



- **Background**
- **IM Challenges**
- **Render Safe Procedures**
- **EOD Tools**
- **Shaped Charge Jet**
- **Conclusion**

- Development of appropriate procedures for the disposal of explosive ordnance are mandated by NATO STANAG 2143 (AEODP-10)
- As a result of Insensitive Munitions (IM) development, many munitions are being introduced with increasingly less shock sensitive energetics with increased critical diameters
- This poses problems for Explosive Ordnance Disposal (EOD) operations in conducting a successful Render Safe Procedure (RSP)
- EOD community understanding of what IM actually means

- Traditional EOD methods for disposal consist of a number of tried and trusted techniques used singly or sometimes in combination
  - shock initiation by donor charge
  - directed energy attack (e.g. shaped charge, EFP)
  - projectile attack.
  - thermal initiation charge
  - combinations of some of the above
- In addition EOD operations sometimes require a non-detonating response (Type IV to Type V IM response)
  - risk of detonation unacceptable
  - vital military installation
  - cultural site etc.



- Increasing proliferation of IM filled ERW
- Require rapid and reliable means of disposal
  - rapid battle field clearance
  - post operational clearance
  - in-situ disposal
  - casualty weapon disposal
- Current methods not appropriate



- NATO EOD Group area of concern
  - NATO nations access to RSPs
  - no procedures or guidance currently available
- NATO munitions to be marked with main fill type (AOP 2 and JOTP 70)
  - identifies filling type
  - assists with election of appropriate RSP
- Require rapid and reliable means of disposal
  - rapid battle field clearance
  - post operational clearance
  - in-situ disposal
  - casualty weapon disposal



- Are current weapons suitable?
  - existing systems effectiveness?
  - manufactured charges still viable?
  - modular user filled charge?
- Useful work already undertaken
  - US Navy Picture courtesy of Alford Technologies
  - EADS TDW
  - need to transition to generic guidance
  - make more comprehensive
  - review other techniques



RUJAG SM EOD Charges



BARRACUDA Charge



Alford's KRAKATOA Modular Charge



Alford's VULCAN Modular Charge

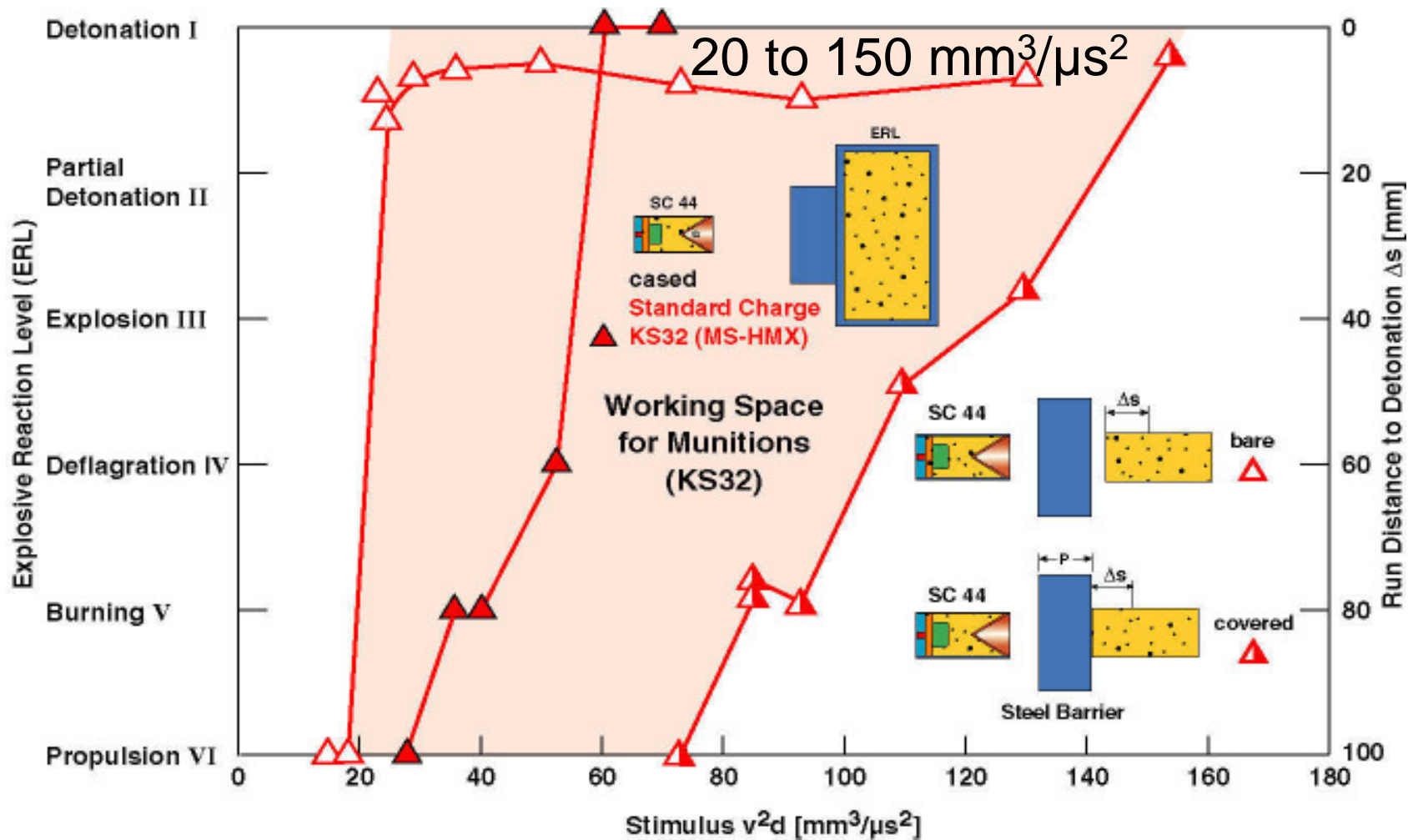
- Shaped charge jet initiation
- Held model critical value for explosive detonation:

$V^2d = \text{constant threshold}$

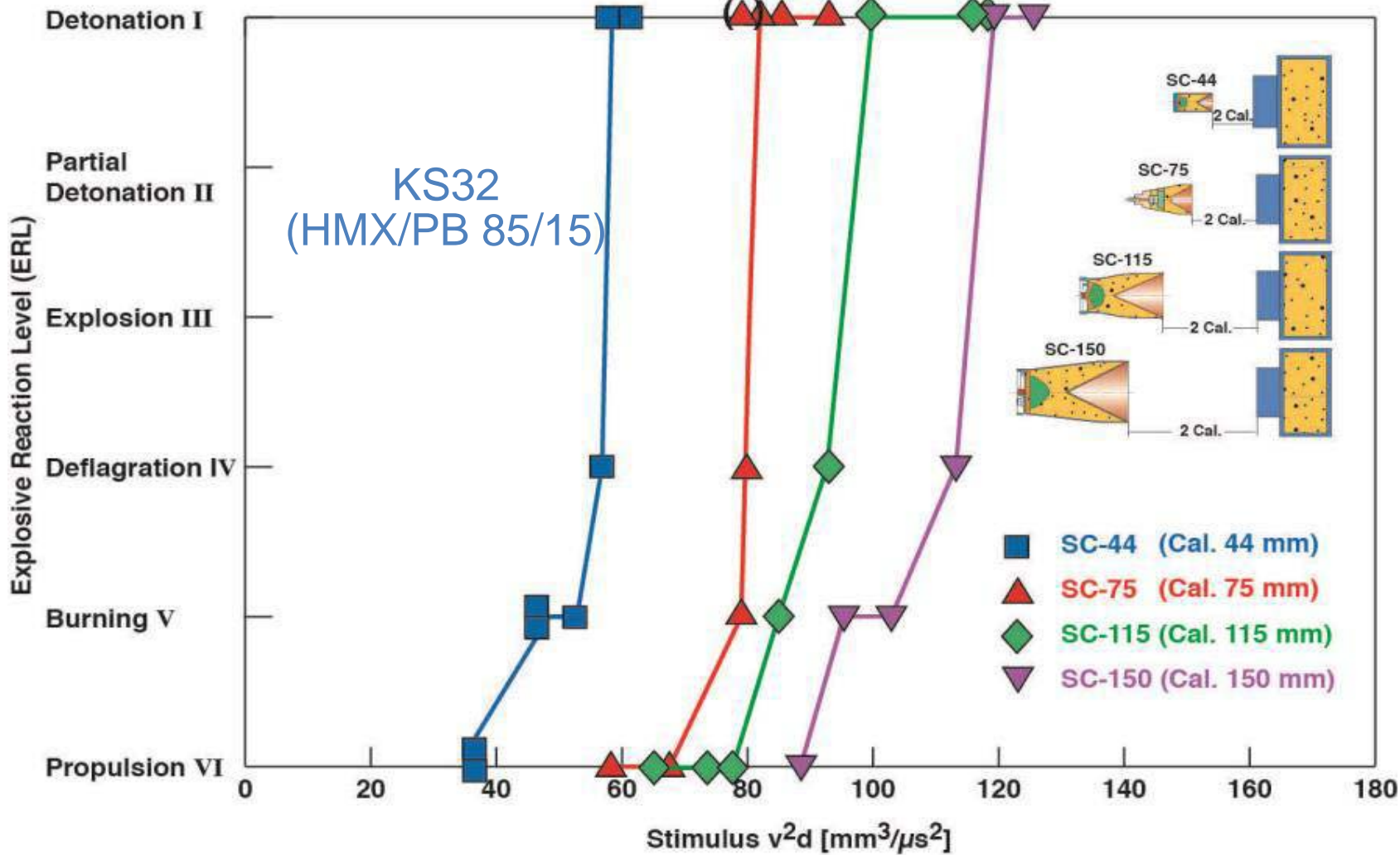
where,  $V$  = impact velocity,

$d$  = impactor diameter.



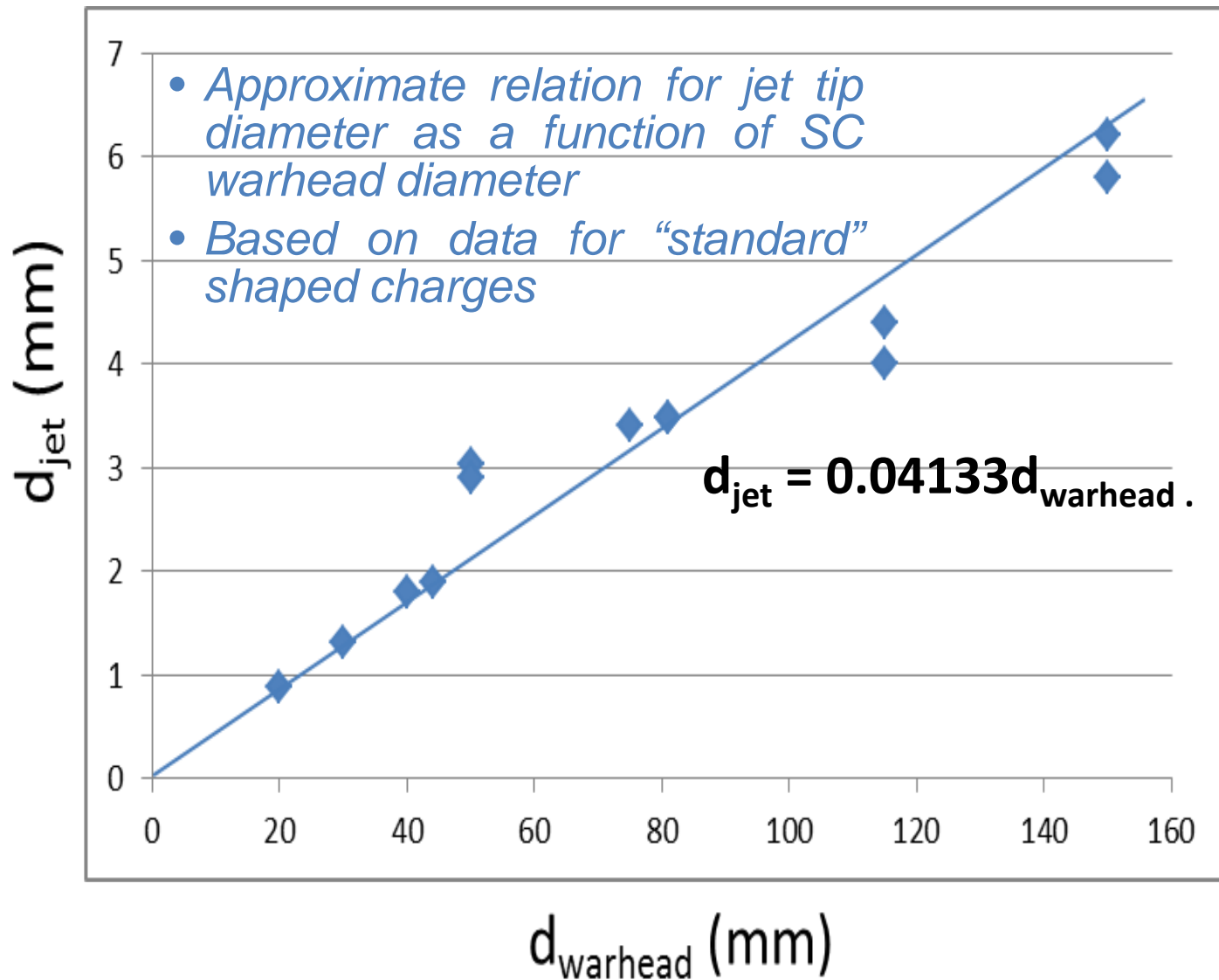


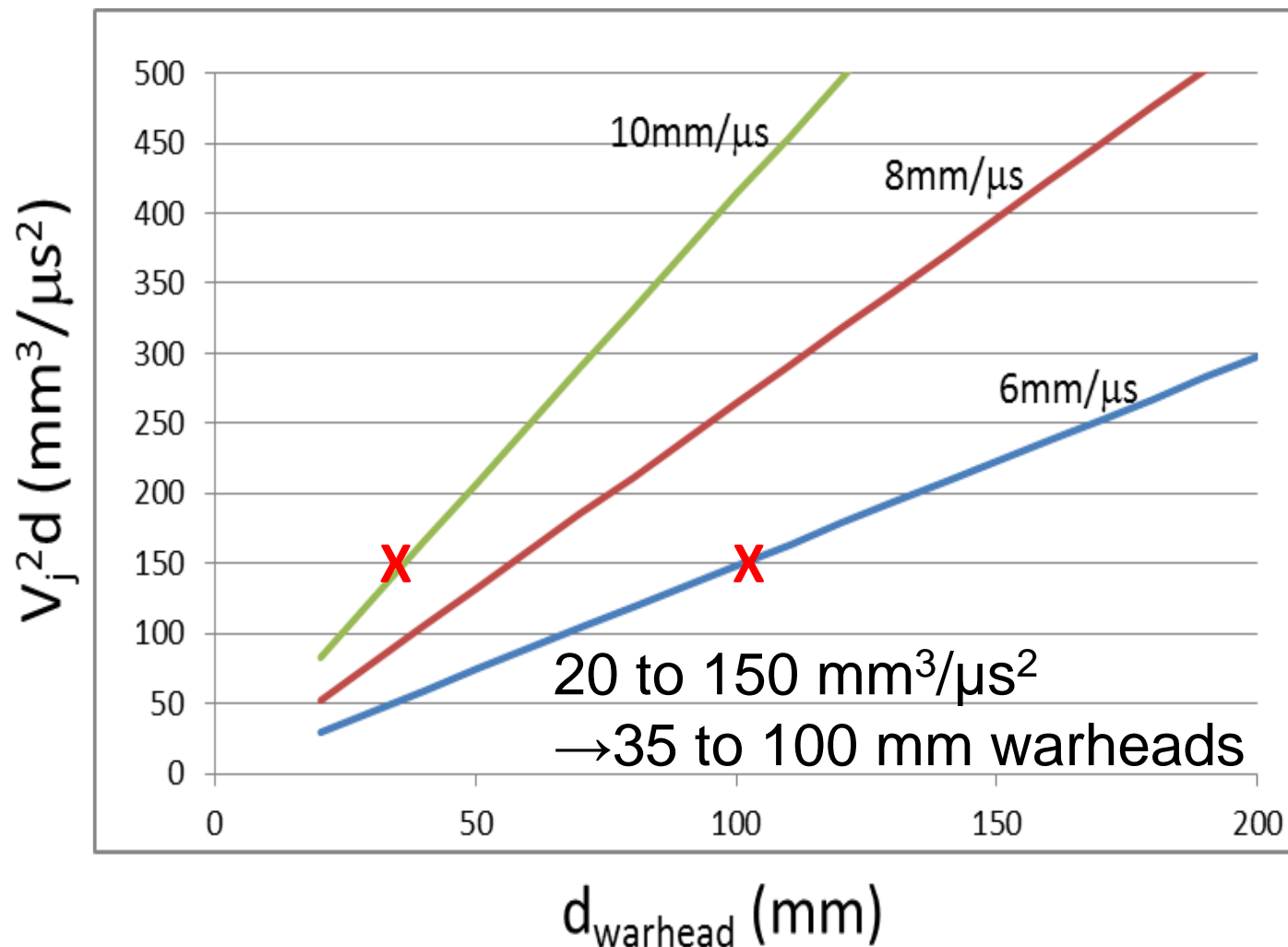
*Unconfined covered charges appear to be the most difficult to initiate!*



*Larger  $v^2d$  values required for initiation by larger shaped charges!*

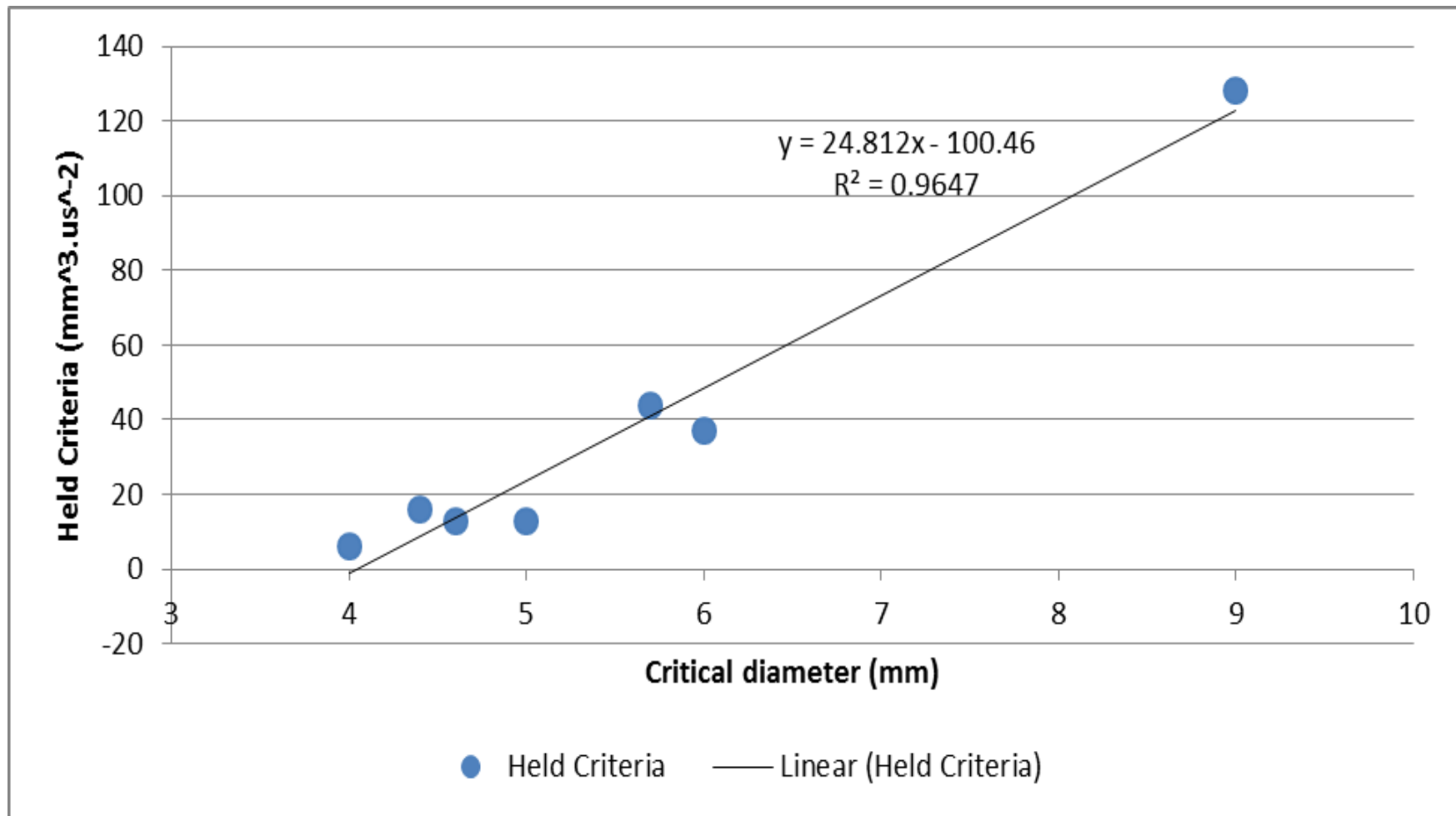
Arnold W., Rottenkolber E., Hartmann T., "Challenging  $v^2d$ ", 2015 Insensitive Munitions & Energetic Materials Technology Symposium, Rome, Italy, 18 – 21 May, 2015.





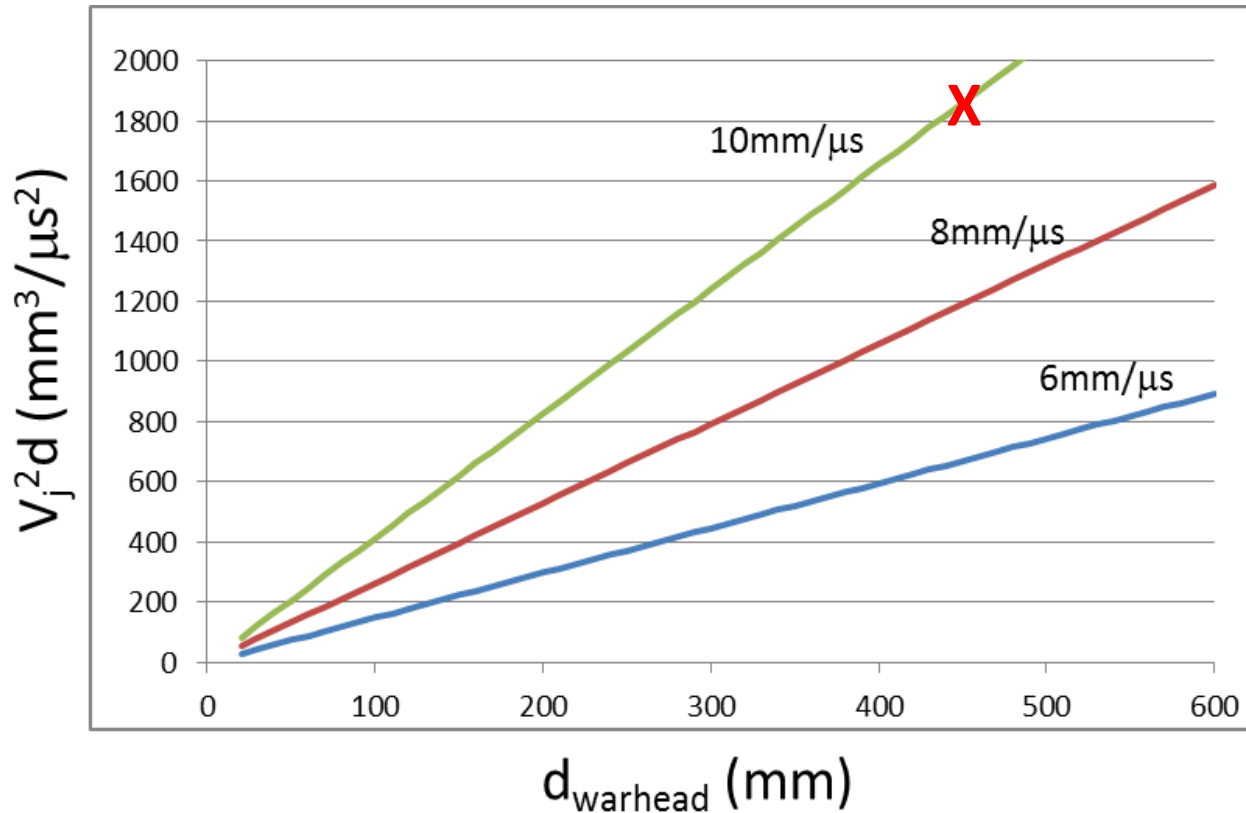
*Most items can be detonated with a reasonable 50mm shaped charge!*

## Held Criteria Correlation to Critical Diameter



# Shaped Charge Example

IMX-101: 66.04mm critical diameter  
Correlation gives 1854 mm<sup>3</sup>/μs<sup>2</sup>



*IMX-101 estimated to require a 450mm diameter to be detonated!*

# Conclusion

- IM compliant munitions do present an EOD challenge
- Reduced sensitiveness energetic materials require different considerations
  - rapid and reliable disposal
  - low order techniques
  - alternate methods of initiation
- Need to provide simple but effective guidance to EOD technicians
- Initially consider directed energy weapons (SCJ, EFP)
- Assess other EOD weapons and techniques
- Institutionalize process for addition of guidance into NATO and national Standards for EOD operations
- Work with guidance of NATO EOD group
- Support from other interested parties welcome, please contact authors

