RADCAT

Radar Catalogue: A Review of Twenty One Ground and Airborne Radar UAP Contact Reports Generally Related to Aviation Safety for the Period October 15, 1948 to September 19, 1976

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Note

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Time given is UTC (first entry) and local (second entry). Some entries cite a six digit reference. The first two digits are the day of the month, the last four are hours (UTC).
Class: R = radar, V = visual.
Location(s): Place names are used whenever possible.
Sources: All references cited are in the open literature.

Table of Contents

1. DATE: October 15, 1948 TIME: 2305 local CLASS: R/V air radar/air visual

LOCATION:
Kyushu
Japan

SOURCES: Hynek 1978 135
McDonald 1968 (House Symp.) 69
Ruppelt 65

RADAR DURATION: 10 minutes overall
(6 separate episodes)

EVALUATIONS: Blue Book - unknown

PRECIS: At 2305 a 2-seat F-61 Black Widow night-fighter was flying off the NW coast of Kyushu, 50 miles at 330 degrees from Fukuoka, when the radar operator picked up a target, range 5 miles at 12 o'clock & slightly below the aircraft (a/c). The a/c speed was between 200 & 220 mph; that of the target was 200 mph, range slowly closing. The aircrew thought they had a friendly fighter. Then the target showed a "slight" change in azimuth and "rapid" closure, appearing at the same time to dive below the a/c. The pilot attempted to follow in a 3500 fpm dive at 300 mph, but air intercept (AI) radar did not immediately reacquire the target. Shortly the radar operator called a second contact, but the target outdistanced the a/c with "a burst of speed dead ahead". On a third intercept the pilot called a visual at 60 degrees to port; the object was visible in clear silhouette against moonlit cloud and the radar acquired a target crossing ahead of the a/c from 45 degrees to port, range 3000' at -5 degrees elevation. The pilot turned to starboard to head off the object, but the radar target put on a "burst of speed" and was lost at 9-10 miles (maximum radar range was 10 miles). At this time the pilot decided that the object he had seen was unfamiliar and queried his ground control station, who reported that there were no known aircraft in the area. The fourth intercept again began with a pilot visual, the object passing above and from the rear. AI radar again picked up the target slightly above at 12 o'clock, range 5 miles, but again it was lost off the set at 10 miles. The fifth and sixth intercepts were similar: The target was picked up at > 9 miles range at 200 mph, the a/c closing with a speed advantage of 20 mph to a range of 12,000', at which point the target pulled ahead to the maximum radar range of 10 miles in about 15-20 seconds.

Visuals: an "excellent silhouette" against a reflective moonlit undercast on the 3rd intercept, and a "fleeting" glimpse of the object passing from above and behind on the 4th intercept. The object appeared as a stubby cigar with a tapering, squared-off tail-end, a little like a "rifle bullet" the approximate size of an a/c fuselage; it had a dull or dark finish, with no visible features or control surfaces. There were no other a/c in the area, and there was no ground radar contact with the object. Target altitudes were between 5-6000'.

NOTES: The fact that no ground radar contact was reported is difficult to interpret; according to the intelligence report the F-61 was detected by ground radar during the incident, but only intermittently. According to McDonald, "The report indicates that this may have been due to 'ground clutter'." However the area of the incident is 50 miles out in the Korea Strait between the Tsu Islands and the west coast of Japan. A more likely reason for intermittent painting of the F-61 is that it was flying at or below 6000' at range 50 miles, a line-of sight elevation on the order of 1 degree and thus close to the likely radar horizon. This might well make the a/c a marginal target whose detectability was critically dependent on aspect. The visual description of the "UFO" - a smoothly moulded appearance without

visible canopy, wings, power section or tail assembly - is consistent with a target of very much smaller radar cross-section than the F-61 at any aspect, making it a very much more marginal target even than the "intermittently" detected F-61.

Of six separate AI contacts two were visually corroborated, one by an "excellent silhouette" which resembled no known controlled aeroform of 1948 and is difficult to equate with birds, clouds, windblown debris or balloons. Perhaps the most plausible explanation is that the pilot saw the shadow of his own a/c on the moonlit undercast. The second "fleeting" glimpse might be dismissed. Nevertheless on each occasion the AI contacts corroborated the visual observations in a natural way, picking up the target as the object would have moved into the forward scanning coverage of the radar - first time moving into the pattern at 45 degrees to port, range 3000' following a visual at 60 degrees; second time being picked up slightly above and at 12 o'clock, range 26,000', moving ahead of the a/c after a visual of the object passing above and from behind. Both acquisitions are consistent with the typical elevation-scan limits of this type of AI radar. The speeds and relative movements of the 6 targets on different headings and at different elevations are individually difficult to interpret in terms of anomalous propagation of ground returns, and collectively impossible to interpret in terms of the same set of AP conditions. At the same time the behavior of the targets exhibits a rational consistency which, supported by two corroborative visual observations, is strongly suggestive of a real radar reflective target.

On the 5th & 6th intercepts, the target accelerated away from the F-61 at a minimum *relative* speed of about 1400 mph, which, added to the aircraft speed, yields a true airspeed of well over 1600 mph. Clearly the target could not have been another aircraft. Yet the intelligence report notes that "the object seemed cognisant of the whereabouts of the F-61 at all times" as though it carried "radar warning equipment" and concludes that the airmen were "of excellent character and intelligence". Both men felt strongly that the object was a controlled vehicle: "In my opinion," offered the radar operator, "we were shown a new type aircraft by some agency unknown to us." The first jets, the Gloster Meteor and the Messerschmidt 262, entered service in 1944, but the first flight to exceed Mach 1 was not achieved until 1947 by the experimental Bell X-1 rocket aircraft, and even if some historically unrecorded prototype development of the X-1 had achieved Mach 2 combined with combat-agility within 12 months one would hardly expect it to be idling around over the Sea of Japan.

In summary the 6 radar and 2 concurrent visual contacts are not easily interpreted in terms of known propagation anomalies or other natural phenomena, and there is a convincing impression of intelligent evasive flying by a vehicle with a performance greatly in excess of known aircraft capability in 1948.

STATUS: unknown

2. DATE: January 22, 1950 TIME: 0240/0440 local CLASS: R/V air radar/air-ground visual

LOCATION: SOURCES: Fawcett & Greenwood 164
Kodiak Naval Air Station

Kodiak Island
Alaska

RADAR DURATION: unspecified

EVALUATIONS: No official

PRECIS: On February 10 1950 a detailed report on "unidentified airborne objects . . . in the vicinity of Kodiak" was sent out from the Divisional Intelligence Office, 17th Naval District, Kodiak Naval Air Station. Numerous copies were addressed to the CIA, the Director of Intelligence USAF, the FBI, the State Department and elsewhere. Its conclusion was that the sightings were of "phenomena . . . the exact nature of which could not be determined by this office", and an evaluation of A-2 was assigned to the reliability and priority of the information contained. Of the detailed report and voluminous enclosures listed - including radar scope drawings, aircraft track charts, weather data and witness statements - little remains for public scrutiny (as usual) but a summary and two less-than-helpful brief comments appended by unidentified individuals. The "summary of the information contained" can be separated into three distinct incidents which read as follows:

> a) At 220240W January Lt. SMITH, USN, patrol plane commander of P2V3 No. 4 of Patrol Squadron One reported an unidentified radar contact 20 miles north of the Naval Air Station, Kodiak, Alaska. When this contact was first made, Lt. SMITH was flying the Kodiak Security Patrol. At 0248W, 8 minutes later a radar contact was made on an object 10 miles southeast of NAS, Kodiak. Lt. SMITH checked with the control tower to determine known traffic in the area, and was informed that there was none. During this period the radar operator, GASKEY, ALC, USN reported intermittent radar interference of a type he had never before experienced (see enclosure (3) [missing]). Contact was lost at this time, but intermittent interference continued.
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> b) At some time between 0200 and 0300W, MORGAN was standing watch on board the USS Tillamock (ATA 192), which was anchored in the vicinity of buoy 19 in the main ship channel. MORGAN reported sighting a "very fast moving red glow light, which appeared to be of exhaust nature, seemed to come from the southeast, moved clockwise in a large circle in the direction of, and around Kodiak and returned but in a generally southeast direction." MORGAN called CARVER, also on watch, to observe this object, and they both witnessed the return flight. The object was in sight for an estimated 30 seconds. No odour or sound was detected, and the object was described to have the appearance of ball of fire about one foot in diameter.

The second incident occurred some two hours after the above radar contact:

> c) At 220440, conducting routine Kodiak security patrol, Lt. SMITH reported a visual sighting of an unidentified airborne object at a radar range of 5 miles, on the starboard bow. This object showed indications of great speed on the radar scope. (The trailing edge of the blip gave a tail-like indication.) At this time Lt. SMITH called attention of all crew members to the object. An estimated ten seconds later, the object

was directly overhead, indicating a speed of about 1800 MPH. Lt. SMITH climbed to intercept and attempted to circle to keep the object in sight. He was unable to do this, as the object was too highly maneuverable. Subsequently the object appeared to be opening the range, and SMITH attempted to close the range. The object was observed to open out somewhat, then to turn to the left and come up on SMITH's quarter. SMITH considered this to be a highly threatening gesture, and turned out all lights in the aircraft. Four minutes later the object disappeared from view in a southeasterly direction.

The third incident occurred about 24 hours later and was solely visual:

d) At 230435W, the day following Lt. SMITH's sighting, Lt. CAUSER and Lt. BARCO of Patrol Squadron One were conducting the Kodiak Security Patrol and sighted an unidentified object. At the time of the sighting the aircraft in which these officers were embarked was approximately 62 miles south of Kodiak. The object appeared to be on an ascending westerly course, and was in sight for ten minutes. During this period the object was observed by Lts. CAUSER and BARCO, and PAULSON, ADi, plane captain. At no time was radar contact made on the object. Lt. CAUSER was unable to close the object at 170 knots.

The summary then amplifies the visual descriptions as follows:

1) To Lt. SMITH and crew it appeared as two orange lights rotating about a common center, "like two jet aircraft making slow rolls in tight formation." It had a wide speed range.

2) To MORGAN and CARVER it appeared as a reddish orange ball of fire about one foot in diameter, travelling at a high rate of speed.

3) To CAUSER, BARCO and PAULSON it appeared to be a pulsating orange yellow projectile shaped flame, with a regular period of pulsation on 3 to 5 seconds, off 3 to 5 seconds. Later, as the object increased the range the pulsation appeared to increase to on 7 to 8 seconds and off 7 to 8 seconds.

Weather and balloon-release information contained in Enclosure 8 (missing) is summarised as follows:

A check with the Navy Weather Center, Kodiak, Alaska revealed that balloons were released at the following times:

22 January - 0445W and 2200W (approximately)
23 January - 0400W (approximately)

On 23 January winds aloft at 1000 feet were reported at 0400W as from 310 degrees, at 36 knots, and at 2000 feet, from 240 degrees at 37 knots, while the object was reported to be on an ascending westerly course.

NOTES: As regards the 230435 visual sighting the "pulsation" of the light, considered alone, is quite suggestive of a light below a swaying radiosonde balloon, periodically occluded as observed from the air. However, the winds aloft data quoted indicate that a balloon released from Kodiak at 0400 would, at a typical climb rate of >1000 fpm, within 2 minutes have encountered winds carrying it NE. If winds above 2000' remained from 240 degrees, then 35 minutes later the balloon would certainly not have been near a position 62 miles south of Kodiak. The upper winds are not specifically stated, however, and it is conceivable that the balloon entered a north-south flow at higher altitude. But for the balloon to reach the observation position within 30 minutes would require a *mean* wind speed during climb of about 120 mph, and therefore maximum wind speeds of very considerably more than 120 mph. This seems improbable in view of the fact that its maximum altitude even after thirty minutes would be no more than about 35,000'. Also, in view of the fact that wind data are only quoted up to 2000' with specific reference to the possibility of a balloon having been sighted, one may reasonably conclude that the sighting took place at around 2000' (this inference finds independent support later) and thus nowhere near a hypothetical one- or two-candlepower radiosonde lamp at 35,000'. (A leaking balloon at lower altitude would be still less consistent with reasonable wind speeds.) Since even a slow aircraft will rapidly close on any balloon, typical balloon-interceptions involve a close dogfight with a blinking light which appears to make rapid and repeated head-on passes during a circling climb. In this case the aircraft "was unable to close the object at 170 knots" during ten minutes of observation. A radiosonde light, furthermore, would not have been orange.

The navy intelligence report considered balloons as explanations for this and the other sightings. Its comment on this hypothesis reads:

> In view of the fact that no weather balloons were known to have been released within a reasonable time before the sightings, it appears that the object or objects were not balloons. If not balloons, the objects must be regarded as phenomena (possibly meteorites) the exact nature of which could not be determined by this office.

A balloon was released from Kodiak at approximately 0445 on January 22, just five minutes after the second radar incident reported by Lt. Smith (para. c above). Given that the release time is "approximate" there is presumably a residual possibility that this balloon *was* in the area at the time of this incident. The report states that Smith "climbed to intercept and attempted to circle to keep the object in sight. He was unable to do this, as the object was too highly maneuverable." This is somewhat consistent with an attempted interception on a balloon. However, the rest of the report is very difficult to interpret as a balloon, in particular the radar-tracked closure at 1800 mph.

The two radar incidents on January 22 are the core of the sequence and invite more detailed analysis than is possible on the basis of the information available. Nevertheless some observations can be made.

The incident beginning at 0240 is not strictly a radar-visual, since the sighting reported by the two watch personnel on the U.S.S. Tillamock was "at some time between 0200 and 0300" and thus may not have been concurrent. However it is reasonable to treat the reports

as possibly related. Two separate airborne radar contacts occurred, the first to the north of NAS Kodiak, the second to the southeast 8 minutes later. These locations cannot correspond to the circling of Kodiak and departure southeast of the object observed visually, however, since that entire manoeuvre occupied only some 30 seconds. It is possible that one of the radar contacts related to this object, whilst the other contact involved the same or another object at a different time which was not observed visually.

The possibility that the second contact may have been a false target generated by RFI is raised by the fact that the radar scope was at that time displaying intermittent interference. However there is insufficient information in the summary to test this hypothesis.

One of many questions which remain is: if the first radar contact (at least) did correspond to the "very fast moving . . . ball of fire" observed visually from shipboard, why was it not also observed visually from the aircraft? It is possible that both radar targets were caused by propagation anomalies and/or interference from another microwave source. The presence of interference, however, does not exclude the possibility that a real target was also being displayed, and contextually this might be a more attractive explanation given the independent visual report which suggests that there may have been a target (of whatever nature) to detect. An equally plausible hypothesis, therefore, would be that the visual object was the exhaust of an unidentified jet - possibly a Soviet reconnaissance platform - which was briefly painted by the radar but visually aspected such that its exhaust flame was not noticed by the aircrew. The abnormal interference could have been due to signals from the intruder's own radar.

In the 0440 incident, two hours later, it is made explicit that radar and visual sightings were concurrent. In this case the object seen visually from the aircraft appeared as "two orange lights rotating about a common center", and was compared by the observers to "two jet aircraft making slow rolls in tight formation." The likelihood that this simile is a correct interpretation seems small, given that the lights were observed for several minutes at different bearings from the aircraft. A comment appended to the intelligence summary by an unknown office identified as OP322C2C opines that "the *possibility* exists that incidents covered by para. 2.a, b & d might be jet aircraft [original emphasis]". No opinion is offered as to the object(s) observed in this case, presumably because the radar-tracked speed is too obviously excessive. The cited 1800 mph, however, is calculated from displayed range-over-time and does not take account of the near head-on closure rate. To correct this figure we need to know the speed of Lt. Smith's patrol aircraft, which is nowhere given. Fortunately this figure can be approximately inferred with reasonable confidence.

Smith's aircraft is given the designation "P2V3 No.4 of Patrol Squadron One". We know that the aircraft were operated by the US Navy on security patrols around its Kodiak Island facility, and that they carried several crew members. They were clearly not small, high-performance interceptors. The likelihood is, therefore, that these were anti-submarine patrols, and this would be consistent with our inference from the weather data that the patrol by Causer and Barco on January 23 was being flown at the <2000' level. "P2V3" could therefore refer to the Lockheed P-2 Neptune anti-submarine patrol aircraft that was in use by the US Navy up until about 1961. This was a piston-engine aircraft, whose speed and range limitations led to the development of its turboprop successor, the P-3 Orion, in

1958. If Smith was flying a P-2 then he was not flying very fast, an inference consistent with other internal details of the reports.

In the 230435 incident other members of Smith's squadron were flying the same Security Patrol, presumably in the same type of aircraft, and attempted to close on the object without success at 170 knots - about 195 mph. Presumably this was equal or close to the plane's maximum speed. This can be roughly cross-checked with information in para. a) of the summary: Smith reported a radar contact 20 miles north of Kodiak NAS, then 8 minutes later he reported another 10 miles southeast of the NAS, which, whilst admittedly vague, is consistent with about 25 miles flown at a speed in the region of 180 mph. Adopting a generous 200 mph as the maximum likely speed of Smith's aircraft during the later radar-visual, and neglecting the component of lateral velocity due to the object's closure from a position "on the starboard bow", and assuming the negligible effect of winds to cancel out in the equation, we have a minimum true airspeed for the object of 1600 mph. If further allowances are to be made for possible inaccuracy in timing it might be safe to conclude that the object was travelling somewhere in the region of Mach 2 or greater. This would be pretty remarkable performance for jets in 1950. Even assuming this conservative speed estimate to be out by a factor of 2, one can hardly imagine jets, hostile or friendly, thundering though the Alaskan night at Mach 1 on a head-on pass with a lighted Navy patrol plane whilst performing "slow rolls in tight formation". In summary, it seems highly unlikely that this sighting was caused by jet aircraft.

The half-hearted suggestion in the intelligence report that the phenomena in all of these incidents were "possibly meteorites" is very much a stab in the dark. None of the features of any of the sightings can be convincingly equated with the characteristics of meteors. Visually the object in the first incident was seen to circle Kodiak and return, and whilst the reported duration of 30 seconds might be questioned as a fallible judgement it is supported by the fact that the first witness watched the object approach and make its wide turn, then had time to call it to the attention of the second witness who joined him to observe its departure. In the two later incidents the visual objects were on rising or turning trajectories and in both cases were in view for minutes rather than seconds.

The radar contacts reported in the first incident are unable to be evaluated in themselves. The radar contact in the second incident is more circumstantial, and the estimate of speed derived from displayed range and elapsed time is reinforced by the observation that the blip showed a distinct tail on the scope. A target will be swept by a number of radar pulses during each scan of the beam, and if it is moving quite slowly relative to the radar these returned pulses will be integrated into a compact arc which displays as a "spot target" on the tube phosphor. A target moving very rapidly might return pulses showing a changing range /azimuth indication during a single sweep of the beam, and the signals corresponding to these pulses will be displaced on the tube, "smearing" the blip reciprocally to the direction of movement. This smearing will be dependent on several additional factors such as beam width, pulse repetition frequency and scan rate, and no quantitative inferences can be made without detailed specifications of the radar involved; however, the report is qualitatively consistent with a target moving at unusually high relative speed.

This target is not consistent with returns from meteor-wake ionisation. Multiple trip effects can distort the displayed speed of targets detected beyond the unambiguous range of the set, and in some circumstances a meteor might be displayed at spuriously slow speeds. But typical true speeds of some tens of thousands of mph could not be reduced by this mechanism by an order of magnitude or greater; the target was evidently on an approximate radial heading, and multiple trip effects do not distort radial velocities; meteors on radial headings are generally only observable by ultrasensitive search radars due to the short length of trail scanned at near-grazing incidence, and airborne radars are of low power; and finally the optimum frequency for ionisation returns occurs at about 100 MHz, with cross-sections dropping by a factor of ten-to-the-fifth at about 1000 MHz, and the airborne radar would have operated at a frequency some ten times higher still.

The reported speed of the target is inconsistent with birds, insects, clear air turbulence, debris, rain, hail, smoke, balloons or other wind borne objects. Partial reflection from headwind-driven waves on an inversion layer just above the aircraft altitude could produce an approaching point target at a displayed speed of twice wind speed (the headwind cancels out the component of Vc due to aircraft airspeed); but winds of 7-800 mph are plainly unrealistic. Several sporadic ground echoes can create the illusion of a fast track on a surveillance PPI when they chance to appear in different locales from scan to scan, but the scan rates of airborne radars are relatively very high indeed an operator is much less likely to be fooled in this way, even disregarding the independent "indications of great speed" given by the smeared target presentation.

Internal noise sources or radio frequency interference from remote emitters can create false, rapid targets on analogue radars, and the report of interference occurring during and after the first radar incident invites analysis of this possibility. The intelligence summary indicates that two naval offices, in particular, found these reports interesting in the context of research into radar interference.

Interference "echoes" will generally display as random speckles or patterns of speckles representing small spots of excitation on individual trace radii. Such speckles do not resemble real targets such as aircraft, which display as compact bright arcs due to the several integrated spots of excitation on several adjacent trace radii. To mimic an aircraft-like target on an inbound radial heading, the noise source would have to be a cyclic microwave emission with a duration and sine-wave amplitude comparable to the passage of one beam-width across a target, having a periodicity minutely shorter than the scan rate of the receiving antenna and with a superimposed pulse repetition frequency synchronised to that of the transmitter. This is a very complex set of requirements for any source other than another radar set of the same or closely similar design, whose scan rate would be on the order of a microsecond shorter. Even an interference signal such as this would typically exceed the receiver threshold over a considerable portion of the scan period, displaying as an anomalous broad arc, without some super-added mechanism to filter a discrete train of pulses similar to those returned from a reflective target. The reason for this is the complex lobing which occurs far beyond the narrow angle of the main beam, which is mirrored in the lobed antenna gain of the receiver. Thus signal strength can exceed the receiver threshold unpredictably at various antenna orientations, displaying virtually anywhere around the scope. On a surveillance PPI this effect might be reduced for a relatively weak

signal if the two antenna rotations were synchronised 180 degrees out of phase such that peak output always corresponded with peak gain. With two forward sector-scanning airborne radars it is possible that this filtering might occur in another way: transmitting and receiving antennae could be oriented in such a way that each time the transmitting antenna scanned towards the receiver only a brief train of pulses was detectable at low gain before it scanned away and signal strength dropped below the threshold. With a sector-scanning transmitter it is possible that this filter effect would also work if the signal entered by washing through poorly-shielded amplifier or receiver circuitry rather than by the antenna link.

The probability of this hypothesis is difficult to gauge. It has to be presumed from the intelligence report that there was no *known* air traffic at this time which could have been responsible. The report does not mention a second radar target which would have been the skin paint of the aircraft responsible, although it is true that on the above hypothesis the other aircraft - at least at the time of this initial contact - would have been on the periphery of Lt. Smith's radar scan limit and at unknown range and elevation, and thus possibly undetected. (Radar indications during the later parts of the attempted interception of the visual object are not specified in the report.) The visual object might itself be taken as an indication that a culprit aircraft was in the area, but the rolling configuration of orange lights and general performance observed visually are inconsistent with a type of aircraft which would have carried radar equipment similar to that on a P-2 patrol plane. And if the aircrew did see an unidentified aircraft of some type on a course similar to that being indicated by a concurrent radar target, then the attempt to disassociate the one from the other by improbable RFI mechanisms does become more than a little strained.

The fact that unfamiliar radar interference was reported by the same aircrew during the first incident two hours before is of ambiguous relevance. It can be taken as strengthening the suspicion that some unknown source of RFI might have been responsible for these and the later targets. At the same time it can be taken as indicating the operator's readiness to interpret unfamiliar radar indications as interference, and as underlining his confidence that the unknown targets appeared to him to resemble "real" radar echoes. Given that the inherent probability of convincing target arcs being generated by RFI must be somewhat low, and given the concurrent visual sighting which is difficult to explain, one might be inclined to give the operator the benefit of the doubt.

The limited comments of two unidentified, presumably naval, offices are included here for perspective:

> The opinion of OP322C2C:
>
> "The *possibility* exists that incidents covered by para. 2.a, b & d might be jet aircraft; however, there is insufficient intelligence to definitely identify the unidentified objects as aircraft. Several reports of similar radar interference have been received from DIO/17ND. It is possible that this is interference from another radar in the vicinity, malfunctioning of components within the radar set, or both."
>
> The opinion of F2:

"Many of the previous reports of radar interference tend to indicate local interference (generated within the aircraft). This looks more like external interference from sources outside the aircraft than previous reports, though it is far from conclusive. These reports are always of interest."

The first reported radar incident can't be evaluated, although broadly concurrent visual sightings are of interest in the context of later events. The third, purely visual, report is likewise unevaluable but again borrows some significance from the context. The core radar-visual incident is not easily explained in terms of the information available, and given the unusual nature of the concurrent visual sighting together with certain quantitative inferences from the radar report this case should be carried as an unknown.

STATUS: Unknown

3. DATE: March 9, 1950 TIME: 1915 EST (approx) CLASS: R ground radar

LOCATION:
Selfridge AFB
Michigan

SOURCE: Hynek HUFOR 1977 123/295
Shough UFO 47-87 215

RADAR DURATION: 1¾ hours (approx)

EVALUATION: Grudge - probable balloon

PRECIS: During radar monitoring of a night flying exercise by F-80s of the 56th Fighter Interceptor Group near Selfridge AFB, an unidentified target was observed by an Air Force controller and three other operators (one of whom was the controller from the previous shift) on the PPI of an L-band CPS-5 surveillance radar and simultaneously on the HRI scope of an S-band CPS-4 height-finder. The presentation of the target, which initially appeared on the CPS-4 at high altitudes, was "definitely that of an aircraft" and comparable to the return from an F-80. The target moved with rapid alterations of height and speed, generally about 20,000' above the highest altitude of the F-80s being monitored. "Several extreme instances of gaining and losing altitude" were observed, the target on the HRI scope rising and falling "up to 20,000' very rapidly" with "erratic" changes of speed observed on both scopes. On at least two occasions the target hovered motionless for a mean period of 2 minutes. Maximum estimated speed was 1500 mph, although the controller noted possible inaccuracy in the timing at this point and, being unable to give the target full attention at this time, was confident only that the target was "very fast". Later the controller was able to concentrate fully on the target, and over a period of 6 minutes during which it was "giving indications on both scopes without fade" he and another operator noted range, height, azimuth and time data in grease pencil on the scope heads. The target became intermittent on the CPS-5 at 2052, range 79 miles, altitude 33,000', but the height-finder carried it to 87 miles before losing it. Subsequent intermittent contacts occurred on the CPS-5 out to 120 miles.

NOTES: The following is the text of a letter, classified SECRET, from the Air Adjutant General to the Director of Intelligence, HQ USAF, Washington, concerning this incidence:

1. Attached for your information are two narrative reports concerning radar sightings of an unidentified flying object.

2. The fact that the object was sighted on the scopes of two (2) radars is considered worthy of special note.

3. Comment of technical experts, this headquarters [HQ Continental Air Command, Mitchel AFB, N.Y.], was solicited and is quoted in part for your consideration:

a. While it is relatively well known that various ionospheric conditions cause reflections at lower frequencies, it is usually considered that those layers have no effect at the frequencies used by the two radar sets mentioned except when temperature inversions or other atmospheric or tropospheric conditions cause ducting and spurious reflections. Presuming that such idealized conditions existed at the time of these observations, it is conceivable that an actual small change in physical lateral action [sic] in reference to the radar set could cause a seemingly greater change in relative position of the "object" as observed on the radar scope due to the varying path lengths the radar energy takes to and from the "object" as a function of the frequency-sensitive layers and angles of incidence of the propagated wave. However the great difference in frequencies of the L-Band CPS-5 and the S-Band CPS-4 radar sets and the evident correlation of observations between these two sets almost rule out the possibility of anomalous propagation effects. Further, the magnitude of velocity and accelerations of the three-dimensional movements of the "object" reported are beyond the capability of known behavior of lighter than air vehicles in controlled flight.
b. Also substantiating this unlikelihood is the fact that the "object" was reported as remaining stationary in free space for a mean period of two minutes.
c. Further validity is lent to the contention of the reports by statements that first indications, which were at high altitudes, were observed on the CPS-4 height-finder before being observed on the CPS-5 surveillance radar set. This follows logic and field experience, inasmuch as the high-altitude coverage of the CPS-5 is known to be poor and the antenna is not capable of being automatically tilted as in the case of the CPS-4 on which the controller may tilt the antenna within wide limits to observe any high-altitude or high-angle objects. It is to be noted that previous field experience with a CPS-5 surveillance radar set has indicated that targets picked up at ranges and altitudes indicated in subject report would probably have a reflection aspect ratio in the order of magnitude of a B-29 or greater.
d. In the absence of detailed vertical and horizontal coverage charts for the specific radar sites and comprehensive weather reports for the area during the period of time these observations were noted, a more complete study or evaluation at this time is not feasible.
e. In summary, no known electronic phenomena, nor combinations of several electronic phenomena, could conceivably produce all of the observations covered by the attached reports.

4. The frequency of reports of this nature has recently increased; instructions have therefore been directed to all radar installations within this command to report scope sightings of unusual objects.

5. It is recommended that reports of unidentified object sightings be reconsidered for submission from all Zone of Interior Air Force agencies.

S/ Neal J. O'Brien,
Col., USAF, Air Adjutant General,
for the Commanding General.

The narrative report of the incident by the controller, 1st Lt. Francis E. Parker, follows:

On the night of 9 March, or radar station was in operation monitoring night flying by units of the 56th Fighter Interceptor Group, Selfridge ASFB, Mich. I came on duty at approximately sundown, relieved 1st Lt. Mattson at the PPI scope (of the AN/CPS-5 Radar Sight), and established contact with the F-80s already airborne. Lt. Mattson, Sgt. McCarthy and Cpl. Melton, who made up the rest of our crew for that night, mentioned to me at this time that an aircraft had been picked up intermittently on the HRI scope of the AN/CPS-4 height finder radar at 45,000 feet and over. I knew the highest assigned altitude of the F-80s was 24,000 feet; the target was not at that time visible on either radar scope, so I attributed the report of the high-flying aircraft to interference, crew inexperience, or both. Over the next fifteen minutes the rest of the crew, mentioned above, repeatedly reported this high-flying target at apparently rapidly changing altitudes without my being able to turn around rapidly enough from my monitoring of the F-80s in the area to observe for myself. Finally, however, I saw this target which was a very narrow and clear-cut presentation on the HRI scope. It was at approximately 47,000 feet about seventy (70) miles out, and the indication was definitely not that of a cloud or atmospheric phenomenon. I checked pilots in the area by VHF and was assured by [the] F-80 pilot at the highest assigned altitude that he was at 24,000 feet. The clarity, narrowness and definition of the presentation was definitely that of an aircraft. The target gave a similar presentation to that given by an F-80, and if anything, narrower. It was definitely at this time not presenting a very large reflecting surface toward our station and I could not at this time pick up the target on the CPS-5, ruling out B-36 or other large aircraft. Further indications of this aircraft were picked up intermittently but with increasing regularity for the next 45 minutes or an hour, and entries were made of these occurrences in the controller's log; though relatively fairly correct, [they] are inaccurate, due to the extreme inaccuracy of Sgt. McCarthy's watch. During this period, approximately 1945 to 2030, this target seemed to stay in the area in which our fighters were flying, sometimes approximating their courses, but 20,000 feet above them. During this same 45-minute period, Lt. Matson and other members of the crew reported, both from the HRI scope of the AN/CPS-4 and another PPI scope of the AN/CPS-5, that the target hovered in one position and also that it progressed from a position given as 270 degrees, 78 miles at 45,000 feet to a position at 358 degrees, 53 miles at roughly the same altitude in 4 - 5 minutes. This would give it a speed upwards of 1,500 miles per hour for this run. I

cannot substantiate this speed. Coverage of target during this run was reportedly intermittent and the times were not to my knowledge accurately tabulated at actual instances of radar pick up during this run. Subsequent individual questioning I undertook with members of the crew bears out the possibility of inaccuracy in timing during this run. I knew only that the target was very fast. I observed during this period, by momentarily turning around and watching the HRI scope, several extreme instances of gaining altitude and losing altitude. I was not able at this time take down the actual figures, but I observed it losing and gaining up to 20,000 feet very rapidly.

I was able, at 2046 EST, to identify this aircraft on my PPI scope (AN/CPS-5) and simultaneously on the HRI scope. The only actual timing and figures I took down on this target I did during the six minutes from 2046 to 2052, during which time the aircraft was giving indications on both scopes without fade. I took down the range and azimuth on the minute for this period and Sgt. McCarthy took down the altitudes. (Sgt. McCarthy's times were off as aforementioned but in this case, due to the fact that we were both following the same target, I have reconstructed these times into my own, which were taken in grease pencil directly on the scope head, and later transcribed.) Information recorded is as follows:

Time	Azimuth	Range in Miles	Altitude in feet
2046	1,560	45	25,000
2047	1,510	49	29,000
2048	1,460	56	35,000
2049	1,420	60	33,000
2050	1,390	67	36,000
2051	1,360	73	38,000
2052	1,330	79	33,000

These figures, although not as spectacular as some of the climbs and speeds I observed, show definitely the erratic speed and altitude changes. The differences in speed from one minute to the next were apparent to me as were the climbs and dives. At 2052 the aircraft faded from the PPI scope and was picked up for periods of one and two minutes up to 120 miles. It appeared to hover for two minutes at approximately 110 miles distant. It faded at 120 miles for the last time. The height-finder carried the aircraft past the six-minute period listed above to a 1,230, 87 miles, 31,000 feet where it faded for the night from the CPS-4.

The CPS-5 was very accurate on this particular night which was supported by the F-80 pilots' agreement with many geographical positions given them off the CPS-5. The AN/CPS-4, though a more erratic piece of equipment, could not, through any known or prevalent weakness in its operation, account for this manner of extreme changes in altitude. I went over all possible errors which could be induced by AN/CPS-4 error exhaustively with my technical personnel.

We are continuing investigations at this station.

I have been a rated pilot since 12 April 1943, and have been assigned to controller duties for approximately 2 1/2 years.

S/ Francis E. Parker
1st Lt. USAF

This articulate, careful report gives every indication of being objective and reliable as far as it goes. (The other narrative mentioned in Colonel O'Brien's letter to the Director of Intelligence is presently unavailable.) Project Grudge personnel evidently accepted the evidence from the observers and technical analysts that there was a real radar-reflective target in this case, concluding that it was "unknown". It did not appear as such in the final Blue Book statistics, however, the reason apparently being that Grudge - in defiance of every opinion and every quantitative argument - added the rider that it was a "possible balloon". When the statistics were later reorganized by Blue Book for Air Force PR purposes all "possibles" and "probables" were collapsed into the "explained" category and this case, along with many others effectively disappeared for many years.

Grudge offered no defense of its "possible balloon" evaluation. Indeed it is difficult to see any grounds for suspecting a balloon given the astonishing wind speeds implied and the fact that the target maintained station at times whilst at others moving at jet speeds on headings 90 degrees apart.

The heading of the 1500 mph run (whose timing accuracy is uncertain, but which was at least "very fast") is roughly NE, for example, terminating due N of the station at 53 miles; whereas the target was subsequently tracked from a position due E at 45 miles (1,560 mils = 88 degrees). The implied heading between these positions is SW for 70 miles, and the target then departed on a heading roughly NE once more at a mean speed of 370 mph.

The variations of altitude are also inconsistent with a balloon. The general trend, if there can be said to be one, is of descent from an initial 47,000' to around 30,000', which would imply negative buoyancy; but having dropped to as low as 25,000' at 2046, the target begins to climb, gaining 13,000' in 5 minutes, which is an average rate of climb of 2600 fpm - more than twice that of a fully buoyant weather balloon. Indeed the maximum measured rate of climb during this run was 6000 fpm, with a simultaneous ground speed of about 480 mph, implying inconceivably violent winds and updraughts which would have tossed the F-80s out of the sky - and possibly leveled half of Michigan.

Birds, insects, weather (rain, hail-cells etc.), clear air turbulence or wind-borne debris cannot account for this behavior. Nor is it likely that internal system faults or mutual/remote radio frequency interference could similarly affect two electronically independent radars with very different receiver bandwidths (on the order of 2gHz apart) even if the presentation and motions of the target were symptomatic of RFI, which they are not. No effect attributable to side lobe returns could account for such a target.

Anaomalous propagation is a poor hypothesis here:
a) because the target behavior is not diagnostic of AP;
b) because the "clarity, narrowness and definition" of the scope presentation is not diagnostic of AP;

c) because the accuracy of CPS-5 positions confirmed by pilot reports does not suggest abnormal propagation;
d) because the super-refractivity due to atmospheric temperature/moisture gradients, and the efficiency of partially reflecting layers, are both sensitive to frequency, rendering it unlikely that correlating returns would be displayed by two instruments;
e) because partial forward scattering from a moving elevated layer would imply (for the 6-minute track alone, means speed 370 mph at a mean altitude of about 30,000') severe hurricane force winds of 185 mph at about 15,000' coexisting with stable stratification, these figures being minima;
f) the mean antenna elevation during the 6-minute plot is about 6 degrees, and the *horizontal* fan beam of the CPS-4 height-finder (whose vertical beam width would be around 1.0 degree) would probably radiate little energy near zero degrees in comparison with the CPS-5's *vertical* cosecanted pattern, making ducted ground returns less likely on the height-finder - yet after the target had become intermittent on the CPS-5 at 1330 mils, 79 miles, it continued to give consistent paints on the CPS-4 out to 1230 miles, 87 miles (a 12-mile track, or a further 115 seconds at the extrapolated mean speed of this run).

No purpose is served by invoking multiple-trip returns from beyond the unambiguous range. The pulse repetition frequency of each set must be identical in order for such echoes to correlate in range, and even then the question of the source of such echoes remains unanswered. The probability of ground returns due to anomalous propagation seems negligible for the reasons discussed, which leaves aerial targets.

Aircraft beyond the unambiguous range of both sets could be displayed at spurious speeds and on distorted courses by multiple-trip echoes, but displayed speed will always be equal to or less than true speeds - never greater - and the echo could not appear to hover on both PPI and RHI scopes unless the target did, so that the required performance envelope for aircraft detected by multiple-trip echoes would be even more remarkable than it is already. Further, the echoes would be confined to the true azimuths, whereas in this case a somewhat con-sistent pattern of behavior was observed at scope azimuths differing by 180 degrees, which would imply chance detections of different multiple-trip aircraft at remote ranges which presented the illusion of a sequence of connected movements by a single object. This in itself seems highly improbable.

Satellites may sometimes be displayed in this way, but aside from objections already discussed none were orbiting in 1950. Speeds and courses are inappropriate for multiple-trip detection of meteor-wake ionization, even if the frequencies and peak powers of the sets had been appropriate. In general, a target which could give a scope presentation comparable to an F-80 even at second-trip ranges (maximum operating range of the set plus the displayed range of the echo) would have to be a much more efficient reflector than an F-80, due to the inverse 4th power signal attenuation of point targets, which implies a much larger aircraft of inferior performance. (Note that in the opinion of technical experts at Continental Air Command the reported echo presentation was comparable to that of a B-29 painted by *first*-trip echoes.) Finally, it should be remembered that the speeds and altitudes indicated would be performance *minima* for a multiple-trip target and the actual displayed performance is already difficult enough to account for.

No fixed-wing or rotor aircraft known to be flying in 1950 could approach the performance envelope of the target, with a transition from extended hover at an altitude of about 45,000' (reportedly observed on both RHI and PPI scopes, ruling out the improbable hypothesis of a steep tangential climb or dive at constant slant range) to ground speeds of over 450 mph in a 6000 fpm climb. Notably, the highest ground speed coincides with the highest rate of climb. The earlier plotted speed of 1500 mph over a 93-mile track may have been inaccurate, as the controller suspected. But again note that even a factor-2 error here leaves a speed which is 25% better than the maximum clean speed in dive of an F-94 (602 mph), the fastest operational jet flying in 1950.

The only hypothesis which, *prima facie*, seems at all attractive in this case is that of a "ghost" - a secondary echo from an aircraft due either to a ground reflector or another aircraft. Details seeming to hint at this possibility are found in the earlier phase of the event:
1) During the roughly 45-minute period from about 1945 to 2030 the target "seemed to stay in he area where our fighters were flying, sometimes approximating their courses"
2) At this time its altitude was about 20,000' above the F-80s, that is, at about twice their altitude of 24,000'
3) Although the echo was good it was at this time observed only intermittently
4) The target presentation was comparable to an F-80 but "if anything, narrower. It was definitely at this time not presenting a very large reflecting surface . . ."

Arguments against a ghost are rather strong, however. Firstly, all of this behavior occurred on the HRI scope of the AN/CPS-4 height-finder, which introduces special circumstances. To understand this, consider how a ghost is generated on the more familiar PPI of a surveillance scope such as the CPS-5.

If an aircraft at 20,000' were so oriented as to scatter radar energy to an efficient ground reflector, the signal could return by the same path, being scattered back off the aircraft to the antenna. If this signal were strong enough to be displayed it could appear on a surveillance PPI as a weak echo on the same azimuth as the F-80 blip but at a greater slant range proportional to the total out-and-back path length - in this scenario the range would be that of the F-80 plus a minum of 20,000', being the minimum distance to a reflector on the ground. Generally such a ghost would be brief and weak, one or two blips appearing as the reflection geometry between aircraft and reflector approached optimum the vanishing as the aircraft flew by and the geometry was quickly lost. In special circumstances involving an efficient corner-reflector, however, such as an empty metal truck or the corner formed between metal fences and wet ground, the reflection geometry could be maintained over some angular distance and the ghost could persist long enough to behave like a solid moving target. Since it would always be displayed on the aircraft azimuth at greater slant range, its movements would appear to relate generally to those of the aircraft, approaching and receding at higher speeds.

On such a PPI display no information about altitude or elevation is available. A height-finder operates differently, however: the antenna radiates a horizontal fan-shaped beam which is broad in azimuth but very narrow in elevation. The target altitude is derived from the slant range and the known elevation of the antenna at the time the reflected signal is

received. This allows some simple calculation. With an hypothetical F-80 illuminated by the main beam so as to generate a ghost by secondary reflection the HRI antenna elevation corresponds to that of the F-80, and the apparent position of the ghost will be in the same "line of sight". In the present case the ghost is known to have been displayed at 47,000', range 70 miles, corresponding to an elevation of approximately 7 degrees. The maximum altitude of the highest F-80 being monitored at the time (checked by radio) was 24,000', which at 7 degrees elevation represents a slant range of about 35 miles. Therefore the minimum geometrically possible ray path to the ground reflector, *via* any of the F-80s at this time, is about twice the range from the antenna to the F-80 which (*ex hypothesi*) is concurrently being displayed on the scope.

Now a reflector of the kind required behaves as a specularly reflecting point target, and because returned signal intensity from point targets varies inversely with the 4th power of the distance we can show, assuming that the scattering efficiency of the F-80 is isotropic, that the maximum theoretical strength of the ghost echo due to a perfectly-oriented 100%-efficient ground reflector would be 1/16 or a little over 6% of the strength of the direct return from the F-80. In practice one would expect the aircraft aspect and the overall geometry to vary in respect to an imperfectly oriented <100%-efficient reflector, making it likely that the mean signal would be even weaker, and the scope presentation fluctuating.

It should also be noted that this hypothetical ghost is being displayed at twice the range of the aircraft. A target at 70 miles might not be thought to be "staying in the area in which our fighters were flying . . . but 20,000 feet above them" if the range to the fighters is only 35 miles.

The consistency of the "ghost" model with the controller's report of a clear, well-defined target which was almost identical to the F-80s and in the same [implicitly geographical] area is rather poor.

(Note: The geometry underpinning the above argument assumes scattering of the main beam by an F-80, not scattering of side lobe radiation. In the latter case the indicated elevation and resultant displayed elevation of the ghost would not be that of the aircraft. However the attenuated signal reflected from a target in any lobe will be on the order of hundreds or thousands of times weaker than that from the same target illuminated near peak gain in the main beam. Moreover, an aircraft so placed as to generate a ghost due to any vertical lobing of the height-finder fan would still generate a far stronger ghost at the boresight position. Nothing is to be gained, therefore, by considering side lobe ghosts; indeed these worsen the theoretical fit, inasmuch as one would expect multiple ghosts as the antenna scanned in elevation.)

A further counterindication is the fact that, during this same period, the target appeared to hover in one spot. If accurate, such a circumstance cannot possibly occur with a moving aircraft and a ground reflector (whichever reflector is primary). Reflections between two aircraft could in principle achieve this, but it is highly improbable that the reflection geometry could be maintained more than very fleetingly. It is also highly improbable that an aircraft-to-aircraft ghost could persist as an extended coherent track for many minutes. The compound probability of these effects is vanishingly small. Any operator would be

surprised to observe an air-to-air ghost reflection occur at any time. Let us assume that one such incident on a given shift is unlikely. Then how likely is it that an operator will observe such effects "intermittently but with increasing regularity for the next 45 minutes or an hour"? A long sequence of improbable ghosts which gave the impression of the track described, involving stationary episodes and culminating in a time-flagged 6-minute plot on HRI *and PPI scopes* "without fade"over a distance of some 50 miles with a final 2-minute "hover" is frankly so improbable as to be for all practical purposes impossible.

Finally, one must consider the failure of the CPS-5 to at first detect the target indicated by the CPS-4 at high altitude. This is not easily understood in terms of a ghost reflection from an F-80 since the F-80s were simultaneously being monitored at 24,000' and below on the CPS-5 by the controller, and the reflection geometry would be the same for both radars, as it obviously must be (*ex hypothesi)* to account for the subsequent simultaneous paints. On the other hand, this does, as the report of technical personnel, HQ, Continental Air Command, points out, "follow logic and field experience" with the CPS-5's known poorer coverage of real targets at high altitude. Again, at the end of the incident the target gave consistent paints on the CPS-4 after it had become intermittent on the CPS-5 at 79 miles, 33,000'. This behavior, too, can be rather easily understood in terms of null zones in the vertical diagram of the CPS-5 due to lobing, a particularly prominent effect at the short-centimetric wavelength of the CPS-5. Vertical lobing is caused by reflected ground-incident energy modifying the free-space pattern, a ubiquitous problem because of the need to fill the surveillance drum with radar energy down to the lowest possible elevations. The horizontal nodding fan of the CPS-4 radiates very little energy at negative elevation angles compared to the CPS-5 (the final boresight elevation of the target was approximately 6 degrees) and so would be relatively free of this sort of defect.

In conclusion there appears to be no satisfactory explanation of this incident. The simplest and most natural interpretation is of a radar-reflective aerial object capable of high subsonic and probably supersonic speeds and extended hover (or near-hover) at high altitude. An object of some size or unusual reflection efficiency is indicated by a radar cross-section comparable (according to cognizant technical specialists) to that of a medium-sized bomber. Aeronautical history does not record any such high-performance aircraft, and clearly none was known to USAF Continental Air Command in 1950. A currently unrecognized natural phenomenon is possible; however, it is fair to say that the behavior of the object in relation to the F-80s, staying in their area and "sometimes approximating their courses" but far above them, could also be interpreted as rational - or at least animate, possibly inquisitive - intelligence.

POSTSCRIPT: It is worth noting that the Blue Book final statistics carry only two "unknown" reports originating from Selfridge AFB for the entire period June 1947 to January 1969 (the present case being carried as "probable balloon"). One of these, Case # 650 (#203 in Brad Sparks' re-evaluated catalogue), was a nocturnal visual sighting of a vertically descending yellowish light which disappeared in level flight at high speed. The witness in this case was none other than 1st Lt. Frank Mattson, one of Controller Lt. Parker's radar crew on the night of March 9, 1950. That sighting took place on March 3, 1950. It isn't easy to conclude, however, that this fact is material to an interpretation of the radar observations just six days later.

4. DATE: September 21, 1950 TIME: unknown CLASS: R ground radar

LOCATION:
Provincetown
Massachusetts

SOURCES: Hynek (1978) 139

RADAR DURATION: unspecified

EVALUATIONS: Blue Book - unknown

PRECIS: An MIT radar observer and 2 colleagues conducting a weather radar project under contract to the US Signal Corps were tracking Air Force F-86s from a radar site at Provincetown. The following is from a report made to Major Tuttle, Staff Weather Officers, 33rd Fighter Wing, Otis AFB, Mass.:

> An exceedingly puzzling event occurred during the 3rd run when the planes were heading northeast at 30,000 feet. We picked up another plane in the radar beam travelling about due north on a converging course towards the F-86s. It was moving very rapidly and I told the pilots about it, its range and direction from them. The echo caught up with, passed, and then crossed the course of the 86s, suddenly went into a very tight (for the speed) turn to the right, headed back toward Boston and passed directly over our flight. (Perhaps went under.) The sketch [unavailable] represents, as closely as we can remember, the relative positions of the two planes. Two other observers were with me at the time and we have checked over the facts rather closely. The pilots will undoubtedly recall the incident. They said they didn't see anything which is not too surprising considering the speed of the object and the fact that it may have passed several thousand feet above or below them and still looked like coincidence to the radar. Figuring conservatively, the speed of the object was approximately 1200 MPH, and the centrifugal force exerted on the ship during the turn amounted to something more than five g's. It gave an excellent radar echo which could not be mistaken for anything else and in all respects except for the velocity seemed a normal radar target. It passed out of the beam while we continued to track our flight, but we focussed on it again for a few seconds shortly after it was rapidly approaching Boston . . . . It was very evidently an interception of some sort on our flight, but what? The turn was utterly fantastic . . . . A few rough calculations concerning control surfaces, angles, etc., only adds to the puzzle that this object must have been entirely unconventional in many and basic respects. Perhaps the thing that bothers me the most is that it gave a very good radar echo, which implies irregular surfaces and comparatively large size, large enough so the pilots might have had a good chance to see it. . . It seems highly probable that I may be poking into something that is none of my business, but on the other hand, it may be something that the Air Force would like to know about if it doesn't already. . . .

NOTES: The description seems to be of a PPI display with no height finder. It appears that the aircraft altitude cited came from pilot reports.

This kind of target behavior - a single discrete target, presentation identical to that of an aircraft, making a continuous track at very high speed with a midcourse turn onto a markedly different azimuth - is not at all typical of anomalous propagation. Partial reflection from moving waves on an elevated inversion could generate fairly good spot targets, but the speed of such tracks is 2 x wind speed with some consistent relationship to wind direction: in this case the target was too fast by an order of magnitude and the rough geography of the account is sufficient to establish a change of heading too great to comfortably equate with winds. Sporadic ground echoes due to superrefractivity can present the illusion of fast targets on any heading, but the probability of a random mechanism generating a coherent track of any length is very low, as is the probability that a number of sporadic returns from very different ground reflectors over a very wide area, each with a very different propagation history, could present a) consistently and b) as "very good" spot targets. Neither CAT nor any other possible atmospheric inhomogeneity seems appropriate to the target presentation, speed or behavior.

Radio frequency interference or spurious internal signals are equally improbable explanations of a target which a) "in all respects" except speed had the presentation of an aircraft target (requiring discrete pulse trains with a systematic reference to the PRF and scan rate of the receiver, such as signals from another similar radar), and b) made a complex PPI track with no obvious geometric relationship to the scope center (implying a source with no systemmatic reference to the scan-rate of the receiver). A so-called spot target such as an aircraft is displayed on a PPI as a short arc composed of the integrated spot returns from a number of radar pulses on adjacent scope traces, whose non-radial movements bear a very complex relationship to a changing set of trace radii; and a repeating noise pulse or pulse-train (even neglecting the complexity of the target arc) which displayed as a track comprising at least one straight sector with a significant vector tangential to the scope radius, plus a "very tight turn", would in itself imply a very complex and fortuitous pattern of changing pulse-repetition frequencies. Such varying cyclicity is not typical of any pulsed emitter in the radar band, and the likelihood of random noise generating such a target is obviously vanishingly small.

Birds, insects, balloons and other wind borne objects are ruled out for reasons including speeds, headings and presentation. Multiple trip returns from aircraft beyond the unambiguous range are not helpful in this case, since moving targets so detected will be displayed at spuriously slow speed proportional to their tangential vector, and the displayed speed is already a problem; and AP ground returns detected in this way are subject to the same objections already discussed.

The date of the incident rules out the possibility of multiple-trip returns from an artificial satellite. But one possibility which deserves to be considered is multiple-trip returns from meteor-wake ionisation: a large meteor on a tangential heading to the receiver at low elevation might be detected by a sensitive search radar circa 1950, although neither the peak output nor the frequency are known. The track of such a meteor might be considerably distorted and appear to execute an approach towards the site and a hyperbolic turn onto a receding heading. Due to the rate of ion recombination the trail will be scanned essentially as a spot target. But there are objections to this hypothesis: 1) the geography and headings cited cannot be made to fit such a trajectory; 2) a meteor trail is unlikely to yield an

"excellent echo" indistinguishable from that of an aircraft even within the unambiguous range of a radar operating at optimum frequency, still less at ranges displayed by multiple trip; 3) displayed speed of 1200 mph is far too low even for this mechanism; 4) the duration of the track (sufficient to allow the operator time to contact the F-86s and supply range and heading of the target before it even approached them) is clearly too great for a meteor which would only be within the earth's atmosphere for a few seconds.

A "ghost" reflection is on the face of it the most plausible explanation. Qualitatively speaking, such apparent "interceptions" by high-speed targets are quite typical of ghosts due to radar energy being scattered from the aircraft to an efficient secondary reflector and back again. The most efficient secondary reflectors are large ground structures, such as metal roofs, and corner-reflectors such as empty trucks and metal fencing. The displayed range of a ghost will exceed that of the primary reflector by an amount equal to the distance between the two reflectors, and the ghost will always appear on the azimuth of the primary reflector. Since the angular rate of the ghost equals that of the primary reflector but at greater displayed range it can appear to move at much higher speeds. In this way, an aircraft flying over such a reflector might be "intercepted" by a ghost which approaches at high speed, merges with or paces the aircraft target briefly and then accelerates away again. In the present case, however, the aircraft were flying at 30,000' so that any ghost due to a ground reflector could not be displayed closer than about 5.7 miles from the F-86s.

For aircraft and ghost to coincide on the PPI the secondary reflector would have to be another nearby aircraft. Since there were apparently two F-86s the possibility arises of reflection from one to the other, but the target was initially painted at considerable range from the two F-86s (far enough that it could be seen closing at 1200 mph whilst the radar operator talked to the pilots about it) whilst the aircraft were evidently flying together on the same heading and both at 30,000. Later the target "passed out of the beam while we continued to track our flight." Finally, it can be shown that if the F-86s were on a NE heading and the "intercepting" ghost was on a N heading then the reflection geometry requires the F-86s to be SE of the radar site, in which case a ghost could not possibly be displayed turning "back toward Boston" (NW of Provincetown) as this would place it at closer displayed range than the primary reflector (an F-86).

Another unreported aircraft would be required as a secondary reflector, but the coincidence of ghost and F-86 echoes would still demand that it flew by in close physical proximity, which raises the questions of why it was not seen and, more importantly, why it was not itself painted by the radar, being (ex hypothesi) an efficient enough reflector to generate a "very good" ghost echo by secondary scattering.

The only possible explanation would seem to be a ghost due in no way the F86s but entirely to another unreported aircraft and a secondary ground reflector. The collocation of the ghost and the F-86s on the PPI would thus be completely coincidental, and a remote primary reflector would explain why it was not seen visually by the pilots. The aircraft would probably have been a fast jet for its ghost to achieve 1200 mph and would be required to maintain a very favourable aspect with an efficient ground reflector for a period evidently of some minutes, initially producing a ghost track on an essentially straight N heading at 1200 mph with a sufficient duration to permit confirmation of its speed and

heading over a number of sweeps followed by radio contact with the F-86 pilots, then turning abruptly as the culpable aircraft flew by the ground reflector. This trajectory simply must represent a ground track of some tens of miles, all the while presenting an "extremely good" ghost return. This is inherently somewhat improbable, and at no time is the presence of the responsible aircraft mentioned despite the fact that when its ghost track turned abruptly onto a heading for Boston it would itself have been displayed on-scope very close to it, and thus very close to the F-86s, its relationship to its ghost then, if at no other time, becoming at least noteworthy - if not actually understood by the operators.

In summary, although there is no visual corroboration of the target in this case and only one radar instrument was involved, the target as described is not easily explained. However, in the absence of scope photographs a ghost echo remains a possible, albeit a not very satisfactory, interpretation.

STATUS: Insufficient information

5. DATE: February 2, 1952 TIME: night CLASS: R/V shipboard radar/deck visual

LOCATION:
Sea of Japan
Near S. Korean coast

SOURCES: Hynek (1978) 126

RADAR DURATION: approx. 10 minutes

EVALUATIONS: Blue Book - unknown

PRECIS: The aircraft carrier USS Philippine Sea was making 13 knots on a 180-degree (S) heading off the E coast of Korea. A single target was detected on radar at 0 degrees (N) range 25 miles approaching the ship. At range 20 miles the target began a wide turn to the E, radius 11-12 miles. The radar operator queried the aircraft controller for an ID of the target. At this point three signal observers on deck independently reported visual sightings to the bridge of an object or objects resembling three "exhaust flames" at 30 degrees elevation and turning away from the ship at the same azimuth as the radar target, which at this time was shown at an altitude of 52,000', range 17 miles and increasing. The aircraft controller determined that the target was not a friendly aircraft, and the general alarm was sounded. The target continued to turn away onto a heading approximately NW until it returned to a 0-degree bearing from the carrier, range now 55 miles, where it split and opened as 2 contacts several miles apart. At this point the radar operator began to make "careful plots, checking constantly" for 3 minutes while the 2 targets headed N abreast on a slightly zigzag course, fading from the scope at range 110 miles. During this period the targets accelerated:

> "Measured speed 10 miles per minute (600 mph) for first minute, 15 miles per minute (900 mph) for second minute, 30 miles per minute (1800 mph) for third minute."

NOTES: According to Hynek's commentary on the intelligence report: "During the time it was in view, the coast of Korea and the island of Ullung Do were visible at a distance of

twenty miles, and an escorting destroyer was visible on the scope 2,000 yards from the carrier." Presumably this means that the coast and island were both seen on radar, rather than visually, although this is unclear. But it should be noted that Ullung Do is some 80 miles from the nearest point on the coast of South Korea at Ulchin, so that at no time could the ship have been 20 miles from both. However this inconsistency is probably an introduced error, and should not be taken to signify any extraordinary propagation conditions.

The radarscope map of the incident is consistent with all speeds, ranges and azimuths cited. It should also be emphasised that independent visual observers estimated the elevation of the "exhaust flames" as 30 degrees when turning past the ship, whilst radar at this point showed the target at 17 miles (slant) range, altitude 52,000', or almost exactly 30 degrees. It is worth noting that at this point it would be irrational to conclude that the target was anything other than aircraft, and if the incident had ended there no "UFO" report would have been submitted. Even the separation of the target would not of itself challenge this conclusion, since more than one aircraft flying within the resolution cell could be displayed as a single echo, and the three "exhaust flames" could be said to confirm this interpretation.

However, the rather careful plotting of speeds up to 1800 mph instantly changes the complexion of the incident, and once it has become a "UFO report" it invites us to attempt all manner of contorted interpretations. The question in a case such as this is whether the a priori improbability of a "UFO" (whatever that might mean) outweighs the prima facie probability that a target consistently tracked on radar and confirmed visually was physically present. This question is not answerable in practice. Suffice it to say that the radar incident has no easy explanation in terms of super-refractive AP of sea clutter or surface ships, partial inversion reflection, CAT, birds, insects, balloons or other wind borne objects, side lobe returns, multiple-trip returns from targets beyond the unambiguous range, spurious internal signals or RFI. A "ghost" echo from an efficient surface reflector (say, the angle made by the side of a ship with the sea - a destroyer was in the vicinity) received via an aircraft as primary reflector might achieve the speeds reported, but: a) no such aircraft, which must ex hypothesi have been within the radiation pattern, was separately detected, and no known aircraft were reported to be in the area; and b) a total radar duration on the order of 10 minutes and a track painted continuously to a range of 110 miles makes any ghost reflection involving a ship only ? mile away extremely improbable. (A ghost reflection with the ship as primary reflector could not achieve the >45 degrees change in azimuth reported, being displayed always on the ship's true azimuth.)

The target behavior appears to have been rational and consistent, without erratic jumps, disappearances or course-reversals, executing a smooth turn with a radius of some 12 miles in the manner of an aircraft, though at somewhat high altitude. Together with multiple independent visual sightings at a position consistent with the concurrent radar target, it is reasonable to conclude that the incident was most probably caused by a real radar-reflective object or objects emitting light resembling that from an aircraft exhaust. However no aircraft in 1952 was remotely capable of speeds up to 1800 mph, and this is the crux of the case: if the displayed speed can be explained then the object(s) can be explained as probable aircraft.

The intelligence report has this to say, pertinent to the possibility of operator error:

> A thorough debriefing was made of the radar operator. Personnel stated that the operator was very intelligent, efficient and cooperative. Operator was cognizant of capabilities and limitations of the radar equipment . . . . The three minutes of careful plotting were made after the object had turned and was heading away from the station. Operator was sure of the accuracy of the plots for the three minutes, and was adamant that the speeds shown were approximately correct.

The likelihood of gross malfunction in the radar display(s) would appear to be minimised by the very close match with the visual azimuth and elevation reported as the target turned past the ship. It is conceivable, however, that there was a range-scale error on the PPI. If, for example, a selected range-scale of 100 miles was actually giving a 30-mile scale due to electromechanical fault, and if the operator failed to notice the error, then there would be a factor-three error in plotted ranges, leading to a true maximum speed on the order of 600mph during the final 60 seconds of the track - roughly the maximum speed of, say, an F-94 in a powered descent. Angular position and motion would of course be preserved.

This hypothesis is highly speculative and, it must be said, not particularly plausible. It is first of all unlikely that an operator with the stated experience would neglect to notice so basic a fault during or after the ten minutes or so of the event whilst making "careful plots, checking constantly", evidently cognisant of the abnormal nature of the track, and the (presumably known) position of the escort destroyer - concurrently displayed at 2000 yards from the carrier - would have been an unmissable and constant reference datum on-scope long before and long after the appearance of the target, not to mention the coasts of Korea and Ullong Do island. (The aforementioned ambiguity in the stated range of these land echoes is unfortunately not relevant to this hypothesis, since: a) if there is an original error here it is in the wrong direction - that is, the displayed range would be exaggerated by 3 to 120 miles, not reduced to 20 miles; and b) it is anyway much more likely that this is a constructional error in Hynek's case summary, the figure of 20 miles referring either to the mainland or to Ullong Do, clearly not to both.)

In conclusion there appears to be no reasonable explanation of the object(s) observed.

STATUS: Unknown

6. DATE: August 5/6, 1952 TIME: 2330 local CLASS: R/V ground-air radar/ ground visual

LOCATION:
Haneda AFB
Nr. Tokyo
Japan

SOURCE: Thayer, Condon 1970 123
McDonald, Sagan/Page 1972 90
Shough UFO 47-87 217

RADAR DURATION: 40 mins. approx.

EVALUATION: Blue Book - unknown
Thayer - AP/Capella
McDonald - unknown

PRECIS: At about 2330 local time on the night of August 5, two control tower operators were walking across the ramp towards the tower to begin the midnight shift at Haneda AFB, adjacent to Tokyo International Airport on the W side of Tokyo Bay. The night was generally clear with bright moonlight (full moon near the meridian), some scattered thin clouds and excellent visibility. The airmen observed an unfamiliar brilliant light in the NE sky which, as they looked at it, disappeared for about 15 seconds and then "returned to approximately the same spot". Puzzled, they went straight to the tower where they indicated the light to the on-duty controllers, who had not noticed it because "the operating load had been keeping their attention elsewhere" according to Air Intelligence Information Report IR-35-52. The four controllers began to observe the light, which was variously described as "exceptionally bright", "intense", "blinding" and "brilliant blue-white". Naked eye comparison was made with a bright celestial body low in the E which the observers believed to be Venus (Venus had set 3½ hours earlier - it was in fact Jupiter, which rose almost due E about 2300 with an apparent magnitude of -2.0): the object was significantly brighter and had a naked-eye angular subtense estimated (on the basis of later comparison with a pilot balloon at known range) of about 3 arc minutes. Observed through 7 x 50 tower binoculars the light appeared as an extended disc of uniform brilliance, specifically "not due to a point source of light", inside a "round dark shape" along the curved bottom edge of which were four distinct lights, with "a glare around the whole thing". IR-35-52 states:

> The light was described as circular in shape, with brilliance appearing to be constant across the face. The light appeared to be a portion of a large round dark shape which was about four times the diameter of the light. When the object was close enough for details to be seen [the changes in apparent size, magnitude and position are discussed later], a smaller, less brilliant light could be seen at the lower left hand edge, with two or three more dim lights running in a curved line along the rest of the lower edge of the dark shape. Only the lower portion of the darker shape could be determined, due to the lighter sky which was believed to have blended with the upper side of the object. No rotation was noticed. No sound was heard.

After a few minutes the controllers called the 528th Aircraft Control & Warning Group's Ground Controlled Intercept (GCI) radar station at Shiroi, about 20 miles NE of Haneda near Shimofusa, above the N end of Tokyo Bay, requesting a search for a low altitude target somewhere to the NE of Haneda. (Visual estimates of the altitude of the object varied. The intelligence report states 1000'-1500' at one point, but includes an estimate of 5000' elsewhere. It is possible that this discrepancy is due either to the inevitable subjectivity of such judgements or to the fact that the source was reported to have ascended somewhat in elevation by the end of the sighting. The 5000' estimate may relate to a later phase of the observation.)

At about 2335 the Shiroi duty controller began a search of the indicated area towards the N end of the bay on the PPI of the CPS-1 10cm surveillance radar. There was nothing on the high beam; but when he tried the low beam he found "three or four blips" which were

"at a position 050 degrees bearing from Haneda, as reported by the tower", although the exact location and disposition of these targets is not stated. "No definite movement could be ascertained." The controller attempted to acquire these targets on the CPS-4 heightfinder, but was unable to do so, apparently due to excessive ground-clutter on the CPS-4 at so low an elevation. At 2345 the relief controller arrived for duty, and the two 1st Lieutenants discussed the desirability of scrambling an interceptor.

Meanwhile back at Haneda the tower operators were still watching the light when, a few minutes later, a call came in from Tachikawa AFB, 21 miles WNW of Haneda, independently reporting a light over the bay. According to Air Intelligence Information Report IR-35-52: "The control tower at Tachikawa Air Force Base called Haneda tower at approximately 2350 to bring their attention to a brilliant white light over Tokyo Bay. The tower replied that it had been in view for some time and that it was being checked." McDonald has pointed out that a bearing "over Tokyo Bay" from Tachikawa would be significantly S of E, whereas the bearing of the light as seen from Haneda was NE, and these two lines of sight would indeed intersect over the N part of Tokyo Bay.

By this time the Shiroi GCI controllers had decided to scramble an aircraft, and at 2355 called in their request to the ADCC flight controller at Johnson AFB, 35 miles W of Shiroi. Five minutes later, at about 0000-01, they had acquired a definite contact on the 50-mile high beam of the CPS-1. According to the statement of the relief controller:

> At the time of the scramble, I had what was believed to be the object in radar contact. The radar sighting indicated the object to be due south of this station over Tokyo Bay and approximately eight (8) miles northeast of Haneda. The target was in a right orbit moving at varying speeds. It was impossible to [accurately] estimate speed due to the short distance and times involved.

A number of visual observers at the radar site attempted to locate the object in the sky to the S of Shiroi but reported seeing nothing. At Johnson AFB, meanwhile, a two-seat F-94B of the 339th Fighter-Interceptor Squadron was experiencing delay due to fuel-system trouble. When it finally got airborne the time was 0003-04, and it reached the Tokyo Bay area several minutes later. By this time the CPS-1 target had been tracked through one approximately circular right orbit of radius 4 miles, about half over the sea and half over land. It was a distinct target over the sea, but was lost for part of the track due to the ground-clutter pattern near the coast. When the F-94 first approached the area the target was still lost and GCI could not supply effective assistance, so the aircraft headed down over the bay in a blind search.

At this time, about 0009-10, the Shiroi CPS-1 displayed a target to the starboard (W) of the F-94 and the controller alerted the pilot, who was easily able to visually identify it as a C-54 in a landing pattern near Haneda. With no unknown target showing on the CPS-1, the controller recalled the F-94 to the N area of the bay and instructed a visual search at an altitude of 5000'.

By about 0012 what appeared to be the same unidentified target had reemerged from the clutter and begun a second similar manoeuvre, described by the controller as "a starboard

orbit in the same area as before," but accelerating now to a higher speed. These manoeuvres are described in the intelligence summary as follows:

> An F-94 was scrambled to investigate. The object at this time had left the ground clutter and could be tracked (on the CPS-1) at varying speeds in a right orbit. Although impossible to accurately estimate speed, Lt. ----- gave a rough estimate of 100-150 knots, stopping, and hovering occasionally, and a maximum speed during the second orbit (just before the F-94 was vectored in) of possibly 250-300 knots.

During this second orbit at about 0012 the target broke into three, and the F-94 was directed towards the strongest target on a vector of 320 degrees. The intelligence summary continues:

> At 0012 the object reportedly broke into three smaller contacts, maintaining an interval of about ¼ mile, with one contact remaining somewhat brighter. The F-94 was vectored on this object, reporting weak contact at 0015 and loss of contact at 0018. Within a few seconds, both the F-94 and the object entered the ground clutter and were not seen again.

The times of AI contact here cited are evidently in error. This paragraph was prepared on the basis of the Shiroi controller's report which, according to the preparing officer Captain Charles Malven, contained erroneous times at this point due to "typographical error". Malven here attempts to reconstruct the times into those consistently reported by other participants, but the time of acquisition of the AI radar contact, and probably the reported 3 minute duration of contact, are still in error by a minute or so. The error is not substantive, however. The signed report of the F-94B pilot states:

> The object was reported [by Shiroi GCI] to be in the Tokyo Bay area in an orbit to the starboard at an estimated altitude of 5,000 feet. I observed [visually] nothing of an unusual nature in this area; however, at 0016 when vectored by Hi-Jinx [GCI] on a heading of 320 degrees, and directed to look for a bogie at 1100 o'clock, 4 miles, Lt. ----- made radar contact at 10 degrees port, 6000 yards. The point moved rapidly from port to starboard and disappeared from the scope. I had no visual contact with the target.

The radar operator's statement confirms and amplifies this account:

> At 0015 Hi-Jinx gave us a vector of 320 degrees. Hi-Jinx had a definite radar echo and gave us the vector to intercept the unidentified target. Hi-Jinx estimated the target to be at 11 o'clock to us at a range of 4 miles. At 0016 I picked up the radar contact at 10 degrees port, 10 degrees below at 6000 yards. The target was rapidly moving from port to starboard and a "lock on" could not be accomplished. A turn to the starboard was instigated to intercept target which disappeared on scope in approximately 90 seconds. No visual contact was made with the unidentified target. We continued our search over Tokyo Bay under Hi-Jinx control. At 0033 Hi-Jinx released us from scrambled mission.

Whilst this activity was going on, the luminous object was still under observation from the tower at Haneda (no information is available about further visual observations from Tachikawa AFB during this time). No exact times are given, but two episodes were observed of apparent dimming, apparent coincident diminution in angular diameter and apparent coincident lateral motion. IR-35-52 states:

> The object faded twice to the East, then returned. Observers were uncertain whether disappearance was due to a dimming of the lights, rotation of object, or to the object moving away at terrific speed, since at times of fading the object was difficult to follow closely, except as a small light. Observers did agree that when close, the object did appear to move horizontally, varying apparent position and speed slightly.

One of the controllers stated:

> I watched it disappear twice through the glasses. It seemed to travel to the East and gaining altitude at a very fast speed, much faster than any jet. Every time it disappeared it returned again, except for the last time when the jets were around. It seemed to know they were there.

The time of the object's final visual disappearance is not reported exactly, but appears to have been no more than a few minutes after the ground- and airborne-radar target(s) had been lost. Thayer's reading of the case file indicates about 5 minutes, but since he reports a total duration of "about an hour" this may be uncertain. McDonald gives 0020 as the time of visual loss after a duration of "about 50 minutes", which may be equally uncertain. 0020 would be quite close to the time of AI radar signal loss at about 0018. The fact that visual disappearance was coincident with the presence of the jets is indicated by the Haneda controller's statement above, but it cannot be established that radar and visual disappearances were simultaneous.

NOTES: A lighted pilot balloon released at 2400 from the weather station, 2000' from the Haneda tower, allowed the observers to scale both the brightness and naked-eye angular subtense of the source against the known 1.5 candle luminosity of the balloon lamp and the balloon's 24" diameter. The angular size of the object "when closest to the tower" was approximately the same as the balloon, about 3 minutes of arc, and "the balloon's light was described as extremely dim and yellow, when compared to the brilliant blue-white light of the object." Another real-time comparison was made between the appearance of the unidentified light when at its faintest and the planet Jupiter: "At the greatest distance, the size of the light appeared slightly larger than Venus [Jupiter], approximately due East of Haneda, and slightly brighter." The implication here is of a very bright source if its minimum visual magnitude exceeded Jupiter's -2.0, and McDonald points out that the balloon light would have an apparent visual magnitude of approximately -0.5 at 2000' (about twice as bright as Capella, at magnitude +0.21 the brightest star visible in the NE quadrant) yet appeared "extremely dim" in comparison with the object. There is a rough but persuasive consistency in these estimates which lends credence to the subjective impressions described by the observers, of an "intense", "brilliant" or "blinding" light, and the quasi-physiological evidence reported in the intelligence summary to the effect that

"observers stated that their eyes would fatigue rapidly when they attempted to concentrate their vision on the object." McDonald concludes that the object must have had a visual magnitude probably well in excess of -3.0 when at its brightest/closest, and there seems no good reason not to accept this as a reasonable approximation. (For comparison, the planet Venus at maximum brilliance attains magnitude -4.28.) In any event it is fair to conclude that it was at least bright enough to appear highly unusual.

The approximate azimuth of the object when first seen appears to be in no doubt. It was clearly stated by observers, and by the preparing intelligence officer, to have been NE or, in one estimate, NNE. The initial radar targets detected at Shiroi were "on a bearing 50 degrees from Haneda, as reported by the tower." NE appears to be a fair approximation. However there were no significantly bright celestial bodies in that part of the sky, and indeed none exceeding or even approaching the magnitude of Jupiter anywhere in the sky (Venus having long set). Thayer suggests that the relatively faint first-magnitude star Capella (magnitude 0.21, 37 degrees azimuth, 8 degrees elevation at midnight) was "the most likely light source".

Given the conjectural atmospheric mechanism by which he proposes that Capella produced the phenomena observed, one can reasonably quarrel with the assertion that this star is "the most likely" source, but there are certainly some arguments in favour of an astronomical explanation. Notably, one of the Haneda observers reported that the object appeared to be higher in the sky at the end of the event, and further that the gain in elevation appeared to be roughly proportional to that of the moon; also the pilot of a C-54 in a landing pattern at Haneda was requested to observe the object, and replied that it looked like "a brilliant star", which was what he assumed it was. Given that the C-54 pilot was observing the same object, and not Jupiter (how precisely he was directed to the right bearing and what his heading was at the time are not known), then its more ordinary appearance when seen from an aircraft at higher altitude would be circumstantial evidence for a propagation anomaly local to, or restricted to the line of sight of, observers on the ground at Haneda. The failure of observers at Shiroi to see anything in the S sky from their position is also consistent with a source at much greater - possibly astronomical - distance from Haneda, as is the failure of the intercepting aircrew to see anything (other than the inbound C-54) in the bay area. However, these persuasive indications are counterbalanced by other arguments, as we will see, and make no more than a circumstantial case without a plausible explanation for the observational details carefully recorded and sketched by experienced tower observers over a period approaching one hour.

Thayer's attempt to account for the reported visual display proposes either or both of two hypothetical mechanisms: 1) a sharp temperature inversion at the boundary between moist air over the bay and an overlying drier airflow, with collected patches of mist or fog at the boundary generating an annular diffraction pattern or corona around an image of Capella; and/or 2) effects due to (a) the focussing of wavefronts along the upper boundary of the refracting layer, producing a region of locally enhanced brightness (so-called "Raman brightening" after the wave-optical theory of mirage advanced by Sir C. V. Raman in 1959) and/or (b) interference of wavefronts, causing the appearance of dark and bright bands as also found (theoretically and experimentally) by Raman. Thayer calculates that a diffraction

corona with a dark aureole of about the size observed might be produced by a mist of 200-micron droplets.

Thayer admits that this explanation is conjectural. Weather data are lacking to substantiate the existence of an inversion, and the additional mechanisms proposed combine to represent "a phenomenon which must be quite rare." Indeed there must be considerable doubt that phenomena due to focussing and, especially, interference of wavefronts have ever been observed at all in the free atmosphere (see: Viezee, "Optical Mirage" in Condon 1970 637, 650, 653) and there is further doubt that, if they can be observed, they could create the luminous display reported from Haneda. Considering these effects first: the predicted Raman brightening arises when plane-parallel rays from a very distant source pass into a relatively thick inversion and are incident on the upper boundary near the critical angle (0.5 degrees) for total reflection. The result is a layer near the top of the inversion, narrow with respect to the diameter of the incident beam, within which there is continual crossing of incident and reflected rays. Because this layer is narrower than the beam, whilst the luminous flux per unit time (neglecting absorption) is preserved, the energy density within the interference layer is greater and hence the brightness of the beam is enhanced for an observer viewing the layer close to the critical angle for total reflection. The crucial phrase here is "the critical angle", since the light must be both incident and viewed at close to 0.5 degrees, which means that the observer must actually be in the inversion layer near its upper boundary, viewing a source at a real relative elevation very near zero. This is why observations of this effect in nature, if they occur, must be extremely rare, and the conditions are only likely to be met briefly by an observer viewing an astronomical source from an aircraft.

In the present case the "source" - Capella - was at a mean elevation of about 8 degrees (2400) during the 50-60 minutes of observation and the observers were (to all intents and purposes) on the ground. Raman brightening could conceivably occur in ground-based observations of a source on the horizon, i.e. rising. But Capella would traverse 15 degrees of Right Ascension during 1 hour, only a proportion of which would be gain in terrestrial elevation (due to the inclination of the celestial equator); that is, the minimum elevation of Capella at 2330, when the object was first seen, must already have been greater than 0.5 degrees. Therefore, Raman brightening would require a highly stable surface inversion initially canted upwards to the NE at somewhat more than 0.5 degrees, gradually increasing its inclination in synchrony with the rotation of the earth over the next 50-60 minutes to an eventual angle of somewhat less than 15 degrees, its upper boundary anchored at no more than a few tens of feet at Haneda and all the while maintaining alignment with the line of sight from the tower to Capella (with only a couple of brief decouplings to allow the transient fadings of the source) to within an accuracy of about 30 arc minutes. This is so unlikely a phenomenon as to be meteorologically preposterous. Furthermore, Raman brightening would not produce enlargement of the stellar image to a disc with perceptible angular extension; rather it would "focus" the available light from what is already effectively a point-source and compress the image.

Banding effects due to constructive and destructive interference of wavefronts within a refracting layer are not known to have been observed in nature, but would be ephemeral and rapidly changing phenomena unlike the stable display observed at Haneda. In

particular, a circular annulus could not be seen along a lateral refracting layer. Raman's experiment involved a collimated beam incident on a heated plate to simulate an inversion layer, the result being a dark zone of total reflection adjacent to the plate followed by a layer of enhanced brightness and then further alternating light and dark bands diminishing with distance from the plate. It is evident that an annular pattern of banding would require variations of refractive index to be symmetrical about the line of sight, a phenomenon that is difficult to conceive. Furthermore such interference effects are only observable at the critical angle within the layer and are therefore subject to the same objections raised above.

The mist/diffraction-corona hypothesis seems less implausible. However, McDonald has criticised Thayer's model on a quantitative basis. He points out that the proposed droplet size of 200 microns is never found in mist but only in raining or drizzling clouds. Maximum droplet diameters of 10-20 microns would occur in hypothetical mist patches under the prevailing conditions, he argues, which would lead to coronal diameters of between 30 and 60 milliradians (100- 200 arc minutes) - several times the size of the full moon and more than an order of magnitude larger than the annular display observed. (It can be added that if rain coud had been present in the line of sight - they were not - it is somewhat improbable that Capella's modest magnitude of 0.21 would be visible at all, let alone as the brilliant centre of a diffraction corona, even viewed with binoculars.) McDonald also points out that a corona with an inner dark annulus several times the diameter of the central luminary equates to nothing in the literature of meteorological optics, and further that the smaller lights visible along the lower periphery of the annulus remain unexplained by any optical model. (It might be noted here that there are three fainter 4th magnitude stars known as The Kids lying near Capella, which could just appear within the field of typical night glasses at the same time as Capella; but these are fully 5 degrees away, clustered to the lower right of Capella, and form no sort of arc. Moreover there is no star conforming to the somewhat brighter light seen lowerleft: Beta and Theta Aurigae are both more than 10 degrees away. There are no stars at all brighter than about magnitude +7.0 - on the order of a thousand times fainter than Capella - within several degrees in the sector below Capella, and thus nothing that corresponds to an arc of "distinct" lights with a radius on the order of 10 arc minutes.)

The vexed issue of the reported movements of the object is interesting, and McDonald calls this "the single most important ambiguity in the case file." He concedes that the object was probably reported to have moved in azimuth but (a little inconsistently) concludes that this movement can have had no relation to the movements of the radar target, and that there was never at any time radar-visual simultaneity. Yet the tower operators statements describe the light initially stationary in the NE, then travelling "to the east" with an apparent gain in range so that "it became difficult to follow closely, except as a small light", then repeating this movement to the E and back before disappearing "when the jets were around". One controller states: "I watched it disappear twice through the glasses. It seemed to travel to the East and gaining altitude at a very fast speed". When the object "returned" from each of these excursions and was "close", the observers each agreed that it appeared "to move horizontally, varying apparent position and speed slightly." Granted that these statements are not as clear as they might be, nevertheless phrases such as "travel to the East" from a position NE and "difficult to follow closely" at least arguably imply non radial motion; and the fact that this motion was observed twice is rather easily related (at least

qualitatively) to the two orbits made by the radar target. McDonald argues that no movements were observed large enough to equate to the 4-mile-diameter radar orbits over the bay, but motion from the NE "to the E" could imply anything up to 45 degrees and is not necessarily inconsistent with the 30-degree subtense of those orbits at Haneda. Further, it has to be remembered that the radar's PPI displays not ground range, but slant range, so that the ground track of a "roughly circular" inclined orbit, or a more complex figure with changing altitudes whose varying slant range approximated a roughly circular PPI track, could be an ellipse or other extended figure with a significantly smaller azimuth change as viewed from Haneda (bearing about 130 degrees W of Shiroi as measured from the rough centre of the radar track). This would reduce the apparent lateral motion, and it is noteworthy that when the object was seen to move from Haneda it did so by "travelling to the East and gaining altitude".

Departures in elevation and azimuth of more than a fraction of a degree would be quite inconsistent with any mirage image of Capella, and the independent line of sight to the similar object reported from Tachikawa would, as McDonald emphasises, be more than 45 degrees away from Capella. It was, however, only a few degrees away from Jupiter which was bright in the east, and the possibility has to be considered that this sighting was of Jupiter. In view of the scant information from Tachikawa no real analysis is possible, but one can only follow McDonald in feeling that probability does not favour this hypothesis, especially given that Jupiter had been rising in the east for many days. What indeed is the likelihood of two independent simultaneous misinterpretations of two different astronomical bodies, when combined with subsequent multiple radar contact with a target appearing to correlate with motions observed visually and detected in the very area triangulated by these two lines of sight?

The radar contacts are clearly central to the case. Thayer's diagnosis of anomalous propagation is inferred from four central symptoms: 1) a "tendency" for targets to disappear and reappear; 2) a "tendency" for targets to break up into smaller targets; 3) a lack of correlation between ground and airborne radar targets; and 4) the fact that nothing was seen visually from Shiroi or from the interceptor despite visibility which the aircrew rated as "exceptionally good". The first three of these points are all arguable, and again one must admit the weight of McDonald's objections.

Firstly he objects that there was no "tendency" for targets to appear intermittently or to break up - i.e., the echoes were in no way described as being unstable or fugitive. IR-35-52 states:

> Lt. ----, GCI Controller at the Shiroi GCI site, has had considerable experience under all conditions and thoroughly understands the capabilities of the CPS-1 radar. His statement was that the object was a bonafide moving target, though somewhat weaker than that normally obtained from a single jet fighter.

This target, though small, was reported as sharply defined. Its appearances and disappearances were evidently due to its passage through the CPS-1 ground clutter pattern, as charted on maps of the radar plot and indicated in several written passages. When away

from the clutter it was distinct and had no tendency to disappear or fluctuate in the manner of an unstable AP echo.

Similarly, it is unreasonable to describe the single episode of fission as a "tendency for the target to break up into smaller targets": this occurred once on the second orbit, and the three fission products were described as small and relatively weak, but still sharply defined, "maintaining an interval of about ¼ mile, with one contact remaining somewhat brighter. The F-94 was vectored on this [brighter] object." And the nub of the issue is in this vectoring and its consequences: Thayer regards the timing discrepancy in the Shiroi controller's report as a basis for doubting that "the GCI radar ever tracked the fast-moving target described by the F-94 crew", despite the specific statement in the intelligence summary that this was due to a "typographical error", and despite the clear contextual evidence. The controller stated (times omitted to avoid confusion):

> Sun Dial 20 [the F-94's codename] was vectored to the target. He reported contact at . . . and reported losing contact at . . . . Sun Dial 20 followed the target into our radar ground clutter area and we were unable to give Sun Dial 20 any further assistance in reestablishing contact.

The F-94 radar operator stated:

> . . . Hi-Jinx gave us a vector of 320 degrees. Hi-Jinx had a definite radar echo and gave us the vector to intercept the unidentified target.

That Shiroi tracked both the target and the pursuing F-94 into their groundclutter whilst the F-94 had radar contact for at least 90 seconds with the same target seems beyond reasonable doubt, if only because their was no other attempted vectoring/intercept episode with which either party could have become confused. This conclusion is surely proven by the very close match in target range and bearing as supplied by Shiroi and almost immediately found by the F94 radar operator: Shiroi sent the F-94 towards the target on 320 degrees, stating that the target would be at 11 o'clock (30 degrees to port), range 4 miles (7000 yards) from the aircraft; a matter of seconds later the APG-33 picked up a target at 10 degrees to port, range 6000 yards, "rapidly moving from port to starboard", and the aircraft followed the target in a starboard turn, unable to close to within the APG-33's lock-on range of 2500 yards but maintaining contact for 90 seconds at 375 knots (about 11 miles of travel), whilst ground radar simultaneously tracked both F-94 and target into its groundclutter. According to IR-35-52:

> Lt. ----, F-94 radar operator, has had about seven years' experience with airborne radar equipment. He states that the object was a bonafide target, and that to his knowledge, there was nothing within an area of 15-20 miles that could give the radar echo.

Further:

> The APG-33 radar is checked before and after every mission and appeared to be working normally.

The last of Thayer's four symptoms of AP is the invisibility of the object from Shiroi and the interceptor, despite the fact that the target range from these observers was at times as low as about 7 and 3.5 miles respectively. Personnel at Shiroi were specifically sent out to look for it, and the aircrew were obviously alert: "Sun Dial 20 was ordered to search the Tokyo Bay area, keeping a sharp lookout for any unusual occurrences." There is no wholly satisfactory interpretation of these facts. Leaving aside the radar indications for the moment, these negative visual searches do lend prima facie support to Thayer's hypothesis that the object being concurrently seen from Haneda was at much greater, possibly astronomical, distance. If the primary visual sighting were a misinterpretation, of course, then the probability of subsequent radar detection of a completely unrelated "UFO" which happened to occur by chance in the same area would become implausibly small, and a conventional cause such as anomalous propagation would have to be seriously considered despite the apparent counterindications.

The general "exceptionally good" weather conditions were certainly conducive to ducting: a calm, clear August night, temperature 78 degrees F, visibility excellent (Mt. Fuji, 12,390', "clearly discernable" from the air at 69 miles SW), and the likelihood of moist air over the bay overlain by advected drier air from land to the SW. Combined nocturnal radiative cooling of the land and evaporation from the sea might be expected to cause temperature and humidity inversions and thus the kind of surface ducting common to such conditions. It would certainly not have been surprising had unusual AP ground echoes been detected, although it is also true that the degree of ground-clutter on the CPS-1 is nowhere indicated to have been abnormal (the CPS-1 was not fitted with MTI so that there was always clutter on-scope). In the absence of detailed information it is possible that the "three or four blips" with "no definite movement" initially picked up on the low beam of the CPS-1 after Haneda called Shiroi were AP targets, perhaps ships in Tokyo bay or beyond detected in a surface duct.

Even during the later phase of the incident, when a clear moving target was detected, no confirmatory contact appears to have been made on the CPS-4 height-finder. (The F-94 was instructed by Shiroi to go to 5000', but it appears that this was only a tactical best-estimate based on the Haneda visual report.) This certainly could be considered as possible circumstantial evidence of a propagation or electronic anomaly, inasmuch as a concurrent HRI track on an electronically independent set with a different operating frequency would typically be considered a counterindication of AP, system noise or radio frequency interference.

This is an interesting point. In the present case the precise wavelengths of the CPS-1 and CPS-4 sets are unstated, but both instruments were in fact Sband, operating in a similar EM region around 10 cms; and to the extent that their respective bandwidths were relatively close they would be proportionately likely to respond to AP conditions with similar false echoes - unlike a situation where a CPS-4 is operated in tandem with, say, an L-band CPS-5 surveillance set. This raises the question of why, given what one might call classic conditions for ducting to occur and the presence (ex hypothesi) of unusually sharp, stable,

moving AP targets on the CPS-1, no targets of any kind were reported on the CPS-4 heightfinder. A possible answer is that the CPS-4 had already been discounted as ineffective (at the time of the earlier, AP-like contacts) due to excessive ground-clutter at low elevation angles, and the controller may have continued to encounter this problem or even given up altogether the attempt to acquire HRI contact with the target. This interpretation implies a differential susceptibility of surveillance and heightfinder sets to AP clutter at minimal elevations, and of course also requires the target being sought to be at a minimal elevation. If these conditions are fulfilled, then the absence of heightfinder plots could no longer in itself be considered diagnostic of AP.

Firstly, the approximate mean elevation at Shiroi of the CPS-1 target (assuming a real target) can be inferred: the F-94 at an altitude of about 5000' acquired radar contact with it at range 6000 yards and at a depression angle of 10 degrees, which places the true target altitude at this time at about 3500'; and therefore, during the times when the controller had a clear PPI target on which to azicate the heightfinder (that is, when the target's orbit took it out of the CPS-1 clutter and over the sea where it was intercepted) the mean elevation of this target at ranges of about 13-15 miles would be only about 2 or 3 degrees. The question then arises of the the likely differential performance of CPS-1 and CPS-4 scopes, possibly in the sort of AP conditions inferred, with targets at such low elevations.

Now a typical surveillance beam with an approximate cosecant-squared vertical profile has a horizontal beamwidth on the order of 1 degree, whereas a typical nodding-fan height-finder like the CPS-4 has a vertical beamwidth also of about 1 degree but a horizontal beamwidth on the order of 4 degrees or so; and it can be seen that when the two sets have matched peak powers and pulse repetition frequencies (for matching range performance) then the total energy radiated per unit time through any 1 degree of elevation by the CPS-4 cannot be less than four times that radiated by the CPS-1, and will in fact be much greater because the CPS-1 output has to fill a much larger solid angle many degrees in elevation. (Even if the powers of the two sets are not matched - only that of the CPS-1 is known: 1 megawatt - and if the power of the CPS-4 is a more modest 500 kW, then the ratio of energy density per degree of elevation must still be on the order of 10:1.) A height-finder beam of 4 x 1 degrees, therefore, will radiate more energy into the solid angle defined by the top edge of the beam and the earth than will the 1-degree surveillance beam if that solid angle is less than about 4 degrees of elevation; and given that the heightfinder's antenna elevation is close to a critical grazing incidence for anomalous propagation of less than about 4 degrees then the onset of ground returns due to AP will be sooner for the height-finder. Put another way, in trapping conditions the 4-degree height-finder beam will have a ground-incident "footprint" four times as large per unit range as the surveillance beam, so that the ratio of the clutter signal to a point-target signal at a given range on the height-finder can be several times larger.

What all this means in terms of relative performance is that, when "looking" for a target at elevations of only 2 or 3 degrees, the CPS-4 antenna can be radiating a great deal of its main-beam output (plus a good deal of sidelobe) into a surface duct at grazing angles liable to severe trapping, leading to clutter returns which would be likely to overwhelm any relatively weak signal from a point target above the duct; but the signal-to-noise ratio of the

CPS-1 could be several times better in the same conditions, preserving the super-clutter visibility of the same point target.

The absence of height-finder plots on this low-elevation target is therefore not necessarily inconsistent with the presence of a solid, radar-reflective body - at least, even though the fact remains consistent with anomalous propagation it is no longer a sufficient condition of that hypothesis. But what of the target tracked on the CPS-1? Can it be described as consistent with AP?

Any kind of anomalous propagation is difficult to entertain in the circumstances. The correlation between X-band 3-cm airborne radar and S-band 10-cm ground radar indications has to be considered good, and the target behavior on either scope during this phase of the events is really not diagnostic of AP. The 2 x windspeed behavior of partial reflection echoes would appear to be entirely inconsistent with displayed speeds on the CPS-1 ranging from zero ("hovering occasionally") to at least 250-300 knots and probably in excess of 375 knots (430 mph) on departure, and the repeated orbital tracks cannot realistically be explained by waves propagating across an inversion surface. Low level winds were light, SSE, overlain by a SW airflow: there is no indication of any anticyclonic circulation of the order of 150 knots (175 mph), and the target headings would at various times have been transverse, or even converse, to either of these (light) winds. The presentation on the CPS-1 was sharply defined, that of "a bonafide moving target", which made two wide movements over an azimuth arc of about 40 degrees and back with a near-doubling of range, during which movements the only reported signal loss occurred due to its passage through the permanent ground clutter. This is not characteristic of an illusory track due to a series of sporadic AP returns from ground (or sea) targets. And when, on the second orbit, concurrent air-ground detection is achieved by independent fixed and mobile radars at very different wavelengths, pulse repetition frequencies and incidences, with correlating position and motion on both scopes, then AP seems out of the question.

The hypothesis of a "ghost" reflection from the F-94 generating the target tracked on the CPS-1 appears to be ruled out. Such a ghost would always appear on the azimuth of the primary reflector (the aircraft) and at greater range proportional to the added trip time to the secondary reflector, yet it seems quite clear that the F-94 approached the target on a heading of 320 degrees (NW) and "followed" it in a starboard turn to the N, over the coast and "into our radar ground clutter". At no time during this track can F-94 and target have been on the same azimuth from Shiroi (some dozen-or-more miles NNE) and at no time can the target have been displayed at greater range - indeed the F-94 would have been at greater range almost the whole time. Furthermore the first orbit of the target was tracked before the F-94 was even airborne out of Johnson, and the notion of a "ghost" echo separating into "three smaller contacts, maintaining an interval of about ¼ mile" is incredible. Finally this hypothesis offers no explanation of the concurrent target painted by the airborne APG-33.

No effect due to sidelobes, multiple-trip echoes, system noise, component failure, radio frequency interference, birds, insects, clear air turbulence, meteorwake ionisation, windborne debris or balloons seems even remotely adequate to the core multiple-radar episode in this case.

Total tracking times were brief, but far from ephemeral: upwards of 90 seconds AI contact is a significant duration, with the very rapid scan and virtually continuous rate of renewal allowing ample time for the operator to estimate the target parameters and assure himself of a "bonafide" point contact. On the CPS-1 the first track was plotted in the clear (away from the ground clutter) for approximately ½ the orbital circumference, about 5 minutes at the mean estimated speed (neglecting stationary episodes) of 125 knots (143 mph), or > 20 paints at 4 rpm - longer if the unquantified hovering episodes are taken into account. The exact timing of the sequence of events is unclear, but roughly consistent assuming a ½-circuit time of about 7 minutes (28 paints per plotted track): Shiroi had the target in clear contact on its first orbit "at the time of the scramble" - about 2355 - so if it had been picked up emerging from the clutter at, say, 2354 it would have been lost in the clutter again by about 000001; the landward half of the 4-mile-radius orbit would be completed in about the same time, leading to emergence from the clutter over the coast at about 000708 (this is consistent with IR-35-52's statement that the Shiroi controller's time for this event, "0017", showed a roughly "ten minute difference" from other personnel statements due to "typographical error"); by about 0012 the target would have been a little more than half way around the seaward sector of its orbit when it split into three, and by 0015 when Shiroi vectored the F-94 onto the larger target it would have been heading towards the coast again, accelerating now and soon lost on GCI radar whilst the F-94 continued in pursuit with the target on-scope until about 0017:30.

No great precision can be claimed for this timetable, of course, due to the large number of missing data-points and the inherent ambiguity of timings which are at best approximate and quantised to the minute; but at the same time, no serious inconsistency emerges. It is notable that ground and airborne radar operators were in no doubt that they had contact with the same "definite" and "bonafide" moving target.

The Haneda/Tachikawa visuals are certainly the most problemmatic part of the report, and how, or even whether, they are related to the radar events is difficult to establish with confidence. In the absence of exact times for the visual movements one can only say that there is a suggestion of angular motions which correlate in a qualitative way with the radar orbits. However, the general bearing of the light from Haneda does correlate with the general location of the radar target(s) over the N of Tokyo Bay; the independent line of sight from Tachikawa does intersect in this same area; and the loss of visual contact from Haneda does correlate at least approximately with the inferred departure of the radar target. These points of correspondence must be weighed against the inability of a C-54 pilot in the air to confirm the strangeness of what appeared to him to be a "brilliant star", the statement that the light appeared to ascend at approximately the rate of siderial revolution, and the failure of observers at Shiroi and the aircrew to visually confirm the Haneda sighting, all of which points are suggestive of an astronomical source. However the brightness, angular size and detailed structure of the object - all of which can fairly be regarded as reliably scaled and described, in terms of the usual standards of witness observation - as well as the less-reliably reported angular motion, are inconsistent with the known propagation properties of the atmosphere as they could affect the image of the brightest body in the NE sky at the time.

The question of *un*known propagation mechanisms therefore arises. In this connection one is struck by certain parallels between the structure of the object and that of the Jovian system: it appeared through binoculars as a disc with three or four small, faint lights disposed in an arc below it. The planetary disc of Jupiter and the four bright Gallileian satellites are quite easily observable through 7x50 binoculars - indeed, some acute observers can see these satellites with the naked eye under favourable conditions near maximum extension, although generally their magnitudes of between +6.3 and +5.1 are obscured by the glare of the planetary disc. Plainly the observers were not looking at Jupiter's true E azimuth, and even directly contrasted the object's apparent brightness with that of Jupiter, so that some kind of mirage image has to be assumed, displaced laterally by some 40-45 degrees for much of the observation, an angle periodically reduced as the image dimmed and shrank back towards the E true bearing of Jupiter. This image would contain some distortion to account for the fact that the four equatorial satellites, which transit Jupiter close to the ecliptic plane, were optically shifted into a pendant arc. Brightening of the disc is also implied, as is some dilation of its image by about 4 diameters from Jupiter's 40 arc seconds to a scaled angle of about 3 arc minutes without observable chromatic aberration. One imagines that such an effect might require a stable, near-stationary "bubble" of severely abnormal refractive-index-gradient performing as a near-perfect achromatic lens. A line of sight from Tachikawa to Jupiter might graze this local discontinuity at a shallower angle, leading to an abnormal appearance for observers there also, and this requirement would place the mirage-producing zone in the region of N Tokyo Bay where extremely unusual radar propagation phenomena were observed.

It is probably safe to say that no such phenomenon has ever been described or modelled in the field of meteorological optics. There are extremely rare reports, however, which appear to indicate dramatic propagation anomalies of a nearly analogous kind. For example, Minnaert (1968) describes a remarkable double-sun which was photographed from a ship in the Indian ocean and witnessed by numerous passengers: an exact duplicate of the solar image, perfect as to colour, shape, size and elevation, appeared offset in azimuth to one side of the true sun. There appears to be no conceivable explanation of this effect in terms of known mirage phenomena, and it indicates that some extraordinary properties of the atmosphere remain to be understood. It is, of course, not excluded that some such atmospheric phenomena might conveniently be termed "UFOs", or may be hypothesised to occur in association with other phenomena which some might choose to call "UFOs".

If one wishes to demur from these spectacular conjectures, then Capella remains the only plausible astronomical source in the NE sky. Novel propagation mechanisms aside, it may be relevant that the details of fine structure were observed through binoculars, which suggests an alternative to diffraction due to atmospheric mist: condensed moisture on the objective glasses or eyepieces (exterior temperature was 5 degrees F above the dew point, but humid conditions in the tower or taking the binoculars out of cooler storage before use might cause the lenses to mist) or trapped moisture or other defects between lens elements which might cause diffraction, internal flares and/or improper focussing. The central image might conceivably be smeared, within an array of fainter secondary images. The likelihood of this hypothesis seems negligible, however, given that the observations lasted upwards of 50 minutes; that tower binoculars would be in not-infrequent use and chronic defects would be noted; that other stars in the NE sky are sure to have shown up the effects of any

misting; that motion of the binoculars would almost certainly reveal the cause of the diffraction/blurring; and that four experienced tower controllers would not be so plain stupid.

The issue of the non-visibility of any light source from Shiroi or the interceptor remains difficult. One point worthy of note, however, is that according to Ruppelt (1956, p.247) who headed Blue Book at the time and discussed the case with Far East Air Force intelligence personnel, one of the tower operators "had the distinct feeling that the light was highly directional, like a spotlight." It is true that the F-94 would probably never have been within less than 45 degrees of the line-of-sight from Haneda during the interception; it is also true that, if the light was the object being tracked on radar, then at the time of the F-94's arrival in the area from the NW - when it would almost certainly have crossed this line of sight, at least in azimuth, on its way down over the bay - the target was over the land at the farthest point of its orbit and the light (ex hypothesi) was only visible from Haneda as "a small light" which was "difficult to follow closely". Thus it is conceivable that the aircrew may never have been in a position to see a directional light source. This argument is not very strong, however, and the degree of directionality implied (a very high degree of collimation with virtually zero effective scattering from the beam) would seem to conflict with the apparent simultaneous visibility of the source from Tachikawa, bearing some 50 degrees away from Haneda. No easy explanation exists for the display observed at Haneda, and one must admit the probability that radar and visual "UFOs" are in some sense related; but no satisfactory integration of all the visual details with the radar events can be achieved at this time.

In conclusion: The possibility exists that the early detection of three or four stationary targets on the low beam of the CPS-1 was due to anomalous propagation, for which there is indirect circumstantial evidence in the form of the general weather conditions and the inferred presence of considerable lowanlge clutter on the CPS-4. It is also true, however, that the visual object was in view from Haneda at this time on the correct bearing, possibly at lower elevation than that subsequently attained, and the targets may have been related. There is insufficient information to argue this point.

During the later radar tracks, however, the indications appear to be in every respect consistent with the presence of at least one high-performance aerial object with a radar cross-section smaller than that of a normal jet fighter, capable of jet-speed evasion of a pursuing F-94 (then probably the most advanced in the air) and erratic variations of speed. Its CPS-1 track showed it "stopping, and hovering occasionally" during a roughly 25-mile circumference orbit at 100-150 knots, implying, if not actual stationarity (the 15-second renewal rate of the PPI is too slow, and the resolution too coarse, to allow full confidence in this judgement, the controller's "considerable experience" notwithstanding, and concurrent height data are lacking) then at least a repeated deceleration to a speed (in light winds) almost certainly well below the 94-knot stalling airspeed of an F-94.

Despite the periodic obscuration of the target(s) due to ground clutter, it is unreasonable to attempt to dissociate the target tracked on the first orbit from that tracked on the second orbit, one component of which was in multiple radar contact during intercept and achieved a speed probably in excess of the F-94's 430 mph; the two behaviors appear to be the

rationally related movements of a single object (or sub-resolution cluster of objects) which had an inordinate range of speed and gave evidence of intelligent, evasive action when illuminated by the radar of the F-94.

The splitting into three contacts immediately prior to F-94's intercept attempt, followed by rapid departure, strikingly suggests something analogous to a tactical manoeuvre responsive to potentially hostile engagement. The fact that one contact remained brighter, with two smaller targets separating out to ranges of some 400 yards, resembles the deployment of radar decoys and might be interpreted as a test of remote drones or active jamming to confuse hostile pursuit. But it is not believed that any such free-flying drones were being deployed by any known small jets in 1952. Infra-red decoy flares were probably under development to counter the incoming generation of IR-guided Sidewinder missiles, but flares would not answer the radar description and would also have been highly visible to the aircrew. Launched missiles would not "maintain ¼ mile separation" from the parent aircraft. The active jamming technology to achieve such false targets was almost certainly unknown in the world of 1952 analogue electronics, and the range of performance indicated is unmatched by any vehicle known to have been flying in 1952.

STATUS: Unknown

7. DATE: December 10, 1952 TIME: 1915 local CLASS: R/V air radar, air visual

LOCATION: Odessa, Washington SOURCE: Thayer, Condon 1970, 140

RADAR DURATION; unspecified

EVALUATION: Thayer - probable balloon

PRECIS: The crew of a 2-seat F-94 flying between 26-27,000' near Odessa at 1915 sighted a very large, round white object which they estimated to be "larger than any known type of aircraft". It appeared to emit faint reddish light from two "windows". Its apparent movements were erratic. It performed a chandelle in front of the aircraft, seemingly able to "reverse direction almost instantly", the closed with the aircraft head-on at high speed before suddenly seeming to stop and break away. Fearing imminent collision the pilot banked the F-94 into a turn. They lost sight of the object at this time and never reacquired it visually, although the weather was clear over an undercast at 3000'. However 15 minutes later at 1930 a target was acquired on the airborne radar: It was moving generally west to east at about 75 knots. The crew believed this target was related to the earlier object, but no simultaneous visual sighting was made.

NOTES: It appears that earlier Blue Book studies concluded that the visual object was a mirage of Venus. However, Thayer's 1968 analysis contains the Spokane radiosonde profile (release time 1900 LST) which does not indicate the presence of temperature inversions near the aircraft altitude. A slight inversion is present at about 30,500' but this is much too far above the aircraft altitude to satisfy the small grazing angle requirement. Furthermore

the small (order of 1/2 degree maximum) image wander due to mirage would seem inconsistent with the extent of motion reported, and the complete disappearance of the source - Venus being a brilliant object that would remain prominent in the clear sky even if the aircraft moved away from the critical mirage angle - is not convincingly explained.

Thayer observes that the Spokane radiosonde release time of 1900 is close to the time of the sighting, and that the appearance and motions of the object are quite characteristic of an encounter with a lighted balloon (saving some peculiar details such as "reversals" in front of the aircraft and the object's disappearance). Further, he observes that a balloon would have risen to at least 17,000' in 15 minutes and that the winds at the highest level plotted for the Spokane profile (18,000') are 260 degrees at 66 knots - not inconsistent with the reported easterly motion of the radar target at 75 knots.

On the face of it this explanation is quite convincing. A number of similar balloon "dogfights" are on record in which the rate of closure with an unexpectedly slow and unexpectedly nearby lighted balloon creates the illusion of a series of rapid, head-on passes. Typically balloon interceptions involve a series of approaches (afterwards shown to have been a slow spiralling climb over the same general area) with a small round light, sometimes blinking and sometimes steady, which eventually seems to move away. The "UFO" is the pendant tracking light below the balloon. There are certain differences in this case:

The object was described as an extremely large round object, larger than any aircraft, not a small ball of light. This might suggests that the balloon itself (probably on the order of 20' across at this altitude) was being seen by reflected illumination from its tracking light, but no such light was reported. The only other apparent source of illumination was the two reddish "windows" presumably on its surface. These are not a recognisable weather balloon feature. They could themselves conceivably have been reflections caused by the 1.5 candle battery lamp carried by such balloons (although this would normally be "white" light), but again no such pendant light was reported. If the balloon fabric was brightly lit then the source of this illumination ought to have been visible too. If the balloon's lamp had failed then it could have been illuminated by bright moonlight (the sky was clear; position and phase of moon unknown) which could explain a large, round "white" body; but the reddish light from the "windows" has no clear interpretation on this hypothesis either.

The disappearance of the object after a single "pass" is also not characteristic of a balloon which - from whatever source - was rather well lit. This would be best explained by supposing that the object seen was not the balloon itself but the small tracking light attached to an unseen balloon, which failed just as the F-94 flew past. It should be noted, however, that this coincidence could not be explained by impact with the F-94 since the Spokane profile shows that this balloon continued its ascent well past the aircraft altitude apparently without incident. In addition the object was seen to perform manoeuvres, including apparently "reversing direction almost instantly", whilst still at range ahead of the aircraft. True, there is some similarity between these types of motions and illusory motions due to balloons encountered at close quarters; but it was only *after* this behaviour that the object appeared to race head-on towards the F-94, and even then it reportedly "stopped

suddenly" before once again pulling away. Such apparent motions would tend rather to favour the inversion-mirage hypothesis, were it not that the weather data are inconsistent.

The balloon hypothesis is therefore not quite as attractive as it at first appears. Nevertheless unusual misperceptions do occur and Thayer's quantitative argument remains to be addressed. If there is good reason to suspect that a balloon was in the area and moving in the approximate direction reported then it would be only reasonable to suspect the balloon, given at least some similarity with known close-encounters with balloons.

There appears to be some confusion here, however, between the times, speeds and altitudes relating to the visual and radar events. The maximum rate of climb of a radiosonde - about 1200 fpm - would indeed put the Spokane balloon at about 18,000' by the time of the visual sighting at 1915; but the altitude of the visually observed "balloon" at this time is fixed very accurately by the aircraft altitude as being 26 - 27,000'. On the other hand the radar target, whose motion appears to correspond with the reported winds at >18,000', was detected at 1930, by which time the balloon would have been at an altitude of about 36,000', having spent some fifteen further minutes climbing through air streams of unknown strength and direction - which negates the apparent match. (A balloon which developed a slow leak at 18,000' might continue to drift at that altitude for some time before coming down. But the Spokane profile shows that this balloon did not leak. The part profile published gives values to at least 38,000' and it was not listed as "lost".) Therefore even if the radar target could be explained as the Spokane balloon - with a little strain, its likely altitude being some three and a half miles above the F-94 - the same balloon cannot have been responsible for the visual at about 27,000' fifteen minutes before since it would have been about two miles too low.

The relative locations of Spokane and Odessa also render the balloon hypothesis dubious. Odessa is 65 miles SW of Spokane: Even at the 66-knot wind speed plotted on the Spokane profile for 18,000' the balloon could not possibly have travelled more than 15 miles from Spokane in any direction by the time of the visual near Odessa, and since this wind was from the west it would be taking the balloon not SW towards Odessa but eastwards into Idaho. In reality, of course, even if the surface and low-level winds (not given) were blowing almost opposite to the recorded 18,000' winds and thus did initially take the 1900 balloon towards Odessa, the mean speeds are likely to have been much slower at low altitudes so that there is an even larger mismatch between the probable range achieved by the balloon (much less than 15 miles) and the 65 mile range to Odessa.

In conclusion there is some doubt about whether the radar target could have been the Spokane weather balloon. There is no good reason at all to think that the earlier visual sighting was due to the Spokane balloon. Apart from appearance and behavior not convincingly like a balloon, the object was at the wrong altitude, the wrong range from Spokane and (probably) the wrong bearing from Spokane to have been the 1900 LST Spokane radiosonde balloon.

A leaking balloon from elsewhere might have been encountered at >26,000' near Odessa and might subsequently have descended towards the 18,000-foot, 66-knot airflow; but it seems a little improbable that this same balloon would be encountered a second time after

15 minutes of flight at jet speed. It is not impossible, however, if the F-94's flight path happened to take it back over the same area. This scenario cannot be evaluated without knowing at least the aircraft's home base and mission/destination, and could not be proven without plotting a specific "lost" balloon against detailed wind flow charts, which is at least impractical and probably impossible. It should also be mentioned that match between winds aloft and radar target motion is suppositious: There is no information on the actual altitude of the target.

Possibly most damaging to the theory that any single balloon could have been responsible for both visual and radar objects is the question of why a balloon which was a noteworthy radar target during the second encounter was not detected at all prior to or during the presumably much closer first encounter.

A still less plausible hypothesis is that two separate radiosonde balloons were involved, neither of which was the one released from Spokane, one having lost its radar reflector and/or instrument package so that it was not detectable. The nearest scheduled release site to Spokane would have been near Tacoma, Washington, about 230 miles W. Others within 300 miles or so include: Great Falls, Montana; Boise, Idaho; Portland and Salem, Oregon; and Cape Flattery, Washington. Given the generally W-E upper airflow indicated at Spokane then Tacoma, cape Flattery and Portland might be suspected as possible launch sites (radiosondes are released 4 times a day, usually at 6-hour intervals, but local times vary). However these balloons do not usually travel large ground distances at low levels. About 90% reach 80,000' and shatter; some 50% reach 100,000' before pressure discovers weakness; a small number continue to 140,000' or even higher. Typical flight times of 60-80 minutes imply average windspeeds of around 200 mph (and maxima far greater) for a Tacoma release to cover the ground distance to the Spokane area before burst, and this balloon would then be at an altitude about 4 times greater than is needed to account for either sighting. Both sightings appear to require balloons with slow leaks, which could have been released at almost any of these sites at almost any time during the previous 12 hours or so given the know pattern of mesoscale wind circulation. But given that 90% of radiosondes complete their ascent to 80,000' it is obvious that the probability of any given flight remaining near 20,000' for an extended period due to slowly dropping buoyancy must be on the order of 0.1 or much less. Probability cannot properly speaking be applied retrospectively, or even calculated in such circumstances, but the coarsest of intuitive guesswork would suggest that the likelihood of two separate balloons suffering similarly and ending up near Spokane/Odessa at the same time must be on the order of <<0.01.

Very large polyethylene balloons with a volume of several million cubic feet had been flown covertly for several years by 1952. Such a balloon could certainly be described as 'larger than any known type of aircraft' and would have been unfamiliar to most pilots. (scientific balloons of this type were later required by the FAA to carry lights below 60,000' but it is doubtful if the same was true of the mainly classified earlier flights.) However it remains a problem to account for the movements described by the two airmen, and an abrupt visual disappearance becomes still less understandable in terms of so large a balloon in a clear sky. If the same balloon was encountered 15 minutes later by radar then why was it not seen visually at this time even though the crew would have been searching for it in the stated belief that the radar target was the same 'UFO'? Perhaps it was much further away at this

time near the limits of radar range. But if it had been nearer earlier, why was it not detectable by radar then?

In summary, the Spokane raadiosonde does not appear to be a plausible hypothesis for either sighting. It could not have been at the altitude or location of the 1915 visual sighting, and on the basis of known times, known ascent rates and the documented 1900 Spokane profile it cannot have been near the required 18,000' level at the time of the 1930 radar contact. The generality of the account can only somewhat plausibly be accounted for by one or two *unidentified* balloons. The argument that there is good reason to suppose the presence of a balloon in the vicinity of the first sighting is actually invalid. The evidence of a balloon in the second instance is entirely circumstantial, based only on a rough and arbitrary match between target motion at an unknown altitude and winds at the 18,000' level. One could as well argue that there is a good match with a group of swans flying downwind at 10,000' - true, but with so many indeterminate variables such a 'correlation' is not meaningful. The corollary, of course, is that the radar target could have been almost anything and there is no positive evidence to connect it with the visual sighting. Indeed, given that the visual object apparently was *not* a radar target one could say there is positive evidence that the two sightings were unconnected. It is possible, however, that the airborne radar was not activated at the time of the first sighting. As regards the visual object, there are certain features that suggest a balloon but other features which are inconsistent with a balloon, implying gross misjudgments of size, appearance and motion. In terms of detection, one would have to conclude that the *modus operandi* is not entirely typical of balloon cases on file.

In conclusion the core sighting cannot be identified as a balloon. The celestial body/elevated inversion/mirage model is difficult to support on the basis of meteorological evidence and the disappearance of the source in a clear sky. But some of the apparent movements are undeniably suggestive of a looming and receding mirage image. It is possible that a bright celestial body on the point of setting could be viewed at the critical grazing angle through a surface inversion on the far horizon that wasn't sampled by the local profile. The Spokane profile in fact indicates a slight surface duct below about 500', and although there is no evidence whatever that this indicates conditions near the far horizon of an aircraft at 26,000' it is possible that the setting of a bright planet (the plane of the ecliptic would dip below the horizon in the WSW) could present a brief mirage image that appeared to dance up and down, expand and contract, before disappearing. Even the reddish 'windows' could with some strain be explained as refractive separation, red light tending to be separated towards the bottom of the image. But in addition to being speculative this hypothesis suffers from the objection that the aircraft was flying above an undercast at 3000'. The case therefore merits further study.

STATUS: Insufficient Information

8. DATE: December 15, 1952 TIME: 1915 local CLASS: R/V air radar/air visual

LOCATION: SOURCE: Thayer, in Condon 1970, 126
Goose AFB

Labrador, NF

RADAR DURATION: unspecified, but brief

EVALUATION: Blue Book - Venus/radar malfunction
Thayer - mirage of Venus/radar malfunction

PRECIS: An F-94B and a T-33 jet trainer were flying at 14,000' when both crews saw a bright red and white object at 270 degrees azimuth. The F-94 attempted to intercept the object but was unable to close the range. At one point during the chase the radar operator acquired a target at the correct approximate azimuth and the AI radar "locked on" briefly, but contact was soon lost. At 1940, after 25 minutes of pursuit at an indicated airspeed of 375 knots, the object faded and disappeared, at which time the F-94 was about 20 miles from its position at the initial sighting.

NOTES: The Air Force conclusion that the radar malfunctioned was not based on evidence of a fault (the AI radar would usually be checked before and after every mission) but simply on the fact that the contact was brief. Venus was setting in the E at about the time of the event and seemed a probable explanation, in which case there would be every reason to dismiss the radar contact as a malfunction. Thayer agrees that the aircrew were probably chasing Venus, but adds that the image could have been a mirage of Venus which would be more likely to mislead experienced pilots and would explain the description of the light as a source with "no definite size or shape". An astronomical explanation is supported by the witnesses' statement that the relative elevation of the object appeared to remain constant despite the varying altitude of the aircraft, by the inability of the F-94 to close on the object, and by the fact that no ground radar contact was reported with the object. The weather was clear with unlimited visibility.

There is a serious flaw in this otherwise plausible hypothesis, however: after 25 minutes of pursuit at an IAS of 375 knots (about 430 mph) the F-94 had covered only about 20 miles on the ground. If it were chasing a stationary celestial body it should have covered some 180 miles during this time. The actual distance would imply a ground speed of about 48 mph (about half the stalling airspeed of an F-94), and headwinds of 380 mph at 14,000' are presumably impossible. This curious anomaly in the report is not explained by Blue Book or by Thayer. It suggests that the pursuit was not confined to a single azimuth and that the F-94 had thus been brought back to a point near its original position when the object disappeared, in which case it could not have been Venus or any other celestial body. A lighted balloon might lead a pilot on an erratic chase, back and forth over a restricted area, but the F-94 would rapidly overtake a balloon and none of the characteristic "dog-fight" behavior of balloon interceptions occurred in this case.

Unless this contradiction can be resolved the object cannot be identified as Venus or any other object with any confidence, and if it was not Venus then a reassessment of the AI radar "lock on" becomes in order. The reported absence of ground radar contact is suggestive, but not wholly probative without information on the range of the aircraft from Goose and the completeness of any report or investigation at that site. The case would appear to merit further study.

STATUS: Insufficient information

9. DATE: February 4, 1954 TIME: 2300 local CLASS: R/V ground radar/ radar/ground visual

LOCATION
Carswell AFB, Texas

SOURCE: Good ATS 1987 274

RADAR DURATION: unspecified

EVALUATION: unspecified

PRECIS: This report was submitted in a PRIORITY message classified CONFIDENTIAL from the Commanding Officer 19th Air Division, Carswell AFB, to Commander 8th Air Force, Carswell; the Director of Intelligence, Washington, D.C.; Air Defense Command, Ent AFB, Colorado; and ATIC, Wright Patterson AFB, Ohio; with distribution to the Joint Chiefs of Staff, CIA and NSA.

At 2300 Carswell GCA radar picked up an inbound target at 13-15 miles. At < 10 miles the target appeared as a one-inch return on the scope. Because the target appeared to be unknown traffic heading towards the base GCA notified the control tower and the Officer of the Day. Personnel in the control tower looked out and saw the object approaching. It passed directly over the tower at an estimated altitude of 3-4000' but no sound could be heard. All personnel in the tower saw the object, and the chief tower operator observed it continuously through binoculars. It resembled an aircraft with a long fuselage, elliptical wings and a stabilizer, but with no visible or audible propulsion unit. There were very bright lights in the nose and tail, and two yellowish ventral lights on the fuselage. One observer believed he could make out a light on each wing tip. None of the observers could identify it as a conventional aircraft. An investigation was later unable to identify any responsible flight and there was "no unusual activity, meteorological, astronomical, or otherwise" which could account for the sighting. The intelligence report concluded that all witnesses were "completely reliable", and that the details of the sighting were "probably true".

NOTES: A possible explanation is that a conventional aircraft flew over the tower, and that the observers, for whatever reason, were mistaken about its appearance and failed to hear it due to strong winds aloft and/or the masking effect of local noise. The case does not appear in the final Blue Book listing of unknowns, and one suspects that the official reflex here would have been to file it under "probable aircraft" notwithstanding the lack of positive ID. This hypothesis is not wholly convincing, however: the visual sighting, by multiple trained aircraft observers in a tower designed to afford an excellent view of local airspace, with both the naked eye and binoculars, does not argue strongly that the object was a conventional aircraft. It is noteworthy that although the observers' expectation was presumably of a conventional aircraft none of them, despite their professional familiarity with aircraft and the object's generally aircraft-like appearance, was able to identify it as such.

Given that some type of aircraft did apparently over fly the field it is reasonable to suspect that the inbound radar target was related to the aircraft. The radar description is frustratingly sketchy, however. The intelligence report states:

> Object was first detected by the Carswell GCA Sta at a distance of 13 to 15 mi fr Carswell attn was drawn to the object because of the large rtrn presented on the scope. Object when viewed on 10 mi scope gave a rtrn of 1 inch. Obr scanned from 10 degs to 02 degs on search and object retained the same rtrn dur this opn. Because of the unusual rtrn, and because object was approaching directly over the fld the GCA opr notified the Airdrome Off of the Day and the tower.

This is confusing. It is not immediately clear whether "the 10 mi scope" is another radar electronically independent of the scope (presumably surveillance) on which the target was first observed at 13-15 miles, or simply another display fed from the same antenna but adjusted to a different range scale. If the latter then there may be an anomaly in the statement that the target appeared as a one-inch return at a displayed range of <10 miles.

A typical GCA surveillance scope with a range of about 50-60 miles (such as the S-band CPN-4 commonly used with electrically-scanned blind-landing radars in the MPN-11 GCA system of mid-'fifties vintage) would not be a very large display, probably no more than about 15" inches across. Adjusted to a 10-mile range scale, an approximately 1" target-arc with a radius of 7½" (10 miles) subtends an angle of about 8 degrees, and if displayed anywhere on the scope other than at the extreme periphery would subtend a still larger angle. This is clearly not a normal aircraft return which would typically be only a couple of degrees or a few millimetres wide: for a typical surveillance beam width of about 2 degrees between the half-power points a 1" target arc anywhere on a 10-milescale PPI of < 15" diameter implies a reflective solid target at least several thousand feet wide.

It is possible that the display sensitivity might be adjusted so that a strong aircraft target would be displayed by its main-beam return flanked closely by smaller echoes from the two major sidelobes, but an experienced operator would be familiar with this type of presentation, which is quite different from the much broader and integrated arc implied. It is conceivable that the operator was so inexperienced that he failed to realise that the display sensitivity was turned up to the point where the screen was fizzing with system noise and clutter, and took the consequent abnormal target presentation to be the norm; but this seems hardly likely, especially in view of the Air Force investigation which noted that all personnel were "completely reliable". It is also possible that the operator's statement was simply misunder-stood or misquoted by the preparing officer.

If it is assumed that the "10 mile scope" is a separate instrument from the airfield surveillance scope on which the more distant target was (presumably) initially detected then it is possibly one of the landing system displays - fed from fixed azimuth and elevation sector-scanning antennae and used to guide aircraft to a blind touch-down. Information on the exact nature of the GCA setup at Carswell in 1954 would be needed to make even broad inferences about the radar cross-section implied by "a 1-inch return" on the landing radar. Certainly a 10 mile range would not be inconsistent with the range of a landing radar. The

report does appear to make a distinction between the "10 mile scope" and the "search" (surveillance) radar mentioned immediately afterwards, possibly supporting the hypothesis that two instruments are involved here. If this is the case then the probability that the the echoes, however anomalous in presentation, were from a real aerial target is considerably strengthened, given that surveillance and landing radars would be electronically independent and operate at very different wavelengths and pulse-repetition-frequencies (tending to rule out RFI, internal noise, component failure, anomalous propagation, multiple-trip echoes and some other possible causes of false blips). It is also relevant that the operator "scanned from 10 degs to 02 degs on search and object retained the same rtrn [return] during this opn [operation]." (This may refer to surveillance beam elevation which can sometimes be altered, either by mechanically elevating the antenna or by shifting the antenna feed, to offer "high" and "low" beams.) A spurious ground return detected on low beam can often be lost by increasing the elevation so that the amount of energy radiated at near-grazing angles required for ducting is reduced.

In summary the radar report is less than adequate. It is not possible to definitely relate the radar target to the visual object except in the most general way, even its displayed bearing being unknown. (The report's entry against question 2 [a], which in the required Air Force format reads "Angle of elevation and azimuth of object when first sighted", is: "Not avail. GCA radar could not furn[ish] this info.") All that can really be said with confidence is that the operator observed a target which he interpreted to be an inbound object, and which was notable for the strength of its radar return, indicating unusual size. This is in essence what the intelligence report says.

The visual reports are somewhat more detailed. According to the intelligence report the "aircraft shaped" object approached Carswell from the SW on a heading of 30 degrees. Its angular subtense was about that of a baseball at arm's length. It was dark grey in colour and appeared to be at least as large as, or possibly larger than, a B-36 (a very large bomber). It left no visible trail or exhaust, had no visible propulsion units or cabin lights and travelled silently over the tower at 3-4000', maintaining its 30 degree heading. After passing over the tower it was observed to continue the same course, the bright light in its tail visible for a further 5 minutes as it appeared to pass 5 or 6 miles N of Meacham Field near Fort Worth. It was lost to sight at an elevation angle of about 5 degrees.

A silent, low-altitude aircraft with elliptical wings and a tail fin might suggest a glider - perhaps some type of towed aerial gunnery target that had come adrift during an exercise. The reported lighting pattern is very curious, however, and this hypothesis does nothing to improve the fit with the radar indication of a very efficient reflector since a glider would a be a light-weight, probably largely wooden, construction with a very poor radar cross-section. Further, the flight pattern is not very typical of a glider - especially an unpiloted runaway, and the estimate of size is grossly inconsistent with any known glider.

This estimate is, however, reasonably consistent with the visual estimate of angular subtense. Allowing for the fact that angles are almost always overestimated, a "baseball" at arm's length might equate to, say, a couple of inches at about 24" from the eye, or about 5 degrees. The object was estimated to be within 3-4000' of the tower. At 4000', 5 degrees equates to about 350 feet. A Convair B-36 had a wingspan of about 230 feet. Thus, roughly

speaking, these estimates are consistent with accurate observation of size, angular subtense and altitude of an object "larger than a B-36". An object of unusually large size is also roughly indicated by the radar report, which in this respect is also consistent.

The state-of-the-art in ECM "active jamming" techniques in 1954 is uncertain, but the remote possibility exists that the object was some sort of experimental ECM drone carrying emitters capable of simulating or enhancing radar targets. Indications of rather accurate visual observation, however, argue quite strongly against this hypothesis.

If there was in reality no "aircraft" at all but only an imaginary outline, an illusion encouraged by a fortuitous pattern of lights - perhaps a formation of jets flying at high altitude - then the silence would be explained. It is perhaps possible that the radar echoes could be explained as the unresolved, integrated returns of several high-altitude aircraft flying abreast, since the PPI would display slant range and cannot distinguish between a low-level target at 10 miles ground range and a target at, say, 40 degrees elevation and an altitude of 35,000' with a ground range of less than 8 miles. However this hypothesis could not be valid if, as appears likely, the target(s) appeared on the landing radar display since the high elevation would be shown on the height scope, and might even be above the elevation limit of the antenna. Furthermore the detailed visual observations over a period of some minutes - including visibility virtually to the horizon - cannot be accommodated without a deal of strain.

In conclusion, this is an interesting and unusual report which would appear to merit further investigation. A great deal more detail on the radar instrumentation, scope presentations, and radar/visual times, ranges, bearings and elevations, is required to finally evaluate it. But some weight has to be given to the experience and stated reliability of the several Air Force witnesses involved, and it is only reasonable to concede that some object was seen and detected by radar. Although the case cannot be said to be probative, therefore, the rough consistency of observations by numbers of trained personnel does indicate the likelihood of some type of very quiet or silent aircraft, having abnormal size, radar cross-section, configuration and lighting, which was not identifiable by flight plan or visually despite close observation for some minutes both with the naked eye and binoculars.

STATUS: Unknown

10. DATE: December 2, 1954 TIME: 1410 local CLASS: R/V ground radar/air visual

LOCATION:
French military
radar site,
Ceuta, Morocco

SOURCES: Vallee CS 1966 186

RADAR DURATION: 60 mins. approx.

EVALUATION: No official

PRECIS: A French military radar site at Ceuta tracked a target which was simultaneously observed visually by the crew of a fighter in the air. The speeds and altitudes of the target were recorded for a continuous period of about I hour from 1410 to 1510, during which time its altitude varied between 7 km (23,000') and 18 km (59,000') with variations in speed from 10 kph (6 mph) to 220 kph (137 mph). The altitude/speed diagram shows a rate-of-climb of >1500 fpm maintained for some 17 minutes (speed 100 mph slowing latterly to 40 mph) up to an altitude of nearly 59,000', levelling off with speed dropping briefly to near-zero, then accelerating steadily to 137 mph over about 12 minutes at the same altitude before suddenly dropping 20,000' in 1 minute down to 39,000' and again levelling off, still at 137 mph, for about 10 minutes, at which point the target dropped, with a simultaneous rapid *dec*eleration, at a mean rate of about 5000 fpm for 3 minutes down to another level of 23,000' at <60 mph, maintaining this speed and level for some 10 minutes until contact was lost.

NOTES: No information is available on the radar type(s) or the nature of the simultaneous air-visual, nor are ranges and bearings given for the target, and the scope presentation is not described. Evidently at least one nodding-fan height finder was involved, but whether there was a concurrent PPI track is unknown. Nevertheless an aircraft would seem to be ruled out by the combination of altitude, somewhat abrupt manoeuvrability, and speed range. Apparently slow speeds, or even brief hovering, might be displayed on the PPI track of a fixed-wing aircraft during a radial climb at constant slant range, but not on a height-finder simultaneously (although a height-finder operated alone is susceptible to a related blind effect - see below). An altitude of nearly 60,000' was at the very limits of the state of the art for fixed-wing flight in 1954, and coincidentally it was on December 1 - the day before this incident - that Eisenhower gave his authorisation for the $19 million USAF/CIA program to develop a revolutionary plane - the U-2 - which could exceed it in extended flight. No helicopter could achieve the height/speed domain of the target. In short, if the record accurately reflects target movements, this would seem to be unbelievable performance for any fixed wing or rotor craft known to have been flying in 1954.

It is possible that multiple-trip returns from an aircraft beyond the unambiguous range of the set could display spuriously slow speeds, since the angular rate of the target is preserved but at much less than the true range. True radial velocities would be accurately displayed, but motion with a component normal to the line-of-sight would be displayed at spuriously slow speeds to a degree proportional to the tangential vector. On a PPI display, true tangential motion of a multiple-trip target could be reduced still further by a simultaneous steep climb, since the 2-dimensional display only indicates the change in azimuth. On an RHI scope the situation is a little different and changes in elevation would not enhance the multiple-trip effect. However, because the elevation angle is preserved it is obvious that multiple-trip returns displayed at a given altitude by the RHI scope must relate to a more distant target at a greater true altitude. Therefore an aircraft is a still less likely explanation of the target if detected on the 2nd trip. Additionally, of course, any such hypothesis would be conditional upon the nature of the undescribed air-visual corroboration of the target.

Whether or not the RHI indications cited were supplemented by a PPI track is very important to an interpretation of the altitude/speed diagram. A nodding-fan height finder

has a poor azimuth resolution, with good discrimination in altitude and range; a surveillance PPI on the other hand does well with range and azimuth but has essentially no resolution in elevation. If the diagram was derived from RHI indications alone, therefore, it may not reflect the true azimuthal vector of target motion and thus the speeds cited would be minima. This would mean that when the diagram shows the target slowing to about 6 mph, this could be merely the rate of change in range - but there could be a simultaneous undisplayed tangential vector in the plane of the resolution cell, which, for a typical beam width of about 4 or 5 degrees, would be on the order of 2 miles across at a slant range of (say) 50 miles. At the highest recorded speed of the target in this case, it would take more than 50 seconds to cross this cell laterally, during which time it would be displayed as stationary. Its echo would then disappear and the operator would be obliged to realign the antenna azimuth left or right to find it again, by which time it could have begun to turn towards a radial heading and would now show indications of increasing speed. In this way the speed diagram might show spuriously abrupt transitions and episodes of near-stationarity. Of course it is normal for a height finder to be operated in tandem with a surveillance PPI, and so it may have been in this case although no track information is presented which positively requires this to be so.

Although angles of elevation cannot be inferred without range data, wide variations in altitude up to nearly 60,000' seem intuitively inconsistent with anomalous propagation. This is not necessarily so, however. For a radar with a range of (say) 200 miles, a target displayed near maximum range with a displayed altitude of 60,000' would represent an elevation angle of only about 3 degrees, and a diminishing amount of trapping or partial reflection might be possible up to about 10 degrees. The altitude variations of the target (representing a couple of degrees at long range) might fairly be described as erratic, and could result from sporadic echoes of ground targets beyond the operating range of the set detected due to superrefractive conditions. Such echoes might be mistakenly interpreted as a single coherent track, and a bright star or planet low on the horizon in the same rough direction - possibly exhibiting abnormal scintillation or perceptible image-wander due to mirage caused by the same atmospheric conditions - could have been seen by the visual observers in the air. Granted, such an hypothesis may not be especially probable and may imply an unusually anisotropic atmosphere (with the target[s] confined to within a maximum azimuth arc of about 20 degrees for a radar range of 200 miles, giving a track length consonant with average speeds of about 75 mph over 60 minutes), but the limited data available do not definitely exclude it. Again, confirmation that the RHI was operated in tandem with an electronically independent PPI scope - and the detailed track information from that scope - would help in assessing this hypothesis, since different operating frequencies and beam shapes would argue against similar sporadic AP echoes occurring in consistent patterns on both scopes.

In conclusion, this potentially very interesting report deserves further investigation - particularly of radar operating characteristics, the ground track of the target and the visual sighting - but unfortunately does not support any definite interpretation as it stands.

STATUS: Insufficient information

11. DATE: June 23, 1955 TIME: 1245 local CLASS: R/V ground radar/ multiple air visual

LOCATION: Utica, N.Y./ Albany, N.Y./ Boston, Mass.

SOURCES: Thayer (Condon 143)

RADAR DURATION: unspecified

EVALUATIONS: Thayer - unknown

PRECIS: A Mohawk Airlines DC-3 was cruising at 3000' in good daylight visibility below a 4000' overcast, about 15 miles E of Utica, N.Y., on a heading ESE to Albany, N.Y. at 160 knots. At about 1215 both pilot and copilot saw an object come over the top of their aircraft from behind, an estimated 500' above their altitude, on a heading that made a 20-degree angle with the vertical as it crossed the windshield. They estimated the length of the object at about 150'. It was described as:

> "light gray, almost round, with a center line . . . . Beneath the line there were several (at least four) windows which emitted a bright blue-green light. It was not rotating but went straight. [The lights] seemed to change colour slightly from greenish to bluish or vice versa [as the object receded]. A few minutes after it went out of sight, two other aircraft (one, a Colonial DC-3, the other I did not catch the number) reported that they saw it and wondered if anyone else had seen it. The Albany control tower also reported that they had seen an object go by on Victor-2 [airway]. As we approached Albany, we overheard that Boston radar had also tracked an object along Victor-2, passing Boston and still eastbound."

NOTES: Thayer's study of this case notes that the crew computed the speed of the object, based on the times of the contacts near Utica and Boston, at 4,500 - 4,800 mph, and he questions the "absence of a devastating sonic boom" which should have been caused by a 150' ellipsoid exceeding Mach 6 below 4000'. On this basis Thayer concludes that the Boston GCA radar report was probably coincidental, and whilst he evaluates the residue as "a most intriguing report that . . . pending further study . . . defies explanation by conventional means" the lack of a related radar track clearly must reduce the interest of the case.

There is an inconsistency here, however. The total travel time for an object flying the 220 miles between Utica and Boston at 4,500 mph is only 3 mins., yet "a few minutes" had already passed before the crew heard reports from other aircraft and Albany control tower, by which time the object should already have been beyond Boston and probably well out to sea. The likelihood seems to be that the error lies in the estimate of speed, which is itself plainly inconsistent with the visual sighting from the DC-3 crew, who watched the object "for several miles" as it moved ahead of them, had time for a clear view and were not rocked by the turbulence of a near air-miss with a large, hypersonic body.

Firstly, we should note that the times given in the report for the beginning and end of the above-described sequence of events, 1215 - 1245, are consistent with the DC-3's trip from Utica to Albany at approx. 160 knots. If the crew heard the report of the Boston tracking as they "approached Albany" at or near 1245, as stated, then the implied average speed of the

object is in the region of 450 mph, not 4500 mph., a factor-ten error which suggests a (not unique) corruption somewhere in the Blue Book reporting chain. This value is in turn consistent with the Albany fly-past, reported "a few minutes" after the Utica encounter: at 450 mph the object would pass Albany about 8 minutes later. There does not appear to be any evidence that the object was hypersonic, and thus there is no reason to discard the Boston report on this basis.

We are left with consistent multiple reports of an object flying between Utica and Boston at approximately 450 mph and detected by radar. The object seen from Albany control tower and two other commercial aircraft is undescribed, but presumably was unidentifiable by the reporters. The radar target is similarly undescribed, but again presumably was unidentified if only because it failed to conform to any flight plan and/or did not respond to radio interrogation.

The Utica sighting, however, is much more circumstantial and prima facie does indeed defy explanation. The overall performance is not itself inconsistent with a jet aircraft, but the description is difficult to reconcile in this way. An aircraft flying just within the overcast might conceivably be difficult to identify, and might even create unusual cloud turbulence in its wake which would obscure its true shape, but the rather specific configuration and lighting pattern are grossly at odds with such an hypothesis.

If the overcast were thin the lighting pattern might relate to a military air refueling tanker (always brightly lit) just above the clouds; but such an operation would never be conducted on a commercial airway, much less without warning, and the hypothesis would still leave a great deal to be added by the witnesses' imaginations. Presumably there could have been unusual towed drones and targets, as well as classified military airborne radar experiments with unusually configured radomes that might have been unfamiliar to commercial pilots in 1955, but this is highly speculative. The Grumman WF-2 Tracer was the first known Airborne Early Warning platform to use a saucer-shaped dorsal radome; the glassfiber structure was massive in relation to the aircraft and in certain circumstances might have given rise to "UFO" reports. But the prototype WF-2 did not fly until March 1957, and no hypothetical early version can easily be squared with the object described.

In summary, the specificity of the Utica description, the independent visual reports from ground and air, the radar tracking (albeit unconfirmed), and the internal consistency of reported times, distances and headings all suggest the probability of a large, unidentified, ellipsoidal object travelling at about 450 mph low over the Eastern Seaboard of the United States.

STATUS: unknown

12. DATE: July 17, 1957 TIME: 0430 CST(approx.) CLASS: R/V ground-(air?) radar/air visual

LOCATION: South Central U.S.

SOURCE: McDonald (Sagan, Page 1972) 56
Craig (Condon 1970) 56, 261
Klass (1974) 186

Thayer (Condon 1970) 136

RADAR DURATION: (ground) few minutes

EVALUATION: Blue Book - aircraft
McDonald - unknown
Craig - tentative unknown
Klass - aircraft/meteor/stars/electromechanical fault
Thayer - tentative unknown

PRECIS: A USAF ECM (electronic countermeasures) reconnaissance RB-47H of the 55th Reconnaissance Wing, Forbes AFB, Topeka, Kansas, with a crew of six, was undergoing an extended night-time exercise involving tests of navigation, gunnery and on-board radar monitors prior to a European mission. Its scheduled course was to take it from a gunnery range in the Gulf of Mexico northward through S Mississippi to Meridian, then west across Louisiana and E Texas making practice ELINT intercepts of ground-based air defense radars and communications stations, turning N for the home run to Forbes at approximately Waco, Texas. The imaging ECM monitors displayed the relative bearings of radar sources whilst associated equipment performed signature analyses of these signals. Two types of monitor were involved: #1, an APD-4F direction-finder, with two hard-mounted wingtip antennae; #2, an ALA-6, with two back-to-back antennae scanning in azimuth at 150-300 rpm in a ventral housing. Signal processing was by APR-9 receiver and ALA-5 pulse analyser. (The #3 monitor operated outside the bandwidth in question and was not directly involved. The only role of this station was in wire-recording intercom and radio traffic.)

The first, purely electronic, event occurred during the northward leg from the Gulf into Mississippi. A second sequence of events, visual and electronic, began when the RB-47 was westbound, on its assigned heading of 265 degrees, altitude 34,500' at Mach 0.75, over the South Central states. The first event involved passive ECM monitor #2 aboard the aircraft (the only monitor then operating, the ECM exercise-proper having not yet begun); the second sequence of events involved electronic detection by passive ECM monitors #1 and #2, air-visual observations by pilot and co-pilot from the flight deck, ground radar detection by FPS-10 air defense radar of the 745th ACWRON, Duncanville, Texas, and (reported but unsubstantiated) detection by airborne active radar aboard the RB47.

The contemporary intelligence summary was compiled by the Wing Intelligence Officer, 55th Strategic Reconnaissance Wing, Forbes AFB, from immediately post-mission crew interrogation, real-time on-board partial wire recordings of interphone and command position conversations, real-time written notations by #2 ECM operator, and a TWX filed several hours after the incident from the 745th ACWRON, Duncanville at 1557Z (0957 CST), July 17 1957 (a CIRVIS flash-report was also transmitted electrically from Duncanville prior to 1055Z whilst events were still in progress). Later information was contained in a 12-page Airborne Observer's Data Sheet (AISOP 2) completed by the aircraft commander Major Lewis D. Chase on September 10. Copies of some of these materials were finally forwarded on October 17 1957 from Air Defense Command Hq., Ent AFB, Colorado, to Project Blue Book, ATIC, Wright-Patterson AFB, where receipt was logged a further 7 days later on October 25. Items among these known materials which were not

forwarded, and are apparently not extant, include the original Duncanville CIRVIS [Communications Instructions for Reporting Vital Intelligence Sightings] flash-report, the original ECM #2 log, and the partial wire recording of interphone and radio traffic.

The essence of the COMSTRATRECONWG 55 intelligence summary follows (all times Zulu):

> ECM reconnaissance operator #2 of Lacy 17, RB-47H aircraft, intercepted at approximately Meridian, Mississippi, a signal with the following characteristics: frequency 2995 MC to 3000 MC; pulse width [length] of 2.0 microseconds; pulse repetition frequency of 600 pps; sweep rate of 4 rpm; vertical polarity. Signal moved rapidly up the D/F scope indicating a rapidly moving signal source; i.e., an airborne source. Signal was abandoned after observation.
>
> At 1010Z [0410 CST] aircraft comdr first observed a very intense white light with light blue tint at 11 o'clock from his aircraft, crossing in front to about 2:30 o'clock where it apparently disappeared. Aircraft comdr notified crew and ECM operator Nr 2 searched for signal described above, found same approximately 1030Z at a relative bearing of 070 degrees; 1035Z, relative bearing of 068 degrees; 1038Z, relative bearing 040 degrees. At 1039Z aircraft comdr sighted huge light which he estimated to be 5000 [feet] below aircraft at about 2 o'clock. Aircraft altitude was 34,500 ft, weather perfectly clear. Although aircraft comdr could not determine shape or size of object, he had a definite impression light emanated from top of object.
>
> At 1040Z ECM operator #2 reported he then had two signals at relative bearings of 040 and 070 degrees. Aircraft comdr and co-pilot saw these two objects at the same time with same red colour. Aircraft comdr received permission to ignore flight plan and pursue object. He notified ADC site Utah [Duncanville] and requested all assistance possible. At 1042Z ECM #2 had one object at 020 degrees, relative bearing. Aircraft comdr increased speed to Mach 0.83, turned to pursue, and object pulled ahead. At 1042.5Z ECM #2 again had two signals at relative bearings of 040 and 070 degrees. At 1044Z he had a single signal at 050 degrees relative bearing. At 1048Z ECM #3 was recording interphone and command position conversations.
>
> ADC site requested aircraft to go to IFF Mode III for positive identification and then requested position of object. Crew reported position of object as 10NM northwest of Ft. Worth, Texas, and ADC site Utah immediately confirmed presence of objects on their scopes.
>
> At approximately 1050Z object appeared to stop, and aircraft overshot. Utah reported they lost object from scopes at this time, and ECM #2 also lost signal.
>
> Aircraft began turning, ECM #2 picked up signal at 160 degrees relative bearing. Utah regained scope contact, and aircraft comdr regained visual contact. At 1052Z ECM #2 had signal at 200 degrees relative bearing, moving up his D/F scope. Aircraft began closing on object until the estimated range was 5 NM. At this time object

appeared to drop to approximately 15,000 feet altitude, and aircraft comdr lost visual contact. Utah also lost object from scopes.

At 1055Z in the area of Mineral Wells, Texas, crew notified Utah they must depart for home station because of fuel supply. Crew queried Utah whether a CIRVIS report had been submitted, and Utah replied the report had been transmitted. At 1057Z ECM #2 had signal at 300 degrees relative bearing, but Utah had no scope contact. At 1058Z aircraft comdr regained visual contact [with] object approximately 20 NM northwest of Ft. Worth, Texas, estimated altitude 20,000 ft at 2 o'clock from aircraft.

At 1120Z aircraft took up heading for home station. This placed area of object off the tail of aircraft. ECM #2 continued to [receive] D/F signal of object between 180 and 190 degrees relative bearing until 1140Z, when object was approximately abeam Oklahoma City, Oklahoma. At this time, signal faded rather abruptly. 55 SWR DOI [Director of Intelligence, 55th Strategic Reconnaissance Wing] has no doubt the electronic D/F's coincided excatly with visual observations by aircraft comdr numerous times, thus indicating positively the object being the signal source.

NOTES: After receipt of summary materials from the Director of Intelligence, ADC, some three months later on October 25 1957, Blue Book opened a file which contains minimal analysis. A preliminary evaluation by V. D. Bryant of the ATIC electronics branch, Wright-Patterson AFB, dated October 30, reads:

This report is difficult to evaluate because there is such a mass of evidence which tends to all tie in together to indicate the presence of a physical object or UFO. With the exception of rather abrupt disappearance of returns on the electronic equipment, an indication that the object travelled at relatively high speed, there are no abnormal electronic indications such as are usually present in reports of this type - extreme speeds, abrupt changes of course, etc. These abnormal indications are usually the basis for considering anomalous propagation, equipment malfunction, etc., as responsible for the "sightings".

The electronic data is unusual in this report in that radar signals (presumably emanating from the "object") were picked up. These intercepted signals have all the characteristics of ground-radar equipment, and in fact are similar to the CPS-6B. This office knows of no S-band airborne equipment having the characteristics outlined. Since the type equipment on the ground (at "Utah") is not known, and since there are no "firm" correlations between the ground [radar] intercept and the sightings from the aircraft, it is impossible to make any determination from the information submitted. On the other hand, it is difficult to conclude that nothing was present, in the face of the visual and other data presented.

The investigation progressed no further, however, and in November the then Blue Book Officer, Captain G. T. Gregory, closed the file with this note:

> In joint review with the CAA of the data from the incident, it was definitely established by the CAA that object observed in the vicinity of Dallas and Ft. Worth was an airliner.

The official conclusion thus reads: "Identified as American Airlines Flight 655."

The contents of the file reveal exactly what the CAA "definitely established". The "joint review with the CAA" consists of a letter from Roy Keeley, Director, Flight Operations and Air Worthiness, CAA, to Brigadier General Harold E. Watson, ATIC, which states:

> The second incident mentioned occurred on July 17, 1957, near El Paso, Texas, and involved American Airlines Flight #655. Investigation of this incident definitely established the fact that the unidentified flying object was American Airlines Flight #966, which had previously departed from El Paso, Texas, en route to Dallas, Texas.

The flight which was "definitely established" as the cause of this incident was #966, not #655, and this was furthermore a quite separate incident reported by the crew of Flight #655 whilst in the vicinity of Salt Flats, near El Paso, Texas. The file contains a wire report of this incident:

> The American Airlines DC-6 air coach [#655] with 85 aboard narrowly averted collision near Salt Flats, Texas, in the pre-dawn darkness of July 17, 1957. Capt. Ed Bachner dived the airliner from its 14,000 ft altitude when he saw a green light ahead. Ten passengers were injured when thrown from their seats. Though the weather was clear, the crew said the other aircraft appeared without warning.

And a Blue Book file comment adds some early speculation that flight #655 encountered a fireball meteor:

> July 17 - 50 miles E of El Paso, Texas - 3:30 a.m. (MST) [0830Z] Amer. Airlines Flight #655 almost collides with huge green UFO! (Shot E.) (Fireballs mounting)

The CAA thus "definitely established" that flight #655 was westbound approaching El Paso, 450 miles W of Dallas, shortly after the eastbound take-off from El Paso of flight #966, whose own ETA at Love Field, Dallas, was 1100Z (which would be about 5 minutes after the RB-47 commander's decision to abandon pursuit of the "UFO" near Dallas and turn for home). Yet incredibly, the conclusion, "definitely established in joint review with the CAA" in 1957, that the Dallas radar-visual "UFO" was flight #655, remained the official Blue Book evaluation 12 years later as at 1969 when the project was disbanded.

By 1967 the RB-47 commander, Lewis D. Chase, happened to have been assigned as an air base UFO Officer, and in that capacity attended a conference sponsored by the University of Colorado pursuant to its UFO-study contract with the Air Force. Chase recalled the incident and an approximate date in September 1957, and staff of the UFO project, who had authority to request access to classified Air Force reports, requested that Blue Book attempt to locate records in its files. Major Hector Quintanilla, incumbent Blue Book officer, responded that there were no records of such an incident. Neither could ADC

find any reference in its intelligence files or operations records (said to be routinely destroyed after 3 years), and the 55th SAC Strategic Reconnaissance Wing declared that "a thorough review of Wing History" disclosed no such incident. However interviews were obtained with Chase, with his former co-pilot James H. McCoid, and with #2 monitor operator Frank B. McClure who, like Chase, was at that time still an Air Force officer on active service. All three men "remained deeply impressed by the experience", according to CU physical chemist Roy Craig, and were "surprised" that no records could be located inasmuch as they recalled debriefing by intelligence personnel; but the evaluations by Craig and by Thayer (an ESSA radar and optical propagation specialist on the staff of the UFO project) for the Condon Report were therefore based solely on the somewhat detailed recollections of these three witnesses.

In 1969, however, University of Arizona atmospheric physicist Dr. James E. McDonald obtained further interviews with all six of the aircrew, and in the same year the formerly SECRET case file was located in the newly-declassified Blue Book records under its true date of July 17 1957. McDonald was thus able to present new and much more detailed expositions, in the *Journal of the American Institute of Aeronautics & Astronautics* in July 1971, and in the proceedings [1972] of an American Association for the Advancement of Science UFO symposium held in December 1969. McDonald's evaluation and the now-public case file, together with further correspondence with Chase and McClure, became the bases of a highly influential re-evaluation of the case by avionics journalist Philip J. Klass in 1974.

This history is of some relevance. The intelligence summary is, quite typically, concise to the point of obfuscation; but the fairly detailed narrative jointly recounted by the aircrew in 1967 is found to be supported in almost every significant respect by this official 1957 record, a fact which bears on the dependability of those observational and circumstantial details which do not appear in that summary record. For example, Craig's 1968 evaluation had remarked on McClure's, McCoid's and Chase's corroborative accounts of the event itself, but had questioned their divergent recollections of what happened afterwards. A retrospective look at this issue is educative.

In their 1967 interviews with Craig, both McClure and McCoid recalled "intensive interrogation" by Wing intelligence personnel immediately on their return to Forbes AFB, but stated that they never heard any more about the incident after that. They also believed that no film or wire-recorded data from the ECM monitors had been taken from the aircraft, since it was merely a practice run and no film or recording wire had been taken aboard.

On the other hand the aircraft's pilot, Chase, did not recall being "extensively" questioned when met after landing by the intelligence personnel, but did clearly recall that some time much later (possibly "weeks" later) he was required to fill in a rather lengthy questionnaire, including sketches and a narrative account of the event, for the Air Defense Command. Further, he believed that film and wire-recorded data had been removed from the "back end" of the aircraft on landing.

These accounts appeared suspiciously contradictory in 1967, and Craig emphasised the "serious lack of agreement" on these issues, concluding that "if" an official report was ever

submitted then "it apparently is no longer in existence", and that electrical-optical recordings recalled by Chase "apparently never existed."

An intelligence file did exist, however, and careful study of it now appears to reconcile the different accounts. According to that file Chase, alone of the crew, did indeed fill in a detailed 12-page Airborne Observer's Data Sheet on September 10 1957 - some 7 weeks later - which did indeed go to ADC intelligence, and this fact would be consistent with his not having been as extensively questioned at the time (for whatever reason) as McClure and McCoid. Also, although Chase was (presumably) mistaken as to the extent of the recorded data removed from the "back end" of the aircraft, his recollection that some wire-recordings were removed is found to be consistent with the contemporary report, which plainly states: "ECM #3 [operated by another, peripherally involved airman] was recording interphone and command position conversations." (This issue will be returned to later.)

With this in mind it is useful to interpolate the contemporary intelligence records (1957) with the crew's collective account(s) of the incident, as given by Craig and Thayer (1968), McDonald (1972) and Klass (1974). Each interpolation is identified by date, and it should be remembered that those due to Craig and Thayer predate the discovery of the official file, whilst those due to McDonald and Klass are respectively concurrent with, or postdate, its discovery and may include details abstracted from it. The relevance of this exercise will later be apparent. (Note: The account supplied by Klass contains few differences of substance from that reconstructed by McDonald; generally speaking Klass's account differs in interpretation, reflecting the hypothesis for which he is arguing, and this interpretation is to a large extent embedded in his narrative. For these reasons Klass's exposition will be considered separately and more fully later in this report, and in the context of his hypothesis.)

The Initial ECM Contact over S. Mississippi (prior to 1010Z, 1st North leg)

1.[1957] "ECM reconnaissance operator #2 . . . intercepted at approximately Meridian, Mississippi, a signal with the following characteristics: frequency 2995 MC to 3000 MC; pulse width of 2.0 microseconds; pulse repetition frequency of 600 pps; sweep rate of 4 rpm; vertical polarity. Signal moved rapidly up D/F scope indicating a rapidly moving signal source; i.e., an airborne source. Signal was abandoned after observation."

2[1957] "The electronic data is unusual in this report in that [the] intercepted signals have all the characteristics of ground-based radar equipment, and in fact are similar to the CPS-6B."

3[1968 Craig] "The mission had taken the crew over the Gulf of Mexico and back over South Central United States . . . . Radar monitoring unit number two, in the back end of the B-47, picked up a strong signal, at a frequency of about 2,800 mHz., which moved up-scope while the plane was in straight flight. (A signal from a ground station necessarily moves down-scope under these conditions, because of the forward motion of the airplane.) This was noted, but not reported immediately to the rest of the crew. The officer operating this unit suspected equipment malfunction, and switched to a different

monitoring frequency range. . . . the frequency received . . . was one of the frequencies emitted from ground radar stations (CPS-6B type antennas) . . . ."

4[1968 Thayer] Quoting McClure: " [This signal] had all the characteristics of a ground site - CPS-6B."

5[1972 McDonald] "Having completed the navigational exercises over the Gulf, Chase headed north across the Mississippi coastline, flying at an altitude of 34,500 feet, at about Mach 0.75 . . . . Shortly after they crossed the coast near Gulfport, McClure detected . . . a signal painting at their 5 o'clock position (aft of the starboard beam). It looked to him like a legitimate ground-radar signal, and, upon noting that the strobe was moving upscope, McClure tentatively decided that it must be a ground radar off to their northwest, painting with 180 degree ambiguity for some electronic reason. But when the strobe, after sweeping upscope on the starboard side, crossed the flight path of the RB-47 and proceeded to move downscope on the port side, McClure said he gave up the hypothesis of 180 degree ambiguity as incapable of explaining such behavior. Fortunately, he had examined the signal characteristics on his ALA-5 pulse analyser before the signal left his scope on the port side aft. In discussing it with me, his recollection was that the frequency was near 2800 mcs, and he recalled that what was particularly odd was that it had a pulse width and pulse repetition frequency (PRF) much like that of a typical S-band ground-based search radar. He even recalled that there was a simulated scan rate that was normal. Perhaps because of the strong similarities to ground-based sets such as the CPS-6B, widely used at that time, McClure did not, at that juncture, call this signal to the attention of anyone else in the aircraft. . . . He was puzzled, but at that point still inclined to think that it was some electronic difficulty."

6[1974 Klass] "Shortly after the RB-47 turned north from the Gulf . . . McClure decided to turn on his equipment and exercise it to assure that it was functioning properly before the aircraft reached Meridian and headed west. . . . As the RB-47 approached Biloxi, McClure tuned his APR-9 receiver to . . . S-band . . . and observed a signal with the familiar characteristics of a CPS-B-type air-defense radar. But, curiously, the bearing shown to this signal source was approximately 5 o'clock [and] was moving "up-scope" - in the reverse direction to normal. McClure concluded that his equipment was probably malfunctioning . . . . McClure told me that a CPS-6B radar was installed at Keesler Air Force Base, near Biloxi, and used for training electronic countermeasures equipment operators. It was operated by the USAF's Training Command . . . . It was because McClure knew that there was a CPS-6B installed near Biloxi that he had tuned to its frequency as the RB-47 flew north from the Gulf."

The Initial Visual Contact over Louisiana (1010Z, West leg)

7[1957] "At 1010Z aircraft comdr first observed a very intense white light with light blue tint at 11 0'clock from his aircraft. crossing in front to about 2:30 o'clock position, copilot also observed passage of light to 2:30 o'clock where it apparently disappeared. Aircraft comdr notified crew . . . ." [Aircraft location at this time recorded in Airborne Observer's Data Sheet as 32 degrees N, 91 degrees 28 minutes W, near Winnsboro,

Louisiana; heading 265 degrees, altitude 34,500', true air speed 500 mph; winds W, 50 mph, weather clear.]

8[1968 Craig] "The pilot saw a white light ahead and warned the crew to be prepared for a sudden maneuver. Before any evasive action could be taken, the light crossed in front of the plane, moving to the right, at a velocity far higher than airplane speeds. The light was seen by pilot and co-pilot, and appeared to the pilot to be a glowing body as big as a barn. The light disappeared visually . . . ." "Plane's altitude: above 30,000 ft . . . . Witnesses recalled seeing . . . lights of cities and burn-off flames at gas and oil refineries below. They have no recollection of other than clear weather."

9[1972 McDonald] "They turned into a true heading of 265 degrees . . . Major Chase, in the forward seat, spotted what at first he thought were the landing lights of another jet coming in fast from near his 11 o'clock position at, or perhaps a bit above, the RB-47's altitude. He called McCoid's attention to it, noted absence of any navigational lights, and, as the single intense bluish white light continued to close rapidly, he used the intercom to alert the rest of the crew to be ready for sudden evasive maneuvers. But before he could attempt evasion, he and McCoid saw the brilliant light almost instantaneously change direction and flash across their flight path from port to starboard at an angular velocity that Chase told me he had never seen matched in all of his twenty years of flying, before or after that incident. The luminous source had moved with great rapidity from their 11 o'clock to about their 2 o'clock position and then blinked out."

10[1972 McDonald] "Immediately after the luminous source blinked out, Chase and McCoid began talking about it on the interphone . . . . McClure now mentioned the unusual signal he had received on his ALA-6 back near Gulfport, set his #2 monitor to scan at about 3000 mcs to see what might show up."

1st ECM/Visual Contacts SE of Dallas (1030-1040Z, West leg)

11[1957] "Aircraft comdr notified crew and ECM operator Nr 2 searched for signal described above, found same approximately 1030Z at a relative bearing of 070 degrees; 1035Z, relative bearing of 068 degrees; 1038Z, relative bearing 040 degrees. [Note: bearings moving up-scope.] At 1039Z aircraft comdr sighted huge light which he estimated to be 5000 [feet] below aircraft at about 2 o'clock [about 60 degrees]. Aircraft altitude was 34,500 ft, weather perfectly clear. Although aircraft comdr could not determine shape or size of object, he had a definite impression light emanated from top of object."

12[1968 Craig] ". . . number two monitor was returned to the frequency at which the signal was noted a few moments earlier and again showed a target [sic.], now holding at the 'two-o'clock' position. The pilot varied the plane's speed, but the radar source stayed at two o'clock . . . After the UFO had held the two o'clock position through various test changes in aircraft speed, the number two monitoring officer informed the pilot that the target was starting to move upscope. It moved to a position dead ahead of the plane, holding a ten-mile range, and again became visible to the eye as a huge, steady, red glow."

13[1968 Craig] "The monitoring officer recalled that the navigator [Thomas H. Hanley], who reported receiving his own transmitted radar signals reflected from the target, not only had a target on his screen, but reported target bearings which coincided exactly with the bearings to the source on the monitoring scope. He also indicated that the officer [J. Provenzano] operating the number one radar monitoring unit, which was of a different type, having a fixed APD-4 antenna . . ., also observed the same display he observed on unit two."

14[1972 McDonald] "[McClure] found he was getting a strong 3000 mcs signal from about their 2 o'clock position, the relative bearing at which the unknown luminous source had blinked out moments [sic.] earlier. Provenzano [#1 ECM operator] told me that immediately afterwards they checked out the #2 monitor on other known ground stations, to be sure that it was not malfunctioning; it appeared to be in perfect working order. He then tuned his own #1 monitor [APD-4] to 3000 mcs and also got a signal from the same bearing . . . . as the minutes went by and the RB-47 continued westward at about 500 mph, the relative bearing of the 3000 mcs source out in the dark did not move downscope on the monitors, as should have occurred with any ground radar, but instead kept up with the RB-47, holding a fixed relative bearing. . . . Chase varied speed, going to maximum allowed power, but nothing seemed to change the bearing of the 3000 mcs source. . . . [Then] it moved upscope and reappeared visually."

ECM/Visual/Ground-Radar Contacts during turn NW towards Dallas (1040-1050Z)

15[1957] "At 1040Z ECM operator #2 reported he then had two signals at relative bearings of 040 and 070 degrees. Aircraft comdr and copilot saw these two objects at the same time with same red colour. Aircraft comdr received permission to ignore flight plan and pursue object. He notified ADC [radar] site Utah [Duncanville] and requested all assistance possible. At 1042Z ECM #2 had one object at 020 degrees, relative bearing. Aircraft comdr increased speed to Mach 0.83, turned to pursue, and object pulled ahead. At 1042.5Z ECM #2 again had two signals at relative bearings of 040 and 070 degrees. At 1044Z he had a single signal at 050 degrees relative bearing. At 1048Z ECM #3 was recording interphone and command position conversations."

16[1968 Craig] "The pilot then requested and received permission to switch to ground interceptor control radar [Duncanville] and check out the unidentified companion. Ground Control in the area informed the pilot that both his plane and the other target showed on their radar, the other target holding a range of ten miles from him."

17[1957] "ADC site requested aircraft to go to IFF Mode III for positive identification and then requested position of object. Crew reported position of object as 10 NM northwest of Ft. Worth, Texas, and ADC site Utah immediately confirmed presence of objects on their scopes."

18[1968 Craig] "The pilot went to maximum speed. The target appeared to stop, and as the plane got close to it and flew over it, the target disappeared from visual observation, from monitor number two, and from ground radar. (The operator of monitor number two

[and co-pilot McCoid] also recalled the B-47 navigator's having this target on his radar, and the target's disappearing from his radar scope at the same time.)

19[1957] "At approximately 1050Z object appeared to stop, and aircraft overshot. Utah reported they lost object from their scopes at this time, and ECM #2 also lost signal.

20[1972 McDonald] "Chase, in reply to my questions, said he recalled that there was simultaneity between the moment when he began to sense that he was getting closure at approximately the RB-47 speed and the moment when Utah indicated that their target had stopped on their scopes. He said he veered a bit to avoid colliding with the object, not then being sure what its altitude was relative to the RB47, and then found that he was coming over the top of it as he proceeded to close. At the instant that it blinked out visually and disappeared simultaneously from the #2 monitor and from the radar scopes at site Utah, it was at a depression angle relative to his position of something like 45 degrees."

ECM/Visual/Ground-radar re-acquisition during turn W of Dallas (1050-1058Z)

21[1957] "Aircraft began turning [port radius around Mineral Wells], ECM #2 picked up signal at 160 degrees relative bearing. Utah regained scope contact, and aircraft comdr regained visual contact. At 1052Z ECM #2 had signal at 200 degrees relative bearing, moving up his D/F scope. Aircraft began closing on object until the estimated range was 5 NM. At this time object appeared to drop to approximately 15,000 feet altitude, and aircraft comdr lost visual contact. Utah also lost object from scopes."

22[1968 Craig] "The pilot began to turn back. About half way around the turn, the target reappeared on both the [#2] monitor and ground radar scopes and visually at an estimated altitude of 15,000 ft. The pilot received permission from Ground Control to change altitude, and dove the plane at the target, which appeared stationary. As the plane approached to an estimated distance of five miles the target vanished again from both visual observation and radar."

23[1968 Thayer] "One of the most disturbing features of the report is [McClure's] insistence, referring to ground and airborne radars [monitors], that '. . . this would all happen simultaneously. Whenever we'd lose it, we'd all lose it. There were no "buts" about it. It went off.'"

24[1972 McDonald] "Chase put the RB-47 into a port turn in the vicinity of Mineral Wells, Texas . . ., and he and McCoid looked over their shoulders to try to spot the luminous source again. All of the men recalled the near-simultaneity with which the object blinked on again visually, reappeared on the #2 scope, and was again skin-painted by ground radar at site Utah . . . . Chase added [that] he requested and secured permission from Utah to dive on the object when it was at lower altitude . . . . He told me that, when he dove from 35,000 feet to approximately 20,000 feet, the object blinked out, disappeared from the Utah ground scopes, and disappeared from the #2 monitor, all at the same time. McClure recalled that simultaneous disappearance too."

Final ECM/Visual Contacts (1055-1140Z, completion of turn and 2nd N leg)

25[1957] At 1055Z in the area of Mineral Wells, Texas, crew notified Utah they must depart for home station because of fuel supply. Crew queried Utah whether a CIRVIS report had been submitted, and Utah replied the report had been transmitted. At 1057Z ECM #2 had signal at 300 degrees relative bearing, but Utah had no scope contact. At 1058Z aircraft comdr regained visual contact of object approximately 20 NM northwest of Ft. Worth, Texas, estimated altitude 20,000 ft at 2 o'clock from aircraft. At 1120Z aircraft took up heading for home station. This placed area of object off the tail of aircraft. ECM #2 continued to [receive] D/F signal of object between 180 and 190 degrees relative bearing until 1140Z, when aircraft was approximately abeam Oklahoma City, Oklahoma. At this time, signal faded rather abruptly."

26[1968 Craig] "Limited fuel caused the pilot to abandon the chase at this point and head for his base. As the pilot levelled off at 20,000 ft. a target [sic.] again appeared on number two monitor, this time behind the B-47. The officer operating the number two monitoring unit, however, believes that he may have been picking up the ground radar signal at this point. The signal faded out as the B-47 continued flight."

27[1972 McDonald] "McCoid recalled that, at about this stage of the activities, he was becoming a bit worried about excess fuel consumption resulting from use of maximum allowed power, plus a marked departure from the initial flight plan. He advised Chase that fuel limitations would necessitate a return to the home base at Forbes AFB, so they soon headed north from the Fort Worth area. McClure and Chase recalled that the ALA-6 system again picked up a 3000 mcs signal on their tail, once they were northbound from Fort Worth, but there was some variance in their recollections as to whether the ground radar concurrently painted the object."

Saving one or two anomalies to which attention will be drawn in due course, it is evident that the >10-year-old recollections of the aircrew and the contemporary intelligence summary are in generally good agreement, as far as they each go. The crew recollections tend to be somewhat approximate as to quantitative values such as exact times, frequencies and so on, whilst building a more coherent narrative with more vivid, qualitative detail than does the terse intelligence report. In some cases, however, the crew recollections of ranges and altitudes are even exact, whilst the episodes reported by them are structurally very close to, and often identical with, the same episodes as reported in the then-SECRET intelligence summary (compare, for example, paras. 21 & 22).

THE ECM SIGNALS

1st ECM signal, S. Mississippi

It is notable that McClure's stated *first* interpretation of the first signal detected during the 1st N leg from the Gulf into Mississippi was in terms of an ordinary S-band radar signal. The near-identity with a CPS-6B output was also noted immediately by the ATIC electronics specialist, who refrained from positively identifying it as such due to lack of

positive information about ground radars in the area and visual and other features of the report suggesting an airborne source. In 1967 Craig learnt from McClure that at the time he had "suspected an equipment malfunction" which somehow caused a ground radar signal to be displayed moving up-scope, and that "the frequency received . . . was one of the frequencies emitted from ground radar stations (CPS6B type antennas) . . . nearby". Later McClure told Klass that it was precisely because he knew of the CPS-6B at Keesler AFB near the coast that he had tuned to that frequency with the idea of checking out the ALA-6 before the scheduled ELINT test on the W leg. (Paras. 1 - 6)

However, although McClure "suspected" a malfunction, and although similar anomalous behavior was in fact specified in the ALA-6 instruction manual (as Klass later pointed out) as a symptom of certain malfunctions, McClure did not conclude that the signal moving up-scope was an erroneously displayed signal from a CPS-6B. Craig related in 1967 that ground radar signals received from time to time during the later events had, in McClure's view, "confused the question of whether an unidentified source . . . was present", but that at the same time these ground signals counterindicated the hypothesis of ALA-6 malfunction:

> On original approach to the area, however, a direct ground signal could not have moved up-scope. Up-scope movement could not have been due to broken rotor leads or other equipment malfunction, for all other ground signals observed that night moved down-scope. [Craig, 1968]

McClure further explained to McDonald why, although at the time he was still "inclined to think that it was some electronic difficulty", he could not understand the movement of the signal in terms of known ALA-6 faults which might induce a 180-degree bearing error to a ground radar source. After the strobe moved up-scope on the starboard side it then "crossed the flight path of the RB-47 and proceeded to move downscope on the port side", at which point "McClure said he gave up the hypothesis of 180-degree ambiguity as incapable of explaining such behavior." [McDonald 1972]

Klass's 1974 exposition, however, returns to this 180-degree-error scenario. At the 34,500' altitude of the aircraft, he suggested, trapped moisture could have frozen and temporarily immobilised the spring-loaded pivot arm in either of two relays which, when actuated by closure of the operator's antenna selector switch, should "tell" the display which of the two back-to-back antennae is in operation. Indeed, the ALA-6 instruction book specifically warns the operator that a 180-degree error in bearing indication can be caused in this way. When Klass contacted McClure the officer recalled that he had turned on the set with the specific intention of looking for a CPS-6B signal from Keesler AFB near Biloxi on the Gulf coast, in order to satisfy himself that his equipment was working properly before they began the assigned test run against ADC radars on the westbound leg of their mission, due to start after the turn near Meridian. (The CPS-6B at Keesler was not an active air defense radar but a set used by the USAF Training Command for ECM training purposes, which McClure evidently recalled from his own training; ADC had none of its operational CPS-6/FPS-10 sets in the vicinity of Biloxi.) On this basis Klass proposed that the RB-47 was at a position SSE of Keesler AFB approaching the coast when this signal was first observed at a bearing of about 150 degrees ("5 o'clock"), corresponding to the CPS-6B radar site at a real bearing of 330 degrees.

This evidence of proximity to Keesler AFB is somewhat persuasive, but also somewhat speculative. Klass states that "When I plotted the flight path . . . and the approximate bearings to the source of the radarlike signal, as McClure had subsequently recalled them for intelligence officer Piwetz [E. T. Piwetz, WIO COMSTRATRECONW 55, Forbes AFB], it became apparent that the radarlike signal could have been coming from the CPS-6B at Biloxi . . ."; but this is a little disingenuous insofar as only one specific estimated bearing (the initial one, 5 o'clock or 150 degrees) is recorded anywhere in the literature as having been offered by McClure, and there is no record of other bearings in the intelligence summary (neither Klass nor McDonald, each scrupulous to advance their arguments by appeal to original sources, list any other values or hint at the existence of other sources).

The aircraft's position at this time is also entirely uncertain. It may have been approaching the coast SSE of Biloxi, as Klass's scenario requires, or it may "shortly" before have crossed the coast "near Gulfport" (nearly 20 miles W of Biloxi and thus >20 miles W of the longitude required by Klass), as McDonald was earlier given to understand. The contemporary intelligence report actually states that the signal was "intercepted at approximately Meridian, Mississippi", which puts the location close to the scheduled turn, 100 miles or so north from either Gulfport or Biloxi. (At the RB-47 speed this spot might be 10 minutes from the coast or a little more, and in the context of an exercise with a duration measured in hours this might just be consistent with McDonald's "shortly after crossing the coast", and is certainly consistent with his statement that Chase and McClure "were quite definite in pointing out to me that the initial ECM contact was made in Southern Mississippi", but is almost certainly not consistent with a location over the inshore waters of Mississippi Sound.)

There appears to be no support therefore for the supposition that the aircraft's position relative to Keesler AFB at the time of the first signal can be established with any accuracy. Since McClure did not at the time consider the anomaly a reportable incident there is no record of its exact time of occurrence, and no record or estimate of elapsed time which would enable a back-calculation from the known times and positions of the RB-47 after 1010Z. Since no time-report was offered by McClure in immediately post-mission interrogation we are left with what he evidently did offer in 1957 - an estimate of location "approximately at Meridian" - together with his 1967 recollection that he had some expectation of picking up the Keesler signal prior to the ECM practice leg due to commence after the turn near Meridian. These facts are perfectly consistent with each other, since the radiation pattern of the relevant S-band vertical-center beam of the Keesler CPS-6B (main beam and lower sidelobe) would, as McClure presumably knew, extend more than 160 miles - well past Meridian - and whether the RB-47 crossed the coast near Biloxi or near Gulfport makes no difference to the fact that it would be flying well within the main beam coverage for more than 100 miles while it crossed S Mississippi and began its turn to the W. It is also psychologically consistent that McClure would check his equipment shortly before the turn for the scheduled ECM run W from Meridian.

In short, there is no basis for disputing the contemporary record that the signal was detected inland, "approximately at Meridian", in which case it is readily apparent that a signal moving up-scope from 150 degrees could not be due to the CPS-6B at Keesler

whether the K-301 relay in the ALA-6 malfunctioned or not. However the fact that the RB-47 would have been within the radiation pattern of a CPS-6B sited at Keesler does raise the question: if the signal detected by McClure was not from Keesler, then where was the Keesler CPS-6B signal which he was hoping to detect? A simple answer to this question would be that the Keesler set was not turned on. Remember that it was not an operational air defense radar, but a Training Command set used only for ECM training purposes. McClure decided to look for it because he happened to know it was there, not because it was in any way involved in the scheduled ECM exercise. This was not a training flight, but an equipment-test against operational ADC radars and communications stations by an experienced crew immediately prior to a mission in Europe. There is no overriding reason to suppose, therefore, that the Keesler AFB training radar was up and running at that time on that particular night.

However let us continue to assume, for the sake of the argument, that the CPS-6B at Keesler AFB was operating, that the aircraft's course took it E of Keesler, and that the anomalous signal was detected by McClure at this time. The hypothesis of ALA-6 malfunction still does not directly address McClure's statement to McDonald that the signal crossed the axis of the aircraft and proceeded down the port side of the scope. It is geometrically impossible for the same 180-degree error to cause the same ground signal to transit in this way. But it is possible that the frozen relay released itself during the observation of the signal, in which case the bearing indication would discontinuously jump 180 degrees and then progress down-scope to port. Whether this answers the description of the event given by McClure is arguable. Since McClure's first interpretation of the signal moving up-scope was in terms of precisely such a malfunction, then one would expect that this development would merely confirm that diagnosis, not cause him to "give up the hypothesis" of 180-degree ambiguity.

It is true, however, that this description of the transit of the signal does not appear in the (admittedly brief) 1957 intelligence summary, and does not appear in McClure's first account as reported by Craig in 1967. Indeed, Craig states that McCoid and McClure both recalled that:

> the target [sic.] could be tracked part of the time on the radar monitoring screen . . . but, at least once, disappeared from the right side of the plane, appeared on their left, then suddenly on their right again, with no trail on the scope to indicate movement of the target between successive positions. [Craig, 1968]

Although both men are here referring to a much later phase of the incident near Dallas one would have to say that some confounding of distant memories is possible, and this may be circumstantial evidence of intermittent ALA-6 failure which (it is not ruled out) may have occurred during observation of the first signal. This issue therefore remains unresolved, despite McClure's rather specific recollection of a signal transit as given to McDonald. It is possible that Craig's necessarily-limited early inquiries simply failed to elicit this information, or that it escaped emphasis in his brief 2-page account for the Condon Report; nevertheless, whilst giving due respect to McClure's testimony, a highly pertinent detail of which there is no record prior to 1969 should not perhaps be allowed too much weight in

the argument, and given that the signal did cross the scope to disappear on the port side aft it is still possible that the signal was not observed to transit continuously.

With some reservations, therefore, it is possible that the signal behavior could be consistent with a malfunctioning relay which corrected spontaneously during the observation, and the principal remaining difficulty is finding a CPS-6B source consistent with the reported position of the aircraft. The location of the aircraft at this time, as has been shown, is somewhat uncertain but appears to have been over southern Mississippi. Given this uncertainty some "fudging" might be justified in order to rescue Klass's plausible identification of Keesler AFB as the signal source. The near identity with a CPS-6B output, the aircraft's flight path which at all events passed not very far from Keesler AFB, and the fact that Keesler was the site of the only CPS-6B (or similar FPS-10) set anywhere in the area, all suggest a strong prima facie likelihood that this radar was the source. Therefore one might allow Klass the benefit of the doubt and follow him in relocating the incident "near Biloxi", and further allow that the aircraft could have been "approaching Biloxi", that is, just coming up to the coast a little to the SSE of the radar instead of "shortly after crossing the coast" as McClure had earlier recalled to McDonald. It is not too unreasonable to suppose that McClure, enclosed in the back end of the aircraft, could have mistaken their position by a few miles (eliding meanwhile the contemporary record that the event occurred nearly 100 miles north near Meridian).

However a position just off the coast can be shown to be inconsistent with the S-band vertical-centre radiation pattern of a CPS-6B which might have been operating at Keesler AFB. (Note: only this beam of the CPS-6B is of the appropriate 3000 mHz frequency. Klass himself explores this pattern in some detail when considering the relationship of the identical FPS-10 coverage to later events near Dallas.) At the RB-47's altitude of 34,500' this is (in plan) a triple concentric annulus pattern with the inner edge of the innermost annulus due to the upper sidelobe falling at a ground range of some 28 miles from the antenna. This is a thin ring approximately two miles broad, encircled by a 7-mile null zone, beyond which the annulus formed by the coma lobe and main beam (which are continuous) commences at 37 miles. This main beam annulus extends to a ground range of some 120 miles, followed by another 20-mile null beyond which occurs the outermost annulus some 15 miles wide due to the lower sidelobe. Thus, a 150-degree bearing from Keesler AFB intersects the upper sidelobe more than 20 miles off the Mississippi coast, which is therefore the closest ground range at which the ALA-6 could have been detecting this signal due to the zenithal radar shadow. This lobe, however, is so narrow that the northbound RB-47 would have crossed through it in something like 20 seconds; and given the 4 rpm scan rate of the CPS-6B (with the beam rotating towards the aircraft only once every 15 seconds) it is improbable that McClure would have chanced to detect this signal at all, virtually impossible that he could have observed it more then twice (i.e., an insufficient number of times to determine a "rapid" up-scope motion), and certainly impossible that he could have had the time also to examine its frequency, pulse length, and p.r.f. on his ALA-5 pulse analyser.

The signal would therefore have to be that of the main beam, which a 150-degree bearing would intersect at a ground range from the coast of more than 30 miles, and because the aircraft must remain within this main beam coverage for a significant number of 15-second

antenna revolutions before flying into the null zone and losing the signal it is plain that its position when the signal was first detected would have to be significantly further S still. If this position were 50 miles from the coast, the RB-47 would be flying N within the main beam for a further 20 miles or so, or about 2½ minutes at Mach 0.75, during which time the monitor would be able to receive perhaps ten scans of the signal moving upscope by about 20 degrees to 130 degrees - still well-aft of the starboard beam - where it would disappear; and this should perhaps be considered the minimum duration and movement compatible with the intelligence report of a signal "moving rapidly up the D/F scope", not to mention McClure's own later testimony. (In order for the signal to progress up-scope as far as 90 degrees - abeam to starboard - or further, requires a flight path far enough east of the Keesler radar to avoid the null and remain in the main beam, implying a first-contact position some 70 miles out over the ocean on a heading which would probably take the aircraft N into Alabama rather than Mississippi.)

These values are in very serious conflict indeed with the crew's statements and the contemporary intelligence report, which consistently implicate a location over land during the N approach to Meridian, Mississippi. Despite the attractiveness of the Keesler CPS-6B as the source, therefore, a "fudge" of some 150 miles or more seems difficult to justify. Further, a map of the mission derived from Chase's 1957 Data Sheet [McDonald 1972] shows that at 70 miles from the Gulf coast the RB-47 had only just completed its turn from the gunnery range onto the 1st north leg. This indicates that the (Keesler) source would have been detected by McClure very shortly (a few minutes at most) after this turn and the gunnery/navigation exercise, and when interrogated upon landing he would be expected to recall this recent manoeuvre as the most natural time-reference. One might expect to find, therefore, that the record based on this debriefing would give the position as "shortly after the gunnery exercise", or "over the Gulf" or even "south of Biloxi", but presumably not "approximately at Meridian, Mississippi" which is given as the reference for the turn onto the west leg of the mission.

In summary, therefore, the inconsistencies introduced by the hypothesis that the up-scope signal came from Keesler AFB are unattractive, and in the absence of evidence that the training radar at that site was operational in the early hours of July 17 1957 Klass's argument is not wholly persuasive and the signal source should probably be considered as yet unidentified.

2nd ECM episode, East Central & Northeast Texas

When a similar signal was later detected close to the Louisiana-Texas border, some minutes after visual observations of the rapid, bluish-white light from the flight deck, the plane was once again in straight flight (this time on a heading of 265 degrees) and, according to the intelligence report, once again the bearings to the source moved up-scope, this time remaining to starboard of the aircraft: at approximately 1030Z it was being displayed at 70 degrees; at 1035Z it had shifted slightly to 68 degrees; three minutes later at 1038Z it had moved up to 40 degrees, staying at that bearing for a while, and it was at about this time (1039Z) that Chase and McCoid saw the "huge light" to starboard at a visually estimated bearing of "about 2 o'clock" [60 degrees]. This sequence appears to corroborate -

in its essential features - the account given by Chase, McCoid and McClure to Craig in 1967, before the contemporary record was known: ". . . the number two monitoring officer informed the pilot that the target was starting to move up-scope. It moved to a position dead ahead of the plane . . . and again became visible as a huge, steady, red glow."

By this stage, recalled McClure, he had already checked the performance of his ALA-6 on other known ground radars back near Meridian and it appeared to be working perfectly when the 70-degree signal was picked up at about 1030Z. According to Provenzano's statement to McDonald, after he and McClure now checked the ALA-6 again, he tuned his own #1 APD-4 fixed-antenna monitor to the same frequency and obtained a signal which confirmed the bearing. This was also recalled by McClure in 1967; he told Craig that "the officer operating the number one radar monitoring unit, which was of a different type . . . also observed the same display he observed on unit two." A recurrence of the hypothesised ALA-6 relay failure could not therefore account for the up-scope motion recorded at this time. Additionally it appears from Klass's inquiries to ADC that there were no CPS-6/FPS-10-type radars operating to the port side aft of the aircraft (in S Louisiana), and by this time the CPS-6B at Keesler AFB would have been well out of range - even if it was operating.

However there was an FPS-10 at Duncanville near Dallas (site "Utah"), broadly forward and to starboard of the 265-degree course being flown by the RB-47, and Klass proposes that the signal came from this site. One's instinct is to agree that this seems highly plausible, and one can show that a heading of 265 degrees from near Meridian (fixed by the known map coordinates of the 1010Z visual near Winnsboro) at 500 mph airspeed, with an approximately 50-mph headwind leading to a true groundspeed of about 450 mph, would place the aircraft approximately level with Timpson, Texas by the time of the first signal contact at about 1030Z. Timpson is about 160 miles from Duncanville, very close indeed to the point at which the RB-47 would have entered the FPS-10's vertical-center lower sidelobe at its cruising altitude of 34,500'. Given a signal with near identical characteristics to those of an FPS-10's vertical-center beam, the probability of all these various parameters matching by chance is presumably negligible and one has to conclude that the signal was very probably related to the output of the FPS-10.

There remain some inconsistencies, however, for which no easy explanation currently exists. The positions of the aircraft at various times during this leg can be inferred with some accuracy, as is here confirmed by the close match between the projected course and the first detection of the Duncanville signal. The ALA-6 had recently been checked on other known radar sites and its accuracy was at this time reaffirmed by a further check and the simultaneous corroboration of the independent APD-4 monitor. Yet the true bearing to Duncanville at this time was 30 degrees, whilst the relative signal bearing was recorded as 70 degrees. (A bearing of 70 degrees to Duncanville would place the aircraft at approximately Teague, Texas, a further 115 miles and 15 minutes of flight time beyond Timpson, which is quite inadmissible.) Therefore one is led to suppose either an error of 40 degrees in observation of the monitor(s), at least by McClure and probably also by Provenzano, or a typographical error in the intelligence report, which is certainly not unheard-of. (Note: the rough signal bearings indicated by Klass on his chart of this portion of the flight path [1974, pl.16] are in error by 10-15 degrees favouring the direction of Duncanville.)

Five minutes later at 1035Z the aircraft would have been over the Angelina River approaching Rusk, Texas, and the bearing to Duncanville had moved downscope to 40 degrees, a one-third increase in starboard displacement; but the signal bearing had changed very little, and if anything had moved up-scope a fraction to 68 degrees - a figure which, incidentally, would imply that the values were being read off the bearing ring with some care, since it is in the nature of the ALA-6 display that its broad fan of closely-spaced strobes, painted with only limited persistence on the tube phosphor once in each 15-second revolution of the source antenna, means that more-than-casual attention is required to estimate a displacement of only 2 degrees. The implied error here - whether observational or, again, typographical - is 28 degrees.

By 1038Z, with the aircraft passing the town of Rusk towards Palestine, the bearing to Duncanville had dropped back to 45 degrees and the signal bearing was still moving up to meet it, reaching 40 degrees at this time. Some sixty seconds later, Chase and McCoid first saw the "huge light" off to starboard (which was to remain in visual contact for 11 minutes). About 1 minute later when the aircraft was approximately at Palestine, Texas, at 1040Z, the bearing to Duncanville had now fallen back to 50 degrees but the 40-degree signal was still there, having remained constant for some two minutes.

At this time a second signal briefly appeared at a bearing of 70 degrees; but two minutes later at 1042Z, when the aircraft was passing Palestine and heading towards the area of Fairfield and Teague, the strobes indicating the second source had disappeared, and the remaining source was now still further up-scope at 20 degrees, with Duncanville now well aft of this bearing at about 55 degrees. According to the intelligence report it was at this time, 1042Z, that Major Chase, having requested and received CAA permission to deviate from the 265-degree flight plan and having requested radar assistance from ADC Duncanville, "increased speed to Mach 0.83, turned to pursue, and object pulled ahead." (Klass's sketch map, in contradiction to the officially reported sequence [see para.15 above], shows this turn well underway before 1042Z and also indicates a signal-bearing at this time of about 40 degrees instead of 20, which errors jointly create a bearing close to that of Duncanville. The true mis-match here would appear to be 35 degrees. Note that the signal bearing, from an initial angle of 40 degrees *east* of Duncanville, has now swung to an angle 35 degrees *west* of Duncanville, moving in an opposite sense to the relative down-scope progression of Duncanville.)

This sequence of events from 1010Z to 1042Z was qualitatively described by members of the crew [e.g., paras. 12 & 14] in a way which one can see is quite accurately supported by these 1957 figures. The source appeared to remain at an essentially fixed bearing for some minutes, then began to move up-scope by 30 degrees, at which time visual contact was made from the flight deck. The source then moved up-scope a further 20 degrees, at which point Chase turned to starboard in pursuit onto a heading of approximately 320 degrees true.

During this turn the bearing to Duncanville would swing rapidly towards the bow, but by 1042.5Z the signal bearing was swinging back in the *opposite* direction, remaining to starboard of the aircraft at 40 degrees (at this time a second signal was detected, as once

before, on a bearing of 70 degrees, remaining on-scope for about 1 minute before disappearing). The RB-47 was now traveling at Mach 0.83 on a NW heading which would take it between Dallas and Fort Worth, approximately over Arlington, Texas, only a few miles from Duncanville. The Duncanville radar site was now, at 1044Z, only fractionally off the bow at a range of about 70 miles, but the signal source, rather than narrowing the angle with the bow towards zero, was now at 50 degrees.

By approximately 1048Z the aircraft, still at 34,500' and travelling at Mach 0.83 (TAS 553 mph, estimated ground speed approximately 530 mph, wind 50 mph at 50 degrees off port bow) would have been leaving the main-beam/coma-lobe coverage of Duncanville's FPS-10 to enter the null zone in which no signal from the FPS-10 could be detected. (About 1 minute later it would pass rapidly through the narrow upper sidelobe in a matter of seconds, at which point the ALA-6 could have received a brief signal if the FPS-10 antenna happened to be pointing to the aircraft at the right moment.) The intelligence report states that McClure lost the signal off his #2 monitor at 1050Z, which seems close enough, once again apparently reaffirming the accuracy of the projected flight path and the evident relationship between the Duncanville coverage pattern and the detectability of the ALA-6 signal.

However at this time this spatial relationship starts to deteriorate. Having passed by Duncanville the aircraft began the port turn which was to take it N of Fort Worth towards Mineral Wells, and the signal was reacquired at 160 degrees. At 1052Z this signal had moved clockwise, aft of the aircraft, to a position of 200 degrees, and initial reacquisition must therefore have been at some time prior to 1052Z. Klass estimates a time of approximately 1051Z and indicates a map location which accords with the aircraft's brief re-emergence into the upper sidelobe NW of Duncanville. But if this is correct, then at the time of the 1050Z signal-loss one minute earlier the aircraft would already have been over half way across the radar shadow cone. This zenithal "blind" zone over Duncanville is just over 50 miles across for the RB-47's projected course and altitude as reconstructed by Klass, and the signal should have remained absent for at least 6 minutes if the final contact south of Duncanville occurred with the upper sidelobe, or at least 7 minutes if (much more probably) it occurred with the main beam. (Note: the aircraft had overflown the visual "object" when it "appeared to stop" at the time of the 1050Z signal loss, and would thereafter have been slowing from its Mach 0.83 pursuit into the port turn which would bring it back over the area. Consequently Klass' model itself requires that the estimated 6-7 minute signal hiatus should be considered a minimum.)

This discrepancy invites closer scrutiny of the times and positions indicated on Klass' chart. It becomes evident that during the crucial period 1042-1051Z the aircraft is shown with an average ground speed of approximately 720 mph, even exceeding 750 mph in the 2 minutes from 1042Z. These excessive rates arise from the attempt to correlate the 1051/1052Z reacquisitions with the known coverage pattern at 34,500', and Klass, evidently aware of the introduced inconsistencies, therefore omits to indicate on his chart the one time (signal loss at 1050Z) which would immediately have drawn attention to them.

These difficulties may not in themselves be fatal, but they are significant, and adjusting the time sequence back or forth to compensate has the unsatisfactory effect of introducing

damaging discrepancies elsewhere. This fact invites reappraisal of some other elements of Klass's overall hypothesis. For example, he states that "McClure's records showed no signal for the five minute period between 5:30 A.M. and 5:35 A.M. [CDT - 1030-1035Z]", and argues that this correlates with the null between the two concentric rings of radar coverage formed by the main beam and lower sidelobe. But there is *no* suggestion whatsoever in the intelligence report that the signal *disappeared* during this time. (See para. 11 above. If Klass's curious interpretation were good for this entry then it would be good for others, with the result that there would have been no signal in the periods 1035-1038Z, 1052-1057Z, or after 1057Z - to cite but the more obvious - during which periods the aircraft was [ex hypothesi] well within the main beam coverage.)

The conclusion that all the signal bearings "were pointing in the general direction" of Duncanville is also unacceptable without some reasonable explanation of errors as large as 40 degrees recorded by an experienced operator during straight and level flight. Was the aircraft axis periodically misaligned with its intended 265-degree course due to a drift to port which, perhaps because of faulty instrumentation, was never properly corrected? From the turn at Meridian through 1010Z the position and 265-degree course of the RB-47 can be guaranteed with some accuracy, being fixed by the known map coordinates of the visual event near Winnsboro, and it is a simple matter to show that a mean navigational error of about 20 degrees, applied consistently to port over the period from just before 1030-1042Z, would bring the aircraft to its point of turn somewhere S of Grapelands, Texas, adding several minutes to the existing discrepancy in the times of its passage through the Duncanville radar shadow. (If the southerly drift had begun before Timpson and nearer to Winnsboro, then the aircraft's eventual position and course would be still more problematic. It goes without saying that any substantial, sustained drift off course implies serious error on the part of the navigator and/or failure of numerous aids - magnetic, gyro and radio compasses, charts, clocks, driftmeters and so forth. A deliberate, premature departure from the flight plan to the south makes no sense in terms of a decision to pursue an "object" to the north; and of course a premature departure to the north - a possibility which will be addressed in a later context - is of no present help since it would *increase* the initial bearing error beyond even 40 degrees.)

The effect of wind on the axial orientation of the aircraft is negligible during the 265-degree leg, since the eye of the westerly was only a few degrees off to starboard. But it can be noted that correcting for any minimal crabbing angle so induced has the effect of *increasing* the true error of the signal bearings from Duncanville, since the axis of the aircraft will be rotated into the wind (starboard) to maintain its heading. During the run NW the aircraft may have crabbed measurably to port since the wind would have been from a relative bearing of about 305 degrees, which would have the effect of reducing the measured error; but one would not expect this reduction to be significant in the context of a mean error of 35 degrees.

The possibility that the values cited in the intelligence summary are errors of dictation or transcription is not very realistic. Such an error might occur once but it is not credible that a whole sequence of such values would be misreported, all skewed systematically in accordance with the independent qualitative description of the operator. There appears to be no good reason to question the competence or honesty of the operator, whose readings were

(at least initially, and at the time of the largest "error") reportedly corroborated by another ELINT officer and an electronically independent monitor subsequent to, and concurrently with, equipment checks performed on known ground radar sites. In short there appears to be no substantial likelihood of systematic error either in navigation or in the chain of detection, observation and reporting during this episode of the event, such as would be required to explain the reported bearing error.

This leaves the possibility of random errors, periodically corrected, in the flight heading of the RB-47. Some deviations are naturally bound to occur due to microscale fluctuations in the windflow, but at 500 mph at 34,500', well above the lowland topography of Louisiana and East Texas on a summer's night, one would expect these to be small, brief, erratic, and certainly insignificant in terms of, for example, the mean 34-degree discrepancy carried from 1030Z past 1035Z. During the period up to the turn near Palestine at about 1042Z, the monitor(s) would have had about 45-50 separate "looks" at the signal.

In summary there is a rough but persuasive congruence between the general area of Duncanville's S-band coverage and the general area in which very similar signals were detected, but the claimed accuracy of this match appears to be spurious. Certain anomalies remain unresolved, in particular the sustained gross discrepancies in signal bearing during the portion of the flight path which is most accurately known, and the problem of reconciling known times, speeds and positions of the aircraft with the radiation pattern in the vicinity of Duncanville.

This latter point bears further emphasis: According to the intelligence report, just before 1050Z when the "huge light" was lost visually, the crew reported its position as 10 nautical miles NW of Fort Worth and this was "immediately confirmed" by Duncanville radar. At 1050Z the "object appeared to stop", the pursuing aircraft "overshot", Duncanville "lost object from scopes at this time" and McClure's monitor "also lost signal" for the first time. The position of the aircraft at this signal loss therefore appears to be fixed some few miles NW of Fort Worth. But according to Klass's interpretation, the Duncanville signal and the visual object had at this point already been reacquired when the aircraft had emerged from the radar shadow northeast of Fort Worth, 25 miles earlier on the track but one or two minutes later in time, having not overflown the light 10 miles NW of Fort Worth but (on his chart) passed a full ten miles to port of its position 16 miles NW of Dallas.

If this sounds confusing, it is worth pointing out that, particularly from about 1050Z, confusion is by no means unique to Klass's attempt to make sense of the incident, as will be brought out later. The point is that the apparent relationship between the recorded data and the Duncanville pattern breaks down on examination: it is not confirmed by those data. It also bears emphasis that the implied relative angular motion of the source of the signal bearings (in particular from 1030-1042Z) is contrary to the relative motion of Duncanville, and it is only reasonable to admit that this behavior is consistent with what the intelligence report characterises as a "rapidly moving airborne source", a source which the flight crew believed was later in simultaneous visual and ground-radar contact. Therefore, notwithstanding the at-least-equally difficult problems that might be raised by any such hypothesis, the evidence directly and uniquely implicating the normal Duncanville FPS-10 signal can be said to remain somewhat ambiguous, and the possibility of abnormal

circumstances (which may or may not be suggested by data we have yet to examine) should not at this stage be dismissed.

The essential conclusion to be drawn from the aforegoing is that there appear to be latent errors in the reconstruction of the flight path. It is presently unclear where those errors may occur and what their magnitudes may be, and it is therefore also unclear what effect their correction would have upon the balance of negative and positive indications presented above. The reconstruction which we have considered (broadly following Klass) and which we have attempted unsuccessfully to refine is essentially based on dead reckoning from a single time-flagged map location assuming the assigned heading, approximate speeds, and the approximate time of an approximate point of turn. The course appears to be approximately consistent up to about 1050Z, but the indications of breakdown after this time suggest that it might have to be reworked if that breakdown cannot be mended by closer study.

The Final ECM Contacts, NE Texas & S Oklahoma

As Craig was told by the crew in 1967, it was about half way around the turn W of Fort Worth that the now-familiar ECM signal was reacquired (just before 1052Z) with visual and ground radar contacts regained simultaneously. Chase and McCoid recalled to McDonald that they looked over their shoulders to see the object behind the plane, and continued to turn towards it while Chase requested ground permission to depart from his 34,500' altitude. The object appeared to be stationary, now at an estimated altitude of 15,000', and Chase put the plane into a dive down to 20,000', but at a range estimated at 5 miles the object once again disappeared visually, the signal disappeared from the ECM monitor, and the target disappeared from ground radar.

The intelligence report supports these recollections quite closely, adding that the first signal bearing was 160 degrees (starboard aft), then at 1052Z "200 degrees relative bearing, moving up [the] D/F scope," that is to say advancing up the port side of the scope, which is broadly consistent with the reported position of the object behind the plane as its relative bearing would change during the port turn. At this time, now several minutes after overflying the object NW of Fort Worth at approximately 1050Z, the aircraft would have been turning S of Mineral Wells when it "began closing on object" to within an estimated 5 nautical miles, at which point the light disappeared at an estimated 15,000' altitude, and ground radar also lost their target. The aircraft would now have been coming back E into the area.

It was at about this time that McCoid, having presumably asked Hanley (the navigator) for an update on the 'Howgozit' fuel consumption graph, became "a bit worried" and indicated to Chase that due to the departure from the flight plan and the use of extra power during pursuit they would have to turn for home, and so when contact was lost at 1055Z Chase informed Duncanville that they were heading N for Forbes. The intelligence report does not state (though it can be read as implying) that McClure's signal had also been lost when the the object disappeared visually and from radar on this occasion, but both McClure and Chase clearly recalled to Craig, and separately to McDonald, that this had occurred. However at 1057Z, two minutes after Chase had informed Duncanville of their departure

for home, McClure regained the signal at a bearing of 300 degrees, indicating a source forward of the port wing at 10 o'clock. Since the aircraft would now be roughly SW of Fort Worth and evidently turning or at least preparing to turn N for home this would be in the general direction of Fort Worth, which is not inconsistent with the fact that 60 seconds later Chase confirmed "visual contact with object approximately 20 NM northwest of Ft. Worth" at an estimated altitude of 20,000'.

Klass's construction has the aircraft still westbound towards Mineral Wells at 1055Z, when the object disappeared for the second time, which is thoroughly inconsistent with the statements of the crew and the contemporary report that the aircraft was *already* turning back when it *appeared* for the second time. Three minutes earlier at 1052Z, Klass has the aircraft still heading NW directly away from Duncanville, which - on his own interpretation - is inconsistent with the report that the signal bearings were moving up-scope to port at this time. Again, his own interpretation itself requires that the aircraft had already turned back towards the SE when Chase dived to 20,000' in pursuit of this light (which Klass identifies as Rigel, rising at 105 degrees true in the ESE), but this occurred at about 1052Z when his chart has the aircraft still headed NW. By 1058Z, when Klass indicates that this second visual contact was first made prior to the attempted diving interception, the intelligence report states that this object had already long disappeared and the aircraft was turning N for home.

The reasonable conclusion here is that Klass's attempted reconstruction is seriously flawed as to courses, times and distances flown, a conclusion which is already suggested by discrepancies on the earlier NW leg of the flight towards Dallas. The most serious confusion here arises from his misreading of the intelligence report. He states that from the initial disappearance of the "huge light" at 1050Z nothing at all was seen visually until the final light ("Rigel") was seen at 1058Z, and his belief that the diving interception occurred at 1058Z reveals the origin of this misunderstanding: he has confounded the two separate contacts at 1052 and 1058Z into an amalgam, and is further misled by what appears to be a typographical error in the report of the 1058Z sighting.

The report states that at this time Chase "regained visual contact with object approximately 20 NM northwest of Ft. Worth, Texas, estimated altitude 20,000 ft at 2 o'clock from aircraft." A location NW of Fort Worth, or anywhere near Fort Worth, being unintelligible in terms of Klass's conviction that the light was Rigel in the ESE, he has elided this statement and fastened onto the ancillary detail that it was seen "at 2 o'clock", which he is able to approximately reconcile with his reconstructed flight path (saving that this, too, has to be fudged as will be shown later). But this reconstruction, which has the aircraft still heading SE then meandering into a starboard turn even further S in a diving pursuit of the light "at 2 o'clock", is plainly in error, and the aircraft was at this time (1058Z) positioning itself to depart N, having advised Duncanville of this necessary manoeuvre several minutes before. The declared position of this new object NW of Fort Worth therefore makes sense, being visible to the departing pilot off the port bow, and it is worth repeating that this position would also not be inconsistent with the ECM signal detected moments before at 10 o'clock from the aircraft. The likelihood is that "2 o'clock" is a transcription error, and it is not ruled out that it should have been 10 o'clock. (Note: Klass offers no specific defense on this point, but does elsewhere [source 199] opine that the

intelligence report "contains two obvious errors, one of which may be typographical." He does not indicate them, however.)

The above discussion turns out to improve Klass's argument in the sense that the up-scope signal movements at 1052Z can now be seen as occurring through the port turn W of Fort Worth, and thus W of Duncanville, so that the broad consistency of the signal bearings with a stationary object in the air somewhere behind the aircraft in the rough direction of Duncanville can also be said to implicate the FPS-10 at Duncanville. But the flight path during this turn cannot be exactly plotted, and the axis of the aircraft co-ordinate system will be tangential to this curve so that its attitude now becomes a significant variable. Neither the Duncanville hypothesis nor the "UFO" hypothesis is therefore testable in respect of these bearings.

However, when the RB-47 was heading N from the Dallas area towards Forbes AFB, some 20 minutes after the turn S of Fort Worth, yet another signal was picked up which, in McClure's opinion, was due to the Duncanville radar. From about 1120Z the bearing remained off the tail between 180 and 190 degrees until 1140Z when the aircraft was "approximately abeam Oklahoma City", at which point the signal "faded rather abruptly." Why McClure regarded these signals as distinct from those detected earlier is somewhat unclear, but in 1971 he responded to Klass's explanation of the case saying: "I know that once we were near Dallas and [heading] North towards Forbes, the signals were undoubtedly CPS-6B/FPS-10 air defense radars. I do not believe any UFO was emitting these signals." Indeed he had said as much to Craig in 1967:

> Limited fuel caused the pilot to abandon the chase . . . and head for his base. As the pilot levelled off at 20,000 ft. a target again appeared on number two monitor, this time behind the B-47. The officer operating the number two monitoring unit, however, believes that he may have been picking up the ground signal at this point. The signal faded out as the B-47 continued flight.

The times cited are approximately consistent with the FPS-10 pattern at 20,000' for a groundspeed of about 300 mph which would bring the aircraft to approximately Sulphur (about 60 miles S of Oklahoma City) as it exited the lower sidelobe. Presumably Chase had reduced power to conserve fuel, and he did recall that the signal had been lost in southern Oklahoma even though the navigator, Hanley, corroborated the intelligence report, saying that it was not lost until they were right up to Oklahoma City. McClure was unable to recall exactly. Howsoever a mean bearing of 185 degrees is persuasive and the overall match is not unreasonable.

At this stage the ambiguities in the evidence appear irresolvable. There remains a very strong case for the Duncanville FPS-10 as the source of the signals in terms of the general area of detectability, frequency, period and pulse pattern, and that the FPS-10 output was detectable appears to be confirmed by the operator's opinion that he was receiving it, at least after about 1120Z. A rough correlation of signal bearings with the location of Duncanville can be argued for the periods 1051-1055Z, and 1120-1140Z.

On the other hand the relationship with the FPS-10 pattern is not without anomaly. The reported location of the aircraft at the time of the initial disappearance of the "huge light" and concurrent loss of ground radar/monitor targets at 1050 is specifically fixed as being close to a position "10 NM northwest of Fort Worth", this being where the "object appeared to stop and aircraft overshot". This has been shown to be consistent with times and bearings along the subsequent flight path, but is clearly inconsistent with the Duncanville radiation pattern since it permits no signal loss at all concurrent with passage through the zenithal radar shadow and indeed requires signal loss to occur when the aircraft has re-entered the main beam. Also the correlation of the 1057Z signal with Duncanville is doubtful, the probable flight path at this time arguing for a bearing several tens of degrees away from Duncanville. Prior to 1050Z the bearing error is not only greater than can easily be explained but is inversely correlated with the bearings to Duncanville in a manner not symptomatic of electromechanical failure. The ground speed required to get the aircraft from its initial turn SE of Duncanville to Klass's signal-loss location at the required time is grossly excessive, even if this location were to fit the radiation pattern, which it does not; but the actual recorded location of this event, which is a far worse fit still, would require an even more excessive speed based on the assumed location of the turn. Therefore some major reconstruction of at least this portion of the flight path prior to 1050Z is clearly in order on any hypothesis, with results that are presently unpredictable.

For the moment it would too much to say that the Duncanville hypothesis has irretrievably broken down, but in its simplest form it no longer looks in very good shape, and it is fair to say that the immediate cause of the anomalous signal bearings remains uncertain. At the same time there is for most of the duration what appears on the face of it to be a provoking correlation between the pattern of signal acquisition, motion and disappearance, and events observed visually and by ground radar. Klass believes these concurrent radar-visual events to be explainable in terms of a civil aircraft, two astronomical objects and coincidence. It is to these matters that we now turn.

The Visual and Ground Radar Contacts

The initial visual sighting occurred at 1010Z during the west leg in the vicinity of Winnsboro, NE Louisiana, before McClure had mentioned the anomalous up-scope signal detected back in S Mississippi. Chase, up front, was the first to spot what he said he at first took to be a rapidly approaching jet with its landing lights on. But it appeared to be at or above their own 34,500' altitude. The "very intense" bluish-white light continued to close fast from about the 11 o'clock position, and Chase called McCoid's attention to it. No navigation lights were visible. At that point Chase warned the crew over the interphone to make ready for a sudden evasive manoeuvre, but before he could take action the light appeared to change direction and shot across the nose of the aircraft at extreme speed to a position which Chase recalled as about 2 o'clock and which the intelligence report refines to "2:30 o'clock". Both men watched the passage of the light and saw it disappear at this point. During the following interphone talk, McClure then brought up the odd radar signal in Mississippi.

Klass suggests that this object was a fireball meteor, its apparent proximity and change of direction being illusions. This is certainly possible and not without precedent. Interestingly it appears that Blue Book initially explained the very similar "buzzing" of American Airlines flight #655 near El Paso, Texas, on the same night (0330 MST/0930Z) as a fireball, but then changed their minds in favour of flight #966 which had recently departed El Paso for Dallas and would (according to Klass) arrive there at about 1050Z in time to play the role of UFO for the second time on the one trip, as we will see. But the "brilliant green" object or "huge green UFO" which "shot" eastwards past flight #655 on its westward approach to El Paso, appearing out of a clear sky "without warning" and causing the Captain to execute a violent manoeuvre which injured 10 passengers, certainly sounds more like a fireball than another Douglas DC-6. The ambiguous sensitivity of the dark-adapted eye to shades of blue and green is well known, and it would be tidy if this incident and the RB-47 sighting 530 miles away could be explained by the same eastbound fireball.

The alpha Capricornid radiant would have been low in the SW sky, and although only the outermost fringe of this shower (July 18 - 30) could have been entered on July 17 its meteors do tend to be slow and bright, even though it is not noted for fireballs. (The alpha Cygnid radiant, the other main shower visible during July, would have been far too high in the sky at over 75 degrees terrestrial elevation.) It would not be the first time that pilots have been misled by the sudden brilliance of a fireball into grossly underestimating its range. Unfortunately the fixed times make this impossible, leaving us with either of two somewhat improbable scenarios: two separate fireballs leading to two similar near-collision illusions for two different flight crews within an hour; or one fireball, plus flight #966 which appeared once as a "huge green" UFO near El paso then again (according to Klass) as a "huge red" UFO near Dallas/Fort Worth.

The next visual sighting of the object in the NW apparently 5000' below the RB-47 at 1039Z, and which Chase pursued in his turn towards the Dallas area, is ascribed by Klass to the star Vega, which he describes as being "brilliant" at a true azimuth of 300 degrees and an elevation of 27 degrees. When the action got closer to the Dallas/Fort Worth area Chase and McCoid started looking at flight #966 in approach to land at Love Field, Dallas, having presumably transferred their attention from Vega at some point. When flight #966 landed, disappearing visually and from ground radar, the RB-47 overflew its position, banked into a port turn to bring it back over the area, and "regained visual contact" just as ground radar "regained scope contact", but an attempt to close on this object was foiled by another simultaneous radar-visual disappearance. Klass offers no interpretation of these events. But a final light was seen as the RB-47 was beginning its turn N for home. This time, argues Klass, they were looking at the star Rigel. Firstly let us consider the flight #966 hypothesis in the context of the reported radar-visual evidence.

The event, or sequence of events, for which Klass offers no interpretation is actually of central importance, but due to his misconstruction of the intelligence report (indicated earlier) he allows the reported ground-radar contacts to recede to a single target which appeared "briefly" only once and was, he believes, misinterpreted in "the excitement of the moment". Further, he states that this contact only occurred "according to the crew account", and that it was subsequently denied by the Duncanville commander in a report to ADC with the statement: "HAD NEGATIVE CONTACT WITH THE OBJECT." Rather than

"question the veracity of the crew report" Klass proposes that this target, reported briefly just before the over flight and ECM/visual disappearance at 1050Z, was American Airlines flight #966 approaching Love Field, Dallas, ETA 1100Z. Its landing lights would explain the "huge light" which the RB-47 overflew, and as it dropped low on final approach it would coincidentally have disappeared from Duncanville radar. If this target had been identified later as this civil DC-6, then "the commander might be too embarrassed to admit the error and could try to dismiss his station's involvement with a brief 'HAD NEGATIVE CONTACT WITH THE OBJECT.'"

This ostensible denial is indeed brief, and seems little with which to fill the three pages of report data transmitted by TWX from Duncanville to Air Defense Command Headquarters some four hours after the event. The context of this phrase, which Klass explicates as meaning that no UFO "had been sighted on the radarscopes - at least the one the RB-47 had been chasing", is therefore unclear. However the report of the incident compiled at the instigation of the Director of Intelligence, Headquarters, Air Defense Command, by the COMSTRATRECONWG 55 Wing Intelligence Officer almost a month later was in no doubt that Duncanville ADC radar had scope contact with the "object", and this information was passed to Blue Book by ADC without any denial. Indeed, the information in this report could hardly have been denied since it was based, not on assertions "according to the crew", but on real-time, on-board voice recordings.

From at least 1048Z (possibly a little earlier) when the ground-radar episode was just beginning, the officer operating the RB-47's #3 monitor, Walter A. Tuchscherer, was "recording interphone and command position conversations". What this means is that the associated equipment designed to record hostile military communications intercepted by this monitor, as well as time-referenced navigational data from the flight deck for post-mission analysis, was now switched on by Tuchscherer and had begun recording the on-board interphone conversations of the crew as well as the radio talk between Chase, in the "command position", and the Duncanville ADC radar controllers. This was evidently the recording which Chase remembered being removed from the aircraft by intelligence personnel when they landed, and equally evidently it informed the report compiled by those personnel.

Having stated that ECM #3 had now (1048Z) begun recording, that report goes on:

> ADC site requested aircraft to go to IFF Mode III for positive identification and then requested position of object. Crew reported position of object as 10NM northwest of Ft. Worth, Texas, and ADC site Utah immediately confirmed presence of object on their scopes.
>
> At approximately 1050Z object appeared to stop, and aircraft overshot. Utah reported they lost object from scopes at this time, and ECM #2 also lost signal.

According to Klass, flight #966 was at this time on final approach to the Dallas, Love Field runway with its landing lights on. But according to this report the "object" was the best part of 30 miles away NW of Fort Worth. If flight #966 was not yet on final approach, and was 30 miles away, it would not have had its landing lights on; and if it was on final approach at Dallas with its landing lights on at 1050 (ten minutes before its ETA) when it

disappeared from the radar, it would have to have flown at about 900 mph to reach Love Field in the maximum of two minutes since radar "confirmed" its position NW of Fort Worth. Furthermore the object which the RB-47 was pursuing had been initially sighted 11 minutes earlier at 1039Z, appearing then as a "huge light" at 2 o'clock from the aircraft which was then about 100 miles SE of the over flight area (based on the "pursuit" speed of Mach 0.83), and flight #966, approaching this area from the west at, say, 200 mph, would have to have been some 50 miles *further* away at this time. It is safe to say that, even had its landing lights been unaccountably on at this time, flight #966 could not have appeared as a "huge light", let alone a "huge, steady, red glow", from a range approaching 150 miles. (Klass realises this, which is why he suggests that Chase and McCoid were initially pursuing the star Vega.)

Klass's model is furthermore internally inconsistent, inasmuch as he indicates flight #966 approaching Love Field being "overflown" by the RB-47, but at the same time indicates the RB-47 on a heading which never passes within 10 miles of it; this makes no sense in terms of the "pursuit" of the "huge light", and still less sense when the aircraft, supposedly having then drawn abeam of the object 10 miles away, rather than turning starboard to correct its approach turns even further away to port and proceeds westwards N of Fort Worth before finally turning back near Meridian some 70 miles from Love Field. This course does, however, make sense if the aircraft is pursuing an object NW of Fort Worth as stated in the contemporary report.

If the luminous radar target which disappeared at 1050Z had been flight #966 landing at Dallas, however, then it evidently would not explain the luminous radar target which reappeared a couple of minutes later. Klass's exposition here passes on to examine the ECM signals newly acquired by McClure to the rear of the plane at this time, but omits all mention of any further ground radar contact and concurrent visuals, giving particular emphasis to the seemingly damaging contention that "the flight crew had not been able to reacquire visual contact with the light . . . Nor did the unidentified target show up on the Duncanville radar scopes." However, this and the ensuing phase of the incident are recorded in the intelligence report in terms which fully support the recollections of all of the crew that ground-radar, visual and ECM monitor contacts were regained almost simultaneously at this time: "About half way around the turn," Craig was told in 1967, "the target reappeared on both the monitor and ground radar scopes and visually at an estimated altitude of 15,000 ft.", and McDonald noted that "All of the men recalled the near-simultaneity with which the object blinked on again visually, reappeared on the #2 scope, and was again skin-painted by ground radar at site Utah", shortly to be lost yet again in another simultaneous radio-optical disappearance when Chase attempted to intercept it. "Whenever we'd lose it, we'd all lose it," insisted McClure in 1967. "There were no 'buts' about it, it went off." The 1957 intelligence report, compiled with the aid of recorded intercom and radio traffic between the aircrew and the Duncanville radar site, confirms:

> Aircraft began turning. ECM #2 picked up signal at 160 degrees relative bearing. Utah regained scope contact, and aircraft comdr [and copilot] regained visual contact. At 1052Z ECM #2 had signal at 200 degrees relative bearing, moving up his D/F scope. Aircraft began closing on object until the estimated range was 5NM. At this

time object appeared to drop to approximately 15,000 feet altitude, and aircraft comdr lost visual contact. Utah also lost object from scopes.

It is certainly true that the ground radar returns, taken alone, are not able to be evaluated, and in another case the bare report of targets gained, lost and regained would be of little interest. Here, however, a flight crew's report of a visually unidentifiable light was "immediately confirmed" at the given position, which suggests at least a *prima facie* likelihood that radar and visual observations were of the same object, as Klass is evidently moved to concede. But at this point the idea that flight #966 could be the culprit is already strained for the reasons we have discussed; when the radar-visual disappearance happens to coincide with loss of the ECM signal detected at the object's bearing, due to the aircraft's passage out of the FPS-10 beam, the strain increases; when contemporary records indicate that the plane was at this time, on the contrary, flying deeper into that beam, the strain begins to tell; when visual, radar and monitor contacts are all then regained simultaneously, with no flight #966 now in the air, coincidence is pushed to breaking point; and when contact is yet again simultaneously lost visually, on ground radar, and (according to the crew's testimony) on the monitor, the hypothesis of coincidence must surely collapse.

There appears to be one possible unifying explanation of the ground/air electronic synchrony. If the Duncanville radar was in fact tracking the RB-47 in the belief that it was the "UFO" then coincidence would no longer be needed. As the plane left the radar coverage its blip would disappear and the onboard ECM monitor would simultaneously lose the radar signal; then as the aircraft turned it could re-enter the radar coverage, its blip would reappear on the Duncanville scopes and the ECM signal would be reacquired. Unfortunately this is untenable. Firstly this offers no explanation for the concurrent visual losses and reacquisition; secondly, radar target and ECM signal loss at 1050 is inconsistent with the westbound flight NW of Fort Worth away from the inner null zone in the radiation pattern; and thirdly, Duncanville had ensured "positive identification" of the RB-47 by requesting that its transponder be switched to send a unique IFF identity code which would distinguish it on-scope from any other target. Having done this Duncanville "immediately confirmed presence of object on their scopes" at the reported visual location.

The use of IFF here is of some importance. IFF Mode 3, as requested by Duncanville, was the transponder mode for joint civil/military aircraft identification (as opposed to the classified military uses of modes 1 and 2 and a separate mode for altitude report) and is still designated as such in modern SSR radar systems which evolved from the IFF principle. IFF is a dedicated system separate from the surveillance radar output, exchanging space-coded pulses at frequencies around 1 gigahertz in the middle of the UHF region between an interrogating transmitter piggy-backed on the ground radar and an active transponder in the aircraft. According to the intelligence report, Chase "requested all assistance possible" from Duncanville shortly before 1042Z, but it appears that it was not until around 1048Z that Duncanville "requested aircraft to go to IFF Mode III for positive identification and then requested position of object." Klass finds it suspicious that "despite the light traffic at that early hour [Duncanville] asked Chase for assistance in locating the UFO," presumably suggesting that they could see nothing substantial until Chase encouraged them to hunt for a target. But this is inconsistent if what they then did "immediately confirm" was the very-substantial American Airlines DC-6 coming in to Dallas on its routine bread-and-butter run

from El Paso. This blip, approaching a nearby major airfield in the manner of dozens of identical blips week in week out, should have been straightforward to identify in 6 minutes - if not by interrogation then by simple familiarity - and a delay suggests not that ADC personnel were watching flight #966, so dumbfounded by this "UFO" as to forget for six minutes that the pursuing RB-47 pilot was waiting for "all assistance possible" in order to intercept it, but that they had quite other problems.

Given that flight #966 was somewhere on-scope, as it presumably should have been since we know that that it left El Paso, the Duncanville operators would doubtless have noted it in response to Chase's preliminary report that he was in pursuit of a UFO in the area, but it would probably be promptly identified, which explains why they did not report back to Chase that they had a "UFO" target on-scope. The operators would be looking for an *uncorrelated* target to correspond with Chase's quarry in order to begin giving him vectors to intercept, and in order to give this assistance they would need to know the instant position of the RB-47. If they had an uncorrelated target and the RB-47 on-scope this would not be a problem, so the reasonable inference is that at least one of these targets was not on-scope at that time. Now the most obvious target on-scope in conditions of "light traffic" should have been that due to the B-47 bomber hurtling straight towards the area at maximum throttle, yet despite having radio contact with the pilot the operators were so uncertain of the location of the RB-47 even after several minutes that they requested positive identification by IFF Mode 3. Whatever else was or was not displayed on the scopes it is plain that the primary need was not "assistance in locating the UFO", but assistance in locating the RB-47. Why should Duncanville have had this problem? The answer is that the RB-47's northwesterly pursuit past Duncanville had taken it through the zenithal radar shadow above the site, and for several minutes it would itself have been undetectable.

At about 1048Z when Duncanville confirmed a target at the location 10 miles NW of Fort Worth, approximately over Lake Worth, the closing aircraft would only just have been approaching the point of emergence from the radar shadow and an object moving ahead of the aircraft (at a visually estimated range of 10 miles according to Chase) and at lower altitude would have emerged a little sooner. When Chase had first contacted Duncanville at about 1040Z the aircraft would have been some 70 miles SW of this point of emergence (based on a ground speed of 530 mph, true airspeed 553 mph - Mach 0.83 - wind 50 mph from 300 degrees relative) and would still probably have been on-scope to the SW of Duncanville, approaching the null inside the main beam coverage which would begin at a ground range of 37 miles from the site. It would not be on-scope for long, however, and an object an uncertain distance ahead of the RB-47 could already have been inside the shadow cone at this time. When, quite shortly after this, the RB-47 blip itself disappeared as it entered the radar shadow, the operators would have been watching the scopes for the uncorrelated target, doubtless noting the inbound scheduled flight on its low-altitude approach NW of Dallas and checking it out. They would have had a plot of the RB-47's NW heading when contacted by Chase, confirmed no doubt by his voice report to them and possibly also by his prior call for permission to the CAA Air Traffic Control Center at Dallas, so that the operators would have a fair idea of where and when to expect its re-emergence. But meanwhile they evidently had no assistance to offer for several minutes as the RB-47 continued through the blind zone overhead. (Note: this perhaps explains Klass's

objection that "the [Duncanville] commander denied that a UFO had been sighted on the radarscopes - at least the one the RB-47 had been chasing." Initially, and for several minutes, they would indeed have had "negative contact with the object" which the RB-47 was chasing, and this context interprets an otherwise puzzling remark.)

Then at about 1048Z, just after Tuchscherer began recording voice traffic at his #3 monitor position, something happened to prompt a query from Duncanville. If a target had then been seen emerging out of the shadow to the NW of the site the operator would need to know if it was the RB-47, and the sure way to identify it would be to request the aircraft to transmit its IFF recognition signal. The operator radioed Chase and asked for "positive identification" by IFF Mode 3; Chase complied, and when the target, now heading to the N of Fort Worth, did *not* display the recognition signal the possibility would arise that this was the "UFO". Consequently Chase would be asked for the estimated current location of the object, which he gave as 10 nautical miles NW of Fort Worth, and "ADC site Utah immediately confirmed presence of object on scopes." A minute or so later the pursuing RB-47 would itself probably have been painted emerging into the pattern, its transponder signal identifying it as it followed the unknown NW. At this time, recalled Chase, "he began to sense that he was getting closure at approximately the RB-47 speed" and at the same time Duncanville informed him "that the target had stopped on their scopes". He veered the aircraft slightly to avert any danger of collision but found that he was coming over the top of the object, visible below at a depression angle of about 45 degrees. At 1050Z it disappeared "like throwing a switch", Chase overshot, "Utah reported they lost object from scopes at this time, and ECM #2 also lost signal."

Note that this construction of events interlocks closely with the times and positions relative to Duncanville and Fort Worth for which other arguments have been put forward above. And note particularly that the course of the aircraft through the Duncanville shadow cone immediately prior to 1050Z appears to be confirmed by this internally consistent interpretation of Duncanville's actions at this time. If this is correct then the obvious implication is that the 3000 mHz radar signal being detected by the RB-47 up until 1050Z was *not* due directly to the Duncanville FPS-10.

The evident correlation of these and subsequent radar/visual events is rather persuasive evidence of some unusual phenomenon or combination of phenomena. The least one should reasonably conclude is that the report is not convincingly explained by American Airlines flight #966.

The object seen at 1039Z apparently 5000' below the aircraft's altitude, which Chase had turned NW to pursue, could not even optimistically be interpreted as flight #966, as Klass realised. He therefore tentatively adopts the explanation, suggested by Rober Sheaffer, that this light was the star Vega in the constellation Lyra. Quoting Sheaffer's description of Vega as "a brilliant star, brighter than the first magnitude" he suggests that although an experienced flight crew would not normally mistake a star for a UFO, given the earlier "fireball" and the signal now being detected by the back-end crew they would be "anxious" and "searching for visual contact." At 1039Z Vega would have been about 30 degrees to starboard of their course (1 o'clock), which is perhaps not unacceptably far from the crew estimate of 60 degrees (2 o'clock); but it was at an elevation of 27 degrees, and at no

altitude does an aircraft close its distance from a star sufficiently to diminish its angle of elevation! At 34,500' Vega was still 27 degrees above the aircraft's level wing. (Note: the wing would be level unless Chase was already starting a tentative starboard turn towards the light, in which case the angle of bank would *increase* the apparent elevation above the wing.) Experiments and case-studies demonstrate a marked tendency for even experienced observers to grossly overestimate elevation angles, in addition to which the psychological effect of relating one's judgement to the ground below from an altitude of 6.5 miles would probably be to further exaggerate the estimated elevation. Thus there is no clear reason why a bright but unspectacular star (visual magnitude +0.14; for comparison the star Sirius at -1.58 is almost 5 times as bright, and Venus, which is commonly described as "brilliant", can be more than 50 times as bright) at fairly high elevation almost a third of the way to the zenith should be singled out in the NW sky as a "huge light" 5000' below the aircraft

Exactly how or when Vega became confused with flight #966 remains obscure. There is no suggestion in the witnesses' testimony or in the intelligence summary that there was anything vague or fugitive about the "huge light" which Chase turned to follow: it was "pursued", "pulled ahead" and appeared to hold a ten mile range in the "perfectly clear" cloudless sky. But at some point, according to Klass, Chase and McCoid ceased looking up at Vega - which would now have been almost dead ahead in the middle of the windshield and compelling enough to appear as a "huge light" - and began looking down at the landing lights of flight #966. According to his own model this transfer of attention must have occurred some time earlier than 1050Z, when the RB-47 flew over the position of flight #966, and, also according to his model, it must therefore have occurred southwest of the position at which the simultaneous ECM signal loss occurred as a result of the plane exiting the FPS-10 radiation pattern. Thus, even with Vega invoked, flight #966 cannot have been closer than about 50 miles away when observed; at this minimum range it would be on top of Dallas airport and would have landed long before the RB-47 got anywhere near it; and, of course, if the RB-47 had got anywhere near it the ECM monitor could not have been receiving the Duncanville signal. Added descriptive details offered by the crew make this scenario even less tenable: the light was a "red glow", a "huge, steady, red glow" which "appeared to emanate from top of object". Vega's elevation of 27 degrees exceeds the critical mirage angle by a factor of fifty, and exceeds even the maximum angle for extreme scintillation by a factor of two. There were no clouds in the NW. Vega therefore could not appear red. DC-6 landing lights are not red.

When the aircraft had later begun to turn for home at 1058Z after the final radar-visual disappearance the flight crew observed another light, construed as the same "object", at a position given as 20 nautical miles NW of Fort Worth, apparently at the same 20,000' altitude as the RB-47. As earlier discussed this position is dramatically inconsistent with the cited relative bearing of "2 o'clock", as viewed from any point on the flight path, but the night was "perfectly clear" and the crew reported that they could see "the lights of cities and burn-off flames at gas and oil refineries below" which would be useful pilotage points to confirm Hanley's navigational reckoning. It seems probable that Chase and McCoid knew well enough where they were in relation to Fort Worth, and since on any possible reconstruction of the course a 2 o'clock bearing would at all times since the original approach from Meridian have been on the opposite side of the aircraft from Fort Worth, one is forced to conclude that the figure "2" is an introduced error (possibly mis-transcribed

from a spoken "ten" on the ECM #3 recording). However Klass elects to accept this bearing, discounts the declared position NW of Fort Worth without explanation, and mysteriously indicates the "apparent position" of this light some 50 miles SSE of Fort Worth, arguing that it was probably the star Rigel given "an unusual appearance" by some clouds in the south.

The aircraft "was heading southeast" and Rigel "was in the southeast at an azimuth of 105 degrees" visible at 2 o'clock from the aircraft, argues Klass. But this is a little fudged, since Rigel, at 105 degrees azimuth, was not SE but barely S of E, and if anything it would appear to port (N) of an aircraft on a SE heading, thus nowhere near 2 o'clock, which is 60 degrees to starboard. In fact there is no reason to suppose that the aircraft was on a SE heading, as has been indicated. However at the time of this sighting "Utah had no scope contact", which it presumably should have had if the same "object" was really 20 miles NW of Fort Worth at 20,000'. There is no indication of how long this object was in sight, whether it moved, what it looked like, or how it disappeared. This final sighting therefore remains unresolved for want of information.

Queries and Conclusions

It is evident that a precise time-flagged plot of the RB-47's off-course movements in the Dallas/Fort Worth area would be the only means of certifying the existence or otherwise of a relationship with the Duncanville FPS-10 radiation pattern. And any original navigational records, wire-recordings, radarscope photographs and so forth which might establish such a plot will, equally evidently, never be available. The course as sketched in the ADC data sheet some weeks after the event by Chase, from which McDonald derived his reconstruction, differs markedly from that favoured by Klass and reportedly refined in correspondence with Chase in 1971. Klass's model can at least be tested, however, inasmuch as it is required to interlock with his FPS-10 hypothesis, and there are seen to be significant timing inconsistencies.

Considered alone such inconsistencies might not be damning, but in the context of the whole they are irreducibly at odds with times and events which are either fixed by the record or which can be reasonably inferred. To further labour one example, Klass's model requires signal loss at 1050Z to have occurred some 30-40 miles south of Duncanville, coincident with the over flight of an American Airlines DC-6 some 10 miles north of Duncanville, which is clearly impossible and furthermore inconsistent with the contemporary record, which tells us that this over flight occurred somewhere NW of Fort Worth. Klass attempts to elide the difficulty by not indicating the location of the RB-47 at 1050Z since, on his own model, ECM signal loss at this time could not be consistent with the Duncanville radiation pattern. If one accepts half of the hypothesis, coupling the 1050Z signal loss to the radiation pattern but forgetting about trying to fit in flight #966 (perhaps there was some other large light source 30-40 miles south of Duncanville), then the whole thing comes uncoupled at the other end because the signal was reacquired in about 1 minute (about 1051Z), which cannot be squared with the time required to cross at least 50 miles of radar shadow (the minimum between brief upper sidelobe contacts). If the Fort Worth location is a gross error (perhaps in debriefing or transcription), and the RB-47 therefore did not have to cross the zenithal radar shadow but made its turn to port due south of

Duncanville and thus quickly re-entered the radiation pattern nearby, then it could not have been anywhere near Mineral Wells at 1055Z, requiring a further error in the record.

On the other hand the documented location of radar/visual/signal loss NW of Fort Worth, 60 or 70 miles away, is consistent with the sequence of subsequent events during and after the turn in the direction of Mineral Wells, with the actions of Duncanville ADC including the delay in providing radar assistance and the need for IFF identification of the RB-47, with signal bearings indicating a source in the rough direction of Duncanville from about 1052Z, and with CAVU conditions favourable to good pilotage which would hardly permit confusion between the small towns of the Texas prairies and the lighted conurbations of the Dallas/Fort Worth area. It seems very significant, if bewildering, that signal loss at this location is also grossly inconsistent with the Duncanville radiation pattern.

This schedule is therefore self-consistent from 1050Z, but still fails to explain the immediate cause of the FPS-10-type signal detected when the RB-47 should not have been directly illuminated by the FPS-10 at Duncanville. It may also not have escaped notice that it is of no help in removing the timing discrepancy between the assumed 1042Z turn from a 265-degree heading and the aircraft's arrival in the Fort Worth area at about 1050Z. When considering Klass's chart of the flight path excessive ground speeds were found to be required during this NW run, which was one of the anomalies which prompted a re-evaluation of his scenario. Therefore, although both Klass's scenario and the present one are about equally embarrassed by this discrepancy and its resolution is not probative in respect of either, it clearly still needs to be addressed, since it has been argued that the initial heading and speed of the RB-47 on its west leg from the area of Meridian are rather well established up until approximately the point of turn. To find out the magnitude and direction of any adjustments that would be required, and to consider whether any are justifiable, it will be necessary to look at this point again in detail. And if any adjustments were both justifiable and useful, how would they affect earlier conclusions about the correlation or otherwise of the 1030-1050Z signal bearings with the bearings to Duncanville?

Given that the 1050Z over flight location was in the area of Lake Worth one is now in a position to work backwards from a second time-flagged map position towards the first, 1010Z near Winnsboro, Louisiana (actually 32 degrees 00 minutes N, 91 degrees 28 minutes W, about 10 miles east of the small town of Wisner). The straight-line distance between these two points is approximately 325 miles on a heading of about 280 degrees, passing approximately over the top of Duncanville and requiring a mean ground speed of about 487 mph; but we know that this distance has to be increased by an initial heading of 265 degrees followed by a turn to the NW. A position for this turn can, as we have seen, be extrapolated by assuming a constant Mach 0.75 (about 450 mph) on 265 degrees, which is supported by the intelligence report's statement that only at the time of this turn did Chase "increase speed to Mach 0.83"; but the required mean speed thereafter becomes excessive. Chase, however, recalled that he actually varied speed before the turn in an attempt to change the relative bearing of the signal source, which nevertheless remained constant to starboard. The exact time of this exercise is unknown, but could have been during the period 1030-1035Z, just after the signal was acquired, when the intelligence report shows a negligible variation between 70 and 68 degrees. Whether the mean effect was to retard or

advance the aircraft is unknown, but there is the possibility of some latitude in the mean true ground speed at this point.

Is it possible that Chase actually altered course slightly, too, with the same experiment in mind? When the "huge light" appeared visually off to starboard at 1039Z in roughly the same direction as the signal it would certainly be psychologically consistent if Chase had elected to veer a little from his assigned course by this time, an "unofficial" outing in the interests of mounting curiosity. After all, the likelihood of interfering with any other traffic at 34,500' would be negligible, the night was "perfectly clear", their assigned turn for home near Waco, Texas, would be coming up shortly, and a little premature nudge towards the north might do no harm. When, according to his statement to McDonald, he "overcame his reluctance about calling attention to these peculiar matters" and sought official CAA permission to "ignore flight plan and pursue object", it would not be surprising if he was in fact already somewhat north of the position actually required by that flight plan, now prudently seeking retrospective sanction for a course of action to which he was already committed. By 1040Z when, according to the intelligence report, he received that sanction, one can well imagine that Chase was already inching the RB-47 further to starboard in anticipation, keen to keep the "object" in his sights. And by 1042Z, when he officially "increased speed [and] turned to pursue" he might have been putting on power and coming out of a turn that was already well underway from a start position some miles north of his assigned course. The cumulative effect of a small deviation of this kind over several minutes could well be significant, and could explain why Chase reached the Fort Worth area somewhat earlier than he "should" have done.

Circumstantial evidence for something of this kind is found in the map of the flight path which McDonald derived from Chase's original 1957 sketch, which does indeed indicate a slight starboard drift beginning west of the Louisiana/Texas border, easing into a less acute turn. Notwithstanding the evident scalar and geographical approximations in this map, this qualitative feature may thus be significant; and given that time needs to be found somewhere on any hypothesis, save the one that the whole report is a tissue of inexplicable yet fortuitously interlocked errors, a premature off-course trend towards the "object" - which is psychologically and tactically plausible - should probably be accepted as the only reasonable explanation.

However, one immediate effect of slightly "straightening out" the bend in the course by such a deviation is to bring the NW pursuit heading of the RB-47 even closer to a diametric crossing of the Duncanville radar shadow, increasing the duration of the anomalous FPS-10-type signal. That is to say the aid which it supplies to the timing with the one hand it removes with the other, and there appears to be no evading this difficulty. The only course adjustment which would reconcile the anomalous signal with the radiation pattern would be to locate the point of turn more than 100 miles further on, about due south of Fort Worth in the area of Waco, with a subsequent heading due N passing to the W of Fort Worth and thus avoiding the zenithal shadow; but needless to say this bears no resemblance whatever to the course as recalled by the crew, as sketched originally by Chase, as reconstructed by Klass, or as allowed by the timing. To have reached Waco by about 1042Z would require a mean air speed of some 630 mph during the 32 minutes since Winnsboro, or about 25% greater than that declared, which is inadmissible; the match between the 1030Z signal

acquisition and entry into the Duncanville lower side lobe is thereby destroyed; Waco was the scheduled point of turn for the mission, but the intelligence report confirms that an unscheduled "off course" turn was cleared with CAA Air Traffic Control; and the speed required for the N leg to Fort Worth would also remain excessive.

A second effect of the inferred starboard departure from a 265-degree heading is to rotate the true signal bearings clockwise during the period from commencement of the drift to the turn proper at 1042Z. The bearing errors from Duncanville will therefore change unpredictably by an angle equal to the difference between the true instant heading and the assigned heading of 265 degrees. Since the extent of this (possibly inconstant) difference is unknown, one can do no more than indicate the gross tendency: if the deviation had begun prior to 1038Z (as it probably should have done in order to become substantial) then the large (order of 35 degrees) positive error recorded prior to this time would be increased; but the relatively small negative error from 1038Z through 1040Z (about 8-15 degrees) would be decreased; and the widening negative error after this time would also tend to be slightly decreased. These changes would probably not be large - only a few degrees - and the overall percentage inaccuracy would probably not be much altered; but it is noteworthy that the bearings to Duncanville during a creeping turn could be moving up-scope, and - especially if the turn proper were commenced prematurely - the up-scope movement of the signal between 1030Z and 1042Z would then no longer necessarily be inconsistent (qualitatively speaking) with the Duncanville signal.

Thus far, then, there is nothing lost and a great deal gained in terms of overall consistency by proposing that Chase tentatively anticipated his official clearance to depart from the flight plan. Some improvement in the match between signal motion and the relative bearing of the Duncanville FPS-10 is achieved, and it becomes possible to get the RB-47 to the Fort Worth area by 1050Z at reasonable speed. But the immediate origin of a signal which was not lost until 1050Z remains unexplained.

Three further anomalies remain to be mentioned. When Roy Craig first interviewed McCoid and McClure in 1967 he was told that the RB-47 navigator, Hanley, had received returns on his airborne radar (as opposed to the emitted signals which McClure was detecting) from a target at bearings coincident with those of the visual object, the signal on the passive monitor(s) and the ground radar target. Chase did not recall this and Hanley, on active service in Vietnam at the time, was not available to be interviewed. However the contemporary intelligence report contains no mention of airborne radar contact. McDonald did later reach Hanley by telephone, and although the former's exposition of the case indicates that Hanley's minimal input was supplementary to more exhaustive interviews with the principal participants, it is nevertheless noteworthy that it contains neither confirmation nor denial; McDonald makes no mention whatever of airborne radar contact. In view of these facts little weight can be attached to the recollections of McCoid and McClure, although it is fair to point out that Craig's summary draws attention no less than five times to the importance attached by them to this issue.

Then there is the brief appearance at 1040Z and again at 1042.5Z of a second signal on the #2 monitor: on each occasion McClure had a signal at 40 degrees relative bearing, each time consistent with the trend indicated by bearings immediately before and after; but

additional signals were both times displayed for a short period at 70 degrees, a wide departure from the trend. As Klass points out, the ALA-6 manual cautions that weaker secondary signals can sometimes be displayed due to scattering of radar energy from an efficient ground reflector. Curiously the 1957 intelligence summary states that at 1040Z when McClure reported having two signals on-scope "Aircraft comdr and co-pilot saw these two objects at the same time with same red colour." Equally curiously neither Chase nor McCoid had any recollection of having seen more than one object simultaneously, and none of the men, including McClure, recalled the simultaneous appearance of two signals on the monitor. In the first interviews with Craig in 1967, however, McClure did recall that on more than one occasion the signal source abruptly disappeared and reappeared at a different bearing before returning, and McCoid agreed that there were simultaneous abrupt dislocations of the visual object, possibly explaining the 1957 statement. If this explanation were correct then the secondary signal - whose strength of presentation is unfortunately not described in the report - would have been displayed not concurrently but alternately, and thus would not be adequately explained as a reflection. However, evidence of another cause is not wholly persuasive and the issue remains unresolved.

A final point concerns the signal characteristics originally determined by McClure's ALA-5 pulse analyser back in Mississippi and which, according to the intelligence report, were exactly the same as the characteristics of the signal later detected over Texas. On the first occasion McClure had not made a permanent record, but when the signal appeared a second time over Texas he wrote down the exact characteristics: the pulse length was once again 2 microseconds, which is *twice* the length of the 1-microsecond pulse from a CPS6B/FPS-10 radar. This could indicate that radar energy was reaching the monitor by two routes - direct radiation and secondary reflection - the longer path length of the latter resulting in its delayed arrival. If this reflected path length is 984 feet (0.186 mile) longer than the direct line of sight then the reflected energy will arrive exactly 1 microsecond later and cause smearing of the detected pulse to 2 microseconds. Such a reflection could be due to energy incident on the ground around the radar site, but would be a transient effect sensitive to small local variations; a 1-microsecond smear would not be expected to be constant between one site and another and over ground distances of many tens of miles with considerable changes of slant range and elevation. If the signal detected over Texas did indeed have the same 2-microsecond pulse length as that detected in Mississippi, therefore, and especially if it remained at 2 microseconds, the probability of smearing due to ground-incident energy would be very small indeed. This discrepancy is thus possibly significant but not probative. (Note: one might speculate here that this was one symptom which caused McClure to differentiate between the "UFO" signal and the normal ground radar signal - presumably with a 1 microsecond pulse - which he believed he was detecting during the flight home towards Forbes.)

To try to weigh and summarise the implications of all the aforegoing is a daunting prospect. Happily there is no one scenario totally consistent with all the evidence, which relieves one of the burden of having to marshal any final proofs. It will be sufficient to indicate a few salient conclusions, invite attention to the more obvious residual anomalies, and indulge in some brief speculation. Some conclusions are:

1) The most detailed, ingenious and influential attempt to explain the ground-radar and visual observations (Klass 1974) is unsatisfactory on a number of counts. Specific arguments leading to this conclusion have been offered in their place, and one should also consider the cumulative improbability of a scenario involving four different, consecutive visual misinterpretations (five, counting the episode which Klass overlooks) together with coincidental, simultaneous radar-visual acquisition or loss on three different occasions.

2) The radar signals detected by the ELINT monitor(s) are very similar to - if not proveably quite identical to - the output of CPS-6B or FPS-10 ADC radars.

3) Evidence that such a source may have been operating in S Mississippi is at best ambiguous, but an FPS-10 is known to have been operating at Duncanville, Texas, and during the later events the RB-47 would for much of the time have been in a position to detect the Duncanville signal. (Note: according to Air Defense Command records checked by Klass no other CPS-6Bs were operating in the South Central region and three other FPS-10s - all in Texas - were out of range of the action near Dallas.)

4) The bearing and motion of the Mississippi signal are difficult to equate with the probable position of the aircraft in relation to a CPS6B which *might* have been operational at Keesler AFB.

5) First detection and final loss of the Texas signal are broadly congruent with the maximum drum of the Duncanville FPS-10, but the bearings to the source are at certain times inconsistent to a degree requiring explanation and the signal was retained for a significant period at times when the RB-47 cannot, on any workable reconstruction, have been flying within the FPS-10 vertical-center radiation pattern.

6) Apart from two brief episodes which can possibly be interpreted as ground reflections, the ALA-6 never displayed two consistent signal sources which could correspond to both the FPS-10 and, simultaneously, a second emitting or reflecting "UFO" source.

7) The core radar-visual episode from approximately 1039-1055Z is unexplained but consistent with the observation of an unidentified object or phenomenon which was a periodic emitter and reflector at optical and radar wavelengths respectively. During this episode ALA-6 signal loss and reacquisition was also *repeatedly* simultaneous with air-visual and ground-radar indications in a manner which cannot be explained.

Point 7 summarises the most puzzling features of the entire sequence and warrants a few more words. If the conclusion to which it appears to point is accepted for the sake of argument, then we have an object which was visually observed in the rough direction of Duncanville, pursued in the rough direction of Duncanville, overflown when it stopped so that it then appeared behind the aircraft in the rough direction of Duncanville, and finally reacquired after the turn, again appearing in the rough direction of Duncanville. Plainly this is all generally consistent (quantitative discrepancies notwithstanding) with the rough

relative bearing of Duncanville, and put thus appears to be a strong *prima facie* case for Duncanville as the source of signals which were believed to relate to the "object". But the bearings are also roughly consistent with the reported motion and positions of an object which was *seen visually and tracked by ground radar in the area*, and these elements of the case put a deal of strain on the *prima facie* interpretation. Given that the contemporary USAF intelligence investigation of the case carries any weight at all, it is worth reminding oneself at this point that, based on interrogations and records studied at the time, the Director of Intelligence of the 55th Strategic Reconnaissance Wing concluded with "no doubt" that "the electronic D/F's coincided exactly with visual observations by the aircraft comdr numerous times, thus indicating positively the object being the signal source."

The movements of this putative "object" as pursued in the rough direction of Duncanville, stopping, then being overflown by the RB-47 on another roughly radial heading away from Duncanville, before being reacquired in the turn and re-engaged during a second inbound pass, are reasonably natural and consistent (uncertainties about exact courses and positions notwithstanding). And if this scenario were correct then it is entirely possible that the bearings to the "object" and to Duncanville would at all times coincide within the practical limits of resolution of the ALA-6 monitor. If this were the case then the monitor display(s) would fail to discriminate between the direct signal from the FPS-10 itself (when this was detectable) and a reflected or re-radiated FPS-10 signal received from the "object". This obviously invites description as a coincidence, but if one might hijack Klass's defense of his own scenario one can observe that coincidences do happen. One might also be tempted to add that an "object" followed in the direction of Duncanville then lingering in the vicinity - as indicated by concurrent air-visual and ground-radar reports - is an elegant, economical and intelligible explanation of that coincidence, whereas the several coincidences required by Klass not only fail satisfactorily to address the radar-visual evidence but are collectively less elegant, less economical and less intelligible.

Neither scenario directly explains the radar signals detected for several minutes during transit of the radar shadow, unless one proposes that a "UFO" was emitting simulated FPS-10 pulse trains with a simulated 15-second period. Of course this is possible. Klass objects that "a spaceship from another world" outfitted with a "large, powerful" FPS-10 radar "simply to play mischievous games with the RB-47" would have caused "intense" interference on terrestrial radar scopes, but this is really word-play: given the premise, the emitter would not have been built by General Electric! It would not necessarily be large, or powerful, or omnidirectional; variable tuning over a couple of dozen mHz is a well understood earthly technique of minimising mutual interference between adjacent similar radars; and the concept of mischief is anthropomorphic. Nevertheless the underlying point is well made and one hesitates to address the implications of this startling idea.

One can more comfortably accept that, in both scenarios, this circumstance could be said to indicate what we might neutrally call abnormal propagation conditions in the FPS-10/RB-47 environment. Anomalous propagation (AP) as normally understood does not seem to apply here, since during the portion of the flight in question the elevation of the aircraft from Duncanville moves from a minimum of 9-12 degrees (normal top edge of main beam coma lobe or upper side lobe) through about 30 degrees (on Klass's model) or more (assuming the slightly revised course discussed above). AP due to abnormal vertical

gradients of refractive index such as commonly occur in the stratified calm air of a summer night is minimal at grazing angles as high as 10 degrees, and subrefractive upward bending of ray paths by a further 20 degrees or more is out of the question in terms of conventional theory. It is believed by some radar meteorologists, however, that there may exist atmospheric layers or more discrete structures with very extreme refractivity gradients and power reflection coefficients which are close to or above the threshold of detectability, by sensitive radars, even at near-normal incidence. Therefore although such phenomena may currently be at or just beyond the horizon of atmospheric physics, some analogous structure cannot be ruled out in this case.

In this regard, the distinguished Chicago University radar meteorologist Dr. David Atlas wrote in 1970 that "while some of the UFO observations require almost incredible atmospheric structures for their explanation on the basis of [radar] propagation phenomena . . . I fully expect that these still incredible atmospheric structures will be found to be entirely reasonable some years hence when our observational capacity can demonstrate their existence." [Sagan & Page 188] Almost all of the propagation phenomena which are really well understood at present are anisotropic in the vertical plane and of some lateral extent - that is, they are due to layers of refractive discontinuity forming roughly parallel with the surface of the earth. Sometimes high reflectivity coefficients occur due to dielectric inhomogeneities associated with atmospheric turbulence in the clear air, particularly in the 20-40,000' altitude region where the turbulence can disturb aircraft, and these layers have been found to show fine structure such as hexagonal convective cells, thermals, travelling waves and even "breaking" waves. It is legitimate to suppose that other phenomena analogous to hydrodynamic boundary effects may occur rarely, and that some of these may be dynamically stable, localised, and possibly often mobile along the interface (one thinks here of eddies and standing waves). The limits of extreme local abnormality in the atmosphere have presumably not yet been discovered, and one thinks back to the contentious models proposed by Menzel in the '50s and '60s in which extraordinarily discrete atmospheric "lenses" were assumed to be responsible for radio/optical "UFO" mirages of a degree and nature so incredible as to be roundly dismissed at the time by atmospheric physicists across the attitude-spectrum from academics such as McDonald to USAF weather specialists.

If one were free to hypothesise an "incredible structure" to account for the phenomena observed over NE Texas in 1957, one would be tempted to suggest that the microwave output from a primary source - the FPS-10 - was somehow being refracted due to a secondary phenomenon analogous to a discrete "bubble" or "lens" of sharp refractive discontinuity, which also perhaps refracted a reddened visual mirage image of city lights. This structure would be required to have high specular reflection efficiency in the 10-centimetre region to present as a ground-radar target, but probably only at incidences on the order of 80 degrees from the normal, and certainly a refractive "lensing" effect of enormous efficiency at incidences closer to the normal so as to intercept and, as it were, "duct" the low power density in the zenithal radar shadow which would be present due to leakage of the FPS-10 output into minor vertical lobes. Its optical image appeared to be below the aircraft, suggesting the possibility of a physical locus which would be in a region of power density higher than that irradiating the aircraft in proportion to the square of its proximity to the transmitter; but the aircraft may have been within the lensing layer, detecting weak

radar energy focussed along its upper boundary by a mechanism qualitatively analogous to (although quantitatively unlike) Raman brightening. (Such a position within the layer could be consistent with the presence of ground returns on the airborne radar via the same path, although its low power would make these less likely and it seems probable that no such returns were received.) Thus during the RB-47's transit of the shadow the "lens" would not have the reflectivity to return these weak pulses to the ground radar, but would perhaps continue to gather and focus them into a signal detectable by the ALA-6. The radio "blurring" incurred during this process could perhaps account for the smearing of 1-microsecond pulses into 2-microsecond pulses.

This structure would therefore have the properties of: 1) specular reflection of detectable 10-cm radar pulses; 2) refraction of weak 10-cm energy with extreme efficiency suggestive of amplification by the focussing/interference of radar wavefronts; 3) extremely efficient refraction/reflection (presumably of city lights) at optical wavelengths, tending to the red end of the spectrum; 4) visual and radar behavior approximating that of a discrete domain exhibiting continuous apparent movement, generally ahead of the aircraft in the manner of a receding rainbow but at least once showing apparent closure to a steep visual depression angle followed by radio-optical disappearance, then reappearance for an episode of apparent near stationarity. In all cases the understood maximum grazing angles would appear to be exceeded by a very large margin, and it is safe to say that no such structure is presently known to atmospheric physics.

The foregoing is not offered as an explanation of the case but merely as an indication of the kind of form which a unifying explanation might be required to take if projected from current knowledge. It is merely picturesque as it stands and clearly constitutes no solution, but "incredible" is of course the very definition of future knowledge, and in that future the spectrum of available explanatory options is always widening. The simple dichotomy "explained-or-alien" is a response to an invalid question, and cases such as this graphically illustrate the wisdom of funding what Hynek called our "poverty of hypotheses", even at the risk of borrowing beyond our security.

In conclusion, whilst there are features of this report for which conventional explanations of varying probability can be suggested individually, the resulting structure is inelegant, unintelligible, cumulatively highly improbable, and most importantly glosses over central features for which no explanation exists. In particular the radar-visual episode near Dallas/Fort Worth invites interpretation in terms of a novel aerial phenomenon, and it is only even-handed to point out that the simultaneous radio-optical disappearances at this time seemed to relate to the approach of the pursuing aircraft on two separate occasions in circumstances which (due to the evident range and altitude differences) are probably not interpretable as due to the mixing and disruption of an atmospheric structure by the passage of the aircraft. The reported movements of the object can generally be interpreted as reactive to the presence of the aircraft in a manner analogous to evasive, rational action. Although strictly speaking there is insufficient information on the radar aspects of this case, it would be churlish to deny the existence of some suggestive evidence of unusual phenomena, and the case should therefore still be carried as an unknown pending further study.

[ADDENDUM. This analysis was prepared without the benefit of knowing the very extensive and detailed work of Brad Sparks which addresses some of the same issues raised here. In particular the issue of the Biloxi radar and the apparent anomaly in the charted flight path. Sparks' research appears to have established, consistent with the time-distance-bearing arguments discussed above, that the Biloxi radar was not in fact operational. The upscope signal is therefore not only anomalous in behavior (for an electromechanical ambiguity) but appears to lack an obvious conventional source. Sparks' study of the flight plan also provides independently a convincing rationale for a course deviation essentially the same as that hypothesised above on time and distance grounds, which considerably strengthens the inference drawn here that the claimed correlation between the UFO signal(s) and the Dallas area radar pattern is probably unsound. See: Brad Sparks, RB-47 RADAR/VISUAL CASE, in: *The UFO Encyclopedia*, Jerome Clark ed., 1998, pp. 761-790.]

STATUS: Unknown

13. DATE: July 25, 1957 TIME: 0025 local CLASS: R/V ground radar/ground visual

LOCATION: SOURCE: Thayer, Condon 1970 145
Niagara Falls, N.Y.

RADAR DURATION: 3 minutes

EVALUATION: Blue Book/Thayer - balloon

PRECIS: Observers (number unspecified) saw a "circular brilliant white object with pale green smaller lights around its perimeter" travelling slowly at nearly constant altitude. Conditions were "clear with excellent visibility". The object went into a "fast steep climb", disappearing from sight in five to eight minutes. The object was also tracked on a CPS-6B radar for some three minutes in a NE heading.

NOTES: Thayer points out that: 1) the rate of climb could not have been very great if the object remained in sight for 5 to 8 minutes; and 2) the NE heading of the target agreed with "the prevailing winds in the area". It appears that the Blue Book file on this case may be even less complete than usual. This fact combined with the above arguments prompted Thayer to concede by default "the official Air Force view that the object was a lighted balloon". But it would appear that no specific balloon release was identified and that the actual winds aloft at the time (as opposed to those prevailing) are unknown. There are several points to be made about this hypothesis.

It is interesting that apparently no attempt was made to interpret the radar target as anomalous propagation, the standard Blue Book default position during this period. The radar and visual sightings are accepted as sightings of one and the same object. This could mean either that it was simply too implausible to invoke AP in this case or that it was unnecessary in this case because radar target and "balloon" were strongly correlated.

A convincing target on a CPS-6B is *a priori* not especially likely to be due to causes such as AP, interference, internal noise or component failure. The reason is that in addition to the

surveillance beam the CPS-6B had integral height-finding by means of two further diverging beams. Measurement of the transit time of a target between these two beams, combined with the range rate fed to the surveillance PPI, yielded the target's approximate altitude. Each of these electronically independent transceivers operated at very different frequencies, and AP effects are frequency-sensitive. If a normal-appearing point target had been tracked in both plan position and altitude by a CPS-6B it would be consistent with Blue Book's decision to opt for a real radar-reflective object - hence the "balloon".

The available information is sparse. Even the exact locations of the radar and visual sites are unknown, for example. Despite the considerable room for conjecture, however, the balloon hypothesis can be criticized if one is allowed to draw some inferences.

It is not specified in the report that the visual observers were service personnel, but it is perhaps likely given that the CPS-6B would have been a USAF Air Defense Command radar and given that the "balloon" was evidently seen at very low level, which implies proximity to the radar site. The reasoning here expands as follows: Weather balloons are not large visual objects. The intercepted arc is undetectable to the naked eye in daylight beyond about 20,000' slant range, and the 1.5 candle lamp of a nocturnal lighted balloon at altitude would be no more than a point source. The object in this case was visually resolved as a disc with a perimeter defined by a number of secondary lights, and if it was a balloon it was inferably no more than a few thousand feet slant range from the observers and at a very low altitude. This implies, in turn, that the "balloon" was close to the radar site where it was detected, because of the way that minimum detectable altitude varies with range.

That Blue Book rather easily dismissed the case as a probable weather balloon, evidently without much attempt to gather confirming data, can be taken to suggest that it took place at or close to a known balloon launch site. This is consistent with the inference in the previous paragraph, and indeed a map of the >100 routine radiosonde launch sites in the US (source, p.146) identifies an airfield a few miles from Niagara, which it is suggested could well be the location of both the radar and the visual observers.

If this chain of inference is correct then several conclusions follow:

1) the balloon was seen by personnel at a site where radiosonde balloons were being launched 4 times a day, 365 days a year, yet they failed to recognize it as a balloon;
2) if it was their own balloon and was seen climbing from a low level (at a typical 1000-1200 fpm) it had been released no earlier than a few minutes and was currently being tracked;
3) records of the release time and weather data would be available, yet after investigation local base intelligence personnel failed to identify the object as their own balloon, forwarding a report of a UFO through channels at a time when there were strong disincentives to do this - including the specific instruction to clear up as many reports as possible at the base level; and
4) Blue Book themselves did not identify the object with any specific balloon launch, despite their suspicion that the object was a balloon, when this should have been easy to do.

Granted there is some supposition here, but it should be noted that the visual description of the object is not strikingly like a balloon. In particular, the ring of green peripheral lights

corresponds to no known kind of balloon lighting. The color could be ascribed to an optical contrast effect if the central disc had been described as red or reddish; but this was described as "brilliant white". Scattering of sunlight through the translucent stretched neoprene of a balloon at high altitude can create an unusual glowing appearance near dusk or dawn: but the green color is inappropriate, the time was past midnight, and this "balloon" was at low altitude. Moonlight is a possible source, but a low altitude radiosonde would not be very distended and thus should be essentially opaque; again there is no convincing explanation for either the brilliance of the central disc or the ring of green lights. If a balloon was being tracked whilst illuminated by a searchlight for some reason this simply increases the strangeness of so noteable an experiment being unknown to base intelligence officers. The only likely source seems to be the balloon's own tracking light, but as has been mentioned these 1- or 2-candle lamps are scarcely "brilliant" and would at best very faintly illuminate the undersurface of the balloon (note that pilots in close encounters with balloons have typically mistaken these lamps for small "UFOs" precisely because the fabric of the balloon itself was invisible); there is essentially no likelihood that this lamp would also be bright enough to generate an array of discrete specular reflections disposed around the periphery of the balloon, and no obvious reason why they should appear green if it did.

This last point raises the suggestion that what was seen was a very large research balloon at great altitude, unconventionally illuminated for who knows what special purpose. When stretched by internal gas pressure at high altitude, the orange-like segmentation caused by the seams of such balloons can be very visible, and it is possible to imagine that the peripheral lights were highlights on a reflective material. But it is difficult to square steady balloon drift at a great height either with the eyewitness descriptions of a "fast steep climb" or with the fact that the CPS-6B only had the target on scope for 3 minutes.

The motion of the object, at least during the 3 minutes of radar tracking, was from SW to NE. The prevailing wind at Niagara is generally SW. This is really the only strong point of similarity between the object and a balloon. The report does not contain any estimate of the speed or kinetics of the radar target, but the visual observers estimated that the object's movement was slow and at a level altitude until it went into "a fast steep climb". Qualitatively speaking this does not sound like behavior typical of a balloon.

Thayer questions the implied rate of climb by pointing out that if it remained visible for 5 to 8 minutes then it cannot have climbed very fast, suggesting that this is consistent with a balloon. However, this argument is not entirely valid. It is an example of a theory-dependent argument: A balloon light isn't very bright; if this light wasn't very bright it can't have climbed high and fast, otherwise it would not have been visible for several minutes; it was visible for several minutes, therefore it must have climbed low and slow. Ergo, it was a balloon.

Firstly, it should be said that there are no data on the intrinsic luminosity of "a UFO", and therefore it cannot be said to what altitude such an object might be visible; hence it is not possible to conclude that the rate of climb implied by a duration of 5 to 8 minutes must have been low. Secondly it can on the other hand be argued that this time is far too short for a balloon. A lighted weather balloon climbing at an average 1100 fpm from an initially very low altitude (*ex hypothesi)* for a mean estimated 6.5 minutes would only have reached an

altitude somewhat above 7000' and should have remained visible - in the "clear" sky with "excellent visibility" - as a source of magnitude in excess of +3, that is, brighter than an average star. (A 1-candle source at 1000 meters has a visual magnitude of +0.8, from which it may be calculated that a 1.5-candle source would be visible to over 15,000' as a 5th magnitude light - that is, still more than twice as bright as a faint star - and could have been seen for about 15 minutes. Indeed, some balloon lamps are 2 candle, so the above values should be taken as minima.)

Conversely, a light which was described as "brilliant" when closest to the observers might be thought brighter than a small lamp of 2 candle or less. At a slant range of only a couple of thousand feet, for example, a 1.5 candle radiosonde lamp would have a brightness of about -1.5, some 5 times fainter than the planet Jupiter at opposition and about 10 times fainter than Venus which is commonly described as "brilliant". Of course these comparisons are only illustrative, since the relative magnitude of a balloon lamp is very sensitive to distance owing to the inverse square relation, and the true distance is not known (without the full radar report). Nevertheless it is fair to say that for a balloon lamp to appear "brilliant" it has to be very close, which means that the start of its visible ascent would be very low, reinforcing the argument that it should have stayed visible from the ground for appreciably longer than 5 to 8 minutes. If the intrinsic luminosity of the source were much brighter, of course, then a visible ascent of this duration implies a proportionately rapid rate of climb to a propor-tionately greater altitude.

These arguments are hardly conclusive, since the start altitude of the ascent cannot be accurately inferred and, more importantly, the "disappearance" of the light may not have been due entirely to its dimming below the level of perceptibility; it may, for example, merely have become indistiguishable from the surrounding stars. The reports of duration could be wrong also. But the match with the behavior of a lighted balloon is hardly conclusive either, and the prior motion of the object has to be taken into account. If it was a balloon then its initial horizontal motion would be best explained by a leaking balloon with a near-neutral buoyancy; but such a balloon could not spontaneously become buoyant again and ascend rapidly out of sight. And anyway, a balloon with less than maximum buoyancy would have a slower rate of climb still less consistent with the mere 5 to 8 minutes during which it was observed visually. It is possible for such a balloon to be caught up by a local updraft, but whether it could remain in such an updraft (in the clear weather of a summer night, let us remember), losing buoyancy all the while, for several minutes until it was borne upwards out of sight is to say the least debatable.

In conclusion, it appears likely that the same object was seen visually by multiple military observers and tracked rather unambiguously on ADC radar for 3 minutes (although there is insufficient information to prove this). The balloon hypothesis is not very strong as it stands. The reported motions of the object can only in part, and inconclusively, be compared to a balloon. The object has not been identified as a specific balloon despite evidence suggesting that it should have been easy for base intelligence officers to do so. Data on the actual winds-aloft conditions at the time were apparently not obtained, so that the only direct correlation invoked in support of a balloon is suppositious. The reported visual appearance of the object, as described by witnesses who might be expected to be familiar with local balloon launches, is not consistent with a balloon. No other conventional

object or phenomenon accords with the description of a brilliant disc encircled with green lights, which reportedly displayed considerable angular motion and appears to have been a radar reflector.

In terms of the information available the case is an "unknown". However, in view of the shortcomings of the Blue Book file - in particular the absence of crucial weather and radar date - it is judged reasonable only to carry the case as "insufficient information", with the rider that it would appear to warrant further study.

STATUS: insufficient information

14. DATE: August 30, 1957 TIME: night CLASS: R/V air radar/air visual

LOCATION: SOURCES: Thayer (Condon 128)
Chesapeake Bay
Nr. Norfolk, Virginia RADAR DURATION: unspecified

EVALUATIONS: Thayer - unknown

PRECIS: A Capital Airlines pilot with 17 years & 3,000,000 miles logged was flying a Viscount at 12,000' approaching Norfolk, Va., with a Northeast Airlines DC-6 "directly above" on the same heading at 20,000. The Viscount pilot saw a "brilliant" object which "flew fast and then abruptly halted 20 mi. in front of us at 60,000 ft. altitude." The Northeast pilot tried to acquire the object on radar: with the antenna at 0 degrees elevation nothing was detected, but with the antenna elevated to 15 degrees he acquired "an excellent blip right where I told him to look for the object." According to the Viscount pilot, the object "dissolved right in front of my eyes, and the crew above lost it from the scope at the same time. They said it just faded away." The entire incident lasted "several minutes".

NOTES: Thayer points out that if the DC-6 radar at 20,000' painted the target at 15 degrees elevation, range 20 miles, this would place the object at a little less than 50,000', not at the 60,000' estimated visually by the Viscount pilot. This might be thought a good match within the limits of observation and second-hand reportage (the DC-6 pilot did not apparently report his radar contact officially), and perhaps does not warrant Thayer's remark that the pilot's visual estimate was "in error". Further, the vertical coverage of the DC-6 radar would be at least several degrees and would paint a target with the antenna boresight aligned to a point somewhat below its real elevation (15 degrees quite possibly being the maximum antenna tilt limit), so it is not excluded that the match between visual- and radar-altitude indications was exact. Thayer's conclusion that the real visual elevation angle from the Viscount was 19 degrees, therefore, appears unwarranted, even if we accept the tacit assumption that radar and visual observations were of the same "object".

However, following Thayer's reasoning for the sake of argument, his analysis concludes that 19 degrees is too steep an angle for any temperature inversion to produce an optical mirage of a celestial body; and the above qualification of that reasoning increases the possible angle beyond 19 degrees, so further lessening the likelihood of mirage. Thayer also

dismisses partial inversion reflection of ground targets at optical or radar wavelengths, concluding that the incident must be considered an "unknown".

Nevertheless, a question mark remains over the apparent absence of any visual sighting from the DC-6 of the "brilliant" light being watched from the Viscount. The DC-6 had to be "told where to look" in order to pick up the radar target; they did so, but apparently still saw nothing. Without an independent report from the crew of the DC-6 it is difficult to resolve this discrepancy. As it is, one must consider the possibility that the Viscount crew were watching something in local airspace which they mistook for a brilliant object at altitude, whilst the DC-6 radar indication was coincidental despite the reasonable match in reported position and time of disappearance. Individually, the visual report could be explained as an initial meteor plus (say) a nearby a/c turning its landing lights on and off, whilst the radar contact could have been system noise, interference, or a high-altitude ice-laden cloud which left radar coverage due to the plane's forward movement. The DC-6 crew, meanwhile, would have been following Viscount's directions and looking up, thus either not seeing a lit a/c below their altitude or assuming it was the Viscount (itself invisible directly below).

The above explanation may be less than probable, particularly given a visual duration of several minutes ("brilliance" of an a/c's forward-facing landing lights would imply a heading significantly away from that of the Viscount, and thus a fairly rapid relative motion), nevertheless it illustrates that the two sightings are insufficiently reported to evaluate with confidence. One possible explanation of the major part of the incident would be a high-altitude research balloon carrying an instrument payload. Such a balloon might reflect the sun brightly even in dark-sky conditions, and might appear suddenly from behind obscuring high clouds. When cut down it would rapidly collapse or shatter ("it dissolved right in front of my eyes") and its radar-reflective payload would fall away under gravity until its chute opened, thus possibly dropping out of the DC-6 radar pattern quite quickly if it were near the lower limit of coverage. However this explanation is quite speculative: a) the time would require to be near dusk or dawn, but the time is not known; b) the a/c heading would have been roughly NS and the object was "in front", thus in the S sky and not ideally placed (i.e., not on the W horizon) to reflect the sun if sky conditions were "night" as reported; c) radar reportedly confirmed the object at less than 60,000', which is low for optimum chance of noctilucence and low for cut-down, which would normally take place at float altitudes above 100,000'; d) there is no explanation for the high-speed initial sighting without assuming a coincidental bright meteor; d) this construction requires a fortuitous distribution of cloud to explain why the illuminated balloon was seen for several minutes from the Viscount, but was at no time visible to the DC-6 crew flying 8000' above.

STATUS: Insufficient information

15. DATE: November 4, 1957 TIME: 2245 local CLASS: R/V ground radar/ multiple ground visual

LOCATION:
Kirtland AFB
Albuquerque,

SOURCES: McDonald (Symp. 115)
Hynek (1978) 76
Thayer (Condon 141)

New Mexico

RADAR DURATION: several minutes
(two episodes separated by approx. 20 mins.)

EVALUATIONS: Blue Book/Thayer - aircraft

PRECIS: Two CAA tower controllers observed a white light travelling E at an estimated speed of 150-200 mph, estimated altitude approximately 1500' on low altitude airway Victor 12. When the light reached the E end of Runway 26 it turned and came down SW in a "sharp descent" towards the tower. The object was at this time believed to be an aircraft confused about its landing pattern (conditions were darkness, scattered clouds and a high overcast, with good visibility despite some light rain over the airfield). A LOGAIR C-46 had just called in for landing instructions, and the tower queried the unknown traffic without response. The object then proceeded across the airfield towards the tower at an estimated altitude of a few tens of feet, at which point it was observed with 7x binoculars and appeared as an approximately egg-shaped body, 15'-18' on its major vertical axis, somewhat like "an automobile on end" with no features or control surfaces and a single white light on its base. It approached a B-58 service pad near the NE corner of Area D (a "brilliantly floodlighted" restricted area S of the EW runway), slowed to approximately 50 mph, then stopped completely, estimated range 3000' ENE from tower. It remained stationary for an estimated 20-60 seconds then began moving again at a modest speed on a heading E away from the tower at 200-300'. At this point the object was approximately over the E perimeter, and in case it might be a helicopter in distress one controller gave it a green light from the tower. It veered SE into an abrupt climb at a speed estimated as approximately Mach 1 (45,000' fpm) and disappeared into the high overcast, a manoeuvre which in the opinion of the observers exceeded the performance of any jet.

At this time the controllers called CAA Radar Approach Control and asked for verification of a fast target to the E. The RAPCON operator confirmed a target on the PPI of the CPN-18 surveillance radar on a 90-degree azimuth approximately over the E perimeter on a heading SE. At an unspecified range the target "reversed in course" taking up a W heading which took it towards the Kirtland low-frequency range station. At this point (a position E of S from the radar site) the target began to orbit for a period of minutes, then moved off on a NW heading "at a high rate of speed" to a position 180 degrees azimuth from radar site (S) range 10 miles, where it was lost.

20 minutes later the operator "scanned radar to the south" as an Air Force C46 (4718N) was taking off W on the EW runway and making a left (S) turn. He saw a target which he took to be the same unknown over the outer marker approximately 4 miles S of the end of the NS runway. The target approached N at "a high rate of speed" to a position 1 mile S of the EW runway, made an "abrupt" W turn and fell into trail with the C-46 on a S heading, maintaining an approximate ½-mile separation for some 14 miles. The target then turned back on a N heading to hover over the outer marker for 1-1½ minutes, then "faded" from the scope.

NOTES: The above precis removes certain inaccuracies from the principal published accounts (Macdonald, quoting partial Blue Book file + witness interviews and site visits;

Hynek, quoting partial Blue Book file). Hynek's account misconstrues the timing of events as a simultaneous radar-visual, introducing discrepancies in the attempt to relate radar and visual course descriptions. McDonald's account is clearer in this regard but does not draw on the original radar operator's report, and thus confounds the later radar event with the former, introducing minor azimuth errors and erroneously stating that the target followed the C-46 off-scope. Thayer's account confuses by stating that the object disappeared from view "behind some buildings" when it came down in Area D, whereas McDonald established (from site visit & base records) that there had never been any such buildings in Area D, only chain-link fencing, and (from witness interview) that the object never in fact disappeared from view. The problem appears to originate with the Blue Book summary, which states that the object "disappeared behind a fence", presumably based on witness statements that the object descended behind a [chain-link] fence.

The Air Force investigation noted that the two tower observers, who had 23 years of aircraft control experience between them, were mature, well-poised, of well above average intelligence, thoroughly consistent and cooperative, unshakeably convinced of the accuracy of what they reported, and were believed to be "completely competent and reliable".

This is a very interesting case despite the evident fact that radar and visual observations were at no time simultaneous. Visual disappearance and radar acquisition were immediately consecutive and fairly consistent as regards target location and heading. The behavior of both visual and radar targets is convincingly non-random, and in many ways does suggest a piloted vehicle, but the Blue Book evaluation of "possible aircraft" (endorsed by Thayer) is less than satisfactory, doing violence to the visual descriptions as well as to certain aspects of the radar track. A helicopter would be more plausible if it were not for the visually-observed Mach 1+ climb out; presumably it was this factor, and possibly the unquantified "high rate of speed" observed on radar, that forced Blue Book to opt for a fixed-wing aircraft. Similarly, Thayer suggests "a small, powerful private aircraft, flying without flight plan, that became confused and attempted a landing at the wrong airport." However, the object was seen visually to maintain station at very low altitude in Area D for a period approaching 1 minute whilst under observation with binoculars, and the target tracked during the second radar episode exhibited the same behavior at least once, "hovering" for somewhat more than 1 minute. The object was observed visually for nearly six minutes, both with binoculars and the unaided eye, in "good" visibility, and for a time close to the ground in a brilliantly floodlit area at a range of 1000 yards, by two experienced observers who declared firmly that it in no way whatsoever resembled an aircraft.

The visual description is more like a partially deflated balloon than anything else. A leaky radiosonde with a tracking light, perhaps released from Kirtland itself, might have drifted around the airfield in a gusty breeze (surface winds were "variable at 10 to 30 knots"). Such a balloon would not be 15'-20' in size since this would be its fully inflated diameter at many thousands of feet, but in conditions of darkness and occasional light rain it might be possible for observers to overestimate its distance, size and speed. However, it has to be said that such experienced control tower operators would be very familiar with balloons in all conditions, and to watch a radiosonde for several minutes with binoculars believing it to be an unfamiliar object travelling between 0 and 700 mph+ would be an unlikely aberration in the circumstances. If the subsequent radar track had been consistent with a radiosonde

one might be willing to accept this order of unlikelihood; but although a period of "circling" is not unlikely for a balloon climbing through variable winds, the target's "high rate of speed" and very marked changes of course render the probability negligible, even disregarding the behavior of the very similar target reacquired 20 minutes later.

This lapse of time is also of relevance to the "confused aircraft" hypothesis: granted that there is no continuity of tracking to certify the identity of these two targets, nevertheless it is valid to observe that the same pilot is unlikely to have still been flying around "confused" after 20 minutes, whereas to assume a second, unrelated "UFO" with very similar characteristics adds another order of unlikeliness. It does seem reasonable to treat the two radar contacts as related.

In general, the ordered and continuous movements of the radar target(s) are unlike those typical of anomalous propagation, and although no refractivity profile is available the gross conditions (winds gusty and variable, scattered clouds with a high overcast and light rain in November) are not very conducive to atmospheric stratification. Multiple-trip returns from an airborne target beyond the unambiguous range seem improbable given the target's movement over a 90-degree sector, at least in part at "high" speed, punctuated by a period of "orbiting", although it is noteworthy that the specified high-speed portion of track from a position E of S on a heading NW (the geometry is very rough) could be construed as approximately radial, which is the heading on which a multiple-trip target's true speed would be displayed (lateral movements being displayed at spuriously slow speed). This positive match is however not a very strong indication given the general context, and would usually require super-refractive conditions for which there is no evidence; also the orbital behavior does not suggest the kind of distorted courses and speeds typically displayed by multiple-trip (although such behavior is conceivable); and furthermore, the second radar episode combines stationarity with "high" speeds unambiguously, which is difficult to equate with any mobile target displayed by multiple-trip returns. No side lobe leakage effects, internal electronic artefacts, RFI, birds, insects or CAT are relevant to such a target. "Interceptions" of a/c by targets in the manner of the second radar episode are often qualitatively similar to "ghost" reflections caused by returns from a secondary ground target via the a/c as primary reflector, but it is readily apparent that the required reflection geometry (with the ghost always on the same azimuth as the a/c and at greater range) does not apply in this case.

In summary the a priori likelihood that radar and visual observations related to the same real target does not seem to be reduced by analysis. This conclusion is reinforced by the ordered nature of the target behavior, both radar and visual, in relation to a number of significant ground installations around the airfield: The (visual) object turned at the end of the EW runway as though on an approach; it came to a halt over a service pad in restricted Area D; it made its rapid ascent once it reached the E base perimeter, coincident with the green light from the tower. The radar target(s) then proceeded from the base perimeter to the low-frequency range station, where it orbited; it reappeared over the S outer marker; it then moved into trail with the C-46; and finally went directly to the (S?) outer marker where it disappeared (possibly by descending below the radar). These are persuasive indications of rational, intelligent behavior, which a priori favour a piloted aircraft or helicopter. The kinetics and appearance of the object, however, are not individually or

collectively consistent with any type of conventional aircraft or helicopter. The possibility of some sort of experimental VTOL aircraft or early RPV cannot be ignored, although this is presumably unlikely around a busy facility adjacent to Albuquerque Airport - without warning, yet open to observation by CAA and other non-military witnesses for twenty minutes or more - given the availability of secure test facilities such as White Sands 150 miles to the S.

STATUS: Unknown

16. DATE: November 5, 1957 TIME: 0510 local CLASS: R/V shipboard radar/deck visual

LOCATION: Gulf of Mexico

SOURCES: Thayer, Condon 165
Mebane (app. Michel FSSLM '58 242)
Lorenzen SEIOS 1966 101

RADAR DURATION: 27 mins. (intermittent)

EVALUATION: Blue Book - Venus/aircraft
Thayer - aircraft/AP/meteor

PRECIS: At 0510 the U.S. Coast Guard Cutter Sebago was in the Gulf of Mexico some 200 miles S of the Mississippi delta at 25 degrees 47' N, 89 degrees 24' W on a heading of 23 degrees true, when a radar target was acquired on a 290 degree true azimuth at a range of 14 miles, heading S. The target turned in towards the ship, closing to 2 miles, then returned N along the ship's port side. The target was lost at 0514, and average speed was calculated as 250 mph.

Two minutes later at 0516 a second target was picked up, bearing 188 degrees, range 22 miles, and was plotted to a position 190 degrees, 55 miles, where it was lost. Departure speed was measured at 650 mph.

At 0520 a stationary target was displayed at 350 degrees, 7 miles range. At 0521 a visual object "like a brilliant planet" was observed from the deck for about 5 seconds travelling S-N at 31 degrees elevation between 270 & 310 degrees azimuth. At about the same time the radar target moved slowly NE, and finally accelerated rapidly, moving off the scope at 0537, 15 degrees, 175 miles range.

NOTES: The most reliable published source is Thayer, drawing directly on the Blue Book case file, and the above precis reflects this. The 1958 account by Mebane appears to contain some errors of timing. Certain circumstantial details in Mebane are of interest, however, drawn from a press report and a radio interview broadcast by WBZ, Boston, on the following day.

The initial explanations offered for the Sebago report in USAF press releases on November 15 & 17 were the planet Venus, two unspecified aircraft - a piston-engine light plane and a jet - plus some possible "false" targets. According to Thayer, the first radar target "behaved generally like an aircraft", and he inclines to accept the Air Force view that it probably was an aircraft, possibly from Eglin AFB to the N. No specific flight could be

identified as the culprit, however. The second target, which Blue Book apparently concluded was probably a jet, is attributed by Thayer to anomalous propagation. Thayer also explains the third target as AP, and the concurrent visual as "undoubtedly a meteor".

Whilst these coincidences may on the face of it seem improbable, and the whole melange a little desperate, Thayer points out that radio refractivity data for Key West, Florida (the nearest applicable soundings) show the possibility of unusual propagation conditions, with marked temperature/humidity stratification conducive to partial reflection echoes. Further, he argues that since the moving visual object appears to have been seen at a time when radar showed a stationary target, and apparently at a different azimuth, the two events cannot be related, and the brevity of the visual sighting is suggestive of a meteor. It is only prudent to point to some reservations about this scenario, however.

An alternative and quite plausible explanation of the visual sighting (in fact proposed by Tulane University astronomer Dr. J. F. Thompson in an interview for the New Orleans Times-Picayune as early as November 6 1957) is Sputnick 2. The second Soviet satellite had been launched on November 3 into an inclined 65-degree elliptical orbit with a perigee of 140 miles, and would have been visible west of the Sebago's position travelling roughly NNW at about that time.

Thayer relates from the report that "the third radar target remained stationary for about 1 min." before moving off to the NE. It is implied that this minute elapsed after the visual object had been observed at 0521, and thus the target movement would have begun not earlier than 0522. But the statement is ambiguous. The stationary target was acquired at 0520; if it then "remained stationary for about 1 minute" its movement would be consistent both in time and approximate heading with the moving object observed visually. This is a moot point, but it might also be noted that times are only given to the minute, and the difference between approximately 0521 and approximately 0522 could only be seconds. Therefore, given that the visual observation was made by members of the crew other than the radar operator - four hands who had gone up to the bridge to look for the object; given the possibility of small errors in independent timing; given that times are only cited to the minute; given that the precision of a phrase like "about one minute" is a debatable estimate of elapsed time; and given that the material discrepancy is only about a minute - then to conclude that the visual and radar movements were definitely inconsistent as to time may be to expect too much of the information available.

The visually observed heading S-N at 31 degrees above the horizon might, as we have said, be consistent with the radar heading SW-NE. However, the visual report has the object moving from 270 degrees to 310 degrees, whereas radar reports the target moving from 350 degrees to 015 degrees. How accurate are these values, and how significant is the discrepancy?

The radar bearings are given "true" - that is, in relation to true longitudinal north. These true values can be read off directly from the bearing ring if the heading marker - a bright scope trace - is aligned to the ship's true course (so-called "north-up" presentation). With the heading marker aligned to 0 degrees ("heading-up"), indicated bearings will be relative to the ship and would have to be corrected by the operator. Furthermore it is essential that

the heading marker is continually stabilised to the true course if true readings are to remain true. This can either be done manually by using a picture-rotate control, or automatically by a linkage with the ship's gyro compass; but even if automatically stabilised it is advisable to check picture orientation from time to time, since the compass will only correct it relative to its initial setting. With the heading marker switched off an operator might conceivably become confused, momentarily, as to whether displayed bearings were true or relative. And on a manually aligned scope an excited operator might neglect to correct bearings for yaw. Therefore there are possible sources of error. However, given that this was a Coast Guard vessel and that the operator would presumably be well-trained, there is no reason not to assume that the marker was correctly set on an automatically stabilised display. The bearings cited are probably accurate.

But the possibility exists that the visual bearings are translated from positions off the bow, which is quite common practice at sea. The figure of 270 degrees might be taken as supporting this guess, since this would correspond to exactly 90 degrees to port and is the kind of "cardinal point" approximation that might well be given by a visual observer recalling a fleeting observation off the port beam and offering a rough guess as to the start-point of a trajectory which was initially seen out of the corner of his eye. If this were the case, then the quoted values would have to be increased by the 23-degree heading of the ship to give true azimuths, yielding bearings of 293 degrees and 333 degrees true. Some allowance might also be made here for what is, ex hypothesi, an approximation of the bearing angles of a transient light seen in the pre-dawn dark, and it is well known that even experienced observers can be quite inaccurate in estimating visual angles, even in relaxed conditions. Perhaps the most that ought to be said is that a light was noticed heading approximately N somewhere off the port (W) bow, and it is far from certain that this is inconsistent with the initial position of the radar target some 33 degrees off the port bow.

There is a fairly important inconsistency in reported speeds, however. According to the radar report, the target moved off relatively slowly from a range of 7 miles, only accelerating rapidly towards the end of its track some minutes later. But the visual observers estimated that the light travelled 40 degrees in five seconds: at a constant range of 7 miles, an angular rate of 8 degrees a second translates to a speed of 3600 mph. And this figure does not allow for the significant radial vector of the target, which - if light and target were one and the same - would drive the true speed very much higher still. We will show later that the mean speed of the radar target was about 650 mph, which, given that it accelerated from zero to its maximum speed shortly before going off-scope, demands that its initial "slow" speed was significantly lower than this figure. Thus, radar-visual consistency would demand that the visual witnesses made at least a factor ten error in their estimate of angular rate.

As regards the hypothesis of partial radar reflection from inversion strata, which Thayer suggests to explain the second and third targets, it should be noted that the refractivity data quoted were indeed, as he concedes, "taken at some distance from the ship's position" - in fact, some 400 miles from the ship's position, and even given that subtropical atmospheric patterns of this sort "tend to extend in rather homogeneous form over large horizontal distances", one has to admit that there is a good deal of speculation here. Furthermore, the refractivity profile on which Thayer concentrates as being especially likely to generate

strong partial reflections was taken at 1800 CST on the following evening; the stratification of the more relevant 0600 CST Key West profile, whilst still significant, is not nearly so marked.

Thayer adduces support for the AP hypothesis from the fact that the two latter targets appeared "suddenly" on the radar, well inside its maximum range (at 22 miles and 7 miles respectively), suggesting thereby that these were probably phantom echoes. However, all three targets appeared well within range, including the first (at 14 miles) which Thayer nevertheless believes was probably an aircraft. This behavior - which can be explained in terms of targets entering the top edge (this being a marine radar) of the radiation pattern - cannot therefore be held to be uniquely diagnostic of AP. His assertion that the targets "were, with the possible exception of the first one, erratic and unpredictable in their movements" finds no clear basis in the report; the latter two targets moved on roughly constant headings, the third being tracked NNE to the maximum range of the display (175 miles), whereas the first - the "aircraft" - meandered south, then east, and then roughly north. The latter two targets displayed high speeds during departure, and one appeared to accelerate from a standing start, but it is mischievous to describe such movements as "erratic and unpredictable", and the first target was at least no less "erratic".

The behavior of the two later targets is interesting in the context of partial reflection echoes, which tend to move at twice the wind-speed at the layer, generally with the wind or at an acute (<90 degree) angle to the wind. At least, the direction of movement will have some component vector related to the heading of the wind. The headings of the radar targets can be reconstructed from the range and bearing data given: In the case of the second target, its heading was 192 degrees, or about SSW; the heading of the third target detected a couple of minutes later was diametrically opposite, 17 degrees or about NNE. Further, the measured speed of the second target was 650 mph, which would equate to winds of over 300 mph, and whilst this might be dismissed as a misreading of sporadic echoes on a relatively fleeting track the third target was painted in movement for some 15 or 16 minutes, which yields an average speed over the 170 mile track of, coincidentally, about 650 mph. Finally, the third target maintained station for one or two minutes before moving off and accelerating, which is not easy to explain as an effect of strong winds driving waves on the surface of an inversion layer.

To summarise so far, some elements of the AP explanation are questionable, and it is not proven that the visual sighting was unrelated to the approximately concurrent radar target although they are markedly inconsistent in terms of estimated speeds.

The visual sighting could have been a meteor or Sputnick 2, and the first radar track apparently did not display any characteristics which could not equate with an aircraft, even though no responsible aircraft could be identified. The radar targets could possibly be explained as noise tracks, although more information about scope presentation and movement would be desirable and the duration of track 3 is possibly excessive. Track 2 could possibly have been a jet flying at high altitude, entering and leaving the top edge of the radiation pattern (a low altitude jet would probably be displayed for longer by a radar designed principally to detect shipping and coastal features). Track 3, with a stationary episode, was almost certainly not a jet as this would require a steep climb or dive on a

radial heading which preserved constant slant range and azimuth for as long as 2 minutes, a highly improbable circumstance. (Multiple-trip echoes from a jet beyond the unambiguous range could give a spuriously high ratio of displayed minimum/maximum speeds if, for example, it turned from a tangential onto a radial heading. Any non-radial motion would be slower than true, since the angular rate is preserved but at spuriously short displayed range. However, given an angular rate which was imperceptible on the scope for one or two minutes at typical mid-'fifties US marine radar scan-rates of 15-20 rpm, yielding at least 15 consecutive paints, a jet-speed target would have to be at such an immense range that one doubts if it could possibly return a detectable signal on such a navigation radar, of low power typically on the order of 30-40 kW or less. If one supposes a target with a proportionately immense radar cross section - say a flight of several large, well-aspected military transports or bombers, integrated below the resolution of the display - then an inconsistency emerges with the displayed speed of 650 mph. The actual true speed of such a multiple-trip target with a non-radial vector would be significantly in excess of this figure.)

The speed of track 3 rules out a helicopter, and no VTOL jets were flying in 1957. Birds, insects, meteor-wake ionisation, CAT, balloons or other wind borne objects are inappropriate. Multiple-trip echoes of Sputnick 2 at a true slant range of (at least) several hundred miles are highly unlikely on a low-power marine radar, and anyway could not explain the extended stationarity and subsequent extreme acceleration of the target. Multiple reflection "ghosts" offer no useful explanation of an echo which was stationary for up to 2 minutes and then accelerated through Mach 1 with a 25-degree change in azimuth: the possible reflection geometries of "ghosts" are complex, but suffice it to say that this behavior requires, amongst other conditions, at least one moving aerial reflector (i.e., aircraft) in the radiation pattern, which as the primary reflector would present a stronger echo than the "UFO" blip itself and would appear to be "shadowing" the UFO at slower speed closer to the ship. No such target was reported. Whatever secondary reflector we might hypothesise (another aircraft, ship etc.), it is highly improbable that this kind of reflection geometry could be maintained for upwards of 15 minutes. And finally, the stationary episode cannot be explained by the same "ghost" echo, requiring either a quite different primary reflector or another explanation altogether.

As a postscript, it is worth adding that another incident involving the ship SS Hampton Roads took place that evening not far (about 180 miles) from the location of the Sebago incident. The ship was at 27 degrees 50' N, 91 degrees 12' W when a "round glowing object" was sighted at apparently high altitude at 1740 LST. It was observed for 10 minutes, and was lost to sight as dusk drew on at 1750. This object was explained by Blue Book as a probable balloon drifting with the upper winds, which is certainly plausible. In the absence of more detail, it is also possible that this was another sighting of Sputnick 2, disappearing as it moved into the earth's shadow.

In conclusion, although a conventional explanation of the Sebago sightings might require a series of coincidences, and although some elements of that explanation remain open to question, nevertheless the visual sighting in particular is of low strangeness, and its correlation with the radar track is somewhat doubtful. Considered alone the radar data

available, whilst interesting, cannot be said to strongly support an unconventional interpretation.

STATUS: Insufficient information

17. DATE: May 5, 1965 TIME: 0110 local CLASS: R/V shipboard radar/ deck visual

LOCATION: Philippine Sea

SOURCES: Hynek (1972) 81

RADAR DURATION: 6 minutes

EVALUATIONS: Blue Book - "aircraft" & "insufficient data"

PRECIS: The official report states:

> At 060910, in position 20 degrees 22 minutes north, 135 degrees 50 minutes east, course 265, speed 15, leading signalman reported what he believed to be an aircraft, bearing 000, position angle 21. When viewed through binoculars three objects were sighted in close proximity to each other; one object was first magnitude; the other two, second magnitude. Objects were travelling at extremely high speed, moving toward ship at an undetermined altitude. At 0914, 4 moving targets were detected on the SPS-6C air search radar and held up to 6 minutes. When over the ship, the objects spread to circular formation directly overhead and remained there for approximately 3 minutes. This maneuver was observed both visually and by radar. The bright object which hovered over the starboard quarter made a larger presentation on the radarscope. The objects made several course changes during the sighting, confirmed visually and by radar, and were tracked at speeds in excess of 3,000 (three thousand) knots. Challenges were made by IFF but were not answered. After the three-minute hovering maneuver, the objects moved in a southeasterly direction at an extremely high rate of speed. Above evolutions observed by CO, all bridge personnel, and numerous hands topside.

The report carried an addendum:

> During the period 5-7 May, between the hours 1800 and 2000, several other objects were sighted. These objects all had the characteristics of a satellite, including speed and [presumably visual] presentation. These are reported to indicate a marked difference in speed and maneuverability between these assured satellites and the objects described above.

NOTES: This report, as usual in Blue Book reports, implies a very great deal of missing information. In terms of the information available, however, the unequivocal statement that very particular movements were several times confirmed visually and on radar makes it of interest. There are minor questions as to the date, which Hynek lists as May 6 in his appended catalogue, and the duration, which he lists in the same appendix as 8

minutes, whereas the report states that the radar targets were held for 6 minutes beginning 4 minutes after visual acquisition, making 10 minutes overall.

The ship would have been about 150 miles S of the Tropic of Cancer steaming at 15 knots on a heading a little S of W towards the northern tip of the Philippine island of Luzon, 900 miles away across open ocean. The first visual sighting was dead ahead at an elevation of 21 degrees. The distance to land rules out an optical mirage of shore lights, and the elevation exceeds the critical grazing angle by a factor of forty, ruling out a mirage of shipboard lights. Further, the approach at "extremely high speed" towards the ship implies (although it doesn't guarantee) that this initial elevation increased during the four minutes. Presumably the light seen was white (as no colour is mentioned, and the comparison made with the visual appearance of satellites mentions no dramatic distinction due to colour) and presumably did not notably flash, scintillate or wander erratically even as viewed through binoculars. It resembled a steady aircraft light and was initially so identified. There seems no reason to suspect any atmospheric-optical component to the initial visual sighting.

Through binoculars the light resolved into 3 sources, one of the 1st magnitude, two of the 2nd, which, visually integrated, would imply a naked-eye object of no great brilliance but brighter than most of the stars. No estimate of visual magnitudes is offered for the objects as later seen "directly over the ship", but it is implied that the overall "presentation" of the lights was dissimilar to, and therefore presumably brighter than, that of satellites. Nevertheless, they do not at any time appear to have been more than moderately bright point sources without noticeable detail or extension.

How the 3 objects first seen visually relate to the 4 objects subsequently seen visually and tracked on radar is not clear. The bearing of the first radar acquisition is not stated, but the 4 targets reduced range from 22 miles to "over the ship", and it is at least implied that this approach bore a natural relation to the visual approach of the 3 lights first seen 4 minutes earlier. The 4 radar targets "spread to circular formation directly overhead", implying a compact initial configuration not inconsistent with the visual observation, and one of the targets made a larger scope presentation than the rest consistent with visual sightings made previously and concurrently.

The SPS-6C is described as an "air search radar" and was probably a moderately long range S-band instrument used for aircraft detection, wavelength in the range 6-20cm, with the normal toroidal scan volume (possibly a sea-going cousin of the CPS-6 multiple-beam search radar). Such a radar would have sensitive clutter rejection characteristics to contend with sea clutter and the motion of the ship, and frequency agility to combat jamming. It was not a tactical targeting radar, and the report does not mention any other radar being used. This being the case, the report of targets which "spread to circular formation directly overhead" may be in need of some interpretation due to the zenithal radar shadow. One of the 4 targets was "off the starboard quarter", and the clear implication is that the center of the circular formation was directly over the ship with the targets disposed around it at elevations significantly less than 90 degrees. No altitude data are quoted, but it might be inferred from this geometry that if the targets were real radar-reflective objects then they were not at extreme altitude, but in relatively local airspace as is also suggested by their initial acquisition at a slant range of only 22 miles. Visually and on

radar, it would seem that the target manoeuvres bore a relation to the presence of the ship consistent with this assumption.

The 3 minutes of stationarity rules out fixed wing aircraft, but might be consistent with reconnaissance helicopters from another vessel (presumably "hostile" given the absence of IFF response). However there are objections to this hypothesis: 1) the targets were observed visually by all bridge personnel and "numerous hands topside" whilst disposed around the ship, and with a quiet deck in the middle of the night 4 helicopters hovering in the vicinity would possibly be heard given that at any moment at least one would be upwind; 2) the initial visual sighting noted the "extremely high speed" of approach, independent of subsequent radar tracking, a phrase employed again to describe the objects' radar-visual departure; 3) the radar targets "were tracked at speeds in excess of 3,000 (three thousand) knots" - about 3450 mph; 4) given that the period of stationarity occupied 3 minutes of a total 6 minutes radar duration, then even neglecting departure time entirely we are left with a window of 3 minutes for the targets to close from an initial range of 22 miles, which leads to an absolute minimum target speed during approach of 440 mph relative to the ship (425 mph true), not consistent with the performance of helicopters.

Birds, insects, balloons or other wind borne objects are clearly not appropriate to this case. The duration of several minutes is alone sufficient to rule out meteor-wake ionisation. Multiple-trip returns from an artificial satellite could not account for 3 minutes of stationarity or the manoeuvring of 4 distinct targets, nor could multiple-trip returns from any single reflector account for simultaneous targets at opposite scope azimuths. Distant ships might be displayed at spuriously close ranges due to super-refractive conditions, and the circular disposition of the targets might result from multiple-trip returns from four such ships detected via an isotropic elevated duct; but the approach and departure of the 4 targets at high speed on narrow azimuths separated by about 135 degrees conflicts with this hypothesis.

The targets apparently approached head on from the W and departed SE, two essentially radial headings which taken in isolation might suggest an internal noise source or RFI, possibly radar pulses from other ships or even (initially) a land-based radar site near Aparri in the Philippines detected due to anomalous propagation. A distant search radar with a pulse length and PRF similar to the SPS-6C but a scan rate slightly out of phase with that of the receiver might be detected as a target reducing range with each scan; a distinct radar source on a ship at sea to the SE might similarly generate a receding target (air radar operates at very different frequencies and pulse rates). However the scenario is at best fanciful, requiring a great deal of coincidence including radars with almost identical scan rates rotating relative to one another such that the orientations of the receiving and (two) sending antennae coincide near peak gain, and more importantly it does not explain 4 distinct targets arriving, spreading over the ship, and then departing.

A more complex hypothesis would be short-pulse signals arriving with a much longer PRF than the receiver and displaying, not as an integrated target arc but as a number of smaller spots distributed on non-adjacent trace radii. If the input PRF were close to a whole multiple of that of the receiver, then these small "point echoes" could appear at similar

ranges forming a group of "targets". If the "scan rate" of the source were, as in the previous scenario, slightly out of phase with that of the SPS-6, then this group could approach scope centre. However, due to the convergence of trace radii such spot arrays will converge to an integrated arc as they approach scope center, not diverge to "spread over the ship", so that a superadded explanation is required.

It is qualitatively speaking possible that if the "scan rates" of the first source and receiver came into phase then the integrated blip could slow and stop, and if at this time the received signal strength were fortuitously enhanced (say, by worsening AP conditions) the same signal might be spuriously displayed at widely separate azimuths due to side lobe-gain as the antenna rotated, the result being a distributed set of apparently different targets at the same displayed range with one (corresponding to the peak gain of the antenna) giving a much brighter presentation, as reported. Such an effect, however, would seem to require yet a third source of RFI pulses, since the bright target corresponding, ex hypothesi to the peak summed gain) was displayed to starboard (N) and thus on an azimuth 90 degrees from the initial signal; also, the same constant source could not generate rapidly moving blips and, consecutively, stationary blips for as long as 3 minutes; this mechanism does not explain the subsequent movement of the blips away into the opposite sector; furthermore the required signal characteristics (pulse length, wavelength and scan rate all comparable to the SPS-6, but PRF several times that of the SPS-6) do not correspond to any likely radar system. And finally, the small spots of excitation produced on the tube in this fashion would (during "approach" and "departure") in no way resemble the presentation of real targets.

Sporadic noise sources seem highly improbable: very great variations in measured speed from hundreds to thousands of knots could result from intermittent noise signals jumping discontinuously between different trace radii on successive scans, but in the absence of detailed scope photos or diagrams one can only say that the likely random behavior of such blips conflicts with the ordered sequence of events reported. Cyclic noise sources local to, or internal to, the transmitter or receiver circuitry are a possible source of ordered blips, but several of the objections raised against remote RFI sources also apply here. In general, any such electronic or propagation artefact must be seen in the context of specifically reported visual corroboration of target movements during the whole incident, and it should be noted that the radar report of targets broadly "over the ship" does not imply the low elevation angles required for anomalous propagation of surface returns or signals from distant radars.

Partial reflection from wind-driven waves on an inversion layer could account for target clusters at moderate speeds, but here too there are problems: 1) target heading changed by about 50 degrees; 2) the reported maximum speed, as well as the minimum speed derived from time and distance data quoted, are impossibly excessive for the 2 x windspeed behavior of such echoes; 3) the 3-minute period of stationarity cannot be explained; 4) such echoes reduce in intensity as the 6th power of the cosecant of the elevation angle, leading to signal strengths proportional to range, and would not be displayed approaching to high elevations in proximity to ("over") the ship.

In summary, it might be possible to conceive a number of highly speculative atmospheric structures and noise/interference effects which, combined with an initial sighting of aircraft, led to a coincidental sequence of radar and visual misinterpretations of false blips, stars and meteors by an overexcited crew. But the probability is far too low to constitute a solution. Given the clear statement of radar-visual concurrence, and observations by the Commanding Officer, all bridge personnel and numerous hands, the very great strain required to deconstruct the coherent sequence of events reported into a conventional interpretation seems unwarranted and uneconomical. There are persuasive indications of ordered behavior on the part of self-luminous, radar-reflective objects which appear to have had some rational intent with regard to the presence of the ship, which objects exhibited speed and manoeuvrability inconsistent with the performance of any vehicle known to have been flying in 1965.

STATUS: Unknown

18. DATE: May 4, 1966 TIME: 0430 local (0340 -Thayer) CLASS: R/V ground/air radar/multiple air visual

LOCATION: Nr. Charleston W. Va.

SOURCES: Hynek (1978) 73 Thayer (Condon 163)

RADAR DURATION: 5 minutes

EVALUATIONS: Blue Book - a/c landing lights

PRECIS: At 0340 (or 0430 - Hynek) a Braniff Airlines Flight 42 707 pilot heading E on jet airway 6 at 33,000' saw a bright descending light off to his left which was also painted by the Boeing's airborne radar. He called Charleston ARTC center and asked if radar showed any traffic for his flight. The Charleston high altitude sector controller was distracted by a 'phone call and hadn't seen the appearance of the target, which he now noticed, 11 o'clock from Braniff, range 5 miles. It was a "raw" target (no transponder, which would give on-screen data on flight ID and altitude), and the controller advised Branniff that it must be an aircraft in the low sector below 24,000' as the only other traffic under his control was an American Airlines flight 20 miles behind him. Braniff replied that the object was definitely above him and now descending through his altitude. The controller suggested that it might be a military research aircraft of some sort and asked Braniff for a visual. Braniff replied that it was not an aircraft but was "giving off brilliant flaming light consisting of alternating white, green and red colours". At this time ground radar showed the target closing range to within 3 miles at 10 o'clock from Braniff; Braniff then advised that it was now turning away from him, and the controller saw the radar target execute a smallradius 180-degree turn and reverse its track NW away from Braniff at approx. 1000 mph. Braniff confirmed this and reported that the object was 20 degrees above the horizon and still descending (Braniff's airborne radar indications at this time are not known).

A sighting of what may have been the same object was made by the pilot of the American Airlines flight 20 miles behind (W of) Braniff: a bright light at 9 or 10 o'clock observed for 3-4 mins. According to the controller, American had been monitoring his communications with Braniff and called the latter, asking if he had his landing lights on. When the controller asked him to amplify, American "politely clammed up". American submitted no report and later disclaimed seeing anything other than what looked like an aircraft with its landing lights on.

NOTES: The likelihood of a real radar-reflective target is in this case quite strong, since correlating returns were reportedly displayed by ground and airborne radars concurrent with matching visuals from (at least) one aircrew. The Blue Book explanation that the object was an aircraft is based on this fact, together with the American Airlines pilot's opinion and the comment that the object displayed no performance beyond the capabilities of an aircraft of the period. No specific identification was offered of the aircraft involved.

According to Thayer's summary of the Blue Book file, the object was first reported by Braniff at a time of 0340 LST, it was picked up at his 8:30 or 9:00 position, the speed of the ground radar target was 750-800 mph with "no unusual maneuvers", and it disappeared off-scope to the SW after making a "sweeping turn". According to the ARTC controller's account (quoted verbatim in Hynek), the incident began at 0430, the target appeared at 11 o'clock from Braniff moving to 10 o'clock, the speed of the target was approximately 1000 mph, and it left to the NE after making "a complete 180-degree turn in the space of five miles, which no aircraft I have ever followed on radar could possibly do." The controller had 13 years experience with USAF and FAA air traffic control, observing all types of civilian and military aircraft including SR-71's. His account is extremely circumstantial as to Braniff's flight number, VHF frequency, altitude, air lane number and heading, and augmented by a diagram (unpublished) showing the geographic locations of the UFO and the aircraft under his control.

There seems no good reason to question the controller's statement that Braniff was "eastbound on jet airway 6", which means that a target closing from 9 or 10 o'clock (N or NW) and retreating on a similar course after a turn, however "sweeping", could not possibly be on a heading off-scope to the SW. Either Thayer's summary, or the Blue Book file, or both, are here inconsistent, whereas the controller's first hand account is not. According to that account, the combined speed and manoeuvrability of the target were outside of his experience, also contradicting the Blue Book file which appears to base its assessment of performance (the origin of the 750-800 mph figure is uncertain) on a statement obtained from the reluctant American Airlines witness: " . . . to me it only appeared to be an airplane at some distance, say six or eight miles, who turned on his landing lights . . . . I thought nothing further of it." This also is inconsistent, inasmuch as the object was well in front of Braniff and thus significantly in excess of 20 miles from American, so that American's estimate of landing light brilliance and distance would be out by a factor of 3 or 4. The same pilot speculated: "I presume it was the air force refuelling." Air-refuelling tankers are indeed always brightly lit, but no such operation would normally be in progress close to a commercial airlane, still less on a descending course through it. An Air Force refuelling operation would, presumably, not be difficult for the Air Force to trace; yet no such operation was discovered by Blue Book despite a witness suggesting it. A

possible explanation might be a cover-up of a military flight conducted in error; but the radar target could not possibly relate to a refuelling tanker on the basis of speed alone. A military fighter could account for the speed, and for the rapid departure when the pilot realised he was straying close to commercial traffic, but presumably not for the tight 180 degree turn.

The visual from Braniff of a brilliant light with multicoloured scintillation is more akin to a bright celestial body seen through a sharp inversion layer than anything else, but not on a descending course through his altitude. (Note: Braniff reports the object descending through his altitude, then somewhat later reports it still in a "descending configuration" at 20 degrees above the horizon. This could be interpreted as an inconsistency, inasmuch as 20 degrees seems a rather high elevation for an object to be seen at a depression angle even from 33,000', and this might imply that the object was less mobile in elevation than suggested. However observers almost always grossly overestimate elevation angles, and there tends to be a visual "quantum" of 10 degrees.) A fireball meteor could fit the "flaming" appearance and gross trajectory, flaring and dying to give the illusion of an object which approached Braniff and then receded; but no trail was reported, and a fireball which was in sight for five minutes would be a very remarkable phenomenon in itself, probably spawning a great many reports, in addition to which the ATC radar track, mimicking the illusory visual approach of the meteor, would become a highly improbable coincidence.

On ground radar a "ghost" echo from a ground target with Braniff as the primary reflector could simulate an "intercepting" target of this nature: it would appear beyond Braniff and always on the same azimuth, closing as Braniff approached the ground reflector and then receeding in a manner qualitatively similar to that described, although the exact geometry would have to be established. However, Braniff was flying at 33,000' so that such a "ghost" could not be displayed closer than 6.25 miles to the a/c. The unknown target approached to 3 miles. A "ghost" produced by secondary reflection from an airborne target, for example an aircraft passing above or below Braniff, could mimic this behavior, and if we assume that the secondary a/c reflector was itself outside the ATC radiation pattern then it would not itself be tracked on the ground - only its ghost would be displayed. The air radar contact and the visual sighting could have been this a/c, since without the ATC radar track we no longer have to suppose extraordinary performance - merely a fast jet with an unusual lighting pattern, possibly viewed through an inversion at Braniff's altitude. The ground-displayed speed of 1000 mph would be the relative speed of the two reflecting aircraft, not implausible for a military jet flying by a 707 on a near-reciprocal heading.

However, the hypothetical a/c would be flying as close to Braniff as its displayed ghost (approx. 15,000' of range or altitude) and thus could hardly be outside the overall ATC radiation pattern (the a/c could hardly have remained in a null zone between radar lobes for several minutes); no other aircraft were currently under ATC control except American, 20 miles away; and 5 minutes is a very long time indeed for such sensitive reflection geometry to be maintained between aircraft separating at better than Mach 1.3.

Further, this hypothesis does not explain the correlation of visual and radar kinetics, and for an inversion layer to explain the abnormal colour scintillations of the light it would have

to be viewed at a rather narrow range of relative elevation angles on the order of 1.0 degree, which is inconsistent with a source which was seen descending at speed for several minutes. Other more complex and less homogeneous atmospheric structures might be hypothesised, but the exercise would be highly speculative and unconvincing.

A similar radar track might be produced on the ATC scope by multiple-trip returns from meteor wake ionisation, although typical ATC wavelengths of 10-50 cm are far from optimum and signal strengths would be low; but the duration is far too long, and Braniff's shorter-wave airborne radar would not have anything like the power output (around 40 kW, or some 5% of typical ATCR output) required for such returns. In general no radar propagation or electronic anomaly can easily explain concurrent, corresponding returns on two very different and physically remote instruments, and the visual observations effectively reduce the probability of anomalous propagation to near-zero.

In conclusion, the target appears to have been a real object emitting brilliant, corruscating light which descended into an Air Route Traffic Control sector at better than Mach 1, passed within 3 miles of a commercial airway in complete radio silence, executed an abnormally sharp 180-degree turn at speed and flew away. The probability of a conventional aircraft seems small: the visual appearance and the radar-tracked turn are the key elements of this report, neither of which were within the experience of the observers. Whilst of relatively low strangeness, therefore, the report must be classified unknown.

STATUS: Unknown

19. DATE: January 13, 1967 TIME: 2200 local CLASS:R/V ground radar/ multiple air visual

LOCATION: Air Traffic Control Center, Albuquerque, N.M.

SOURCES: Hynek (1978) 72

RADAR DURATION: 25 mins.

EVALUATIONS: official not specified

PRECIS: The pilot of a Lear jet flying near Winslow, Arizona, reported a red light at their 10 o'clock position that flashed on and off and several times quadrupled itself vertically, appearing to "retract into itself the lights below the original light". A National Airlines pilot in the area was queried by Albuquerque control tower, and after initially denying any sighting confirmed that they had been watching the object "doing exactly what Lear jet said" approximately 11 o'clock from their position. Albuquerque radar painted an unidentified target in a position consistent with the visual report, and for much of the 25 minutes during which the object was watched from the Lear, Albuquerque maintained radio conversation with the pilot. Whenever the red light was "on", ground radar painted a single target, but whenever it was visually "off" radar painted nothing. Radar apparently did not detect any changes coinciding with the quadrupling of the light. After a while radar showed the target closing range with the Lear, and the tower warned the pilot, who reported that the object began "cat-and-mouse" manoeuvres with his a/c involving rapid accelerations. At

2225 the object began a 30-degree ascent with great acceleration and was watched by the Lear pilot for 10 seconds until it was out of sight. At this time Albuquerque radar lost the target from their scope. Both Lear and National declined to officially report a UFO.

NOTES: Much of the significance of this case depends on details of the "catand-mouse" manoeuvres and the degree to which the radar target movements correlated during this episode. Unfortunately this information is lacking.

The downward "quadrupling" of the light is very suggestive of a multiple inferior mirage due to highly stratified atmospheric conditions, and celestial bodies can appear dramatically reddened, particularly when near setting. Since the critical grazing angle for an optical mirage is on the order of 0.5 degree this would presumably indicate a light source above the horizon for an aircraft at altitude, and would require the same (vertical) viewing angle from both aircraft. Thus Lear and National need to have been at roughly similar flight altitudes with, probably, a bright celestial body near the horizon. The visual disappearance of the object might be due to its setting below the critical angle, and the rapid "cat-and-mouse" movements of the object (in the absence of detailed description) could be due to sudden excursions of the mirage image (on the order of 1 degree) due either to movements of the aircraft relative to the refractive layer or to local discontinuities in the layer. Unfortunately we do not know the relative altitudes of the two aircraft, or the true azimuth at which the light was observed. However, it can be noted that the radar target which appeared to confirm the object near Winslow would have been due west from Albuquerque and thus not necessarily inconsistent with the azimuth of a setting star or planet viewed due west from Winslow. The same sharp inversion/lapse strata responsible for such a mirage might be expected to favour anomalous propagation of radar energy and thus the possibility of false echoes.

There are some problems with this hypothesis, however: 1) During 25 minutes of observation a celestial body above the western horizon would have declined by some 6 degrees, or at least 10 x the critical grazing angle for a mirage, and this makes some unlikely demands on the changing altitudes of the mirage layers and the two aircraft over the duration of the sighting; 2) to keep a celestial body in view for 25 mins the Lear was presumably flying a roughly straight course, during which it probably covered on the order of 100 miles at least - a great distance over which to remain in the same inversion domain; 3) the visual departure of the object, moving upwards at a 30-degree angle for ten seconds at a considerable angular rate, is inconsistent with the optical geometry of any mirage; 4) the repeated flashing of the light on and off suggests an intermittent superior mirage of a celestial body otherwise invisible below the horizon, which is at odds with the consistent downward multiplication of the image suggesting an inferior mirage of a source above the horizon.

An intermittent source would more aptly explain the flashing off and on, such as a beacon on a radio mast, which would also to some extent evade the problem of maintaining the critical mirage angle for many minutes. However, there is also the general question of the repeated simultaneous radio and optical disappearances of the source: this cannot be explained by an intermittent ground light, and optical disappearance of a celestial body due to the Lear's altitude departing from the optimum mirage angle or flying in and out of

localised inversion/lapse domains cannot explain simultaneous signal loss at the radar site. In general it might be noted that the rather extreme atmospheric stratification required for the multiple mirage images would be expected to generate a great deal of AP clutter, and is not usually so anisotropic as to generate a unitary target over a narrow range of azimuths for 25 mins. In summary, the radiooptical AP hypothesis is superficially attractive but conjectural, and suffers from several serious deficiencies.

Other explanations of the radar target have to address the simultaneous radio-optical disappearances, which argue strongly for a real radar-reflective body. The object would be an anisotropic reflector and emitter - that is, an object with a high radar aspect-ratio in elevation (i.e., side-on:tail-on), zigzagging, rotating, or oscillating, and carrying a light which was visible to Lear only when it presented its greatest radar cross-section to Albuquerque. One could imagine a slowly spinning balloon with an underslung radar-asymmetrical instrument package bearing a red running light, if this could explain 25 minutes of jet-pursuit. A very large research balloon at high altitude over the horizon might be "pursued" for 25 minutes, and (improbably, given small radar crosssection at extreme range) might be painted by second-trip returns which displayed it in spurious proximity to the Lear over Winslow. But this could not explain the high-acceleration 30-degree visual ascent and disappearance, and the lights required to be carried by such balloons during night launches would hardly be prominent at the implied distant ground range and float-altitude of over 100,000'.

The illusion of a high-acceleration manoeuvre might be created by a small weather balloon near the a/c, but such a balloon could not be pursued at jet speed for 25 minutes. Furthermore weather balloon lights are not red; the quadrupling of the light would still require the superadded improbability of a rare optical mirage with a fortuitously maintained altitude relationship between the aircraft, the rising balloon and a slowly canting inversion layer; and the final radar-visual disappearance would remain unexplained and coincidental.

Visually, a reddish light could be explained as the tail-pipe of a jet, and periodic disappearance could relate to a circling or zig-zagging flight pattern which would present a changing aspect with a factor 5 or 10 fluctuation in radar cross-section (10-20 sq. m. down to 2-3 sq. m. for a small fighter). Close to the operational maximum range of the set, the returned signal might drop below the noise threshold as the a/c turned tail-on, and the distance between Albuquerque & the area of Winslow is >200 miles which would be consistent with the action occurring near the limits of an ATC surveillance radar. On this hypothesis the Lear would have been proceeding N or S with the jet ahead, tail-on to the Lear and side-on to the radar whenever it was visible. Such a jet could explain the final ascent and radar/visual disappearance by a climb and turn, tail-on to the radar and out of the pattern. This hypothesis is speculative, however, without knowing the frequency of the light's on-off cycle, the Lear's heading, the displayed speeds of the radar target, and the nature of the "cat-and-mouse" episode. 25 minutes is very a long time for a military jet to be flying at high speed (ahead of the Lear) in such an unusual fashion. Finally, the repeated quadrupling of the red light observed from two aircraft with only a single target appearing on radar is entirely unexplained without recourse to a superadded mirage phenomenon

which is itself very rare and which renders the whole scenario too improbable to be convincing.

In conclusion, the raw visual description alone is strongly suggestive of mirage, although most other features of the case - qualitative and quantitative - argue against mirage as normally understood, and the simultaneous on/off radar-visual periodicity confirmed by radio between the observers as it was happening does argue quite strongly that the radar target and visual object(s) were related. The case should therefore be classified as "unknown" pending further investigation.

STATUS: Unknown

20. DATE: November 8, 1975 TIME: 0053 MST CLASS: R/V ground radar/ ground visual

LOCATION: SOURCES: Fawcett & Greenwood 30
Malmstrom AFB Klass (1983) 101
Montana

RADAR DURATION: unspecified

EVALUATIONS: NORAD - unknown

PRECIS: National Military Command Center (NMCC) "Memorandum for the Record", 0600 EST, November 8 1975, subject: "Unidentified Sightings":

1) From NORAD Command Director: At 0253 EST [0053 local] 8 Nov, Malmstrom AFB, Montana received seven radar cuts on the heightfinder radar at altitudes between 9,500 and 15,500 feet. Simultaneous ground witnesses observed lights in the sky and the sound of jet engines similar to jet fighters. Cross-tell with FAA revealed no jet aircraft within 100 NM of the sighting. Radar tracked the objects over Lewistown, Montana, at a speed of seven (7) knots. Two F-106 interceptors from the 24th NORAD Region were scrambled at 0254 EST [0054 local], and became airborne at 0257 EST [0057 local]. At the time of the initial voice report, personnel at Malmstrom AFB and SAC sites K-1, K-3, L-3 and L-6 were reporting lights in the sky accompanied by jet engine noise.

2) 0344 EST From NORAD Command Director. Objects could not be intercepted. Fighters had to maintain a minimum of 12,000 feet because of mountainous terrain. Sightings had turned west, increased speed to 150 knots. Two tracks were apparent on height-finder radars 10-12 NM [nautical miles] apart. SAC site K-3 reported sightings between 300 feet and 1000 feet, while site L-4 reported sightings 5 NM from [NW of] their position. Sightings disappeared from radar at position 4650 N/10920 W at a tracked speed of three (3) knots.

3) At 0440 EST, NMCC initiated contact with the NORAD Command Director who reported the following: at 0405 EST [0205 local], Malmstrom receiving intermittent tracks on both search and heightfinder radars. SAC site C-1, 10 NM SE of Stanford, Montana, reported visual sightings of unknown objects.

At this time, as noted in a subsequent NORAD report to NMCC logged at 0522 EST that morning:

> At 0405 EST [0205 local] SAC site L-5 observed one object accelerate and climb rapidly to a point in altitude where it became indistinguishable from the stars.

The main report continues:

> 0420 EST [0220 local]: Personnel at 4 SAC sites reported observing intercepting F-106s arrive in area; sighted objects turned off their lights upon arrival of interceptors, and back on upon their departure. 0440 EST [0240 local]: SAC site C-1 still had a visual sighting on the objects.

NOTES: There are some insignificant differences in the transcription of this message in the two sources. The only material ones are in para. 2, where Klass notes a range and bearing for the L-4 visual (interpolated above) omitted by Fawcett & Greenwood, and appears himself to misquote the minutes of latitude for the radar coordinates. (It should also be noted that F & G give a separate narrative of what appears to be the same sequence of events at Malmstrom on the same date [source 30, para.3] but with different times, altitudes and SAC site locations. The source of this confusion is uncertain.)

NORAD reported to the NMCC Deputy Director for Operations that the possibility of height-finder tracks being caused by auroral ionisation had been considered and rejected after a check with weather services "revealed no possibility of Northern Lights." The 0522 EST addendum to NORAD's initial reports, in part interpolated above, reads in full as follows:

> At 0405 EST SAC site L-5 observed one object accelerate and climb rapidly to a point in altitude where it became indistinguishable from the stars. NORAD will carry this incident as a FADE remaining UNKNOWN at 0320 EST [0120 local], since after that time only visual sightings occurred.

This is the extent of the known official evaluation. The meaning of FADE is uncertain: Klass interprets it as "radar target fading out"; F & G also suggest this, but add that another Air Force code-term, "Faded Giant" meaning an incident involving tampering with nuclear weapons, might be relevant in the context of a Sabotage Alert situation. However, in the context of the NORAD message neither of these interpretations is convincing, and FADE is probably an acronym.

Klass interprets this 0522 EST message as indicating that NORAD had since concluded that the "intermittent" search and height-finder radar tracks being reported at 0205 local were caused by anomalous propagation conditions. This is quite possible, if speculative given that the message is hardly unambiguous. But on this interpretation 0120 local would presumably be the time of disappearance of the two earlier radar tracks described in para. 2 above, and it is certainly useful to consider the case as two distinct sequences of events.

Accepting that NORAD had discounted the 0205 radar tracks, Klass proposes that concurrent and subsequent visual reports were of bright celestial bodies. He notes that Venus was "particularly bright", rising about 0230 local time. Reports of the objects "turning off their lights on arrival of the interceptors, and back on again upon their departure" he interprets as due to observers focussing their dark-adapted eyes on the "intense glow" of the F-106s' jet exhausts and being temporarily distracted from the "distant" celestial objects which "would be much fainter and, comparatively, dark." (source 103-4) This is a little strained, however. The report does state (although brevity breeds ambiguity) that personnel at four separate missile sites described this behavior: how many would be looking up the jet-pipes of the F-106s, and for what proportion of their unknown flight paths? Further, para. 2 states that the mountainous terrain forced the interceptors to fly above 12,000': how "intense" is a jet exhaust viewed at a slant range of several miles, as compared with a "particularly bright" Venus? Klass's hypothesis may be correct, but it is not without some supposition.

As regards the 0205 radar tracks, these may have been exactly or approximately concurrent with visual sightings from SAC site C-1; and if they were exactly concurrent they may or may not have been consistent with the reported visual position and movement of the "unknown objects". With so little information the report cannot be treated as a radar-visual incident. There is also insufficient information to diagnose the target(s) as anomalous propagation: if, for example, the target detected on search radar correlated with the heightfinder indication, then AP might be less attractive because such effects are frequency-dependent and the two instruments would probably operate at different frequencies. The description of both displayed targets as "tracks" may suggest a coherent sequence of paints, or multiple random blips on the two scopes. It should be noted, however, that "intermittent" tracking is not of itself diagnostic of AP as Klass implies: a real radar-reflective target can be painted intermittently for various reasons including nulls between radar lobes, variations in aspect, variations in range, variations in altitude near the bottom of the beam, weather, shadowing, and ground clutter.

Turning to the earlier events the picture appears to be slightly more coherent, and if NORAD's apparent disregard of the radar tracks after 0120 local means that they had been explained as AP, then by the same token its retention of the earlier tracks as UNKNOWN implies that these had not. Klass appears to come to the same conclusion, and suggests that these "few intermittent radar targets" (source 101) and "very slow-moving radar targets" (source 103) could have been due to migrating flocks of birds. It is true that even single birds could be detected by sensitive search radars, and flocks can have an integrated radar cross-section as large as an aircraft. But two points need to be made:

1) Klass's statement that these earlier targets were "intermittent" should be ignored as the insinuation it is. They are nowhere stated to have been intermittent, and If we extract the radar events and times from the report in clear sequence we have the following reconstruction:

0053: height-finder displays targets between 9,500' and 15,500'. During the next minute, personnel check flight plans with the FAA, radar displays the targets moving over Lewistown at 7 knots, and NORAD considers scrambling interceptors.

0054: NORAD issues scramble authority.

0057: 2 F-106s airborne and vectored towards targets, but could not fly safely below 12,000' and were unable to intercept. Meanwhile two targets were being tracked, 10-12 miles apart, which turned onto a W heading and accelerated to 150 knots, eventually slowing to 3 knots.

0120: the targets disappeared from radar in the vicinity of the 8000' Big Snowy Mountains, some 20 miles S of Lewistown.

There are many questions raised by this narrative, but there is no suggestion that the radar tracks were "intermittent".

2) Birds might account for targets at 7 knots, but could not then accelerate to 150 knots (>170 mph) and decelerate again to 3 knots without transiently encountering severe hurricane-force winds, and the indicated target altitude on the height-finder at this time was evidently some way below the minimum safe 12,000' level of the F-106s since it was for this reason that the "objects could not be intercepted". This is not inconsistent with concurrent visual estimates of < 1000', which cannot be relied upon as accurate but do indicate low altitude. Winds on the order of 150 mph at only a few thousand feet, in clear, starry conditions conducive to flying, are not to be thought of. Moreover, the bird hypothesis fails to address concurrent visual sightings of lights and engine noise (reported, it should be emphasised, before the interceptors were launched).

It would make more sense to interpret such targets as multiple-trip returns from aircraft flying beyond the unambiguous range. It would be possible for such echoes to display spuriously slow speeds changing proportionally to the tangential vector. But again the concurrent visual and aural reports are inexplicable in terms of jets which would have to be at second-trip, or more probably > thirdtrip ranges, as required both by the gross speed distortion and by the absence of any known jets within 100 nautical miles.

It is noteworthy that "at the time" when the NORAD Command Post received "the initial voice report" from the radar site, "simultaneous" reports were being received from Malmstrom AFB and 4 SAC missile sites of "lights in the sky accompanied by jet engine noise." Personnel plainly believed that the targets were jet aircraft (a sound very distinct from helicopter rotor noise), which is why they queried the FAA about jets in the area. And this is the nub of the incident: jets were heard, lights were seen, and radar showed uncorrelated targets simultaneously in the same area: yet Malmstrom had no jets in the area; according to the FAA there were no other jets in the area; and there are very few jets in the world even today that can fly at 3 knots. (Spuriously slow displayed speeds are possible briefly on a surveillance PPI if an a/c on an inbound radial heading were to climb tangentially to the antenna, thus maintaining similar slant range; but probably neither

repeatedly nor for extended periods. The same anomaly cannot occur with a height-finder, however, whose fan beam scans in elevation.)

The absence of clearly reported search radar paints at this time is noteworthy but inconclusive. In mountainous terrain there would be a groundclutter problem, and the search PPI would certainly have been fitted with MTI (Moving Target Indicator) or analogous signal processing designed to suppress stationary ground clutter. This system could also suppress targets moving at only 3-7 knots. The height-finder's horizontal fan beam, scanning between operatorselectable elevation limits, does not constantly radiate high levels of groundincident energy and so does not have the same permanent clutter problem, which means that it can operate with relative effectiveness without the use of MTI. It is therefore possible that these very slow targets could be preferentially detectable on the height-finder. Search radar may have displayed the targets during part of this incident, since they were reported at 150 knots for a time, but this is far from clear.

In summary, some later events of the night are ambiguous and could have been misinterpretations of astronomical or other phenomena, although this is conjecture and open to some criticism. The initial radar/visual/aural detection of some kind of lighted, apparently jet-powered aircraft is convincing, however, and the failure of SAC Malmstrom, NORAD and the FAA to identify any aircraft, either by radio, by transponder codes, by interception or by flight plan, is quite puzzling. The implied performance of the aircraft is also extraordinary for any fixed-wing jets other than vertical takeoff and landing (VTOL) aircraft, which would have to be U.S. or Canadian military and thus presumably known to NORAD. Helicopters would better fit the performance, but personnel at several sites independently reported identifying the sound of jets, not rotor noise. There is no obvious explanation of these facts, and some weight has to be given to NORAD's decision to carry this phase of the incident as "UNKNOWN". The reports that the objects sounded like jets certainly invite the legitimate suspicion that they may have been jets, despite these counterindications; but the balance of the evidence argues quite strongly that they were not jets, and subsequent visual reports (with ambiguous radar corroboration) from several sites, describing objects with unusual lighting and flight patterns, do borrow some added credibility from that conclusion.

STATUS: Unknown

21. DATE: September 19, 1976 TIME: 0030 local CLASS: R/V air radar/ ground visual

LOCATION:
Nr. Tehran,
Iran

SOURCES: Klass (1983) 111
Fawcett & Greenwood 82

RADAR DURATION: unspecified

EVALUATIONS: No official

PRECIS: The principal source for this case is a memorandum-for-the-record prepared by Lt. Col. Olin R. Mooy, USAF, executive officer to the chief of the USAF section, Military Assistance & Advisory Group (MAAG), Tehran. The report contains information supplied

by Iranian officials in addition to details obtained in a debriefing of one of the Imperial Iranian Air Force (IIAF) aircrews involved, which was attended by Mooy and Colonel J. R. Johnson, USAF, at the invitation of Iranian officials. The debriefing was also attended by, amongst others, Lt. Gen. Abdullah Azerbarzin, IIAF Director of Operations. The debriefing took place on September 19, the day of the incident. Mooy's report was distributed to several US agencies, and copies classified CONFIDENTIAL (some with minor edits in prefatory paragraphs) appear in the files of the State Department, CIA, USAF and DIA (Defense Intelligence Agency), the latter with an appended Defense Information Report Evaluation. The complete version follows:

1. At about 12:30 AM 19 September 1976 the IIAF Command Post received a telephone call from the ADOC [Air Defense Operations Center] representative at Mehrabad [a joint civil-military airport near Tehran]. He said that Mehrabad had received four telephone calls from citizens living in the Shemiran area [of Tehran] saying that they had seen strange objects in the sky. One lady described them as a kind of bird, while another lady said, "Please tell this helicopter with a light on to get away from my house because I'm scared." (There were no helicopters airborne at the time.) The citizens were told it was probably stars.
2. The Command Post called Brigadier General Yousefi, assistant deputy commander of operations. After Yousefi talked to Mehrabad tower and determined Babolsar and Shahroki radars did not have the object, he decided to look for himself. He noticed an object in the sky similar to a star but bigger and brighter. He decided to scramble an F-4 from Shahroki to investigate.
3. The F-4 took off at 01:30 AM and proceeded to a point about 40 NM north of Tehran. Due to its brilliance the object was easily visible from 70 miles away. As the F-4 approached a range of 25 NM he lost all instrumentation and communications (UHF and Intercom). He broke off tghe intercept and headed back to Shahroki. When the F-4 turned away from the object and apparently was no longer a threat to it the aircraft regained all instrumentation and communications.
4. A second F-4 was launched at 01:40 AM. The backseater [radar operator] acquired a lock-on at 27 NM, 12 o'clock high position with the Vc (rate of closure) at 150 MPH. As the range decreased to 25 NM the object moved away at a speed that was visible on the radar scope and stayed at 25 NM.
5. The size of the radar return was comparable to that of a 707 tanker. The visual size of the object was difficult to discern because of its intense brilliance. The light that it gave off was that of flashing strobe lights arranged in a rectangular pattern and alternating blue, green, red and orange in colour. The sequence of lights was so fast that all colours could be seen at once.
6. The object and the pursuing F-4 continued a course to the south of Tehran, when another brightly lighted object, estimated to be 1/2 to 1/3 the apparent size of the moon, came out of the original object. This second object headed straight towards the F-4 at a very fast rate. The pilot attempted to fire an AIM-9 missile at the object but at that instant his weapons-control panel went off and he lost all communications (UHF and Interphone). At this point the pilot initiated a turn and negative-G dive to get away. As he turned the object fell in trail at what appeared to be about 3-4 NM. As he continued in his turn away from the primary object the second object went to the inside of his turn, then returned to the primary object for a perfect rejoin.

7. Shortly after the second object joined up with the primary object another object appeared to come out of the other side of the primary object going straight down, at a great rate of speed. The F-4 crew had regained communications and the weapons-control panel and watched the object approaching the ground anticipating a large explosion. This object appeared to come to rest gently on the earth and cast a very bright light over an area of about 2-3 kilometers.

8. The crew descended from their altitude of 26M [26,000'] to 15M [15,000'] and continued to observe and mark the object's position. They had some difficulty in adjusting their night visibility for landing so after orbiting Mehrabad a few times they went out for a straight-in landing. There was a lot of interference on the UHF and each time they passed through a Mag. bearing of 150 degrees from Mehrabad they lost their communications (UHF and Interphone) and the INS [Inertial Navigation System] fluctuated from 30-degrees to 50-degrees. The one civil airliner that was approaching Mehrabad during this same time experienced communications failure in the same vicinity (Kilo Zulu) but did not report seeing anything.

9. While the F-4 was on a long final approach the crew noticed another cylinder shaped object (about the size of a T-bird [a small jet trainer] at 10 NM) with bright steady lights on each end and a flasher in the middle. When queried, the tower stated there was no other known traffic in the area. During the time that the object passed over the F-4 the tower did not have a visual on it, but picked it up after the pilot told them to look between the mountains and the refinery.

10. During daylight the F-4 crew was taken out to the area in a helicopter where the object apparently had landed. Nothing was noticed at the spot where they thought the object landed (a dry lake bed), but as they circled off to the west of the area they picked up a very noticeable beeper signal. At the point where the return [sic] was loudest was a small house with a garden. They landed and asked the people within if they had noticed anything strange last night. The people talked about a loud noise and a very bright light - like lightning.

11. The aircraft and the area where the object is believed to have landed are being checked for possible radiation. More information will be forwarded when it becomes available.

NOTES: Whatever further information may have "become available" is unfortunately not available in the public domain. According to Fawcett & Greenwood, "reliable" US govt. sources acknowledged privately that the official file on this case was 1½" thick, but no agency has admitted possession of documents pursuant to FOIA requests. Whilst this is currently hearsay, there does seem to be no good reason why information which was promised should not have been forwarded; and if it was not volunteered by MAAG, there is at least some evidence that it would have been actively sought.

The only known official US response to the Mooy message is a one-sheet DIA Defense Information Report Evaluation, which allows an analyst to check multiple-option replies to standard questions on the reliability, value and utility of the information with a section for general remarks. The DIRE form indicated that the DIA analyst processing the report considered it to have been "Confirmed by other sources"; that he thought its value to be "High", which the form defines as "Unique, Timely, and of Major Significance"; and that he thought the information was "Potentially Useful". Under "Remarks" the analyst wrote:

An outstanding report. This case is a classic which meets all the criteria necessary for a valid study of the UFO phenomenon:
a) The object was seen by multiple witnesses from different locations (i.e., Shemiran, Mehrabad, and the dry lake bed) and viewpoints (both airborne and from the ground).
b) The credibility of many of the witnesses was high (an Air Force general, qualified aircrews, and experienced tower operators).
c) Visual sightings were confirmed by radar.
d) Similar electromagnetic effects (EME) were reported by three separate aircraft.
e) There were physiological effects on some crew members (i.e., loss of night vision due to the brightness of the object).
f) An inordinate amount of maneuverability was displayed by the UFOs.

Once again, no further information on the progress of the report through the DIA evaluation chain is available. But given that it was flagged as prima facie of potentially major significance one would expect some attempt to be made to secure an update, either actively through MAAG or, more probably, through inhouse intelligence channels and such sources as NSA communications intercepts. There is thus every possibility that more, unacknowledged hard-copy has existed on this incident, and Fawcett & Greenwood's "reliable sources" may well have been correct. It might be noted that the DIRE form's commentary on the original message states: "Confirmed by other sources", which would also be consistent with this inference.

However, the MAAG memo is the only available direct official source, supplemented by newspaper stories which have only limited value. The following analysis is based pricipally on the Mooy document, with additional reference to published quotes from a transcript of the F-4s' radio communications with Mehrabad Tower. [Note: The most influential public analysis of the case was published by Klass, and since he proposes a scenario - quite widely respected - which purports to undermine the reliability of the report as a whole, a detailed commentary on his 11-page polemic is included as an appendix to this entry.]

The core episode is the interception by the second F-4. The radar target in this case appears to have had a very strong scope presentation, comparable to a Boeing 707. A specific estimate of radar cross-section is difficult to derive from this comparison, owing to typical fluctuations due to aspect of as much as two orders of magnitude; but assuming the operator to have meant that the target compared with a 707 under similar conditions, then given that the target was moving ahead of the F-4 we have a tail-on figure of between 20-50 square metres. A 707's side-on cross section, however, might exceed 1000 square metres, so that the above figure should be taken as indicating only a rough minimum due to the uncertainty about the operator's assumptions.

This strong target was not fleeting, but appears to have been held for a period somewhat in excess of 1 minute. After the initial lock-on at 27 nautical miles range the F-4 closed with a Vc of 150 mph to 25 n. miles, which alone would have taken some 50 seconds. Subsequently the Vc reduced to zero and the target "stayed at 25 NM" for an unspecified period. According to an account of the pilot's UHF transmissions it was during this period that he armed his weapons and made ready to engage:

> [The pilot] told the control tower that it [the target] had reduced speed. The pilot said the plane was working well and he was preparing to fire missiles at the UFO. After a moment's silence he said he had seen a 'bright round object, with a circumference of about 4.5 metres, leave the UFO.' [Tehran Journal, September 21, quoting transcript of tapes released to Persian-language Ettela-at]

The debriefing record states that this object had a visual angular subtense of between 10 and 15 minutes of arc, but although angular measure must be more reliable than subjective estimates of "circumference" there is insufficient detail to infer anything from these figures. If, as the raw account appears to imply, this angular measure applies to the object as it appeared on separation from the primary object, and if the primary object was at the time at a range of 25 miles, then the secondary object would be on the order of 500 feet in diameter. This conflicts dramatically with the value quoted (admittedly second-hand) from the control tower tapes, and probably suggests that the estimate of angular subtense relates to the period when the object had approached the F-4. The only distance value quoted here is the 3-4 miles at which the object appeared to trail the F-4. At 3 miles the subtense implies an object some 50 feet or more in diameter, with a circumference on the order of 150 feet, which is still in excess of the quoted size estimate by a factor of 10. Whilst one might assume that a typographical error somewhere in the chain of translation and quotation has changed "45 metres" to "4.5 metres", which would rather too neatly tie up these figures, it is preferable to accept that the crew misjudged the size and/or angular subtense of the secondary object. Such misjudgements are typical of visual reports even from quite skilled observers. All that should be concluded is that the secondary object appeared to have noticeable extension (unlike a stellar point-source) and was rather bright.

It is not specifically stated that this secondary object was also detected on radar. A radar target would not be indispensable for fire-control purposes, the AIM-9 "Sidewinder" being a fire-and-forget infrared-guided missile. (One version of Sidewinder, the AIM-9C, was radar-guided, but it was withdrawn from service due to unreliability and it is safer to assume that the missiles in question here were a commonly-used IR-guided version.) Radar range information would be desirable in order to usefully deploy the AIM-9 in ideal circumstances, owing to its close air-combat range limitations; but in the present case the object was approaching the F-4 from near dead-ahead "at a very fast rate", and this is far from an ideal circumstance. Seeing something approaching, and knowing that the head-on rate of closure could be extreme, the pilot could be justified in deciding to launch a missile even without the benefit of accurate radar range updates from his backseater. Therefore, although there is no reason to conclude that this target was not on radar, and although the "very fast rate" cited may have been measured on radar, it is also possible that this target was only visual.

Howsoever, at this point the F-4's weapons-control electronics failed and the pilot, unable to use his missiles, executed an evasive turn and dive, at which point the primary target would presumably have been lost from the scan limits of the AI radar although, again, this is not specifically stated. Nevertheless it is clear that the primary target was held for a period probably well in excess of 1 minute during this episode. It was a strong target

comparable to a large jet and was displayed on the scope in a position that at least approximately corresponded with the "intensely brilliant" strobing lights.

It is possible for airborne radars to display ground targets. If the F-4 were heading N over Tehran during pursuit (as was the first F-4) then two possibilities present themselves as causes of false targets: 1) an isolated high peak of the Alborz coastal range (up to >18,000') could be detected as a large target just within the lower elevation limit of the AI radar; 2) a ship on the Caspian Sea, perhaps detected by anomalous propagation, could present a strong target. However, although the second F-4 must have approached the area from the S or SW (from Shahroki), that it was on a N heading during the pursuit is arguable: the report states that the "object and the pursuing F-4 continued a course to the south of Tehran" (emphasis added). Further, no sea or ground target detected in this way could be displayed moving ahead of the intercepting aircraft. The following points are relevant to these and similar hypotheses.

During pursuit the aircraft would presumably have been climbing towards its target, since initial acquisition was at "12 o'clock high", and the report states that the F-4 subsequently descended from 26,000' to 15,000', implying that the attempted interception took place at or above 26,000'. Thus, considering the likely rate-of-climb of the F-4 during a minute or so of pursuit, this radar-visual episode would have taken place with the aircraft between about three and five miles high and, for much of the time, in a nose-up attitude. A target displayed at "high" elevation, or with the aircraft nose-up, (inexactitude notwithstanding) is unlikely to be due to superrefractive AP of ground echoes due to the rather narrow grazing angle requirement, even neglecting displayed "airspeeds". If the elevation were only a few degrees then partial reflection of radar energy from a sharp inversion layer above the F-4's altitude could be scattered back from distant ground reflectors; but with the aircraft flying over a ground track of some 10-12 miles (at Mach 1) such an echo would not be expected to display as a distinct spot target - resembling an aircraft and good enough to give a radar lock-on - for more than a minute, given likely inhomogeneities in the inversion layer and the changing reflection efficiency of discontinuous terrain. Direct specular returns from layers or localised domains of very extreme refractivity can occur, and such specular returns could evade the grazing angle requirement and the problems of discontinuously reflecting terrain; but such phenomena are normally only detectable on very sensitive search radars, and even if a specular clear-air echo could produce a very strong and persistent spot target on a low-power AI radar the target could not move ahead of the pursuing aircraft as described.

Spurious internal signals or RFI are possible causes of false blips, and where the noise input pattern is such as to simulate a scanned target would be most likely to display essentially linear motion on a radial vector (as in this case) rather than complex non-radial tracks. However the description of target motion is sketchy, and a consistent spot target displayed for a significant duration is far from being the most probable symptom of such effects. According to Klass, IIAF maintenance technicians reported no indication of internal radar faults when the F-4 returned to Shahroki (source 119). Also, the coincidence of a somewhat striking concurrent visual sighting is relevant to all the hypotheses considered above.

In general, the probability of any such false radar indication occurring during a particular flight must be inherently low - that is, very much less than unity; the probability of a celestial body such as Jupiter (see attached commentary on the analysis by Klass) coinciding with the azimuth of the false target, and exhibiting the reported appearance due to mirage, haze-scattering or extreme convective scintillation, is also much less than unity; and the probability of this scenario will be the still-smaller product of these two fractional values. It must also be considered that the first F-4 may have acquired a radar target (although this is not specifically stated), since the report quotes a range of 25 nautical miles for the object at the point when the intercept was broken off due to communications/electronics failure - the same range at which the second F-4 experienced the same reported failure. If so then the probability would drop by a further fractional multiple. (The paraphrased newspaper account based on the audio tape of the first F-4's communications with Mehrabad does not clarify this point, although at one point the pilot is quoted as saying: "Something is coming at me from behind. It is 15 miles away . . . now 10 miles away . . . now five miles . . . . . It is level now, I think it is going to crash into me. It has just passed by, missing me narrowly . . . ." This sounds like radar ranging information, but plainly not from the nose-mounted AI radar, and the rearward-facing passive RWR sensors on the F-4Es which made up the bulk of the IIAF Phantom fleet at this time cannot indicate range. The IIAF did have a handful of RF-4E reconnaissance versions with APQ-102 side-looking radar but, other objections apart, these aircraft carried only a small mapping radar instead of the AI radar in the nose and were unarmed. It seems likely that the pilot was offering visual estimates of range.) It is pointless to pursue this exercise quantitatively, but it is legitimate to say that an interpretation which does not rely on improbable coincidence might be more attractive.

Prima facie the most likely cause of such a target is another aircraft, and concurrent visual observation of an object bearing what might be construed as one or more strobing beacons is possibly support for this hypothesis. The radar operator stated that the target was comparable to a 707 tanker, and air refuelling operations are always brightly lit, so the question arises: could the object have been an air refuelling tanker such as a KC-135 (an adapted 707 airframe) - perhaps part of some US operation which the IIAF were unable to trace? The secondary light appearing to detach from, and then reattach to, the primary object might be explained as the position lights and/or glowing jetpipe(s) of one or more refuelling aircraft. The vivid strobing colours of the primary object could have been a mirage effect due to an inversion along the line of sight.

The main problem with this hypothesis is target velocity. The report does not contradict the reasonable assumption that the F-4 was doing its best to intercept a potentially hostile intruder, and would therefore have been using its speed to attempt to close within weapons range (the audio tapes disclose that the first F4 made its approach at Mach 1, but there is no specific airspeed cited for the second F-4). Even at maximum speed a Stratotanker is not capable of much above 450 knots, and would therefore have been going hell-for-leather even during the first phase of the intercept when the F-4 was able to close at a Vc of 150 mph for some 50 seconds. To subsequently pull ahead "at a speed that was visible on the radar scope" and then maintain separation from a pursuing Phantom, capable of better than Mach 2 at altitude, would be impossible for any tanker. There is no propagation mechanism which would cause such a target to be displayed at spuriously high speeds, and it is also

true to say that this hypothesis cannot readily cope with other, and rather specific, elements of the visual description - for example, the second "emitted" object which approached the ground and illuminated its surroundings. Generally speaking it is highly improbable that any such military activity would have been taking place over Tehran without the knowledge of the IIAF or USAF officials working with the Military Assistance Advisory Group. If MAAG/USAF did know something then Mooy's report of the incident, and the DIA's response to it, may have been disingenuous, which leaves open the possibility that some more sensitive military activity was taking place.

It is possible that such a radar target could have been generated by deception jamming techniques. The technical specifications of the Westinghouse radar installed on the IIAF F-4 would be required to evaluate this with confidence, but in 1976 it may have been a conical scan pulse-Doppler system vulnerable to velocity track breaking (which can manipulate the range and hence speed of a false target) and bearing deceptions related to the "inverse gain" jamming which can generate targets at false azimuths on surveillance scopes. By analysing the incoming radar signal and feeding back false frequency-modulated signals, an aircraft equipped with a jamming pod can "steal" its own blip from the attacking radar and create in its place a fake target with spurious bearing, velocity and scope presentation. Such techniques are much more difficult to apply to later monopulse radars, but similar deceptions are effective against most analogue or digital time-domain or frequency-domain systems. The reported disruption of communications and weapons-control functions on the F-4s, as well as UHF on a civil airliner, might superficially suggest that some such jamming deception was involved - perhaps a blind test of a new system in simulated operational conditions. Further circumstantial support for the idea that Tehran's electromagnetic environment was being widely jammed might be drawn from the fact that, according to Klass (source 115), "the Mehrabad radar was inoperative at the time", which might be construed as implying a malfunction. On this hypothesis the secondary objects emitted by the primary target might be interpreted either as infrared flares, deployed in order to decoy the F-4's AIM-9 IR-guided missiles when the target's own radar-warning receivers detected a hostile lock-on, or alternatively as photoflash cartridges or flares dispensed to illuminate the terrain for photoreconnaissance purposes.

However it would seem unnecessary for the US to test any such system in foreign airspace, and extremely risky for anyone to test it in real combat against lethally-armed interceptors! If it were a covert reconnaissance penetration by an aircraft of a hostile foreign power, the crew would have to be very confident of their electronic/IR defenses to meander around the skies over Tehran for upwards of 60 minutes. A secondary body which appeared to approach the F-4 at speed, fall in trail, then turn back for a "perfect rejoin" with its parent object, cannot be interpreted as a flare without considerable strain, and anyway IR flares are normally deployed in clusters. (Another type of decoy in use at the time was the ADM-20 "Quail", a tiny pilotless jet carried by USAF B-52s. Released from the bomb bay, the Quail carried ECM equipment to simulate a fake B-52 radar signature and could fly for around 30 minutes at 500 mph. It was expendable, however, and obviously was not designed to hang around the parent aircraft, let alone return to it. Numerous other expendable drones and "harrassment vehicles" are known to have been developed for various reconnaissance, ECM and tactical assault roles. A few are recoverable, but not by the parent aircraft.) Furthermore, no covert operation would be advertised with aircraft

lighting of "intense brilliance". And finally, whilst jamming of communications and radar are both possible there is, even today (1994), no known EW technology capable of remotely disabling fire-control electronics, which fact leaves this element of the report dangling as an uncomfortable coincidence. In general, the jamming deception hypothesis is a poor fit to the overall sequence of events, and since it itself presupposes some type of unidentified aerial intrusion there appears to be no advantage in pursuing it as an explanation for the reported radar target.

It was noted above that the Mehrabad radar was reportedly "inoperative" during the incident, for reasons unspecified. It is not unusual for an airport radar to be switched off if there is no expectation of inbound traffic. The Mooy memo states that, according to IIAF assistant deputy commander of operations Brig. Gen. Yousefi, he was informed at some time shortly after 0030 that Babolsar and Shahroki radars (presumably IIAF air-defense radars) "did not have the object" which had recently been reported by civilian observers in the Tehran area. This information relates to a time-frame some while before the launch of the first F-4. Is this reported absence of ground radar confirmation significant?

Babolsar is actually located about 100 miles NE of Tehran on the Caspian coast, and on the far side of the Alborz Mountains which rise to about 18,000' in the line of sight. Shahroki is about 130 miles SW of Tehran, and assuming normal refractivity (4/3 earth) a 1° lower beam edge elevation would give a radar horizon at this range of some 20,000'. Even a 0.1° horizon would be almost 10,000'. Therefore, assuming that Mooy's phrase, "did not have the object", means that the Shahroki and Babolsar radars were operational yet did not display an uncorrelated target near Tehran at the time of Yousefi's inquiry, then the significance of this report depends on several variables. If a target were at low altitude (say, a few thousand feet) it might well be below the radar horizon. Also, an air-defense search radar would certainly have pulse-Doppler MTI to eliminate stationary ground clutter, and a stationary target (i.e., hovering) could be rejected along with the clutter. There are thus several reasons why a target could be unreported by a radar at Shahroki yet be visible in the sky from Tehran. By far the most likely reasons for extended undetectability would be low altitude or true stationarity. (Certainly, since Shahroki and Babolsar were at different ranges and bearings from Tehran then MTI vagaries such as blind speeds and tangential fades become very unrealistic explanations.) If the visual sightings at this time were of a real, radar-reflective object, therefore, we should expect them to be consistent with an object that was either not moving or at an altitude of no more than a few thousand feet, or both.

The information is very sketchy indeed. One civilian thought it was a light attached to a helicopter which, it is implied, appeared to be hovering nearby for an extended period since he desired it to "get away from my house", whilst another described "a kind of bird". Brig. Gen. Yousefi described an object "similar to a star but bigger and brighter." A Mehrabad tower controller was quoted (Tehran Journal September 20 1976) as saying that it was flashing coloured lights over the south of the city at about 6000' altitude. Whilst there is obviously very little to be said about these statements, nevertheless they are collectively not inconsistent with an object which was stationary in the sky and/or at low altitude.

As for the later phases of the incident, the report simply does not state whether or not any IIAF ground radars were involved. (The target range information cited for first F-4 could,

in the absence of clear reference to an AI target, be interpreted as having come from GCI radar, but this is speculative.) Note that only in the case of the second F-4's intercept do we have any information about target altitude, where it is implied that the object was by this time at about 26,000', travelling fast, and thus a definite potential ground radar target; but given a launch time of 0140 the F-4's ETA over Tehran at Mach 1 would be about 0155, or a good half-hour after Yousefi's decision to scramble and perhaps as long as 45 minutes after Mehrabad tower informed him by telephone that Babolsar and Shahroki "did not have" a target. It is quite possible that by this time these radars did have a target, but there is no record that Mooy asked about this or that information was volunteered. At the time of Mooy's attendance at the second F-4 crew's debriefing, a matter of hours after the event, it is presumably possible that full reports from (say) Shahroki or Babolsar were currently in preparation, in the process of transmittal, or sitting in someone else's "in" tray, and might well have been amongst the "more information" which Mooy undertook to forward when available, but apparently never did. The absence of reported ground radar confirmation in Mooy's memo therefore raises an unresolved question, but does not constitute probative evidence.

In summary, the radar-visual core of the incident reduces to an AI lock-on to a strong target, held for upwards of a minute, with a correlating visual observation of strobing coloured lights sufficiently brilliant to impair night vision. The radar target presentation was comparable to a 4-engine jet, with implied maximum airspeed probably well in excess of Mach 1. Such a target is not explainable as birds, insects, CAT, balloons or other wind-borne objects. The probability of superrefractive AP or partial scattering seems low in this case. Random RFI, sporadic internal noise or deception jamming are all possible if improbable explanations of such a target, but none is compelling in the overall context. There is nothing about the primary radar target itself which positively rules out an aircraft, even though indications of a very large radar-reflecting area are somewhat inconsistent with fighter-type performance. In the context of the visual description and the behavior of associated secondary objects, however, there is no plausible explanation in terms of conventional aircraft. The visual report can be interpreted as a misperception of an abnormally scintillating celestial body and a couple of coincidental meteors, but this seems rather contrived and contradicts several features of the visual report, as well as requiring the added coincidence of an improbable radar anomaly (some aspects of the visual descriptions are further considered in the Appendix to this entry).

In conclusion, although several peripheral aspects of the incident are difficult to evaluate and some questions about the core radar-visual episode remain unanswered, in terms of the not-insignificant quantity of information available it is judged reasonable to carry the incident as an unknown.

APPENDIX

Commentary on Philip J. Klass's "UFOs Over Iran"
See: Klass, P., "UFOs, The Public Deceived", Prometheus Books 1983, chapter 14.
The following commentary relates to page & paragraph numbers:

> p. 113 para. 1: "If the flight crew's report was accurate in all details, then clearly this UFO was outfitted with an exotic weapon that could induce electrical-electronic failure . . . . Yet this posed a curious anomaly: If the UFO did indeed have such a remarkable defense at its disposal, why had it seemingly fired a rocket-missile against the F-4, which already had been rendered harmless? Did this mean that UFOs suddenly had turned aggressive and hostile?"

Comment: The "curious anomaly" seems to be a straw man erected to be knocked down. "Exotic weapons" and "rocket-missiles" are mere science fiction, and the argument is neither logically sound nor pertinent.

> p. 113 paras. 2 & 3: "If there were any truth to the oft-repeated claims [that the US military or the government know UFOs to be extraterrestrial] this Iranian incident should have generated an appropriate response. Presumably the USAF would itself have launched an all-out investigation, importing a team of specialists from the United States and the late Shah would have been asked to impose official secrecy to keep all news of the incident out of the press. Yet none of these things happened.[original emphasis]
>
> "Mooy's memorandum-for-the-record was not even classified (that is, stamped 'Top Secret') in the MAAG files. Later, when a copy was sent back to the U.S. and distributed to a number of agencies . . . [it] was classified "Confidential" - the lowest security level. There was no followup investigation of the incident by the USAF or MAAG personnel, according to Mooy. Nor were there any further MAAG dispatches on the subject from Tehran, although the incident was widely publicised in Iranian newspapers. Perhaps the best indication of how seriously the U.S. government was concerned . . . is that a copy [of the memo] was leaked to NICAP [National Investigations Committee on Aerial Phenomena] soon after it was received in the U.S. . . . .

Comment: Whilst speculation about US government attitudes in hypothetical circumstances is not pertinent to the facts of the case, this theme is relevant to the later development of Klass' argument and therefore must be addressed.

Firstly, the absence of acknowledged follow-up information from Tehran is a point addressed in the attached case evaluation: this absence is ambiguous, and could be held to support a variety of interpretations. The stated absence of any US investigation is a conclusion based on one interpretation of the fact that no further information on the affair is available. This conclusion depends on the collateral assumption that such investigation would be conducted by local MAAG/USAF personnel, and conveyed in further unclassified dispatches from Tehran. These assumptions are questionable, and indeed conflict with Klass's own proposition that if US authorities had taken the UFO incident seriously then imported specialists would have been brought in to investigate under a security blanket so tight that total press-censorship, even in Iran itself, would have been an option. This scenario is perhaps a little extreme, but a level of secrecy could be inferred from the fact that when the second F-4 (which had had the major role to play in the incident) returned to Shahroki it was quarantined in an outlying revetment, and local USAF personnel and technical representatives of both McDonnell Douglas & Westinghouse were prevented from approaching it (see later). If something like the scenario which Klass believes ought to have been enacted was in fact enacted, then it would be highly unlikely that local company representatives or local USAF personnel would be invited to participate, and it would be entirely consistent if they were actively excluded. Of course there is no direct evidence that such a secret investigation did occur, which is why Klass states that it did not; but equally, if it was secret then by definition one would not expect there to be direct evidence. As regards Klass's hypothesis that the US would have asked the Shah to impose press censorship in Iran: 1) Klass states that the Shah was in fact not asked, although how he could know this is unclear; 2) all of the Iranian press stories which Klass quotes were published within about 36 hours of the incident - some within about 12 hours, and thus probably in preparation before Mooy was even able to prepare his memorandum - so that these are not counterinstances to the censorship hypothesis; 3) U.S.-instigated press censorship from a later date, even if considered as an option, would probably have been adjudged belated and to little purpose; 4) if any stories were censored it follows that they were not published - i.e., it is impossible to prove a negative; 5) Klass's assertion that censorship is a necessary condition of serious U.S. government interest is unfounded speculation.

As regards the fact that a copy of the Mooy memo was allowed to "leak" from a US government source, this could be taken to indicate that, as Klass suggests, the memo was not regarded as a highly sensitive document, a conclusion supported by the low-security classification assigned to it by agencies in the US. Whether the fact that the memo was not regarded as highly sensitive should be taken as meaning that the incident was not regarded as very important is another matter. By the time the copies of the memo were being processed through the in-trays of the CIA, DIA etc. the story was already widely known through the Iranian press, including English-language newspapers, who published articles describing all its essential features as early as September 20 - the following day. It is debatable if Mooy's memorandum-for-the-record, prepared subsequent to a debriefing which took place sometime on September 19, was by then even lodged in MAAG files, let alone transmitted abroad. Given that it had not been classified by MAAG at this time, and considering the extent of simultaneous IIAF press contact (partial transcripts of both F-4s' taped radio communications were published almost immediately in the Persian-language

Ettela'at and reprinted in English in the *Tehran Journal* the next day, September 21), the likely estimate of US agencies at a later date would be that the document, which anyway was only a preliminary summary of complex events, had been effectively compromised as a source of secure intelligence. There would be no point in classifying it "Top Secret", and indeed such a move might be counterproductive, only fuelling suspicions of a cover-up. Whether any additional material was in fact covered up is of course impossible to prove without evidence which, *ex hypothesi*, would be subject to that cover-up. The "national security" exemptions of the Freedom of Information Act allow government agencies the latitude to withhold information from public access by defining it as an issue of "national security", a fact which Klass implicitly concedes when he argues that the availability of even one unclassified memo and the absence of total press-censorship points to a lack of government concern.

> p. 114 para.1: "[Major General Kenneth P. Miles, USAF, chief of MAAG, Tehran, forwarded, at Klass's request] a photocopy of the unclassified Mooy memorandum, as well as several articles on the incident . . . . Miles added: 'I share your view that there is no evidence to suggest that the earth is being visited by extraterrestrial spaceships.'"

Comment: Neither the view which Miles endorses, nor the assumptions underlying the view which he and Klass dispute, are pertinent to the facts of the case.

> p. 114 para.2: "One of the [Tehran newspaper articles] quoted a Mehrabad airport controller as saying that the UFO was flying at an altitude of about 6,000 feet over the southern part of sprawling Tehran, alternately flashing red, blue and green lights. Yet Mooy's memorandum, based on information offered by the second F-4 crew, said the first F-4 had been 40 nautical miles north of Tehran when that airplane encountered mysterious electrical-electronic problems."

Comment: Klass is incorrect to state that Mooy's memorandum is based only on information supplied by the second aircrew at their debriefing, and there is no justification for the assertion that the description of the first intercept is based on the second-hand recollection of this second aircrew. Klass does this because he wants to suggest, and later develop, the idea that the second aircrew were untrained, sleepy, confused and prone to make mistakes. By nurturing the impression that the entire memo rests on their recollections, he is then later free to imply that several details are questionable. The information noted by Mooy in his paras. 1, 2 & 11, for example, plainly comes from other IIAF documents, or operations officials - such as Director of Operations Lt. Gen. Azerbarzin himself - who were conducting the debriefing, and details of the first intercept may presumably have come from the same sources.

The Mehrabad controller's statement re-quoted by Klass comes from a newspaper story. Klass will elsewhere, and correctly, decline to credit newspaper stories in preference to the official memorandum, and should in conscience do so here.

However, granting the accuracy of the newspaper story insofar as it goes, the indicated contradiction is false. Firstly, the sequence of ground and air observations covered by the

Mooy memo spans something like 1½ hours, and the newspaper quotation does not state the time at which "the UFO" was flying over the south of Tehran (Klass's adjective, "sprawling", is a journalistic device to maximise the impression of distance). Secondly, even if the quoted visual sighting over the south of Tehran does relate to a time when one of the F-4s was in pursuit there is no justification for the assumption that it was the first F-4; and according to Mooy's memo the second F-4 "continued a course to the south of Tehran" in pursuit of the object. Thirdly, the first visual sightings (there were many) were relayed by Mehrabad tower to the IIAF Command Post at 0030; the first F-4 took off from Shahroki (130 miles SW of Tehran) at 0130; and at Mach 1 the aircraft would have taken until about 0145 to reach the intercept point 40 miles N of Tehran, or nearly 1½ hours after the first visual reports from the Shemiran area. Thus, there is no suggestion of simultaneity and the contradiction proposed by Klass does not exist. If the same "UFO" first sighted visually was subsequently intercepted by the first F-4 the implication is of an object heading N from Tehran at this time, which is consistent with:

> p. 114 para.3: ". . . Based on these tapes [of the first F-4's radio communications with Mehrabad as paraphrased in a newspaper article] the first F-4 flew over Tehran at the speed of sound . . . and the pilot called the Mehrabad tower when he first spotted the UFO. [Lieutenant] Jafari drescribed the UFO as being 'half the size of the moon . . . It was radiating violet, orange and white light about three times as strong as moonlight.' Although the pilot was flying at maximum speed, he said that 'on seeing him coming the UFO increased its speed,' that is, he was unable to close on the bright light."

Comment: Note that the F-4 approaches over Tehran, that is, on a N heading in pursuit of the object, which appears to accelerate ahead of him. Note also, however, that this account is based on a partial quotation of an article in the English-language newspaper the *Tehran Journal*, which itself is quoting in translation an article from the Persian-language paper *Ettela'at* which, in turn, is a blend of quotation and paraphrase is from a transcription of the audio tapes.

> p. 114 para.4 "[According to the same article] Mehrabad tower told him [Jafari] to return to base if he could not close on the object and the pilot agreed to do so, but a few moments later he radioed: 'Something is coming at me from behind. It is 15 miles away . . . now 10 miles away . . . now 5 miles . . . . It is level now, I think it is going to crash into me. It has just passed by, missing me narrowly . . . .' The newspaper said that 'the disturbed voice of the pilot . . . then asked to be guided back to base. It was at this time that a second plane was ordered to take off.' This account indicates that there was not any mysterious malfunction of the electrical-electronics equipment aboard the first F-4, contrary to the account in the Mooy memorandum. The explanation for this discrepancy is that Mooy and Johnson sat in on the debriefing only of the second F-4 crew, and this misinformation must necessarily have resulted from the fact that the two crews had not had a chance to compare notes prior to the debriefing."

Comment: Again we have the suggestion that an error, if error there was, can be laid at the door of the second F-4 crew. There is no basis for this in the Mooy memorandum. Mooy states that the first F-4 lost instrumentation and communications and the error, if error there was, could as well have been Mooy's. If Klass were right and the aircrews "had not had a

chance to compare notes" then the information stated by Mooy in the same paragraph - that the first crew had visually acquired the object at 70 miles and closed to 25 miles - could not have come from the first F-4 crew via the second F-4 crew. Even if we suppose that all the information in this paragraph did come from the second F-4 crew, then there are really only four possibilities: a) they were relaying accurate information from the other crew or an intermediate source; b) they were relaying inaccurate information in good faith; c) they were lying; d) they were the source of the information but it was misunderstood, by Mooy and/or someone else. If the newspaper account is to be taken as the whole truth, then they were not relaying accurate information. Presumably the airmen did not make up a story out of whole cloth, so that if the electronics malfunction did not occur, and if they stated that it did, then someone else gave them inaccurate or ambiguous information. Alternatively, information relating to the second aircrew's own intercept may have been mistakenly interpolated by Mooy into his account of the first intercept. Wherever the information originated there is no basis whatever to infer any failure of judgement or honesty on the part of the debriefed aircrew, and the newspaper story should be interpreted with caution.

> p. 114 para.4 cont.: "It also is important to note that the glowing object that Lieutenant Jafari reported seeing was 'coming at me from behind.' Since he, presumably, was chasing the bright light in the sky at the time, which would have been dead-ahead of him, the object coming at him from the rear seemingly was quite unrelated to the object he was chasing."

Comment: This is "important" to Klass because he regards it as inconsistent or in some other way diagnostic of error or untruth. Why this should be so is unclear; if Jafari is reporting two separate UFOs, then he is reporting two separate UFOs. But there are other interpretations: Jafari could have meant, for example, that a secondary object was 'coming from behind' the primary object, not from behind his aircraft, similar to the behavior later reported by the second F-4; the context of the translated quotation would have to be studied to exclude this interpretation. In fact, however, the sequence of events bears closer scrutiny. The pilot was advised to turn back to Shahroki and stated that he was complying, then "a few moments later" he reported the object coming from behind. Given the chain of quotation, translation and interpretation leading up to this account, Klass's "few moments" could well have been enough time for the pilot to have initiated his turn before reporting the object on his tail. There is no justification for Klass's assumption that he was still watching the primary object "dead-ahead" at this moment.

> p. 115 para.1: [According to the Tehran Journal's paraphrase of its translation of the second F-4's radio transcript] 'the pilot reported having seen the UFO and told the control tower that it had reduced speed. The pilot said the plane was working well and he was preparing to fire missiles at the UFO. After a moment's silence he said he had seen a "bright round object, with a circumference of about 4.5 meters, leave the UFO." A few seconds later the bright object rejoined the mother craft and it flew away at many times the speed of sound.'

Comment: Klass points out that there is no mention here of the communications and weapons control failure reported by the aircrew in their debriefing, nor any mention of the radar contact so specifically described in the same debriefing. In particular he argues that if

the F-4 had lost UHF contact with the tower as reported it would have interrupted these radio communications. As Klass later admits (p.116 para.1) it must be "prudent" to give more credence to the official memorandum of the debriefing than to a newspaper account. It is therefore unclear what point he is making. However, for the sake of argument it should be noted that according to the debriefing the electronic failure did not occur until after the secondary object described above had approached the F-4, and thus is outside the timeframe of the radio talk quoted. The fact that the newspaper chooses to collapse the entire sequence of subsequent events into one bland sentence is hardly evidence of anything except the perennial failings of journalese. The newspaper paraphrase of the tapes may add colour to the first-hand debriefing record, but it is plain that it should not be taken as a complete and authoritative source, omitting as it does a great many other aspects of the incident, and conflicting as it does with other newspaper stories quoting other "official sources", *vide:*

> p. 116 para.1: "Despite this disclaimer from an unidentified 'official source,' it seems prudent to put more credence in the Mooy memorandum, since it is based on notes taken during the debriefing of the second F-4 crew, although it is clear from the Mehrabad tower tape recording that the second crew's account of what happened to the first F-4 contains serious errors."

Comment: Klass has just quoted at length an article in the newspaper *Kayhan International*, September 21, which, on the basis of an unattributed government statement, contradicted almost everything that other newspapers had so far reported about the affair as well as a great deal of the Mooy memorandum (which at this time was not yet in the public domain). According to this account, all that happened was that one of the F-4 pilots saw a light which soon disappeared; there were no electronic outages, no secondary objects, no pursuit of the aircraft, and neither pilot made any attempt to open fire. The account of radio communications published in *Ettela'at* 'left the official "frankly puzzled."' Klass's gesture in the direction of "prudence" is less than wholehearted, but one can quite see why he shrinks from endorsing this particular newspaper story when it calls in question the radio transcript against which he has found the second aircrew's debriefing account so wanting. The story is quoted to foment doubt about the Mooy memo, then irresolutely disowned, with Klass - appearing by sleight of hand to have his cake and eat it - conceeding that there are indeed doubts. An inadmissible line of questioning has been stricken from the court record, but its effect lingers in the minds of the jury.

> pp. 116 para.2 to 117 para.1: Klass details his attempts to obtain information on any follow-up investigation that might have taken place, seeking contacts with "IIAF officials who might be willing to assist in my investigation." He writes to Colonel John Wilson, USAF, who had been in Iran at the time; Wilson can add nothing. He writes to IIAF vice-commander Azerbarzin (who had been Director of Operations at the time and present at the debriefing), telling him that he is sceptical of the report; Azerbarzin does not reply. He writes to the Iranian Ambassador in Washington, Ardeshi Zahedi, telling him that he is sceptical; Zahedi never replies. A letter to an Iranian science writer is returned "seemingly unopened". He writes to a professor of astronomy at Tehran University who had been quoted in a *Tehran Journal* article about the affair, telling him that he thought there was a "prosaic explanation"; the

> professor does not reply. He writes to a McDonnell Douglas technical representative in Tehran, but receives no reply. A letter to a Tehran executive of E-Systems Inc. is answered; but the "brief" response says that the writer can add nothing.

Comment: Klass becomes suspicious that this reticence is significant, and later (p.120 paras. 2 & 3) develops a conspiracy theory. The IIAF, he observes, was the multi-billion-dollar pride and joy of the Shah, and if (as Klass proposes) shoddy maintenance was leading to electronic glitches whilst aircrew training was so poor that pilots were "rattled" by bright stars and radar operators didn't know how to use their equipment, then "this would have been very embarrassing to IIAF officials - and to the Shah if it became public knowledge. This might also explain why USAF officials had not paid undue attention to the incident." To save embarrassment, suggests Klass, the authorities played up the UFO angle and made sure that the real problem was kept quiet.

Earlier, Klass has argued that if Iranian or (more particularly) US authorities had taken the "UFO" incident seriously there would have been a widespread clamp-down on information; this didn't happen, therefore the authorities did not take the "UFO" incident seriously. Now he is suggesting that there was indeed a widespread clamp-down on information, but this does not lead him to re-evaluate the logic of his own argument. Instead it is further evidence that the "UFO" incident was not taken seriously.

> p. 117 paras. 2 & 3: Ambassador Zahedi was pictured in the *National Enquirer* smilingly accepting a cheque for charity worth $5000 on behalf of the F-4 crews, selected by a panel of scientists as prizewinners for "the most scientifically valuable UFO case" of the year. The paper also stated: "Earlier this year Lieutenant General Abdullah Azarbarzin . . . told the *Enquirer* that virtually all communications, navigation and weapons control systems aboard the two Phantom jets were jammed by the UFO."

Comment: According to this newspaper the IIAF vice-commander, more than a year after the event, was personally certifying that the report of electronic anomalies in both F-4s, as given in Mooy's contemporary record, was correct. Klass italicises these words, stopping short of accusing Azarbarzin of a falsehood but implying confabulation at a high level. "It would be far less embarrassing . . . . Instead of possible humiliation, the IIAF flight crews later would be honoured for the best UFO case of the year by America's largest-circulation newspaper." (p.120 para.3) The most one can say is that this is speculation.

> p. 117 para.3: "[Remote interference with fire-control electronics would be of] obvious import . . . . Yet USAF officials on the scene, who should have been gravely concerned if they accepted the IIAF crew's account at face value, seemingly were oblivious to the matter."

Comment: Whether or not any USAF personnel in Tehran accepted the account at face value is irrelevant to the facts of the case. And recording the facts as reported within hours of the event and forwarding them to interested US authorities with a promise of updated information when available is not being "oblivious to the matter." It has already been pointed out that, on Klass's *own* hypothesis, if US authorities took the report at face value it

would not have remained the responsibility of personnel at the local level but would have become the subject of a more secure intelligence operation. Further, we note again that USAF and company personnel on the scene were not "even allowed to get close to the [quarantined F-4 at Shahroki], let alone being asked to check it over" (p.118, para.2), which can be taken as meaning that they would have liked to, but that such unilateral local initiatives were prevented.

Klass's conspiracy theory has by now become quite sweeping, implicating Ambassador Zahedi, Gen. Azarbarzin, a Tehran University professor, a science writer, Middle East reps. of McDonnell Douglas and E-Systems, IIAF personnel all the way from Shahroki maintenance workshops to the vice-commander - even perhaps the Shah! - none of whom seem able or willing to help Klass in pursuit of his "prosaic explanation". He manages to contact Mooy by 'phone, but he only confirms that there was no further local action by USAF or IIAF personnel "that I am aware of", and certainly does not disclaim any part of the information in his original memorandum (p. 117 para.1). All of this is open to various interpretations. But if Klass is right in suspecting a cover-up, is the reason which commends itself to him the most plausible? His evidence comes from two anonymous employees of Westinghouse Electric (manufacturer of the F-4's radar) who had been in Tehran and Shahroki at the time:

> p. 118 para.2 "The Westinghouse tech rep [at Shahroki] told me that only the second F-4 was briefly 'quarantined' when it returned to the base by being placed in a remote revetment . . . . This confirms that only the second F-4 experienced any seemingly mysterious UFO-induced effects."

Comment: This is speculation. What it confirms is that for whatever reason the second F-4 was quarantined in a remote revetment at Shahroki. His conclusion, that the report as written up by Mooy and endorsed by Aazarbarzin is false, is a *non sequitur*. However, having noted that no local US specialists were allowed near this F-4, Klass's interpretation of this proceeds by hearsay, ellipses and insinuations:

The F-4 was "briefly" quarantined, then "less than a week later . . . returned to active duty, seemingly none the worse for its UFO encounter." IAAF maintenance crews, according to what Klass's Westinghouse informant was told, "'claimed that . . . the only thing they found wrong was that one of the radios had some static in it,'" which is "not an unusual complaint", adds Klass, implying that no unusual aftereffects of the UFO encounter can be brought as evidence. But then we have a change of tone, preparatory to the argument that poor maintenence must have caused the reported electronics outage, as well as the radar contact: the same tech rep was called in about a month later to adjust the plane's radar, which according to Klass implies that the radar might not have been working properly on September 19, causing a false target; also, it turned out that this F-4 allegedly had a history of power outages, so that it must have been quarantined in order to fix embarrassing glitches out of sight of foreign eyes. The suggestion is now that there was a great deal wrong with the F-4 when it flew back to Shahroki! This tells us more about Klass's journalistic technique than it tells us about the facts of the case - which here reduce increasingly to opinions quoted from Klass's anonymous Westinghouse informants whose own position in this affair is unknown. Indeed, reading carefully discloses that the story of

the F-4's poor service history comes from an anonymous rep in Tehran who looked into events at Shahroki "as far as he could", and is in turn relating what he had heard from an anonymous McDonnell Douglas rep at Shahroki. Thus Klass's account is itself based on a story retold at second hand, whose ultimate source (a McDonnell Douglas employee) has by implication already been called in question - because when the McDonnell Douglas rep in Tehran had failed even to answer Klass's letter about the incident this was one of the many "frustrating" rebuffs which caused Klass to suspect a cover-up! Indeed, what would these manufacturers' reps' vested interest be here when approached by a senior editor of *Aviation Week & Space Technology* with a predatory eye to exposing faulty avionics in their products? It would be to disarm any suspicion of design or manufacturing defects by passing the buck to IIAF maintenance technicians with stories about probable sloppy workmanship and inept aircrews. This is exactly what Klass's informants do: he quotes yet another anonymous company source to the effect that the IIAF was no more than a "flying country club for the sons of rich families"; the Shahroki electrical shop was "notorious for poor performance" offers another; pilots had almost no training at all in night flying; radar operators were "not too knowledgeable", were "not really trained" to use the radar or fire-control instrumentation and only wanted to "move into the front seat", argues a Westinghouse rep; and so on. And all this in the Shah's "pride and joy"! It seems a wonder that the IAAF were ever able to get two planes into the air in the first place.

> p. 119 para.4: "One thing is evident: the second F-4 crew was clearly 'rattled'. This is obvious from their report that the target on their radar scope was at a range of twenty-five miles, but they were preparing to fire an AIM-9 air-air missile whose maximum range is only a couple of miles. . . . Thus their missile could not possibly have reached the 'target-blip' appearing on their radar."

Comment: Mooy's debriefing record clearly states that the primary target was at 25 miles when "*another* brightly lighted object . . . came out of the original object. *This* object headed straight toward the F-4 at a very fast rate. The pilot attempted to fire an AIM-9 missile at the object . . . ." [Emphases added] Klass's confusion stems from his interpretation of a story published in the Tehran Journal which is too vague and compressed to be relied upon even if it did clearly contradict the debriefing - which it does not. This third-person narrative is based on translation of the Persian-language newspaper account of the taped radio communications and reads as follows: "[The] pilot reported having seen the UFO and told the control tower that it had reduced speed. The pilot said the plane was working well and he was preparing to fire missiles at the UFO. After a moment's silence he said he had seen a 'bright round object, with a circumference of about 4.5 meters, leave the UFO.' A few seconds later the bright object rejoined the mother craft and it flew away at many times the speed of sound." Klass concludes that "preparing to fire missiles" means that the pilot was at that instant about to push the button and engage the object at a range of 25 miles; but, even allowing that this phrase is a precise quotation of the pilot's words (for which there is no justification), "preparing" in this context is no more than a declaration of intent to open fire - which would suggest reasonable caution and may even have been required by the IIAF rules of engagement. When the secondary object unexpectedly headed straight towards his aircraft and the pilot did decide to launch a missile at it, he would have been unable to do so had he and his weapons-control panel not both been primed - i.e., "prepared".

> p. 119 para.4: "Later I would be told that this second F-4 crew had been awakened out of a sound sleep and dispatched on the UFO mission, so it is entirely possible that their judgements may have been clouded by not being fully awake."

Comment: This is pure nonsense. No doubt if the crew had been wide awake for hours at the time of their 0140 scramble Klass would have argued that they must have been fatigued after a long day and ready to nod off!

And now (p.120 para.5 et seq.) we see why Klass has persisted in his quaint description of the secondary object reportedly emitted as a "rocket-missile" and a "missile-like object", although the report describes a highly manoeuvrable object which "fell in trail" with the F-4 at a distance of 3-4 miles as the pilot executed an evasive turn and dive, then "went to the inside of his turn" and headed back to the primary object "for a perfect rejoin." The phrase "missiles or rockets" is one used by an Eastern Airlines captain over Virginia in 1975 to describe what, according to the FAA, were "probably" fireball fragments, and Klass now quotes this case in illustration of the fact that pilots can sometimes report bright meteors as UFOs.

> p. 121 para. 4 et seq.: "Is it possible that the missile-like objects reported by both of the Iranian F-4 pilots, and the glowing objects reported by ground observers near Tehran to have fallen from the sky or flitted across the sky, might have been meteor fireballs?" Klass then embarks on a discussion of other sightings from Morocco and Lisbon on the same night as the Tehran event that he takes to have been probably one-and-the-same fireball meteor.

Comment: This is pureed red-herring as, eventually, Klass admits, because these reports "would not coincide with the timing of the missile-like objects reported by the two Iranian F-4 pilots, which would have occurred several hours earlier." Furthermore both Lisbon and Morocco are some 3,500 miles west of Tehran! Once again, the "missile-like" image is reinforced to help the reader follow his argument. He notes that an abnormal number of "fireball" sightings that night would be expected because there were two meteor showers underway at the time. Aside from the fact that there is a meteor radiant in any observer's sky on any night of the year (see B.A.A. Handbook, 1922), and neither the September Aquarids nor the Southern Piscids are major North Hemisphere showers, the reported fireball trajectories were W-E according to Klass; but the two object reported as "buzzing" the F-4s from ahead and behind (allowing that their trajectories would have been in part straight) would have been heading approximately N-S and S-N. The first F-4 was heading N when, according to Klass, the object passed him from behind (although, as has been argued, the aircraft at this point appears to have already turned back for Shahroki, which would suggest a heading N-S); and the second F-4 was pursuing the object on "a course to south" when a secondary object headed "straight" for him. Klass describes an "object coming at him [the first F-4] from behind (from the west) that passed overhead", although there is no justification for these details in the report. The pilot only described an object "coming from behind [his a/c or the UFO]", and indeed the phrase "level with me now" implies the object flanking him if anything, and certainly does not imply that it passed "overhead". Klass wants to paint a picture that fits with his meteor theory, including

inventing the E instant heading of the F-4, because the (possible) meteor sightings were of objects travelling W-E. In fact he even fudges this: the Moroccan "fireball", he says, was reported ". . . coming out of the W or SW on a NE heading similar to the [W-E] trajectory reported [from Portugal]." The Moroccan reports describe a heading either NE or north of NE, generally paralleling the Moroccan Atlantic coast; Klass inserts the "west or southwest" for effect.

Finally, the identification of the earlier Morocco-Portugal reports as meteor sightings is less than certain since consistent reports from numerous areas stretching in a rough line along the western Moroccan coastal zone, from Agadir in the south to Fez in the north, spanned about one hour. A typical sighting was made by a Moroccan official who personally briefed the US Defense Attache: he saw it from near Kenitra at 0115 local, travelling low and parallel to the coast at a very slow speed like that of an aircraft preparing to land. When distant it appeared to be disc-shaped, but when it passed closer to his position he could see it as a luminous tubular object. In reply to a request for assistance sent by the American Embassy in Rabat, Secretary of State Henry Kissinger stated that no U.S. aircraft were in the area, there was no record of any satellite re-entry and there were no prominent meteor showers, but speculated that the object may have been a sporadic fireball meteor on a rare tangential trajectory or an unlisted satellite re-entry. (Messages 250801Z Sep. 76 and 052041Z Oct. 76) However, if the reported times are correct these theories are untenable: sightings in Morocco occurred between 0100 and 0200; the object was reported from Portugal (in the same time zone and N of morocco) just after 0210. Klass speculates that Portugal may have been using Daylight Saving Time whereas Morocco was not, which would place the Lisbon sighting at 0110 Morocco time, although he was "not able to resolve" this; but even if this were true it would not remove the 60 minute difference between first and last sightings in Morocco. (In terms of trajectories the Portuguese incident could have involved the same object. This one reportedly passed W-E. It was sighted by an aircrew bound from Lisbon to Africa and thus on a heading roughly S, and appeared to pass by within a few hundred yards of their aircraft, so that an object following the Moroccan coast NE could have crossed the nose of an aircraft flying south from Lisbon. This geometry would hold true either for a simultaneously-sighted fireball at (say) one or two hundred miles from the Moroccan coast, or for a slow-flying object in local airspace which was independently sighted later.) It is possible that most of the Moroccan times are in error and that a fireball was seen, but the case is far from proven on the available evidence and, in summary, these incidents are of extremely tenuous relevance to the events over Iran several hours earlier and 3,500 miles away.

> p. 122 para.3: "[The F-4 crews] would be under considerable stress [and] if they saw meteor fireballs zipping across the sky, they could, quite understandably, conclude that these were rockets or missiles which the unknown object was firing at them."

Comment: That crew "stress" was "considerable" is as suppositious as the "soundness" of the sleep out of which Klass says they were woken. Moreover, the "firing" of "rockets" once again is a distortion of the facts as reported.

> p. 122 para.4: "Under such stressful conditions, even experienced flight crews become unreliable observers . . . . The second F-4 crew admitted that they were

> experiencing "some difficulty in adjusting their night visibility", according to Mooy's report, and they had difficulty attempting a landing at Mehrabad Airport, despite its modern lighting-landing aids."

Comment: The crew did not "admit" anything; they stated that their night vision had been affected. Klass is again attempting to erode witness competence by baseless insinuation. It is perfectly clear from Mooy's report that the problems with night vision occurred after the event and as a direct result of the brilliance of the object(s) (as the DIA evaluation notes) not from some pre-existing "stress". This misrepresentation is carried over into the landing episode, the reader being encouraged to believe that the crew were so "stressed" that they could hardly fly the plane, or even see the airfield! Mooy's report again makes clear that they orbited Mehrabad a few times to allow their night vision to recover, then "went out for a straight-in landing." This seems perfectly sensible. Doubtless Klass would diagnose unreasoning panic if they had landed without waiting for their eyes to become properly dark-adapted.

> p. 123 para.1: "It might seem difficult to accept the idea that the F4's power system chanced to malfunction when the aircraft 'passed through a Mag bearing of 150 degrees from Mehrabad', as the crew reported . . . . But it seems to me equally unlikely that a UFO would decide to 'zap' the F-4 only when it was on one specific bearing relative to the airport. The F-4 crew report that an airliner approaching Mehrabad at the same time experienced a communications failure seems mysteriously related to the F-4 problems. But whereas the F-4 experienced malfunctions in many of its avionic systems - indicating electric-power-system problems - the airliner seemingly experienced trouble only with one piece of radio equipment."

Comment: It would be more "difficult" to accept Klass's proposal if he pointed out that the same failure happened "each" time on "several" orbits of the F-4. Clearly it is not the bearing from Mehrabad that is significant here but the location as defined by the intersection of that bearing and the orbital track of the F-4. This location is presumably where the airliner radio failure occurred - "in same vicinity (Kilo Zulu)". Klass also states without justification that the F4 crew reported this airliner's radio failure - presumably with the "stress" and "poor training" of the F-4 crew in mind. The debriefing contains no such suggestion. It seems unlikely that the F-4 crew would be the source of intelligence about events on board a civil aircraft with which they would have had no contact, and much more likely that this information, like other background supplied in the memorandum, came to Mooy via his other IIAF sources from Mehrabad control tower and/or the civil aircrew. Klass suggests that the F-4 experienced strikingly different effects from those reported by the airliner. But only the F-4's UHF radio failed in this vicinity, with some "fluctuation" in the inertial navigation system; not as Klass describes it "malfunctions in many of its avionic systems indicating electric-power-system problems". Why such phenomena, if related to the "UFO", should have happened is unknown, but plainly Klass's straw-man hypothesis that the "UFO decided to 'zap' the F-4" is irrelevant and anthropomorphic science-fiction.

> p. 132. para.2: Klass passes on a suggestion offered by Mooy to explain the "beeping signal" detected by the searching helicopter next day in an area off to the west of the spot where the F-4 crew thought the bright light emitted by the primary "UFO" had

> landed. Mooy observes that some large transport aircraft in service in the area carried emergency crash-locator beacons which transmitted a similar type of signal, and these had been known to eject occasionally during flight as a result of "severe turbulence". Moreover turbulence was often "experienced over the mountains near Tehran."

Comment: This is an interesting hypothesis, although some points need to be qualified. If it is logical that the UHF failure (which reportedly had occurred before when the F-4 approached within some 25 miles of the object in the air) was related to the location of the object whose position on the ground had been "observed and marked" by the aircrew before they came in to land, then it would follow that the bearing from Mehrabad of this landing location was 150 degrees magnetic. This would be SW of Tehran, not inconsistent with the fact that the F-4 had been pursuing the primary object "on a course to the south of Tehran" when it emitted the bright object which appeared to land. The "mountains near Tehran" which would be responsible for severe turbulence, however, are concentrated in the Alborz Range to the N and NW; whereas a bearing SW from Tehran indicates lower terrain in the direction of the Dasht-e Kavir salt pans some 50 miles from Mehrabad. This conjecture is supported by the description of the "landing" site as a "dry lake bed", and the topography would thus not be consistent with the severe mountain turbulence which, *ex hypothesi*, might prematurely eject a crash-locator beacon.

It is true to say, however, that this incident has no direct relationship with the events of the previous night, and none is being claimed. If the search helicopter did randomly pick up a radio beacon this is not evidence of anything except the finding of a radio beacon. It should be noted that the "beacon" signal was not in fact detected at the site marked as the landing point by the F-4 crew. There, "nothing was noticed", and it was when the helicopter circled "off to the west of the area" that the signal was first picked up and followed to the point at which it was strongest. The only part that this signal appears to have played in the affair - whatever it may have been; and a crash locator beacon remains a clear possibility - is that it fortuitously led the helicopter to a "small house with a garden" whose occupants, when questioned, confirmed that they too, like many other in the Tehran area, had seen a "bright light" and heard a loud noise during the night.

> p. 123 para.3: Klass suggests that the primary object reported by both F-4 crews and the objects sighted from the ground might have been "a celestial object, perhaps the bright planet Jupiter. Certainly the second flight crew's description sounds like many other UFO reports, where the object proved to be a bright celestial body, and this would explain the F-4's inability to 'close' on the object.""

Comment: Klass has long since ceased to address the F-4's reported radar lock-on during this "inability to 'close'" - indeed, he never addresses the radar target(s) at all, save to imply that the operator was probably confused and inept. Considered simply as a visual report there is some similarity to (say) a bright planet viewed along an inversion layer with consequently extreme scintillation, and it is true that Brigadier General Yousefi described an object which, from the ground, appeared "similar to a star but bigger and brighter".. But consider the different bearings involved: a Mehrabad tower controller told the *Tehran Journal* that at one point the object was over the south of Tehran, that is, on a bearing SW from the airport; yet the first F-4 pursued the object on a heading due N, looking "so bright

it was easily visible from 70 miles" and "half the size of the moon . . . radiating violet, orange and white light about three times as strong as moonlight." If this was Jupiter, then what was the object which the second F-4 pursued on "a course to the south of Tehran", exhibiting "intense brilliance" with a pattern of strobing coloured lights? Note also the localisation of the initial civilian reports "in the Shemiran area", which is suggestive of something in local airspace rather than something celestial.

> p. 123 para.4: "If the prosaic explanation seems strained, consider the alternative: that the 'UFO' was an extraterrestrial spaceship with the remarkable ability to selectively disable many avionic systems on the F-4, only the radio equipment on an airliner, without causing any interference in any IIAF air-defense radars or the Mehrabad radio equipment. Despite this remarkable defensive capability, the 'UFO' decided to fire an 'old-fashioned' rocket-missile at the second F-4, which missed the airplane and landed on a dry lake bed without causing an explosion. And the next morning this rocket-missile mysteriously disappeared, leaving behind only a mysterious beeping radio signal, similar to that emitted by crash locator beacons."

Comment: Klass can see no alternative to his own scenario, other than "an extraterrestrial spaceship", which in another author might betray a certain poverty of imagination. But Klass is not so ingenuous, and in this concluding paragraph is erecting his last row of straw men: 1) The "spaceship" is at best an irrelevance; 2) what was previously a mundane set of faults attributable to an "electric-power-system-outage" is now mysteriously "selective"; 3) there is no information in any available report about what may or may not have occurred at any air-defense radar sites concurrent with the brief periods of avionics failure; 4) if there was no "interference" noted at any such sites, the relevance of this fact to avionics failures in three aircraft near Mehrabad would be at best unclear; 5) whether Mehrabad UHF radio reception suffered any concurrent "interference" is difficult to know when the only aircraft with which communication could have occurred (the F-4 and "the one civil airliner" in the area) suffered radio failure; 6) why any possible "interference" with Mehrabad UHF equipment should be a necessary condition of avionics failures occurring in these aircraft is unclear; 7) the "remarkable defensive capability" of the object and its ability to "decide" actions are pieces of anthropomorphic science-fiction; 8) "an 'old-fashioned' rocket-missile" is more science-fiction, and even the image which Klass intends to convey has no basis in the reported facts; 9) the complaint that the secondary object "missed" the aircraft assumes without justification that it was intended to "hit" it; 10) since the "rocket-missile" is imaginary there is no reason to expect any "explosion" on the dry lake bed; 11) it is untrue that "this rocket-missile mysteriously disappeared", since there is no evidence that such a device existed in the first place; 12) the "mysterious beeping radio signal" traced to a spot some distance from the site many hours later may well have been unconnected with the incident, and if this is indeed the case then nothing whatsoever is to be inferred from it.

Summary: Many of Klass's arguments are logically flawed, a number of "facts" adduced as evidence are found to be speculation and hearsay, and the overall framework of his scenario is in some important respects internally inconsistent. Most significantly, he fails to address the core quantitative details of the original radar-visual report in any way. In conclusion, Klass's analysis fails to clarify our understanding of the case.

STATUS: Unknown

The End