

PRIMARY FRAGMENT CHARACTERIZATION TOOLS: A DDESB TECHNICAL PAPER 16 UPDATE

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US Army Corps
of Engineers.



DDESB TECHNICAL PAPER 16

- Analytical prediction of primary fragment characteristics
- Used in explosives safety site planning, test prediction, protective construction, and more
- Methods are detailed and extensive
- Implementation by hand calculation is tedious and prone to human error.
- TP 16 distribution to DoD and DoD Contractors Only.

Technical Paper No. 16

Revision 5

METHODOLOGIES FOR CALCULATING PRIMARY FRAGMENT CHARACTERISTICS



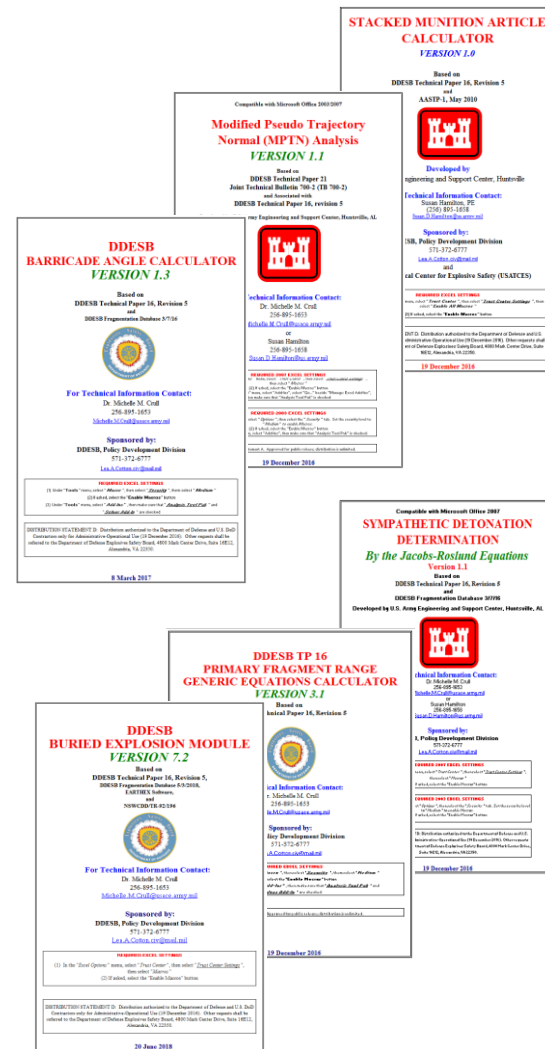
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Department of Defense Explosives Safety Board
Alexandria, VA
15 September 2016

Revision 5 – 15 September 2016

TECHNICAL PAPER 16 TOOLS

- Since Revision 3, TP 16 has included stand-alone Excel-based software tools.
- Formatted as excel template files (.xlt, .xlsm, .xlts)
- TP 16 Tools (in order of original release)
 - + Buried Explosion Module (BEM)
 - + Barricade Angle Calculator (BAC)
 - + Generic Equation Calculator (GEQ)
 - + Jacobs-Roslund Calculator (JRC)
 - + Modified Pseudo Trajectory Normal Calculator (MPTNC)
 - + Stacked Munition Article Calculator (SMAC)
- Distribution varies by tool
 - + 2 are Distribution Unlimited
 - + 4 are DoD and DoD Contractors Only



TECHNICAL PAPER 16 TOOLS – THINGS TO KNOW

- Each tool has a splash screen
 - + Title
 - + Version Number
 - + Technical Help Contact Number
 - + Version Date
 - + Computer Settings information
 - + Distribution Statement
 - + more
- Tools are occasionally updated
 - + Bug fixes
 - + New munition information
 - + Continual Improvement
- TP 16 Chapter 9: User Guides
- Check the DDESB website to obtain the newest versions

DDESB **BARRICADE ANGLE CALCULATOR** **VERSION 1.3**

Based on
DDESB Technical Paper 16, Revision 5
and
DDESB Fragmentation Database 3/7/16



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REQUIRED EXCEL SETTINGS

- (1) Under "Tools" menu, select "Macro", then select "Security", then select "Medium"
- (2) If asked, select the "Enable Macros" button
- (3) Under "Tools" menu, select "Add-Ins", then make sure that "Analysis ToolPak" and "Solver Add-In" are checked

DISTRIBUTION STATEMENT D: Distribution authorized to the Department of Defense and U.S. DoD Contractors only for Administrative-Operational Use (19 December 2016). Other requests shall be referred to the Department of Defense Explosives Safety Board, 4800 Mark Center Drive, Suite 16E12, Alexandria, VA 22350.

8 March 2017

BURIED EXPLOSION MODULE (BEM)

- Determines fragmentation/debris hazards resulting from buried detonations
 - + Crater or Camouflet?
 - + Fragmentation Distance
 - + Soil Ejecta Distance
 - + Non-essential Personnel Distance
- Multiple Burial Mediums (Soils and Water)
- Embedded Fragmentation Database
- Distribution Restricted - DoD and DoD Contractors Only

*Based on DDESB Technical Paper 16, Revision 5
(ENGLISH UNITS)*

BURIAL CHARACTERISTIC INPUTS		
BURIAL MEDIUM Soil <input type="text"/>	SOIL TYPE Dry Sand <input type="text"/> <small>(See TP 16, Revision 5 for soil details)</small>	DEPTH OF BURIAL (ft) 2.00 <input type="text"/>
EXPLOSIVE CHARGE INPUTS		
ITEM DESCRIPTION 100 lb GP Mk 1 Bomb <input type="text"/>		NUMBER OF ITEMS <input type="text"/>
DONOR CHARGE EXPLOSIVE TYPE Ammonia Dynamite (50% Strength) <input type="text"/>	TOTAL WEIGHT OF DONOR CHARGES (lbs) <input type="text"/>	HORIZONTAL DISTANCE (for pressure calcs) <input type="text"/>
VALUES USED IN BEM CALCULATIONS		
SINGLE ITEM NEW (lbs) <input type="text" value="65.00"/> ITEM DIAMETER (in) <input type="text" value="7.900"/> SINGLE ITEM MAXIMUM FRAG. WEIGHT (lbs) <input type="text" value="0.1165"/> SINGLE ITEM MAXIMUM FRAG. VELOCITY (ft/s) <input type="text" value="8,519"/>	TOTAL TNT WEIGHT USED (lbs) <input type="text" value="65.00"/> FRAGMENT WEIGHT USED IN CALCULATIONS (lbs) <input type="text" value="0.1165"/> FRAGMENT VELOCITY USED IN CALCULATIONS (ft/s) <input type="text" value="8,519"/>	
BURIED EXPLOSION MODULE OUTPUTS		
CRATER OR CAMOUFLET? <div style="border: 1px solid black; padding: 5px; display: inline-block; margin: 5px;">CRATER</div>		
Surface K328 Distance (ft) <input type="text" value="1,318.8"/> Buried Equiv. K328 (0.066 psi) <input type="text" value="844.8"/> ft Buried Equiv. K24 (2.3 psi) <input type="text" value="49.5"/> ft	TRUE CRATER RADIUS (ft) <input type="text" value="8"/> MAX. SOIL EJECTA DISTANCE (ft) <input type="text" value="436"/> MAX. FRAGMENT DISTANCE (ft) <input type="text" value="1,452"/>	NON-ESSENTIAL PERSONNEL DISTANCE (ft) <input type="text" value="1,452"/>
Pressure Values Greater of Soil Ejecta and Max. Frag. (1452 ft) <input type="text" value="0.0357"/> (psi) <input type="text" value="141.8"/> (dB) User-Entered Horizontal Distance (ft) <input type="text" value="-N/A-"/> (psi) <input type="text" value="-N/A-"/> (dB)	Note: Provide essential personnel equivalent K24 overpressure distance and protection from all fragments.	
WARNING MESSAGES		
Note 4: User-Entered Distance Out of Limits -- Extrapolated - Ref. TP 16		

BURIED EXPLOSION MODULE (BEM)

- Most Useful when...
 - + Item must be detonated in place but is too hazardous for unmitigated surface detonation
 - + Munitions Response Activities primarily but occasional use in RDT&E community
- Tips and Tricks...
 - + Burial can be achieved by adding a mound of soil above the item (ensure depth of burial is achieved in all directions)
 - + Camouflets are not required in all situations – burial can be used to mitigation fragmentation to a specified distance.

*Based on DDESB Technical Paper 16, Revision 5
(ENGLISH UNITS)*

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SINGLE ITEM NEW (lbs) <input type="text" value="65.00"/> ITEM DIAMETER (in) <input type="text" value="7.900"/> SINGLE ITEM MAXIMUM FRAG. WEIGHT (lbs) <input type="text" value="0.1165"/> SINGLE ITEM MAXIMUM FRAG. VELOCITY (ft/s) <input type="text" value="8.519"/>	TOTAL TNT WEIGHT USED (lbs) <input type="text" value="65.00"/> FRAGMENT WEIGHT USED IN CALCULATIONS (lbs) <input type="text" value="0.1165"/> FRAGMENT VELOCITY USED IN CALCULATIONS (ft/s) <input type="text" value="8.519"/>	
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WARNING MESSAGES		
Note 4: User-Entered Distance Out of Limits -- Extrapolated - Ref. TP 16		

BARRICADE ANGLE CALCULATOR (BAC)

- Determines cross-sectional barricade configuration to contain fragments within a specified distance given:
 - + Barricade height above munition or
 - + Horizontal distance between munition and barricade wall
 - + Currently considers Max. Frag. Distances only
- Uses a tabularized embedded fragment trajectory approximation
- Embedded Fragmentation Database
- Distribution Restricted - DoD and DoD Contractors Only

ENGLISH UNITS

Note: White cells are user input cells. All other cells are calculated.

SELECT ITEM DESCRIPTION 155 mm M107 (Composition B filled)	SELECT UNITS English
SELECT INITIATION MODE Design Mode	ENTER FRAGMENT DISTANCE (ft) 2450
	NUMBER OF ROUNDS Single
SINGLE ITEM MAXIMUM FRAGMENT WEIGHT (lbs) 0.664101 SINGLE ITEM MAXIMUM FRAGMENT VELOCITY (ft/s) 3,584.4 SINGLE ITEM MAX FRAGMENT DIST. (MFD-H) (ft) 2,630.0	
FRAGMENT WEIGHT USED IN CALCULATIONS (lbs) 0.664101 FRAGMENT VELOCITY USED IN CALCULATION (ft/s) 3,584.4 MAX FRAGMENT DIST. FOR CALCULATION (ft) 2,630.0	
BARRICADE ANGLE	
MEASURED FROM HORIZONTAL (°)	46
MEASURED FROM VERTICAL (°)	44
BARRICADE LOCATION	
SELECT KNOWN DISTANCE Horizontal Distance, X	Horizontal Distance to Barricade, X (ft) 10.0 Vertical Distance to Top of Barricade, Y (ft) 10.4

X = Distance to barricade
Y = Distance to top of barricade from center of round

BARRICADE ANGLE CALCULATOR (BAC)

- Most Useful when...
 - + Barricades must be designed dynamically to meet specific needs on a case-by-case basis
 - + RDT&E and Munitions Response applications
- Tips and Tricks...
 - + A plan-view geometry analysis should always be performed in addition to using the BAC.
- Future Updates...
 - + Navy funded updates to implement barricades for HFD.

ENGLISH UNITS

Note: White cells are user input cells. All other cells are calculated.

SELECT ITEM DESCRIPTION 155 mm M107 (Composition B filled)	SELECT UNITS English
SELECT INITIATION MODE Design Mode	ENTER FRAGMENT DISTANCE (ft) 2450
	NUMBER OF ROUNDS Single
SINGLE ITEM MAXIMUM FRAGMENT WEIGHT (lbs) 0.664101	
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SINGLE ITEM MAX FRAGMENT DIST. (MFD-H) (ft) 2,630.0	
FRAGMENT WEIGHT USED IN CALCULATIONS (lbs) 0.664101	
FRAGMENT VELOCITY USED IN CALCULATION (ft/s) 3,584.4	
MAX FRAGMENT DIST. FOR CALCULATION (ft) 2,630.0	
BARRICADE ANGLE	
MEASURED FROM HORIZONTAL (°) 46	
MEASURED FROM VERTICAL (°) 44	
BARRICADE LOCATION	
SELECT KNOWN DISTANCE Horizontal Distance, X	Horizontal Distance to Barricade, X (ft) 10.0
	Vertical Distance to Top of Barricade, Y (ft) 10.4

$X = \text{Distance to barricade}$

$Y = \text{Distance to top of barricade from center of round}$

GENERIC EQUATION CALCULATOR (GEQ)

- Provides a worst-case estimate of fragmentation effects based on known munition properties.
 - + Compares the NEW and/or diameter to those of hundreds of other munition items
 - + Uses trends in the data to approximate MFD-H and HFD
 - + Can also determine a maximum permitted NEW and/or diameter based on available distance
 - + Also able to provide estimates of required thicknesses for barricades and engineering controls.
- Distribution Unlimited – Publicly Releasable

**PRIMARY FRAGMENT RANGE GENERIC EQUATIONS CALCULATOR
VERSION 3.1**

INPUTS

Munition Description <input type="text"/>	CHECK KNOWN INFORMATION (i.e. NEW and/or Diameter) <input checked="" type="checkbox"/> NEW Enter actual NEW vice TNT Equivalent NEW <input checked="" type="checkbox"/> Diameter	ENTER KNOWN INFORMATION (i.e. NEW and/or Diameter) NEW (lb) <input type="text" value="0.00001"/> Diameter (in) <input type="text" value="5"/>
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SELECT UNITS
ENGLISH

ENGLISH UNITS

	Robust (ft)	EHC (ft)	Non-Robust (ft)
Maximum Fragment Distance - Horizontal (MFD-H)			
Based On NEW Entered <small>(Eq 4-1, 4-3, and 4-5)</small>	Out of Limits	Out of Limits	Out of Limits
Based On Diameter Entered <small>(Eq 4-7, 4-9, and 4-11)</small>	2,349.3	2,312.4	1,554.4
<i>Maximum Calculated Distance</i>	<i>(ft)</i> 2,349.3	<i>(ft)</i> 2,312.4	<i>(ft)</i> 1,554.4
Hazardous Fragment Distance (HFD)			
Based On NEW Entered <small>(Eq 4-13, 4-15, and 4-17)</small>	Out of Limits	Out of Limits	Out of Limits
Based On Diameter Entered <small>(Eq 4-19, 4-21, and 4-23)</small>	416.7	272.2	302.3
<i>Maximum Calculated Distance</i>	<i>(ft)</i> 416.7	<i>(ft)</i> 272.2	<i>(ft)</i> 302.3
Maximum Fragment Distance - Vertical (MFD-V)			
Based on Maximum Calculated MFD-H (ft) <small>(Eq 4-25)</small>			
<i>Maximum Calculated Distance</i>	<i>(ft)</i> 1,772.0	<i>(ft)</i> 1,745.1	<i>(ft)</i> 1,189.5

Note: "Out of Limits" indicates that the user-entered information is outside of the valid limits of the methodology as specified on the notes page.

SI UNITS

NEW (kg) <input type="text" value="0.00"/> User Entered Value	Diameter (mm) <input type="text" value="127.00"/> User Entered Value
---	--

	Robust (m)	EHC (m)	Non-Robust (m)
Maximum Fragment Distance - Horizontal (MFD-H)			
Based On NEW Entered <small>(Eq 4-1, 4-3, and 4-5)</small>	Out of Limits	Out of Limits	Out of Limits
Based On Diameter Entered <small>(Eq 4-7, 4-9, and 4-11)</small>	716.0	704.8	473.8
<i>Maximum Calculated Distance</i>	<i>(m)</i> 716.0	<i>(m)</i> 704.8	<i>(m)</i> 473.8
Hazardous Fragment Distance (HFD)			
Based On NEW Entered <small>(Eq 4-13, 4-15, and 4-17)</small>	Out of Limits	Out of Limits	Out of Limits
Based On Diameter Entered <small>(Eq 4-19, 4-21, and 4-23)</small>	127.0	83.0	92.1
<i>Maximum Calculated Distance</i>	<i>(m)</i> 127.0	<i>(m)</i> 83.0	<i>(m)</i> 92.1
Maximum Fragment Distance - Vertical (MFD-V)			
Based on Maximum Calculated MFD-H (m) <small>(Eq 4-25)</small>			
<i>Maximum Calculated Distance</i>	<i>(m)</i> 540.1	<i>(m)</i> 531.9	<i>(m)</i> 362.5

Note: "Out of Limits" indicates that the user-entered information is outside of the valid limits of the methodology as specified on the notes page.

WARNINGS

NEW value is outside the valid range for Robust Items
NEW value is outside the valid range for EHC Items
NEW value is outside the valid range for Non-robust Items
USE OF THIS TOOL IS NOT PERMITTED OUTSIDE VALID RANGES.

JACOBS-ROSLUND CALCULATOR (JRC)

- Determines if propagation by fragment strike is likely to be cause by a selected donor munition.
 - + Compares donor to each munition in the fragmentation database.
 - + Displays a yes/no response for both intentional and unintentional detonations
- Embedded Fragmentation Database
- Requires ability to run macros
- Distribution Restricted - DoD and DoD Contractors Only

Input Units:	English Units	Calc By:		Date:	
Donor Munition:	10 in Cannonball Shell	Checked By:		Date:	
Distance b/w Rounds:	15 ft				
Multiple Rounds??	No				

Donor Munition Properties		Database Values				
Fragment Type		Initial Velocity (ft/s)	Striking Velocity (ft/s)	Fragment Weight (lb)	Fragment Diameter (in)	Fragment Diameter (mm)
Maximum Wt Frag - Intentional Detonations		1659	1633	3.5556	2.67	67.91
Design Wt (95% CL) Frag - Unintentional Detonations		1659	1617	0.8186	1.64	41.62

[Show/Hide JR Coefficients](#)

Exposed Munition Properties and Critical Velocity Calculations
 The following calculations use the Jacobs-Roslund methodologies to determine the critical fragment velocity required to cause

User Entered Exposed Munition Properties				Critical Fragment Velocities				Is Donor Likely to Cause Propagation???	
Munition	Explosive Type	Wall Thickness [^]		Max Wt Frag		Design Wt. Frag		Max Wt Frag	Design Wt Frag
		(in)	(mm)	V _c (m/sec)	V _c (ft/sec)	V _c (m/sec)	V _c (ft/sec)		

Notes: [^]Wall Thickness should be equal to the thinnest case thickness of the exposed item.

[Clear Results](#) [Calculate](#)

Database Exposed Munition Properties				Critical Fragment Velocities				Is Donor Likely to Cause Propagation???	
Munition	Explosive Type	Wall Thickness [^]		Max Wt Frag		Design Wt. Frag		Max Wt Frag	Design Wt Frag
		(in)	(mm)	V _c (m/sec)	V _c (ft/sec)	V _c (m/sec)	V _c (ft/sec)		
1 Pounder Common Mk 2	Black Powder	0.39	9.9060198	914	2997	1220	4002	No	No
10 in Cannonball Shell	Black Powder	1.8	45.720091	1151	3775	1714	5622	No	No
100 lb Parrott Projectile	Black Powder	1.25	31.750064	1058	3471	1521	4990	No	No
3 in Stokes (Black Powder)	Black Powder	0.19	4.8260097	880	2887	1150	3772	No	No
9 in Cannonball Shell	Black Powder	1.6	40.640081	1117	3664	1644	5393	No	No

JACOBS-ROSLUND CALCULATOR (JRC)

- Most Useful when...
 - + Planning specific storage scenarios or evaluating risks associated with two concurrent operations
 - + Determination is being made of the maximum credible event (MCE)

- Tips and Tricks...
 - + If only interested in a single Donor/Exposed Item combination, add the exposed item as a user-entered munition. This uses no macros and makes it easy to find the exposed item your looking for.

Input Units: English Units		Calc By:		Date:	
Donor Munition: 10 in Cannonball Shell		Checked By:		Date:	
Distance b/w Rounds: 15 ft					
Multiple Rounds?? No					

Donor Munition Properties		Database Values				
Fragment Type		Initial Velocity (ft/s)	Striking Velocity (ft/s)	Fragment Weight (lb)	Frag Diameter (in)	Frag Diameter (mm)
Maximum Wt Frag - Intentional Detonations		1659	1633	3.5556	2.67	67.91
Design Wt (95% CL) Frag - Unintentional Detonations		1659	1617	0.8186	1.64	41.62

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User Entered Exposed Munition Properties				Critical Fragment Velocities				Is Donor Likely to Cause Propagation???	
Munition	Explosive Type	Wall Thickness ^A		Max Wt Frag		Design Wt. Frag		Max Wt Frag	Design Wt Frag
		(in)	(mm)	V _c (m/sec)	V _c (ft/sec)	V _c (m/sec)	V _c (ft/sec)		

Notes: ^AWall Thickness should be equal to the thinnest case thickness of the exposed item.

[Clear Results](#) [Calculate](#)

Database Exposed Munition Properties				Critical Fragment Velocities				Is Donor Likely to Cause Propagation???	
Munition	Explosive Type	Wall Thickness ^A		Max Wt Frag		Design Wt. Frag		Max Wt Frag	Design Wt Frag
		(in)	(mm)	V _c (m/sec)	V _c (ft/sec)	V _c (m/sec)	V _c (ft/sec)		
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9 in Cannonball Shell	Black Powder	1.6	40.640081	1117	3664	1644	5393	No	No

MODIFIED PSEUDO TRAJECTORY NORMAL CALCULATOR (MPTNC)

- Approximates HFD based on test data per procedures from TB 700-2.
 - + MPTN methodology is discussed in DDESB TP 21
 - + Quickly sorts and analyzes debris data
 - + Requires user to input frag weight, radial distance from ground zero, and angle (location) of each piece of debris.
- Requires ability to run macros
- Distribution Unlimited – Available for Public Release

Modified Pseudo Trajectory Normal (MPTN) Analysis

Input Units: English Units Calc By: SDH Date: 1/29/2014
 Test Description: Example Item Check By: Date:

Sympathetic Detonation Test Results Clear Test Data Insert Rows
 Test Date: 1/1/2014

Frag # (Not Req'd)	Distance (ft)	Weight (lb)	Angle (Degrees)	Description (Not Required)	X	Y	Angle (Radians)	Distance (m)	Weight (gm)
44	187.58	0.02	89	Piece of plastic lifting lug	3.27	187.55	1.553	57.1716	7.4000
43	76.25	0.26	89	Piece of plastic liner from supplemental charge	1.33	76.24	1.553	23.2399	120.0000
46	243.17	0.37	89	Piece of case	4.24	243.13	1.553	74.1146	167.6000
47	526.75	2.89	89	Piece of case	9.19	526.67	1.553	160.5456	1311.4000
42	769.67	21.34	90	Bottom of #6 case (red)	0.00	769.67	1.571	234.5840	9677.1000
45	202.33	0.03	91	Piece of case	-3.53	202.30	1.588	61.6672	12.4000
38	426.25	14.47	125	Bottom of #7 case (brown)	-244.49	349.16	2.182	129.9147	6562.5000

Modified Pseudo Trajectory Normal (MPTN) Analysis

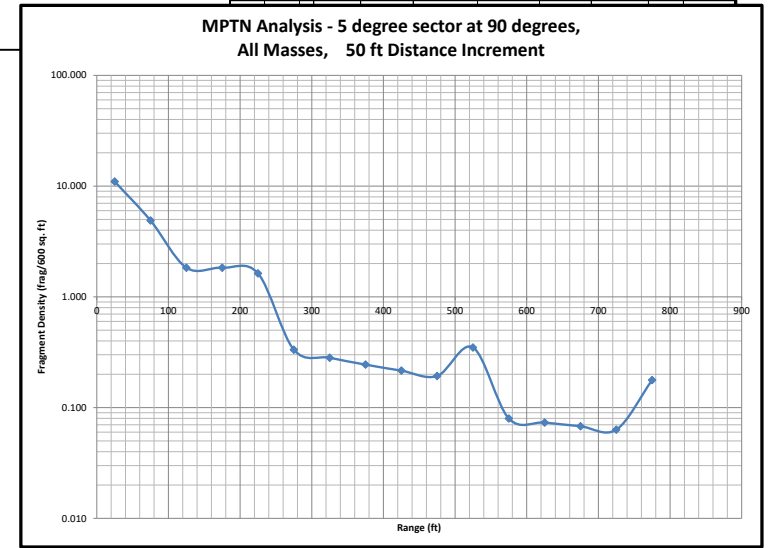
Munition: Example Item Calc By: SDH Date: 1/29/2014
 Checked By: Date:

5 Degree Sector at 90.00 degrees
 Distance Increments 50 ft
 Min Mass for 50 lb Frag 0.22 lb - default value 0.22 lb
 Ignore Min Mass Requirements? yes

Notes: PTN = Number of pieces in sector + Number of pieces that flew through sector
 MPTN = Number of pieces in sector + 1/3 number of pieces that flew through sector
 PTN Density = PTN/Area(600 sq ft)
 MPTN Density = MPTN/Area(600 sq ft)

Populate Plot Clear Inputs

Relevant Test Data	Distance Range (ft)	No. Points in Distance Range	Pseudo Trajectory Normal (PTN)	Modified Pseudo Trajectory Normal (MPTN)	Area of Sector (ft ²)	Area/600 (ft ²)	PTN Density (frag/ft ²)	Ravg (ft)	MPTN Density (frag/ft ²)
44 187.58 0.016317 89	0 50	6.00	2.000	2.000	09.08	0.182	33.002	25	11.001
43 76.25 0.2646 89	50 100	1	6.00	2.667	327.25	0.545	11.001	75	4.889
46 243.17 0.369558 89	100 150	5.00	1.667	1.667	545.42	0.909	5.500	125	1.833
47 526.75 2.891637 89	150 200	1	5.00	2.333	763.58	1.273	3.929	175	1.333
42 769.67 21.3801 90	200 250	2	4.00	2.667	981.75	1.636	2.445	225	1.630
45 202.33 0.027342 91	250 300		2.00	0.667	1199.91	2.000	1.000	275	0.333
	300 350		2.00	0.667	1418.08	2.363	0.846	325	0.282
	350 400		2.00	0.667	1636.25	2.727	0.733	375	0.244
	400 450		2.00	0.667	1854.41	3.091	0.647	425	0.216
	450 500		2.00	0.667	2072.58	3.454	0.579	475	0.193
	500 550	1	2.00	1.333	2290.74	3.818	0.524	525	0.349
	550 600		1.00	0.333	2508.91	4.182	0.239	575	0.080
	600 650		1.00	0.333	2727.08	4.545	0.220	625	0.073



MODIFIED PSEUDO TRAJECTORY NORMAL CALCULATOR (MPTNC)

- Most Useful when...
 - + Determining HFD based on test data
 - + HFD required for Hazard Classification, analysis of test data
- Tips and Tricks...
 - + Default parameters on the Analysis sheet are as required per the TB 700-2.
 - + Strict application of TB 700-2 process does not always work well for primary fragmentation.
 - + Adjusting some of the default parameters can make the process work better in some instances.

Modified Pseudo Trajectory Normal (MPTN) Analysis

Input Units: English Units Calc By: SDH Date: 1/29/2014
 Test Description: Example Item Check By: Date:

Synthetic Detonation Test Results Clear Test Data Insert Rows
 Test Date: 1/1/2014

Frag # (Not Req'd)	Distance (ft)	Weight (lb)	Angle (Degrees)	Description (Not Required)	X	Y	Angle (Radians)	Distance (m)	Weight (gm)
44	187.58	0.02	89	Piece of plastic lifting lug	3.27	187.55	1.553	57.1716	7.4000
43	76.25	0.26	89	Piece of plastic liner from supplemental charge	1.33	76.24	1.553	23.2399	120.0000
46	243.17	0.37	89	Piece of case	4.24	243.13	1.553	74.1146	167.6000
47	526.75	2.89	89	Piece of case	9.19	526.67	1.553	160.5456	1311.4000
42	769.67	21.34	90	Bottom of #6 case (red)	0.00	769.67	1.571	234.5840	9677.1000
45	202.33	0.03	91	Piece of case	-3.53	202.30	1.588	61.6672	12.4000
38	426.25	14.47	125	Bottom of #7 case (brown)	-244.49	349.16	2.182	129.9147	6562.5000

Modified Pseudo Trajectory Normal (MPTN) Analysis

Munition: Example Item Calc By: SDH Date: 1/29/2014
 Checked By: Date:

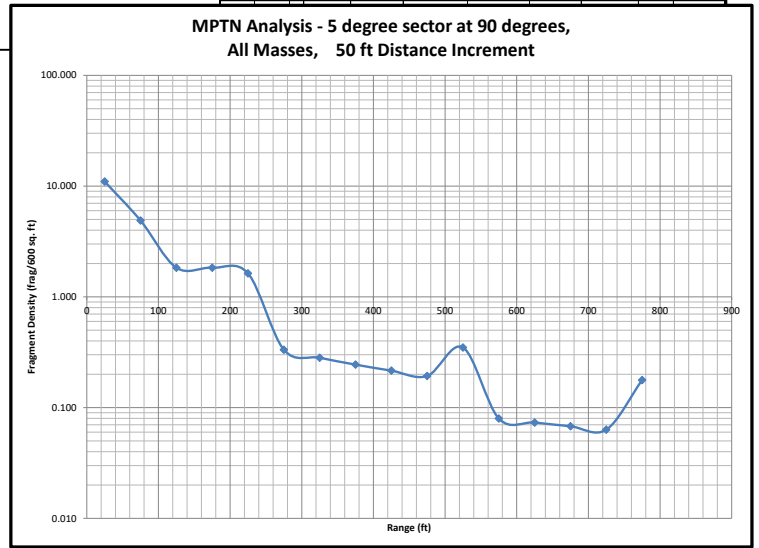
5 Degree Sector at 90.00 degrees
 Distance Increments 50 ft
 Min Mass for 50 lb Frag 0.22 lb - default value 0.22 lb
 Ignore Min Mass Requirements? yes

Notes: PTN = Number of pieces in sector + Number of pieces that flew through sector
 MPTN = Number of pieces in sector + 1/3 number of pieces that flew through sector
 PTN Density = PTN/Area(600 sq ft)
 MPTN Density = MPTN/Area(600 sq ft)

Populate Plot Clear Inputs

Relevant Test Data	Distance (ft)	Weight (lb)	Angle (Degrees)
44	187.58	0.016317	89
43	76.25	0.2646	89
46	243.17	0.369558	89
47	526.75	2.891637	89
42	769.67	21.33801	90
45	202.33	0.027342	91

Distance Range (ft)	No. Points in Distance Range	Pseudo Trajectory Normal (PTN)	Modified Pseudo Trajectory Normal (MPTN)	Area of Sector (ft ²)	Area/(600 ft ²)	PTN Density (frag/ft ²)	Ravg (ft)	MPTN Density (frag/ft ²)
0 - 50	6.00	2.000	2.000	09.08	0.182	33.002	25	11.001
50 - 100	1	6.00	2.667	327.25	0.545	11.001	75	4.889
100 - 150	5.00	1.667	545.42	0.909	5.500	125	1.833	
150 - 200	1	5.00	2.333	763.58	1.273	3.929	175	1.833
200 - 250	2	4.00	2.667	981.75	1.636	2.445	225	1.630
250 - 300	2.00	0.667	1199.91	2.000	1.000	275	0.333	
300 - 350	2.00	0.667	1418.08	2.363	0.846	325	0.282	
350 - 400	2.00	0.667	1636.25	2.727	0.733	375	0.244	
400 - 450	2.00	0.667	1854.41	3.091	0.647	425	0.216	
450 - 500	2.00	0.667	2072.58	3.454	0.579	475	0.193	
500 - 550	1	1.333	2290.74	3.818	0.524	525	0.349	
550 - 600	1.00	0.333	2508.91	4.182	0.239	575	0.080	
600 - 650	1.00	0.333	2727.08	4.545	0.220	625	0.073	



STACKED MUNITION ARTICLE CALCULATOR (SMAC)

- Determines HFD from a specified stack of munition items.
 - + Horizontal or Vertical munition orientation
 - + Stacks in open or in ECM
 - + Also displays MFD-H
 - + Advanced user options: increased stack HFD fidelity, required barricade material thicknesses
- Embedded Fragmentation Database
- Distribution Restricted - DoD and DoD Contractors Only

SMAC
Stacked Munition Article Calculator
VERSION 1.0

INPUTS

UNIT SYSTEM: MUNITION:

MUNITION ORIENTATION: STACK GEOMETRY (enter number of items)

ITEMS ON SIDE FACE:

STACK IN ECM? ITEMS IN TOP LAYER:

USER DEFINED MUNITION
(enter properties for a single munition)

FRAGMENTATION METHOD:

CYLINDRICAL CASE WEIGHT:	20	lbs		450	ft
TOTAL NO. OF FRAGMENTS:	7000			2000	ft
CRITICAL VELOCITY:	3000	ft/s			

RESULTS - ENGLISH UNITS

CRITICAL VELOCITY:	3000		ft/s		
EFFECTIVE NUMBER OF ITEMS:	1.5				
TOTAL NO. OF FRAGMENTS:	10500				
SINGLE ITEM HFD:	450		ft		
SINGLE ITEM MFD-H:	2000		ft		

STACK HFD: 450 ft

STACK MFD-H: 2660 ft

STACKED MUNITION ARTICLE CALCULATOR (SMAC)

- Most Useful when...
 - + Predicting test data, quantifying fragmentation hazards from stacks of munitions, siting known stacks of munitions.
 - + RDT&E and site planning applications
- Tips and Tricks...
 - + For stacks of mixed items analyze the stack configuration for each item present. Use the worst case.
 - + Take care to ensure numbers of items on side face and in top layer include all items in the stack and not just items visible in cross-section.

SMAC Stacked Munition Article Calculator VERSION 1.0									
INPUTS									
UNIT SYSTEM: English	MUNITION: User Defined								
MUNITION ORIENTATION: Horizontal	STACK GEOMETRY (enter number of items) ITEMS ON SIDE FACE: 2								
STACK IN ECM? Yes	ITEMS IN TOP LAYER: 1								
Update Results									
USER DEFINED MUNITION (enter properties for a single munition)									
FRAGMENTATION METHOD:	Naturally Fragmenting								
CYLINDRICAL CASE WEIGHT:	20 lbs	HFD:	450 ft						
TOTAL NO. OF FRAGMENTS:	7000	MFD-H:	2000 ft						
CRITICAL VELOCITY:	3000 ft/s								
RESULTS - ENGLISH UNITS									
CRITICAL VELOCITY:	3000	ft/s							
EFFECTIVE NUMBER OF ITEMS:	1.5								
TOTAL NO. OF FRAGMENTS:	10500								
SINGLE ITEM HFD:	450	ft							
SINGLE ITEM MFD-H:	2000	ft							
<table border="1"> <tr> <td>STACK HFD:</td> <td>450</td> <td>ft</td> </tr> <tr> <td>STACK MFD-H:</td> <td>2660</td> <td>ft</td> </tr> </table>				STACK HFD:	450	ft	STACK MFD-H:	2660	ft
STACK HFD:	450	ft							
STACK MFD-H:	2660	ft							

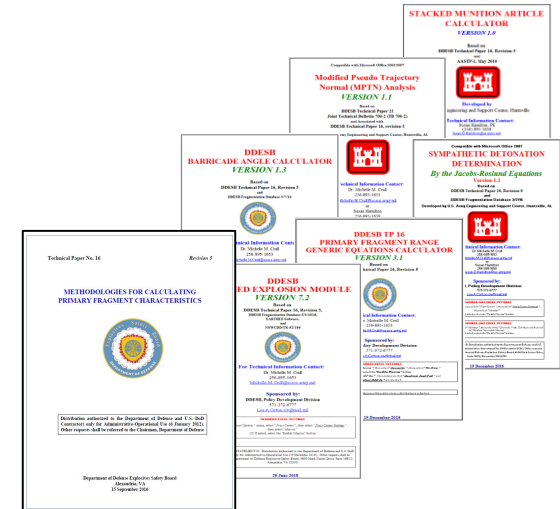
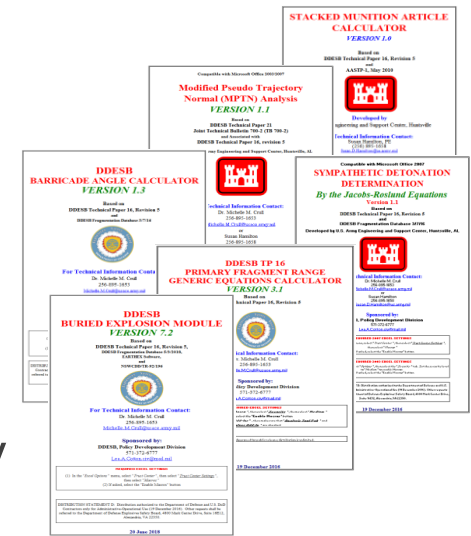
WANT MORE INFORMATION ON TP 16 AND TP 16 TOOLS?

- TP 16 Tools Course

- + Tuition Free
- + 6 hour online course taught over 2 days.
- + In-depth discussion of each tool
- + Hands on experience and examples guided by experts
- + Tentative dates in November 2018 and February 2019

- Full TP 16 Course

- + Tuition Free
- + 3 day in-person course
- + Learn to model munitions, determine frag characteristics, and use all the tools
- + Hands on experience and examples guided by experts
- + August 28-30, 2018 in Huntsville, AL



QUESTIONS?

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