[redacted]

DECLASSIFIED

REPORT NO. R-1164

DATE 28 May 1935

SUBJECT

FR-1164

TEST OF GENERAL ELECTRIC RECOGNITION
SIGNAL SYSTEM

DECLASSIFIED by NRL Contract
Declassification Team
Date: [illegible]
Reviewer's name(s): [illegible]

BY

Declassification authority: [redacted]
[illegible]

NAVAL RESEARCH LABORATORY

BELLEVUE, D. C.

DISTRIBUTION STATEMENT A APPLIES
Further distribution authorized by ______
UNLIMITED only.

U.S. GOVERNMENT PRINTING OFFICE 1932 4—7436

DECLASSIFIED

DECLASSIFIED: By authority of
5000A Dated: 8 Jan 1958

Entered By: E. Bliss Code 2027

NRL Report No. R-1164
General Electric Recognition Signal System

[redacted]

28 May 1935

DECLASSIFIED

NRL Report No. R-1164
Bu.Eng.Prob.No. A9-9

NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report on

Test of General Electric Recognition Signal System

Distribution Unlimited

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

Approved for
Public Release

Number of Pages: Text - 4 Tables - 2 Plates - 1

Authorization: Bu.Eng.letter C-NOs 31598 (4-16-W3) of 16 April 1935.

Date of Test: 13 to 23 May 1935.

Prepared by:

R.M. Page, Jr.Physicist

Reviewed by:

A.H.Taylor, Physicist. L.C.Young, Radio Engineer

Approved by:

J.B. Will, Comdr., USN,
Acting Director.

DECLASSIFIED

Distribution:
Bu.Eng.(5)

ts

DECLASSIFIED: By authority of
5000A Dated: [illegible] Jan 1958

Entered By: E. Bliss Code 2027

AUTHORIZATION

1. This problem was authorized by Bureau of Engineering letter reference (a), and additional references pertinent to this problem are listed as references (b) and (c).

Reference: (a) Bu.Eng.Secret letter C-NOs 31598 (4-16-W3) of 16 April 1935 to NRL.
(b) Bu.Eng.Secret letter S-L5 (3-6-W9) of 23 April 1935 to NRL.
(c) Com.Off.USS SEMMES Secret letter S67/DD189(152) of 4 April 1935 to Bu.Eng.

OBJECT OF TEST

2. The object of this test is to determine the suitability of the General Electric recognition signal equipment as a secret homing system for aircraft.

ABSTRACT OF TEST

3. The transmitting equipment was set up at this Laboratory under the supervision of engineers F.G. Patterson, C.E. Perleberg and H.B. Thomas of the General Electric Company. Slight damage, apparently incurred in shipment, was repaired before normal operation was obtained. General performance under operating conditions was noted. The transmitting equipment remained at this station throughout the test.

4. The receiver was installed in the Laboratory truck and its general performance noted. The truck was then driven to nearby points in Maryland and Virginia at distances of 1-3/16 to 4-1/2 miles, and bearings on the Laboratory were observed at ten such points. These were checked with true bearings. The receiver was then installed in the radio research plane at the Naval Air Station, Anacostia, D.C., and two test flights were made. The signal was rendered unintelligible in flight by vibration microphonics and ignition interference.

CONCLUSIONS

(a) Until the receiving equipment is made to operate satisfactorily on a plane in flight, no demonstration of the apparatus as a homing system for aircraft is possible. Certain known properties of the system, however, have a pertinent bearing on this application.

(b) The manner of indicating bearing in the present model is not well adapted to guidance of the pilot. Bearing relative to the transmitter is indicated by a code number which must be converted into degrees or direction by the observer and which has no relationship to direction of flight. When the pilot has determined his bearing on the transmitter, he must then determine his course by compass.

(c) An uncertainty of bearing of plus or minus 15° is present. In so far as this uncertainty is due to conditions surrounding the receiver, it can be eliminated for each plane by calibration in flight. That part which is due to frequency instability of the transmitter can be reduced only so far as the frequency stability of the transmitter can be increased. That part, if any, which is due to conditions surrounding the transmitter and antenna can not be eliminated unless the transmitter and surroundings maintain a constant configuration and orientation relative to true north.

(d) In view of recent developments in high frequency vacuum tubes, it should be a relatively simple matter to redesign the entire transmitting equipment for much greater efficiency, simplicity, frequency stability, and compactness. The present installation at this Laboratory, however, is sufficient for further tests of the equipment as a secret homing system for aircraft if and when a suitable aircraft receiver is furnished.

(e) The system in general appears promising as a secret homing device for aircraft.

RECOMMENDATIONS

(a) That the receiver be redesigned to operate on a plane in flight.

(b) That the indicated bearing be correlated with direction of flight so that a single instrument will give continuous indication of angle between direction of flight and direction of transmitter from plane.

(c) That the degree of ignition interference elimination possible at the receiver be determined, and that this Laboratory be advised as to the amount of additional shielding and bonding necessary on the test plane.

DESCRIPTION OF MATERIAL UNDER TEST

5. The material under test consisted of a transmitting system and a receiving system for short wave coded signals. The transmitting equipment included one 1000-watt transmitter unit, one motor-driven rotating antenna array, one sighting head for directing and controlling the coded signals, one water cooling system, one rectifier unit and one motor-generator set. The receiving equipment included a short wave super-heterodyne receiver and a de-coding unit which converted the received signals into a code number. Coupling to antenna was made through a tuned transmission line both at transmitter and receiver.

6. The equipment tested was a development model and could be improved considerably in efficiency, simplicity, frequency stability and compactness by application of more recent developments in short wave technique. The receiver was not designed for aircraft use.

METHOD OF TEST

7. Ground Test. The transmitter was installed on the Laboratory roof and the receiver in the field truck. The truck was then driven to nearby points in Maryland and Virginia, at distances of 1-3/16 to 4-1/2 miles. At each observation point the truck was stopped, the receiver warmed up for five to ten minutes, and the de-coded signal was observed. The location was spotted on a Washington, D.C. Geological Survey Quadrangle, and in cases where the truck could be seen from the Laboratory roof, the bearing of the truck relative to the Laboratory was observed by means of a transit on the Laboratory roof. Ten observations were made, four of which were checked by the transit. Of the remaining six points, one was taken at a distance of two miles with a hill intervening, and the other five were taken with trees or trees and buildings intervening. The signal was noticeably weak at a distance of 4-1/2 miles with trees and buildings between transmitter and receiver.

8. Flight Test. The receiver was installed on the radio research plane at the Naval Air Station, Anacostia, D.C. Two attempts were made to get data in flight. The first was unsuccessful. On the second flight the plane flew at 2500 feet altitude and circled the Laboratory at a two-mile radius. No signals could be distinguished through other electrical disturbances, so the plane came in to a 1-1/2-mile radius. At this distance an occasional reading was possible. Through continuous two way communication between the plane and the Laboratory, the bearing of the plane relative to the Laboratory was observed with the transit on the Laboratory roof at the instant of reading the code number at the receiver on the plane. Six readings were obtained on this flight.

DATA RECORDED

9. The data for both ground and flight tests are included as Tables 1 and 2.

10. A chart for the ground test is included as Plate 1.

DISCUSSION OF PROBABLE ERRORS

11. The uncertainty of spotting location on the map was such as to introduce errors in no case exceeding one degree.

12. Errors of sighting and reading the transit were less than one degree.

13. The time correlation between readings of transit and receiver for flight tests was probably within one second, giving a probable uncertainty of one degree from this source.

14. The uncertainty of reading the received code number was about two degrees for the ground test and from 5 to 180 degrees for the flight tests.

15. The maximum observed errors were $+13^{\circ}$ and -17° for the ground test and $+15^{\circ}$ and -18° for the flight test. In most cases, errors greater than 5° may be attributed to the apparatus under test or to distortion of the field pattern relative to the apparatus by circumstances around the transmitting and receiving antennas.

16. Interference due to electrical and mechanical disturbances on the plane made nearly all readings on the plane uncertain to plus or minus 180°. There was some indication that the received code number was influenced by the direction of flight relative to the transmitter, but the difficulty of obtaining readings in flight made it impossible to determine the magnitude of this effect.

RESULTS OF TESTS

17. As the subject equipment was not suitable for aircraft use due to the susceptibility of the receiver to interference from ignition and mechanical vibration, the system could not be properly tested as a secret homing device for aircraft. Land tests indicated deviations from true bearing as great as 17°. Some of the deviation is due to conditions surrounding the receiver, but the relative influence of these conditions and those surrounding the transmitter is undetermined.

CONCLUSIONS

18. Until the receiving equipment is made to operate satisfactorily on a plane in flight, no demonstration of the apparatus as a homing system for aircraft is possible. Certain known properties of the system, however, have a pertinent bearing on this application.

19. The manner of indicating bearing in the present model is not well adapted to guidance of the pilot. Bearing relative to the transmitter is indicated by a code number which must be converted into degrees or direction by the observer and which has no relationship to direction of flight. When the pilot has determined his bearing on the transmitter, he must then determine his course by compass.

TABLE 1.

CIRCLING BELLEVUE AT APPROXIMATE 1-1/2 MILES RADIUS AT 2500 FT. ALTITUDE

Point No.	True Bearing (Transit)	Dial	Indicated Bearing	Indicated Bearing Corrected Due to Sighting Vanes	Error
1	197	44	220	212	+15°
2	122.5	23	125	117	-5.5°
3	94	18	90	82	-12°
4	13	1	5	357	-16°
5	355	69	345	337	-19°
6	279	57	285	277	-2°

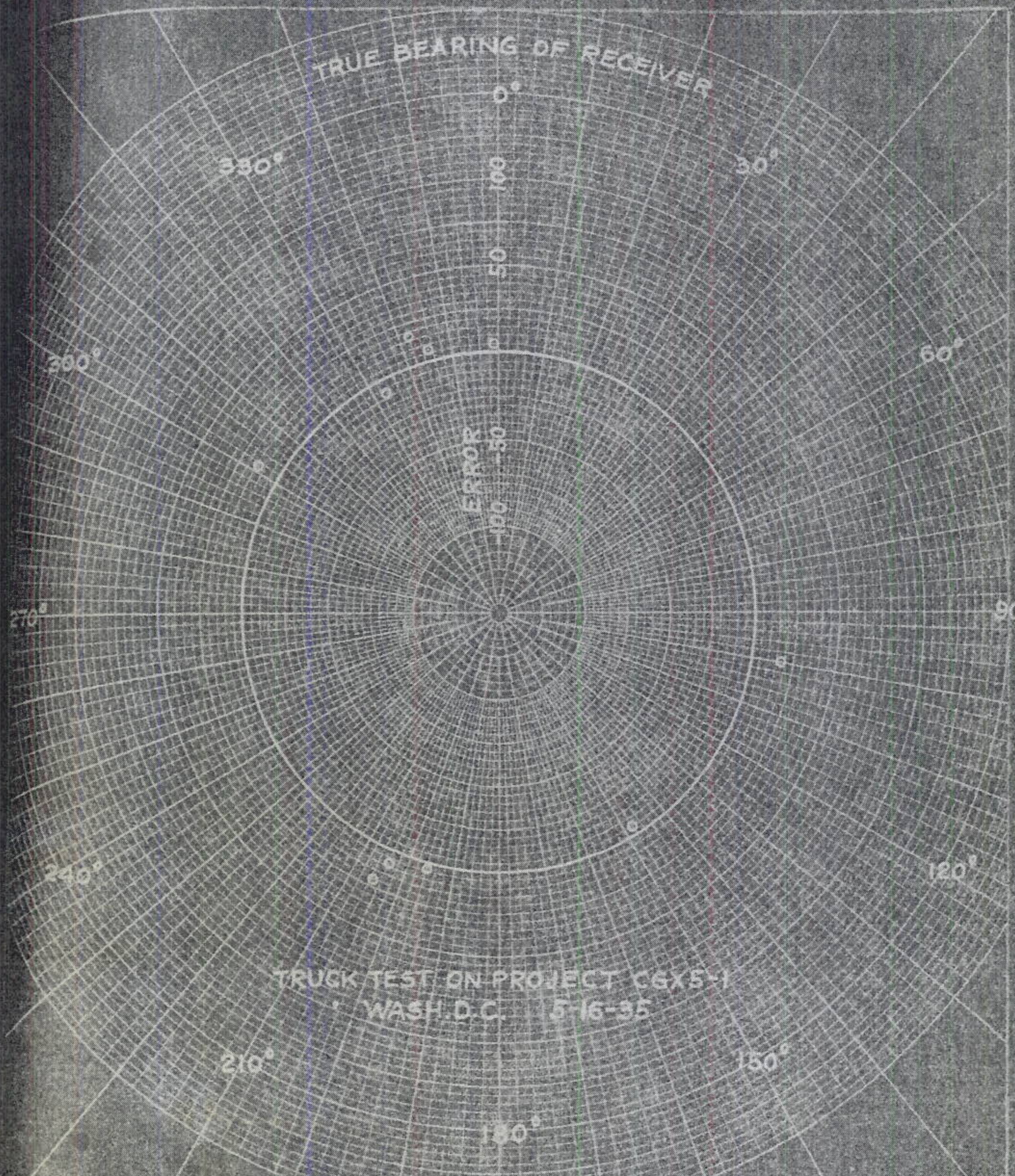
TABLE 2.

TRUCK TEST ON PROJECT C6X5-1.
WASHINGTON, D.C.

Point	True Bearing From Map	True Bearing From Transit	Distance	Scale Reading	Indicator Bearing	Error	Notes	Mean Error +9
1	148.5	148	1-5/8	29	145	-3		-12
2	100		2	23.5	117.5	+17.5	Out of Sight	+8.5
3	20		3-1/4	5.5	27.5	+7.5		-1.5
4	345		3-1/2	70.5	352.5	+7.5	" " "	-1.5
5	342.5	342.5	3-3/8	0	0	+17.5		+8.5
6	333	332	2	67	325	-8		-17
7	301	300.5	1-3/16	63	315	+14.5		+5.5
8	196		4-1/2	40	200	+4	" " " Weak trees	-5
9	204		3-1/2	42.5	212.5	+8.5	Partially clear	-.5
10	205.5		3-1/4	45.5	227.5	+22	Clear	+13

These points are plotted on Washington, D.C. Geological Survey Quadrangle (Mr. Young).

DECLASSIFIED



DECLASSIFIED

PLATE I