HAZARD EVALUATION OF SOME PROPELLANTS ADOPTING UN METHODS OF 1986

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INTRODUCTION

1.1 Hazard classification of propellants used in various ammunition stores have been an intriguing phenomenon as different manufacturing countries have adopted different standards and as a result a propellant with similar chemical and physical characteristics could be accepted as HD1.1C or HD1.3C. This involved manifold problems including transhipment, quantity distance considerations and other aspects related thereto.

1.2 With the publication of U.N.Recommendations on "Transportation of Dangerous Goods", Tests & Criteria; First Edition; New York 1986, a new vista has been opened for adoption of standardised methods for classification of items belonging to Class-I, Explosives, in their respective hazard divisions; viz, HD/1.1,1.2,1.3 or HD 1.4.

1.3 A number of full scale trials have been conducted by us adopting Test series 6 as described in the aforementioned publication and ten propellants belonging to different composition groups and accepted in India as HD1.1C, used in different ammunition stores ranging from Small Arms Ammunition to large calibre Mortar and Gun ammunition have been reclassified as pertaining to UNHD 1.3C.

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BACK DROP

2.1 The list on classification of Explosives published in June 1987 by ESTC, London has shown about two dozen propellants as pertaining to UN HD1.1C, however, they did not mention as to whether their hazard divisions were evaluated using UN methods of 1986. Similarly the Directorate of Explosives Safety in India has declared practically all the propellants manufactured by Defence Ordnance Factories as pertaining to HD1.1, however, they had used detonating pellets and Detonator No.27 or Electric Detonator No.33 for giving the initiating impulse.

2.2 The UN Recommendations on "Transport of Dangerous Goods", Test & Criteria; First Edition; New York 1986, stipulated standardised procedures, as recommended by the U.N.Committee of Experts on Explosives, under Test Type 6 (a, b & c), however, these tests needed full scale field trials.

2.3 A few experiences of past as gained in some of the Ordnance Factories had shown certain propellants behaving as UN HD1.3C items and therefore it was decided to conduct trials adopting UN methods of 1986 to ascertain their Hazard Divisions as per these standardised procedures.

RESULTS & DISCUSSION

3.1 Ten propellants belonging to composition groups like, NGB (Yugoslav composition); Small Arms NC.1140/1058/688 etc. (Swedish & French composition) and some Indian developed compositions were subjected to trials adopting procedures described under Test Type 6(a,b&c). These propellants earlier classified as UNHD1.1C have turned out to pertain to UNHD1.3C. Relevant details of these propellants are placed at Annexure I.

3.2 *This reclassification, whereas, would affect the Quantity distance aspects in the existing manufacturing units, would also accord a pragmatic and standardised classification throughout the world.*

3.3 *Propellants are basically meant to defflagrate and as such assigning them UN HD1.1 is a debatable concept in itself and in case a detonating impulse is given to them under confinement (in contrast to UN methods which stipulate use of 30.0 g of Black Powder), they are very likely to detonate, contrary to the function they are expected of.*

METHODOLOGY

4.1 *United Nations Recommendation on "Transport of Dangerous Goods"; Tests & Criteria; First Edition; New York 1986, have described Test Series 6 from page No.144 onwards. Tests under this series are sub-divides as Test Type 6(a) or Single Package Test; Test Type 6(b) or Stack Test and Test Type 6(c) or External Fire Test and the behaviour of a substance accepted as Class-I, Explosive under these tests indicates its UN HD; whether same pertains to HD1.1,1.2,1.3 or 1.4. Whereas trials under Test Types 6(a) & 6(b) are required to be conducted on three occassion, trial under Test Type 6(c) is to be done only on one occassion.*

4.2 *Test Type 6(a); Single Package Test: In the trials conducted by us a card-board carton of volume 0.15m^3 was used being placed over a 3 mm thick mild-steel witness plate.30.0 g of G-12 (Gun Powder) was used to initiate the propellant material placed in confinement of 0.5 to 1 meter thick layer of sand filled gunny bags. G-12 was ignited using Safety-Fuze No.11, MK-II passing through unignitable tube kept in the propellant*

medium. Quantities of propellant varied from 135.0 kg to 180.0 kg in case of different propellants. Relevant data and observations are placed at Annexure II & IIA.

4.3 *Test Type 6(b); Stack Test: Five to six number of original service packages containing propellant material were placed over the M.S. witness plate in a way to give the worst configuration: Propellant in the centre-most package was initiated using 30.0 g of G-12 as mentioned in para 4.2 above.*

4.4 *Test Type 6(c); External Fire Test : Five to ten numbers of packages filled with propellants were placed over a specially fabricated iron-grill, on three sides of which 2 mm thick Aluminum screen as stipulated in the U.N.Recommendations were erected. The height of grill was at a minimum of 750 mm above the ground level and the three Al-Screens were placed at distances varying from 4 to 5.2 meters. Adequate quantities of fire-wood were placed all around the propellant filled packages and fuel-liquid was sprayed profusely and then the fire-wood ignited.*

OBSERVATIONS

5.1 *Whereas Test Types 6(a) & (b) were conducted on three occassions, test type 6(c) was conducted only once. In some trials major events were video-taped and in some trials still photographs were taken of the important events. Details of observations and findings are abridged at Annexure-II & IIA. Some still photographs are placed at Annexure-III.*

5.2 *It is noteworthy to observe that there had been absolutely NO DAMAGE to 3 mm thick M.S.Witness plate and also there was NO SIGN of any crater formation at the test site in all the trials*

5.3 *There had been no instantaneous explosion/ detonation and the propellant burnt-off leading to defflagration. Brilliant flames leaped upto 25 meters height in some cases.*

5.4 *In Test Type 6(b), in some trials the propellant material only in the initiated package burnt-off and the other packages remained unaffected.*

5.5 *In Test Type 6(c) external fire continued for some minutes before the propellant caught fire.*

EVALUATION

6.1 *The findings and observations have been evaluated in light of stipulations contained in the UN Recommendations of 1986 against each Test Type i.e. Test Type 6(a), 6(b) and 6(c).*

6.2 *The observations clearly suggest all the ten propellants tried adopting UN methods as pertaining to UN HD 1.3C and accordingly the analysis of observed and recorded events led to infer that all these ten propellants stood reclassified to UN HD1.3C.*

SUMMARY

7.1 *In quest of standardisation of Hazard divisions of different propellants used in a variety of ammunition stores, a number of trials have been conducted jointly by the Indian Ordnance Factories Organisation and the Directorate of Explosives Safety, Ministry of Defence, Government of India adopting Test Series 6 and thereunder Test Types 6(a), 6(b) & 6(c) as stipulated in UN Recommendations on "Transport of Dangerous Goods", Tests & Criteria; First-Edition; New York 1986.*

7.2 *Ten propellants earlier assigned UN HD1.1C have been reclassified as HD1.3C as the result of full scale trials conducted adopting UN methods of 1986.*

ACKNOWLEDGEMENT

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BIBLIOGRAPHY

1. ***U.N.Recommendation on "Transport of Dangerous Goods", Tests & Criteria; First Edition, New York 1986.***

2. ***ESTC, London, Pamphlet on "Classification of Military Explosives", published in June 1987.***

ANNEXURE - II

QUANTITIES OF PROPELLANTS VIS-A-VIS PACKAGES USED IN DIFFERENT TESTS

Sr. No.	Propellant Code	Test Type 6(a)	Test Type 6(b)		Test Type 6(C)		REMARKS
		Quantity per $0.15m^3$ volume of Card-board Carton. (Kg)	Package used	quantity Per Test (Kg)	Package used	Quantity used (kg)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	NGB-051	135.00	C.27A Metallic containers (2Nos)placed inside one C26A Wooden package.	150.00	As in Test Type 6(b)	300.00	For Test Type 6(a), a Card-board Carton of Volume $0.15m^3$ was made as per stipulations contained in UN Recommendations, and for Test Types6(b) and 6(c) Original Service packages were used.
2.	NGB-221						
3.	NGB-011	-do-		-do-		300.00	
4.	NGB-241						
5.	NGB-204	96.00	A pair of Card-board Cartons placed in a C27A metallic container which is placed in C26A wooden package.	96.00	-do-	160.00	
6.	NC-1140	150.00	C27A Container and C26A wooden package	180.00	-do-	300.00	
7.	NC-688	135.00		150.00	-do-	300.00	
8.	NC-1058	150.00					
			-do-	180.00	-do-	300.00	
9.	Ball Powder	160.00	Plywood rectangular container with alkathene liners.	240.00	-do-	200.00	
10.	Propellant T-28	160.00	C.128MK XIII cases with Alkathene	280.00	-do-	520.00	

ANNEXURE - IIA

SOME IMPORTANT OBSERVATIONS DURING TEST TYPES 6(a),6(b) & 6(c)

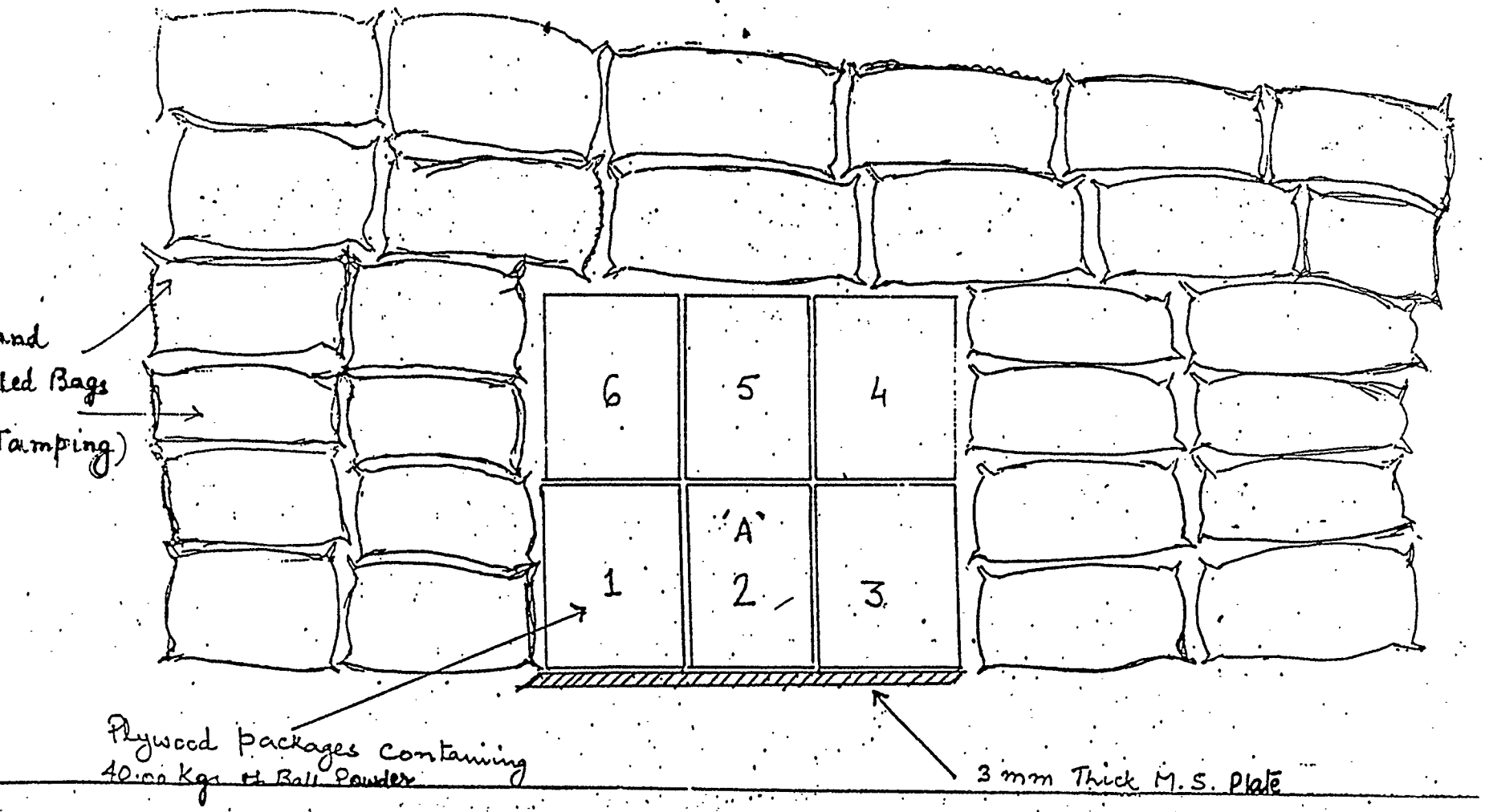
Propellent Code	Test Type(a)	Test Type 6(b)	Test Type 6(c)
(2)	(3)	(4)	(5)
NGB-051 NGB-221	No effect on MS witness plate. No detonation but material burnt-off with mild bang. Brilliant flames upto 10m height.	Burning with hissing sound Material only in the initiated package burnt off leaving other packages unaffected.	After 8 minutes of exposure to flames,Ist package caught fire and entire material got burnt in six minutes. No fire balls etc.No effect on Aluminum Screens.
NGB-011 NGB-241	-do-flame height upto 15 m.	-do-.	After 3½ minutes of flame exposure, the material started burning with bright flames.
NGB-204	No effect on MS Plate No detonation/No crater formation. Flames upto 10 m height.	-do- Flames with sparkling effect and hissing sound. Flame height upto 5m.	Brilliant sparkling flames. After 4½ minutes. Propellant burnt for about five minutes.
NC-1140	--do-- Flame height upto 20m.	Flames with hissing sound.	Ist package caught fire after 5minutes of exposure to external fire and thereafter propellant burnt with bright flames.
NC-688	-do-	-do-	Initial exposure of packages for two minutes.NO FIRE BALL.
NC-1058	-do-	-do-	-do- Initial exposure for 4 minutes.
Ball Powder	-do-	-do-Material only in the package which was initiated withG-12 burnt leaving others uneffected.	-do-
Prop.T-28	-do-	Material in all packages(6Nos.) burnt off with bright flames.	-do-Flame height upto 25m. No effect on Al.Screen.

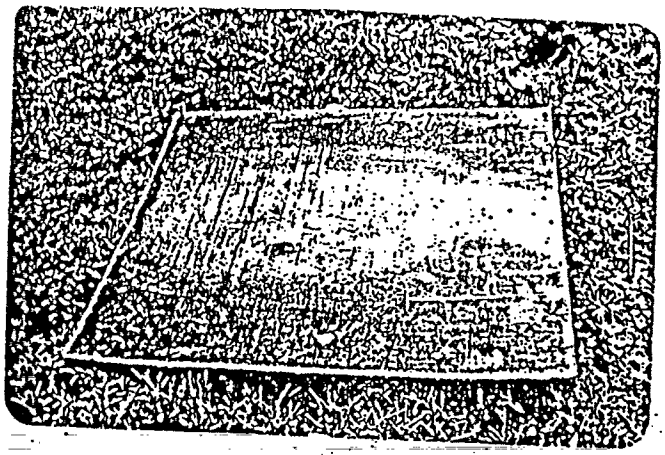
PROPELLANTS RECLASSIFIED USING U.N. METHODS -- --

.No.	Propellant Code	Used in	Composition Group	Physical characte -ristic.	Earlier classif -ication	Reclassified as per U.N. Methods.	Remarks
1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	NGB.051 NGB-221	81mm Mortar Ammn.	Modified Yugoslav Comp. NCB; 57.5+ 1.5 % NG; 40.5+ 1.5 % + Others including Graphite	Flake Propellants	HD1.1	HD1.3	All the ten Propellants had behaved as HD1.1C with detonating impulse, however, with black powder in Test Type 6(a) and 6(b) and also in Test Type 6(c), they behaved as Mass Fire belonging to HD1.3C.
	NGB-011 NGB-241	120mm Mortar Ammn.					
	NGB-204	84mm Carl Gustav Ammn.	Modified Swedish Comp. (as above) less Graphite	Strip Propellant	HD1.1	HD1.3	
	NC-1140	7.62 mm SAA	Swedish Comp. NC:97.0+0.5 % + others.	Cylindrical grains length : 1.14mm dia :0.84mm	HD1.1	HD1.3	
	NC-688	9 mm Ammn.	NC:98.5 % + others.	Cylindrocal Grains L:1.00mm d:0.50mm	HD1-1	HD1.3	
	NC-1058	30mm Aden GunAmmn.	NC:98.0 % + others.	Cylindrical grains l:1.3mm d:0.4mm	HD1.1	HD1.3	
	Ball Powder	7.62mm SAA	French Comp. NC:90% NG:9.0+2.0% (+) others	Ball/or Spheroids.	HD1.1	HD1.3	
0.	Propellant T-28	106mm A|T RCL Ammn.	NC:67.25+1.80% NG:25.00+0.75% (+) others.	Multitubular Cylindrical Grains of 12mm length.	HD1.1	HD1.3	

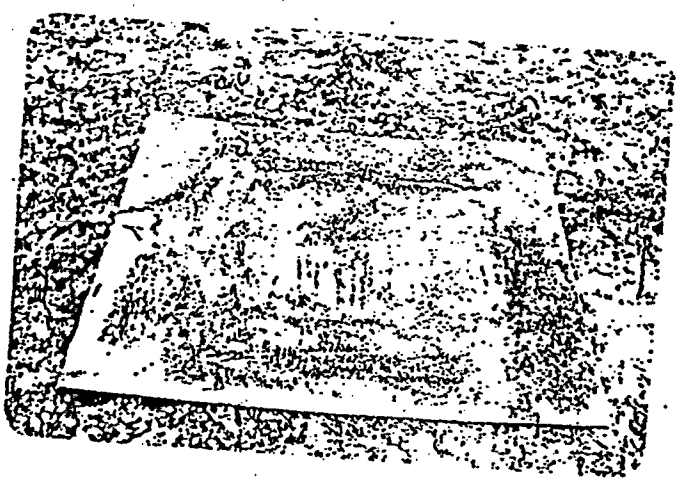
: Flames as seen under Test Type 5(c)

ARRANGEMENT OF PACKAGES IN TEST TYPE 6(b).





Photoplate : 3mm THICK M.S. WITNESS PLATE BEFORE THE TRIALS.



Photoplate : EFFECT OF TRIALS ON WITNESS PLATE UNDER TEST TYPE 6(a).