NATO OTAN

NATO STANDARDIZATION AGENCY
AGENCE OTAN DE NORMALISATION

NSA

14 June 2007 NSA0592(2007)-AIR/4623

To: AC/224 STANAG Distribution

STANAG 4623 (EDITION 1) – HARD AND DEEPLY BURIED TARGETS (HDBT)

Reference: AC/224(AG/2)D(2004)0003 (Ratification Request)

1. The enclosed NATO Standardization Agreement, which has been ratified by nations as reflected in the NATO Standardization Document Database (NSDD), is promulgated herewith.

2. The Reference listed above is to be destroyed in accordance with local document destruction procedures.

ACTION BY NATIONAL STAFFS

3. National staffs are requested to examine their ratification status of the STANAG and, if they have not already done so, advise the Secretary AC/224(ACG/2), through their national delegation as appropriate of their intention regarding its ratification and implementation.

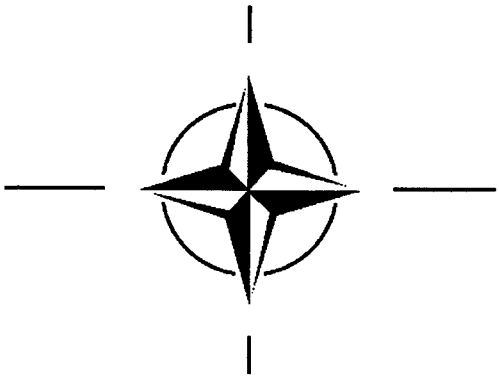
J MAJ
Major General, POL(A)
Director, NSA

Enclosure:
STANAG 4623 (Edition 1)

NATO Standardization Agency – Agence OTAN de Normalisation
B-1110 Brussels, Belgium Internet site: http://nsa.nato.int
E-mail: g.thibaut@hq.nato.int – Tel 32.2.707.4288 – Fax 32.2.707.4103

STANAG No. 4623
(Edition 1)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)



NATO STANDARDIZATION AGENCY
(NSA)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: Hard and Deeply Buried Targets (HDBT)

Promulgated on 14 June 2007

for

J. MAJ
Major General, POL(A)
Director NSA

RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date Entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Director NATO Standardization Agency under the authority vested in him by the NATO Standardization Organisation Charter.

2. No departure may be made from the agreement without informing the tasking authority in the form of a reservation. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

4. Ratification, implementation and reservation details are available on request or through the NSA websites (internet http://nsa.nato.int; NATO Secure WAN http://nsa.hq.nato.int).

FEEDBACK

5. Any comments concerning this publication should be directed to NATO/NSA – Bvd Leopold III - 1110 Brussels - BE.

Annex A to
STANAG 4623
(Edition 1)

STANAG 4623
(Edition 1)

NAVY/ARMY/AIR

NATO STANDARDIZATION AGREEMENT (STANAG)

HARD AND DEEPLY BURIED TARGETS

AIM

1. The aim of this agreement is to standardize the categorization of Hard and Deeply Buried Targets (HDBT). In addition, it provides a mathematical equation for computation of concrete equivalent thickness, applicable to kinetic energy penetrator warheads.

AGREEMENT

2. Participating nations agree to use the categorization of the Hard and Deeply Buried Targets (HDBT) as identified in this STANAG. The mathematical equation is provided to aid in the determination of concrete equivalent thickness in order to aid nations in categorizing specific targets.

DETAILS OF THE AGREEMENT

3. HDBTs are fixed, unitary, high value facilities or functions to which considerable reinforcement (hardening) has been applied, or which have been constructed under the earth's surface and covered with materials such as soil, gravel, rock, reinforced concrete, and other strengthening materials to frustrate attacks and intelligence collection efforts. HDBT include tunnels constructed deep below the earth's surface or deep within mountains.

The following categories identify target hardness as well as target types: (For the purposes of this STANAG, concrete is defined as having unconfined compressive strength of 35 MPa.)

CATEGORY I (0-2 m concrete)	**CATEGORY II** (2-6 m concrete)	**CATEGORY III** (6-9 m concrete)	**CATEGORY IV** (9-20 m concrete)	**CATEGORY V** (>20 m concrete)
Aircraft shelter SAM bunker Magazines Support bunker G & C bunker Cave door	Missile bunker Underground GCI Single-story C^3 Underground facility doors Nuclear storage	Launch control Multistory C^3	Hard C^3 Submarine pens Very hard C^3 Underground facilities	Very hard C^3 Underground facilities

Category IV and V targets are deeply buried (more than 30 m of earth overburden) and are constructed of reinforced concrete ranging from 1 m to 3 m thickness. If an equivalent concrete thickness were assigned to this category, it would be approximately 10 m. Targets in this category typically use rock overburden as part of their protection scheme, and, in some cases, the targets are dug into rock. The rock targets are generally protected by a minimum of 3 m of 276 MPa hard, granite-type rock.

4. The concrete equivalent thickness for a given target shall be calculated via the following equation:

$$D_{equiv} = \Sigma (D_{concr} * f_{qual} * f_{\alpha}) + \Sigma (D_{cover} * f_{mat})$$

Annex A provides the definitions of the variables, the units and the tables for determination of the numerical values of the variables.

IMPLEMENTATION OF THE AGREEMENT

5. This STANAG is implemented when a nation has issued instructions that the categorization identified herein will be employed by that nation.

Definitions:

D_{equiv} equivalent total thickness 35 MPa concrete (meters)

Σ sum of each individual component layer

D_{concr} thickness of concrete layer (meters)

f_{qual} $(\sqrt{\text{compressive strength concrete used (MPa)}})/6$

(for impact velocities greater than 550 m/sec, multiply f_{qual} by f_V, where:
$f_V = 1+ ((0.22V – 121)/250)$

V impact velocity (meters/sec)

f_α correction factor due to angle of attack; (α is the 3-dimensional angle between the penetrator longitudinal axis and the flight path)

D_{cover} thickness of covering layer(s) (meters)

f_{mat} factor accounting for material strength in covering layer

Angle of attack	f_α
0° - 2°	1.0
2° - 5°	1.03
5° - 10°	1.07
10° – 20°	1.1
> 20°	∞ (damage to the penetrator)

Values of f_{mat}	**minimum**	**average**	**maximum**
Layer of stone			
Concrete, 35 MPa compressive strength	1.00	1.00	1.00
Sandstone, 15 MPa compressive strength	0.36	0.48	0.82
Limestone, 50 MPa compressive strength	0.74	0.99	1.67
Basalt, 60 MPa compressive strength	0.83	1.10	1.88
Granite, 110 MPa compressive strength	1.11	1.47	2.50
Quartzite, 140 MPa compressive strength	1.33	1.76	3.00

Values of f_{mat}	**minimum**	**average**	**maximum**
Layer of soil			
Sand	0.21	0.24	0.25
Loam	0.15	0.17	0.19
Sandy loam	0.18	0.21	0.22
Clay	0.11	0.12	0.14
Rubble or Boulder Overlay			
High strength boulder overlay; 0.4 m average bolder diameter, 150 MPa compressive strength, layer's thickness 2.0 m			
Air filled voids	1.43	1.60	1.74
Sand filled voids	2.50	2.71	2.86
Grout filled voids	6.67	7.33	7.50
Low strength boulder overlay; 0.4 m average bolder diameter, 30 MPa compressive strength, layer's thickness 2.0 m			
Air filled voids	1.25	1.30	1.33
Sand filled voids	1.88	2.07	2.22
Grout filled voids	6.52	6.67	6.77

(*Values for the factors in this Annex are from a combination of simulation models and actual tests*)