



Insensitive Munition Solutions for Anti-Structure Munition Grenade

by

Carl J. Campagnuolo, PhD

William J. Andrews

Vincent Gonsalves

USSOCOM

56rd Annual Fuze Conference

May 14-16, 2009



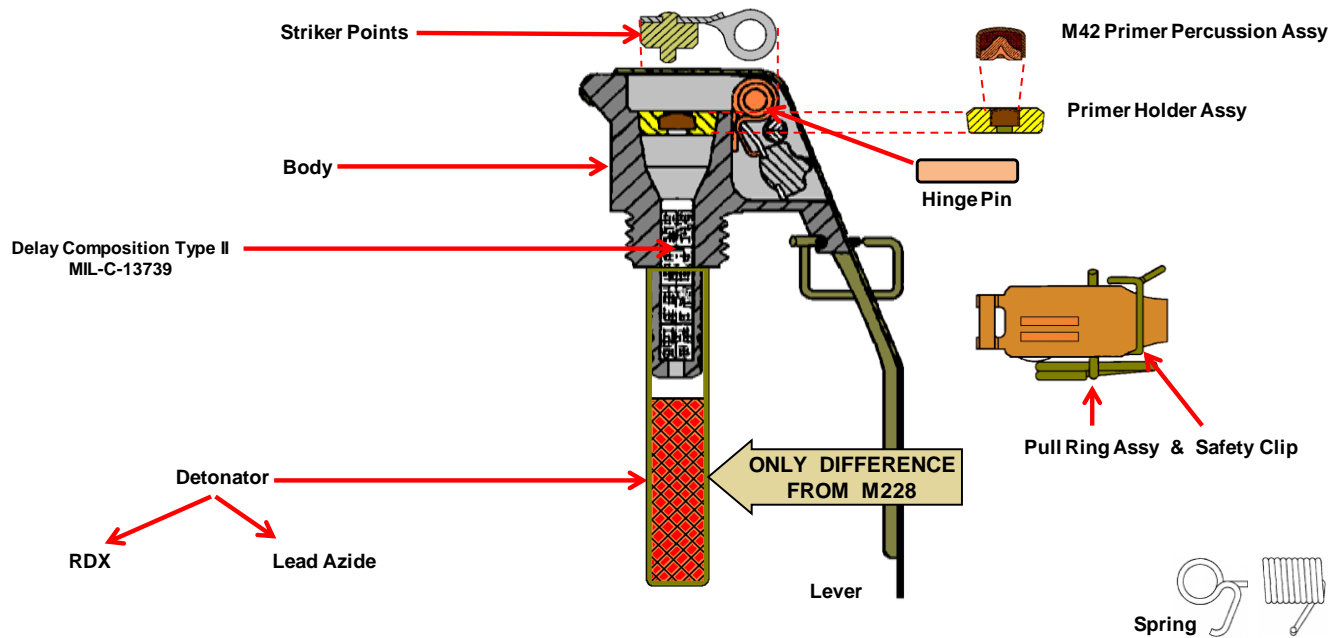
Grenades



M67 and ASM Grenades



M213 HE Hand Grenade Fuze





ASM Grenade



Eutectic Collar



Aluminum Dip
Braze Base Cap





IM Test Results



- ❑ The current design fails all IM tests. This is primarily due to the sensitive energetics in the M213 Fuze (C70 Detonator).

IM Test Summary For M67 Hand Grenade							
Component	H/C	FCO	SCO	BI	FI	SD	SCJ
M67	1.1	I	I	I	I	I	(F)

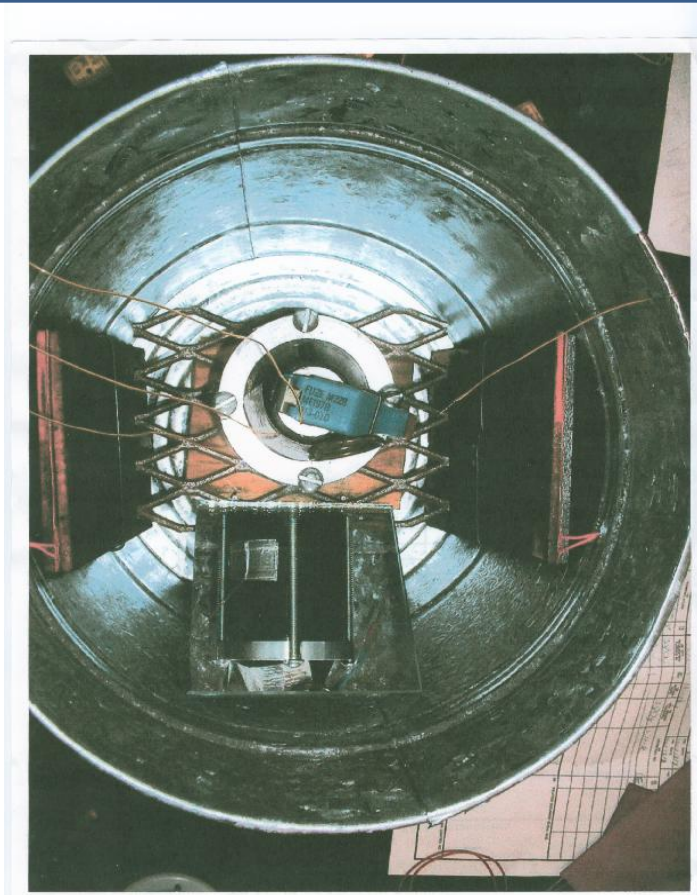
* Reactions shown in Parenthesis () are assessed, not based on actual test scores

- Type VI: No Reaction
- Type V: Burn
- Type IV: Deflagration
- Type III: Explosion
- Type II: Partial Detonation
- Type: I Detonation

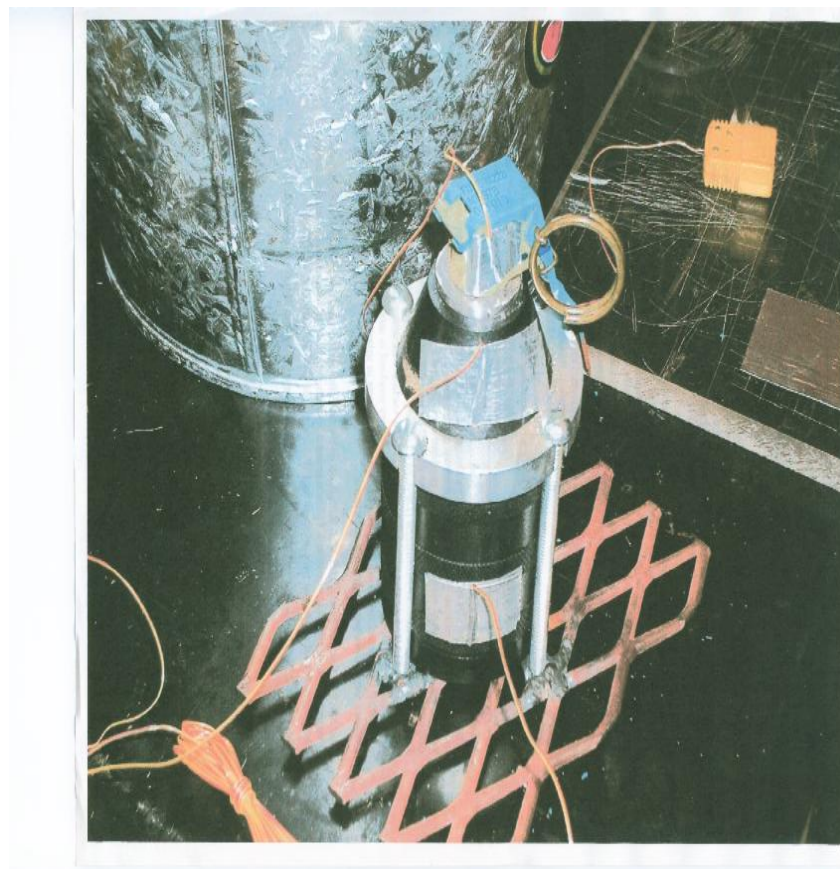
- FCO: Fast Cook-off
- SCO: Slow Cook-off
- BI: Bullet Impact
- FI: Fragment Impact
- SD: Sympathetic Detonation
- SCJ: Shaped Charge Jet



ASM Grenade, Slow Cook Off Test with M228 Fuze



ASM GRENADE SCO Test
M228 Fuze



ASM GRENADE SCO M228
Fuze Test Set Up



Explosive Components

EXPLOSIVE COMPONENTS		
Description	Composition	Quantity/Grains
M213 Fuze Assembly		
M42 Percussion Primer	PA-101 Mix, Lead Azide, tetryl	0.33 gr
Delay Composition	Barium Chromate 60% Potassium Perchlorate 15% Nickel 13% Zirconium-Nickel Alloy 12%	20.0 gr
Detonator Assembly	RDX 65% Lead Azide 25% Lead Styphnate 10%	31.8 gr
Booster	PBXW-128 (Now PBXN-114)	16.0 g
Main Charge	PBXN-109	Maximum of 380.0 g



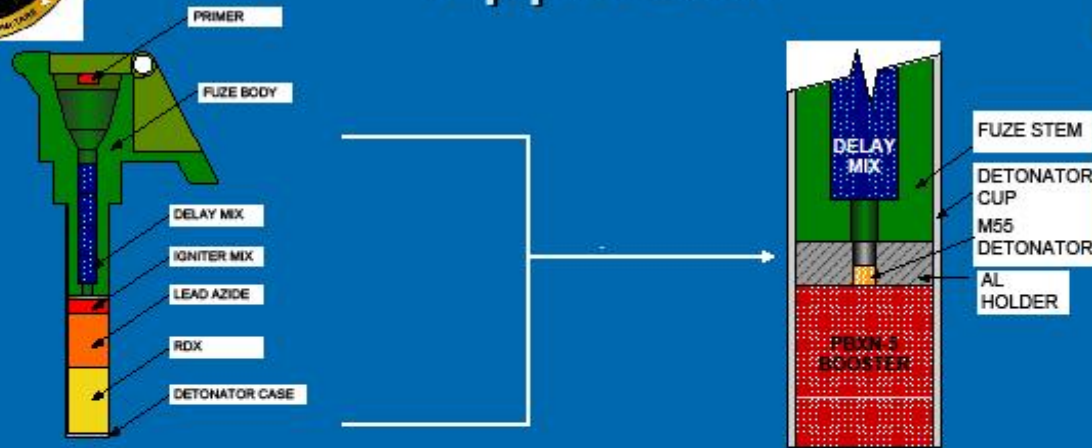
How to Solve the Problem

- Remove the fuze during SCO and FCO by replacing the fuze adapter with a eutectic metal that melts at about 240° F. Let the pressure from the burning PBXN-109 push the fuze out.
- This technique can be used for both the M67 and the ASM Grenade.
- The Comp B fill for the M67 Grenade must be replaced by an insensitive explosive such as PBXN-109, which burns rather than explode (as the ASM Grenade).
- Replace C70 Detonator in the fuze with a secondary explosive, i.e., PBXN-5. Secondary explosives burn rather than explode.

From 2008 Fuze Conference, G. Chang



Approach



➤ M55 Detonator to Booster

- Reduced quantity of lead azide and lead styphnate
 - Improve Safety
- Single point failure issue resolved

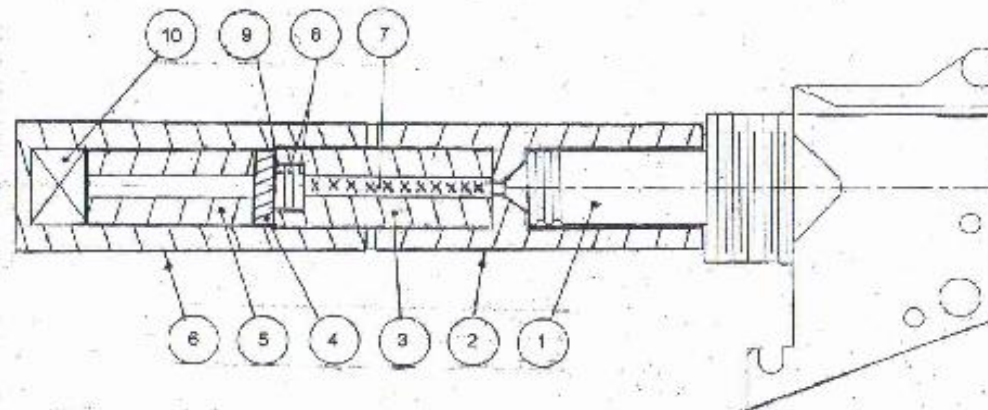


Fuze Column Improvement

NOTE: UNLESS OTHERWISE SPECIFIED

1. Material Drawing or AWD 114-56
2. All Part Part 205 Materials
3. Drive 2.00 x 0.000 2000 2000 2000
4. All Dimensions are in INCHES UNLESS OTHERWISE SPECIFIED

REVISIONS		
NO.	DESCRIPTION	DATE
1	Initial Design	4/15/64



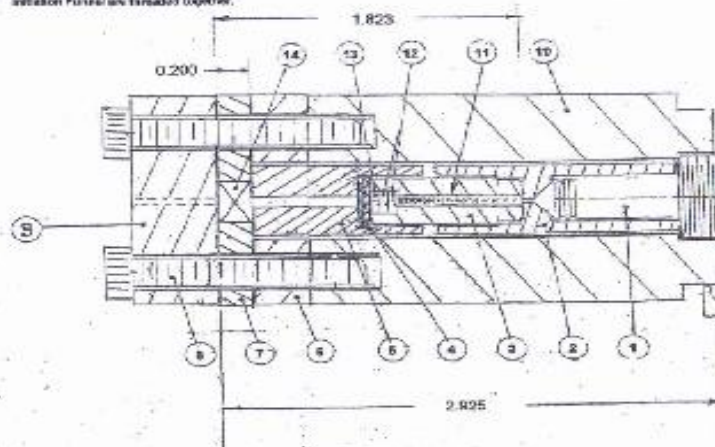
OUTPUT PELLET, high density PEG-4007	10
DELAY PELLET, high density PEG-4007	9
DELAY PELLET, high density PEG-4007	8
DELAY, PEG-4007	7
OUTPUT HOUSING	6
BARREL, 4.00 in. dia. ID x 6.75 in. long	5
FLYER DISC, 0.002 in. Rad. 6061 Aluminum	4
RETENTION HOUSING	3
INITIATION FUZE	2
W/5'S HE HAND CREAMED FUZE	1



Fuze Testing Fixture

NOTE: USE THE FOLLOWING SPECIFICATIONS:

1. Material Drawing per AMS 7011, 2A
2. All Tins, Fast .025 inches
3. Remove Burr and Break Sharp Edges .205 inch/min.
4. All Dimensions shall be $\pm .0025$ (16:1 CB)
5. Capfire Barrel, Initiation Housing & Initiation Pin must be threaded together.



Part	Description	Qty	Remarks
1	Init. Delay	1	
2	Init. Delay	1	Use 200 in. Series Add Without Block
3	Charge to 4.700 inch Diameter. General Changes to Parts List.	1	

OUTPUT PELLET, High Density - 1.4 g/cc PEX-6497 (1 ea. RP-1)	325 mgs.	24	
DELAY PELLET, High Density PEX-6497 (2 ea. RP-2)	22 mgs.	25	
DELAY PELLET, High Density PEX-643 (2 ea. RP-2)	48 mgs.	22	
DELAY, PEX-643 Powder (3/16" pack)	15 mgs.	21	
TEST BODY, Aluminum 4061-T6	58-0863	20	
WITNESS BLOCK, Aluminum 4061-T6	58-0861	5	
RETAINER BOLTS, 1/4"-18, 2 each	Std. Mat.	8	
OUTPUT PELLET (RP-1) HOUSING HOLDER, Aluminum 6061-T6	58-0870 F	7	
TEST BODY EXTENSION, Aluminum 4061-T6	58-0866	5	
CAPFIRE BARREL, 0.700 inch long with 4.064 inch dia. bore	58-0959	5	
FLYER DISC, 0.250 inch thick Aluminum 4061-T6 flat stock	58-0862	4	
INITIATOR HOUSING, with 0.200 inch dia. bore, as 282	58-0952	2	
INITIATOR PLUNGER, with 0.032 inch dia. hole in tip, as 282	58-0958	2	
MSGL HE HAND GRENADE FUZE	Reference	582251	1

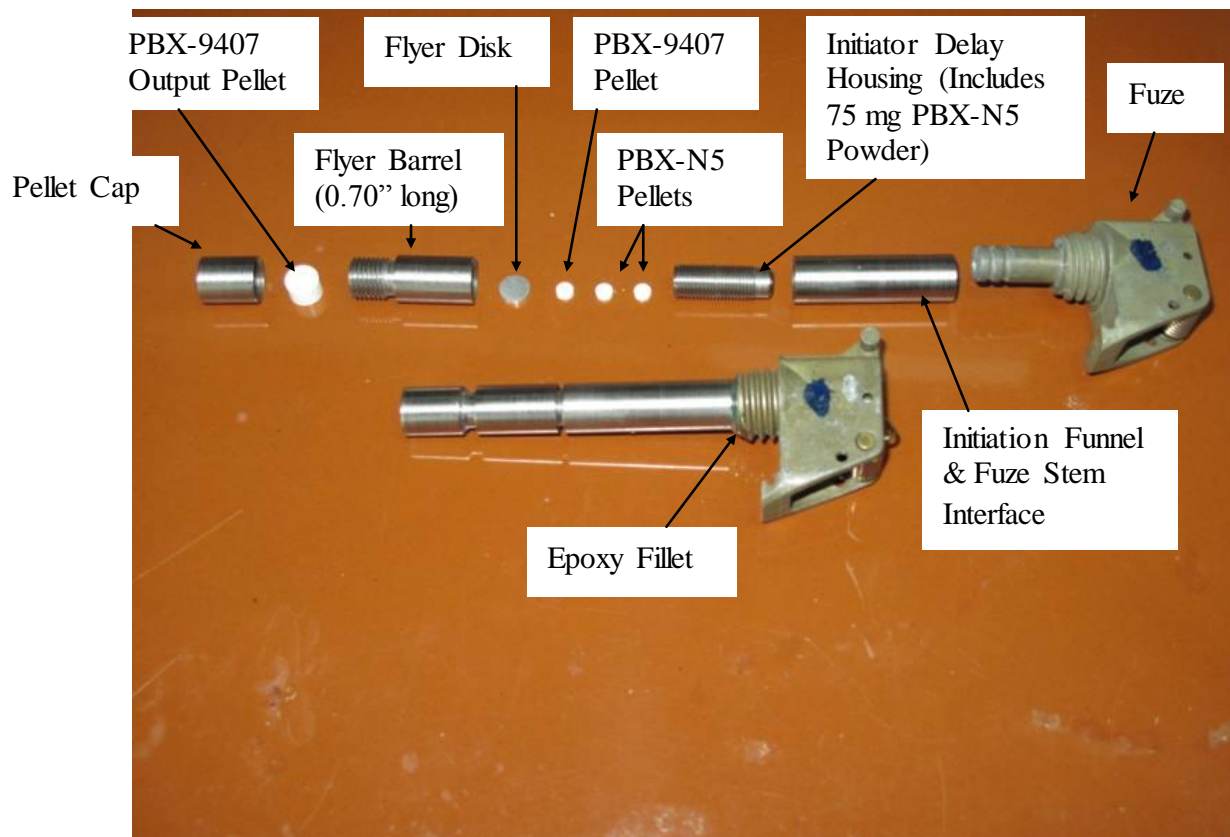


IM Fuze





DDT- Fuze Assembly

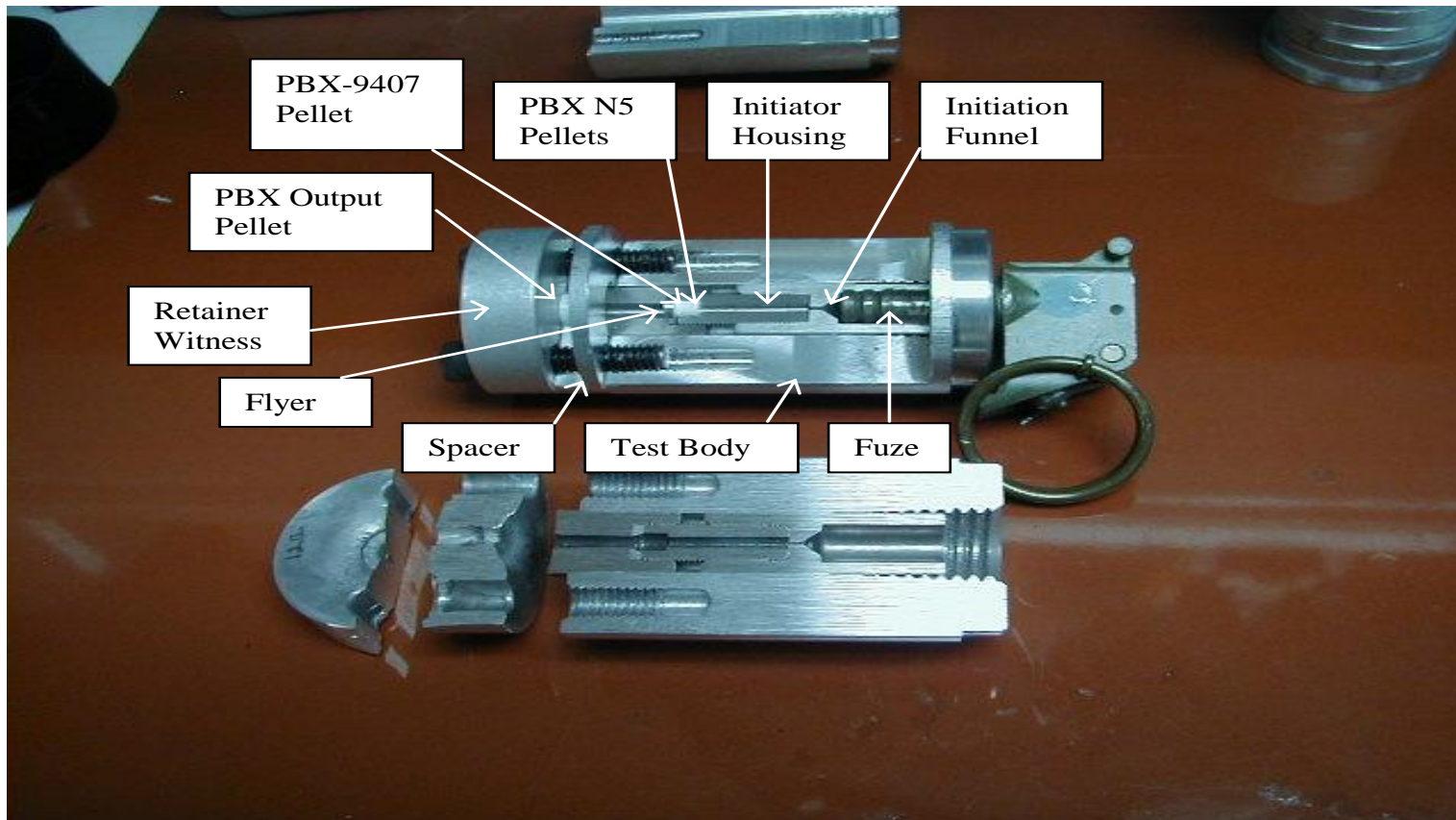


DDT-Fuze Assembly

Note: DDT-Fuze Assembly diameter = 0.420", and length = 2.720"



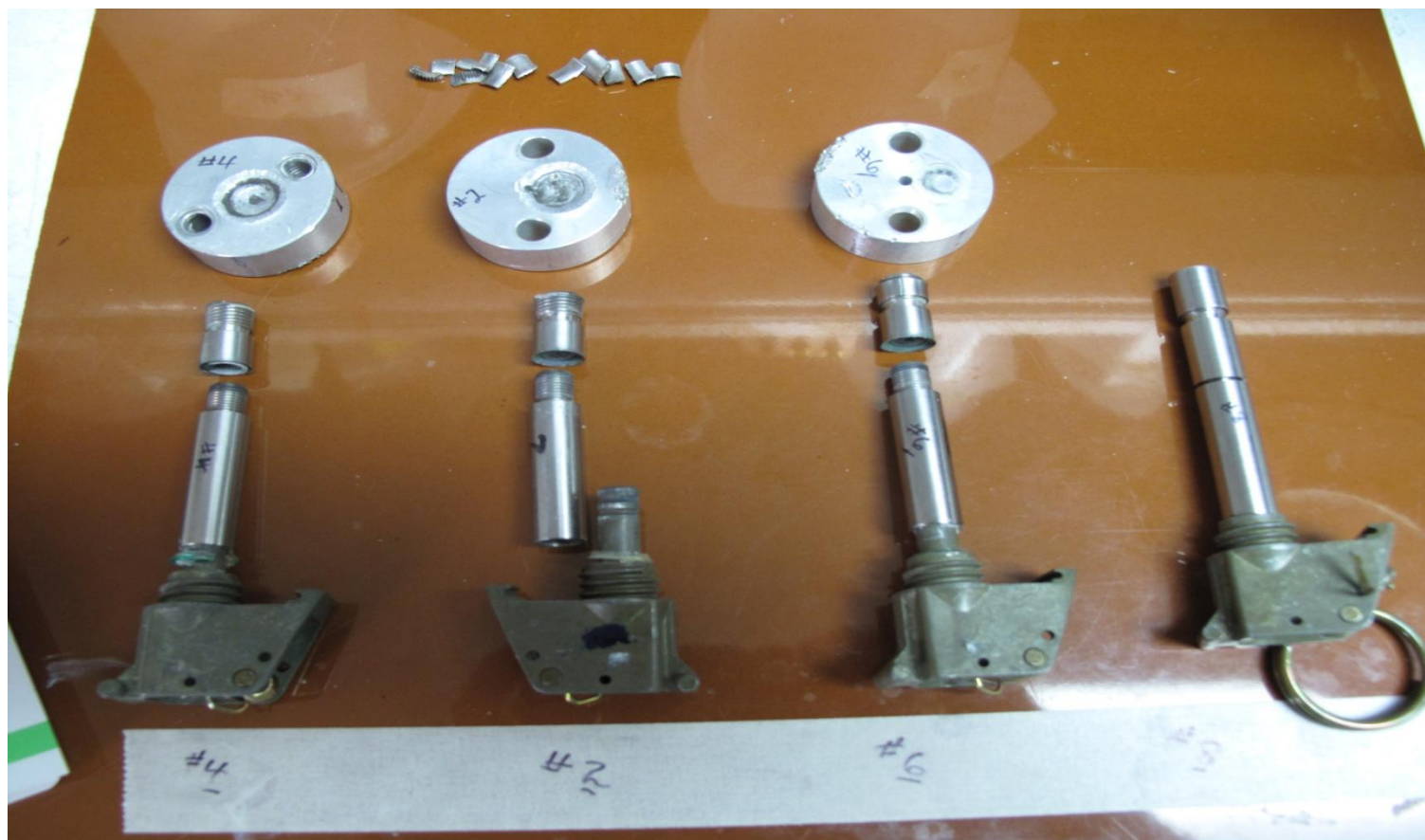
Grenade Sectional Assemblies



Grenade Sectional Assemblies:
Test Assembly &
Post Tested Assembly

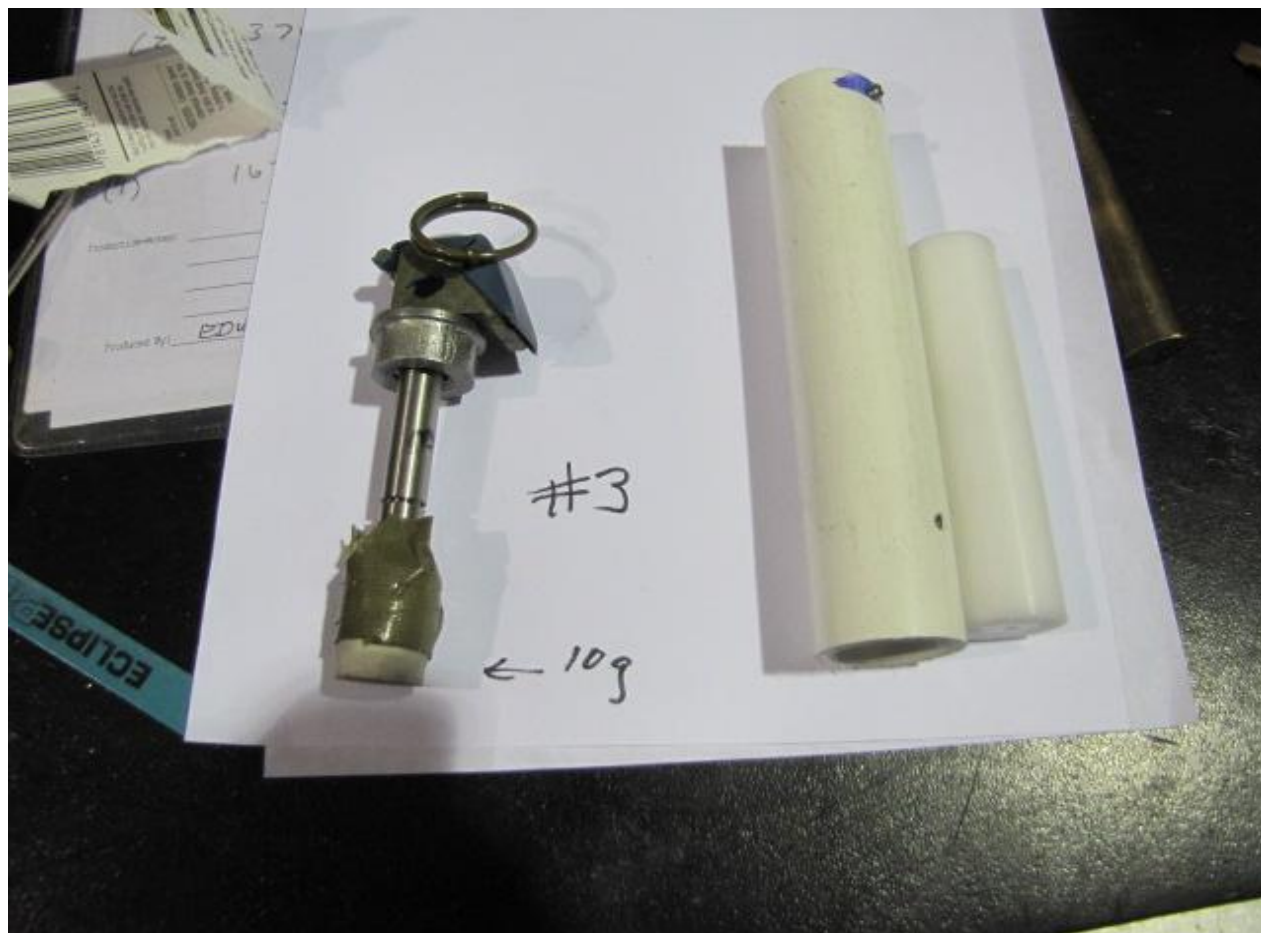


Fuze Test Results





Test of Fuze with PBXW-128 Booster





Apparatus to Test Fuze





Test Results

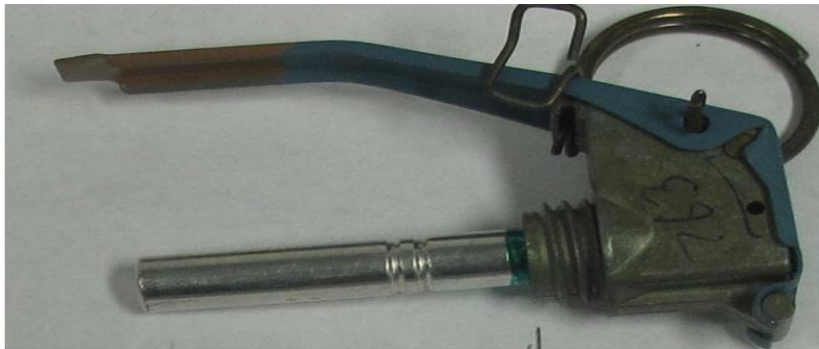




Means to Shorten the Fuze Length

Removal of a High Density PBXN-5 pellet

M213 Fuze



1.823 in

Current IM Fuze Design



2.610 in
3 Output
Pellets

NOTE: 2 pellets reduces length to 2.560 in



Recommendation From FESWG

- Removal of Low density pellet, PBXN-5 is not acceptable according to MIL STD 1316E:
*'The explosive material used in fuze systems shall not be altered by any means (precipitation, recrystallization, grinding, **density changes**, etc.) likely to increase its sensitivity beyond that at which the material was qualified and at which it is customarily used, unless it is requalified.'*
- Tests are being conducted to initiate two high density pellets directly from the delay column output
- Shorten Fuze Barrel from 0.700 to .0500". Early tests indicated that an acceptable detonation pressure could be obtained from the smaller length.
- Assuming these changes result into an operational prototype, the M213 length of 1.823" will be achieved.

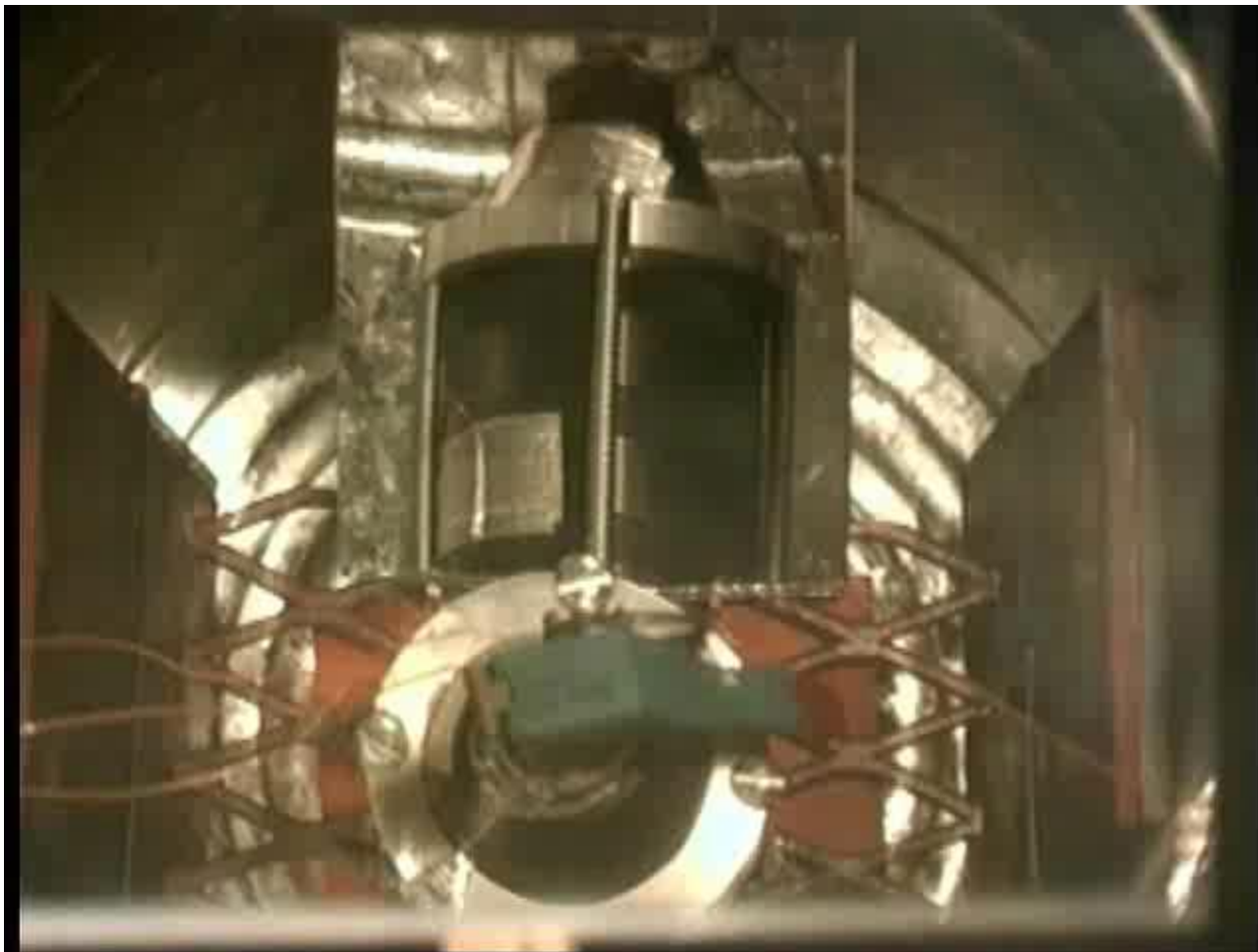


Way Ahead

- Improve interface between spit holes and flyer driver pellets to provide a hotter, more direct initiation.
- Eliminating redundant components to shorten the fuze.
- Introduce a second signature into the fuze.



Slow Cook Off ASM Grenade M228 Fuze



Event Video



M67 Slow Cook Off Test

M228 Fuze



Event Video



Dr. Carl J. Campagnuolo

941 359-2239

US SOCOM

drccamp@msn.com