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Christ White
P-82 file

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28 January 1954

MEMORANDUM FOR: THE RECORD

SUBJECT: Completion of APD Project #82, Radar Detection Tests, Personnel Balloon.

1. "Radar Detection Tests, Personnel Balloon" is an APD project which examined the vulnerability of the Personnel Balloon to detection by radar. It also covered an examination of the detectability of components of and accessories to the Balloon.

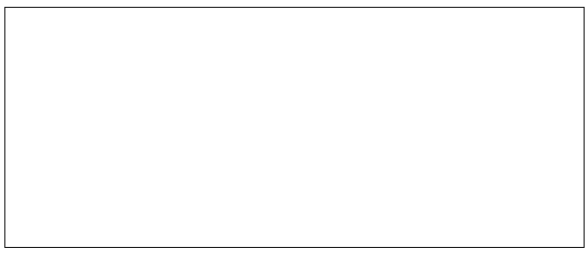
2. Comprehensive tests were run from 10 January 1952 to 18 February 1952. A final report was submitted by ONR on 24 February 1952. This report made overall recommendations for decreasing detectability as well as describing the investigatory techniques used in this program. An analysis of this report was prepared by APD and sent to RDAB on 16 June 1952. This completed APD activity in this project.

3. In view of the fact that APD activity in this project has been terminated and since APD has received no subsequent inquiries on Detection of Personnel Balloons by radar, Project #82 has been completed.

Holmes Bailey
HOLMES BAILEY

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Approved.
Walter J. Driscoll.
Chairman, APD Panel
17 February 54



Office of ONR Field Representative
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Minneapolis, Minnesota

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REGISTERED AIRMAIL



24 February 1952

From: ONR Field Representative, Navy Balloon Projects
To: Chief of Naval Research
Department of the Navy
Washington 25, D. C.
Att'n: Code 461 (Cdr. Buass)

Subject: Project 171 (Contract N6onr 2-5209) Jan-Feb field tests; report of

- References:
- (a) Flight #671 Radar Time-Altitude Plot and Ground Track, Radar #5
 - (b) Flight #671 Radar Time-Altitude Plot and Ground Track, Radar #1
 - (c) Flight #671 Data Sheet for SCR-584 tracking
 - (d) " " " " " Theodolite "
 - (e) " #672 Radar Time-Altitude Plot and Ground Track, Radar #3
 - (f) Flight #672 Radar Time-Altitude Plot and Ground Track, Radar #5
 - (g) Flight #672 Data Sheet for SCR-584 tracking
 - (h) " " " " " Theodolite "
 - (i) Flight #673 Radar Time-Altitude Plot and Ground Track, Radar #1
 - (j) Flight #673 Data Sheet for Theodolite tracking
 - (k) Flight #673 Radar Time-Altitude Plot and Ground Track, Radar #1
 - (l) Flight #676 Radar Time-Altitude Plot and Ground Track, Radar #5
 - (m) Flight #676 Radar Time-Altitude Plot and Ground Track, Radar #4
 - (n) Flight #679 Radar Time-Altitude Plot and Ground Track, Radar #1
 - (o) Flight #679 Radar Time-Altitude Plot and Ground Track, Radar #5
 - (p) Flight #679 Radar Signal Strength Trace, Radar #1
 - (q) " " " " " " " #5
 - (r) Map of WSPG area
 - (s) PPI Camera pictures
 - (t) Still and motion pictures of subject flights

1. Thirteen balloons were expended on the subject tests between the period of 10 January to 18 February of this year. One cell failed, one had to be destroyed on the ground because of unfavorable winds,

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but eleven successful manned flights were made by personnel representing the ONR contractor, General Mills, Inc. Each flight is described in the following paragraphs.

2. Flight #671, the first flight made during the tests at the White Sands Proving Ground in New Mexico, was launched in mid-afternoon of 10 January. The full interim system was employed and a 251GDH cell (2.5 mil Plax with 890 (glass)tapes) utilized.

- (a) The launching was from T station (a distance of about six miles from G station) at 1426 and the landing made at 1513 (total time 47 minutes) along highway #70, northeast of Parker Station, about twelve miles away from the launch site. Two incidents regarding the flight are worthy of noting. First, the contractor did not have an inflation hose available for the first flight, so Eb-ner utilized an inflation tube as a substitute hose and the inflation had to be conducted slowly. Second, the wind of 12-15 knots was at the critical point and the cell whipped around badly during the launching causing some slight damage. The flight was actually made with a small hole which undoubtedly resulted from the unfavorable wind and efforts by the launching crew to handle the cell during inflation. A later "post-mortem" of the flight concluded that the launching had been made in minimum conditions (with max winds) and the winds of 12-15 knots were undoubtedly the upper limit in which a launching could be possible with current techniques. Present for this test were four representatives of the contractor, plus the ONR field representative, and the ONR technical representative.
- (b) Radar tracking for this flight consisted of two sets operating at station G, radar #5 in the X band, radar #1 in the S band, plus the SCR-584, an S band set, which operated from the Desert Weather Station almost due north of G station.

- (1) See reference (a). Radar #5, an X band set, picked up the signal soon after launching about six miles away and a good signal was reported. The reference signal (1.0) was a fixed target at 31,500 yards. The search continued in automatic control for over 15 minutes, as the balloon climbed to about 4,000 feet above the ground, and with the signal holding steady at 1.0, dropping to 0.9, then at 20 minutes the signal dropped to 0.8 and the control had to be shifted from automatic to manual. This was at a range of 16,000 yards. For the next 15 minutes the balloon gradually

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descended and the signal grew weaker until it was about 0.4 at 20,550 yards, 35 minutes after takeoff. Almost abruptly, one minute later, a strong signal was received (1.0 strength) and a shift was made into automatic control. Still with a 1.0 signal at 45 minutes after takeoff remote control concluded the track to the impact point at a range of 24,150 yards.

- (2) See reference (b). Radar #1, an S band set was also employed at G station to track the target and obtained a good signal soon after takeoff and shifted into automatic track. After about ten minutes the signal was lost briefly, then shifted back into automatic after about a one minute lapse. The track continued in automatic until about 28 minutes after takeoff then shifted on and off automatic control for the next six minutes. The remainder of the flight was then tracked in remote control, but an adequate pip was obtained for manual tracking up to the end of the flight.
- (3) See references (c) and (d). The SCR-584, an S band set, was also employed from the Desert Weather Station to track the target. A theodolite was set up near this set and readings were taken simultaneously from the two. The SCR-584 picked up the target at 3 minutes after takeoff and maintained a track from 1424 to 1458 using the "A" scope. The signal was only fair at best, then became poor and finally the target was lost at a distance of approximately 16,200 yards due to ground obstructions.

3. Flight #672 was launched in mid-afternoon of 11 January and, again the full interim system was employed. The cell used was a 251GDH (2.0 mil Flax with 890 tapes).

- (a) The inflation was routine, with light westerly surface winds, and the launching east of N station, occurred at 1426 MST. The course of travel at altitude was approximately 030 degrees, with a swing toward the north in the low levels while descending. Impact was southeast of Holloman AFB (on the Oliver Ranch) at 1634, a total of two hours and eight minutes. Total distance travelled was approximately 30 miles and the ballast consumption was under one lb/hr.
- (b) Radar tracking on the flight consisted of set #3, operating on the S band, and set #5, operating on X band, from "C"

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station, plus the SCR-584 from the Desert Weather Station.

- (1) See reference (e). Radar #3 acquired the target twenty minutes after launching at a range of 17,520 yards. As a reference this signal was reported as a strength of 1.0. For a period of 47 minutes the set tracked, but was never able to switch into automatic track. The signal increased to 1.4 twenty-five minutes after launching, then gradually lessened to 1.2 at forty minutes after launching. For the next ten minutes the signal varied from 0.5 to 1.4. For the next ten minutes the signal varied between 0.4 and 0.9 and the final reading, at a distance of 36,840 yards, was 0.4. Variations in signal strength were believed to be caused by rotation of the cell which provided a varying reflective surface.
- (2) See reference (f). Radar #5 picked up the target with a signal adequate to commence tracking at nine minutes after takeoff. The range was 16,150 yards and the target was visible but gave a poor signal. At this time a signal strength of 0.5 was recorded. The reference for signal strength (1.0 signal) was a fixed target at a range of 31,850 yards. A few minutes later the set was switched into automatic track and remained in automatic for only about ten minutes with a recorded signal as high as 0.7 (compared with the original 0.5). By 1457 (when the target was almost due north of C station) the range was recorded as 19,450 yards and the operator reported the signal strength fluttering between 0.3 and 0.7. The set was in remote track at this time and remained so during the remainder of the flight. By 1502 (range 21,770 yards) the signal was recorded as "poor" by the operator ---0.5. From then on the signal grew constantly weaker and at 1522 was reported as "occasional pips," signal strength 0.2.

Tracking continued until 1534 when the target was lost. The target at this time was about 3,000 feet above the surface and was on its way down. The target was lost because it went down behind or in front of a hill, however it is important to note that the last range reported was 37,320 yards, and the signal strength less than 0.1. According to the operator the signal before

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the target disappeared over the hill was "not reliable".

After the flight was made the Officer in Charge of C station said he was disappointed with the showing made by his two radars used. Adjustments were made to the sets and he claimed they would be at peak efficiency (one third better than at present) for the remainder of the Skyhook tests.

- (3) See references (g) and (h). SCR584 from Desert Weather Station was also utilized to track the target. Desert Weather Station is a little over 3 miles almost due north of C station. Also at the site was a theodolite which was able to acquire the target while it was still on the ground. The 584 picked up the target 24 minutes after launching at a range of 13,100 yards. During the first 24 minutes the target had mountains in the background and was not detectable in the ground clutter. Readings from then on were taken every two minutes on the "A" scope until the target was lost 64 minutes after launching at a range of 31,800 yards. Desert Weather's 584 is at a few feet lower elevation than the sets at C station, so lost the target a couple of minutes earlier. The theodolite, even lower than the 584 dish, lost the target 15 minutes earlier due to the hill obstruction.

During the entire period a very poor signal was reported by operators of the 584 and it is doubtful if the target could have been tracked much farther away. The operators' report of "off target" at 64 minutes after the launch is of extreme interest but needs a detailed explanation to be of value. The undersigned and the ONI technical representative departed from C station and went to Desert Weather, arriving about 30 minutes after launch time. Observing that the operators were on the target and using only the "A" scope a request was made for them to switch from the "A" to the PPI, making sweeps as in a normal search. The operators--- after taking a reading at 32 minutes---obliged and started sweeping. On the PPI, however, the target was lost in ground clutter and couldn't even be found. After several minutes of searching the operators were allowed to switch back to the "A" scope and were able to acquire the target in time for their reading at 36 minutes after launch time.

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4. Flight #673 was launched early in the morning of 15 January with the third GMI pilot aboard and again the full interim system was used. The cell was a 251BDH (1-1/2 mil. Visking) with 890 tapes.

- (a) Inflation was routine with a 3 man GMI crew (including the pilot) and the launching was made at 0830 MST from a point just east of N station. Conditions were ideal with surface winds which were calm to light southwesterly. The course of travel at altitude was 080 degrees with light southeasterly surface winds at the point of impact near Escondido. The overall flight time until impact was two hours, ten minutes, and the total distance traveled was about 38 miles.
- (b) Radar tracking of the flight consisted only of Set #1, operating in the S band. Other operations in the area required X band silence thus no X band set was used. The SCR-584 from Desert Weather Station was not available because of the morning raob.
- (1) See reference (1). Radar picked up the target and started its track 13 minutes after launching with a good signal. At 0850 the set was shifted into automatic track, then a few minutes later had to return to remote again. The signal strength decreased slowly throughout the remainder of the flight, the set was able to keep tracking out to a distance of approximately 22 miles. The target was lost at 0952 as the cell descended and the pilot started drag roping. The O in C of C station remarked that it was his belief that the set was at its maximum range when the target was lost because the signal was quite weak. He added, however, quite significantly, that it appeared to him that the set was tracking balloon material and man primarily because throughout the flight the signal varied in strength. For instance near the end of the flight the signal increased once from very poor to fair, for no apparent reason. It was his opinion that some metal parts had rotated into position at this point to become good reflective surfaces. This opinion of his was borne out by later tests of the stripped down gear.
- (2) Although the SCR-584 at Desert Weather Station was not utilized it is significant to note the optical tracker lost the target about the same time as the C station radar.

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5. Flight #674, attempted again from east of N station, on Sunday, 20 January, actually wasn't a flight at all, merely a balloon expended because of too much wind during inflation. The atmosphere was fairly unstable and a squall moved across the mountains close by Condron, the original launching site, and unfavorable winds resulted. It was therefore decided to move up to the favorite location at N station where, it was believed, favorable winds would exist. Upon arrival there the surface wind was 5-8 knots, so the cell was laid out and inflation began. So did the wind. It started increasing gradually at first, then became gusty. During the critical period (with the sail existing) the wind was approximately 18-20 knots. Damage occurred when the balloon brushed some cactus, but this was repaired and inflation continued. Finally the wind tore a 3 cornered hole in the cell near the equator and it was conceded finally that the flight was doomed, so the rip cord was pulled and the cell cut down. Several lessons were learned. The cell, a 251GDH (2.0 mil Flax with 890 tapes) withstood a terrific beating and it was believed by those present that a diffuser, thus a more rapid inflation, might have saved the day. It was also generally agreed that launchings should not be recommended with winds in excess of 15 knots. It was also bitterly learned that a sufficiently adequate area should be cleared before inflation. It is hoped that movies of the debacle, taken unfortunately by the undersigned, are adequate to present visually the problems encountered by the valiant 3-man GMI launching crew.

It was regretted by all that Cdr. Buass should be treated to such an unorthodox display while on the scene to witness his first 171 launching.

6. Flight #675, launched in the evening of 22 January, was the first flight for the fourth GMI pilot, yet was made to fulfill his objective of "up and over" and also to check out the SE-1M which was operative, but had not been used for tracking. The cell was a 251GDH (2.0 mil Flax) with 890 tapes. The full interim system plus adequate gear for an all night flight---metal flashing light, knife, water bottles, food, etc., were used. A standard corner type reflector was also carried, then dropped after about 20 minutes in the air.

- (a) The inflation was routine, with light surface winds, and the site was behind the Navy administration building with the launching at 1920. One incident, worthy of noting, occurred during inflation when the suspended parachute fell from its mooring ring at the equator. It was never positively established

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but fairly well decided that the linen mooring line had not broken, the knot had merely slipped and pulled out. Thanks to Ebnetter's perceptive design the nylon safety line was properly in place, so in the few minutes the parachute was secured again in position and ready for use. This, incidentally, was the first the safety line was ever necessary, but proved its worth and established itself as a "must" in the interim system.

Wind data (from SBPG and from El Paso) was obtained before the flight and a flight plan prescribed for the pilot. The forecast was not brilliant, but the wind data was adequate for the pilot to navigate well enough to follow his course fairly well. His time aloft was eleven hours and forty-five minutes with the impact about 15 miles northeast of Pyote AFB. The overall distance traveled was approximately 215 miles.

(b) The only tracking of this flight consisted of the portable SK-1M, operating on a frequency of approximately 195 megacycles. Site of this radar was at G station.

(1) The PPI camera had been installed immediately prior to this flight, but had not been used. When the launching personnel arrived at the radar site immediately after the launching, the operator, EPC Swanson, was busily sweeping and trying to acquire the target. His results were negative. Further, there was jamming of the film so results are absolutely unknown. Pictures were taken each sweep, with three sweeps per minute, and negative numbers 1850 to 1945 are applicable to this flight for analysis as to whether there was or wasn't a target in the PPI scope.

7. Flight #676, again with the fourth GMI pilot, was launched in the early afternoon of 24 January. The cell used was a 251BD (1.5 mil Visking) with 880 tapes, but revisions were made to standard interim system gear in an attempt to reduce its detectability and evaluate same. The two largest metal reflective surfaces were removed from the system for evaluation. The standard suspension bar and load ring were replaced with counterparts made of wood. No barograph was flown and other metal parts were at a minimum. The metal valve, however, remained intact.

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- (a) The inflation and takeoff were routine with the launching site again being behind the Navy Administration building. The launching was at 1400 and the pilot headed westerly--- toward the mountains---until he gained flight altitude, then headed in the desired easterly direction and leveled out on a course of 080 degrees. The overall time in the air was four hours and five minutes, however the pilot spent the last half of the flight drag roping northward and finally impacted a couple hundred yards south of road #70, right at the gate to the White Sands National Monument. Distance from the launching site to point of impact was about 53 miles, however the actual distance traveled was probably nearer 45 miles.
- (b) Radar tracking for this test was furnished by the portable SK-1X set erected at station C, also the following three permanent C station sets, #4 and #5, both X band sets, also #1, on the S band. Desert Weather's radar was not available.
- (1) See reference (k). Set #1 acquired the target at 1416 at a range of 13,000 yards and an altitude of 2800 feet, then went into automatic track within a few minutes. Although relative signal strengths were not recorded by the operators for this test (this was unknown at the time) it is important to note that a fairly smooth track was maintained until 1505 when the target was about 26,000 yards away. At this time the signal strength decreased to the point where remote control tracking had to be utilized. About 12 minutes later the tracking shifted briefly into automatic again for a couple of minutes. From then until 1530 when the target dropped behind a hill at a range of about 41,000 yards, the tracking was in remote with a constantly weakening signal which was almost unreliable at 1530.
- (2) See reference (1). Radar #5 picked up the target and started tracking it at 1410 in remote. The signal never became strong enough to switch into automatic and at 1500 the A scope pip was so weak that the target was lost at a range of about 21,000 yards. For the next five minutes the set was on the target

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only occasionally with a very unreliable signal reported. An instantaneous reading was reported at 1505, then the target was lost for good at a range of 25,540 yards.

- (3) See reference (n). Radar #4 was on the target at 1407 and traced it in remote control with a fair signal until 1445 when the set tracked in automatic for almost ten minutes. From 1455 until 1517 the set tracked in remote with a signal of decreasing strength and the target was finally lost at 1517.
- (4) The SK-1M, operating on its most efficient frequency, 192.5 mc, was utilized for this test with negative results. Only the PPI camera pictures will be able to provide any positive data for evaluation. Pictures were taken from #3020 to #3215. At one time, about 1431, the operator thought he had acquired a moving target bearing 320 degrees, range 10,500 yards, so shut off the PPI scope camera, stopped sweeping, and attempted to start tracking the target with the A scope. By 1440 it was decided the target, if any, was lost so the camera was started again (with picture #3098) and the sweeps resumed. The SK-1M was not secured until approximately 1600.

8. On Sunday, 27 January, an antenna (cut to the proper wave length to form a near perfect reflective surface) was borne aloft by two pillow balloons as a test of the SK-1M equipment. This, of course, was not considered an official project flight so there was no flight number assigned. Unfortunately a signal was picked up which did not change in range or bearing (about 210 degrees at 12,500 yards) and nothing else appeared on the scope, so was considered a failure. The first picture taken was #3270, at about 1600, and the set was secured at 1825 with plans to try it again at another time.

9. Flight #577 was launched in mid-afternoon of 28 January, and was a 3-pilot hedgehop with full interim system gear except for the cell used which was a 2078D (1.5 mil Wiaking) with 800 tapes.

- (a) Inflation was outstanding in that Bonotex's new diffuser was used for the first time and worked like a charm. Gas went in faster than bottles at the manifold could be opened. Otherwise the inflation from a point east of F station in a 5 knot southwesterly wind was routine and the

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launch was made at 1420. The first hop lasted about 20 minutes, then came down about a mile away from the launching site. The second hop was an hour and twenty minutes in duration, with impact only a few miles north, and the third hop lasted one hour and ten minutes. Impact of the third hop was a few miles farther to the north, right along highway #70.

(b) The only radar available for this test was the SK-1M, which had to maintain silence until 1345 when it could be used.

(1) At 1545 then, the search was started and the FPI camera commenced with picture #3540. The operator picked up two airplanes, close in at 1555, tracked them until 1603 when the planes were lost at 064 degrees, about 12 miles. At about this time (or a little later) there was a camera failure and film had to be changed. It appears that the pictures from #3615 to #3750 (approximately) were lost. At 1650 a target was picked up at 10 miles, bearing 007 degrees. This pip came from the vicinity of the third hedgehop and was at a time when the pilot was at a fairly low altitude so was probably the balloon however the flight was terminated within the next half hour. It is hoped good data can be obtained from the pictures taken at this time.

A group of 2 to 4 planes were picked up at 1720 over 50 miles away, bearing 130 degrees, and they were tracked for the next ten minutes in to a distance of 28 miles, bearing 195, when they disappeared (probably coming into the traffic pattern at El Paso). From then until 1855, when the gear was secured, there were no other targets detected on the scope.

10. Flight #678 was launched in the early evening of 29 January with the third GMI pilot aboard. The objective of the flight was the same as flight #675---over the mountains. Gear included the full interim system, with extras (including a duplicate test antenna), and the cell was a 251CDH (2.5 mil Flax) with 890 tapes.

(a) The launching site was at the rear of the Navy administration

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building and a normal inflation transpired. The twenty-nine bottles of helium were quite speedily emptied into the cell because of the diffuser and the launching was made at 1720. Duration of the flight was eleven hours and forty-five minutes with impact in the desert a few miles from Toyah (on highway 80, eighteen miles west of Pecos), about 175 miles away from the origin. Predetermined flight levels were assigned the pilot for a flight plan after a single station analysis (by choice) was made of the synoptic weather situation, a prognostic chart was made for each of the selected flight levels, and the proper levels then selected to navigate the pilot to the desired impact point. The only forecasting data allowed the forecaster (ONR Field Representative) were two pibal runs at WSPG, one three hours prior to the flight and one fifteen hours before the flight.

With this sketchy information the forecast was only fair--- the impact point was southwest of the target point by about 50 miles---but with greater continuity and evaluation of single station reports it is believed this error could be reduced somewhat in practise.

(b) Due to the launching time only the SK-1M was available for tracking. To obtain a maximum signal as soon as possible another antenna (cut to the proper wave length) was carried at the start and dropped by the pilot just before he passed over the SK-1M set.

(1) Pictures taken with the PPI camera began at #3995 and the set was turned on and sweeping at launch time. Twenty-five minutes after the launching the operator reported a fairly good signal bearing 279 degrees, range three miles. The set tracked the balloon in to 2900 yards, bearing 282 degrees, then lost the target (almost directly overhead) thirty-one minutes after takeoff. The next bearing was at 099 degrees, 3400 yards range, as the target started to open. This was fifty minutes after launching and the signal was reported as good (the antenna had been dropped before this). The A scope only held the target for a few minutes and the last reported position before it was lost was 104 degrees, 4200 yards. The camera was started again and search resumed. Sixty-one minutes after takeoff the target was again picked up at 102 degrees, 7000 yards with a fair signal. Three minutes

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later the position was reported as 9100 yards, bearing 104 degrees. The target was then lost again. At 80 minutes after takeoff a target was picked up at 095 degrees, 14,700 yards, but the operator was not sure whether it was or wasn't the desired target. The signal was reported as "not too good." For the next forty minutes the set was continued in operation and pictures were taken, but the true story will only be known when the pictures are evaluated.

11. Flight #879, the final flight from ASPG, was made on 31 January and was the highlight of the tests because a completely "non-interim system" was used. This flight was referred to as the "naked test" because of the absence of all metal parts and fittings. A rather ingenious harness was used and five fully inflated pillow balloons were carried along as a partial means of losing altitude (in lieu of the standard valve). The cell used was a 251 CDH Special (2.0 mil Plax) with 890 tapes.

- (a) Takeoff was at 1320 from the favorite site east of N station and 26 cylinders of helium were emptied for adequate lift. Course of the flight was 095 degrees and the impact, just west of road #54, was at 1500. The time aloft was 100 minutes and the distance traveled about 20 miles. Despite the fully stripped gear and pilot discomfort while aloft, the flight was routine.
- (b) Radar tracking was furnished by three sets, all at station C. In addition to the SK-1M, sets #5 (X band) and #1 (Sband) were utilized.

- (1) See reference (n). Radar #1 did not acquire the target until 1345, twenty-minutes after the launch, but five minutes after beginning to follow the balloon the signal was adequate for the operator to shift into automatic track. The range at that time was about 14,000 yards. Automatic tracking continued until 1425 when the signal strength became weak enough at that range (26,000 yards) that the set was shifted into manual. At 1439 the target was lost in ground clutter (almost at maximum range), but a good signal was recorded again two minutes later and the target was then tracked for another ten minutes in automatic. The balloon then descended behind a

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mountain across the desert and the signal was then lost at 1451. The pilot ascended again just before impact and the radar picked up an instantaneous plot a couple of minutes before impact. The signal at this time (range about 20 miles) was reported as weak and intermittent and the gear was apparently extended to its utmost at that range.

(2) See reference (o). Set #5 was on the target almost immediately after takeoff and starting tracking at 1329. At 1347 (range 13,000 yards) the signal was adequate for a shift to automatic. The set had a little trouble in automatic at 1353, but didn't actually have to shift into manual until about 1400. This set remained tracking in manual until 1425 when the target was lost at about 24,000 yards.

(3) The SK-1M started sweeping about 1230 because the operator was told to watch for a group of pillow balloons (five of them) which were released about that time. Sweeps were made and the PPI camera was turned on, but the operator was never able to detect the group of pillow balloons which were launched from the main flight launching site.

At 1520 the flight was launched and the radar started sweeping and taking pictures, starting with #4146. At 1531 the operator logged the target at 332 degrees, 12,900 yards with a fair signal. One more plot of the target was made of the target at 1548 on a bearing of 014 degrees, range of 14,100 yards and a rather weak signal reported. The target was then lost and not picked up again, however the camera was kept active until the set was secured at 1513. The last picture taken was #4360.

(4) See references (p) and (q). As a matter of interest and the subject for a more detailed technical evaluation of the tests on flight #679, the referenced signal strength traces for radars #1 and #5 should prove to be a source for additional data.

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The following details regarding the sets used in this test should also be of some value to a radar expert. Radar #1 is an S band set, type MPQ12 (Army designation), had a peak of 175 kw, a dish diameter of 10 feet, operated on a frequency of 2840, had a beam angle of 2.24 degrees (hasty calculation), had horizontal polarization and a parabolic antenna illuminator.

Radar #5, the X band set, is an MFG2 (Army), had a peak power of 130 kw, a dish diameter of 8 feet, operated on a frequency of 9310 with a beam angle of 1.3 degrees, had horizontal polarization and a parabolic antenna illuminator.

12. In a post mortem of the above described series of radar evaluation tests at White Sands the earlier statement by the O in C of station C (that the sets were primarily tracking pilot and polyethylene) seemed to be borne out. It was his opinion, however, that the maximum range which could be expected of his sets was 20 miles. He also stated that no search type radar could even compete with his sets for tracking the target, because of the high concentration of energy his narrow beam sets were able to pin point on the balloon.
13. As a result of the radar tests it seems that the interim system should be modified to the extent of replacing the suspension bar and load ring (in particular) with components made from a substitute material (plywood, fiberglass, etc.). It also seems advisable to utilize a different material (plastic) for valve construction. By reducing the amount of reflective metal surfaces in the above simple manner the radar vulnerability of the vehicle will have reached its minimum (except for the possible use of sprayed coatings, etc.) with only a slight modification of the proven interim system.
14. After leaving White Sands Proving Ground, the ONR field representative and one of the GMI representatives spent a week at Pyote AFB with the main objective of making long flights and obtaining more data about the forecastability of the impact point. It was intended to make several flights at least from Pyote, but only two balloons were expended and one of the two had to be cut down. A hasty departure from Pyote on rather short notice precluded any more flight tests.

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15. Flight #880 was launched from the airplane parking apron at Pyote AFB on the night of 4 February. The full interim system was employed and the cell was a 251GDH (2.5 mil Plax) with 890 tapes.

- (a) It would not be an exact truth to say the inflation and launching were routines. First, the full launching crew consisted of only the two mentioned above in paragraph 14. A helium trailer---instead of the manifolded bottles---was used for helium source, but did not alter any of the standard inflation procedures. During the cell layout it was noticed there was no "D" ring or any other mooring device installed at the equator for rigging of the parachute. Such a device was then constructed from 880 tape on the spot and affixed in the proper location. Near the end of inflation the mooring tape pulled off and the parachute fell to the ground. The pilot decided to take off regardless, so was provided with a chest pack for his personal safety.

When the balloon "appeared" to be fully inflated, the pilot climbed aboard and was secured in the harness. During the weigh-off it was discovered he was much too light, so valved for a long time in an attempt to reach a state of equilibrium. Although the valve had been tested earlier and was operating properly, the slight rustling of the wind around the fully inflated cell during the weigh-off made it impossible to tell whether or not the valve was functioning properly while he was valving gas. Finally an additional sand bag with 26 pounds of ballast was added and provided an adequate weight for a safe takeoff.

The launching time was 2155, about two hours later than intended, but the launch was very nice and the pilot made a normal ascent to his proper altitude. A local single station forecast had been prepared (based on a takeoff time of 1800) in the late afternoon by the undersigned and flight levels were assigned to the pilot. Information available was not adequate for maximum accuracy, however, and the flight had a trajectory farther north (and faster) than expected. Impact the next morning at 0745---after a flight of nine hours and fifty minutes---was north of Eastland, Texas (on road #80), a distance of about 260 miles. It is of meteorological interest to note that a "hindcast" of the trajectory and impact point were made by the undersigned, before the pilot telephoned back to Pyote. The hindcast,

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based on current upper air from Big Springs and El Paso, was surprisingly accurate and the impact point selected was probably within 15 miles of the actual---an error of five percent or less.

15. Flight #681, scheduled for a duration of 24 hours, was attempted the evening of Thursday, 7 February, but was never launched. The cell, a 207C (2.0 mil Plax) had 880 tapes. The layout and inflation were routine and the surface wind of 8-10 knots provided no undue problems. When gas started valving from the appendix, it was realized the cell was full, so preparations were made for adding more ballast and weighing off the pilot and gear. It was then discovered one main load tape had snapped at the ring and two others seemed on the verge of breaking, so the rip panel was pulled and the flight had to be cancelled. Tests of the tape have not been made as yet, but it seems only possible for one of two things to have happened, namely, faulty tape or faulty construction which could have been caused by the broken tape being shorter than the other tension members. An analysis will be made at the GMI laboratory.
16. The final phase of the subject tests was conducted aboard ship (the PCE 870) off NAS Corpus Christi, Texas, and consisted of two flights from shipboard with water landings in Corpus Christi Bay.
17. Flight #682 was launched early Sunday afternoon, 17 February and the full interim system was used, plus a Mae West and rubber liferaft. The cell flown was a 251CDB (2.5 mil Plax) with 890 tapes.

- (a) The layout area used was on the fantail and the helium bottles were rigged between the depth charge racks. The anchor point for rigging the harness was a tubular metal step on an after gun tub for a 40 mm gun. About the only non-standard procedure employed consisted of doubling the cell back on the deck (because of the lack of space) rather than laying it out in a straight line.

Target point was selected as the water inside Padre Island (inside the Bay) and the crash boat was standing by at the designated site. A helicopter was also standing by and communication with operations, air traffic, reserve center, crash boat, radar, ship, was ideal. The morning upper air was obtained from Aerology, then the undersigned made a forecast, selected a launching site and navigated the

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ship to a point up wind from the desired launching spot. When the proper point was reached, and everything in readiness, the ship was brought around down wind (about a 10-12 knot wind) and the inflation began. It was about the simplest inflation and launching of the field trip up to that time. The helicopter arrived over the ship on time as a "balloon guard", the pilot was weighed (slightly heavy), the ship was brought around to starboard to bring the wind from starboard and the pilot was gently eased over the port rail. Ballast had to be dropped rather quickly because the cell started to settle toward the water. Because of being in the lee of the ship there were also the usual swirling winds found in the lee of any windbreak. In a few seconds, however, the pilot started a satisfactory rate of rise and was on his way---with the helicopter tagging along and circling the gear like a dutiful dog following his master.

Time of the takeoff was 1310 and the ship at that time was 25 miles from the impact point and about 12 miles from Padre Island. When the pilot was sighted by the crash boat, same was reported to all concerned so was the splash, at 1413, and then the safe recovery of the man and gear. The crash boat then returned to the boat house and the whirly bird returned to base for more fuel. The final phase occurred when the helicopter landed on the dock alongside the boat house, picked up the gear and pilot, then returned them aboard the ship.

The overall operation was as smooth as humanly possible and the expected unforeseen obstacles never occurred. As a combined air-sea rescue drill the operation was also excellent because of the close coordination required of all concerned.

- (1) As a radar evaluation test, however, the flight was a disappointment. Although the radar evaluation was only a secondary objective it was hoped that some data would be received. Radars employed were the ASR unit on the deck, GCA at the main NAS, and the search radars (SO-4 and SA-3) at the Reserve Center. All were in the S band and none reported any positive results. The circling helicopter actually hindered the test as a radar evaluation.

18. On the following day it was planned to run two tests if at all

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possible and thus to conclude the PCE launchings. The ship, therefore anchored outside of Aransas Pass all night, ready for arriving at the launching point as early as possible the next morning. Fate, however, in the form of seasickness, stepped in and struck a cruel blow at the project group aboard and reduced the complement from four to two as two of the GMI pilots succumbed during Sunday evening. The undersigned, however, and the one fully seaworthy GMI pilot, however, selected assistants from the crew and the ship got underway at dawn on Monday, 18 February. Seas were moderate (however the wind was never more than 14 knots) and the ship motion added to the discomfort of the suffering GMI pair.

After reaching the selected launching point (chosen from upper wind data furnished by NAS Aerology) the only delay of the two day operation was encountered. No word regarding the helicopter was received. So, layout and inflation were delayed. It was somewhat of a surprise to see the whirly bird arriving on station at the proper time according to an earlier ETD which had been sent to all concerned. The ship was then quickly sent cross wind for a short period of time to reach the most favorable launching point, then turned down wind toward the beach and preparations for the flight began.

- (a) Flight #683 was a bow launching and after turning downwind (where seas were following, thus much smoother) the two absent GMI pilots appeared on deck for "limited duty". The cell used was a 251CDH (3.0 mil Plax, heaviest flown) with 880 tapes. The anchor point forward on the starboard side consisted of a deck pat-eye and the crook in a drain pipe. Helium was manifolded in the gun tub of the forward 3 inch gun and were lashed to the deck in a horizontal fashion. The cell was layed out much like on flight #682, that is doubled back, however there was more space for the layout on the bow than there had been on the fantail. The inflation and launch were purely routine, even simple. Motion of the deck made the weigh-off a little difficult, but a fairly accurate weigh-off was made. Then, when all was in readiness, all engines were stopped and the pilot glided off into space. At first there appeared to be a false take-off and so some ballast was dropped. It was probably not necessary, however, because the cell by then was out of the air "wash" of the ship and started ascending quite fast so that the pilot had to valve some gas.

All in all the flight was routine, the same as the one on the

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previous day. The life raft was not carried, otherwise the interim gear was the same as on flight #682, including the altimeter which did not function. The pilot, therefore, used cigarette smoke to sense ascent and descent. Time of launch was 1129, at a point about 18 miles from the target and the winds at altitude were so strong that the splash was made at 1202. Since the crash boat was slightly outmaneuvered (its top speed was 11.5 knots) and falling behind at the splash point, the whirly bird picked up the pilot and returned him to the beach while the boat retrieved the gear.

Equipment was not available for the second planned flight so it was cancelled. Since the weather outlook was not bright, the ship returned to the dock. The forecast the next day indicated unfavorable winds so it was decided to cancel further flights since basic requirements had been met and procedure standardized to satisfaction.

It was generally agreed the two shipboard launchings were the easiest of the 13 made during the field trip and standard water ditching procedure should be facing aft, harness unbuckled, for the gear to be pulled away from the pilot by the wind immediately upon hitting the water.

(1) Radar evaluation of #683 was again negative.

19. References (a) through (r) are merely classified as restricted so are being forwarded under separate cover. Reference (s) has been forwarded previously and photographs of reference (t) will be forwarded by the contractor.

MALCOLM D. ROSS

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