NDIA 48th Annual Fuze Conference

NSWC / Dahlgren Division

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5” Cargo Projectile Ringing Test

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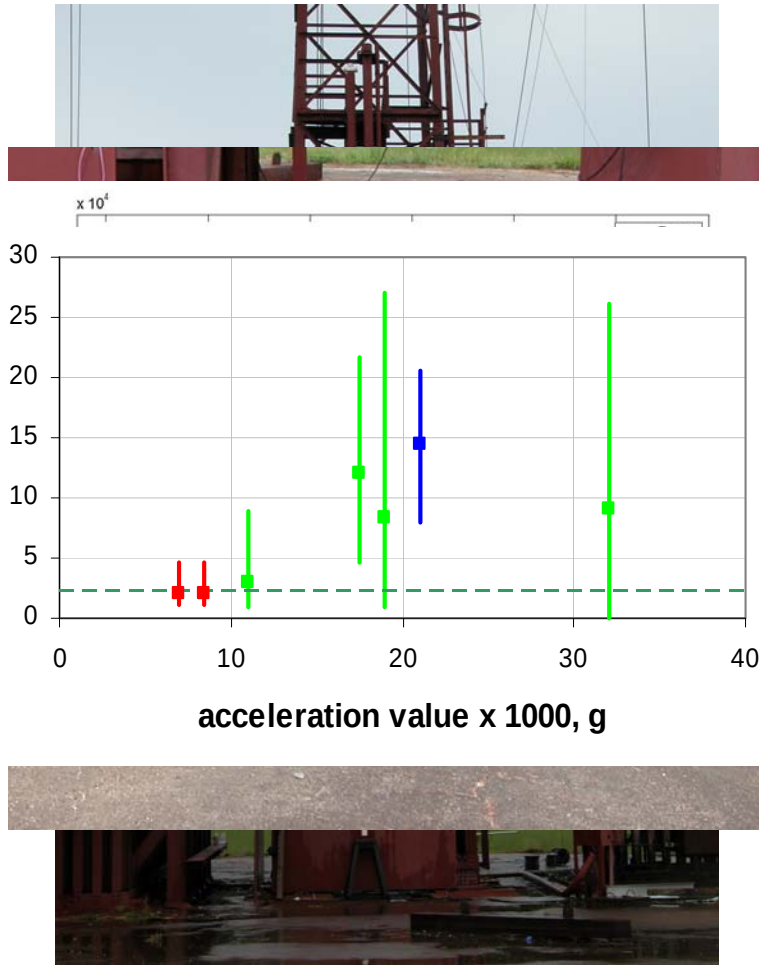
Agenda

- Introduction and Purpose
- Ringing Test Setup
- Test Procedure
- Projectile Load Configurations
- Test Results

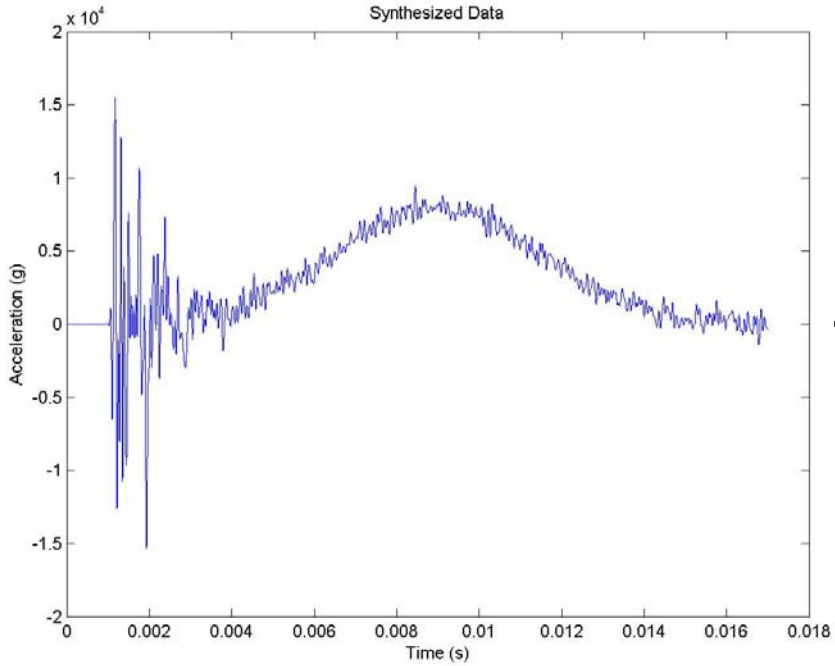


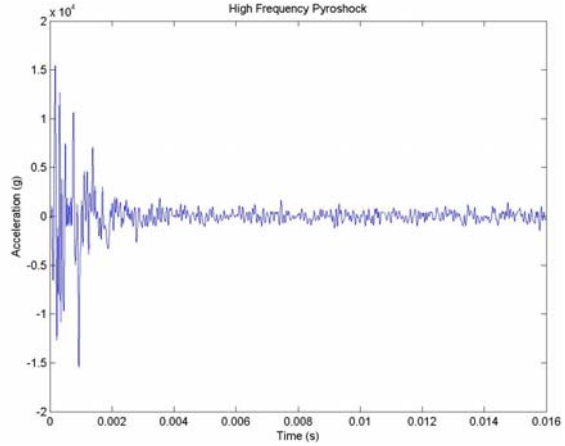
Issue

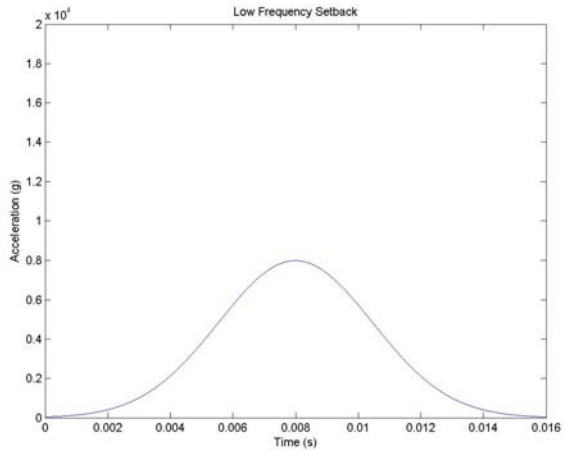
Projectile Type	Description	Fuze dud rate (%)
KE-ET	buffer pellets and tungsten pellets vibration loaded	9%
KE-ET	column down the center of the tungsten pellets	8%
KE-ET	tungsten pellets poured and tamped	3%
KE-ET	tungsten pellets vibration loaded	12%
HE-ICM	contained 49 inert XM80 grenades	2%
HE-ICM	contained 49 inert XM80 grenades	2%
ILLUM	contained inert candle	14%

- Certain cargo projectiles cause fuze duds
- Program Office asked to devise a test to investigate projectile fuze dud rates

Prior 5 inch Gun Testing

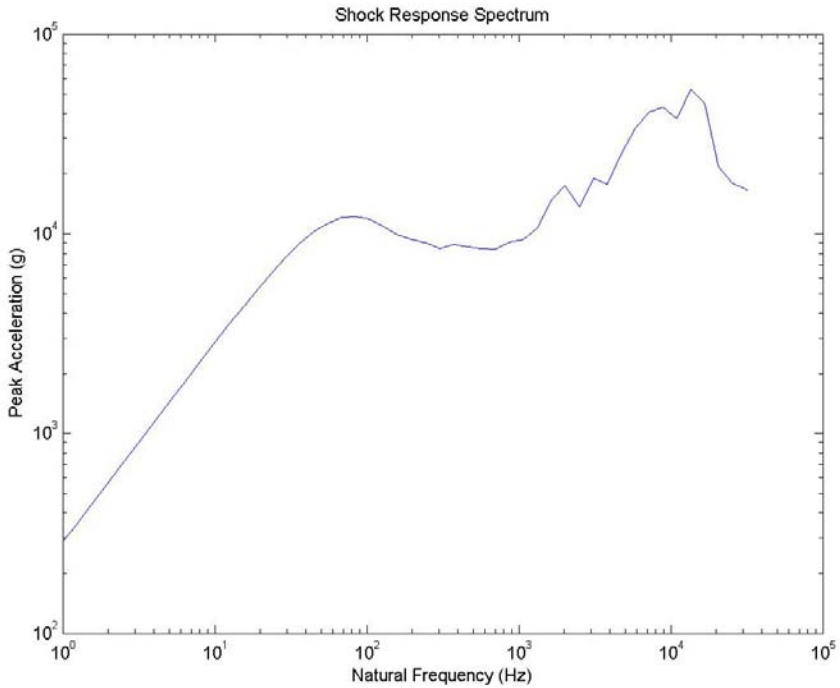


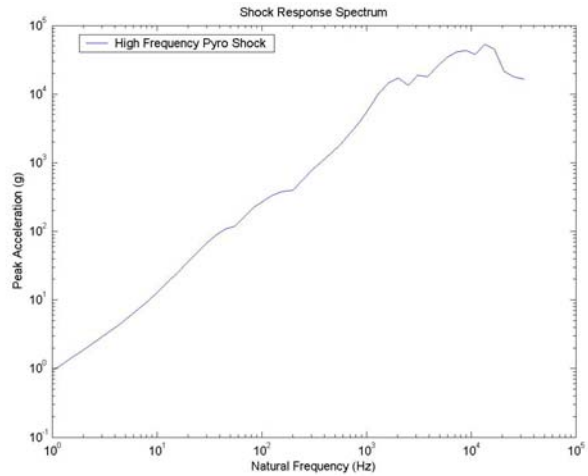


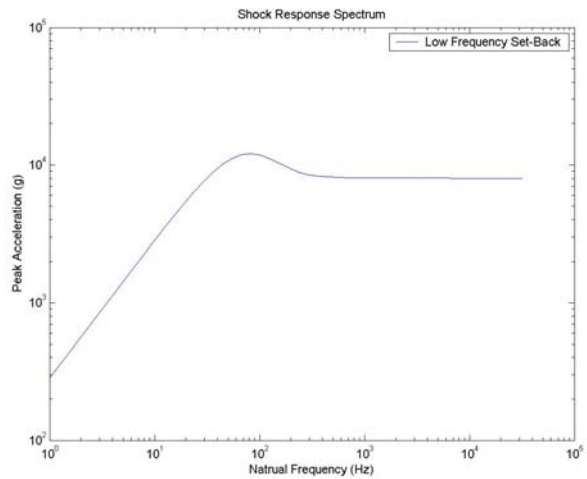


- Synthesized acceleration vs. time graphs for instrumented 5-inch projectile

Prior 5 inch Gun Testing

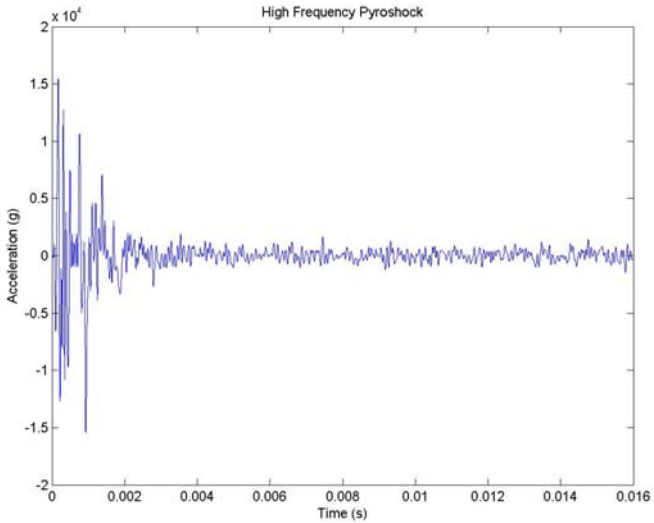






- Shock Spectrum Analyses of synthesized data

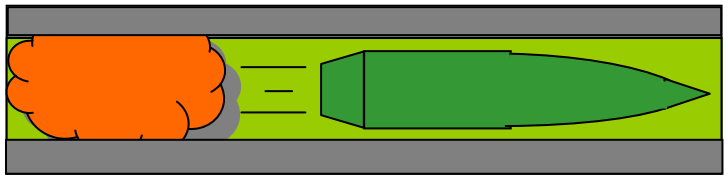
Stress Wave from Gun Fire

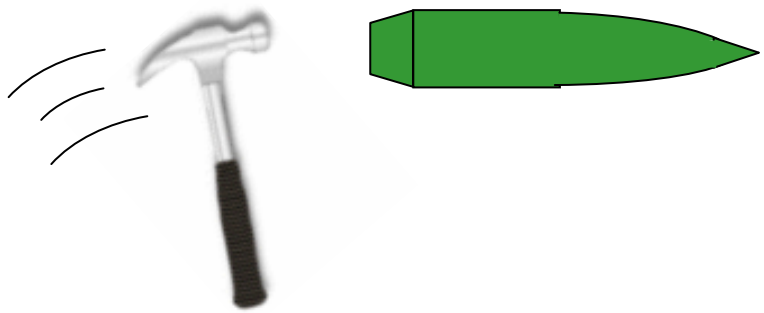


Direction of stress wave propagation

- Produces very intense, brief impact on the projectile aft end similar to a hammer blow
- A stress wave is produced which travels through the projectile body and into the fuze region, may cause fuze duds

Purpose





- Ringing Test attempts to produce a stress wave similar to the one present at gun fire without the expense of gun testing
- Test shows relative differences of acceleration values in the fuze region of various cargo projectiles
- Eventually the test could serve as a screening test for projectile design

Test Setup

- PVC Pipe
- Steel Ball Bearing
- Test Stand
- Steel Plate
- Fuze Cavity
- Accelerometers
- Oscilloscope

Design of Key Test Components

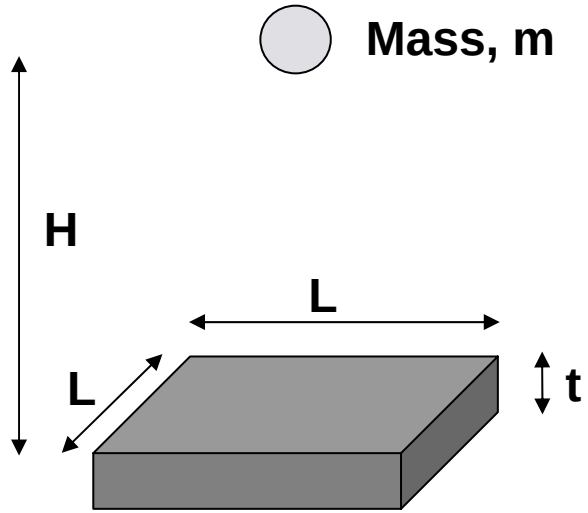


Plate Dimensions

$$\omega_n = 4.07\sqrt{\frac{Et^2}{\rho L^4\left(1-\nu^2\right)}}$$

ω_n : Natural Freq. of first mode (rad/sec)
E: Elastic Modulus (lb/in^2)
t : thickness of plate (in)
ρ: mass density (lb-sec^2/in^4)
L: dimension of one side of square plate (in)
ν: Poisson's ratio

Plate Deformation

SolidWorks/
Cosmos Express

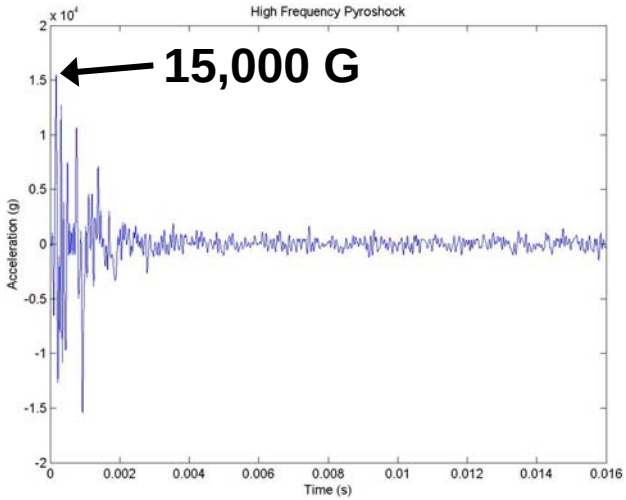
Impact Force

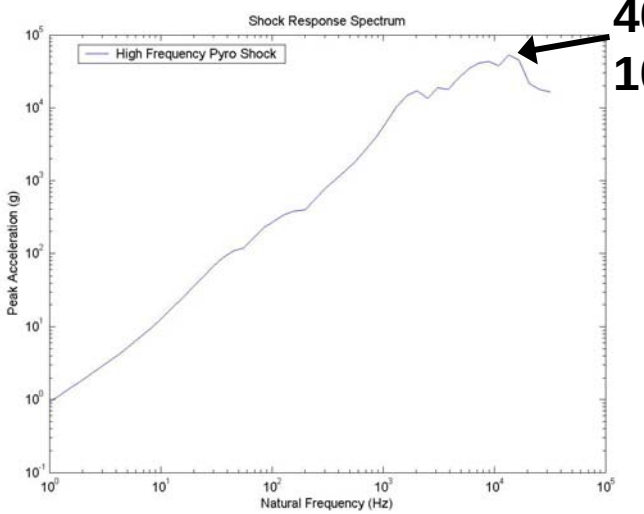
Test Procedure

- DRB was placed on the aft end of the projectile
- Projectile was screwed into the steel plate
- Fuze cavity was installed and torqued to 90 ft-lb
- Accelerometers were attached
- Steel ball was dropped 10 times
- Accelerometers removed, next round loaded

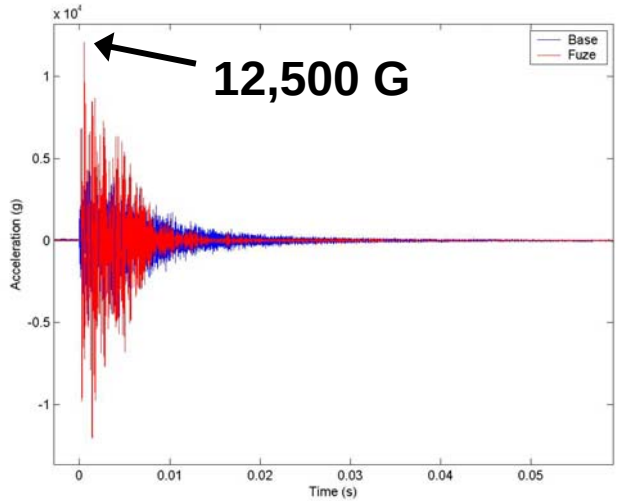
Reproducing Pyroshock of Gun Fire

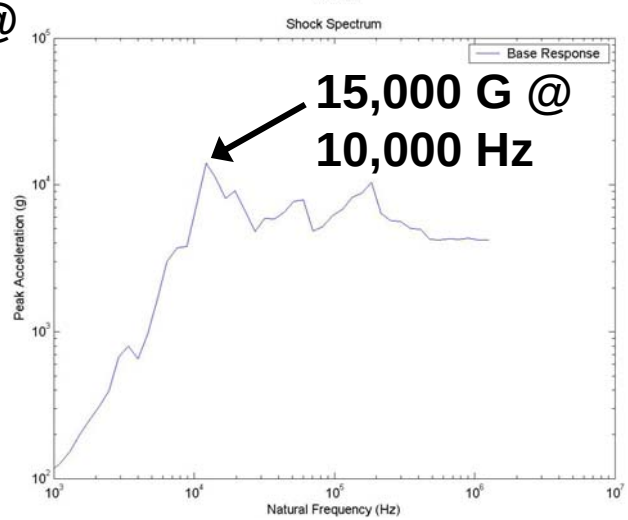
5-inch Gun Fire Results





Ringing Test Results

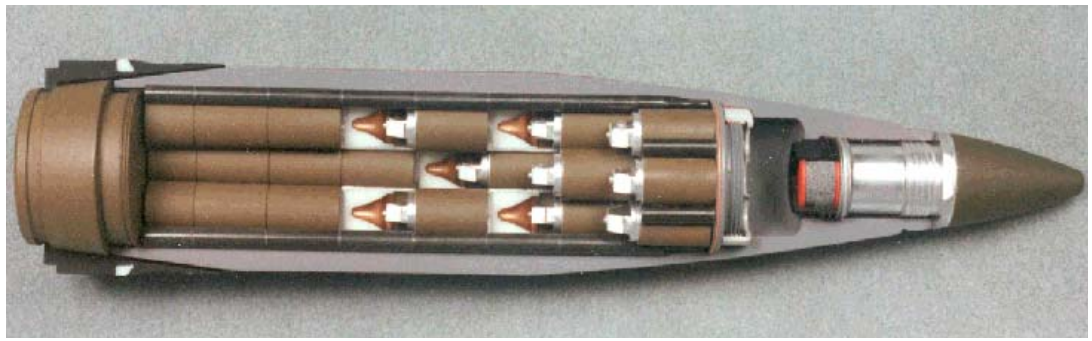




5” Cargo Projectiles Tested

KE-ET

HE-ICM



ILLUM PROJECTILE

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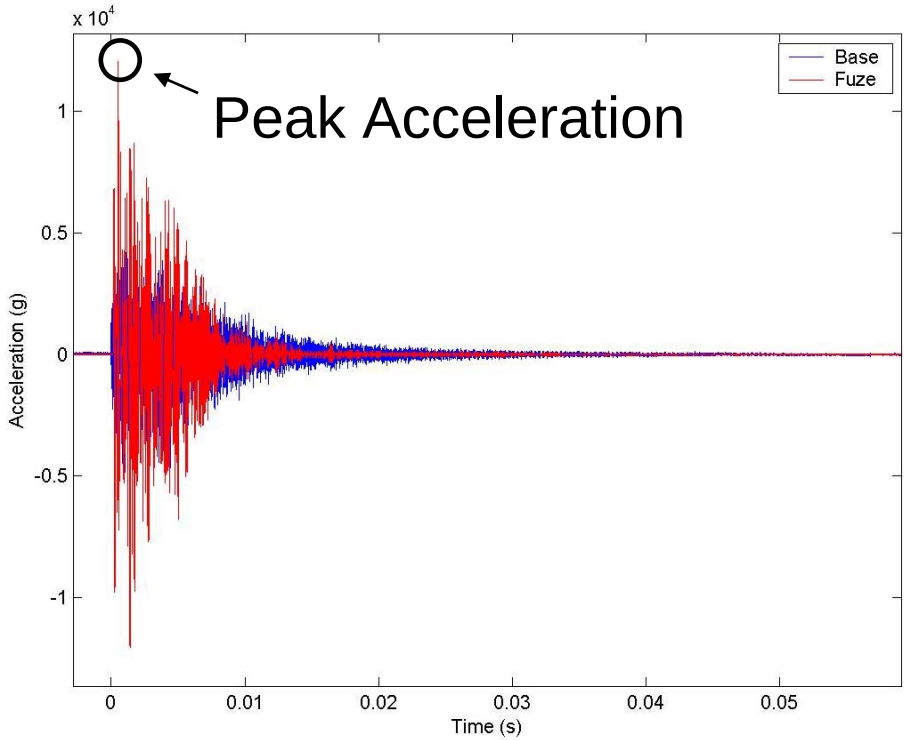
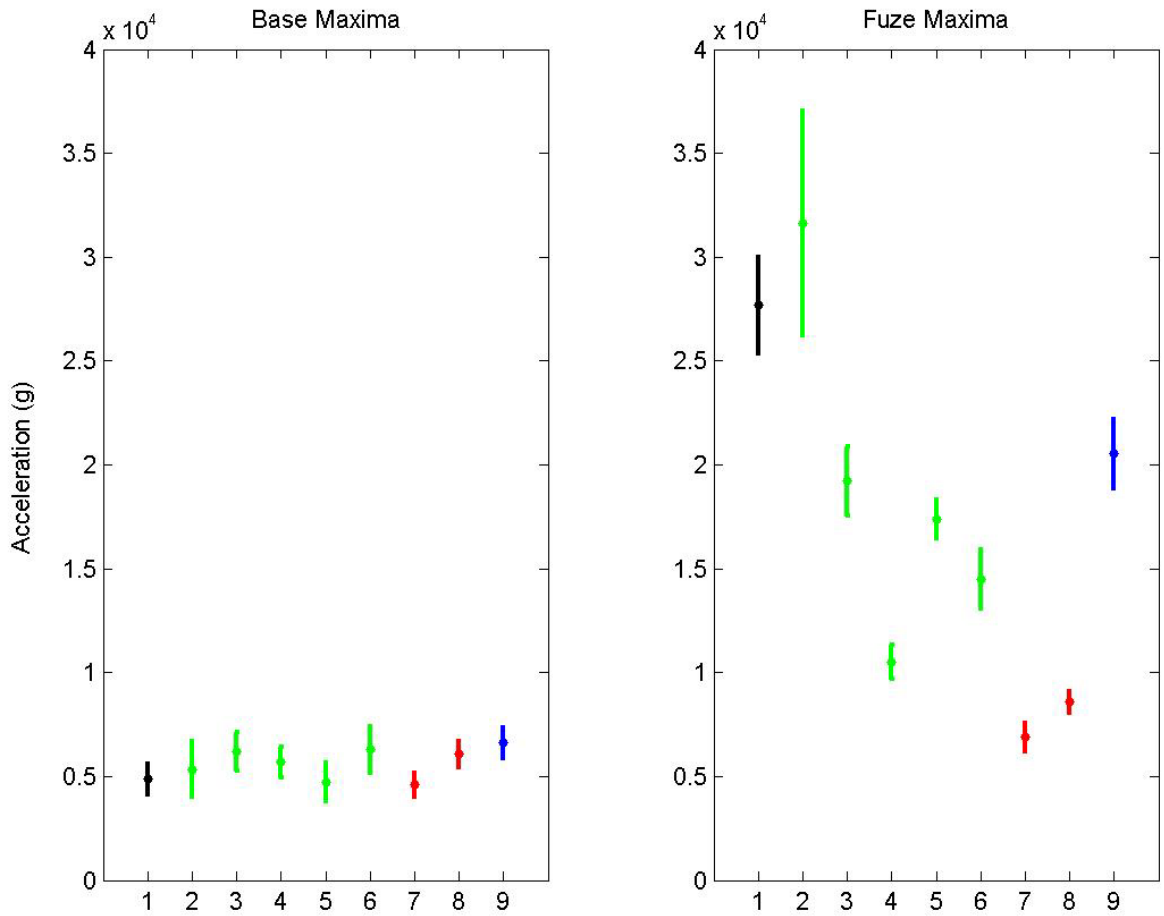
Data Analysis



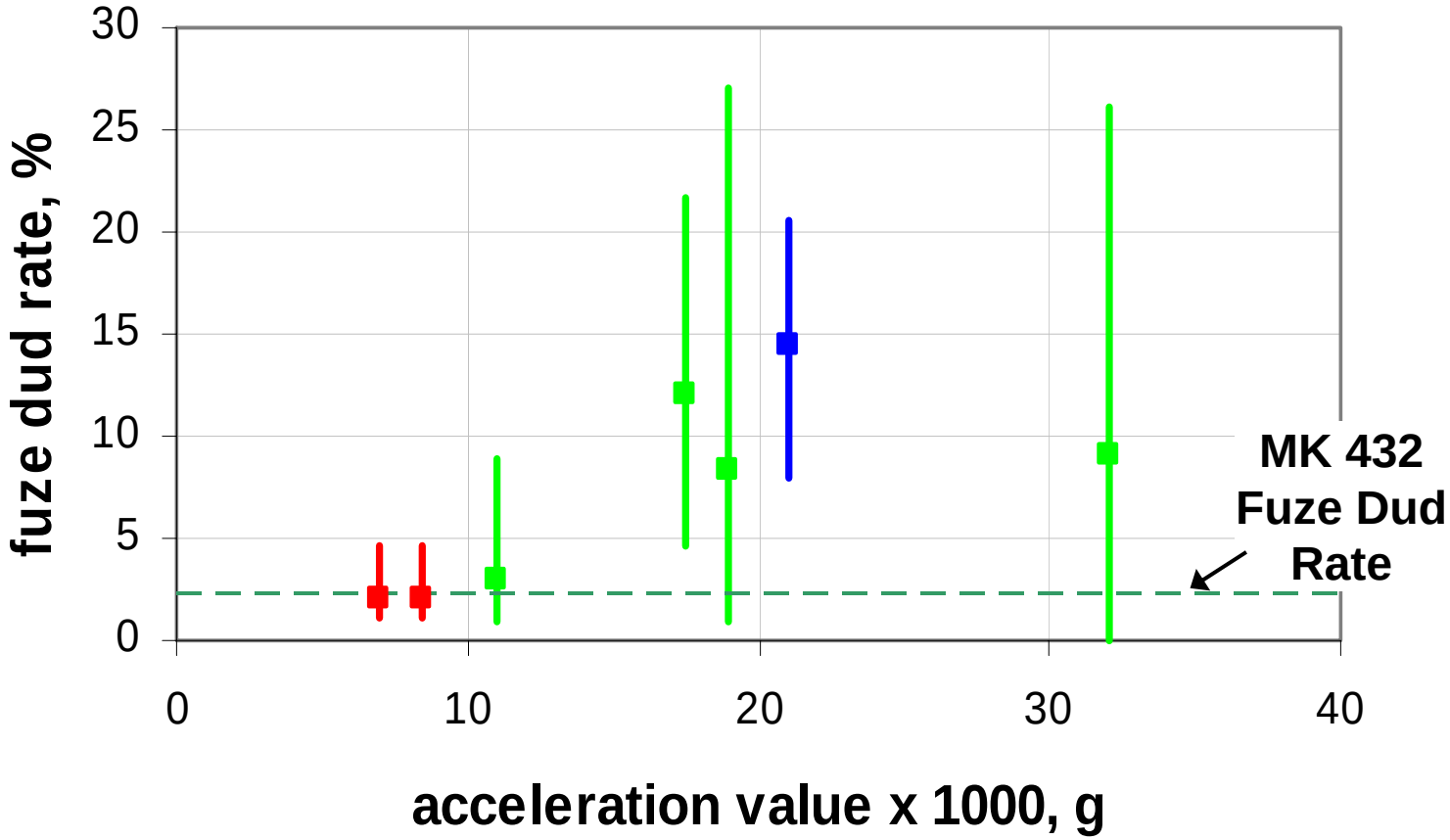
- The peak acceleration was found for each of the 10 impacts
- The mean of the 10 peak accelerations was found
- The 95% confidence interval was found for the mean

Stress Wave Amplification



- Certain projectile configurations amplify stress wave more than others

A Trend Exists



There is a trend in fuze performance depending on the mean peak acceleration value

Conclusions

- Correlation does exist between fuze functionality and projectile type
- Well packed loads with few joints will amplify stress wave, may cause low fuze function rates
- Loose loads / jointed loads will absorb stress wave, may cause high fuze function rates
- Continue to develop the Ringing Test as a simple and inexpensive screening method for projectile design

Future Testing

- Model stress wave caused by gun launch through a projectile
  - Observe how stress wave is amplified
- Plan to test production KE-ET rounds
  - Production rounds from Crane perform better than test rounds
  - Further validate the Ringing Test