DC No. 5433-ME
18.04.2016

IND/ME/911:2015

FLEXIBLE LINEAR SHAPED CHARGES

(FLSC 3, 8 & 10)

(DS Cat Nos. FLSC 3 1375 000 504
FLSC 8 1375 000 505
FLSC 10 1375 000 506)

V. Thaigerajan 4/10/19

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CONTROLLERATE OF QUALITY ASSURANCE (MILITARY EXPLOSIVES)

AUNDH ROAD, PUNE - 411 020.

DEPARTMENT OF DEFENCE PRODUCTION

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AMENDMENT RECORD

Amendment		Authority letter	Clauses Affected	Remarks
D.C. No.	DATE			

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THIS SPECIFICATION OR ANY OTHER PATTERN, DRAWINGS OR ANY OTHER INFORMATION ISSUED IN CONNECTION THEREWITH MAY ONLY BE USED FOR A SPECIFIC ORDER PLACED BY THE COMPETENT AUTHORITY. IT IS NOT TO BE USED FOR ANY OTHER PURPOSE WHATSOEVER WITHOUT THE EXPRESS WRITTEN SANCTION OF THE DIRECTOR GENERAL OF QUALITY ASSURANCE, MINISTRY OF DEFENCE, NEW DELHI - 110 011 .

0. FOREWORD

0.1 This specification has been prepared by the Controllerate of Quality Assurance (Military Explosives), Aundh Road, Pune - 411 020.

0.2 This specification has been approved by the Ministry of Defence and is mandatory for use by Defence Services.

0.3 This specification is a revision of IND/ME/911(Prov) and supersedes the same.

0.4 The Quality Assurance Authority for the item covered in this specification is The Controller, CQA(ME), Aundh Road, Pune - 411 020.

0.5 Any enquiries regarding this standard/specification in relation to an invitation to tender or a contract in which it is invoked should be addressed to the Quality Assurance Authority named in that invitation to tender or contract.

1. SCOPE

1.1 This specification is meant to govern manufacture, supply and quality assurance of Flexible linear shaped charges 3, 8 & 10 for use in destruction of Rocket vehicles structure by cutting outer stage rocket motor cases & fuel/oxidiser tanks, and also for use in linear cutting/separation of metal body.

2. RELATED SPECIFICATIONS AND DOCUMENTS

2.1 The related documents mentioned at clause 2.2 are those applicable at the date of publication of this specification. It is contractor' s/manufacturer's responsibility to confirm their current applicability and to obtain from the Authority Holding Sealed Particulars (i.e. CQA(ME) Aundh road, Pune-411 020) information concerning any change that may be necessary due to cancellation, replacement or supersession of any of these documents.

2.2 The following related specifications have been referred to in the preparation of this specification :-

(i)	JSS 1376-01: 2010 (Rev No. 3)	-	RDX (Injected stabilised) Gr. 1B
(ii)	JSS 8010-48:2012 (Rev No. 2)	-	Lacquer, Nitrocellulose, Adhesive orange and red
(iii)	Lead tubes	-	Appendix 'D' to this specification.
(iv)	Cord Backing material	-	Appendix 'E' to this specification.
	(a) Rhodorsil CAF4	-	Proprietary product of M/s Rhone Poulene Silicone Department, France.
	(b) Rhodorsil 481 2A		
	(c) Primer M. B.	-	Proprietary product of M/s IDE Processors International Sales Corporation, Kew Gardens, New York 11915 USA OR M/s Axel Plastic Research Lab. INC Bo 855 5820 Broadway woodsize, NEW YORK 11377.
	(d) Mould release		
(v)	Cord backing moulds	-	(Consisting of a) A base consisting of grooves for keeping cords & b) A lid for keeping the cords in position. They are assembled together by screws.
	FLSC - 3	-	Drg. No. 0274-05-02-00
	FLSC - 8	-	Drg. No. 3211-67-05-01-00
	FLSC - 10	-	Drg. No. 0275-02-00-00
(vi)	Aluminium for Booster sleeves	-	Appendix 'F' to this specification.
(vii)	Target material for plate test	-	Appendix 'B' to this specification.

2.3 Copies of the related specifications, drawings & other documents are obtainable on payment as follows:-

SPECIFICATION		SOURCE OF SUPPLY
(i) JSS	:	The Director Directorate of Standardization Standardization Documents Centre Ministry of Defence Room no 05, 'J' Block Nirman Bhawan PO New Delhi - 110 011
(ii) IND/ME/Specification and Drg. No. 0274-05-02-00 Drg. No. 3211-67-05-01-00 Drg. No. 0275-02-00-00	:	The Controllerate of Quality Assurance (Military Explosives), Aundh Road, PUNE-411 020.

3. DESCRIPTION

The charges shall consist of core of RDX encased in a sheath of pure lead over which is a coat of backing material. The charges manufactured shall be free from surface flaws like cracks, dents etc. & also shall conform to the requirements mentioned in clause 6.3

4. MANUFACTURE

4.1 Manufacture

The charges shall be manufactured by a process which has received authoritative approval. The Quality Assurance Authority shall be informed regarding the process used & shall be given prior notification of any proposed deviation there from. All the deviations from the approved process, however slight, shall be recorded immediately & all material affected shall be set aside pending the decision of the Quality Assurance Authority.

No operation which may modify the physical properties of the material in a lot will be carried out after it has been submitted for the tests unless authorised by the Quality Assurance Officer.

A brief description of the process of manufacture is given in Appendix 'C'.

4.2 INGREDIENTS

4.2.1 The ingredients used in the manufacture of charges should conform to the relevant specifications as mentioned in clause 2. 2.

5. SUPPLIER'S INSPECTION OF STORES/CONSIGNMENT

5.1 Before tendering the store for inspection the supplier shall carry out a thorough inspection of each delivery to satisfy himself that the store fully conforms to this specification and shall render a certificate to that effect to the Quality Assurance Officer/Quality Assurance Authority.

* Not applicable when the store is manufactured in Ordnance Factories.

6. QUALITY ASSURANCE

6.1 Inspection

6.1.1 The charges & the packages in which they are packed shall be subject to the Quality Assurance by & to the approval of the Quality Assurance Officer/Quality Assurance Authority.

6.1.2 Samples of the material & of the packages may be taken from any portion of the batch/lot/consignment.

6.1.3 If on examination, any sample be found not to conform to this specification, the whole batch/lot/consignment may be rejected.

6.1.4 The foregoing provisions shall equally apply to the prime contractors & sub-contractors, if any.

6. 2 SAMPLING

6.2.1 The manufacturer shall supply free of charge, the materials required by the Quality Assurance Officer for testing purposes & shall provide the necessary facilities & apparatus which may be required for carrying out the tests called for by this specification.

6.2.2 The Quality Assurance Officer shall have access at all times to all departments of manufacturing plant which are concerned with the production & storage of the material under the order.

6.2.3 Two representative samples shall be drawn from a batch of 7 to 10 Nos. in case of FLSC 3 & 2 Nos. from a batch of 30 to 60 Nos. in case of FLSC 8 & FLSC 10.

6.2.4 If, on examination, any sample be found not to conform to this specification, the whole batch/lot/consignment may be rejected.

6.3 TEST REQUIREMENTS

6.3.1 Samples taken from any portion of the batch/lot/consignment of the material shall conform with clause 3 & in addition shall conform to the following test requirement.

s. No.	CHARACTERISTICS	PASSING STANDARD	TEST METHOD
1.	Visual Examination	Shall be free from surface flaws like cracks, dents.	
2.	Charge density in g/metre	FLSC- 3 - 8.40 ± 0.2	Appendix 'A'
		FLSC- 8 - 24.0 ± 2.0	
		FLSC-10 - 35.0 ± 2.0	
3.	Flat plate test	Precise & continuous clean cut on target.	Appendix 'B'

In addition to the above, the charges should satisfy the following requirements.

S. No.	CHARACTERISTICS	PASSING STANDARD		
		FLSC 3	FLSC 8	FLSC 10
1.	Sheath	Pure lead*	Pure lead*	Pure lead *
2.	Core explosive	RDX	RDX	RDX
		Gr. 1 B	Gr. 1 B	Gr. 1 B
3.	Width before backing in mm	5.3 + 0.2	10.5 ± 0.5	12.0 ± 1.0
4.	Height before backing in mm	5.10 + 0.2	10.0 ± 1.0	10.0 ± 1.0
5.	Width after backing in mm	6.0 + 0.20	12.0 ± 0.50	12.0 ± 0.50
6.	Height after backing in mm	6.0 + 0.20	12.5 ± 0.50	12.5 ± 0.50
7.	Core load g/m	8.4 + 0. 2	24.0 ± 2. 0	35.0 ± 2.0
8.	Cutting capability	B-26 SWP Al. Alloy 5. 0 mm	15 CDV6 Steel 2. 0 mm	15 CDV6 Steel 3. 5 mm

NOTE: * Purity of lead shall not be less than 99. 5%, Appendix 'D' refers.

S. No.	CHARACTERISTICS	PASSING STANDARD		
		FLSC 3	FLSC 8	FLSC 10
9.	Maximum length of the segment in mm	3400	1800	1500
10	Booster type (Details given in Appendix 'B')	BST-4	BST-6	BST-6

NOTE : Booster is introduced in between THE FLSC & detonator for stablising & augmenting the detonation wave produced by detonator.

7. PACKAGING

7.1 The flexible linear shaped charges are to be packed in metal lined wooden container having separate grooves of appropriate size for each cord. The grooves being lined with cotton or felt. The details are given in Drg. No. CQA(ME)/DRG/230(Prov)

7.2 Silica gel packets are to be kept inside the containers.

7.3 The exposed ends of the cords, if any, should be coated with NC varnish to specification JSS 8010-48.

7.4 Direct sunlight should not fall on the containers & are to be stored in magazines & kept earthed.

8. MARKING

8.1 All packages containing the material shall be durably & legibly marked with the following details (as applicable)

(i) Nomenclature & specification number

*(ii) Name & address of the consignee

*(iii) A. T. or S. O. No. & date

*(iv) Consignment number

(v) Lot/Batch No. & date of manufacture

(vi) Gross & net mass

(vii) Consecutive number of package & total number of packages in the consignment.

* (viii) Date of supply

* ix) Contractor's initials or recognised trade mark.

* Not applicable when the store is manufactured in the Ordnance Factories.

8.2 A Government Explosive Group No 1.1 D marking of approved pattern shall be affixed to each container by means of a prescribed label. Alternatively the marking may be applied by means of a stencil.

8.3 The paint used for marking shall conform to IS 138 (Latest Issue) & to the satisfaction of the Quality Assurance Officer/Quality Assurance Authority.

9. DEFENCE STORES CATALOGUE NUMBER

Defence stores catalogue numbers allotted to these store are rearranged
FLSC 3 - 1375 – 000 504, FLSC 8 - 1375- 000 505 & FLSC 10 - 1375 – 000 506

10. SAFETY OF OPERATIONS

10.1 Nothing in this specification shall relieve the manufacturer of his responsibility for the safety of operations.

10.2 Safety certificate No. ---------- is applicable (available on application to CQA(ME), Aundh Road, Pune)

11. SUGGESTIONS FOR IMPROVEMENT

Any suggestions for improvement in this particular document may be forwarded to the Controller, CQA(ME), Pune.

Date : 06/04/2016

(Mrs. MGP DHANRAJ)
CONTROLLER
CQA(ME), Aundh Road
Pune - 411 020

APPENDIX 'A'

DETERMINATION OF CHARGE DENSITY

1. PREPARATION OF SAMPLE

A) FLSC -3 (Batch size 7 to 10 Nos.)

Two cords selected at random shall be marked as QC cord No. 1 & QC cord No. 2. QC cord No. 1 will be cut into three segments of equal length). From both ends of each segment, 10 pieces each of 20 mm length are cut & marked. Thus making a total of 60 pieces for charge density determination. The remaining three segments to be marked as FPT 1, 2, 3 and kept for flat plate tests. The QC cord No. 2 is cut in to two equal parts. Then from each half 20mm long 10 pieces are cut from two ends making 40 pieces in total. The left over two pieces are made into 4 & marked as FPT 4, 5, 6 & 7 & kept for flat plate tests. A total of 100 pieces for charge density & 7 pieces for flat plate tests are thus obtained.

B) FLSC - 8 & 10 (Batch size 30-60)

Two cords selected at random are marked as cord No. 1 & cord No. 2. Five pieces each of 50mm length are cut from both the ends from cord No. 1. The remaining lengthy piece is cut into two segments (1 & 2) and from cut portion 5 pieces (2 + 3) of 50mm length are made. thus a total of 15 pieces of 50mm length are made from one cord. The remaining two pieces are marked as FPT-1 & FPT-2 for flat plate tests. The same procedure is followed for cord No. 2. This makes a total of 30 pieces for charge density determination and 4 pieces for flat plate test together from both the cords.

CHARGE DENSITY DETERMINATION

The cut pieces are serially arranged & length measured at 3 different points across the cross section & the average length is taken. Care should be taken not to spill any charge during handling. The mass of each piece is taken on electronic balance. The weighed pieces are placed in a conical flask containing approximately 50ml of acetone & left for 4 hours with intermittant shaking for complete dissolution of RDX. The pieces are then removed & dried for 10 minutes at room temperature and are weighed again. The difference in mass gives the mass of the charge for given length and then charge density per unit length (1M) is calculated.

APPENDIX 'B'

FLAT PLATE TEST

The specimen for this test are prepared as described in clause 1 of Appendix 'A'.

The pieces marked for flat plate test are assembled on accepted target plate (requirements given below). The cord is laid out exactly at the centre of plate leaving about 60 mm at the other end for assembling the booster (details given below) and detonator (IED 3). The cord is fixed on the plate with adhesive tape. The booster (without aluminium sleeve) and detonator (type No. IED 3) are assembled with adhesive tape ensuring the axial alignment between detonator, booster & FLSC as accurately as possible. The gaps at interfaces should be within 0. 25mm. The resistance of the detonator is checked. This set is placed on channel support as per Fig. 1. It is then fired from a distance of 200 meters. A precise & continuous clean cut is required to be obtained.

Accepted batch of the cords are then released for elastomer backing. Each cord is checked for any cracks, dents on the surface & ensured that no RDX is exposed. The height, width & length are measured.

SAFETY PRECAUTIONS TO BE TAKEN DURING FLAT PLATE TEST

a) Non sparking tools/knives must be used wherever specified.
b) Only approved/certified circuit tester should be used for checking the continuity during the test.
c) Firing should be done from behind proper protection cover.
d) A radius of 200 meters should be marked as dangerous zone.

TARGET MATERIAL SHOULD CONFORM TO THE FOLLOWING REQUIREMENTS

Sl. No.	Characteristics	FLSC - 3	FLSC - 8	FLSC -10	Ref to test method
1.	Type of material	Aluminium alloy B-26 SWP	15 CDV6 -Steel	15 CDV6 - Steel	-
2.	Thickness in mm	5.0 + 0.2 mm - 0.0 mm	2.0 + 0.2 mm - 0.0 mm	3.5 + 0.20 mm - 0.00 mm	-
3.	Length in mm	650	350	350	-
4.	Width in mm	100	75	75	-
5.	Composition	Cu - 4.3%	C - 0.1 to 0.16 %		ASTM Std Vol 12 Method E-34
		Si-0.8%	Mn- 0.8 to 1.1 %		
		Mn-0.8%	Si- 0.2 % Max		
		Mg-0.8%	Ni- 0.5 %		

Sl. No.	Characteristics	FLSC - 3	FLSC - 8	FLSC -10	Ref to test method
			Cr - 1.25 to 1.5 %		
			Mo - 0.8 to 1.0 %		
			V - 0.2 to 0.3 %		
			S - 0.03 % max.		
			P - 0.03 % max.		
6.	Ultimate tensile strength in Kg/mm^2	42. 5	95 to100	95 to 105	ASTM B-557
7.	Elongation percent	8	-	-	-
8.	Hardness	145 BHN	290 - 313 BHN.	290 - 313 BHN	-

APPARATUS/EQUIPMENTS FOR FLAT PLATE TEST

1. **Igniter circuit tester**

Igniter circuit tester dry cell operated portable for field use with safe limit of 1. 5 mA for measure bridge wire resistance of electro explosive devices.

Range	-	0 to 30 ohms
Leastcount	-	0.01 ohm

There must be build in arrangement to cut off power supply in case the current exceeds safe limit.

2. **Dynamo condenser Exploder**

a) Type - Portable, b) total circuit resistance - 800 ohms max, c) Maximum No. of detonators fired in series - 200 Nos.

Tested & approved by Central Mining Research Station, Dhanbad.

3. **Firing Cable**

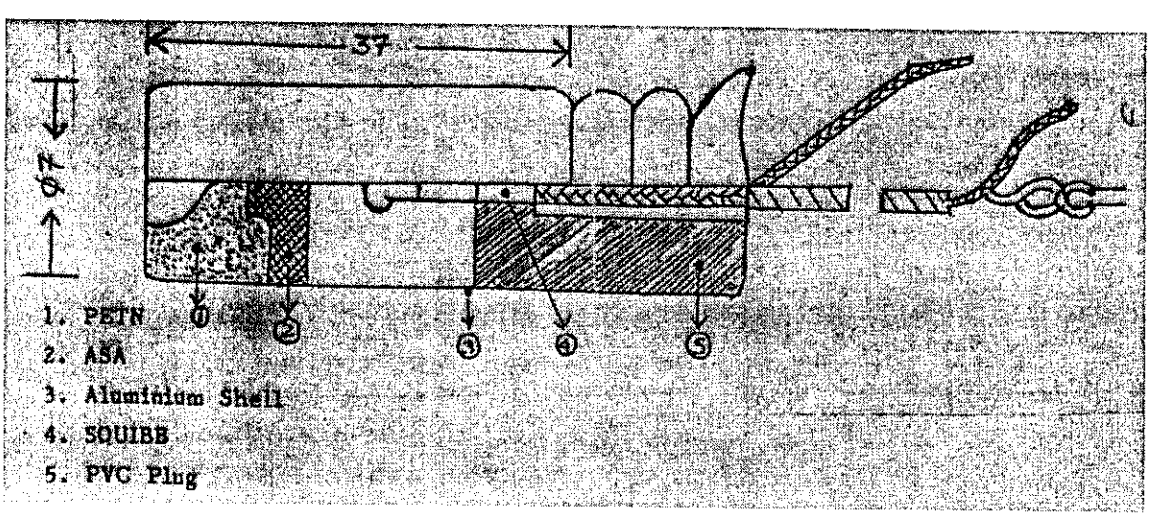
Two core cable (flexible). with 20 AWG (19/32) multistranded with tin plated copper, wire with PVC insulation (colour red & black) & with over all PVC sheathing.

4. **Booster BST 4 AND BST 6**

	Sheath Material	Core Explosive	Charge mass	Length in mm	Dia in mm
BST 4	Lead	RDX	75 ± 5mg	9.0 ± 0.2	6.5 ± 0.2
BST 6	Lead	RDX	325 ± 25mg	11.5 ± 0.5	10 ± 0.2

DETONATOR DRIED-3: DRG. No. 3211-00-12-00-28

Overall length	37 mm (Approx)
Diameter	7 mm
Shell material	Aluminium
Explosive Charge	100 mg PETN
	100 mg ASA
Type of squibb (LFIN Based)	PSQ - 3A



APPENDIX 'C'

METHOD OF MANUFACTURE OF FLSC

Method of manufacture of FLSC of various calibres involves batch process with most of it operations controlled manually. A brief discreption of the process is as follows:-

Injected dried RDX of 0. 15% moisture content is filled manually in a lead tube sealed at one end in small increments. The tube size and Quantity to be filled depends upon the type of the cord to be manufactured. This filled tube is then crimped at the open end to seal the charge completely. The sealed lead tube is then passed through the roller operated by remote control with varying grooves. After that the tube is passed through another roller with 'V' shaped grooves to give it desired 'V' shape. The shaped tube is then given the backing of an elestomer in metallic mould. This backed & shaped tube forms the final product.

APPENDIX 'D'

REQUIREMENTS OF LEAD TUBE

The lead tubes required for FLSC 3, 8 & 10 and BST -4 & 6 should conform to the following requirements.

Sl. No.	Description	O. D. mm	I. D. mm	Wall thickness mm	Length mm	Charge mass g/metre
1.	FLSC-3	16.20 ± 1.0	9.4 ± 0.50	3.4 ± 0.25	380 ± 5	8.40 ± 0.2
2.	FLSC-8	16.20 ± 11.0	9.4 ± 0.50	3.4 ± 0.25	560 ± 5	24.0 ± 2.0
3.	FLSC-10	20.5 ± 1.5	12.7 ± 1.0	3.9 ± 0.25	380 ± 5	35.0 ± 2.0
4.	BST-4	16.2 ± 1.0	9.4 ± 0.50	3.4 ± 0.25	225 ± 5	7.5 ± 0.5
5.	BST-6	16.2 ± 1.0	9.4 ± 0.50	3.4 ± 0.25	225 ± 5	32.5 ± 2.5

Purity of lead - 99.5 % min.

Melting point - 315°C min.

PURITY OF LEAD

Reagents: 1. EDTA solution 0.05M (Dissolve 18.613 g of disodium dihydrogen ethylenediaminetetra-acetate dihydrate in water & dilute to 1 litre in a volumetric flask with deionised water)

2. Xylenol orange indicator (Dissolve 0. 5g of Xylenolorange in 100 ml of distilled water)

PROCEDURE : Weigh accurately 0. 6 g of lead sample in a 500 ml conical flask. Dissolve the sample in dil HNO_3 (5 ml of Conc. HNO_3 diluted to 150 ml of water)

Pipette 25. 0 ml of leadion solution into a 250 ml volumetric flask, dilute with about 25 ml of distilled water, and add 3 drops of the indicator solution. If the colour of the solution is red, add very dilute nitric acid, cautiously and with stirring until the solution acquires a yellow colour. Now add powdered hexamine (hexa- methylenetetramine) until the colour is intensely red- this step ensures that the solution has the correct pH (about 6) for the subsequent titration. Titrate with standard EDTA until the colour changes to lemon yellow.

(A white ppt is usually formed during the titration, but this disappears at the end point. It is, therefore, essential to maintain the contents of the flask well stirred to add the titrant drop-wise near the end point & to wait 2-3 minutes before taking final burette reading.)

1 ml 0.05M EDTA = 10.3605 mg of Pb.

MELTING POINT

Lead tube filings are made & placed in the capillary. M. P. is determined by using electrically heated melting point apparatus.

CORD BACKING MATERIAL

It consists of

1) (i) Rhodorsil CAF4
(ii) Rhodorsil 41812A
(iii) Primer MB

These are the proprietary products of M/s Rhone Poulene Silicone Department, France & can be procured from M/s Society Chimique Dela Coumeuve No. 45 Quai Luciaante France 93300.

The cured elastomer (Rhodorsil CAF4 & Rhodorsil 4812A in the proportion 50: 1) should conform to the following requirements.

Ref to test method

1.	Tensile strength	18 ± 5 Kg/cm^2	ASTM D-412
2.	Elongation percent	270 ± 20%	-do-
3.	Hardness	40+3 shore 'A'	ASTM D: 2240-75

2) **MOULD RELEASE AGENT** : (MOLD WIZ AZN AEROSOL)

PAT 606 - Propritory product of M/s IDE Process International. New York.

Alternate source : M/s AXEL Plastic Research Lab
INC Box 855 58 20
Broadway Woodsie
New York 1137

APPENDIX 'F'

REQUIREMENTS OF ALUMINIUM FOR BOOSTER SLEEVES

1. Type B-51 SWP A1 Alloy Extruded rod 15mm dia.

2. Chemical composition:

   a) Si - 0. 1 %

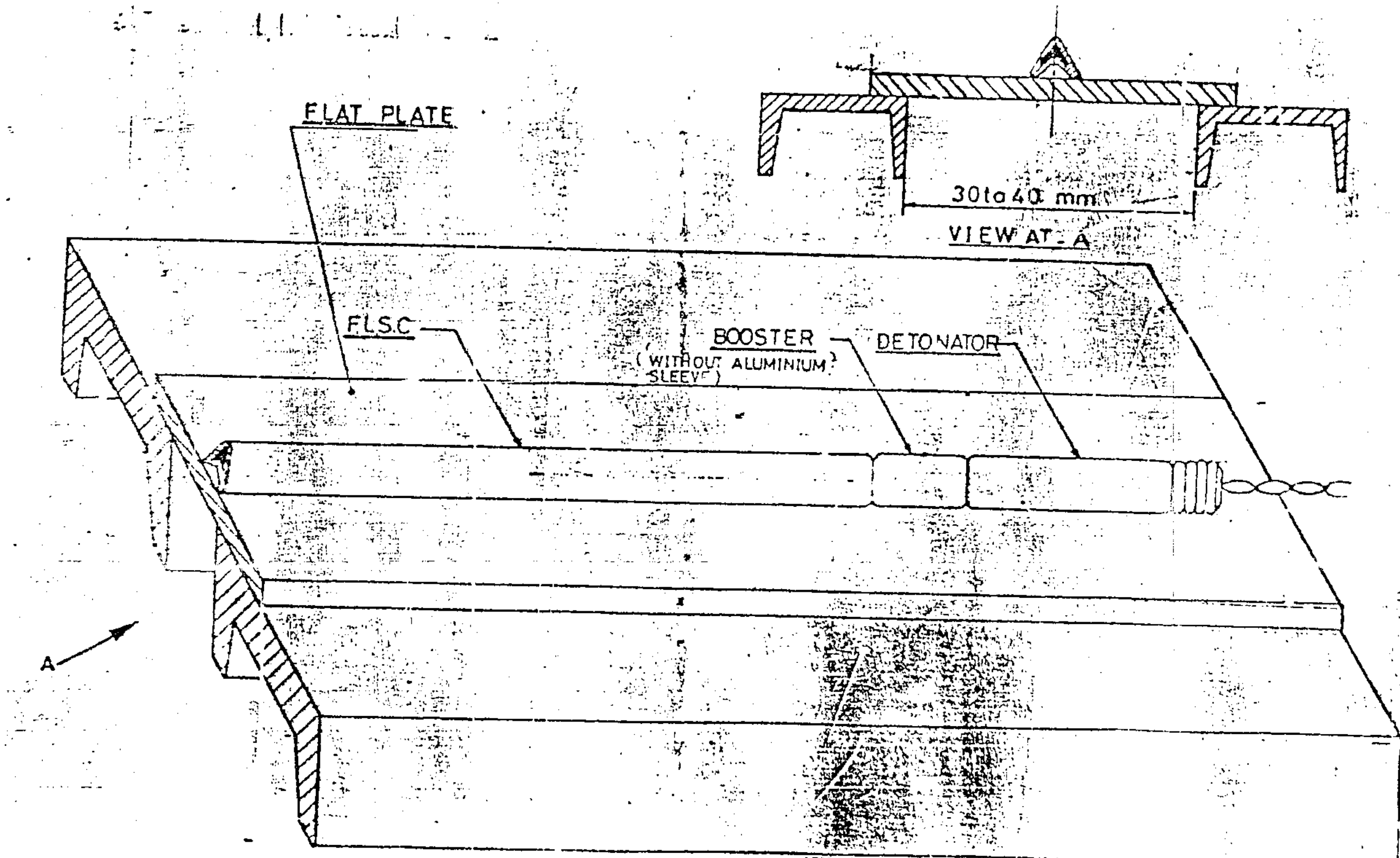
   b) Mg - 0.6 %

   c) Mn - 0.5 %

   (Method of Analysis as per ASTM standard volume 12 Method E-34)

3. UTS: 30 Kg/cm^2 (Tested as per ASTM B-557)

4. Hardness: 100 BHN



FLAT PLATE TEST LAY OUT

FIG. 1