37TH ANNUAL GUN & AMMUNITION SYMPOSIUM & EXHIBITION
Panama City, Florida, April 14-18, 2002

XM-80 GRENADE POINT BURST REFERENCE
AND CASING EXPANSION INVESTIGATIONS

GARY L. BOYCE

U.S. ARMY RESEARCH LABORATORY
AMSRL-WM-TC
ABERDEEN PROVING GROUND, MARYLAND 21005
(410) 278- 3129 FAX (410) 278-6564
Outline

- Objectives
- Background
- Phase I & II Experiments
- Observations
- Conclusions
Background
Example of Arena Testing

All angles on collection panel are measured from reference point

DPICM – Dual Purpose Improved Conventional Munition
Objectives

• PHASE I:

Validate a “reference plane” and a “reference origin” establishing a standard operating procedure for XM-80 grenade arena testing

Observe XM-80 grenade shell expansion

• PHASE II:

Observe the grenade shell expansion, section of fragments and individual fragment for orientation
Experimental Approach

• PHASE I

*Use radiographic diagnostics to establish the fragmenting XM-80 grenade reference plane with respect to the horizontal plane*

• PHASE II

*Use radiographic system and unique shielding method to observe selected portion of the XM-80 fragment expansion*
XM-80 Grenade

Weapons & Materials Research Directorate
Terminal Effects Division

XM-80 Grenade

Nominal dimensions

31mm stacking height

46mm height

casing, ASIS 4140 steel

Point Burst Reference???

Reference Plane???

(.center of grenade mass 1.262” and center of H.E. mass 1.267”)

Measured 31.75mm (1.25”) from bottom of skirt
Phase I Experimental Arrangement

Grenade axis of symmetry
XM-80 grenade
Protection cassette
Foam support with 25mm hole
25mm plywood support table
Focal point to film

Side View
Not to scale with nominal dimensions
Phase I Experimental Arrangement
XM – 80 Shell Expansion

Rd 412

\[ V_{EC} = 793 \text{ m/s} \]

\[ V_1 = 0774 \text{ m/s} \]

\[ V_2 = 1093 \text{ m/s} \]

\[ V_3 = 1093 \text{ m/s} \]

\[ V_4 = 1171 \text{ m/s} \]

\[ T_1 = 30 \mu s \]

\[ T_2 = 60 \mu s \]
Phase II
Experimental Arrangement

Overhead View

Not to scale / nominal measurements (mm)

Top view

Protection Pack

film cassette

Grenade

Steel shields

T1

T2

T3

T4

T5

102

1219

1727

432

1918

51mm opening
26.5° angle

Celotex witness
1219 x 1219

178

305

305

305

11
**Formed Fragment Observations**

TOP VIEW

- **Steel shields**
- **Grenade**
- **Formed fragment shell**
- **Observed fragments**
- **Leading fragment**

T<sub>2</sub>, T<sub>1</sub>, 26.5° angle
Experiment Arrangement & Post-mortem
Radiographic Observations
Composite Image Rd 416

$T_5 = 888\mu s$  $T_4 = 654\mu s$  $T_3 = 420\mu s$  $T_2 = 186\mu s$  $T_1 = 0\mu s$

Group 1  Group 2  Frag 1  Frag 2
Majority of Fragment Groupings

Group 1

Group 2
Radiographic Observations
Composite Image Rd 419

Grenade supported on 50.8mm Styrofoam
25.4mm grid
Radiographic Observations
Composite Image Rd 421

Grenade supported on 25.4mm RHA
25.4mm grid

$T_5 = 1022 \mu s$
$T_4 = 695 \mu s$
$T_3 = 440 \mu s$
$T_2 = 186 \mu s$
$T_1 = 30 \mu s$
Grenade Support
Foam vs Steel

Grenade supported on 50.8mm Styrofoam
Grenade supported on 25.4mm RHA

\[ T_1 = 30 \mu s \]
\[ T_2 = 186 \mu s \]
<table>
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<tr>
<th>Rd No.</th>
<th>Distance from Reference Point (RF) (m)</th>
<th>Maximum Speed (m/s)</th>
<th>Orientation Angle from RF (degrees)</th>
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<td>411(casing)</td>
<td>0.1312</td>
<td>-</td>
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Cumulative Measured Fragment Orientation

ALL FRAGMENTS TRACE BACK TO THE POINT BURST ALONG THE REFERENCE PLANE (LINE)
Maximum Fragment Velocity as a Function of Distance

Maximum Velocity

Single XM-80 Grenade Experiment

Fragment Group 1 & 2 seem to have similar slopes

Cumulative XM-80 Grenade Experiments

Fragment speeds are a round-to-round variation
Summary
Grenade at $T = 0 \ \mu s$

point burst reference
reference plane $90^\circ$
31.75mm (1.25")
skirt
casing section of interest
top
base
axis of symmetry
Conclusion

Phase I  (Establish a Reference Line and Point)

• **Reference plane** is 31.75mm (1.25”) from the bottom of grenades’ skirt

• **Point burst reference** is located at the intersection of the reference plane and the axis of symmetry

Phase II  (Observe Grenade Expansion)

• Grenade’s shell expansion is similar when supported by foam or steel

• Fragmentation is separated into 2 major groups
  • Group 1 is directed at 85° to 90°
  • Group 2 is directed at 80° to 85° due to the tapering of explosive / Taylor angle

• Minimum number of fragments are directed at 90° to 95°, due to corner effects