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BRL

TECHNICAL NOTE NO. 1175

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MODIFICATIONS OF 20MM T282 HE SHELL TO PERMIT A BALLISTIC MATCH OF THE M99 SHELL

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DEPARTMENT OF THE ARMY PROJECT NO. 5B03-03-001
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BALLISTIC RESEARCH LABORATORIES

ABERDEEN PROVING GROUND, MARYLAND

ERRATA

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SUBJECT: Modifications of 20-mm T282 HE Shell to Permit a Ballistic Match of the M99 Shell

AUTHOR: Eugene D. Boyer

1. Table of data, Page 7; change the TYPE Column to read:

   Special
   M99

   Mod. 4

   Mod. 2

   Mod. 1

   Mod. 3

   Round 3897 should read 4897.

2. Zero-yaw Drag Coefficient, page 9; The symbols should read:

   ● Special M99
   △ Mod. 4
   ○ Mod. 2
   □ Mod. 1
   ▲ Mod. 3

3. Change Reference 1 to Reference 2.

B A L L I S T I C   R E S E A R C H   L A B O R A T O R I E S

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(10) Eugene D. Boyer

(16) DA

Department of the Army Project [redacted] 5B03-03-001,
Ordnance Research and Development [redacted] TB3-0108

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050 750

B A L L I S T I C   R E S E A R C H   L A B O R A T O R I E S

TECHNICAL NOTE NO. 1175

EDBoyer/anw
Aberdeen Proving Ground, Md.
February 1958

MODIFICATIONS OF 20MM T282 HE SHELL TO PERMIT A BALLISTIC MATCH OF THE M99 SHELL

ABSTRACT

Results of tests of alterations which will permit the use of a 20mm T282 HE shell body in the manufacture of a M99 practice shell are presented.

The Ordnance Ammunition Command of Joliet, Illinois has large stock piles of 20 mm T282 shell bodies which can not withstand the high pressures and velocities required for the normal HE round. It is therefore desirable, if practical, to salvage these bodies by using them in another round with lower pressure and velocity limits. The most obvious use is to attempt to use these bodies in the manufacture of practice rounds. The current choice is the M99, a practice projectile for the M97 shell. The M99's velocities and pressures are lower than those for the T282 HE shell. The M99 is 0.35 calibers longer and weighs 485 grains more than the T282 shell. In order to achieve proper weapon functioning and to duplicate the in-flight properties of the M99 these discrepancies must be corrected. In an initial attempt the Ordnance Ammunition Command designed a dummy fuze which corrected both the length and weight of the shell. With these modifications, it was only necessary that the drag of the two shell be the same to yield a match. This new design was designated the 20mm Special M99. Several rounds were manufactured and sent to the Development and Proof Services of Aberdeen Proving Ground for testing. The firings by D&PS showed shorter time of flight figures for the special M99 than for the regular M99. The Ballistic Research Laboratories then fired four of these rounds as a check. The drag values (Table of Data) were reduced to zero-yaw values by the relationship $K_D = K_{D_0} + K_{D_{\delta^2}} \overline{\delta^2}$, where $K_{D_{\delta^2}} = 2.1$ 1/square radians. In comparing these K_{D_0} values with those of the M97 shell of Reference 2 (Fig. 1) a 12% decrease was observed. All other stability properties were in adequate agreement with the M97 shell.

The proposed fuze of the special M99 has a spherical nose. Since drag is a function of the shell's contour and major modifications are obviously undesirable, the drag could be increased by replacing a spherical tip with a meplat. Several meplat diameters were tried. These firings indicated that a fuze design with a meplat diameter of 0.320

calibers should yield the required drag of the M99 projectile. This modification, for the present purpose, should have negligible effect on the stability properties of the shell. Therefore, it would appear that by using the T282 HE body it is possible to manufacture a shell which will be undistinguishable in its drag characteristics from the M99 shell, at least at supersonic speeds.

The physical properties of this new shell are given in Figure 2 and its photograph in Figure 3.

Eugene D. Boyer

EUGENE D. BOYER

TABLE OF DATA

TYPE	ROUND	M	K_D	$\sqrt{\overline{\delta^2}}$ (deg)	s	$\lambda_1 x10^3$ $(ft)^{-1}$	$\lambda_2 10^3$ $(ft)^{-1}$
Special M99	4808	1.802	.1642	1.2	2.63	2.74	.98
	4807	2.082	.1628	3.7	2.79	2.00	1.71
	4806	2.441	.1456	2.7	2.95	1.76	1.66
	4805	2.463	.1486	3.3	3.03	1.92	1.54
Mod. 1	4911	2.311	.1920	1.4			
	4913	2.360	.1868	1.4			
Mod.2	4910	1.897	.1874	1.2			
	4912	2.387	.1658	1.4			
Mod.3	4900	2.367	.1826	1.4			
	4898	2.519	.1735	1.0			
	4899	2.578	.1736	1.0			
	3897	2.593	.1727	0.0			
Mod.4	4915	2.383	.1587	1.4			
	4914	2.389	.1585	1.4			

M	Mach number
K_D	Drag coefficient
$\overline{\delta^2}$	Mean squared yaw
s	Gyroscopic stability factor
$\lambda_{1,2}$	Yaw damping rates

REFERENCE

1. Mahoney, J. A. Ballistic Study of a Special 20mm, M99 Type Projectile D&PS Report, September 1957.

2. Boyer, E. D. Comparison of Aerodynamic Characteristics of 20mm HEI Shell M97 with Fuze M75 and 20mm Shell T216E1 With Fuze M505, BRLM 865 April 1955 (C).

3. Charters, A. C. and Stein, J. The Drag of Projectiles with Truncated Cone Headshapes, BRL Report 624, March 1952.

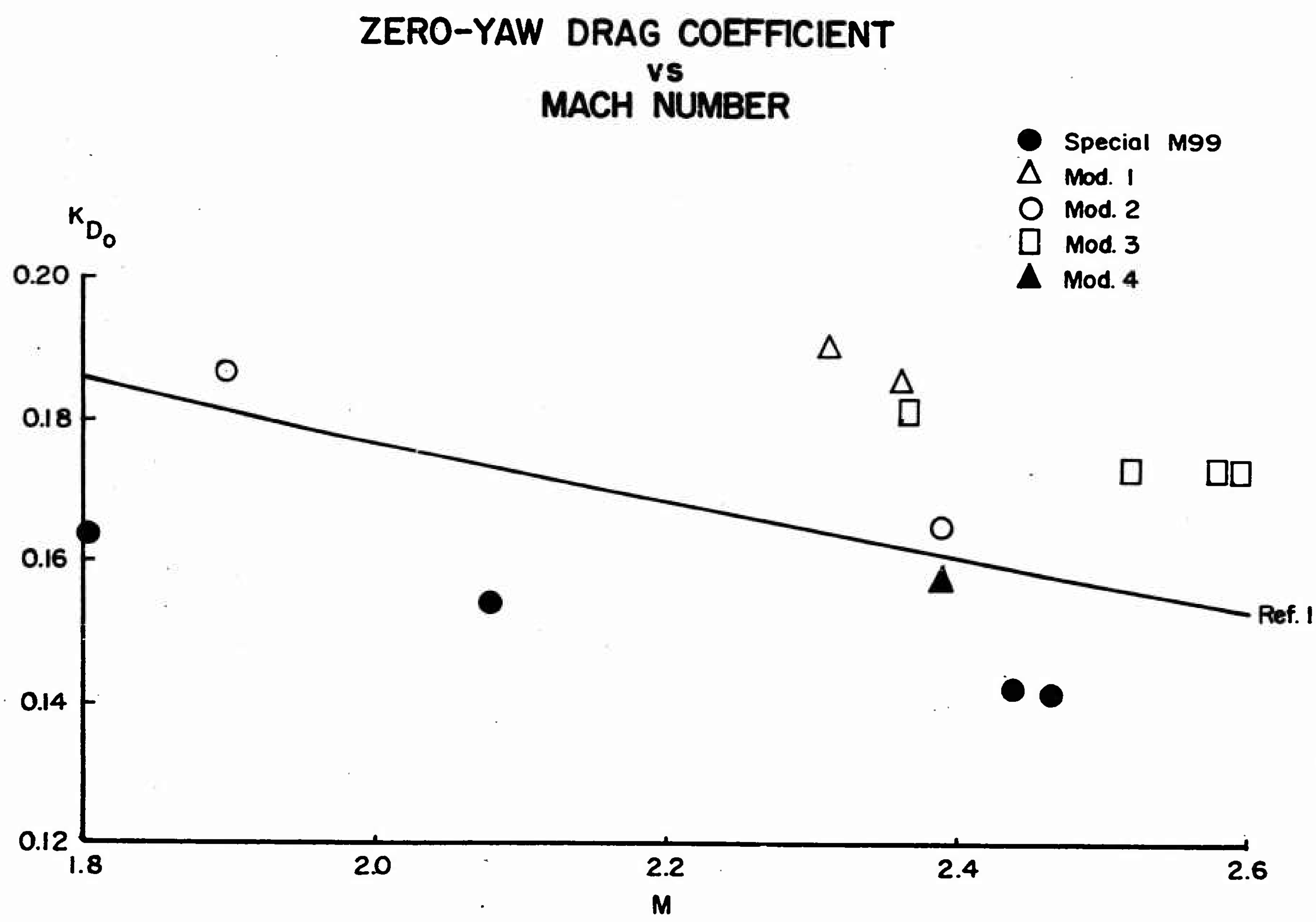
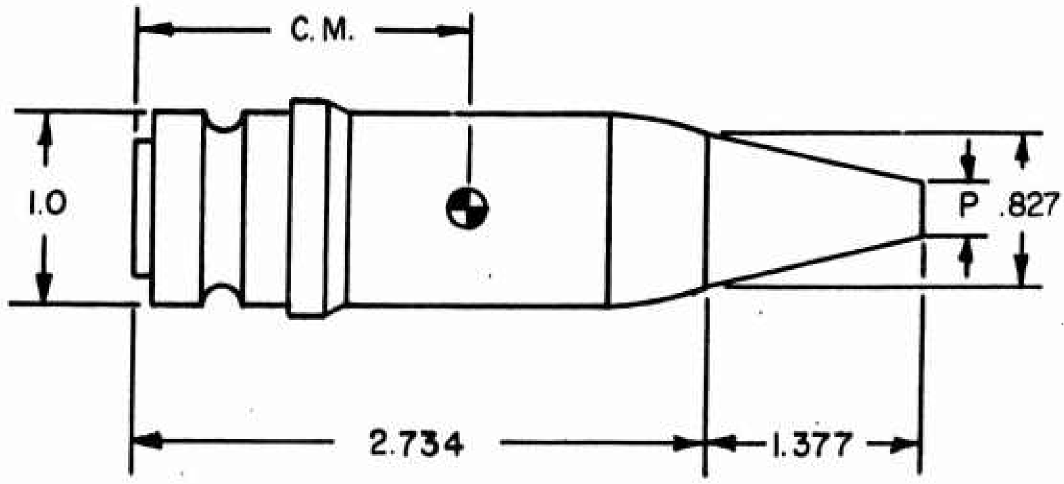

ZERO-YAW DRAG COEFFICIENT
vs
MACH NUMBER
Special M99
Mod. 1
Mod. 2
Mod. 3
Mod. 4
K_{D_0}
0.20
0.18
0.16
0.14
0.12
1.8
2.0
2.2
2.4
2.6
M
Ref. 1

FIG. 1

PHYSICAL PROPERTIES



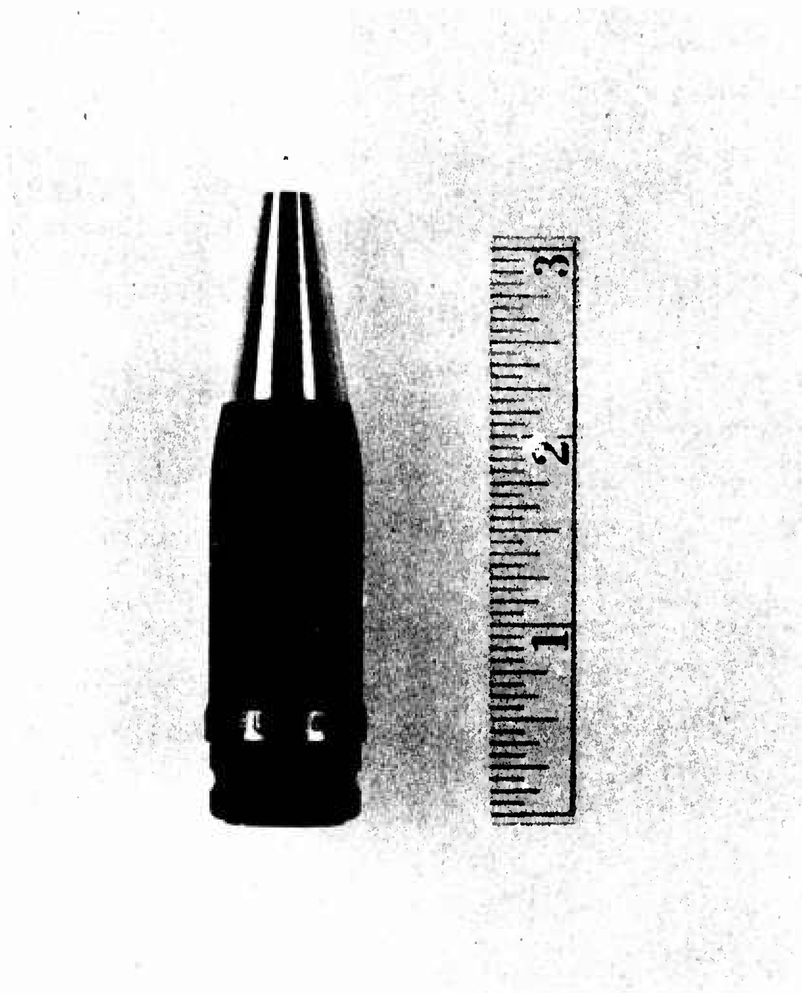
	Special M99	Mod. 1	Mod. 2	Mod. 3	Mod. 4
C.M.	1.64	1.5	1.5	1.48	1.5
WT.-Grams	130.5	76.46	76.27	77.53	76.40
A GM-IN^2	9.03				
B GM-IN^2	9 1.6				
P	* *	.370	.332	.291	.370 *

* Fuze Contour Given a 250 Microinch Finish (Normal Finish is 25 Microinches)

** Spherical Nose Blended into Cone Angle

NOTE: ALL DIMENSIONS ARE IN CALIBERS

FIG. 2



MODIFIED T282 BODY TO SIMULATE M99 PROJECTILE

FIG. 3