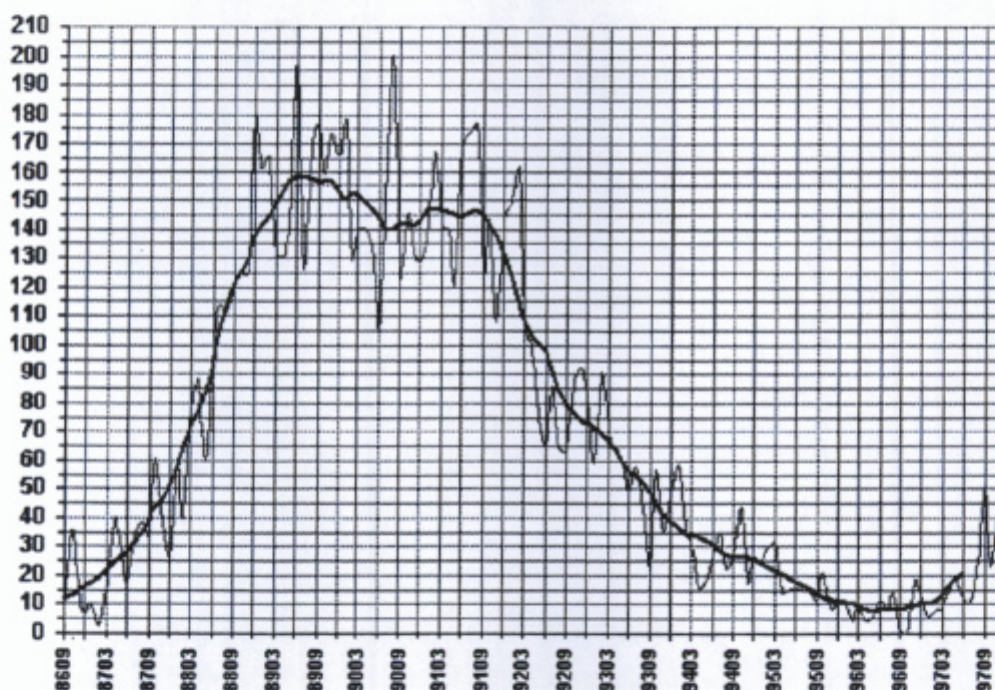


FIGURE 2: SOLAR CYCLE SUNSPOT NUMBERS (CYCLES 21-23)

Note: The heavy curve is a smoothed approximation. In the UAP context finer grain required (Figure 3)

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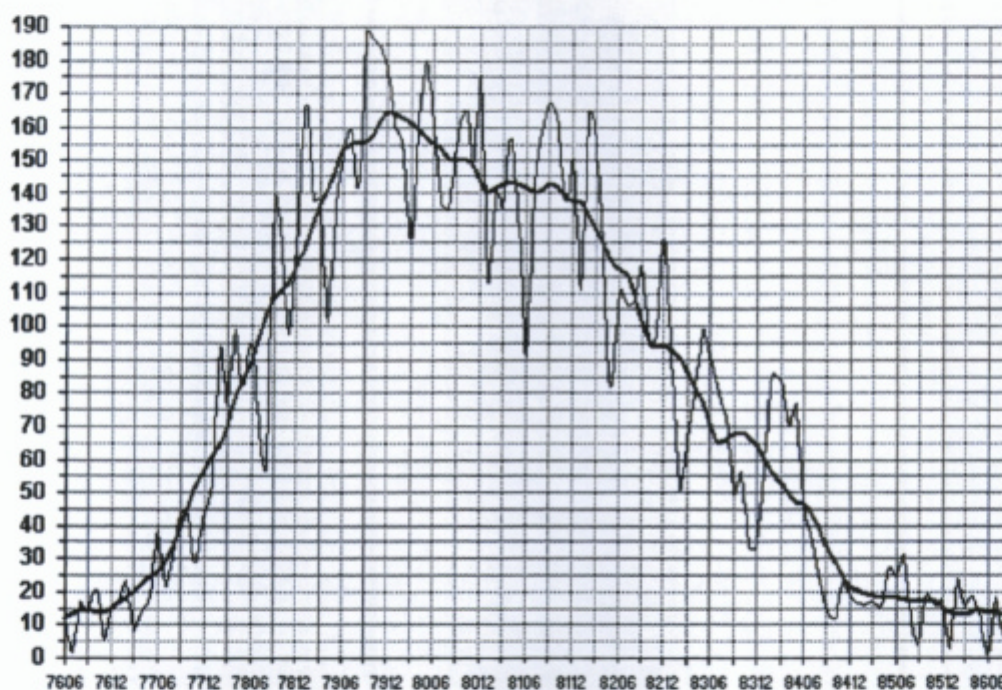


FIGURE 3: SOLAR CYCLE No 21(1976-1986)

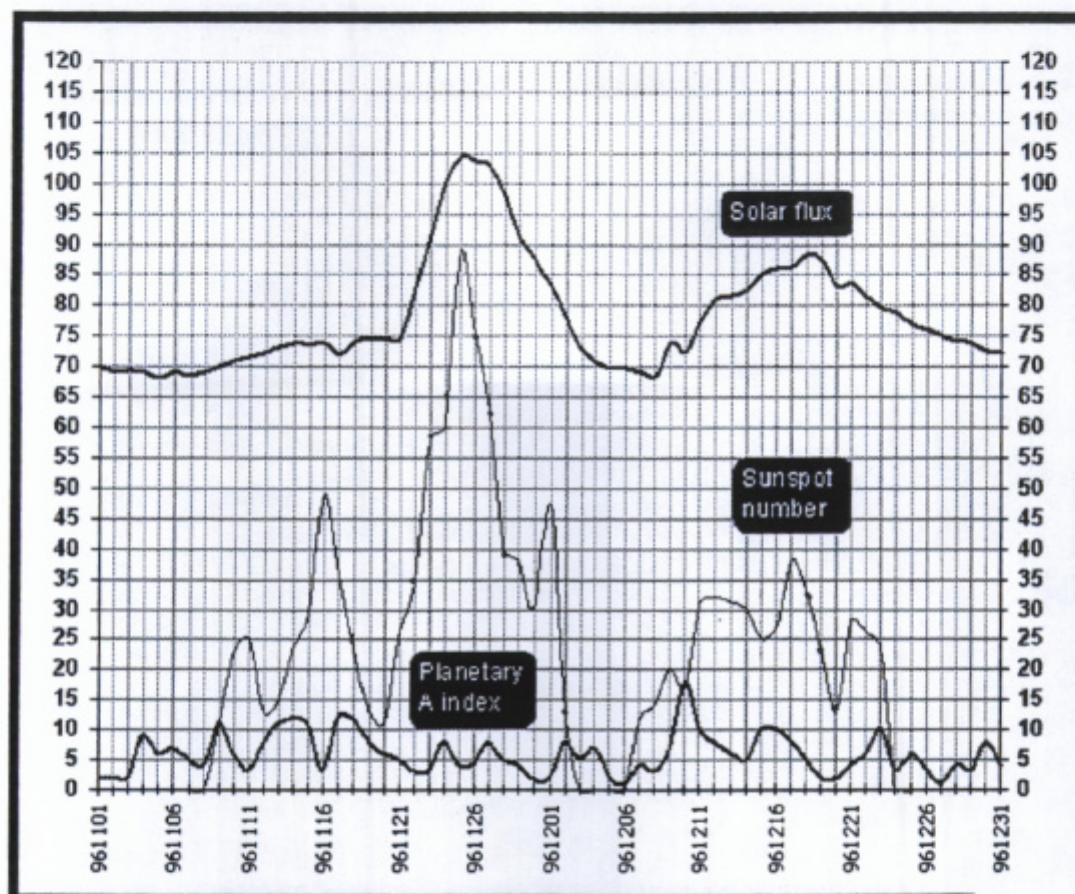


FIGURE 4: EXAMPLE DETAILED SOLAR FLUX/SUNSPOT NUMBERS
FOR JAN/FEB 1996 (U)

WORKING PAPER NO. 17

VISUAL OBSERVATION OF SATELLITES

	Para	Page
Orbital Period	1	17-1
Inclination	2	17-1
Re-entry	3	17-1
Satellite Brightness	4	17-1
Comparison of Brightness with Stars	5	17-1
Cylindrical and Balloon Satellites	6	17-1
CONDITIONS FOR VIEWING SATELLITES	7	17-1
Earth's Shadow	9	17-2
Repeat Observations	12	17-3
Spells of Visibility	14	17-3
Angles of Elevation	16	17-3
Flash Periods	17	17-3
Sightline Rates	18	17-3

17 February 1999

i

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VISUAL OBSERVATION OF SATELLITES

1. **Orbital Period** This could be relevant to UAP studies, as an event (i.e. satellite mistaken for a UAP) could be reported once or more on the same pass or on successive passes. The orbital period (i.e. in this UAP context the time of appearance or reappearance) is shown at Figure 1. Thus if the orbit altitude is changed from 200km to 1500km the orbit time changes from 88 to 116 minutes. Hence, UAP sightings with similar characteristics and at these approximate time intervals could be satellite sightings.¹

2. **Inclination** This is the angle at which the plane of an orbit cuts the equator. It determines the maximum latitude reached by the satellite and hence its potential to be observed in the UKADR.

3. **Re-entry** The effect of air drag (even with much reduced density) causes LEO satellites especially to re-enter the atmosphere. This occurs even with elliptic orbits, which suffer higher drag at each perigee. The lifetime of the satellite is a function of its mass and drag and is thus directly proportional to its mass/area ratio. Because the upper air density is variable, precise re-entry timing is difficult to predict. A visual example of re-entry (Skylab 1) is shown at Figure 2. It is important to note that the colours produced can be white, whitish-yellow, with touches of orange, red, green and blue, all colours often reported as UAP events. Re-entry velocity can be close to 8km sec⁻¹ and the pyrotechnic display ceases when it has descended to ~30km altitude, having commenced its glow at 90km altitude. After 30km the remaining fragments fall at a steeper angle. A single calculation shows that a 60km downward path (at 8km per second) lasts only about 7.5 seconds.

4. **Satellite Brightness** Brightness depends on size, shape, surface finish and 'phase angle' relative to the sun. A spherical satellite (e.g. 40+m in diameter (Echo 2 balloon) or 0.3m dia, at the other extreme, may have all its surface illuminated facing the sun. This occurs if a spherical satellite is in the east with the sun just below the horizon in the West. If the sun is in the west when the

satellite is in the West, only a crescent is illuminated. The texture of satellite surface (i.e. its surface finish) varies. A white or shiny surface is brighter than a black satellite. It may be partially illuminated and hence seen as an inclined disc, rather than a sphere.

5. **Comparison of Brightness with Stars** It is possible that some UAP reports (from those with knowledge of astronomy) may rate the UAP in terms of the 'magnitude' scale defined by reference to standard stars/planets and even compare a UAP brightness with that of a familiar star (e.g. Pole Star). The level 'magnitude 1' is the brightest with 'magnitude 6' roughly the faintest. the Pole Star has a magnitude of 2.1 Sirius; (a regular UAP report), Mars and Salyut-type systems have a magnitude of -1 (i.e. 2.5 times brighter than a star of magnitude 0 such as Vega, itself 2 times brighter than a star of magnitude 1. Figure 3 relates magnitude against satellite diameter, velocity and range from observer. Although this is short-range it can be roughly approximated to orbit height when a satellite is viewed approximately overhead.

6. **Cylindrical and Balloon Satellites** Brightness is estimated by converting to the brightness of an equivalent sphere from the side-on area of the cylinder (i.e. length x diameter) and then taking the square root to give the equivalent sphere. (e.g. $8 \times 2 = 16\text{m}^2$ (cylinder side area) = 4m diaspherical equivalent). Clearly the area would be less when viewed end-on. Cylinder area viewed may fluctuate, if they are tumbling, giving the appearance of flashing lights. Balloon satellites are very sensitive to air drag. They may break up in space, producing several reflecting objects.

CONDITIONS FOR VIEWING SATELLITES

7. This is a key topic for UAP filtering. A satellite can only be seen:

- If illuminated by the sun
- If the observer is well in shadow
- If the satellite is against a dark background.

¹ "Observing Earth Satellites" Desmond King - Hele. MacMillan 1983.

8. Certain conditions apply for viewing to occur, and which set the conditions (or eliminate!) the possibility of a satellite being mistaken for a UAV.

- The sun must be at least 10° below the horizon (giving a shadow height of at least 100Km).
- The satellite must be higher than the shadow.
- Faint satellites can only be seen when the shadow height is $>100\text{Km}$ but less than the satellite's height, (which may be as low as 200Km).

9. **Earth's Shadow** Evening observations of low satellites are usually possible only during the hour or two while the shadow is climbing from 100Km to the satellite's height. The sequence is reversed in the morning. Because of earth's shadow, a low satellite can only be normally observed from 2 narrow bands of latitude (one in each hemisphere). Figure 4 illustrates the limitations during northern summer for a satellite in near-polar orbit with the sun in near orbital plane. The earth's shadow is shown with a sharp edge, but in practice this is fuzzy. The height of earth's shadow is absolutely fundamental for satellite observation, for example, in the Figure (at point P) the shadow height PS is approximately equal to earth's radius ($\sim 6000\text{Km}$), so the only satellites visible overhead at point P would be more than 6000Km high and probably faint and difficult to see. In UAP evaluation most events which catch the eye and might be reported are likely to be bright.

10. Earth's shadow height varies with time of year. Figure 5 shows the variation at 50°N , local time. For viewers near London, Time = GMT. For every degree of longitude west of Greenwich four minutes must be subtracted. This chart can be used two ways; it shows the height of the evening shadow:

- Working from date (e.g. 2 March) at latitude 50°N sunset is $\sim 17.45\text{hrs}$, twilight lasts nearly one hour - hence the sky will not be dark enough to view satellites until $\sim 18.40\text{hrs}$, when the shadow height is 100Km. By 19.10hrs the shadow has reached 200Km altitude. After that no

satellite lower than 200Km height can be seen overhead, though they could still be observed in the West where the shadow height is still lower. By 21.00 hrs the shadow height exceeds 1000Km and many brighter satellites at these altitudes can be seen.

- Alternatively, if the satellite height is known the chart can be used in reverse. This is a less likely scenario in trying to eliminate mis-reported UAV reports.

11. It is observed that (using the 100 and 400 curves at Figure 5) at 50°N on 1 January, the period available for satellite viewing is only from 17.12-18.18hrs. By April this has lengthened to about 1 hour and from approximately 20 May to 20 July a satellite could be seen at any time of the night. In June any satellite higher than 300Km is always above the earth's shadow at latitudes greater than 50°N . These are all important factors in correlation with potential UAP windows of observation. The observing period is actually slightly more than Figure 5 might suggest (since this is plotted for a satellite overhead). Clearly the satellite might be at some other elevation angle. In the dark eastern sky it is sometimes possible to observe before the end of twilight. For a satellite at 400Km altitude at longitudes up to 10° to the west of the observer it is possible to observe up to 40 minutes longer than the figure indicates.

12. A rule of thumb (for 50°N) is that over the greater part of the year (excluding May, June, July) the possible observation time for a faint satellite ($\sim 200\text{Km}$ altitude) is one hour and two hours if its height is doubled. As an example (with reference to Figure 5) the observer sees a satellite at 21.30hrs on 29 August the shadow height on the diagram is 500Km. Hence the satellite will be in shadow and visible unless its height exceeds 500Km.

12. **Repeat Observations** Observation of a satellite on successive evenings is subject to longitude changes at which it crosses the latitude of the observer. A satellite appears to be $\sim 1^\circ$ (0.986°) further west on successive nights due to the 360.986° rotation in 24 hours because the earth spins through 360° 23hrs 56 minutes and spends

the remaining four minutes 'catching up' on the small angle needed to bring it to the same direction relative to the sun. The same satellite will also have a time-shift in arrival at the observer's latitude, by several minutes. Clearly this varies with orbit type. The daily shift to the West is shown at Figure 6 for near circular orbits. Hence, from the UAP aspect reports could be received, shifted in time and elevation angle on successive days/nights with an observer in the same position - or by an observer in a different position.

13. Figure 7 shows two successive ground tracks of a 90 minute period satellite at an inclination of 65° . This shows that the 22.5° shift in track longitude is such that it is unlikely that the same observer will see two successive transits. The spell of visibility of a particular satellite varies as the orbital plane swings westward. For example, a 500Km altitude satellite will reach a point where the shadow height is less than 500Km. The satellite will be visible in the evening for some weeks, but as it swings further west will be invisible because of the glare of the setting sun. Next, it will pass over in daylight for many weeks, then into morning twilight and after a spell of potential morning visibility will once again enter eclipse before repeating the cycle.

14. **Spells of Visibility** Satellites (in circular orbit) can pass over on either a north or southbound track. It is important to note the concept of 'spells of visibility' because these are likely to generate successive spurious UAP reports. It can be shown that evening visibility lasts for $v/4(1-x)$ days, where v is the length of one evening's visibility time and the value x (the daily westward shift) is given from Figure 6. For example, for a satellite at 400km altitude, visibility is ~2 hours per evening/night, the value of x is zero (polar orbit), the visibility is 30 days. With an inclination of 70° , period 92 minutes, then x is 2.8 (Figure 6), hence the spell of visibility is reduced to $30/3.8 \approx 8$ days. If satellite height is increased the spell of visibility increases. This rule of thumb becomes inaccurate after ~ 1 month - but is of no concern for UAP elimination purposes. The important fact is that a given satellite is observable (given atmospheric clarity) for a number of successive days and this can result in mistaken reporting as a UAP on one or more of these days.

15. After a spell of visibility a circular orbit satellite becomes visible again (from the same location) after $1440/4(1+x)$ days or $12/(1+x)$ months. Slightly different rules apply to eccentric orbits.

16. **Angle of Elevation** This is one parameter which often occurs in UAP reports. Figure 8(a) and 8(b) show the angle/range/altitude relationship.

17. **Flash Periods** It is possible to time the satellite flash period. This feature may appear in UAP reports. Flashes (seen with the naked eye) from MOLNIYA satellites have been reported at once per minute (even from 40,000km range). These flashes tend to come from flat panels and have magnitudes which can exceed those of VENUS at its brightest.

18. **Sightline Rates** UAP reports occasionally include times and angles. Some examples are:

- (a) Satellite at 200km altitude. The minimum orbital speed is 7900m.s^{-1} (e.g. SKYLAB altitude 235km).
- (b) Satellite at moon distance travels at 975m.s^{-1} .
- (c) An equatorial orbit (circular) at 10,200km passes once every eight hours.
- (d) A 100-300 nautical mile high orbit passes, typically, once every 90 minutes.

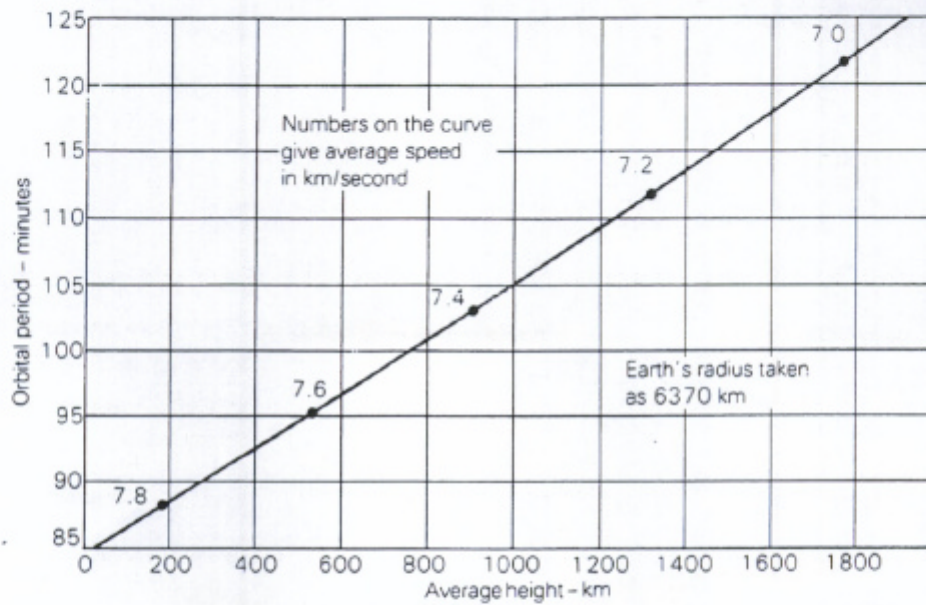


Figure 1: Orbital period of a satellite versus its average height above the Earth (U)



Figure 2: Photograph of the descent of Skylab 1 over Australia on 11 July 1979 (U)

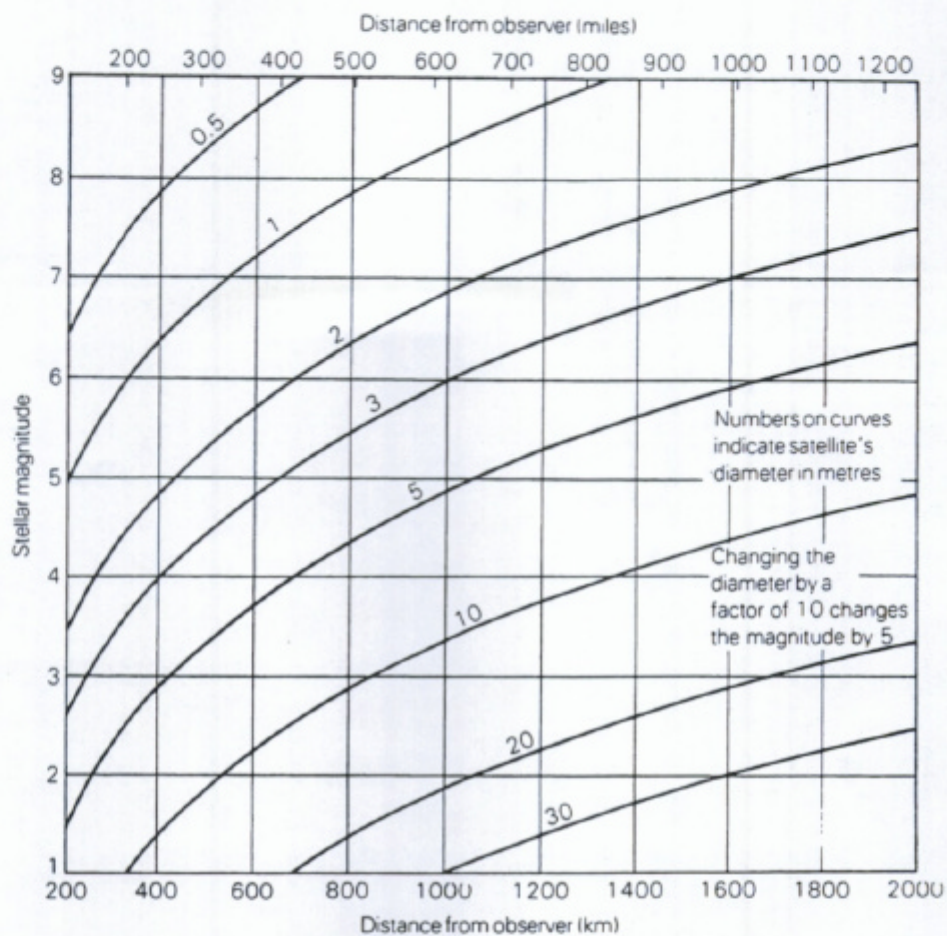


Figure 3: Spherical Satellite - Visual Brightness for given Range and Diameter (U)

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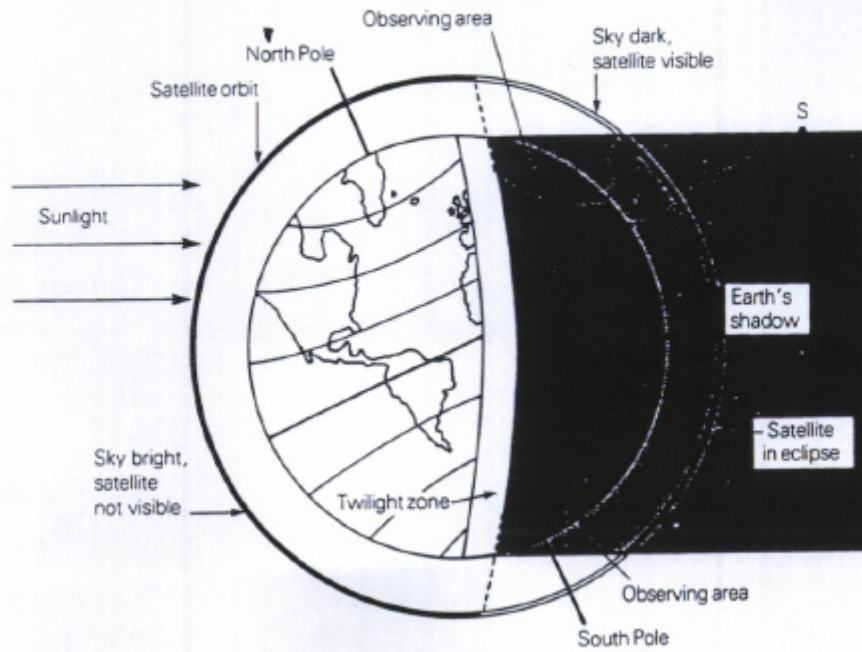
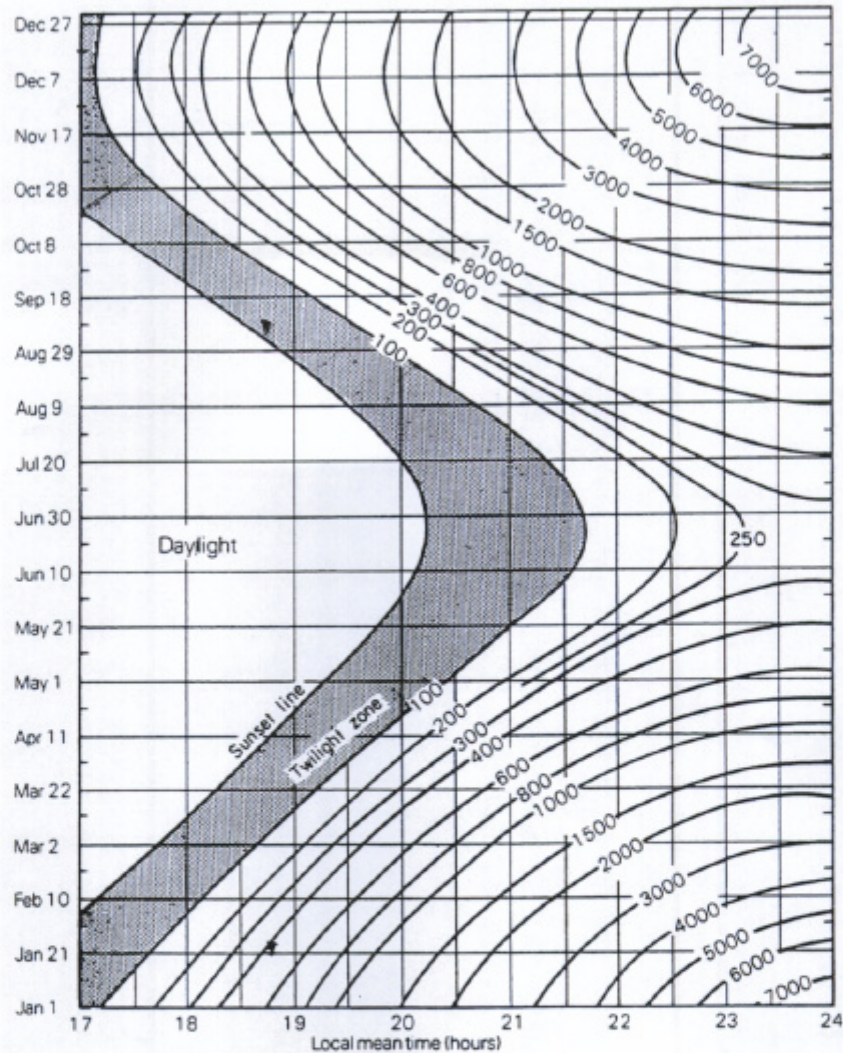


Figure 4: Example - Satellite Visibility Sectors (U)

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**Figure 5: Satellite Viewing Windows (for Latitude 50°N) for Earth's Shadow
Altitudes up to 7000Km (U)**

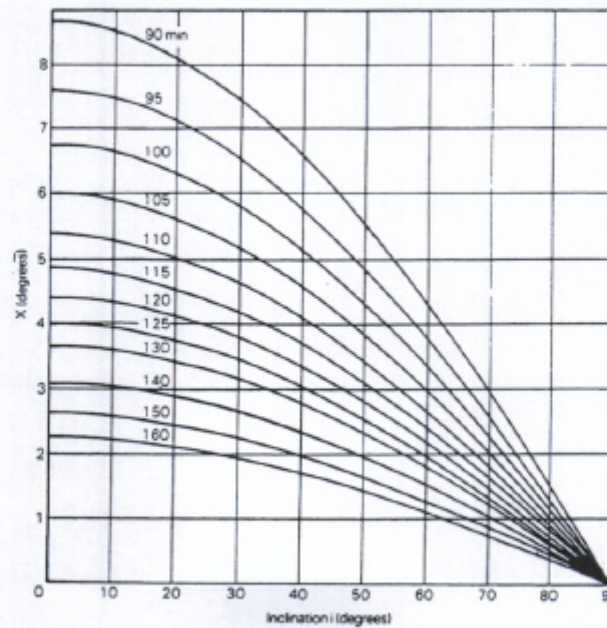


Figure 6: Daily Shift of Observed Position to the West for given Orbital Period (U)

Note: X (Degrees) is Nodal Regression.



Figure 7: 90 Minute Orbit Tracks at 65° Inclination (U)

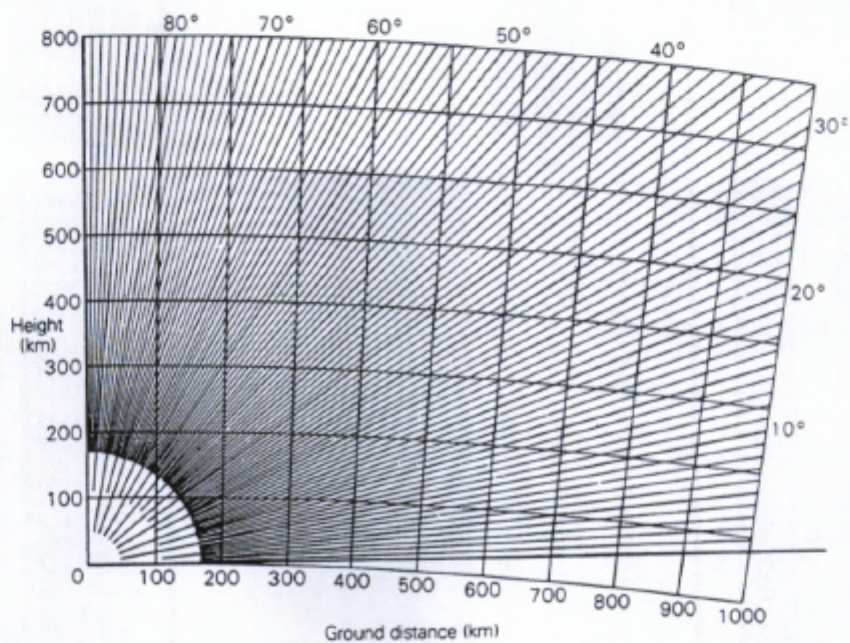


Figure 8(a): Satellite Elevation to 800Km Altitude (U)

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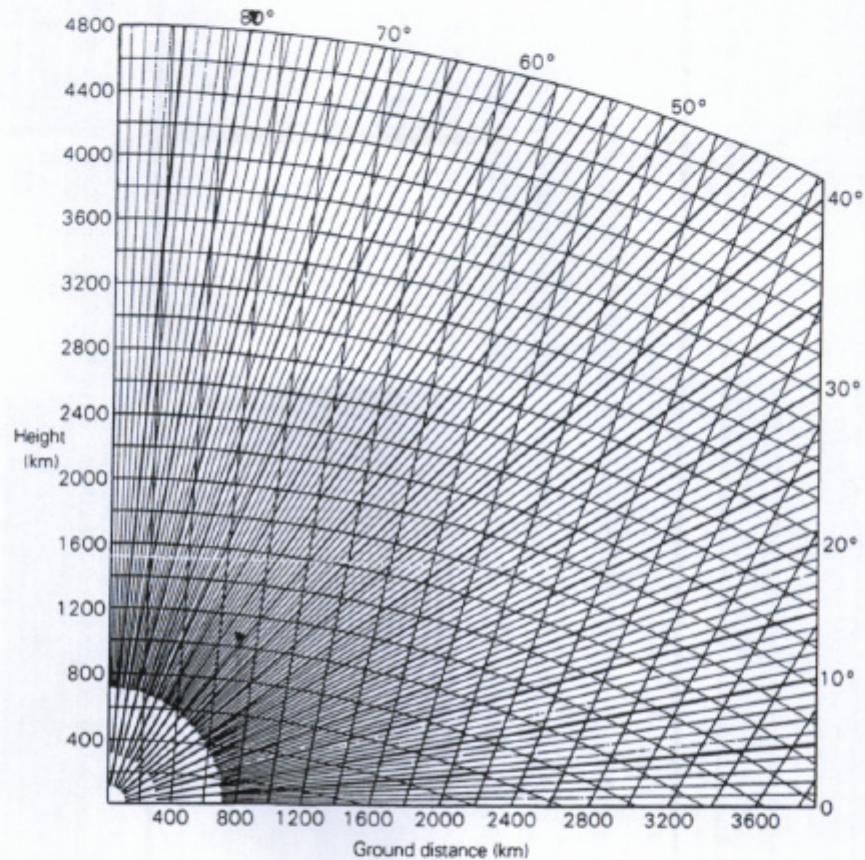


Figure 8(b): Satellite Elevation to 3000Km Altitude (U)

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WORKING PAPER NO. 18

PROJECTED SHAPES/SHADOWS, FLUORESCENCE, LUMINESCENCE
& SONOLUMINESCENCE

	Para	Page
PROJECTED SHAPES AND SHADOWS	1	18-1
FLUORESCENCE AND LUMINESCENCE	3	18-1
ABSORPTION AND SCATTERING	4	18-1
Gas Absorption	6	18-2
Aerosol Fluorescence	7	18-2
Scattering Intensity	8	18-2
Pollution	9	18-2
SONOLUMINESCENCE	10	18-2

PROJECTED SHAPES AND SHADOWS

1. Frequently UAP reports suggest shadow shapes (i.e. objects apparently seen in silhouette). It is believed that a proportion of these are projected shadows from any object which is opaque, or near opaque at the wavelength of the surrounding light. Thus a shadow with a fairly sharp edge is reported, although much closer examination would show that the shadow is not absolutely sharp.

2. The shadows of aircraft and helicopters are frequently seen on the ground, often in film or video taken from the same platform. Less well known (to terrestrial observers) is the projection of aircraft shapes on to cloud layers and the consequent moving shadows seen from beneath the clouds. Further, it is possible for rainbow-like arrays to be produced through sunshine via aircraft windows, which can be projected on to clouds some kilometres distant. These can be reported as UAPs with colours.

FLUORESCENCE AND LUMINESCENCE

3. Earthlights are seen in the dark but they are not observed by reflected light. They actually provide the light energy which the eye receives and be classed as 'fluorescent', whereas, luminescence is visible light, generated by the conversion of energy invisible to the eye. Luminescence is a general term classified according to the means of excitation; examples are:

- Bioluminescence is generated by bio-chemical reaction.
- Cathodo-luminescence is generated by electron bombardment.

Luminescence is called fluorescence or phosphorescence, depending on the rate of decay; phosphorescence persists for some time. Fluorescence ceases when electron bombardment stops (i.e. within $\sim 10^{-8}$ sec.). Therefore to obtain continued fluorescence, continuous electron bombardment is needed. (See also para 6 below).

ABSORPTION AND SCATTERING

4. When ambient light impinges on a gas its intensity is affected by the absorption and, as a result its velocity will be less in the medium than in free space. The medium may not reduce the intensity by equal amounts for all wavelengths. No substance is known which absorbs all wavelengths equally, although some can approach this condition over a wide range of wavelengths. Normally one would expect selective absorption to occur.

5. Bodies can cause different effects for transmitted and reflected light. Hence, an observer on one side of the body, receiving energy which has passed through a gas may observe one colour, whereas an observer of the same object using reflected (i.e. back-scattered) light can see a different colour. True absorption represents the actual disappearance of light, the energy of which is converted to heat motion of the molecules. In the UAP context there appears to be complete absorption when a totally 'black' shape

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appears between what are taken to be highly charged 'balls' seen as sources of coloured or white light, usually at the extremities, forming a triangle, cone or rectangle.

6. **Gas Absorption** The absorption spectra of gases at ordinary pressures show narrow dark lines, although it is possible to find regions of continuous absorption. After an atom or molecule has taken up energy from light it may collide with another particle and an average increase in the velocity of particles may occur. Each atom energised can only exist for 10^{-7} to 10^{-8} sec. and unless a collision occurs the energy will be emitted as radiation. At low pressures the time between collisions is long, hence the gas becomes a source of radiation and there is not true absorption. The re-emitted light often has the same wavelength (resonance radiation). Under some circumstances the re-emitted light may have a longer wavelength than the incident light. This is known as fluorescence. In either resonance or fluorescence some of the light will be removed and dark lines would be seen in an examination of the spectral response.

7. **Aerosol Fluorescence** If it is postulated that some UAP comprise clouds of aerosol particles, then it is necessary, briefly, to examine fluorescence from solids. According to Stoke's Law the wavelength of the fluorescent light is always longer than that of the absorbed light. In the UAP context it seems unlikely that (if fluorescence is indeed the mechanism of making an aerosol cloud appear as a visible mass) this could be caused by radiation of the particles by any radar system. The source radiation must be shorter in wavelength than visible light, leading to the postulation that the cause

may be IR or UV bursts from a natural source.

8. **Scattering Intensity** The scattered intensity is proportional to the incident intensity and to the square of the volume of the scattering particle and on wavelength. Hence, if an aerosol cloud exists (say at high altitude) and is radiated with a light source, the reflected light seen by an observer will be critically dependent on particle size. Long waves would be expected to be less effectively scattered than short ones because the particles themselves present obstructions to the waves, which are smaller (compared with the wavelength) for long waves than for short ones. The intensity viewed is proportional to $1/\lambda^4$. As red light ($\lambda = 7200$) has a wavelength 1.8 times as great as violet light ($\lambda = 4000$) the law predicts $(1.8)^4$ or ten times greater scattering for the violet light from particles much smaller than the wavelength of either colour. Hence, if white light is scattered from sufficiently fine particles the scattered light always has a bluish colour. If the size of the particles is larger, then the scattered light becomes whiter.

9. **Pollution** In passing it is suggested that the reported increase in atmospheric pollution (particularly over large cities) may have a bearing on the charged aerosol phenomena (reported at Working Paper No. 19) and thereby the increasing incidence of UAP reports. That there is a clear connection with the particles in suspension in earthquake and volcanic zones is reported elsewhere in the report.

SONOLUMINESCENCE

10. Sonoluminescence is the production of wide-spectrum light, visible by the human eye, due to the compression of gas

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bubbles by sonic (i.e. sound air pressure) shock waves. While this can be easily reproduced under laboratory conditions under water, and the light emitted extends from IR to UV, covering the entire human eye spectrum, it is not clear whether the conditions could (perhaps exceptionally) exist in the atmosphere. If this is so, then sonoluminescence could be a candidate source for the very short UAP events (e.g. <1 second), which are frequently found when examining the UAP reports. Although it is some 60 years since the discovery of the effect little serious work on understanding and quantifying the phenomenon has been done - mainly because of lack of measurement technology.

11. The science behind the sonoluminescence effect can be summarized as:

- A very small volume must be present (appearing, for example, as a gas bubble (cavity) in water) which must contain a gas other than pure oxygen or nitrogen. However, even a 1% impurity is sufficient to invoke sonoluminescence.

- Successive rarefactions and compressions must be present for the gas to pulsate rapidly.

- The radius of the gas bubble will expand when the pressure goes negative (e.g. for a bubble in water the radius can typically change from 4 to 40 microns).

- The sudden collapse (Rayleigh 1917) reaches supersonic velocities (1.4 kilometres per second quoted), stopping only when the gas in the bubble reaches a 'hard core' minimum radius (when the molecules can get no closer together).

- Photons of several eV energy level are emitted, at which time the temperature is estimated as being in the tens of thousands of degrees K. At this point the bubble surface is reported to 'bounce', with a surface acceleration which exceeds millions of g, causing a non-linear amplification effect (focussing) of the energy

- Several alternative theories are currently proposed for the micro-detail of the effect. However it is clear that flash duration depends upon, among other factors, the intensity of the emission and the gas/water mixture. The **longest** flashes occur with the **brightest** emissions. The effect is also pressure dependent.

- There are close analogies with cavitation bubbles in sonar.

12. The fact that this effect can be seen by the unaided eye was perhaps first reported in the original version of EXODUS (20:18); where "and all the people **saw** the sounds". This was removed in later translations (presumably as being impossible!) If the sonoluminescence effect can be produced, even under exceptional conditions in the atmosphere, it may account for some UAP reports.

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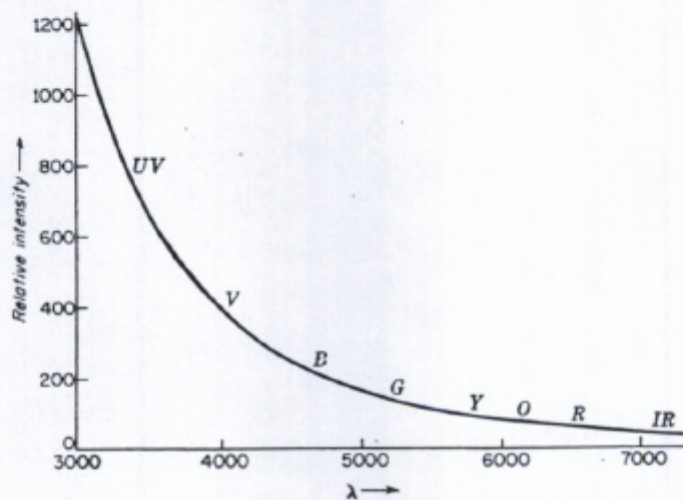


FIGURE 1: INTENSITY OF SCATTERING VS WAVELENGTH (RAYLEIGH'S LAW)

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WORKING PAPER NO. 19

CHARGED DUST AEROSOLS - DUSTY PLASMAS

&

ATMOSPHERIC PLASMAS AS REFLECTORS AND ABSORBERS

	Para	Page
Introduction	1	19-1
Streamlined Shaping	4	19-1
UAP Model	6	19-2
Motion	8	19-2
Particle Characteristics	9	19-2
Speed of Cloud	10	19-2
Lights	13	19-3
Colours	14	19-3
Electrical Attraction	15	19-3
Radar Reflections	17	19-4
SUMMARY- Dusty Plasmas	18	19-4
ATMOSPHERIC PLASMAS AS ABSORBERS & REFLECTORS	21	19-4
Plasma Lifetime	22	19-5
Reflection	23	19-5
Absorption	24	19-5
INTERACTIONS		
Plasma Interaction with Objects & Aircraft	26	19-5

January 26, 2000

i

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CHARGED DUST AEROSOLS - DUSTY PLASMAS

1. **Introduction** There are numerous reports of unidentified flying objects of cigar, toroidal, spherical and a host of other regular shapes moving in earth's atmosphere due to the action of forces of an unknown nature. Depending on the witness's perception at the time, the object can have 'navigation lights', 'searchlights', be of various single colours or even multiple colours. The objects reportedly can change flight direction suddenly, stop, accelerate or decelerate. Reports by aircrew have included "buzzed by shining glass balls or cones" or "like soccer balls made of glass". Mukharev (Russia) ¹ takes all these factors into account in his hypothesis that aerosol aggregation can accumulate electrical charges due to the action of the same process (charge mechanisms) as in thunderclouds. There are several types of 'dusty plasma'. For example, 'Dusty Dense' plasmas and 'Dust in a Plasma' are different. In the former the particles remain electrostatically trapped in the plasma volume. A strong electric field is needed in the gas in order to increase ionisation rate and maintain the structure against electron loss. An equilibrium is achieved by the balance between ionisations in the plasma volume and the charged particles lost at the extremities. Within the core of the effect the particles take up an ordered structure (rather like a crystal lattice). Russia has taken a particular interest in combustion plasmas since 1994, and the science of dusty plasmas has recently achieved several milestones. Several researchers have used microspheres as the experimental medium [An area of potential military interest is in the possible use of microspheres as chaff to produce false targets].

¹ Mukharev L.A. "Hypothesis on the Nature of Atmospheric UFO" Radiotekhnika Elektronika No. 8 1991 pp1437-1443

2. When dust particles are between separated charges (e.g. visualise as in a volume between capacitor plates) the dust will suspend in a matrix and a balancing of the charges causes the dust to suspend in flat layers. By using a laser beam it has been shown that the dust can be moved, or the crystal lattice 'fractured'. The radiation intensity of a low power laser can also accelerate the particles and the momentum given to them depends on their size, distribution, surface area and mass. If the sustaining source is removed the dust falls under gravity. Since the particles can be made to form specified alignments, there are specific industrial applications being researched for this technology, but the UAP context is potentially a special case - since clearly if the charge suddenly leaked away, the plasma would vanish. The overall equilibrium of the charged particles in the medium is thus defined by external conditions. It is suggested that Dusty Plasmas may well be closely related to at least some of the UAP reports; which frequently describe what appears to be a plasma (often with several 'centres' of turmoil), which are either attracted towards each other, held by some type of mutual repulsion field at a set distance from each other for long periods, or merge or collapse.

3. Just as in thunderclouds, spark discharges can occur, leading to the formation of an electromagnetic field, it is postulated that because the EM field will vary through the volume (because of the renewal of particles as the cloud moves) this will give rise to a reactive force which will maintain its motion.

4. **Streamlined Shaping** For a high cloud velocity, it is suggested, that those particles which are retained are so held by the amount that the EM field exceeds the surface aerodynamic drag forces. Therefore, once motion commences the 'object' assumes a shape due to aerodynamic drag and naturally becomes 'streamlined' - for example aircraft

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fuselage shaped, (e.g. cigar), flattening sphere (i.e. disc or fat cigar), or even triangular, with curved edges. As air drag will operate in all planes, then all extremities of the original aerosol charged body (whatever its original format) will tend to be 'smoothed'. Eventually the EM field within the charged envelope will dampen and dissipate and the more sharpened contours will disperse and either be no longer recognised as a shape (i.e. as a UAP), or will vanish completely.

5. If high intensity EM field values occur, a gas discharge is possible at its maxima, giving rise to 'bright lights' on the surface of the UAP. (see paragraph 13 below)

6. **UAP Model** Mukharev, commencing with a postulated spherical aerosol, considers the natural equations for the electrical and magnetic oscillation modes, and derives a model. It is postulated that the most probable initial excitation is by streak lightning [Comment: Note that this can be present in either a 'wet' or 'dry' electrical storm condition]. The model estimates the dielectric constant of the medium from which the sphere comprises and Mukharev points out that this is similar to the dielectric constant of a plasma. It is determined by the character of the time-dependence of the field in which the aerosol is located. The ratio of the internal and external dielectric constants sets the conditions. This will depend upon whether the aerosol is one which dampens out with time - in which case a negative dielectric constant is obtained; or one where the field is sinusoidal. Mukharev shows that the amount of energy of the EM field within, say, a 1m^3 volume of the aerosol cloud is only ~ 8 Joules. Therefore, it is claimed that the field of the UAP could be excited by a spark discharge.

7. The postulation shows that the aerosol cloud can remain within boundary

conditions which do not result in immediate breakdown, but have a finite lifetime. For the purposes of the model it is shown that the Lorentz Force (Earth's Magnetic Field) is negligibly small compared with the aerodynamic drag force. The outcome is a postulated UAP which has motion.

8. **Motion** As the cloud moves in the atmosphere the aerosol particles located at its surface are removed by the air stream. (The energy of the EM fields associated with these particles being transformed into EM momentum). As a consequence of the momentum conservation law, the EM momentum arising within the closed system of the cloud must be compensated by the mechanical momentum. Hence, a force arises at the leading edge of the cloud which causes the cloud to accelerate until the force becomes equal to aerodynamic drag. After some time the cloud gradually decelerates because of the dampening field.

9. **Particle Characteristics** The particles may be variable in diameter and the entire mass of material in the aerosol cloud may amount to only a fraction of a gram. It has been suggested that this low mass, resulting in absence of inertia, may be the reason for the exceptional 'manoeuvrability' suggested by UAP reports; and also a tendency towards rapid acceleration.

10. **Speed of Cloud** It is possible to relate particle size to the drag-force by using the Reynolds number for the particles moving in a laminar stream, at velocity v :

$$\text{Re} = \gamma r_s v / \eta$$

/where:

where: γ is the density of the atmospheric medium, r_a the particle radius for $1.5\mu\text{m}$. The velocity of laminar noiseless motion is shown below

For this situation Re must be ≤ 10 (since the radius of the particles, their velocity for $\gamma = 1.29\text{kg.m}^{-3}$ must be inter-related by the conditions $r_a < 1.4 \times 10^{-4} \cdot v^{-1}$. Thus the higher the observed velocity of the UAP the smaller the dimensions of the particles forming it. Examples are:

Particle Radius	$1.5\mu\text{m}$	0.05mm
Velocity(metres per.second).	$280^{[1]}$	3
	$2340^{[2]}$	

Notes: [1] Up to an altitude of $\sim 3\text{Km}$

[2] At an altitude of 15Km , where the density of the atmosphere has decreased.

11. It is therefore noted that, at 15Km altitude, the aerosol cloud can move at up to about seven times the speed of sound. Hence, this correlates with reports of fast-moving UAPs, much faster than aircraft. An aqueous aerosol moves at high velocity and evaporates quickly. Hence, life time can be short. A long-lived aerosol cloud forming a UAP can only consist of solid dust particles of very small size.

12. The energy of the EM field in the cloud and the aerodynamic (i.e. atmospheric) drag force are proportional to the cloud volume. Therefore the velocity and path taken should not depend on cloud dimensions. For

example, if a charged aerosol cloud has moved distance L (e.g. 40km) with a velocity v (e.g. 30ms^{-1}) a volume density can be calculated (in this case $4 \times 10^3\text{m}^3$).

13. **Lights** For a high field potential (e.g. $> 10^5\text{V.m}^{-1}$) an electrodeless corona discharge should occur in the zones of maximum E field intensity; giving rise to light emission from the aerosol cloud. If the field intensity varies throughout the aerosol, localised luminous zones can occur - due to alternate regions of maxima and minima. Hence, it is postulated that 'navigation lights' are reported. In the E_{11} mode, for example two 'lights' or a luminous strip can be formed. If the number of discharge zones increases, the number of 'lights' will increase which will be equally distributed around the cloud as luminous zones or 'portholes'.

14. **Colours** It is suggested that different colours might be produced by the presence of particles in the discharge zones.

15. **Electrical Attraction** If the discharge connects with some conducting object (Earth's surface or aircraft), the 'beam' causes the aerosol cloud to re-orientate and even move along with a moving object such as an aircraft.

16. It is postulated that when 'searchlight beams' are reported from UAPs that most of the energy is concentrated in a discharge cone and can cause damage by the high voltage but very small intensity current. This can lead to involuntary closure of electronic and electrical circuits (switches) and have adverse health effects on humans (see Working Paper No. 25). On the ground the discharge can leave marks, bend grass etc.

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17. **Radar Reflections** No information has been found on the possible radar reflectivity from charged dust aerosols, but some data is available on radar scatter from 'Dusty Plasmas'. There may well be some overlap in the terminology and applicability. The latter topic is covered at Working Paper No.5, on radar reflectivity.

SUMMARY

18. **Dusty Plasmas** The work reviewed above shows that it is theoretically possible for a charged cloud of particles to exhibit characteristics of visibility and motion similar to many UAP reports received. Further, the implication that atmosphere-borne particles must be present strengthens the proven circumstances where UAPs are reported more frequently in dust-laden scenarios, e.g. near volcanoes and earthquakes. For the uninitiated it would not take too much imagination to observe such a cloud, especially one with bright spots and turn this into a UAP, with portholes!

19. As the formation of clouds (of the charged aerosol type) would clearly depend on the presence of atmospherically-carried particles, it may well be worth making correlation studies of sightings of UAPs with geographical locations where dust is produced, e.g. quarries, or where other pollution particles are emitted (e.g. from power stations or factories). It may also be useful to compare the incidence of sightings in areas taken both during and after cessation of work where dust or other particles are produced. For example, where factories have closed or applied dust/smoke control regimes, or where dusty quarries operated but no longer do so. However, a considerable amount of effort would be required to properly investigate this suggestion. The critical information is not available on the database created for this study.

20. The topics of 'dust in plasmas' and 'dusty plasmas' have become of particular importance in the last two to three years. These plasmas can easily be produced under laboratory conditions, but much more research is required to understand all the mechanisms involved. This may well point towards an understanding of such plasmas in the atmosphere.

ATMOSPHERIC PLASMAS AS REFLECTORS & ABSORBERS

21. The electromagnetic properties of a plasma at atmospheric pressure is an inter-disciplinary topic, combining plasma physics, radio wave propagation, and air chemistry. Plasmas in the atmosphere can either reflect or absorb electromagnetic waves, depending on plasma characteristics. A high reflection co-efficient requires a grazing angle of incidence. A high absorption requires a high collision rate, a low plasma density and a plasma transition of about one wavelength. The power to sustain a plasma in air is high because of the short plasma lifetime unless continuously replenished. The bandwidth, as an absorber, can extend from Metric to I Band. However, absorption peaks at VHF/UHF. In an atmospheric plasma, electrons undergo numerous collisions with atoms and molecules in the background gas(es) and the collisions convert the electromagnetic energy which may be feeding the plasma to heat and damp the essential electron motion. The collision rate varies with pressure and temperature. Also water vapour has an effect - so that, for example, 50% relative humidity approximately doubles the sea-level dry air collision rate.

22. **Plasma Lifetime** The plasma lifetime depends on the electron density and the pressure (altitude). The presence of gases other than those normally in air can change lifetime significantly. For example by a factor of ~10,000 for helium.

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23. **Reflection** If a rapid transition occurs, from free space to plasma (caused, for example, by the presence of large electrical/electromagnetic forces), the plasma will reflect. If the transition is diffuse, the plasma will reflect at a grazing angle. If the plasma transition gradient is too long, then the plasma patch will transmit (i.e. allow through) more energy than it reflects.

24. **Absorption** The absorption bandwidth depends on the collision rate and the plasma gradient. It is possible to generate a plasma absorber which is lightweight, has high attenuation per wavelength and can be switched on and off. Quite apart from any UAP-related properties, it is seen that there are potential military applications in the control of EM scattering and Low Observables.

25. The power requirements to sustain a plasma are dependent on the volume, the electron density required, the energy to generate electron-ion pairs and the lifetime required; and, of course the altitude (pressure) and the medium.

INTERACTIONS

26. **Plasma Interactions with Objects and Aircraft** The interaction of plasmas alone, or when surrounding other objects are complex, since plasmas can act both as absorbers and reflectors. In addition, for transmitters, it has been shown in practice that the presence of a plasma can introduce an inductive reactance into an antenna mounted on a body, thus modifying its performance, causing an increase, for example, in radiated power. The change in radiated power is a function of the ratio of plasma frequency to signal frequency. In the UAP context it seems likely that the response of an impinging EM wave-front on reaching a plasma might be affected. If the radiation from a plasma is capable of modifying an

antenna on transmit, then presumably it will do so on receive - hence it seems possible that the presence of a plasma in proximity to a radio receiver (especially at VHF/UHF) may modify the receiver front-end characteristics and even off tune or dampen normal reception. This may well be the cause of reports that receivers, in what could be termed the 'near field' of a UAP, suffer loss of function (receive and transmit) until the UAP and receiver are separated. Usually the UAP moves away or if the vehicle ignition is working, it is hurriedly driven off. In the context of radio transmission, the frequency dependence of this phenomenon also depends upon the inductive reactance introduced by the plasma layer improving the antenna towards resonance and reducing the resistive losses, such that the efficiency is maximised. [Apart from the UAP-related aspects, a factor of military importance may be that the antenna can be made smaller].

27. **Interaction with Aircraft** Because it is usually unclear as to what the entity comprises, coupled with the surprise factor, most encounters with what are clearly charged masses have been assumed to have been with ball lightning (Working Paper No 2). Whether this is the case - and whether charged aerosols are a variation of the same physical realisation - is not currently clear. The laws of motion of a plasma ball and the effects when in close proximity to an aircraft in flight are of special interest to MOD. It is assumed that the charge on the ball diminishes with time, due to the leakage, where the air layer is adjacent to the ball's surface. In effect it is likely to behave as a non-deformable solid sphere, in aerodynamic terms, in a flow of non-compressible fluid. The charged mass is likely to be 'captured' by the exhaust of aircraft engines and to follow the aircraft, maintaining both its shape and keeping a constant distance from the tail assembly. It is further assumed that the force required (which, if it were a solid ball would be required to overcome drag and stay behind the aircraft.

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This force would be several tons!) is much less in practice. It seems probable that the air-stream would lose some of its viscous properties over the surface of the sphere (i.e. the presence of the plasma, it is suggested, would reduce drag). This has been shown to be the case in experimental observations. Frequent reports in Russia suggest that plasmas/charged bodies start to respond to the presence of an aircraft at a range of about 10km. N. I. Gaidukov and others have published papers on this phenomenon. Frequently, large aircraft crews have found (and indeed the Russian Aviation authorities now advise them) that if the plasma appears ahead of the aircraft, while it is impossible to lose the attracted entity by acceleration, it is nevertheless possible to carry out manoeuvres to make the mass fall astern, where it will remain until it dissipates, with no further danger to the aircraft. The Russians have reportedly lost aircraft to ball lightning (it is not clear whether these are the same claims as the four fatalities they have had chasing "UFOs"), hence their particular interest in the phenomenon, and the large number of published papers.

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DIS SCIENTIFIC & TECHNICAL MEMORANDUM 55/2/00

WORKING PAPER NO. 20

OPTICAL MIRAGES

	Para	Page
OPTICAL MIRAGES		
Optical Conditions	1	20-1
Object Position	2	20-1
UAP CONTEXT	3	20-2

17 February 1999

i

XXXXXXXXXX S.40

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OPTICAL MIRAGES

1. **Optical Conditions** An optical mirage is a phenomenon associated with the refraction of light in a cloud-free atmosphere, resulting in the apparent displacement of a distant object. The refraction is caused by abnormal air densities, which cause the light to travel in a curvilinear path. Object shapes can be distorted and scintillation can cause rapid changes in the observed colour, shape and position of the object. For a stationary observer the effect can last for hours; for a moving observer only seconds or minutes. Mirages have the following characteristics:-

- Mirage images are seen at low grazing angles near the horizontal plane.
- Mirages can only be seen if there is a long uninterrupted sightline.
- Mirages are associated with atmospheric gradients which give anomalous propagation
- Focusing and interference of the wavefronts can give rapid movement and enhanced brightening.
- Distortions and colour changes can be accompanied by multiple images.
- Objects on the surface (e.g. ships) can appear as if they are elevated.

2. **Object Position** The amount the object is apparently (visually) displaced from its true position (angle) depends on the variability of the density of the medium (hence its value of refraction index). The effect is well understood in physical optics, and is pressure (P), temperature (T) and wavelength (λ) dependent. The spatial variations can be expressed in terms of P, T and λ and the resulting practical values of refraction (minutes of arc per km) for the ratio of temperature to altitude is significant. In the simplest terms this means that:

- One degree of arc represents the largest angular change between the true and false (mirage) position of an object.
- When the image appears **above** the true position this is known as a **superior** mirage. When below the true position, the term used is an **inferior** mirage.
- There must be the coincident conditions of a temperature inversion and the presence of light to illuminate the object at grazing angle.
- Vertical stretching can lead an observer to **under estimate** the true distance to the luminous object.

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UAP CONTEXT

3. The key factor in eliminating or including the mirage phenomena as a potential UAP event is that of low grazing angles and long distances, since it is unlikely (from the type of UAP details usually received) that the other detailed meteorological conditions will be known. In the UKADR the combination of long path lengths and low grazing angles is more likely to occur at sea.

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DIS SCIENTIFIC & TECHNICAL MEMORANDUM 55/2/00

WORKING PAPER NO. 21

IONOSPHERIC PLASMA

	Para	Page
Formation of Plasma	1	21-1
Extent	3	21-1
Motion	4	21-1
Power	5	21-2
Radar Echoes	6	21-2

17 February 1999

i

XXXXXXXXXX S.40

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IONOSPHERIC PLASMA

1. **Formation Of Plasma** Within the troposphere operate powerful processes which orientate the separation of electric charges; for example, thunder conditions give rise to huge vertical separation of charges. Meanwhile it is understood, that wind is responsible for horizontal charge distribution. When charges are displaced it is possible for the creation of image charges which make the ionospheric plasma unstable, with the result that a downward electron stream is ejected from the bottom of the ionosphere which may produce 'airglow' in a narrow high altitude band. Because these visible manifestations can be seen at night, they are often described as 'nocturnal lights'. They appear to have a close connection with one class of UAP sighting.

Figure 1¹ Shows the mechanism, which is explained in the following sequence:

- Due to wind over the earth's surface in a hilly region a positive charge is deposited on the hills.
- A negative charge becomes attracted to the moving air mass (shown moving to the right on the figure).
- Corresponding 'mirror' charge images are formed with an upward E field (E_U) above the hills and a balancing downward field (E_D) restores equilibrium.
- At the ionosphere E_U causes instability and an electron

stream from the ionosphere is downward-accelerated by the electric force.

- 'Airglows' (UAPs) are formed when electrons are stopped in the lower atmosphere.
- The glows or 'nocturnal lights' occur in a relatively thin altitude layer and visually appear as bright spots of appreciable angular size moving across the night sky.

2. The supporting theory is explained in some detail at ¹. It seems likely that the reports of 'silvery discs' at very high altitude are the same phenomenon. Below ionospheric altitudes researchers agree that air conductivity cannot prevent the onset of electric fields of considerable strength. In effect the middle atmosphere can become electrically de-coupled from the ionosphere. The ground and the ionosphere can be considered, in effect, two plates of an enormous capacitor. The conductivity of the ionosphere is of solar origin (hence, the investigations elsewhere in this report on possible solar flux/solar flare connections with the rate of UAP reports).

3. **Extent** The size of 'nocturnal lights', which is believed to be produced by an electron stream which penetrates to the lower atmosphere, is considerable, in order to be seen at long visual distances (slant ranges) of ~100km, where, it is calculated, the diameter can be several hundred metres. [As an example, an object of 905m diameter at 100km range has the same **angular** extent as that of the moon].

¹ BROVETTO P AND MAXIA V. "On the Instability of the Ionospheric Plasma..." ILNUOVO CIMENTO Italy 1995.

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4. **Motion** A high angular velocity is produced because the phenomenon is light (i.e. nothing (no mass) actually moves physically). It is analogous to the movement of a CRT beam when the spot (i.e. UAP) moves. The very high angular velocity can give the impression that the light is at much lower altitude than is the case. The actual altitude of the nocturnal lights is ~50km.

5. **Power** Light emission occurs when ionized molecules or ionized atoms re-combine with electrons, with a sharp increase when the electrons are stopped. At the path end, when the electrons are stopped, a disc-shaped light is always originated, with its axis always parallel to the earth's geomagnetic field. The power of reflected light which is required for an observer on Earth (by comparison with that from other air-objects, including satellites) is estimated as between 0.3 and 3kW. A calculation of power (with its emission as visible energy) available from the postulated electric field phenomena, is 10 to 100kW, well exceeding that required.

6. **Radar Echoes** Radar echoes can be obtained due to the conductivity of the ionised air. The light emitting layer, caused by the electrons, is probably an effective radar target although, in some instances, this would be well above the elevation-slant range capability of typical terrestrial search radars, and beyond the slant range of air intercept radars. Radar detection of UAP is considered in Volume 2, Working Paper No 5 and at Volume 3.

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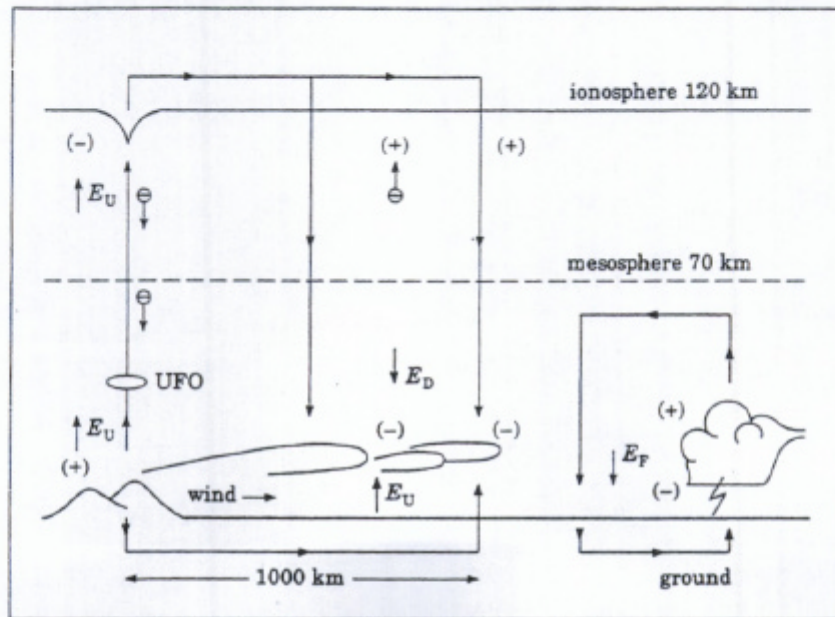


FIGURE 1: CONDITIONS FOR IONOSPHERIC PLASMA FORMATION

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WORKING PAPER NO. 22

ARTEFACTS

	Para	Page
'Angel Hair'	1	22-1
Metallic Artefacts	2	22-1
Summary	3	22-1

17 February 1999

i

XXXXXXXXXX S.40

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'ANGEL HAIR'

1. It is believed that this fibrous material resembling filaments, spider webs or candy-floss-like streamers is formed by reciprocal attraction between polarised dust particles. Sometimes the material is sticky. It can be carried large distances before being deposited and has been likened to long chaff and has even been named 'spacegrass'. It can leave a smoky or misty deposit. The thin filaments appear to be an electrostatic precipitation of atmospheric dust, which is unstable, and which eventually disintegrates and vanishes. On at least one occasion a UK witness has collected what was probably 'angel hair' in a jar, believing it to have come from a 'UFO' which "hovered at the bottom of his garden". The author of this report personally observed this material drifting in a light breeze in Norfolk on a hot but breezy summer's day in 1997.

METALLIC ARTEFACTS

2. Although no such artefacts have been found in the UKADR, it is claimed in Russia and Ukraine that items have been scientifically analysed. The results are not known. The Russians, like the USA, have never produced the artefacts which are claimed by some media reports to have been found. This seems to be quite extraordinary in view of the fact that it would be reasonable to expect that this might solve the extra-terrestrial hypothesis of 'UFO' origins once and for all. The Brazilian claim of 'extra-pure aluminium' artefacts was not sustainable after analysis.

SUMMARY

3. No proven tangible artefacts have been obtained by the public for display, or shown by governments to exist. The metallic materials analysed scientifically

have not been shown to be of unknown elements. It is a fact that that some materials have entered the earth's atmosphere as a result of meteor activity and have survived to impact. Analysis has shown nothing to connect these with any type of flying vehicle or threat. MOD does not hold any such material

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DIS SCIENTIFIC & TECHNICAL MEMORANDUM 55/2/00

WORKING PAPER NO. 23

LINKED VORTEX RINGS

	Para	Page
LINKED VORTEX RINGS	1	23-1
Experimental Vortices	2	23-1
Challenger Spacecraft Video Recording	4	23-1

17 February 1999

i

XXXXXXXXXXXX S.40

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LINKED VORTEX RINGS

1. Quite apart from the possibility of water spouts, dust eddies, whirlwinds and similar atmospheric vortex phenomena, which can be reported as UAPs, there is the possibility of linked vortex rings, such as those filmed from the US spacecraft Challenger on its post-launch ascent. It is suggested that aerial formations of this kind may be related to the UK sightings of the type shown at Working Paper No. 11, Figures 2 to 7.

2. Experimental Vortices

Experimental work has been done¹ on linked vortex rings and this phenomenon has been modelled. Initially the vortex rings are formed separately. Under certain conditions, when collisions occur, linking is possible of distinctively separate rings. Some results shown at Figures 1(a) and (b). The appearance of linked vortices to an observer clearly depends:

- The viewing aspect.
- The relative position of the viewing light source.

3. If the ring assembly is rotating slowly then the component strands might be visible. The Challenger example cited shows the complex component strands (which, overall, could be described as being contained in a cylindrical volume) rotating (rolling) about its radius at an estimated rate of about 50-60 times a minute. However, if the structure was not rotating and viewed, for example, end-on, it would appear as either a solid ball, reflecting light according to the scattering of its component particles or as a dark spherical

silhouette if between the sun (or light source, such as light cloud background) and the observer.

4. **Challenger Spacecraft Video Recording** The few extant reports on this topic (which were fortuitously connected with the Challenger incident only because the Department had collected open-source material on this space-launch) are not connected with UAPs, since the unusual effects are studied purely from the interest of fluid physics. However, the brief footage taken by the Challenger crew seems to be very similar indeed to a number of UAP reports received by the Department. Some examples are at Figure 2. Unfortunately the imagery taken from the video does not do justice to the original, which can clearly be seen 'rolling', or 'tumbling', as described above.

5. No attempt has been made in this brief investigation to correlate the 'linked vortex' postulation with the conditions for their formation in the atmosphere or of a possible combination of this effect with an electrical/charged particle or EM field effect.

¹ "Linking of Vortex Rings" Aref and Zawadzki. Nature Vol. 354 Nov 1991.

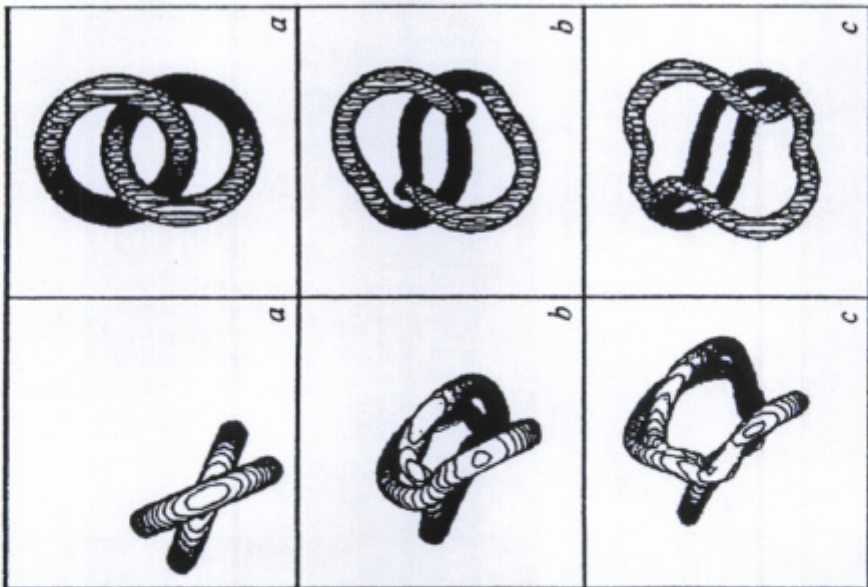
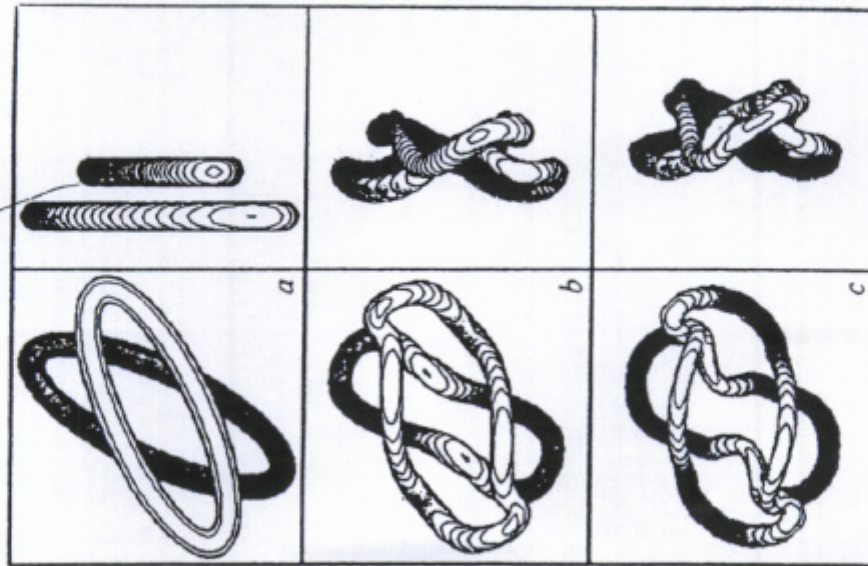


FIGURE 1(a): LINKED VORTEX RINGS

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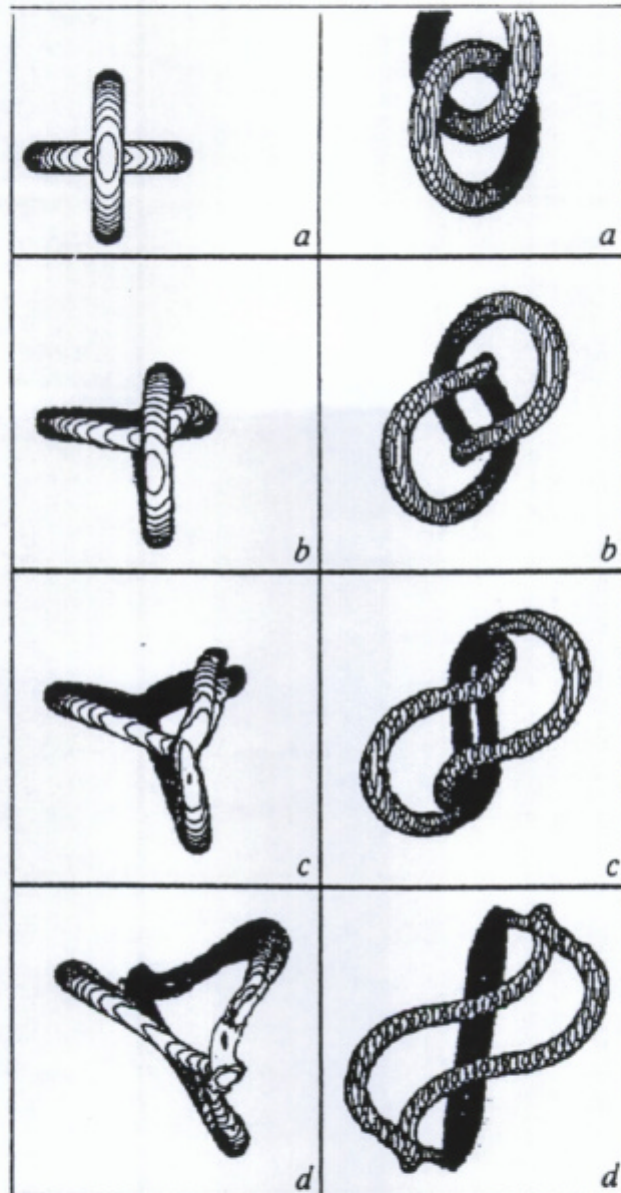


FIGURE 1(b): LINKED VORTEX RINGS

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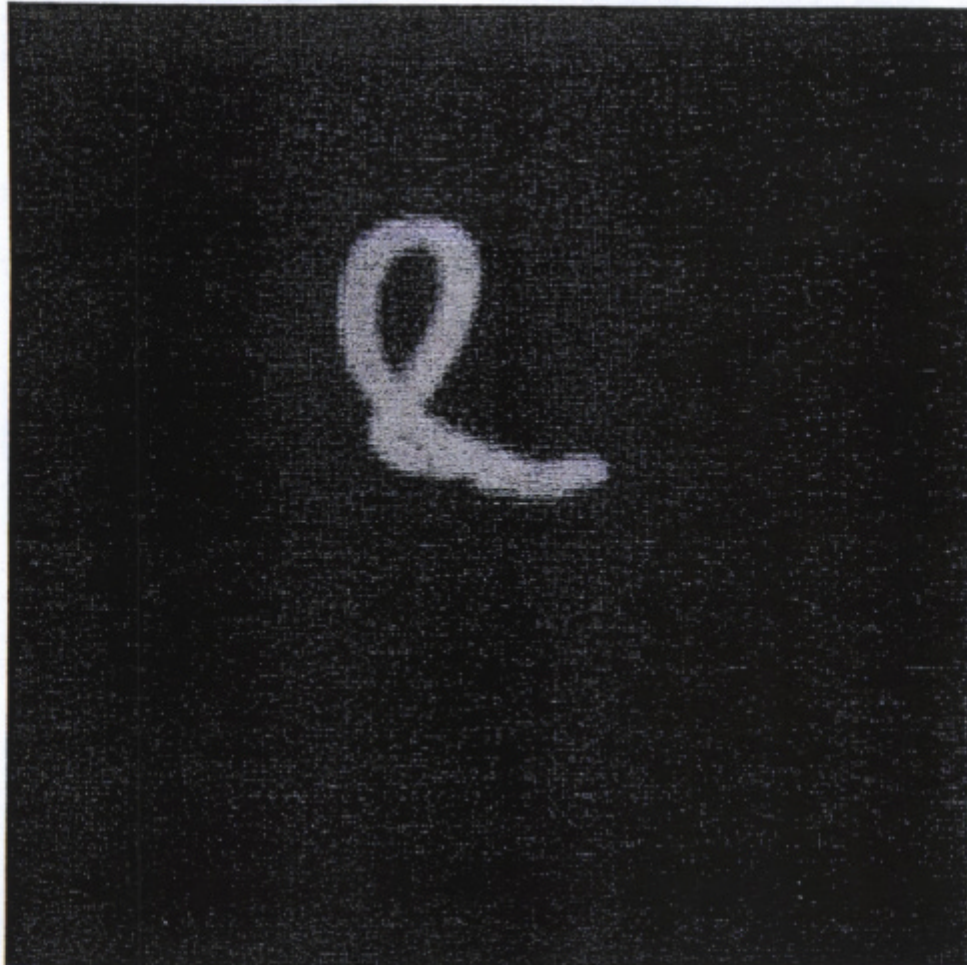


FIGURE 2: ROTATING/TUMBLING OBJECT (CHALLENGER SPACECRAFT)

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DIS SCIENTIFIC & TECHNICAL MEMORANDUM 55/2/00

WORKING PAPER NO. 24

'SPRITES', 'ELVES' AND 'BLUE JETS'

(ATMOSPHERIC AND IONOSPHERIC PHENOMENA)

	Para	Page
INTRODUCTION	1	24-1
SPRITES	2	24-1
Measurements	4	24-1
Effect on RF Propagation	7	24-2
TERRESTRIAL GAMMA FLASHES	8	24-2
BLUE JETS	9	24-2
POSSIBLE UAP LINKS	10	24-2
EXTERNAL ENERGISATION	11	24-2
OBSERVATION OF SPRITES	12	24-3

17 February 1999

i

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SPRITES, ELVES AND BLUE JETS

INTRODUCTION

1. Three types of transient optical luminous vertically-orientated phenomena have been observed at high altitudes above thunderstorms: 'Elves' at roughly 90km, which is an enhanced airglow, 'Sprites', a reddish glow from 50-90km and an upward-moving bluish beam emission from cloud tops, known as 'Jets', below 40km. Large area multi-cell thunderstorms lead to the formation of vertically-orientated cylindrical structures of gravity waves closely resembling those observed in optical emissions associated with transient luminous glows. These are believed to occur as a result of transfer of large amounts of charge (from clouds at altitudes of 5-10km) to the ground. Apart from the visual effects, these charge transfers are known to generate upper ELF Band signals (>300kHz). The Sprite path can also be located at high altitudes between the ionosphere and cloud tops. The luminous emission at low altitude is red. The likely explanation is gas breakdown by the additional electromagnetic fields of lighting discharges. Some Sprite 'bluish tendrils' were observed to extend down to 20-30km altitude. Horizontal magnetic field variations have also been observed in the frequency range of the earth-ionosphere cavity resonance. These phenomena have been studied recently in the USA, Germany and in the Antarctic.

SPRITES

2. Sprites are the older known phenomenon, first being reported 100 years ago. They last tens of milliseconds and can thus be sensed by the human eye. They are sometimes described as 'fan shaped' or

'carrot-like' in shape. They can extend laterally for several kilometres. Other observers have reported 'upward forks', due to divergence of the striations.

3. Electric field discontinuities can occur over stratiform clouds at 10-16km altitude and this is believed to be due to the positive cloud-to-ground discharges. Satellite-based instruments have also detected gamma-ray flashes (see para. 7, below). Current theories suggest that Sprites, Gamma-ray Flashes and Blue Jets are all types of discharge produced by a run-away air breakdown.

4. **Measurements** A TV slit spectrograph recently recorded 25 events and measured optical wavelengths in a band from 540 to 840nm, although other measures have spanned from 450-800 nanometer. The fleeting columns of luminosity have also been imaged by CCD cameras. Sprites are found to have a bright core less than 2km in horizontal dimension, they followed the associated lighting (below the (cumulonimbus) cloud) within a few milliseconds, and rose to peak intensity in 0 to 3 ms, fading a few tens of milliseconds later. Sprites can easily be observed from aircraft and from the ground, and have been seen from spacecraft.

5. More than 150 discharges measured (in the USA) in August 1993 extended, exceptionally, down to cloud tops below 20km altitude. In 1994, 56 Blue Jets were recorded at one location in just 22 minutes. They can extend from anvil cloud tops either partially or fully up to the ionosphere.

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6. The peak intensity of the optical emissions is determined primarily by the removal of the thundercloud charge and its altitude. A vertically striated fine structure of sprites often repeatedly occur in the same place in the sky.

7. **Effect on RF Propagation** At least one researcher has considered red sprites to comprise an infinite vertical slab of plasmas with the ability to backscatter in the VHF/MF RF Bands. The sprite plasma conducting columns are known to produce wide-angle scattering of VLF signals. Further, rapid onset and rapid decay perturbations of sub-ionosphere propagation occurs. The sprite luminosity decays at a much faster rate than the perturbations. Propagation ducting is probably a by-product. Ground-based radar has been used to observe the effect of sprites on propagation in the vicinity of chaff, using both monostatic and bi-static configurations. Hence, sprite effects may be seen on radar.

TERRESTRIAL GAMMA FLASHES (TGFs)

8. A new phenomenon (discovered in the 1990s), known as TGFs, are probably also related to atmospheric lightning. However, the time-duration of TGF (estimated at up to 250 μ sec) is too short for human observation, which possibly limits at 280 μ sec and is not, therefore, pursued further in the UAP context (the reader is referred to the Working Paper on After-Images).

BLUE JETS

9. Blue Jet vertical velocities are $\sim 100\text{km}\cdot\text{sec}^{-1}$ at about 40-50km altitude. Another, competitive, phenomenon ('Blue Starters') may also occur.

POSSIBLE UAP LINKS

10. Although the field 'trigger' levels and current flows involved in finally ionising the atmosphere to produce sprites and blue jets in visible form are large (assuming all other field conditions and particle conditions are ready), it is postulated that a situation could exist where the charged atmospheric conditions are at the point of transition in which an **added potential** might cause a trigger to occur. This has been briefly investigated because a ship's Master reported a visual UAP event when his radar was first switched-on (in the Baltic Sea). It is assumed, since this occurred on a merchant ship, that the RF was I Band (standard 9375MHz maritime search).

EXTERNAL ENERGISATION

11. The phenomenon is a gas ionisation process for which, when the right threshold conditions exist an additional field is required to trigger the event. It is believed that, for example, a remote, rather than close-by lightning charge could reach the pre-charged volume and cause the glow to be triggered. A short bibliography is at the end of this paper. Since the initial quantification of the effect is quite recent, the following key attributes are taken from the best available (and most relevant to this study) published papers. Further work would be needed to confirm the postulation that a radar (or laser in some cases) could cause the ionisation to occur, thus making a pre-charged but hitherto invisible mass become visible to the human eye. Although the possibility might be linked with sprites/blue jets it is recognised that the 'added' energy available from terrestrial (or airborne) sources will be low in comparison with the huge energy levels in electrical storms. However, the principle is established that any highly charged gas could finally reach ionisation point by the

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addition of extra energy. Hence, it does not seem unreasonable that if swamp-gases, (if they are a component of earthlights), or even incompletely formed ball-lightning, might react to the addition of external energy. This, it is suggested, might account for the so-named 'close encounters of the fifth kind', where, it is claimed by ufologists that an airborne visual object appears to respond to, or be modified, by probing it with a terrestrial beam of energy. Since the shipping incident described at para. 11 above, was at I Band, the implications are that this is at **least** possible with I Band military radars (e.g. Air Intercept Radars) if the critical atmospheric conditions exist.

OBSERVATION OF SPRITES

12. It is clear that a visible and measurable phenomenon of red (Sprites), possible with blue offshoots ('tendrils') or blue (Blue Jet) columns exist; and that they can be seen:

- From aircraft, in particular, because they appear where high-flying aircraft are likely to be.
- Above severe thunderstorms.
- On occasions from ground-level when the cloud-breaks allow a sight-line.

The phenomena appear for a few milliseconds and could be reported as UAPs. Working Paper No. 4 confirms that the human eye will detect and possibly retain an after-image on the retina. Finally, they might be 'triggered' by a radar in the vicinity.

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WORKING PAPER NO. 25

OVERVIEW OF MAGNETIC FIELD EFFECTS ON HUMANS

	Para	Page
INTRODUCTION	1	25-1
NEUROLOGICAL RESPONSE TO MAGNETIC FIELDS	4	25-2
Temporal Lobe Activity	5	25-2
Magnetic Flux Levels	10	25-3
KEY FINDINGS	14	25-4
COMPARISON WITH EARTH'S NATURAL MAGNETIC FIELD	19	25-5

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OVERVIEW OF MAGNETIC FIELD EFFECTS ON HUMANS

INTRODUCTION

1. As a result of research (and ignoring man-made air-objects which are frequently mis-reported as UAP and other natural though exceptional meteorological phenomena, such as cloud formations), there appears to be four types of electrical charge-related formations that can occur in the atmosphere, covered in the Working Papers Nos. 1,2,10,19 & 21:

- Ball Lightning
- Ionospheric Plasmas
- Earthlights
- Electrically-charged Aerosols.

It is known that visible and invisible fields can be sensed when close to a UAP. In the absence of any other postulations it is assumed that the fields are electromagnetic or magnetic (or both) in nature. Further away from the object only the emissions in the visible part of the electromagnetic spectrum are sensed; as is frequently the case by human observers, photographic film and video camera detectors. The results summarised are those of medical experiments in which the intention was to study the human brain response to external fields, particularly in the area of epilepsy. There is no UAP connection given in the scientific papers. The connection is made here, because of the apparent relevance to this study.

2. The fields investigated for medical purposes in Canada have some common characteristics, and the scenario which, in

'close encounters', reportedly produces 'alien' and similar descriptions, may be the result of the close proximity of one or more of these field types. The difficulty is that little, if any, instrumentation is available when these phenomena occur - hence suppositions rely on theory with few actual measurements on which to base firm evidence. It is clear that, while some screening from field effects can occur when a witness is in a vehicle, this may not be completely effective. Further, electrical/electronic equipment failure or poor performance or partial failure is often reported at the time, both in vehicle equipment, such as radios - including Police radios - and even ignition failure. For the radios, one theory is that a strong (magnetic) field off-tunes resonant circuits in radios which use ferrite-rod type antennas. Since radio components are normally in a metal box, the implication is that the field couples with the antenna, causing a larger than normal current to flow in the antenna and into the front-end receiver coils, mounted on the ferrite rod.

3. Using the near-field ranges, calculated at Working Paper No. 2, and the example magnetic field levels used to cause temporal lobe effects, it is possible to calculate the minimum energy level which must be at the source. Further, those reports where electrical equipment has been reported as unstable (noisy) or even unworkable until the UAP moved away, have always been scenarios where the UAP has been very close - even overhead. Assuming a free-space magnetic field attenuation, proportional to $1/R^2$ and a signal level (at the observer's position) of 1mG, then, for the ranges shown, the source power is calculated, below:

Range (m)	Power at Observer (m. Gauss)	Power at Source (m. Gauss)
1	1	1
5	1	25
10	1	100
20	1	400
25	1	625

NEUROLOGICAL RESPONSE TO MAGNETIC FIELDS

4. On several occasions Persinger, et al [1], carried out measurements on volunteers to assess the (medical/neurological) response to bio-frequency magnetic fields; while making concurrent EEG pattern readings on the subjects. In 1990 18 male and 18 female volunteers (University Students) with ages ranging from 18 to 25 years were exposed to 9Hz, 4Hz, and 16Hz fields, plus a sham (control) field. The field strength was varied 0.3mG to 1.0mG (100nT) and pulsed at both polarisations. The fields were generated by solenoids fed, via a filter circuit, with square waves. The resulting imaging effect was caused by the successive rising and falling edge of the square wave and the components 0.1 μ F, 5.19mH and 5.2 Ω resulted in an impulse, with rise-time <0.1msec. The experimental decrease returned to zero polarity within 0.3msec, proceeded through a maximum reversed polarity at 0.6msec

and then returned to the zero condition at 1.0msec. Thus, the amplitude of the maximum reversed polarity was 1/6 of the initial rise peak; with a positive and negative mirror at the beginning of each wave. Hence (in the first test case) a 4Hz square wave passed through the circuit, generated 4 initially positive and 4 negative pulses per second. The test chamber was opaque to any other radio interference.

5. **Temporal Lobe Activity** A significant temporal lobe activity was registered. These areas are the most electrically labile of the human brain. It was demonstrated that people who already possess high levels of activity in this area are likely to experience:

- Mystical or paranormal activities
- Fear
- 'Out of body' activities
- Tingling or vibration.

6. The psychological profile of such people is that they are naturally disposed towards inordinate interests in poetry, mystical or the paranormal, philosophical (religious) and a sense of special purpose, whereby infrequent or unusual events (such as transient social or astronomical events) acquire a special, personal, meaning. There are strong connections between temporal lobe response activity and epilepsy.

7. Major factors of interest are that the experiments were made in an acoustically screened (as well as Faraday) chamber to exclude sounds which could be detected and responded to by the temporal lobes. Hence, all responses were caused by

the only influence present - the magnetic fields.

8. Two further important factors are noted:

- No artefacts were present in the test area to visually suggest themes (for example a space theme is known to evoke 'alien' presence, a religious artifact is known to evoke reflections on death etc.).
- Elaborations and attributions are known to depend on the personality of the subject. People who display frequent temporal lobe signs generate more frequent and intense experiences.

The former was circumvented by placing the subjects in a plain chamber with low intensity red lighting. The second was, to an extent, reduced by taking an adequate population sample.

9. Instrumentation placed on the subject's head measured the temporal lobe bipolar electroencephalegraphic activity. Test results (which overlap with separate experiments with 85 volunteers, described at paper[1], below) are combined at Table 1. There was a general increase in all classes of experience when the fields were at 4Hz and 9Hz, compared with the 16Hz (and sham) values. It was noted that people who display more intuition (than sensing), perceiving (than judging) and feeling (than thinking), tend to display enhanced

temporal lobe signs. The intensity of the spinning and tingling were less than the other 'symptoms' reported.

10. In 1991 Persinger et al continued their neurological experiment, with human subjects. This time they were exposed to spatially-rotated complex magnetic fields applied across the temporal lobes of the brain. It was discovered that the fields markedly increased the interaction with the neuro-electrical ensembles. Several field frequencies and pulse patterns were used. The results indicate that a person's temporal lobe profile affects the types and intensities of experience reported when exposed for short periods to fields of this type. The full list of 'symptoms' produced is shown at the matrix at Table 1. They appear to be amazingly similar to those reported by people who have had close encounters with a UAP. The words used in the Table are those reported by the 85 male and female volunteers (20 to 37 years).

11. **Magnetic Flux Levels** The magnetic field strength was 1mG (100nT). A 16Hz pulsed wave generated more experiences of thought intrusion than a 4Hz wave. A **positive** feedback ringing (also at 4Hz) evoked more visual memories and image than the mirror image of the same wave. The effects included vivid visual sensations, memory fragments, a sense of intense meaning, intrusion of ideas or images, mystical experiences and alterations of boundaries defining 'self'.

12. It was deduced that an applied magnetic sine wave would be minimally effective (compared with the filtered square wave used) **unless** the

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current densities are sufficient to produce potentially dangerous disruptions in neuronal assemblies.

13. During the experiments the 1Hz to 1kHz magnetic ambient background level was 0.025mG (2.5nT) and hence was negligible. The **rotating** magnetic field was either applied in a ringing or in a pulse burst format (see Fig. 1). The field spatial rotation, presented with four solenoids, comprised patterns of four per second rotated once every two seconds. The research showed, once again, that the phenomenological profile of a person within the experimental setting is a function of his (or her) temporal lobe sensitivity, the demand characteristics of the setting and the magnetic field patterns.

14. The conclusions of the experiments showed that:

- Magnetic fields, rotated bilaterally once every two seconds (over the subject's temporal region) evoked stronger and more frequency experiences than when the field was static.
- Moving yellowish-green and purplish lights were only reported when the field was 'ON'.
- The only 'frequency-specific' effect (within the 4-16Hz region used) was in the enhanced number of thought intrusions when at 16Hz, rather than at 4Hz.

- Smells were reported (when clearly there were none in the test-chamber in reality).
- Normal people, placed in exotic introspective-oriented settings, report experiences that suggest temporal lobe signs and symptoms.
- There is some suggestion that effects might be cumulative.
- The sensitivity of time response as well as what is 'seen or felt' is likely to be conditioned by the subject's personality.

15. In 1996 another experiment was made[3] when another 33 subjects were exposed to four test conditions, a control (sham), left lobes, right lobes and both left and right together. The field level was 10mG (1 microT) and with 1mG (or 0.1 microT) applied on the other side. Exposure periods lasted 15 minutes (Three segments of five mins on, five mins off). The objective was to investigate long term memory effects. The group whose **left hemispheres** had been exposed exhibited approximately **twice** the number of accurate ideas relative to other test conditions. The results show that the complexity of the 'signature', or the 'information' within a magnetic field may be more important than its intensity.

KEY FINDINGS

16. The key question is what does this all mean in the UAP context? The

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following observations are considered important.

(a) As seen at Table 1 the effects on a human of weak magnetic fields, used for the neurological experiments described, are uncannily similar to these reported by witnesses who have had 'close encounters' with a UAP. The effects experienced depend upon the phenomenological profile of the person.

(b) If a human brain is affected in this particular way it seems logical that a UAP might be emitting similar levels of magnetic energy, since it produces the same effect on an observer.

(c) In the wider context the 'alien', 'time lost', 'spaceship' and other descriptions only ever occur when the observer is very close to the UAP - implying that the human is probably within the UAP near-field and that magnetic (or electro magnetic) emissions are given off in which at least some fall within the energy levels given, at the point where they reach the observer. Clearly, if the observer is some distance away, to achieve an adequate level the signal source must be greater and attenuated by the time it magnetically couples with the subject.

(d) A magnetic field is not the only emission from a UAP, as visible colour emissions are seen by observers at all distances and, on occasions heat is also reported. A spectrum of emissions is, reportedly, present during the medical experiments carried out.

The magnetic field strengths used on the human volunteers, although low, had a dramatic effect. It seems likely that very much stronger source fields must emanate from UAPs if:

- The memory effects last longer.
- The magnetic energy is, reportedly, sufficient to disrupt electronic and electrical equipment, some metres from the UAP.

17. The magnetic field from a UAP could be directional (even highly so) - hence relative aspect of an observer or equipment nearby, to peaks and nulls of magnetic field, might also determine the local effects. The orientation (left or right temporal lobes or both) of the humans to the received direction might be critical.

18. With reference to Table 1 it should be noted that these responses were obtained in a test chamber with zero visual stimulation. If the subject **was** confronted with a visual stimulation in the form of a nearby UAP it can easily be appreciated how the 25 responses listed could, however unwillingly, fit into an 'extra-terrestrial' scenario in the mind of the subject. It is clear that the effect could

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be sufficiently vivid as to be so real to the witness(es) concerned to warrant a UAP report to the authorities. In 20 out of 25 instances the reports due to the magnetic fields in the test chamber tally with effects felt and reported during close proximity to a UAP. Close encounters are infrequent; witnesses at greater distances do not report these effects. It seems logical to conclude that they are at a range where the field energy is negligible. If the effect is caused purely by a magnetic field, then it seems likely that the field exists between the UAP and earth, with the flux lines 'leaking' to earth sensibly mostly beneath the object, with some fringing effects.

COMPARISON WITH THE EARTH'S NATURAL MAGNETIC FIELD

19. Working Paper No. 12 briefly reports on the natural magnetic field to which every citizen is exposed. It is noted that this amounts (average at mid latitude for the UKADR) to a gamma field value of about 48,850. [Also expressed as 0.485 Gauss or 48,500n Tesla]. Hence, as noted at para 4 above, the bio-magnetic field was only 100nT (i.e. nearly 500 times less than the natural field). **The key observation is that although very weak in comparison, unlike the earth's field, the experimental field was pulsed/rotated.** It therefore seems possible that fields produced by one or more plasma types listed at paragraph 1, above and for example, a plasma conceptually produced by a meteor may radiate. It may also 'pulse' (though, of course, not necessarily at the same rate observed visually; where witnesses very close to UAP events

often report 'pulsating lights' and even 'pulsating sounds').

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Experience Number	Magnetic Field Experiments	% of Occasions	Reported UAP Effect Correlates
1	'Felt Dizzy or Odd' ^[2]	80	✱
2	'Felt presence of someone or something' ^[4]	36	✱
3	'Felt Tingling Sensations'	76	✱
4	'Saw Vivid Images' ^[3]	65	✱
5	'There were pleasant vibrations'	67	-
6	'I felt as if I had left my own body (detached from)'	46	✱
7	'I experienced anger'	20	[7]
8	'Experienced sadness'	37	[7]
9	I heard a ticking sound'	50	✱
10	'There were odd smells'	9	✱
11	'There were odd tastes in my mouth'	13	✱
12	'I felt as though I was somewhere else'	69	✱
13	'Experienced childhood thoughts'	42	[7]
14	'Same idea kept recurring'	77	✱
15	'Felt as though spinning' ^[1]	36	✱

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Experience Number	Magnetic Field Experiments	% of Occasions	Reported UAP Effect Correlates
16	'Dream-like images'	32	✓
17	'Lights varied in intensity'	16	✓
18	'Experienced fear or terror'	40	✓
19	'I felt the experiences did not come from my own mind'	20	✓
20	'I cannot move'	[6]	✓
21	'Colours blue-purple' ^[5]	[6]	✓
22	'Colours yellow-golden' ^[5]	[6]	✓
23	'red-yellow' ^[5]	[6]	✓
24	'I am moving forward through a closed space on all sides'	[6]	✓
25	'Floating'	[6]	✓

- Notes:
- [1] "I see something mechanical turning round and round"
 - [2] "I am flying in the sky"
 - [3] "I see bats and birds flying"
 - [4] "There is something in here with me"
 - [5] "Colours are seen in order, first No. 21, then 22, then 23".
 - [6] No percentages were given in the results published
 - [7] The experiences 7, 8, 13 are not observed in any UK UAP reports. It is, of course, possible that these responses are suppressed by the fact that (unlike the medical experiments) UAP witnesses are additionally confronted with the strong visual stimulus of a steady or fluctuating bright white or coloured object in close proximity.

TABLE 1: CORRELATION OF MAGNETIC EXPERIMENTS AND UAP REPORTS
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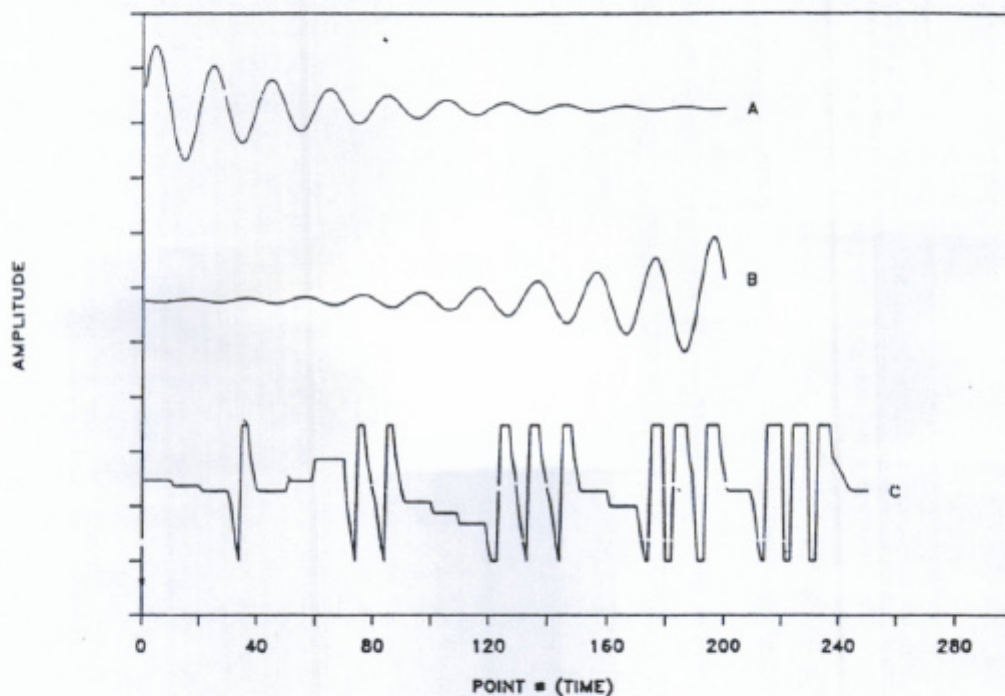


FIGURE 1: RINGING & BURST MODE MAGNETIC MODULATIONS

NOTE: HORIZONTAL SCALE IN MILLISECS

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