



TOOLS

<https://www.msiac.nato.int/tools/>

Contents

Introduction to MSIAC Tools	4
Accessing MSIAC Tools	4
Application of MSIAC Tools	5
Browser-based Tools	
AIMS - Advanced Insensitive Munitions Search	8
ARM - Analytical Response Models	10
EMC - Energetic Materials Compendium	12
MADx - MSIAC Accident Database Exchange	14
MQDCAT - MSIAC Quantity Distance Consequence Analysis Tool	16
MTM - Mitigation Techniques For Munitions	18
SASo - Safety Assessment Software	20
MSaS - Munition Safety Standards Database	22
Downloadable Tools	
Insensitive Munitions Benchmarks	26
NEWGATES - NIMIC Excel Worksheets on Gap Tests	28
TEMPER - Toolbox of Engineering Models for the Prediction of Explosive Reactions	30
MCYLEX - MSIAC Cylinder Expansion Database	32



Introduction to MSIAC Tools

Since establishment as a NATO project in 1991, MSIAC has developed a suite of tools to support our member nations' efforts to design, develop, procure, and use safer munitions. During this time our tools have evolved and grown with both the needs of the community and advances in technology.

We remain focused on providing member nations with a set of tools that are not only useful to their munition safety activities, but also easy and intuitive to use.



Accessing MSIAC Tools

All MSIAC tools are accessed through the MSIAC website:

<https://www.msiac.nato.int/tools/>

Most of the MSIAC tools are browser-based, and can be used directly in your web browser without the need to download or install any software. A small number must be downloaded before use; we are actively working to replace these tools with browser-based versions.

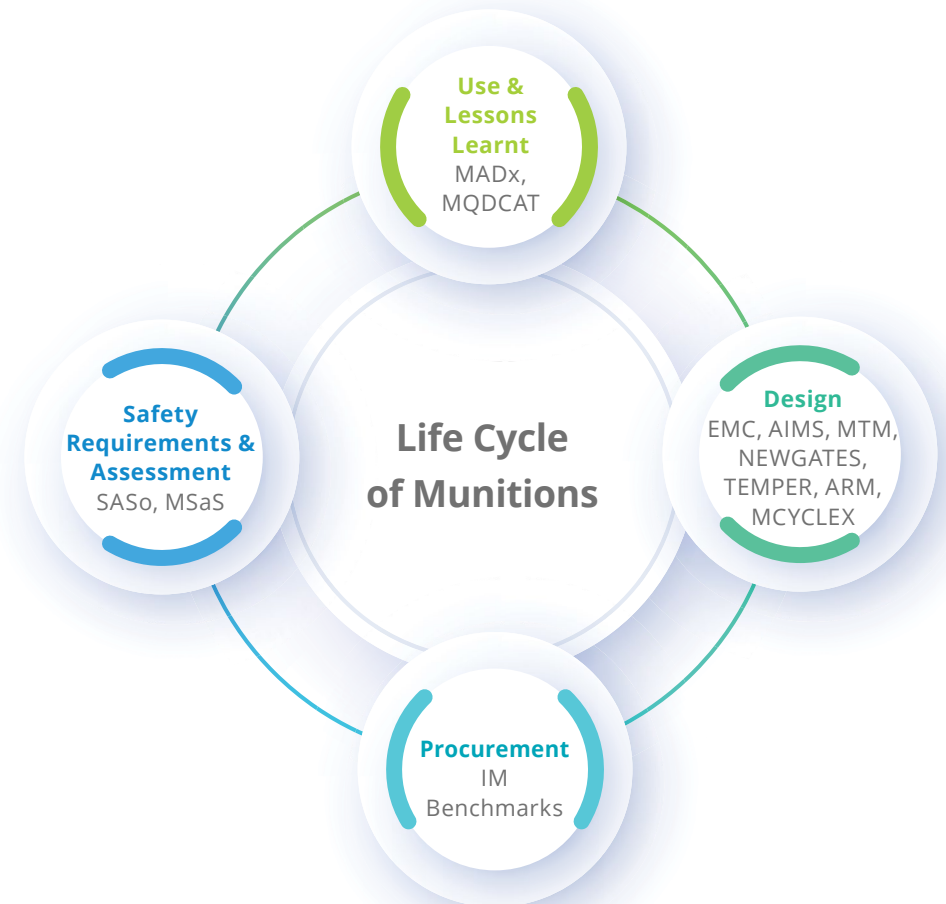
MSIAC tools can only be accessed by users with an active MSIAC account, approved by their national MSIAC representative. To apply for an account complete the form on our website:

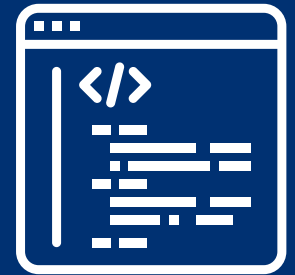
<https://www.msiac.nato.int/contact-access/request-secure-website-access>



Application of MSIAC Tools

The MSIAC tools can be used at different stages in the life cycle of munitions, as shown in the image below.





Browser-based Tools

The following tools can be accessed and used directly in your web browser

AIMS - Advanced Insensitive Munitions Search

Advanced Insensitive Munitions Search (AIMS) is a fully searchable database of IM test results. It is intended to support munitions designers, test centres, IM boards, program managers and munitions suppliers.

AIMS provides access to IM test results for munitions and generic test units for each threat defined by the NATO IM policy: fast heating, slow heating, bullet impact, fragment impact, sympathetic reaction and shaped charge jet impact.

Each test result is fully referenced, searchable and in certain cases access is granted directly to the source material. The information is displayed in a table that provides the munition's name, its main characteristics (energetic material, caliber, case material, packaging), mitigation, test set-up and test results. A detailed view provides additional information on the munition and the test itself, and when available, a picture of the test is included.

The platform also allows users to search through all the databases at once. The results are displayed per IM threat in separate tabs that reproduces the interfaces of each database. Tests performed with the standardized IM threats can also be sorted in a synthesized table that allows comparison of the munition's IM signatures.

Users can also access the related NATO test standards, the list of references used to populate the database as well as a description of commonly used generic test units and shaped charges.

Responsible TSO:	Warhead Technology and Propulsion Technology
Documents:	O-156 AIMS Advanced Insensitive Munitions Search
Link:	https://aims.msiac.nato.int
Available to:	All approved users

Fast Cook-Off (217) Print Export Comment

FCO Test ID	Tested Item Characteristics						Mitigation	Test Setup			Results		Ref
	Munition (Tested Item)	Energetic Material	Composition	External Diameter/ Thickness (mm)	Case Material and Thickness (mm)	Pack.		Family / Name / Material	Type of FCO	Item Orientation	Average Fire T° (°C)	Reaction Type	
3646	105 mm APFSDS-T (Gun Propellant)	CLP-26	RDX NC Ener. Plasticizer	105	Brass	Packaged	Container / Case / Brass Cartridge Case / Dress	Fuel Fire	Horizontal		III/IV		206
3647	105 mm L31 Shell (Warhead)	Unknown	Unknown	105	Steel	Not Documented	None / /				II		87
3648	105 mm M393 HEP IM Shell (Warhead)	Enhanced Blast Explosive	Unknown	105	High Fragmentation Steel	Packaged	Case / Brass Cartridge Case / Brass Container / PA117 / Steel Venting Device / Reduce Strength Locking Pin /	Fuel Fire	Horizontal		IV		86
3657	105 mm PGU 44B HE Shell (Gun Propellant)	M-1	Others 85% NC 10% DNT 5% DBP	105	Brass	Packaged	Venting Device / Ø3/4" Hole (x6) / Container / PA71 /		Vertical Nose Down	> 815	V	315-330	424 423

AIMS IM Databases Other Databases Databases Search References NATO Standards Help

ID	Munition	Tested Item	Energetic Material	Database	Reaction Type	Updated
1626	2.75" Rocket - M151 Warhead GTU	Warhead	PBXIH-137	Fragment Impact	I (x1)	11 months, 3 weeks ago
1625	2.75" Rocket - M151 Warhead GTU	Warhead	PBXIH-137	Fragment Impact	I (x1)	11 months, 3 weeks ago
1624	2.75" Rocket - M151 Warhead GTU	Warhead	PBXIH-137	Fragment Impact	III (x1)	11 months, 3 weeks ago
1623	2.75" Rocket - M151 Warhead GTU	Warhead	PAX-21	Fragment Impact	I (x1)	11 months, 3 weeks ago
1622	2.75" Rocket - M151 Warhead GTU	Warhead	PAX-21	Fragment Impact	IV (x1)	11 months, 3 weeks ago
1621	2.75" Rocket - M151 Warhead GTU	Warhead	PBXN-109	Fragment Impact	I (x1)	11 months, 3 weeks ago
1620	2.75" Rocket - M151 Warhead GTU	Warhead	PBXN-110	Fragment Impact	I (x1)	11 months, 3 weeks ago
1619	2.75" Rocket - M151 Warhead GTU	Warhead	PBXN-110	Fragment Impact	V (x1)	11 months, 3 weeks ago
4181	M430A1 40 mm grenade	Warhead	Comp A-5	Slow Heating	V	1 year, 11 months ago
4180	M430A1 40 mm grenade	Warhead	Comp A-5	Slow Heating	V	1 year, 11 months ago
4184	M430A1 40 mm grenade	Warhead	Comp A-5	Fast Heating	V	1 year, 11 months ago
4183	M430A1 40 mm grenade	Warhead	Comp A-5	Fast Heating	IV	1 year, 11 months ago
4179	Rocket motor	Rocket Motor	AP-HTPB	Fragment Impact	V	1 year, 11 months ago
4178	Rocket motor	Rocket Motor	AP-HTPB	Fragment Impact	V	1 year, 11 months ago

Fast Heating (225) Export Comment

FH Test ID	Tested Item Characteristics						Mitigation	Test Setup			Results		Ref
	Munition (Tested Item)	Energetic Material	Composition	External Diameter/ Thickness (mm)	Case Material and Thickness (mm)	Pack.		Family / Name / Material	Type of FH	Item Orientation	Average Fire T° (°C)	Reaction Type	
3646	105 mm APFSDS-T (Gun Propellant)	CLP-26	RDX NC Ener. Plasticizer	105	Brass	Packaged	Container / Case / Brass Cartridge Case / Dress	Fuel Fire	Horizontal		III/IV		206
3647	105 mm L31 Shell (Warhead)	Unknown	Unknown	105	Steel	Not Documented	None / /				II		87
3648	105 mm M393 HEP IM Shell (Warhead)	Enhanced Blast Explosive	Unknown	105	High Fragmentation Steel	Packaged	Case / Brass Cartridge Case / Brass Container / PA117 / Steel Venting Device / Reduce Strength Locking Pin /	Fuel Fire	Horizontal		IV		86
3658	105 mm PGU 44B HE Shell (Gun Propellant)	M-1	85% NC 10% DNT 5% DBP Others	105	Brass	Packaged	Venting Device / Ø3/4" Hole (x6) / Container /		Vertical Nose Down	> 815	V	315-330	424 423

ARM - Analytical Response Models

Analytical Response Models (ARM) is a suite of empirical and analytical models used for assessing munition safety, in particular the response to threat environments associated with Insensitive Munitions (IM) requirements.

ARM is being incrementally developed as a browser-based replacement for the MSIAC TEMPER application.

The initial modeling capability provided in ARM is for the prediction of detonation by impact threats using the Jacobs-Roslund impact initiation model, supplemented by the MSIAC modified Jacobs-Roslund model; over time, additional functionality will be added including the THOR equations.

Responsible TSO:	Warhead Technology
Documents:	L-254 Analytical Response Models (ARM) Application Specification
Link:	https://arm.msiac.nato.int
Available to:	All approved users

☰
ARM

Model

Baseline initiation model
Jacobs-Roslund

Impactor

Material
Steel

Shape
Flat End Rod

B
0

C
1.7

Mitigation

Empty

Acceptor

Component
Comp B

Structure
Bare Plane Explosive

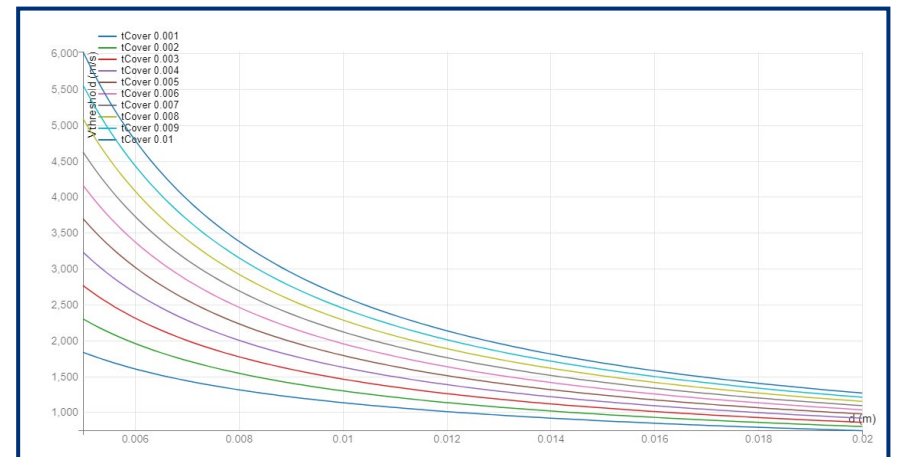
A
96.77

Graph

Output
V_{threshold} versus d for a set t

$$V_{threshold} = \frac{A}{d^{1/2}}(1+B)(1+C\frac{t_{cover}}{d})$$

d min (m) 0.005	d max (m) m 0.02	Number of d intervals m 100
t cover min (m) 0.001	t cover max (m) m 0.01	Number of t constant curves m 10
<input checked="" type="checkbox"/> Autoscaling of y axis	Axis y min 0	Axis y max 10000



EMC - Energetic Materials Compendium

Energetic Materials Compendium (EMC) is a fully searchable database of composition, performance and sensitivity data for energetic material formulations and their constituent substances. It is intended to support scientists and engineers during the design phase of new munition systems; equally, it may assist through life activities where knowledge of energetic material properties is required.

The data in EMC is sourced entirely from open source publications, and includes entries for high explosives, gun propellants, rocket propellants and pyrotechnic formulations.

Formulation data can be searched across multiple fields such as performance (e.g. detonation velocity), sensitivity (e.g. impact), physical properties (e.g. thermal conductivity), composition details (e.g. component percentage), manufacturer and application.

Energetic and non-energetic components can be searched by name, Chemical Abstract Service (CAS) number, and chemical formula, as well as chemical, physical, explosive, hazard and safety properties.

A side-by-side comparison tool for both the formulations and components databases allows users to compare properties for up to four materials.

All information in EMC is fully referenced, and in certain cases source material can be accessed directly via the MSIAC Laserfiche database.

Responsible TSO: Energetic Materials

Documents: O-157 The Development and Future of EMC

Link: <https://emc.msiac.nato.int>

Available to: All approved users

Formulation Search

Use this page to search for a formulation by name, browse the table or perform an advanced search by selecting your search criteria.

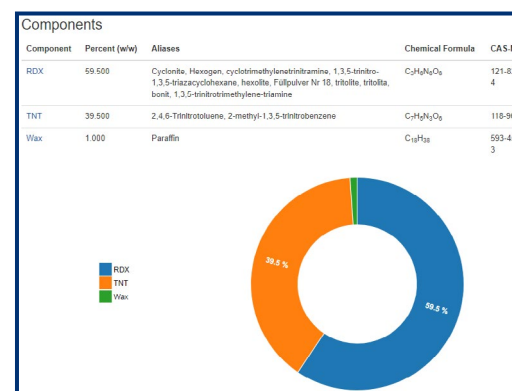
Select a criteria:

Name: contains

or

Formulations (1311)

Name	Aliases	Type	Applications	Density	Compare
10307-67-A		Gun Propellant	Gun Propellant, Medium calibre munition, New	1.496 g/cm ³	<input type="checkbox"/>
10312-16-1		Gun Propellant	Gun Propellant, Medium calibre munition	1.518 g/cm ³	<input type="checkbox"/>
10312-16-2		Gun Propellant	Gun Propellant, Medium calibre munition	1.417 g/cm ³	<input type="checkbox"/>
10324-27-1		Gun Propellant	Gun Propellant, Medium calibre munition	1.341 g/cm ³	<input type="checkbox"/>
10324-27-2		Gun Propellant	Gun Propellant, Medium calibre munition	1.341 g/cm ³	<input type="checkbox"/>



Component TNT

Aliases: 2,4,6-Trinitrotoluene, 2-methyl-1,3,5-trinitrobenzene

Formula: C₇H₅N₃O₆

CAS: 118-96-7

SMILES String: N/A

GHS:

Chemical Properties

Property	Value	Notes	Reference
Enthalpy of Formation	-80.6 kJ/mol	calculated	667
Molecular Mass	227.13 g/mol		
Nitrogen Content	18.5 wt-%		
Oxygen Balance	-74.0 wt-%		

MADx - MSIAC Accident Database Exchange

The MSIAC Accident Database Exchange (MADx) contains details of over 16,000 accidents and incidents involving munitions. Information is provided by Australia, Canada, France, Germany, the Netherlands, Switzerland, the United Kingdom and the United States. MADx is intended to provide information in support of munition safety assessment activities during introduction into service for the purpose of hazard identification; it may also be used to support in-service activities such as incident investigations.

The database contains information about the accident date, location, weapon and munition type, cause, life cycle phase, damage category, and both the number of fatalities and injuries.

All national contributions are presented in a common format, allowing the whole database to be searched on the aforementioned criteria. Search results are displayed in a summary table including a brief description of the accident, date and location. Results are also displayed as histograms that show the number of accidents per year, probable cause, category and country. The application also offers the possibility to select a list of accidents and then print or export as a spreadsheet for further analysis.

Note:

Access to MADx is restricted to government employees of contributing nations; however, all MSIAC nations are invited to contribute, and will in turn gain access to the database.

Responsible TSO:	Munitions Transport and Storage Safety
Documents:	None
Link:	https://madx.msiac.nato.int
Available to:	Approved government users from contributing nations

The screenshot shows the MADx search interface. It includes a search bar with a 'Search' button. The search filters are organized into two columns:

- Reporting Country:** A dropdown menu with options: Australia, Belgium, Canada, France, Germany.
- Reporting Country ID:** A text input field.
- MADx ID:** A text input field.
- Life cycle phase:** A dropdown menu.
- Begin date:** A date picker (dd/mm/yyyy).
- End date:** A date picker (dd/mm/yyyy).
- Category:** A dropdown menu.
- Damage cost:** A dropdown menu.
- Fatalities:** A dropdown menu.
- Injuries:** A dropdown menu.
- Free text:** A text input field with a search scope dropdown (Search in selected field(s) or default to all).
- in:** A dropdown menu with options: Description, Location, Munition type, Batch, lot, serial number of the munition, NATO Stock Number.

Below the search filters, there is a 'Search' button and 'Print' and 'Export' buttons. The results section shows 'Accidents (16872)' and a table with columns: ID, Reporting Country, Date, Description, Life cycle phase, Location, Munition type, Cost, F, I, Probable cause.

ID	Reporting Country	Date	Description	Life cycle phase	Location	Munition type	Cost	F	I	Probable cause
20002	Australia	04/24/2021	Whilst programing LESCUT rounds for RPD 21-2 laptop was connected ...		At Sea (G)	Transmitter, Countermeasures LESCUT	0	0	0	TBD

The screenshot shows the details for Accident 6539. It includes a 'Back to results' link and a message: 'The results of the search contains 482 accidents.' There are 'Print' and 'Export' buttons. The accident details are as follows:

- ID:** 6539
- CID:** 17973
- Reporting Country:** France
- Date:** 08/05/1940
- National type:** TBD
- Life cycle phase:** TBD
- Description:** Incendie et explosions de munitions et nitrate ammonium: Un incendie se déclare dans un wagon chargé d'explosif sur une voie d'une gare de triage. Sur les voies voisines se trouvent des trains comprenant de nombreux wagons d'artifices de guerre et de munitions qui explosent à la suite de la propagation du feu (effet domino). La chaleur de l'incendie provoque ensuite éclatement de fûts de toluène qui se trouvent dans un établissement situé de l'autre côté du grillage qui clôtüre la gare. L'hydrocarbure s'enflamme et forme une nappe qui coulant selon la pente atteint un hangar qui abrite 240 t de nitrate d'ammonium pur en sacs. L'explosion a creusé un trou en forme d'entonnoir profond de 3 m en son point le plus bas et dont le bord dessine grossièrement une ellipse ayant pour axe 39 et 26 m. L'explosion aurait été provoquée par un obus lancé par une des explosions de munitions.
- Location:** FRANCE
- Munition type:** NA
- Batch munitions:** NA
- NSN:** NA
- Weapon type:** NA
- Damage cost:** 0
- Category:** NA
- Fatalities:** 0
- Injuries:** 0
- Probable cause:** Human - Other
- Contributing factors:** NA
- Corrective actions:** NA
- Lessons learned:** NA

MQDCAT - MSIAC Quantity Distance Consequence Analysis Tool

The MSIAC Quantity Distance Consequence Analysis Tool (MQDCAT) performs an experimentally validated consequence analysis of the accidental initiation of various types and quantities of munitions in various types of magazines, and with possible mitigation measures in place. This includes blast damage to buildings, direct blast injury, thermal effects, as well as hazards from debris

and fragments. The results can be compared with current QD standards for all Hazard Divisions (HD) over the full range of NEQ. This provides insight into which consequences are to be expected at the QDs and informs risk analysis. MQDCAT also supports further development of QDs, making use of up to date experimental results.

Responsible TSO:

Munitions Transport and Storage Safety

L-229 Experimental and Theoretical Basis of NATO standards for safe Storage of Ammunition and Explosives – Final Report

Documents:

L-252 Specification of the MSIAC Quantity Distance Consequence Analysis Tool (MQDCAT) v2.4

L-289 Release Notes for MQDCAT v2.6

Link:

<https://mqdcat.msiac.nato.int/>

Available to:

All approved users

MQDCAT
HELP

Potential Explosion Site (PES) Input

PES type
ECM (Earth Covered Magazine)

PES direction
Front

Barricade
No

PES Probability of event (1/year)
0.00001

Optional fields

Ammunition Input

NEQ of single round and Maximum NEQ for calculations

Q_0 (kg) Q_{max} (kg) - optional
1 100000

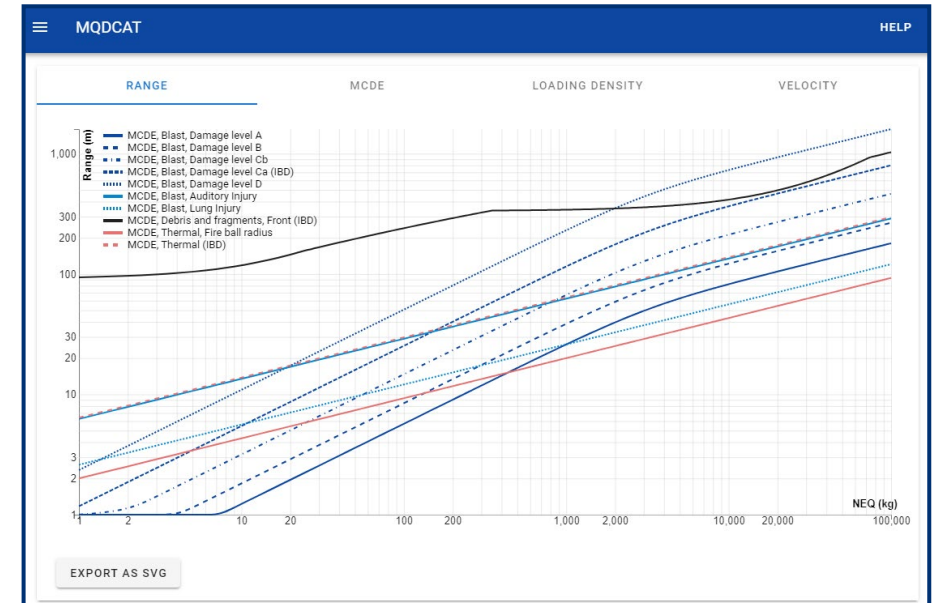
NEQ of interest
 Q_{int} (kg)
10000

Hazard Division
HD1.1

Maximum Credible Detonation Event
Set to stored NEQ

Value of MCDE is **NEQ**

Cased ammunition
 No (bare charge)
 Yes (fragmentation)



MTM - Mitigation Techniques For Munitions

Mitigation Techniques for Munitions (MTM) is a database of technologies and techniques that may be used to improve the response of munitions when exposed to threat environments defined by NATO Insensitive Munitions (IM) policy. It is intended to support munitions designers, IM boards, program managers and the military by describing potential solutions to satisfy the requirements of national IM policy.

Over 400 examples of mitigation technologies and techniques are included, all of which can be filtered and searched on criteria including threat type, munition category,

and the system level at which the mitigation is applied. Each entry in the database provides a detailed description of the particular mitigation technology or technique, including images (where available).

Each technology is fully referenced, and in certain cases source material can be accessed directly via the MSIAC Laserfiche database.

Responsible TSO:	Propulsion Technology
Documents:	O-165 MTM – Technical Specifications O-173 MTM – Easy Access Online
Link:	https://mtm.msiac.nato.int
Available to:	All approved users

MTM Examples References Definitions Help Matthew

Select a criteria

Search or Clear search

Export PDF View

Examples (400)

Filter results:

ID	Description	Threats and Hazards	Components	Categories	Techniques	Permanent modification	Configurations	Ref.
2	Intumescent coatings to replace the NASA formulation EX-1C-82.	FH	Rocket Motor, Warhead	Bomb, Missile	Thermal protection	Yes	Packaging	5
3	Fire retardant	FH	Propelling Charge	Artillery	Thermal protection	Yes	Packaging	111
4	Smart thermal insulating material "Aerocal", mix of a resin and of endothermic charge which absorb heat by reacting.	FH	Rocket Motor, Warhead	Bomb, Missile	Thermal protection	Yes	Packaging, System Design	7
5	Assessment of several fire-retardants applied on containers and boxes in storage.	FH	Propelling Charge, Warhead	Artillery, Mortar	Thermal protection	Yes	Packaging	8
6	Assesment of several types of plugs on containers.	FH	Propelling Charge	Artillery, Mortar	Passive venting device	Yes	Packaging	9

MTM Examples References Definitions Help

Back to results The results of the search contains 400 examples.

Export PDF

Use of barrier and spacing to enhance the pallet design of mortar shell.

The US 120 mm mortar shell M934A2 and container has been redesigned to enhance its IM properties. Several changes to the existing two-round metal over-pack and fiber unit pack were considered. Venting of the metal over-pack provided pressure relief during cook-off scenarios; however, hazardous fragments were still thrown beyond 49 feet. The final packaging design includes use of a PA-174 Monopack (unit pack) with the addition of customized HDPE barrier materials and spacing at the palletized load level to successfully mitigate sympathetic detonation and reduce the number of hazardous fragments thrown beyond 49 feet.

**120 mm Mortar M934A2
Final packaging configuration**

Techniques	Arrangement, Barrier	Components	Propelling Charge, Warhead
Categories	Mortar	Threats	SR
Configurations	Packaging	Permanent modification	no
References	Insensitive Munition (IM) Enhancement of the 120 mm M934A1 High Explosive (HE) Mortar Cartridge		

SASo - Safety Assessment Software

Safety Assessment Software (SASo) is a browser-based tool designed to assist munition designers, procurers and any personnel supporting these activities in the identification of appropriate safety-related requirements and associated standards. It consists of:

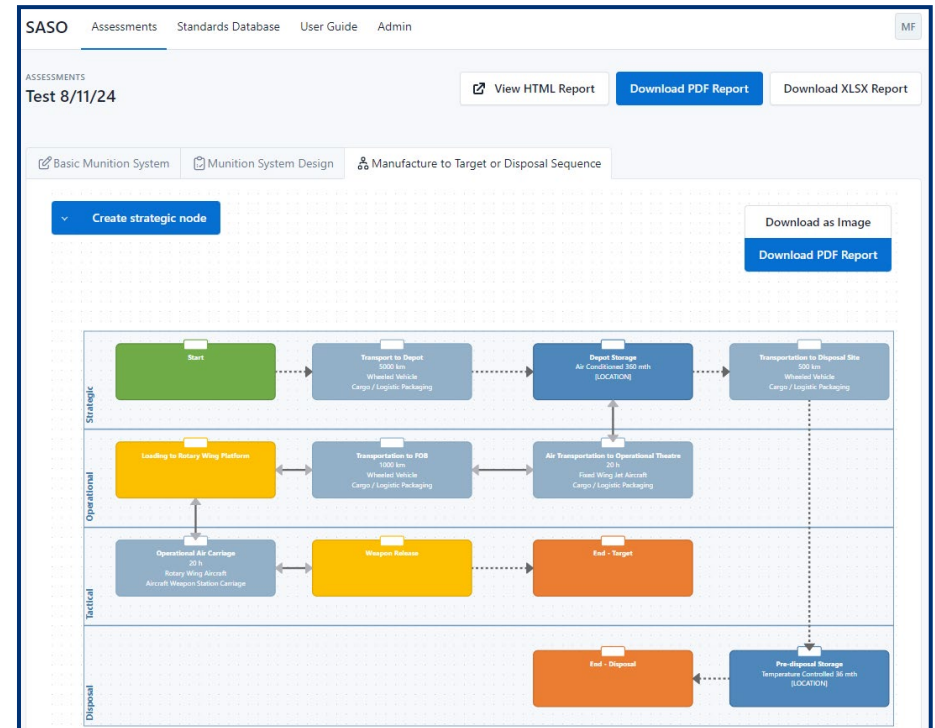
- A drag-and-drop graphical user interface (similar to MS Visio) that allows users to rapidly construct a Manufacture to Target/Disposal Sequence (MTDS) for a munition system. The resulting flowchart can be exported as a high quality image file and used in associated munition reports. Each “node” in the flowchart represents a specific lifecycle activity, for which the user defines parameters such as location, duration, configuration, etc.
- Once the MTDS has been constructed, SASo will generate a list of “design safety requirements” and “assessment requirements”. The “design safety requirements” are

based on basic information provided by the user on the munition design. The “assessment requirements” are based on the activity types defined in the MTDS, and also draw out all associated parameter information from each MTDS node

- Each requirement has an associated standard or standards (default NATO, but also US and UK if desired)

The output of SASo consists of:

- An assessment report which details the MTDS (including image), and a list of design and assessment requirements, plus all associated standards. Each of the standards is hyperlinked and accessible on the MSIAC secure website for convenience
- A V&V matrix (.xlsx format) containing the same information as the assessment report, with space for compliance assessment



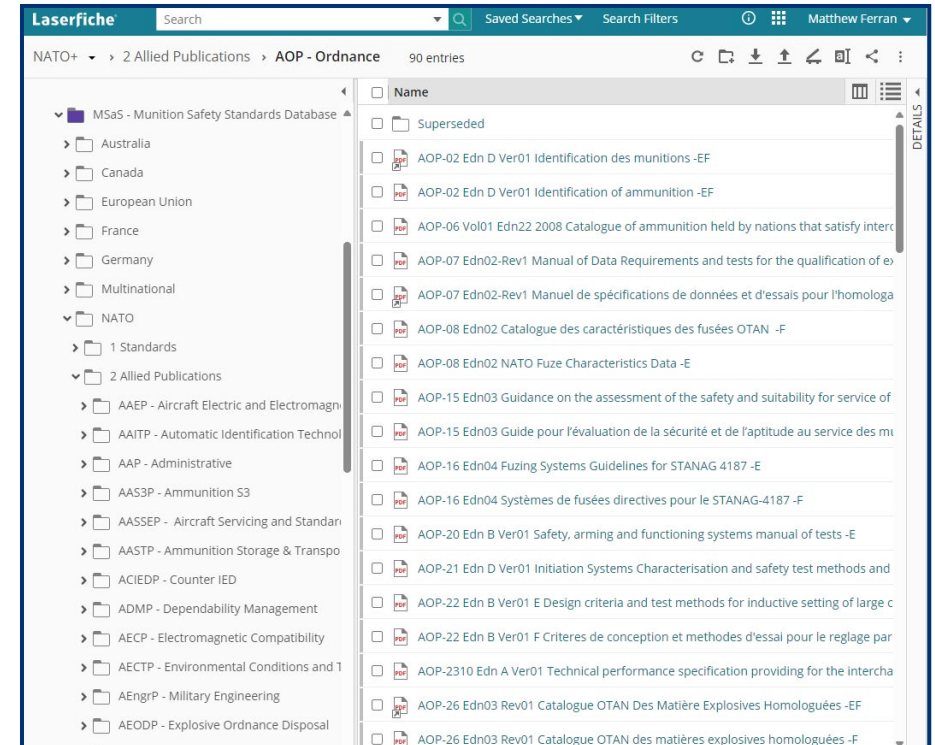
Responsible TSO:	Munition Systems
Documents:	None
Link:	https://saso.msiac.nato.int
Available to:	All approved users

MSaS - Munition Safety Standards Database

The Munition Safety Standards database (MSaS) is a repository of some of the most important NATO, national and international standards related to munition safety. MSaS is regularly updated with the most recent versions of relevant standards; it also includes a history of previous versions of standards that have been superseded or cancelled.

Note:

- It is not the intention of MSaS to provide access to all NATO standards, only a curated selection of those deemed most relevant to munition safety. For a comprehensive listing of all NATO standards please refer to the NATO Standardization Office (NSO) website: <https://nso.nato.int/>
- Individual access to standards within MSaS is restricted based on user nationality, in accordance with all applicable document release statements.

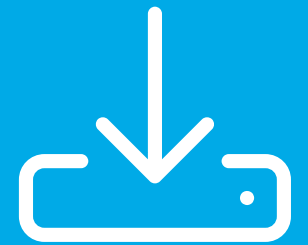


Responsible TSO: Munition Systems

Documents: None

Link: <https://www.msiac.nato.int/tools/msas/>

Available to: All approved users



Downloadable Tools

The following tools must be
downloaded to your computer
before use

In insensitive Munitions Benchmarks

It is a common misconception that reduced munition vulnerability is either not achievable, or must come at the expense of reduced performance. In sensitive Munitions (IM) Benchmarks is a resource intended to demonstrate that, with careful system design, it is entirely possible to deliver munitions which meet NATO and national vulnerability requirements without compromising on performance.


munitions which have improved vulnerability over comparable predecessors, and which in some cases meet or exceed NATO IM requirements.


IM Benchmarks is formatted as a brochure that can be easily shared with stakeholders such as user representatives, requirements setters, and procurement staff, in order to help them be properly informed in their decision making processes.

For each of the three operational environments (i.e. land, sea and air), IM Benchmarks provides select examples of high-performing

Format:	.pdf
Responsible TSO:	Warhead Technology
Documents:	None
Link:	https://www.msiac.nato.int/tools/imbenchmark/
Available to:	All approved users

120-mm HE Mortar Cartridge (IM-HE M530B2 MECAR XF®)

Performance Comparisons			IM Technology	
	Comp B	XF®11585		
Formulation	RDX/TNT (60/40)	TNT/RDX/NT0/AL/Wax	<ul style="list-style-type: none"> New energetic – XF11585 TNT 31%,RDX 27%, NTO 21%, Al 13.5%, Wax 7.5% Fuze adapter mechanical venting 	
Gurney velocity	2.68	2.29		
VoD	7.97	7.30		



Customers

- Program Phase: End Development
- M530B2 meets performance requirement
- Type qualification ongoing.

IM Benefits (cost analysis)

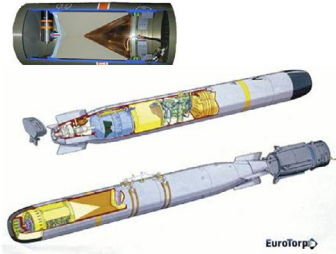

- Similar cost

IM Signature

	FH	SH	BI	FI	SR	SCJI
M530A2 (Comp B)	I		II		II**	
M530B2 (XF11585)	V	V	V	NR	III*	III**

* 1830 m/s ** w/o packaging *** PG-7G simulant

Lightweight Torpedo (MU90)

Performance Comparisons		IM Technology																			
<ul style="list-style-type: none"> Tip velocity 8925 ms⁻¹ 		<ul style="list-style-type: none"> IM High Explosive: V350 (Isostatic pressed) Booster V350 Logistic container with a sandwich barrier 																			
																					
				<p>IM Benefits (cost analysis)</p> <ul style="list-style-type: none"> MU 90 Cost: TATB-Minimal effect on unit cost 																	
<p>Customers</p> <ul style="list-style-type: none"> Denmark, France, Germany, Italy, Poland, Australia, New Zealand 		<p>IM Signature</p> <table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th></th> <th>FH</th> <th>SH</th> <th>BI</th> <th>HFI</th> <th>SR</th> </tr> </thead> <tbody> <tr> <td>Octol (HMX/TNT)</td> <td style="background-color: red;">I</td> <td></td> <td style="background-color: red;">I</td> <td></td> <td style="background-color: red;">I</td> </tr> <tr> <td>MU-90</td> <td style="background-color: green;">V</td> <td style="background-color: green;">V</td> <td style="background-color: green;">V</td> <td style="background-color: yellow;">IV</td> <td style="background-color: green;">NR</td> </tr> </tbody> </table> <p><small>* In logistics container</small></p>			FH	SH	BI	HFI	SR	Octol (HMX/TNT)	I		I		I	MU-90	V	V	V	IV	NR
	FH	SH	BI	HFI	SR																
Octol (HMX/TNT)	I		I		I																
MU-90	V	V	V	IV	NR																

NEWGATES - NIMIC Excel Worksheets on Gap Tests

NEWGATES is a database of common gap test set ups and test results. It has been designed to provide scientists and engineers with a tool to compare gap test results and/or calculate critical initiation pressure and time.

NEWGATES comprises:

- Information about 10 gap test configurations (description and diagrams, complete with dimensions, scope, principles and principles of operation)

- Pressure calibration curves
- Time calibration curves
- Shock curvature calibration curves
- Several thousand fully referenced gap test results
- Over 250 Hugoniots, as well as a module to analytically determine Hugoniot parameters for an energetic material from its ingredients

Format:	Spreadsheet (.xlsx)
Responsible TSO:	Warhead Technology
Documents:	O-89 The NIMIC Excel Worksheets on Gap Tests (NEWGATES) O-219 Improving the MSIAC Gap Test Computational Tool and Database L-148 Ed3 NEWGATES Version 1.10 User Guide
Link:	https://www.msiac.nato.int/tools/newgates/
Available to:	All approved users

NEWGATES

NIMIC

Excel Worksheets on Gap TESTs

Version 1.12

Problems/Questions: **MSIAC or Ernest Baker**

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Email: msiac@msiac.nato.int or e.baker@msiac.nato.int

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Gap Test Results for Explosive Ingredients
Gap Test Results for Compositions
Hugoniot Calculation
Critical Diameter-Gap Tests correlations
INFORMATION ON GAP TESTS
Small Scale Water Gap Test
NOL Small Scale Gap Test
LANL Small Scale Gap Test
Intermediate Scale Gap Test
NOL Large Scale Gap Test
LANL Large Scale Gap Test
Expanded Large Scale Gap Test 1 UN (7b) EIDS Gap Test
Expanded Large Scale Gap Test 2 UN (7b) EIDS Gap Test
Modified Expanded Large Scale Gap Test
Super Large Scale Gap Test
Insensitive High Explosive Gap Test
MRI Small Scale Gap Test (Scale 1 donor)
IAD Φ 40 mm
Mini-Gap Test

← Built as a macro

← Built as a macro

Neither MSIAC nor the participating Nations can guarantee nor warrant the adequacy, accuracy, currency or completeness of the Technical Information contained in this database.

STANAG 4488
USER GUIDE
Version 1.12 update
REFERENCES
BIBLIOGRAPHY
Pressure Comparison

NOL LARGE SCALE GAP TEST
INTRO

US: MIL-STD-1751A Method 1041 (NOL)

Scope
This method covers the test procedures to be used for the determination of the large scale shock sensitivity of explosive materials. This technique is primarily designed to be used for booster explosives, main charge explosives and propellants with critical diameters less than 36mm.

Principle
Like other gap tests, this test is a measure of the shock required to initiate and propagate a high order detonation in the explosive being tested. The sensitivity of the acceptor is determined as a function of the thickness of a cellulose acetate or PMMA barrier which is used to attenuate the shock output of the donor explosive. Cellulose acetate and PMMA have shown equivalence as shock attenuators. Results are expressed as the thickness of the attenuator at which the acceptor is initiated 50% of the time.

Apparatus

Donor	Explosive	Radius	RD	mm	25.4
Pentolite	Length	LD	mm	50.8	
	Name				Pentolite
	Density		g/cm ³	1.56	
	State			pressed	
Cardboard	Thickness	CTD	mm	2.8	
	Name				Cardboard
	Density		g/cm ³	NA	
Attenuator	Gap	Name		PMMA	
Cardboard	Density		g/cm ³	1.18	
	Thickness	CTA	mm	2.8	
	Name				Cardboard
	Density		g/cm ³	NA	
Acceptor	Explosive	Radius	RA	mm	18.288
Steel	Length	LA	mm	139.7	
	Thickness	CTA	mm	5.6	
	Name				Steel
	Density		g/cm ³	NA	
Witness	steel plate 101.6mm x 9.5mm placed 1.59mm beyond the end of the acceptor.				

TEMPER - Toolbox of Engineering Models for the Prediction of Explosive Reactions

TEMPER is a tool that uses empirical and semi-empirical models to predict munition response to insensitive munitions (IM) threats.

It includes models for fragment impact, shaped charge, sympathetic reaction and thermal threats such as:

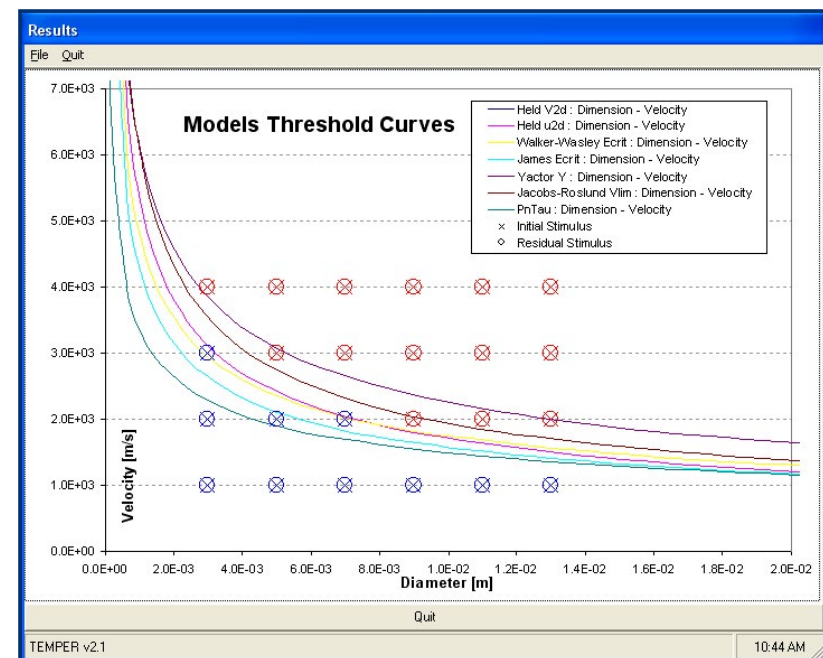
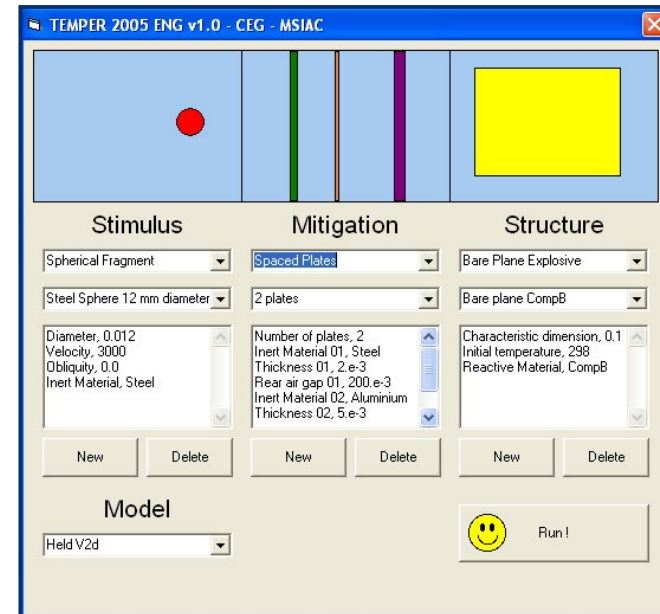
- An MSIAC modified Jacobs-Roslund model that is based on an analysis of many experimental test results and that requires only one parameter.
- The implementation of conical fragment that enables simulation of the NATO fragment defined in STANAG 4496.

- The modelling of a residual fragment after perforation of a mitigation for conical-ended and parallelepiped fragment. This model may be used to simulate the impact of a NATO fragment on bare or packed munitions.
- A sympathetic reaction model, SANDI, that is based on a different approach than that of the One on One Warhead model.

Note:

The functionality of TEMPER is being incrementally included in the browser-based application ARM.

Format:	Executable (.exe)
Responsible TSO:	Warhead Technology
Documents:	O-176 Temper status and recommendations L-139 TEMPER v2.0 – User's Manual
Link:	https://www.msiac.nato.int/tools/temper/
Available to:	All approved users



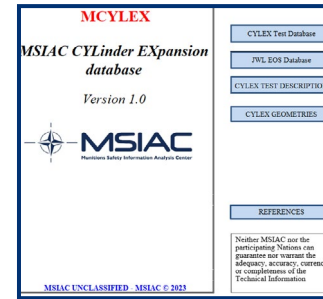
MCYLEX - MSIAC Cylinder Expansion Database

MCYLEX is a database of high explosive cylinder expansion test setups and test results, as well as a collection of Jones-Wilkins-Lee (JWL) equation of states. It has been designed to provide scientists and engineers with a comparison and analysis tool.

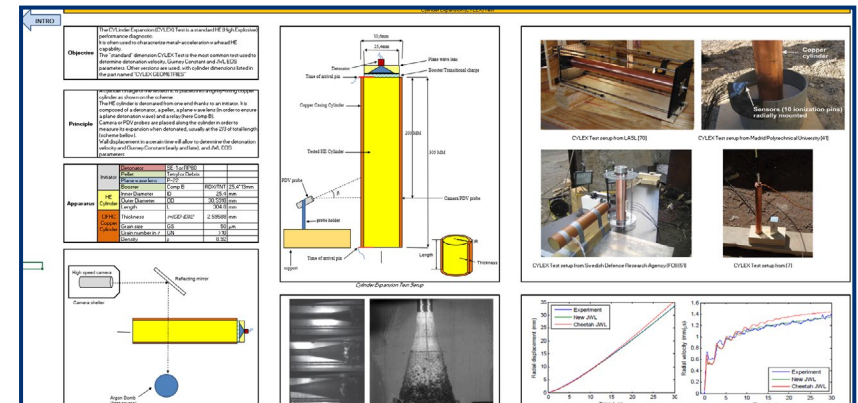
MCYLEX provides:

- A database of high explosive cylinder expansion experimental test results with source references that includes comparisons and analysis.
- A database of JWL equation of state parameters along with references that can be used for modelling of high explosives.

- A listing and descriptions of cylinder expansion test geometries and setups.



Format:	Spreadsheet (.xlsx)
Responsible TSO:	Warhead Technology
Documents:	O-222 MCYLEX Introduction (MSIAC CYLinder EXpansion Database)
Link:	https://www.msiac.nato.int/tools/mcylex/
Available to:	All approved users



Substance	Composition	Method	Initial Density (g/cm³)	Expansion Velocity (m/s)	Measurement Technique	Probe Angle (°)	Initial Velocity (m/s)	Probe Velocity (m/s)	Probe Length (mm)	Probe Diameter (mm)	Probe Mass (g)	Probe Length (mm)	Probe Diameter (mm)	Probe Mass (g)	Probe Length (mm)	Probe Diameter (mm)	Probe Mass (g)
100%TNT	100%TNT	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
100%RDX	100%RDX	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
100%HMX	100%HMX	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90
100%PETN	100%PETN	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%NIJ	100%NIJ	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
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100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
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100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
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100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
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100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
100%ANFO	100%ANFO	1.60	1														



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