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TECHNICAL MEMORANDUM 762

REDSTONE

FLIGHT TEST EVALUATION REPORT OF REDSTONE MISSILE 2014 (U)

September 1960

ARMY MISSILE TEST CENTER

WHITE SANDS MISSILE RANGE GMD 8844-60C

New Mexico

[redacted]

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(CNFA) ABSTRACT (U)

(CNFA) REDSTONE MISSILE 80F4 WAS FIRED FROM WHITE SANDS MISSILE RANGE AT 1000 HOURS, 44 MINUTES, 7.795 SECONDS ON 15 MARCH 1960. ALL MISSILE SUBSYSTEMS AND COMPONENTS PERFORMED SATISFACTORILY AND IMPACT WAS WITHIN THE DESIRED CEP OF 500 METERS.

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SECTION 1

(U) INTRODUCTION (U)

(U) THIS REPORT IS THE NINTH OF A SERIES OF AFTC FLIGHT EVALUATIONS WHICH ARE INTENDED TO GIVE A LIMITED ANALYSIS OF EACH TEST.

(U) FLIGHT TESTS OF THE REDSTONE MISSILE AT WSMR ARE ENGINEERING-USER TYPE TESTS, IN WHICH AN ATTEMPT IS MADE TO COORDINATE ENGINEERING EVALUATION AND TACTICAL TRAINING REQUIREMENTS.

(U) AN ENGINEERING-USER TEST CANNOT BE CONSIDERED A NORMAL OPERATION FROM THE STANDPOINT OF SYSTEM RELIABILITY, INASMUCH AS THE SYSTEM IS SUBJECTED TO MODIFICATION AND TEST WHICH WOULD NOT BE PRESENT IN A TACTICAL OPERATION. ALSO, AN ENGINEERING EVALUATION IS LIMITED TO SOME DEGREE BY THE LACK OF CAREFULLY CONTROLLED CONDITIONS WHICH WOULD EXIST IN A PURE ENGINEERING TEST. HOWEVER, BY ANALYTICAL REASONING, IT IS USUALLY POSSIBLE TO OBTAIN A LIMITED EVALUATION OF BOTH SYSTEM PERFORMANCE AND THE WRITTEN AND UNWRITTEN PROCEDURES WHICH EXIST FOR THE TACTICAL SITUATIONS.

SECTION 2

(CNHA) MISSILE CHARACTERISTICS (U)

1. (U) MISSILE NUMBER: 2014

2. (U) LAUNCHED: 15 MARCH 1960, 1000 HOURS 44 MINUTES 7.795 SECONDS MST FROM WSMR.

3. (CNHA) PERTINENT COORDINATES:

LAUNCHER

GEODETIC LATITUDE	32.417702°
GEODETIC LATITUDE	106.320482°
ELEVATION	1,231.212 METERS

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4. (CNHA) RANGE:

LAUNCHER TO TARGET	142.243 KM	- 88.386 ST. MI.
		- 76.669 N. M.
LAUNCHER TO IMPACT	142.186 KM	- 88.351 ST. MI.
		- 76.639 N. M.

5. (CNHA) MISS-DISTANCE:

RIGHT	289.6 METERS
SHORT	54.8 METERS
RADIAL	294.7 METERS

6.(CNHA) PRESETTINGS:

G	-1375.60	X	80
S	93471.98	Y	768
F	-.01 168.125	Z	457
F	168.065	H	-.01 -.242
F	.01 168.205	H	-.071
I	321.097	H	±.01 ±.100
J	808.895	K	354.212443°
L	354	L	26°
M	351	N	10.54

7.(CNHA) SPECIAL MISSIONS:

FIRST FLIGHT TEST OF LINE TV CAPSULE

TRAINING ROUND FOR A BATTERY, 40TH FIELD ARTILLERY MISSILE GROUP.

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SECTION 5

(CNNA) TRAJECTORY DATA (U)

(CNNA) A SUMMARY OF DATA SUPPLIED BY DRD-S IS AS FOLLOWS:

(CNNA) FLIGHT PATH (U)

TYPE	DATA AVAILABLE	REDUCTION
DOVAP	.2 - 326.2	.2 - 326.2
ASKANIA		
BODY UNIT	2.2 - 314.6	2.2 - 314.6
THRUST UNIT	130.4 - 305.8	130.4 - 305.8
TDMH	.2 - 31.7	.2 - 31.7
FPS-16		
R-112	9.1 - 335.2	9.1 - 335.7
R-114	33.2 - 358.1	33.2 - 358.1

(CNNA) ATTITUDE (U)

IGOR AND TELESCOPE	.2 - 130.2	.2 - 130.2
TDMH	1.3 - 31.7	1.3 - 31.7

(CNNA) DOVAP DATA ARE CONSIDERED THE MOST RELIABLE AND HAVE BEEN USED FOR EVALUATION PURPOSES. THIRTY-ONE DOVAP RECEIVING STATIONS WERE IN OPERATION FOR THIS FLIGHT. THREE DOVAP TRANSMITTERS WERE USED WITH SWITCHOVER POINTS AT 155.8 SECONDS AND 265.6 SECONDS. MORE DETAILED INFORMATION ON DATA REDUCTION CAN BE FOUND IN REFERENCE 2.

[redacted] (CNNA) T+ ARE 1.1 SECONDS OF DOVAP DATA PUBLISHED IN "FINAL DATA REPORT ON SOME [redacted] ASKANIA AND DOVAP TRAJECTORY DATA FOR REDSTONE BOLVO 8 MISSILE NR CC 2014" ARE INCORRECT DATA AND SHOULD BE IGNORED.

[redacted]

EQUATION SOLUTION WAS GOOD. PRECALCULATED CUT-OFF TIME WAS 104.267 SECONDS. THE DIFFERENCE BETWEEN ACTUAL AND PRECALCULATED CUT-OFF TIMES CAN BE ATTRIBUTED TO THE FOLLOWING: MISSILE 2011 HAD A LIFT-OFF WEIGHT OF 62,273 POUNDS. THE LIFT-OFF WEIGHT USED IN THE PRECALCULATED TRAJECTORY WAS 61,737 POUNDS, OR 536 POUNDS LIGHTER THAN ACTUAL.

(CNHA) AT CUT-OFF RANGE DISPLACEMENT (ξ) WAS -1130 METERS AND RANGE VELOCITY ($\dot{\xi}$) WAS -5 METERS/SECONDS. ξ HAD DECREASED TO -500 METERS AT REENTRY. TERMINAL GUIDANCE REDUCED THIS ERROR TO -100 METERS AT IMPACT.

(CNHA) LATERAL VELOCITY ($\dot{\zeta}$) REMAINED WITHIN ± 8 METERS/SECONDS GOOD GUIDANCE SIGNAL LIMITS DURING POWERED FLIGHT. ZETA-DOT LEVELED OFF AFTER SEPARATION AND REMAINED AT ABOUT -1.6 METER/SECONDS UNTIL REENTRY. THIS CAUSED AN ERROR IN LATERAL DISPLACEMENT (ζ) OF ABOUT -230 METERS AT REENTRY. TERMINAL GUIDANCE REDUCED THIS ERROR TO 0 AT IMPACT. SURVEYED LATERAL MISS-DISTANCE WAS 207.6 METERS RIGHT. SINCE THE ζ DOT WAS AT ZERO THIS SEEMS TO INDICATE A LAYING ERROR OF ABOUT 7 MINUTES.

SECTION B

(CVHA) CONTROL SYSTEM (U)

(CNHA) THE MISSILE WAS WELL CONTROLLED THROUGHOUT FLIGHT.

(CNHA) THE IDEALIZED CONTROL EQUATIONS WERE USED TO MAKE QUALITATIVE COMPARISONS BETWEEN THE CONTROL FUNCTIONS AND THE RESPECTIVE VANE DEFLECTIONS. BIASES OF LESS THAN 1° WERE INDICATED IN SOME OF THE TELEMETERED VALUES. THERE WAS NO ATTEMPT TO ESTIMATE THESE BIASES BECAUSE OF THEIR SMALL MAGNITUDE RELATIVE TO ACCURACY CONSIDERATIONS.

(CNHA) DURING POWERED FLIGHT PITCH WAS NORMAL. AT LIFT-OFF A ROLL VELOCITY OF 9 DEGREES/SECOND OCCURRED. POSSIBLE CAUSE WAS A MALALINEMENT OF A JET VANE, HOWEVER, NO DOCUMENTATION EXISTS TO PROVE THIS CONJECTION. THE YAW ANGLE WAS CONSTANTLY NEGATIVE, REACHING A MAXIMUM OF 4.5 DEGREES. THIS WAS A RESULT OF A CONSTANT WIND FROM THE WEST WHICH REACHED MAXIMUM OF 93 METERS/SECOND. ATTITUDE ANGLES AT CUT-OFF WERE 0.15 DEGREE IN PITCH, -0.33 DEGREE IN YAW AND -0.66 DEGREE IN ROLL.

(CNHA) BETWEEN CUT-OFF AND SEPARATION OSCILLATIONS OF INCREASED AMPLITUDE WERE OBSERVED IN ALL THREE ATTITUDE ANGLES WITH A MAXIMUM OF -4.38° IN PITCH. THIS HAS BEEN OBSERVED IN ALL PREVIOUS FLIGHTS AND IS CONSIDERED NORMAL. OSCILLATIONS IMPARTED BY SEPARATION WERE DAMPED OUT BY 175 SECONDS.

(CNHA) DURING COAST PHASE THE ATTITUDE ANGLES WHICH DEVELOPED CORRESPOND TO TERMINAL GUIDANCE MANEUVERS AND DAMPING EFFECTS. MAX PITCH, YAW AND ROLL ANGLES DURING COAST PHASE WERE -5.96°, -4.44°, -1.43° RESPECTIVELY. MAXIMUM DEVIATIONS FROM 180 SECONDS TO IMPACT WERE 1.09 DEGREE PITCH, 1.05 DEGREES YAW AND 1.28 DEGREES ROLL.

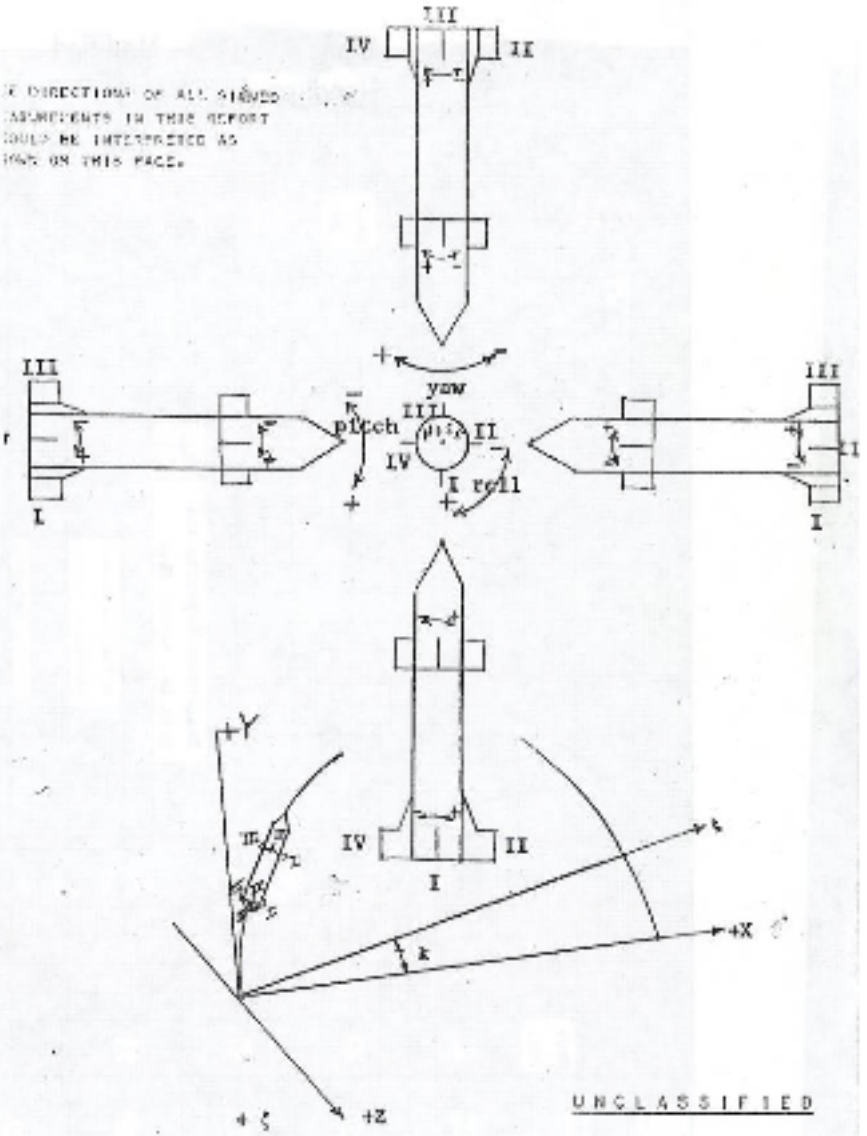

Fig. 5.7(U) Measurement Polarities.

(U) REFERENCES (U)

1. PRELIMINARY DATA REPORT NUMBER 2746, "REDSTONE ROUND 8 MISSILE NR CC 2014". (U), CONFIDENTIAL MODIFIED HANDLING AUTHORIZED, MSMR-IRM-DRD-S, 22 MARCH 1960.

2. "TRAJECTORY DATA FOR THE TEST FIRING OF REDSTONE MISSILE NR 2014 IF FIRED UNDER AN AIMING AZIMUTH OF 354.21243° FROM N" (U), SECRET, ABMA REPORT NR DA-TM-1-60, 6 JANUARY 1960.

3. FINAL DATA REPORT NR 9608, "TOMM, ASCENSION AND DOVAP TRAJECTORY DATA FOR REDSTONE ROUND 8 MISSILE NR CC 2014" (U), CONFIDENTIAL MODIFIED HANDLING AUTHORIZED, MSMR-IRM-DRD-S, 2 MAY 1960.

4. CORRECTION TO FINAL DATA REPORT 9608, "TOMM, ASCENSION AND DOVAP TRAJECTORY DATA FOR REDSTONE ROUND 8, MISSILE NR CC 2014" (U), CONFIDENTIAL MODIFIED HANDLING AUTHORIZED, MSMR-IRM-DRD-S, 26 MAY 1960.

5. FINAL DATA REPORT NR 9835, "ATTITUDE DATA FOR REDSTONE ROUND 8, MISSILE CC 2014" (U), CONFIDENTIAL MODIFIED HANDLING AUTHORIZED, MSMR-IRM-DRD-S, 6 MAY 1960.

6. DATA REDUCTION REPORT 3RD-N-1686, REDSTONE ROUND NR 8, MISSILE NR 2014, 3 VOLUMES, CONFIDENTIAL MODIFIED HANDLING AUTHORIZED, MSMR-IRM-DRD-N, 23 APRIL 1960.

7. "PREFLIGHT DATA (ZERO WEEK) REQUIRED FOR THE FINAL TRAJECTORY CALCULATION FOR MISSILE 2014" (U), SECRET, CHRYSLER CORPORATION MISSILE DIVISION, 3 DECEMBER 1960.

8. REDSTONE FIRING TEST REPORT FOR REDSTONE MISSILE 2014 (U), CONFIDENTIAL, TEST BULLETIN 895, MSMR-ON-STD, JUNE 1960.

TABLE I (Cont'd) [redacted]

(CNWA) MISSILE WEIGHTS (U)

WEIGHT	ACTUAL (Pounds)	PRECALCULATED (Pounds)	ACTUAL MINUS PRECALCULATED (Pounds)
H_2O_2 Remaining at CO	179	907	-58
LOX Remaining at TF	3,380	3,483	-103
ALC Remaining at TF	3,432	3,145	287
H_2O_2 Remaining at TF	170	805	-35
Body Unit after Separation	11,057	11,057	---
Average Mixture Ratio	1.451	1.376	.075
Burn Time (LO-TF)	104.815	104.267	.548

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TABLE I

[redacted]

(SM-A) MISSILE WEIGHTS (U)

WEIGHT	ACTUAL (Pounds)	PRECALCULATED (Pounds)	ACTUAL MINUS PRECALCULATED (Pounds)
LIFT-OFF WEIGHT (LO)	68,273	67,737	536
CUT-OFF WEIGHT (CO)	24,159	23,947	212
TERMINATION OF FLOW WEIGHT (TF)	24,019	23,846	173
LOX CONSUMED (LO-CO)	22,171	21,509	662
ALC CONSUMED (LO-CO)	15,282	15,632	-350
H_2O_2 CONSUMED (LO-CO)	637	625	12
TOTAL WEIGHT LOSS (LO-CO)	38,114	37,790	324
LOX CONSUMED (LO-TF)	22,430	21,585	845
ALC CONSUMED (LO-TF)	15,358	15,655	-297
H_2O_2 CONSUMED (LO-TF)	642	627	15
TOTAL WEIGHT LOSS (LO-TF)	36,954	37,891	363
LOX VENTED (POWERED FLIGHT)	22	22	---
N_2 USED (POWERED FLIGHT)	2	2	---
AVERAGE TOTAL PROPELLANT FLOW RATE (POUNDS/SECOND)	363.4	362.2	1.2
LOX FILLING WEIGHT	25,897	25,430	467
ALC FILLING WEIGHT	18,910	18,835	75
H_2O_2 FILLING WEIGHT	820	840	-20
LOX REMAINING AT CO	3,459	3,559	-100
ALC REMAINING AT CO	3,508	3,168	340

SECTION 9

(CNHA) PROPULSION SYSTEM (U)

(U) Graphs of propulsion system parameters are shown in Figures 9.1 and 9.2.

(CNHA) Missile 201A was equipped with an A-7 engine. The thrust controller was set at 315 psia. Telemetered combustion chamber pressure, as from an initial surge, leveled off at about 309 psia. However, the telemetered value of P_c before ignition was 6 psia. Atmospheric pressure at X-30 minutes was 12.75 psia. Telemetered P_c after thrust decay went to -6 psia. This suggests that the chamber pressure telemetry transducer had a constant bias of about 7 psia. Assuming this to be the case P_c was held constant at approximately 316 psia. This is within the accuracy of the thrust controller.

(CNHA) Average H_2O_2 flow rate was 6.1 pounds/second. Alcohol flow rate averaged 145.8 pounds/second. LOX flow rate was approximately 811.5 pounds/second.

SECTION 10

(CNHA) CONCLUSIONS (U)

(CNHA) The flight of Redstone Missile 201A was a success. All missile components performed satisfactorily and the missile impacted within the desired CPE.

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SECTION 6

(CMHA) MISSILE TRAJECTORY (U)

(U) Graphs of trajectory parameters are shown in Figures 6.0 through 6.7.

(CMHA) The actual trajectory was slightly behind, and higher than the precalculated flight path. This accounts for the late times of reentry and impact.

(CMHA) All times in this report are given with respect to missile lift. Event times are as follows:

	Actual	Precalculated
Cut-off	104.815	104.267
Separation	125.3	125.0
TV Capsule Ejection	246.32	246.0*
Camera Pod Ejection	281.14	281.0**
Reentry	301.56	301.31
Impact	326.2	324.54

(U) Impact was recorded optically by the Askania cinetheodolite located at G-140 at the time given above.

SECTION 7

(CMHA) GUIDANCE (U)

(U) Graphs of telemetered guidance parameters are shown in Figures 7.1 through 7.5a.

(CMHA) The guidance system on Missile 2014 operated satisfactorily. Cut-off was initiated by the cut-off computer at 104.815 seconds. The cut-off

* (CMHA) Nineteenth step on program tape.
** (CMHA) Twentieth step on program tape.

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(U) PREFLIGHT (U)

(U) REDSTONE MISSILE 2014 ARRIVED IN TACTICAL CONTAINERS V A A B AT HOLLOMAN AFB, N. M., ON 30 NOVEMBER 1960, AND WAS THEN GROUND TRANSPORTED TO THE MISSILE ASSEMBLY BUILDING AT WSMR. AFTER PRELIMINARY CHECKOUT THE MISSILE WAS USED BY "A" BATTERY 209TH ARTILLERY GROUP, "B" BATTERY 217TH FIELD ARTILLERY BATTALION, AND THE 630TH ORDNANCE COMPANY FOR TRAINING ON THE BLOCK II MISSILE SYSTEM. AFTER COMPLETION OF THIS A COMPLETE MISSILE AND MEASUREMENTS SYSTEMS CHECKOUT WAS PERFORMED BY WSMR PERSONNEL. MISSILE 2014 WAS THEN TURNED OVER TO THE 89TH ORDNANCE COMPANY FOR ORDNANCE PRE-ISSUE CHECK. ON 7 MARCH 1960 THE ORDNANCE COMPANY ISSUED THE MISSILE TO THE F RING BATTERY. MISSILE 2014 WAS FIRED ON 15 MARCH 1960.

(U) DETAILED INFORMATION ON CHECKOUT AND FIRING OPERATIONS CAN BE FOUND IN THE FIRING TEST REPORT (REFERENCE 8) AND NOTES TAKEN BY THE ARTILLERY BOARD AT FORT BLISS.

SECTION 4

(DNHA) TELEMETRY (U)

(U) MISSILE 2014 CARRIED A STANDARD TELEMETRY PACKAGE TRANSMITTING ON A FREQUENCY OF 226.7 MC WITH A BAND WIDTH OF 100 KC AND TWO WATTS POWER OUTPUT. THE INFORMATION TRANSMITTED CONSISTED OF 15 FM/FM CHANNELS AND TWO PAM/FM/FM CHANNELS EACH CONSISTING OF 27 INFORMATION SEGMENTS WITH A COMMUTATION RATE OF 10 FRAMES PER SECOND.

(DNHA) IN ADDITION MISSILE 2014 CARRIED A DORSETT TELEMETRY PACKAGE OPERATING ON A FREQUENCY OF 229.9 MC. THREE CHANNELS ON THE DORSETT PACKAGE WERE PARALLELED WITH COMMUTATED MEASUREMENTS ON THE REGULAR PACKAGE. THESE WERE PLATFORM PITCH POSITION (VIBUS PROGRAM (174), ANGULAR VELOCITY-PITCH (36), AND VOLTAGE SERVO BATTERY (D-8 BUS)(51A). NO INFLIGHT CALIBRATIONS WERE AVAILABLE FOR THESE THREE MEASUREMENTS. THE DORSETT PACKAGE RECEIVED ITS POWER FROM THE D-8 BUS, DUE TO VARIATIONS IN THE D-8 BUS VOLTAGE THE TRANSMITTED SIGNAL WAS NOISY.

(DNHA) ALL CHANNELS ON THE STANDARD PACKAGE OPERATED SATISFACTORILY. LOSS OF SIGNAL AT SOUTH RANGE STATIONS WAS AT 325 SECONDS. LOSS OF SIGNAL AT NORTH RANGE STATIONS OCCURRED AT 326.2 SECONDS.

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UTM Easting	[redacted] 375,840.57 meters
UTM Northing	3,587,314.25 meters

Target

φ	33°41' 32.718"
λ	106°29' 29.620"
H	1,471 meters
E	361,751 meters
N	3,728,858 meters

Warhead Impact

φ	33°41' 32.015"
λ	106°29' 18.198"
H	1,480 meters
E	358,048 meters
N	3,728,832 meters

Thrust Unit Impact (Main Piece)

φ	33°35' 51.388"
λ	106°26' 32.375"
H	1,582 meters
E	366,171 meters
N	3,718,280 meters

TV Capsule Impact

φ	33°36' 55.727"
λ	106°27' 31.436"
H	1,588 meters
E	364,677 meters
N	3,720,283 meters

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(U) CONTENTS (U)

REDSTONE

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FLIGHT TEST EVALUATION REPORT

OF REDSTONE MISSILE RU1 (U)

[redacted]

By: C. W. Peterson
J. L. Dase
W. A. Oelger

Technical Memorandum 762

September 1960

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Per CO&I, HQ, [redacted]

Date [redacted]

By [redacted]

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Redstone Project Manager

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Ordnance Mission
White Sands Missile Range
New Mexico

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