AD NUMBER
AD331390
CLASSIFICATION CHANGES
TO: unclassified
FROM: confidential
LIMITATION CHANGES
TO: Approved for public release, distribution unlimited
FROM: Controlling DoD Organization: Director, Naval Research Laboratory, Washington, DC 20375.
AUTHORITY
NRL/Code 5309 memo dtd. 20 Feb 1997; NRL/Code 5309 memo dtd. 20 Feb 1997

AD NUMBER
AD331390
CLASSIFICATION CHANGES
TO confidential
FROM secret
AUTHORITY
31 Jul 1974, per document marking, DoDD 5200.10

SECRET

NRL Report 58
Copy No. 87

MADRE EVALUATION VI

[UNCLASSIFIED TITLE]

J. M. Headrick, J. L. Ahearn, S. R. Curley,
F. H. Utley, W. C. Headrick, and M. E. Thorp

Radar Techniques Branch
Radar Division

July 27, 1962

SECRET

UNCLASSIFIED

NOX

U. S. NAVAL RESEARCH LABORATORY
Washington, D.C.

SECRET

DOWNGRADED AT 12-YEAR INTERVALS
NOT AUTOMATICALLY DECLASSIFIED
DOD DIR 5200.10

SECURITY

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Sections 793 and 794. The transmission or revelation of its contents in any manner to an unauthorized person is prohibited by law.

NRL Report 5825

MADRE EVALUATION VI

[UNCLASSIFIED TITLE]

MINUTEMAN SKIN AND EXHAUST BOUNDARY ECHOES

[SECRET TITLE]

J. M. Headrick, J. L. Ahearn, S. R. Curley,
F. H. Utley, W. C. Headrick, and M. E. Thorp

Radar Techniques Branch
Radar Division

July 27, 1962

U. S. NAVAL RESEARCH LABORATORY
Washington, D.C.

CONTENTS

ABSTRACT
[Secret]

The Madre Radar was used to observe one Minuteman launch over the horizon and another above the horizon. Evidence of a skin tracking was displayed. Exhaust boundary echo size estimates and doppler characteristics were obtained.

PROBLEM STATUS

This is an interim report on one phase of the problem; work is continuing on this and other phases.

AUTHORIZATION

NRL Problem R02-23
Project RF 001-02-41-4007
MIPR 30-635-8-160-6136
MIPR 60-2134
ARPA Order 160-61

Manuscript submitted April 1, 1962.

MADRE EVALUATION VI
[Unclassified Title]

MINUTEMAN SKIN AND EXHAUST BOUNDARY ECHOES
[Secret Title]

INTRODUCTION

The aims of the Madre project and a description of the equipment complex located at the NRL Chesapeake Bay Annex have been summarized in prior evaluation reports. In brief the Madre radar is an HF, coherent, MTI system using clutter rejection filters. Signal processing employs sampling, time compression, signal storage, and several forms of spectrum analysis.

In this report, the observations made on two Atlantic Missile Range launches will be disclosed and discussed. The tests were of Minuteman vehicles, numbers 0115 and 0113. The first was observed "over the horizon" using a frequency of 13.68 mc. The second was observed above the horizon using a frequency of 26.6 mc. The burn time exhaust boundary echoes in the two tests were striking in their similarity.

AMR TEST 0115

The Minuteman was launched at 10:23:52 EST (1523:52Z) on 8 March 1962. The radar radiated 3 MW peak, 80 KW average, on an azimuthal bearing of 185° and at a 90 pps rate. In an attempt to illuminate the missile trajectory down to zero altitude, a frequency, 13.68 mc, near the antenna's lower limit, was chosen. Considerable absorption prevailed at this frequency, such that backscatter was received for ranges from 760 to only 1240 naut mi. The high level backscatter occupied 800 to 1100 naut mi indicating illumination of the form sketched in Fig. 1. Thus the missile trajectory was viewed exclusively after ionospheric refraction and for altitudes between 60 and 170 km.

The receiver was time gated so that echoes coming from the range interval between 450 and 900 naut mi were processed. These signals were reduced to a zero frequency IF, sampled, and stored, such that the prior 20 seconds of information was continuously available on a time-compressed basis. The real time analysis was that of doppler frequency and intensity as a function of radar range. The display presented a range rate or doppler versus range plot on a cathode ray tube. Pictures of the displays during AMR Test 0115 are given in Figs. 2a and 2b. The vertical ordinate, as labeled on the left, gives the available doppler running from 0 to 45 cps. The horizontal ordinate, as labeled across the top, gives range running from 450 to 900 naut mi. Both of these scales are only approximate; calibrated strobes are available for precise measurements. The time after T_0 is given in the form of hours, minutes, and seconds on the counter located at the bottom of each display picture. The high amplitude exhaust boundary reflections are easily seen from T+2 minutes 14 seconds through T+2 minutes 54 seconds. The coordinates are 680, 5 through 680, 45, and the returns are typical of the exhaust boundary, being very discrete in range and having doppler components that fill the 45 cps available. Various meteor trail returns can be seen at distances from 475 to 650 naut mi and at low dopplers; some have high enough amplitude to exceed the processing system's linear range and harmonics start to show. Some other pulsed system was on the Madre frequency at a near synchronous repetitive rate and can be seen in the first picture, T+0, as a triple pair

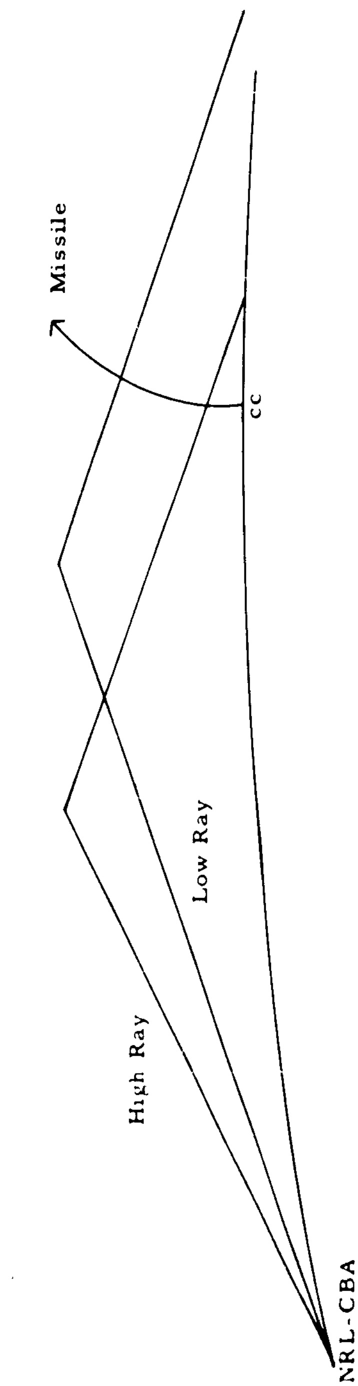

Fig. 1 - The high and low limiting ray paths by which backscatter was received

of targets located at coordinates 800, 34; 800, 23; and 800, 13. These pulses slowly decrease in range and manage to coincide with the first missile returns in the picture of T+2 minutes 13 seconds. For this test the data processing was operated to optimize sensitivity. Skin echoes or any doppler information that might be present in the exhaust reflections were lost due to the high amplitude of the exhaust echoes. However, a very approximate determination of the exhaust radar cross section can be made. A calibration signal is present in the pictured displays at coordinates 580, 40 and its amplitude was 1μv peak to peak at the receiver input terminals. If the simple radar range equation is is applied to a signal of this size at the missile's distance,

$$\sigma_c = \frac{Pr(4\pi)^3 R^4}{Pt\ G^2\lambda^2} \text{ or}$$

$$\sigma_c = \frac{(2.5 \times 10^{-15})}{3 \times 10^6} \frac{(4\pi)^3 (1200)^4}{(12.6)^2 (21.9)^2} = 45 \text{ m}^2.$$

The display resolution bandwidth is 1/3 cps, and if it is considered that the received power from the missile exhaust is spread uniformly over the 45 cps available doppler and it is estimated that the signal level in each 1/3 cps is 3 db greater than the calibration signal, the exhaust radar cross section

$$\sigma = 2\left(\frac{45}{1/3}\right)\sigma_c \text{ or}$$

$$\sigma \doteq 1.2 \times 10^4 \text{ m}^2.$$

This is very approximate and probably lower than the actual size since path losses were ignored.

In order to obtain a more detailed intensity and velocity history, a spectrum analysis versus time was performed on the clutter filtered zero frequency IF which had been magnetic tape recorded. This analysis is given in Figs. 3a and 3b. Here the analysis filter (about 3 cps bandwidth) has scanned from 10 to 90 cps and therefore the available 45 cps doppler is seen both above zero and subtracted from 90 cps in a mirror image form. The missile returns are apparent from T+119 seconds through T+172 seconds, and these two times coincide with third stage ignition (82 KM) and thrust termination (143 KM). Above 90 cps on the chart, the expected doppler frequency of the third stage viewed after reflection from a 265 KM ionosphere and computed from post-flight data is plotted. The exhaust boundary returns do have a recognizable intensification near the expected doppler. Along the edge of the diffuse exhaust returns and somewhat obscured by them, a hard discrete velocity line can be seen from T+129 to T+132. This line is considered to be a brief skin track. A close scrutiny of times between T+150 and T+160 shows another discrete line, almost submerged in the diffuse exhaust reflections; this velocity line has a different time rate from that of the third stage and is probably skin reflection from the ballistic second stage. It was very disappointing that definite missile returns were not demonstrated prior to T+119; however, at least three factors worked against earlier detection. These factors were: just prior to T+119 the missile was in a velocity null of the radar; the previously mentioned interfering signals coincided with the missile range thereby degrading sensitivity; the missile in the early launch phase was in an antenna pattern null.

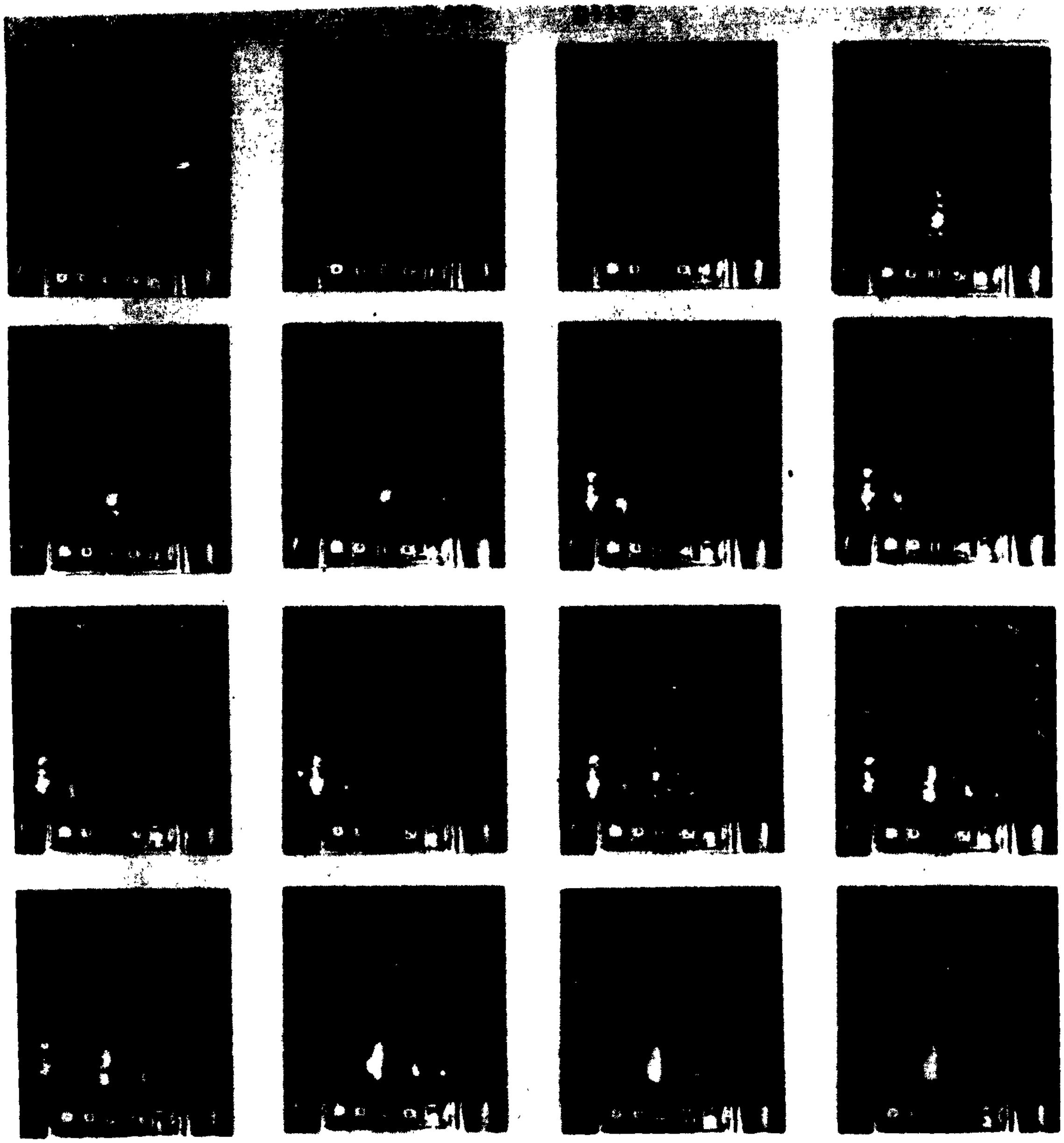

Fig. 2a - Test 0115 doppler versus range display. Range in nautical miles is given across the top. Doppler in cycles per second is indicated on the left ordinate. The counter at the bottom gives time after launch in hours, minutes, and seconds.

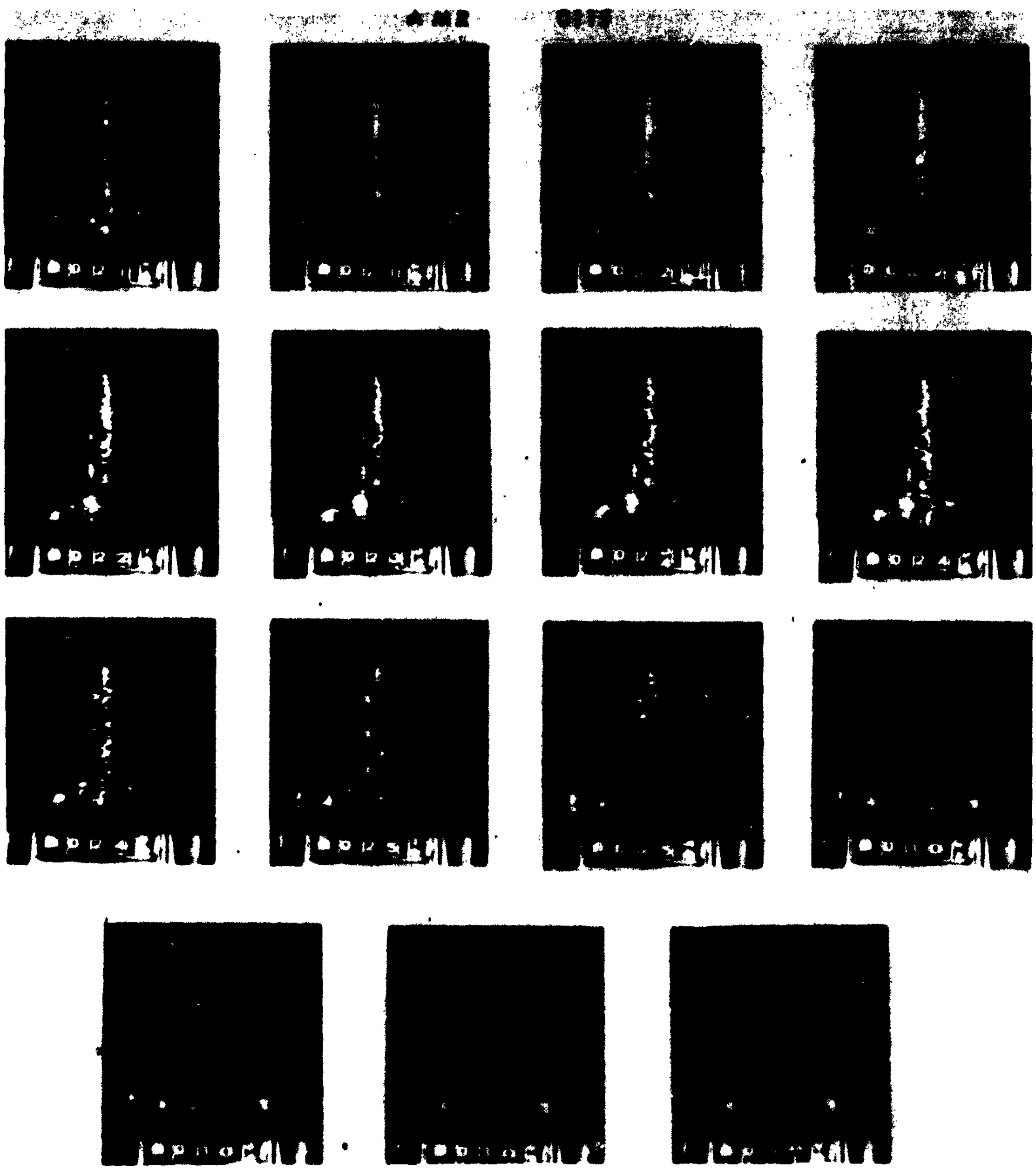

Fig. 2b - Test 0115 doppler versus range display. Range in nautical miles is given across the top. Doppler in cycles per second is indicated on the left ordinate. The counter at the bottom gives time after launch in hours, minutes, and seconds.

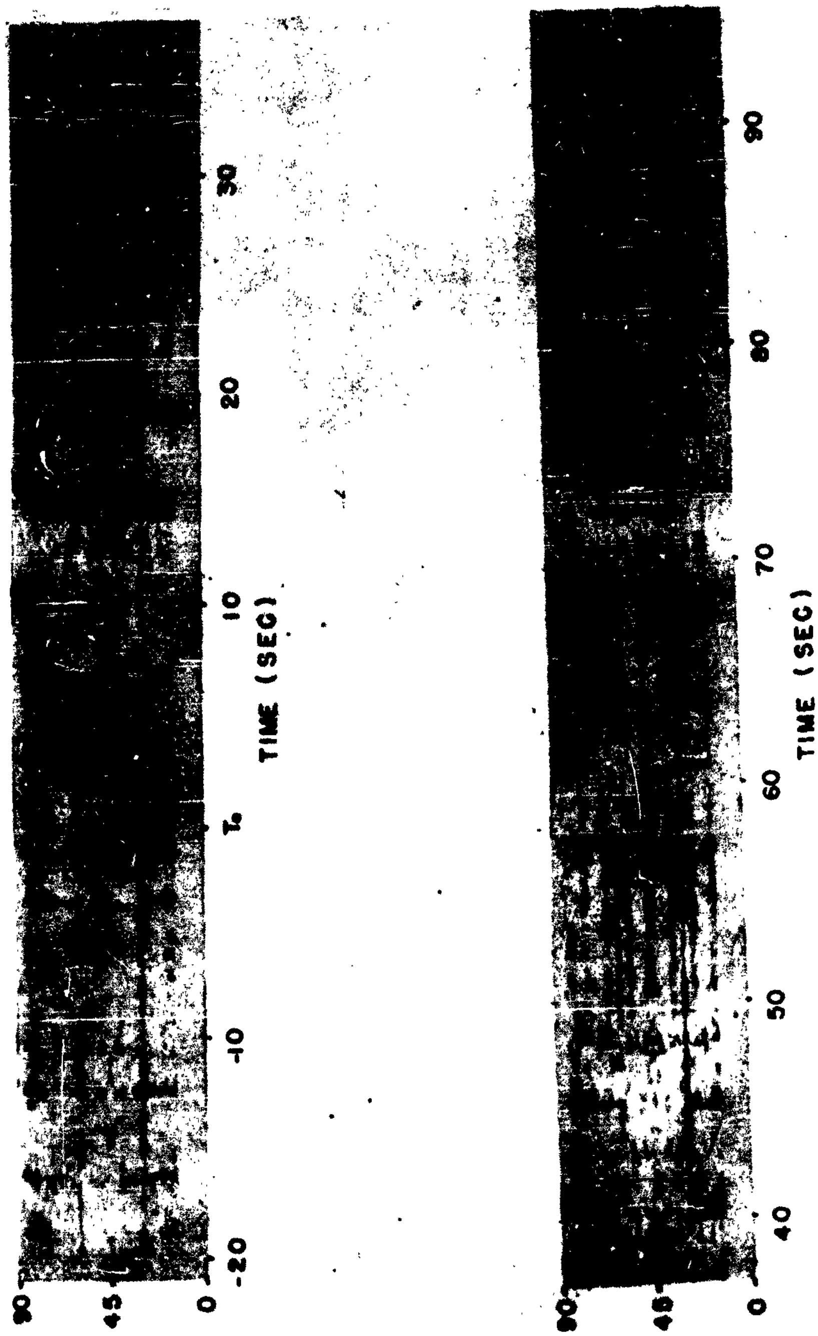

Fig. 3a - Test 0115 doppler intensity versus time spectrogram of the range gated zero frequency IF

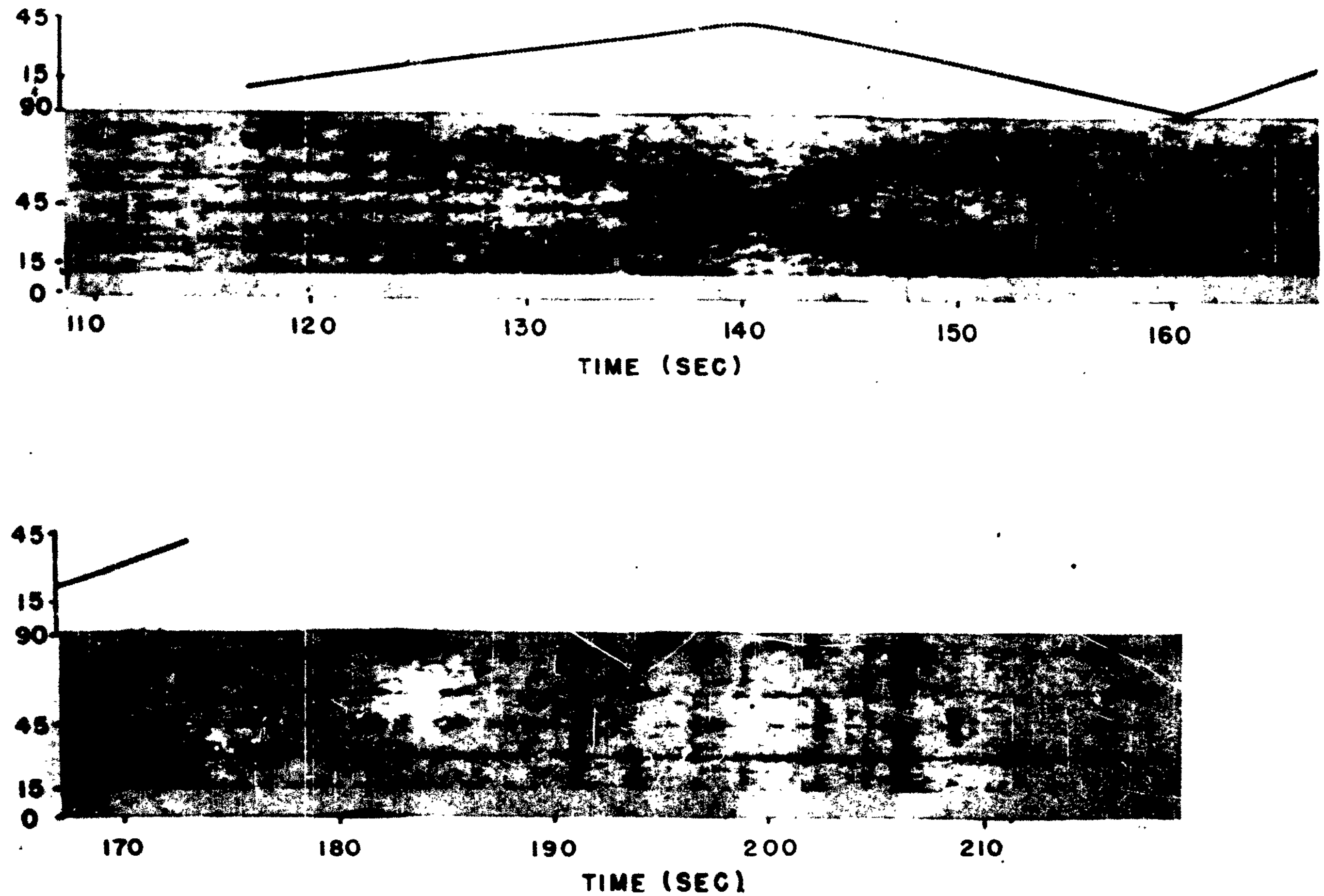

Fig. 3b - Continuation of Test 0115 doppler intensity versus time spectrogram. The expected doppler as computed from post flight data is plotted above the spectrogram.

AMR TEST 0113

This Minuteman was launched at 8:30:02 p.m. EST (0130:02Z) on 22 March 1962. The radar radiated 4.5 MW peak, 100 KW average, on an azimuth of 185° and at a 90 pps rate. Since the lower frequency (13.5 mc) limit of the antenna would not allow illumination of the early missile track for the prevailing ionosphere, the radar was operated at 26.6 mc for direct look observations. No earth's back-scatter was detected at this frequency. Real time analysis and display were as described for the previous test (0115). Figures 4a and 4b are pictures of this display where times and ordinates are as described before; that is, time in the form of hours, minutes, and seconds is given below each picture; radar range from 450 to 900 naut mi runs across the top, and the left vertical ordinate gives the available 45 cps of doppler. The system sensitivity can be roughly estimated from the calibration signal at coordinates 750, 5 which was one microvolt peak to peak at the receiver input. The exhaust boundary echoes at about 680 naut mi range and filling the 45 cps available doppler can be easily noted in the interval between T+2 minutes, 11 seconds and T+2 minutes, 59 seconds. With this form of analysis and display the exhaust boundary reflections for the two missiles are quite similar in character.

The echoing cross section can be estimated as on the previous test. The one microvolt peak to peak calibration signal corresponds to an area at the missile range,

$$\sigma_c = \frac{Pr(4\pi)^3 R^4}{Pt\ G^2 \lambda^2}$$

$$\sigma_c = \frac{(2.5 \times 10^{-15})}{(4.5 \times 10^6)} \frac{(4\pi)^3 (1200)^4}{(25.5)^2 (11.26)^2}$$

$$\sigma_c = 27 \text{ m}^2$$

Since the calibration signal is in the edge of a velocity null it is estimated that the exhaust returns in each 1/3 cps resolution bandwidth are 3 db below the level of the calibration signal. The exhaust cross section is:

$$\sigma = 1/2 \left(\frac{45}{1/3}\right) \sigma_c$$

$$\sigma = 1/2\ (135)\ (27)$$

$$\sigma \doteq 1.8 \times 10^3 \text{ m}^2.$$

A cross section obtained thus must be considered very approximate. This value is less than an order of magnitude smaller than that of Test 0115; however, the frequency is doubled and the ambient ionization is decreased by at least one half.

Again a detailed spectrum versus time analysis was made and is displayed in Figs. 5a, 5b, 5c, and 5d. The exhaust boundary echoes start at T+119, third stage ignition (118 KM) and persist until T+164, presumably thrust termination (195 KM). Above the spectrogram the third stage (under thrust) expected doppler is plotted as a solid line and the second stage (ballistic) doppler as a dotted line. The exhaust boundary echoes fill the available 45 cps doppler and during the last part of third stage burn a discrete velocity line appropriate for the third stage is readily seen. This is undoubtedly skin reflection both reinforced by some exhaust components and somewhat submerged in the doppler diffuse exhaust returns. After T+165 and until T+380 an intermittent velocity line from the ballistic second stage is seen. Agreement with the computed doppler (admittedly not precise since SECO position was estimated) is good.

DISCUSSION

The lack of a lower frequency antenna has prevented Madre demonstration of a missile skin track from the ground up. However, experience in over the horizon tracking of aircraft indicates the feasibility of such skin tracking. It is felt that the fragmentary indications of over-the-horizon skin echoes for Test 0115 and the good above-the-horizon skin reflections for Test 0113 confirm the feasibility.

The rather large exhaust boundary reflections, which are wonderful for missile identification, tend to overwhelm skin returns; however, applicable approximated doppler information may be extracted from the exhaust echoes.

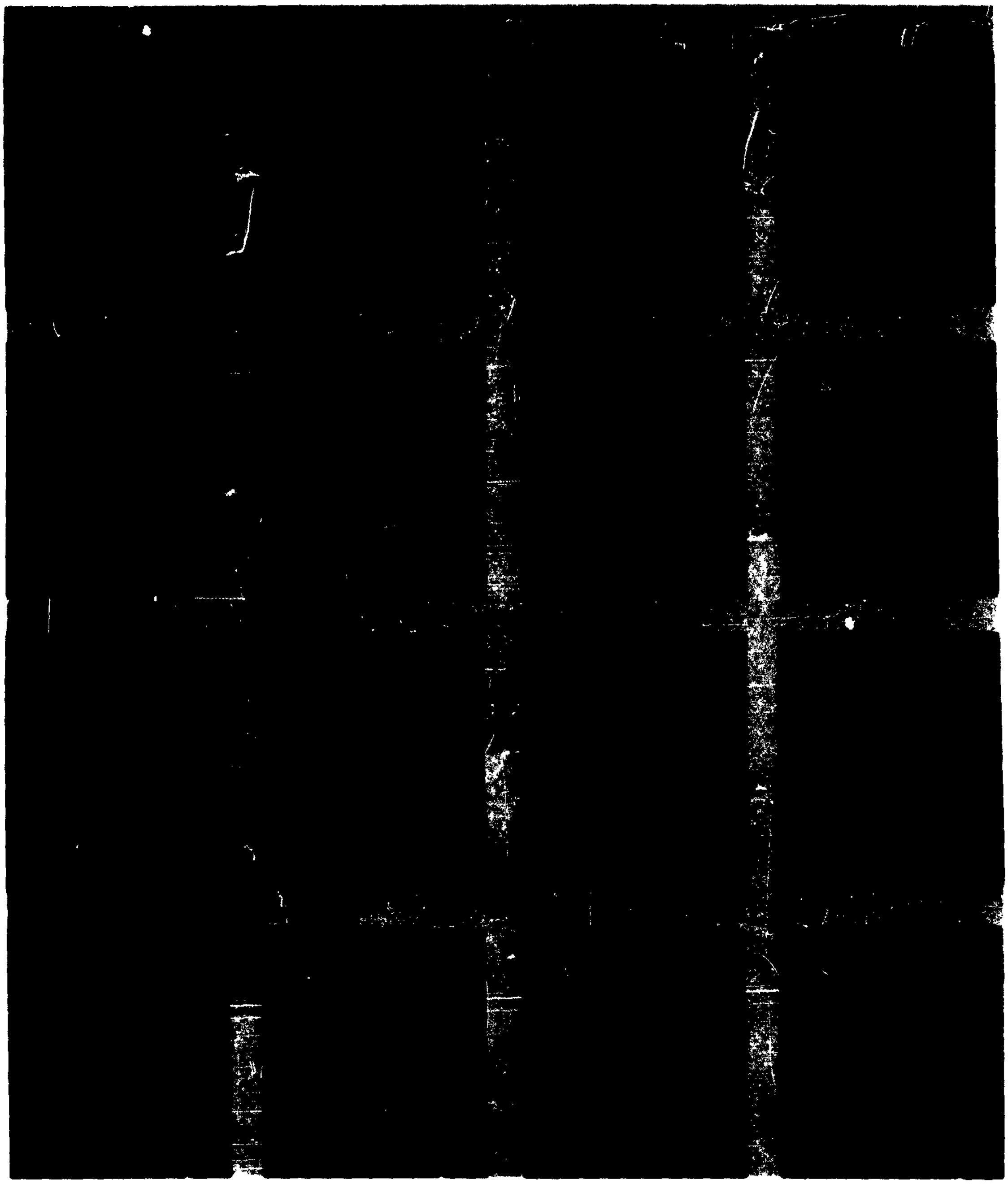

Fig. 4a - Test 0113 doppler versus range display. Range in nautical miles is given across the top. Doppler in cycles per second in indicated on the left ordinate. The counter at the bottom gives time after launch in hours, minutes, and seconds.

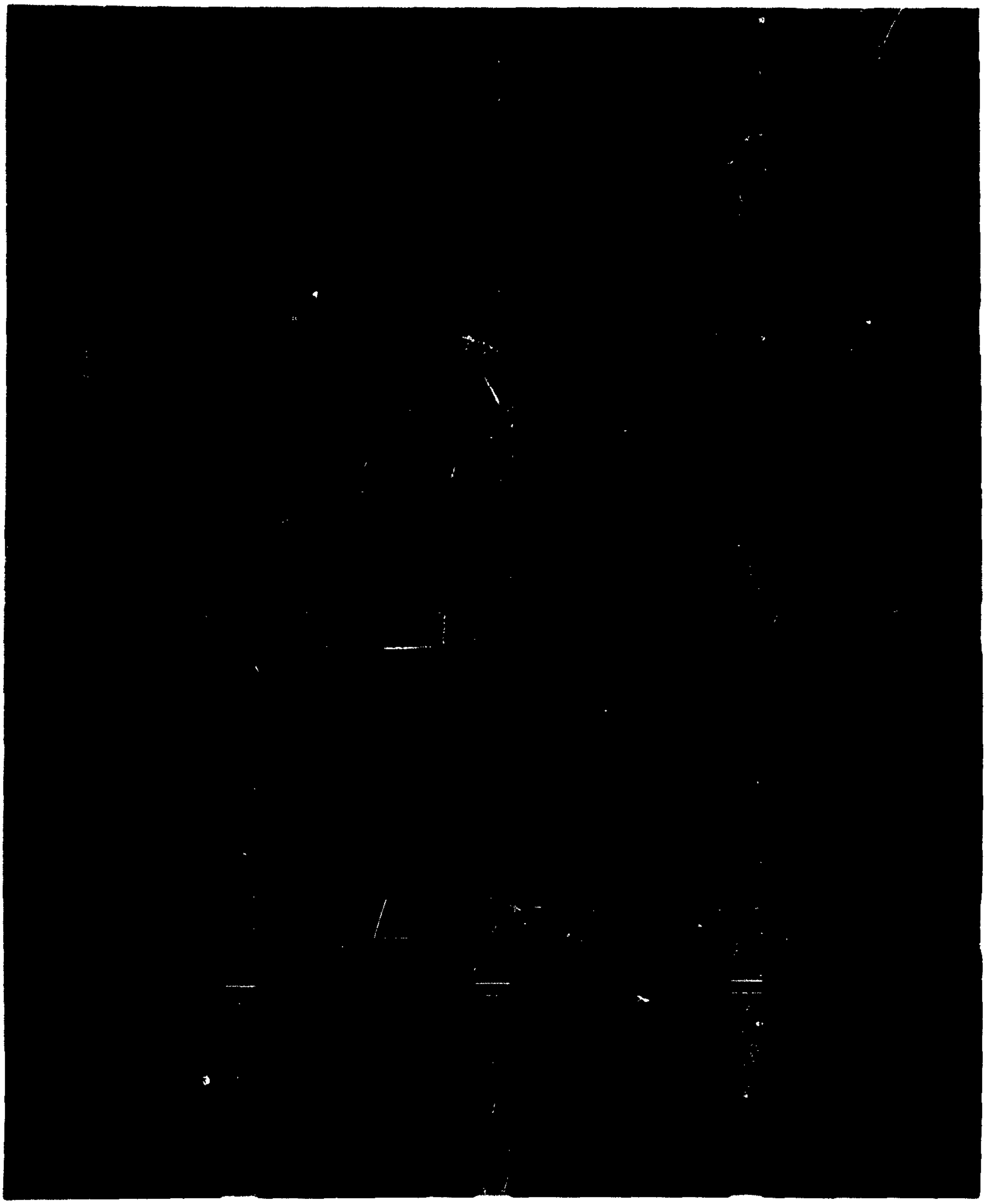

Fig. 4b - Test 0113 doppler versus range display. Range in nautical miles is given across the top. Doppler in cycles per second is indicated on the left ordinate. The counter at the bottom gives time after launch in hours, minutes, and seconds.

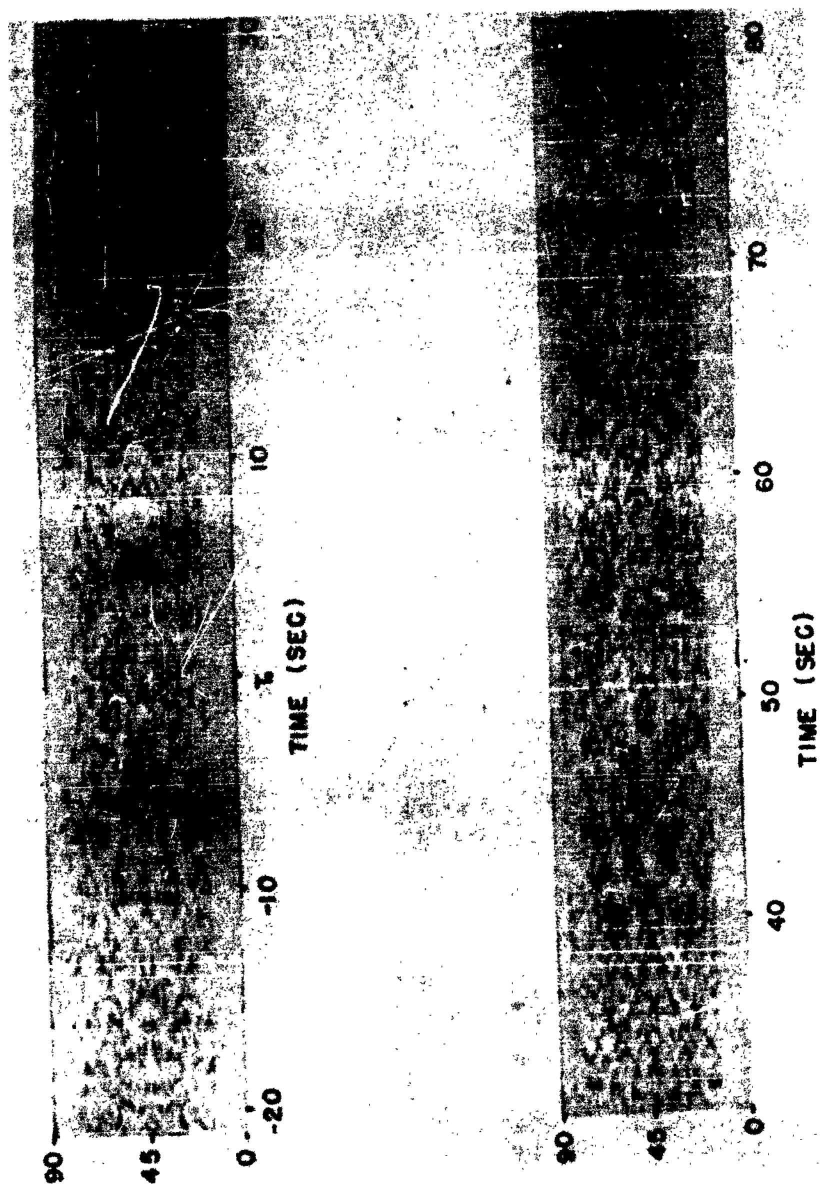

Fig. 5a - Test 0113 doppler intensity versus time spectrogram of the range gated zero frequency IF. Time after launch is along the horizontal and doppler is given on the vertical in cycles per second.

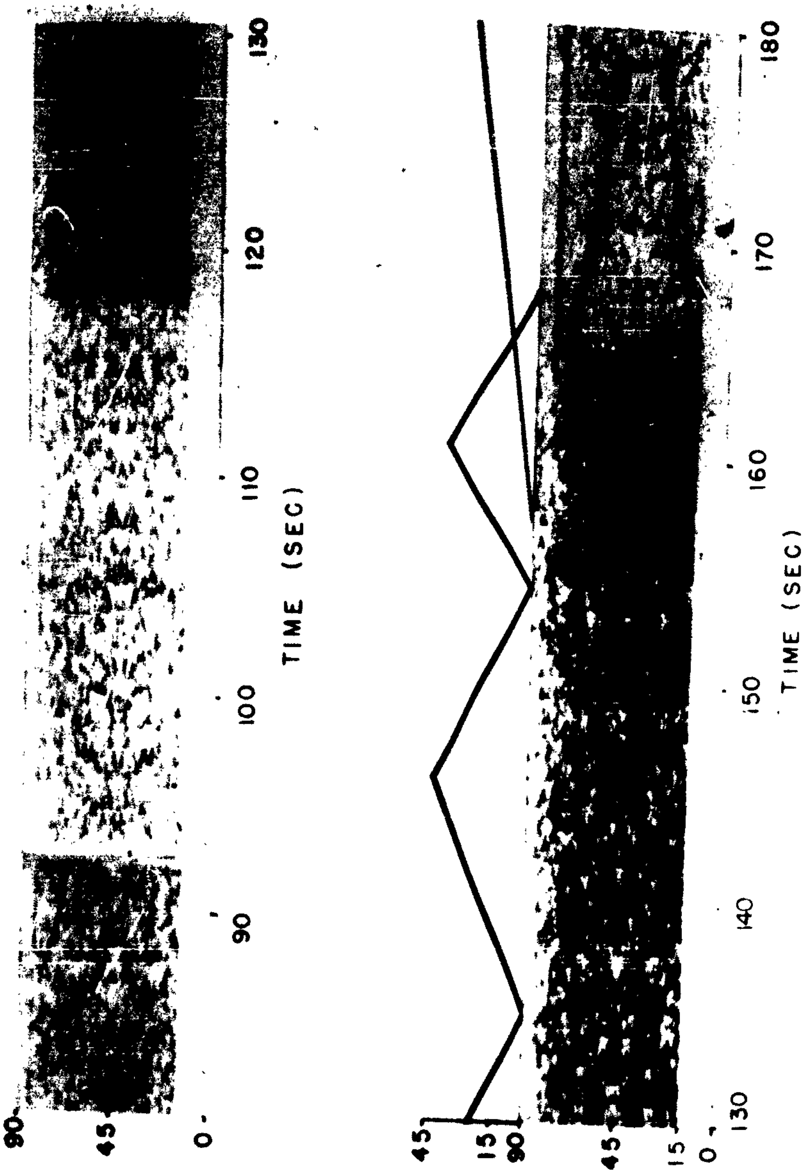

Fig. 5b - Test 0113 doppler intensity versus time spectrogram continuation of Fig. 5a. The powered third stage expected doppler is plotted above the spectrogram as a solid line. The spent second stage expected doppler is plotted as a dotted line.

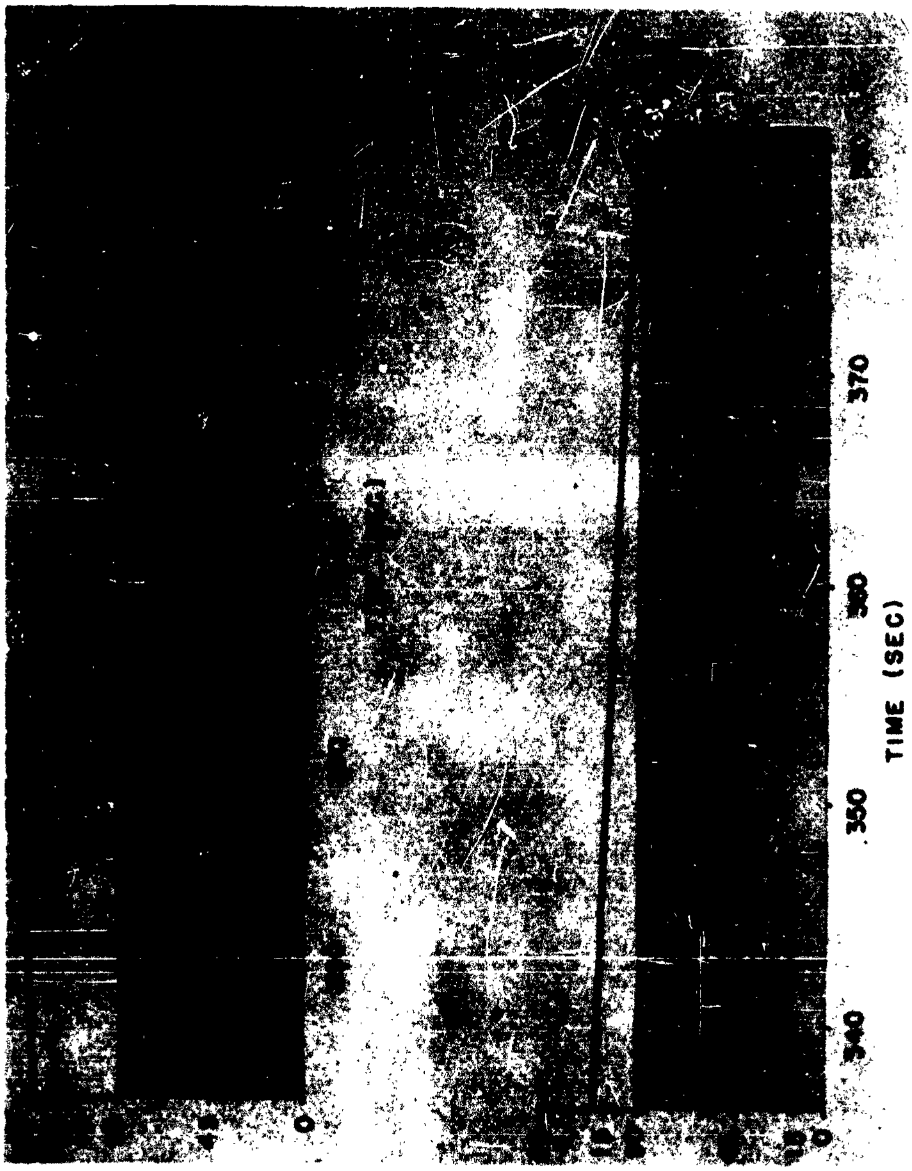

Fig. 5c - Test 0113 continuation of Fig. 5b

Fig. 5d - Test 0113 continuation of Fig. 5c

DISTRUBUTION

	Copy No.
Dir., Advanced Research Projects Agency, Wash. 25, D.C.	1-4
Dir., Weapons System & Evaluation Group, Rm. 1E880 The Pentagon, Wash. 25, D.C. Attn: Mrs. Sjogven	5-6
NBS, US Dept. of Commerce, Wash. 25, D.C. Attn: Mr. L. E. Tveten	7
Dir., National Security Agency, Wash. 25, D.C.	8
CO, USNOTUnit, Patrick AFB, Florida Attn: CDR A. L. Jacobson	9
Dir., USNEL, San Diego 52, Calif.	10
Chief of Naval Research, Dept. of the Navy, Wash. 25, D.C.	
Attn: Code 427	11
463	12
418	13
Chief of Naval Operations, Dept. of the Navy, Wash. 25, D.C.	
Attn: OP-92	14-17
OP-30	18
OP-70	19
OP-71	20
OP-07T	21
OP-03EG	22
Chief. BuShips, Dept. of the Navy, Wash. 25, D.C.	23
Dir., Special Projects Div., Dept. of the Navy, Wash. 25, D.C.	24
Director of Defense (R&E), Dept. of Defense, Wash. 25, D.C. Attn: Air Defense	25-26
CO, USNATC, Patuxent River NAS, Patuxent River, Md. Attn: Mr. D. Decker	27
CO, USNOL, Corona, Calif. Attn: Mr. V. Hildebrand	28
CDR, Naval Missile Center, Point Mugu, Calif. Attn: Technical Library, Code N03022	29-30
CO, US Army Signal Radio Propagation Agency, Ft. Monmouth, N.J. Attn: SIGRP-A	31
CDR, Army Rocket & Guided Missile Agency, Huntsville, Alabama	32

DISTRIBUTION (Cont'd)

	Copy No.
CO, Picatinny Arsenal, Technical Research Section AAWL Dover, New Jersey Attn: Dr. Davis	33
Office, Director of Defense (R&E), Office of Electronics Rm. 301033, The Pentagon Attn: Mr. J. J. Donovan	34
CO, US Army Signal Electronic Research Unit, P.O. Box 205 Mountain View, Calif.	35
Office, Chief of Ordnance, Dept. of the Army, Wash. 25, D.C. Attn: ORDTX - Dr. C. M. Hudson	36
Hdqs., USAF, Office Asst. Chief of Staff, Wash. 25, D.C. Attn: MAJ A. T. Miller	37
Hdqs., AFCRLabs, Hanscom Field, Bedford, Mass. Attn: CRRK, Dr. Philip Newman	38
CRRI, Mr. William F. Ring	39
CDR, RADC, Griffiss AFB, New York Attn: RALTT, Mr. F. Bradley	40
RCLTS, Mr. T. Maggio	41
CDR, Air Technical Intelligence Center, USAF, Wright-Patterson AFB, Ohio Attn: Dr. P. J. Overbo	42
Mr. Goff	43
Hdqs., USAF, Dept. of the Air Force, Office for Atomic Energy DCS/O, Washington 25, D.C.	44
Hdqs., USAF, Washington 25, D.C. Attn: AFDRD-GW	45
CDR, Air Force Office of Scientific Research, Wash. 25, D.C. Attn: Code SRY	46
Hdqs., Offutt AFB, Nebraska Attn: Strategic Air Command	47
CDR, Air Force Ballistic Missile Div., Air Force Unit Post Office Los Angeles 45, Calif.	48
Hdqs., North American Air Defense Command, Ent AFB Colorado Springs, Colo. Attn: NELC (Advanced Projects Group)	49
Dir. of Communications and Electronics, Ent AFB Colorado Springs, Colo. Attn: ADOAC-DL, ADC	50

DISTRIBUTION (Cont'd)

	Copy No.
Electro-Physics Labs., ACF Electronics Div., 3355 - 52nd Ave. Hyattsville, Md. Attn: Mr. W. T. Whelan	51
Stanford Electronics Lab., Stanford Univ., Stanford, Calif. Attn: Dr. O. G. Villard	52
Raytheon Mfg. Co., Wayland Laboratory, Waltham, Mass. Attn: Mr. D. A. Hedlund	53
General Electric Co., Court St., Syracuse, N.Y. Attn: Dr. G. H. Millman	54
Lockheed Aircraft Corp., Calif. Div., Burbank, Calif. Attn: Mr. R. A. Bailey	55
Pilotless Aircraft Div., Boeing Airplane Co., Seattle 24, Wash. Attn: Mr. F. S. Holman	56
The Martin Co., Baltimore 3, Md. Attn: Dr. D. M. Sukhia	57
Radio Corp. of America, Aerospace Comm. and Controls Div. Burlington, Mass. Attn: Mr. J. Robinovitz	58
MIT, Lincoln Labs., Box 73, Lexington 73, Mass. Attn: Dr. J. H. Chisholm (Radio Prop. Group)	59
Mr. Melvin Stone	60
The Pennsylvania State Univ., University Park, Penna. Attn: Mr. H. D. Rix	61
The Rand Corp., 1700 Main St., Santa Monica, Calif. Attn: Dr. Cullen Crain	62
Bendix Systems Div., The Bendix Corp., 3300 Plymouth Road Ann Arbor, Mich. Attn: Mr. C. M. Shaar (Assoc. Dir. of Engineering)	63
Smyth Research Associates, 3555 Aero Court, San Diego 11, Calif. Attn: Mr. Steven Weisbrod	64
Convair Div. of General Dynamics, 3165 Pacific Coast Highway San Diego 12, Calif. Attn: Dr. Bond	65
Stanford Research Institute, Menlo Park, Calif. Attn: Mr. L. T. Dolphin, Jr.	66-67

DISTRIBUTION (Cont'd)

	Copy No.
Thompson Ramo-Wooldridge, Inc., Box 90534 Airport Station Los Angeles, Calif. Attn: Technical Information Services	68
APL/JHU, 8621 Georgia Ave., Silver Spring, Md. Attn: Mr. G. L. Seielstad (NavOrd 7386)	69
Chief, Army Security Agency, Arlington Hall Station Arlington 12, Va.	70
CDR, Air Force Systems Command, USAF, ASD, Wright-Patterson Air Force Base, Ohio Attn: ASNDCE, Mr. W. A. Dynes	71
Airborne Instruments Laboratory, Melville, Long Island, New York Attn: ESRDT, MAJ Henry Jones	72
Analytic Services, Inc., 5202 Leesburg Pike, Alexandria, Va. Attn: Mr. Ray Timm	73
CDR, Ent AFB, Colorado Attn: LtCol M. R. Gripe, Hqs. NORAD, NPSD-R	74
Hdqs., USAF, Washington 25, D.C. Attn: LtCol R. M. Cosel AFDRT	75
Dir., National Security Agency, Fort George G. Meade, Md. Attn: C-3141	76
Westinghouse Electric Corp., Defense Center-Baltimore, Technical Information Center, P.O. Box 1693, Baltimore, Md.	77
Institute of Science & Technology, The Univ. of Michigan, P.O. Box 618, Ann Arbor, Mich. Attn: BAMIRAC-ad	78
Systems Branch, US Army Scientific Liaison & Advisory Group P.O. Box 7157 Apex Station, Wash. 4, D.C. Attn: Mr. Richard A. Krueger	79
Aero Geo Astro Corp., P.O. Box 1082, Edsall & Lincolnia Roads Alexandria, Va.	80
Director, DASA Data Center, P.O Drawer QQ, Santa Barbara, Calif.	81
ASTIA, Arlington, Va. Attn: TIPDR	82-91

SECRET

Naval Research Laboratory. Report 5825 [SECRET]. MADRE EVALUATION VI [Unclassified Title], by J. M. Headrick, J. L. Ahearn, S. R. Curley, F. H. Utley, W. C. Headrick, and M. E. Thorp. 19 pp. and figs., July 27, 1962.

The Madre Radar was used to observe one Minuteman launch over the horizon and another above the horizon. Evidence of a skin tracking was displayed. Exhaust boundary echo size estimates and doppler characteristics were obtained. [Secret Abstract]

1. Ballistic missiles - Launching - Radar analysis

I. Madre
II. Minuteman
III. Headrick, J. M.
IV. Ahearn, J. L.
V. Curley, S. R.
VI. Utley, F. H.
VII. Headrick, W. C.
VIII. Thorp, M. E.

SECRET

SECRET

Naval Research Laboratory. Report 5825 [SECRET]. MADRE EVALUATION VI [Unclassified Title], by J. M. Headrick, J. L. Ahearn, S. R. Curley, F. H. Utley, W. C. Headrick, and M. E. Thorp. 19 pp. and figs., July 27, 1962.

The Madre Radar was used to observe one Minuteman launch over the horizon and another above the horizon. Evidence of a skin tracking was displayed. Exhaust boundary echo size estimates and doppler characteristics were obtained. [Secret Abstract]

1. Ballistic missiles - Launching - Radar analysis

I. Madre
II. Minuteman
III. Headrick, J. M.
IV. Ahearn, J. L.
V. Curley, S. R.
VI. Utley, F. H.
VII. Headrick, W. C.
VIII. Thorp, M. E.

SECRET

SECRET

Naval Research Laboratory. Report 5825 [SECRET]. MADRE EVALUATION VI [Unclassified Title], by J. M. Headrick, J. L. Ahearn, S. R. Curley, F. H. Utley, W. C. Headrick, and M. E. Thorp. 19 pp. and figs., July 27, 1962.

The Madre Radar was used to observe one Minuteman launch over the horizon and another above the horizon. Evidence of a skin tracking was displayed. Exhaust boundary echo size estimates and doppler characteristics were obtained. [Secret Abstract]

1. Ballistic missiles - Launching - Radar analysis

I. Madre
II. Minuteman
III. Headrick, J. M.
IV. Ahearn, J. L.
V. Curley, S. R.
VI. Utley, F. H.
VII. Headrick, W. C.
VIII. Thorp, M. E.

SECRET

SECRET

Naval Research Laboratory. Report 5825 [SECRET]. MADRE EVALUATION VI [Unclassified Title], by J. M. Headrick, J. L. Ahearn, S. R. Curley, F. H. Utley, W. C. Headrick, and M. E. Thorp. 19 pp. and figs., July 27, 1962.

The Madre Radar was used to observe one Minuteman launch over the horizon and another above the horizon. Evidence of a skin tracking was displayed. Exhaust boundary echo size estimates and doppler characteristics were obtained. [Secret Abstract]

1. Ballistic missiles - Launching - Radar analysis

I. Madre
II. Minuteman
III. Headrick, J. M.
IV. Ahearn, J. L.
V. Curley, S. R.
VI. Utley, F. H.
VII. Headrick, W. C.
VIII. Thorp, M. E.

SECRET

MEMORANDUM

20 February 1997

Subj: Document Declassification

Ref: (1) Code 5309 Memorandum of 29 Jan. 1997
(2) Distribution Statements for Technical Publications NRL/PU/5230-95-293

Encl: (a) Code 5309 Memorandum of 29 Jan. 1997
(b) List of old Code 5320 Reports
(c) List of old Code 5320 Memorandum Reports

1. In Enclosure (a) it was recommended that the following reports be declassified, four reports have been added to the original list:

Formal: 5589, 5811, 5824, 5825, 5849, 5862, 5875, 5881, 5903, 5962, 6015, 6079, 6148, 6198, 6272, 6371, 6476, 6479, 6485, 6507, 6508, 6568, 6590, 6611, 6731, 6866, 7044, 7051, 7059, 7350, 7428, 7500, 7638, 7655. Add 7684, 7692.

Memo: 1251, 1287, 1316, 1422, [redacted], 1500, 1527, 1537, 1540, 1567, 1637, 1647, 1727, 1758, 1787, 1789, 1790, 1811, 1817, 1823, 1885, 1939, 1981, 2135, 2624, 2701, 2645, 2721, 2722, 2723, 2766. Add 2265, 2715.

The recommended distribution statement for the these reports is: **Approved for public release; distribution is unlimited.**

2. The above reports are included in the listings of enclosures (b) and (c) and were selected because of familiarity with the contents. The rest of these documents very likely should receive the same treatment.

J. M. Headrick
Code 5309

Copy:
Code 1221 — CR OK 7/2/97
Code 5300
Code 5320
Code 5324