



# 20<sup>th</sup> Annual Ground Vehicle Survivability Symposium



**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

## **Piezo Fuze Characterization**

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# Report Documentation Page

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| 19a. NAME OF RESPONSIBLE PERSON   |                                    |  |  |

- Review ARL Drop Test Method
- TARDEC Charge Circuit
- Temperature Effects on Fuze Sensitivity
- Alternate Modal Analysis Characterization

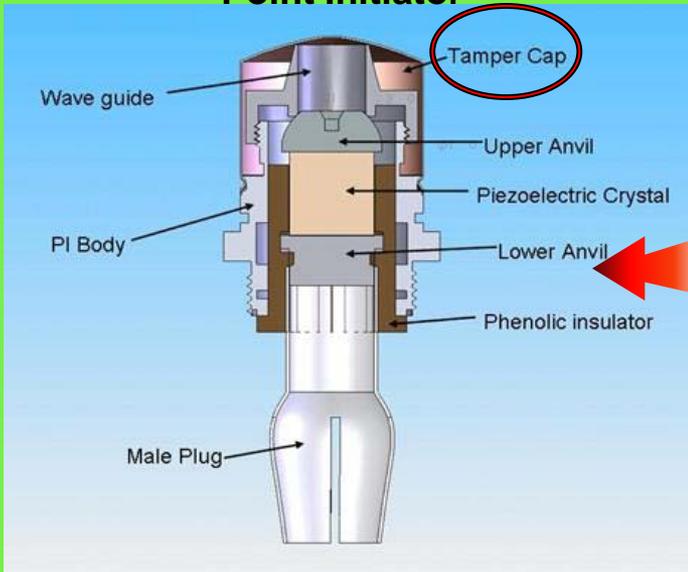
**BLUF:** Threat fuze sensitivity should be included in test planning for live fire evaluation and pre-detonation assessment.

Characterization of the Point Initiator's of Rocket Propelled Grenades allows TARDEC to sort threats for optimal test sequences and reduces uncertainty.

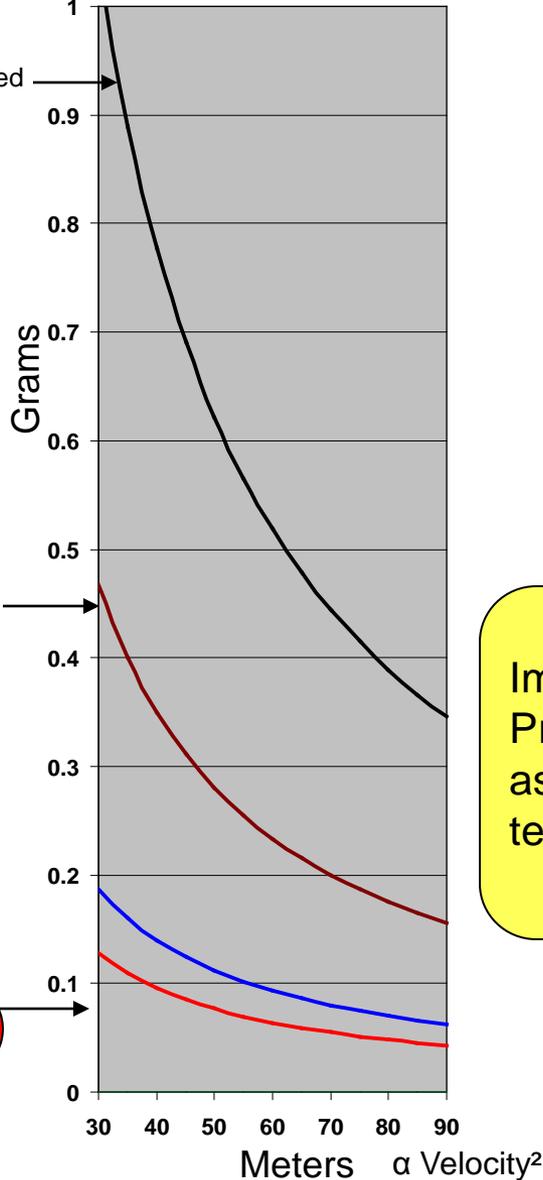
Drop Test Characterization Method is time consuming but required due to the variability in foreign threats

- Variability is a potential for misleading test results

## Point Initiator



## Grams on nose Vs distance from target for RPG-7Gs of different sensitivities



These rounds missed DSTL as they developed a suspended mass duding armor



These rounds missed developers of a net based duding armor

$KE = \frac{1}{2}MV^2$

Typical raindrop is 80mg



Instrument for non destructive testing of piezo before live fire tests

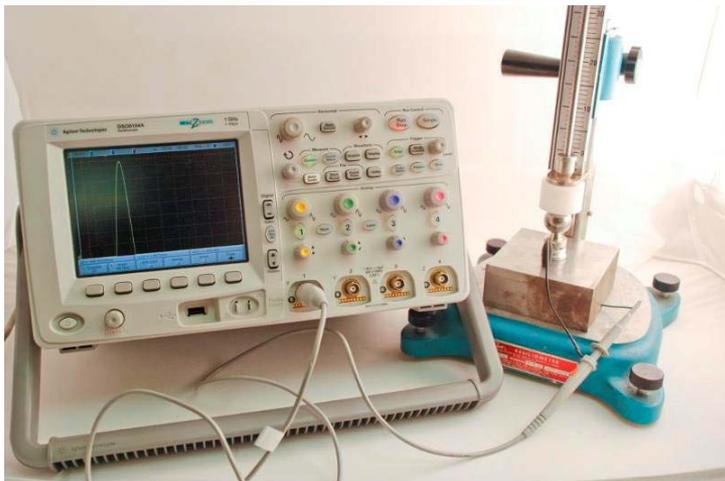


Point Initiator with Tamper Cap



Point Initiator with Tamper Cap Removed

Important for Pre-detonation assessment in test planning



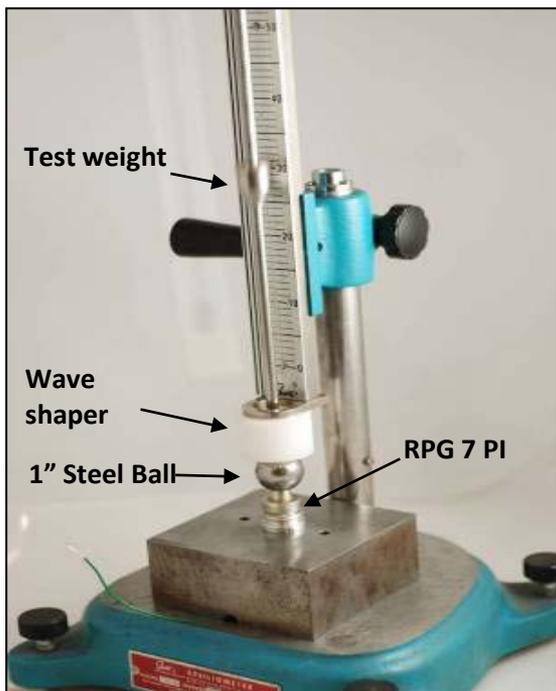
## U.S. Army Research Laboratory Test Method Setup

### Equipment

- Vertical Rebound Resilience Tester
- Oscilloscope
- 100:1 Test Probe
- 1" Steel Ball Bearing
- 1" Thick Low Density Polyethylene Wave Shaper
- Steel Block Base

### Setup Procedure & Test Procedure

- RPG-7 Point Initiator Sensitivity Test Operating Procedures prepared by Survive Engineering Company



Test setup and procedure optimization has been ongoing with ARL (continuous improvement).

## RPG-7 Sensitivity Classifications

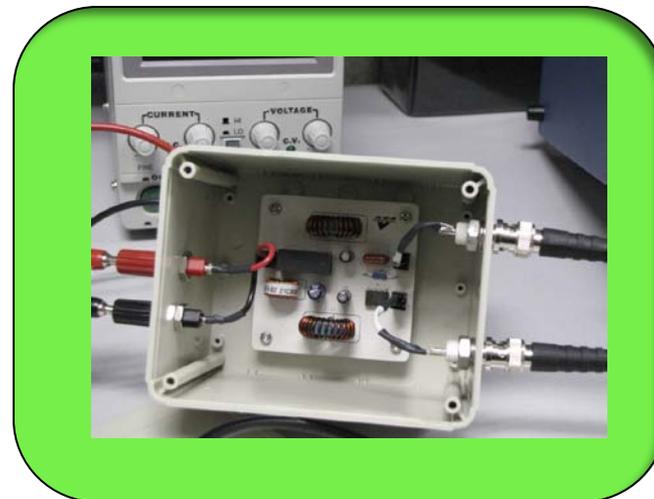
- Very Sensitive
- Sensitive
- Average
- Insensitive
- Very Insensitive

ARL recently improved the drop test method by adding a charge circuit

- Replaces the need to match the capacitance of the PI, Oscilloscope and Probe
- Prototype printed circuit board was designed by the GCVDI

• Charge Circuit data compared to Drop Test using the probe data - correlation is above 92%

## • Repeatability Variable / Challenges



Basic Charge Amp Circuit



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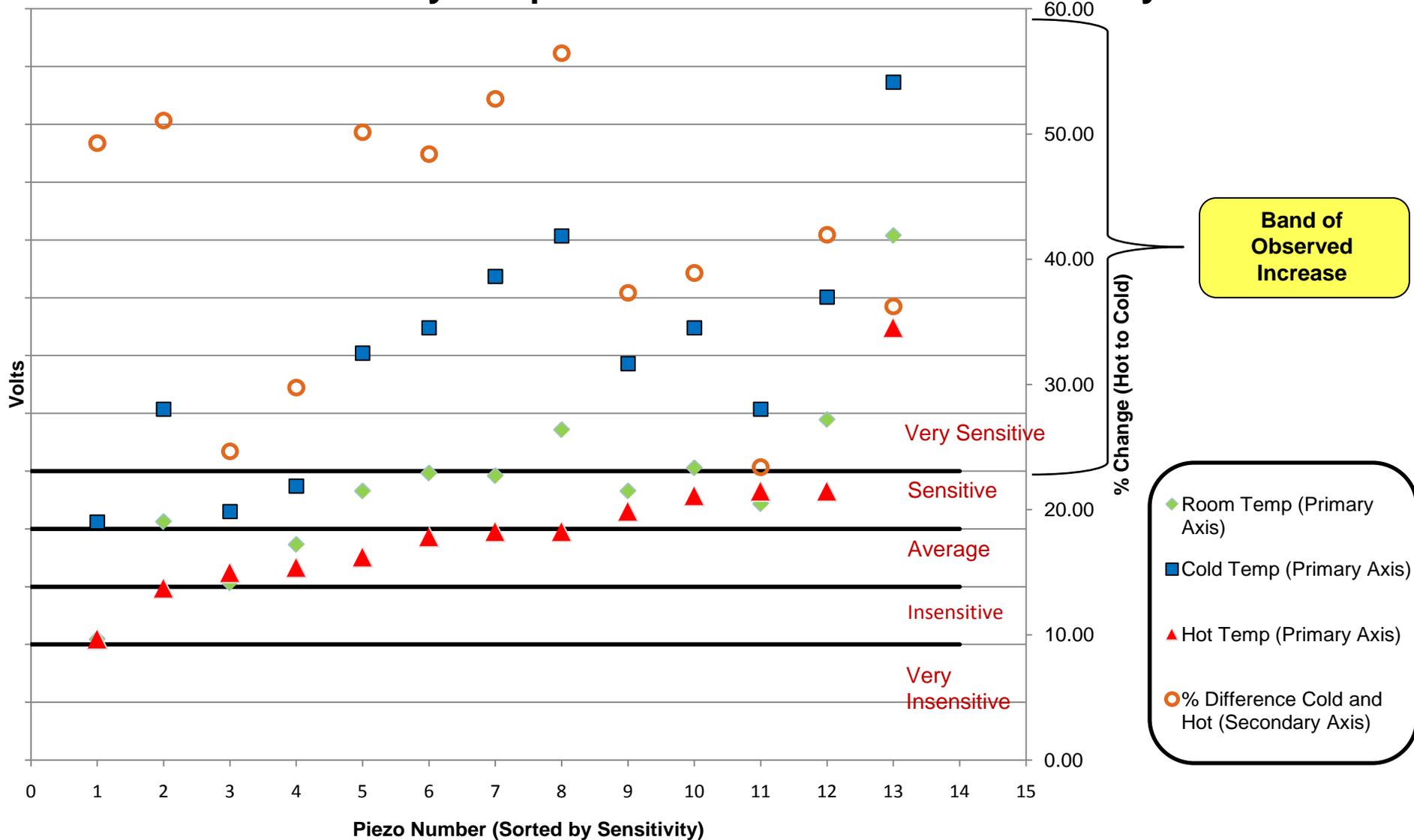


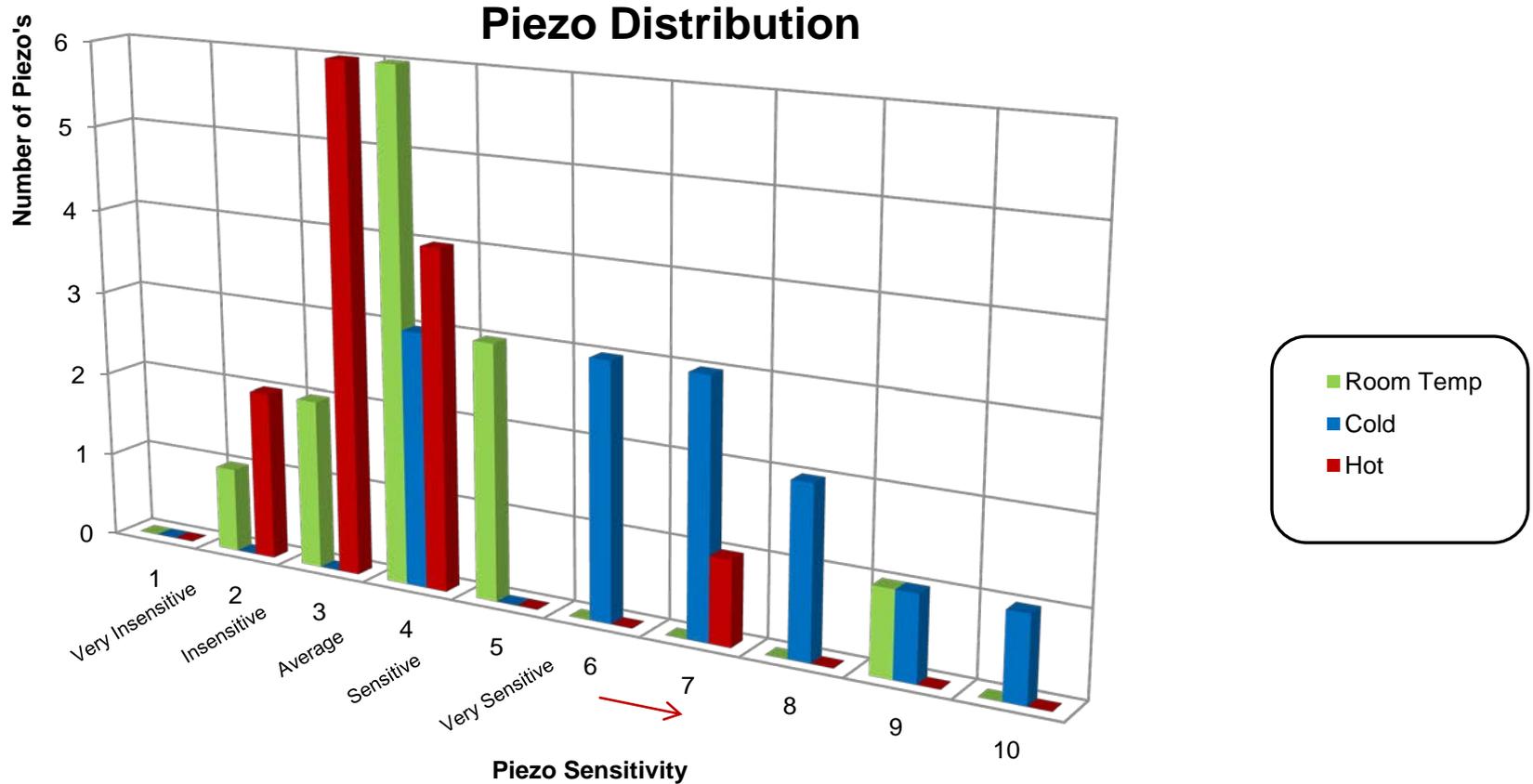
**BLUF – Temperature is a significant factor of sensitivity: Notable effects have been observed in the sensitivity of the Point Initiators utilizing temperature ranges.**

- The point initiators were tested in three different temperatures: Cold (near freezing), Hot (  $\sim 120^{\circ}$  ), and Room Temperature.
  - Baseline (Room Temperature  $\sim 75^{\circ}$  ) was conducted with no environmental alterations.
  - Decreased temperatures ( $\approx 40^{\circ}$  below baseline) were simulated using a freezer to cool the Point Initiators and steel block.
  - Increased temperatures ( $\approx 45^{\circ}$  above baseline) were simulated using an oven to heat the Point Initiators and steel block.
- The Point Initiators were ran through the drop test characterization method after they have been subjected to the environmental condition being tested.

**The sensitivity of the Point Initiator returned to the baseline sensitivity after returning to room temperature. Repeatable Effect**

## Preliminary Temperature Effects On Piezo Sensitivity

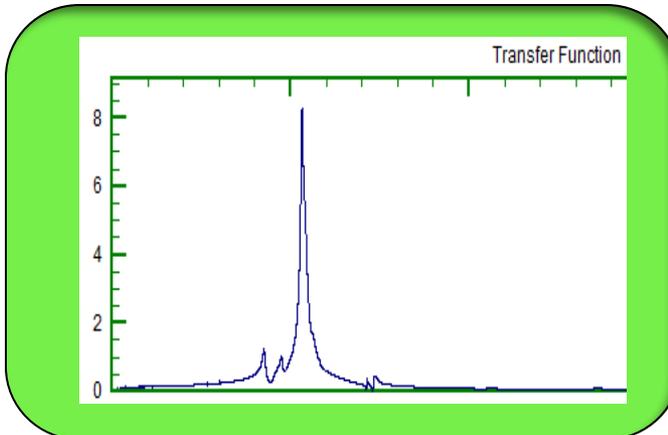
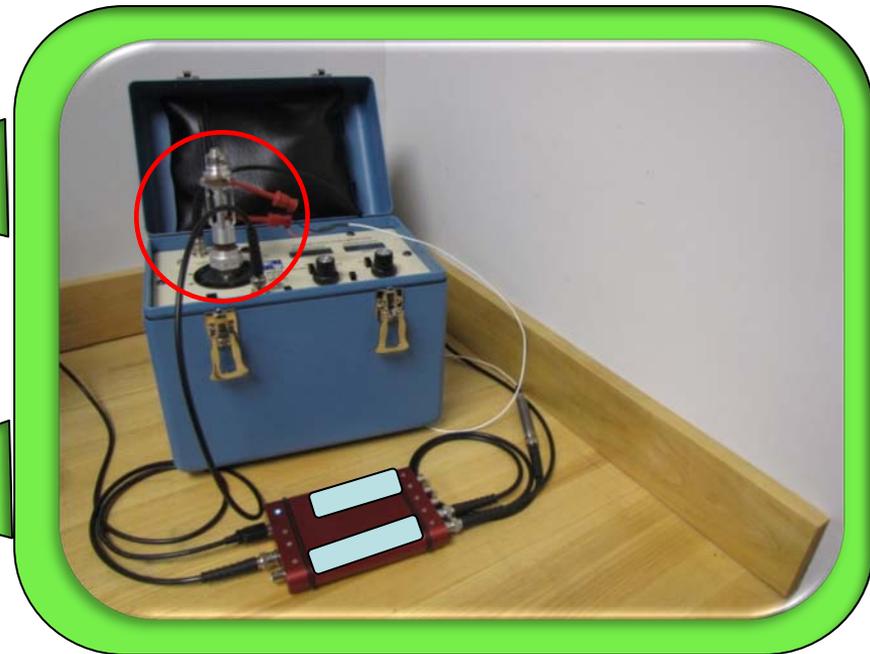




Three major reasonable considerations for future test planning for the relevant environment: Piezo Sensitivity, Altitude (Velocity), and Temperature (Increase in Piezo sensitivity).

The purpose of investigating the modal method is to determine if a non-destructive way of testing PI's is possible. If the Piezo output at its natural frequency correlates with the drop test data then it may be viable. The main advantage of the modal method would be that none of the natural characteristics of the Point Initiator are altered.

### Modal Test Setup



Piezo Holder Assembly

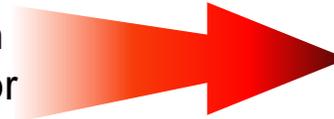
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## Modal Test Procedure

- Swept sine wave signal exciting the modal shaker
- Analyze the data using a real time analyzer (Fast Fourier Transform)
- Record the peak amplitude and frequency
- Compare modal results with data from drop test for potential correlation

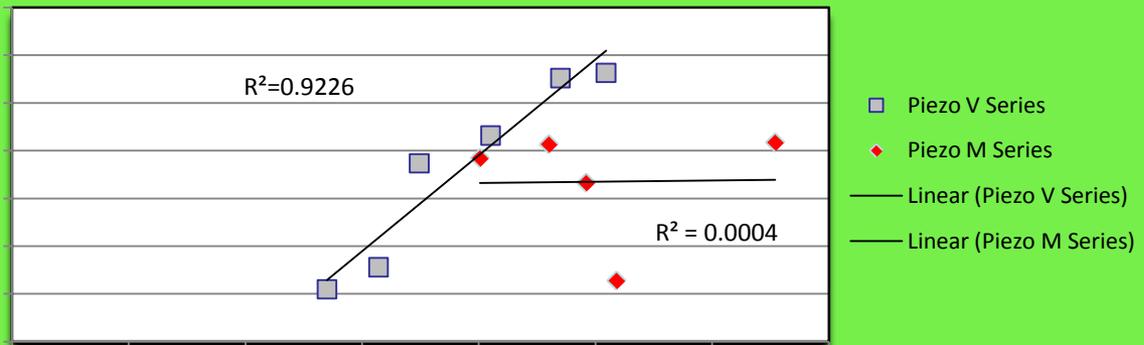
## Preliminary Observations

- The correlation of the V-Series was extremely high
- The correlation of the M-Series was extremely poor



Currently, these two series assemblies are believed to be identical. Observations have shown that the series data does not follow the same trendline. This may be due to different assembly procedures and /or different materials etc., and merits further investigation

Correlation of V-Series and M-Series to the ARL Drop Test Data using initial frequency spectra for discrimination

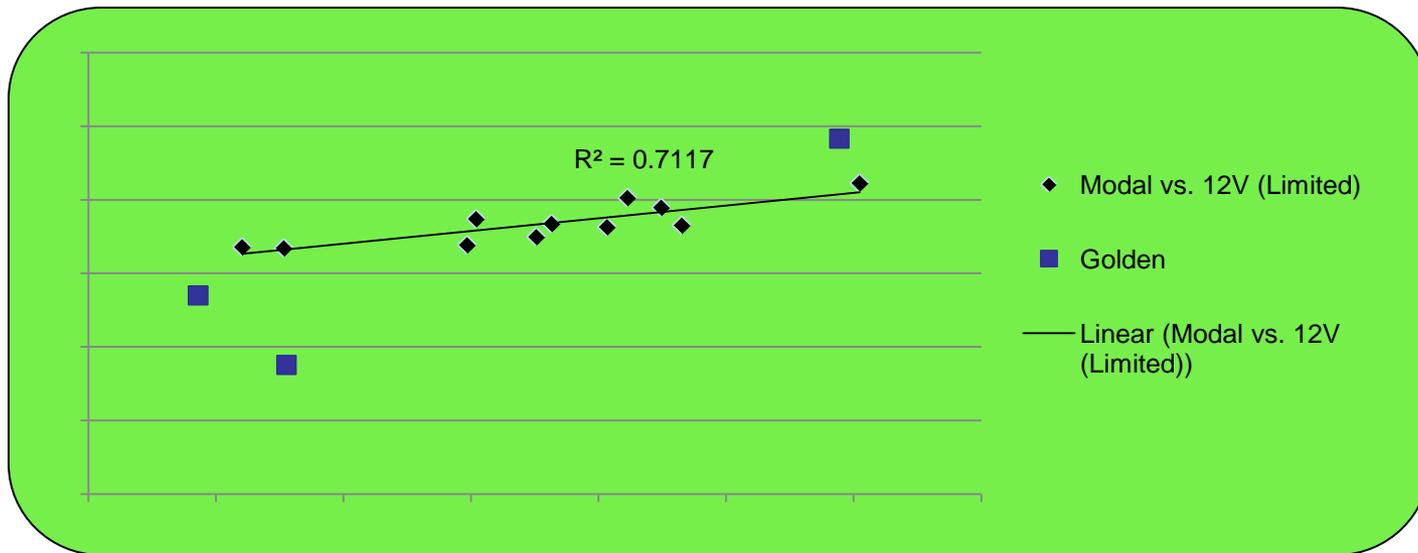


## Repeatability

- Repeatability of the drilled fixture is increasing and is approximately 80%
- Mass of the fixture has an affect on the test setup

## Correlation

- Correlation between the modal method and drop test method is increasing and currently around 70 %
- More samples are needed to gain a better understanding



Interesting results thus far, merits further investigation



# Questions ?