भारत सरकार
GOVERNMENT OF INDIA
रक्षा मंत्रालय
MINISTRY OF DEFENCE

संयुक्त सेवा विनिर्देश
JOINT SERVICES SPECIFICATION

ON

HOMOGENOUS MACHINABLE ARMOUR PLATES: 4 mm TO 300 mm NOMINAL THICKNESS

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मानकीकरण निदेशालय
रक्षा उत्पादन विभाग, रक्षा मंत्रालय
'एच' - ब्लॉक, निर्माण भवन डाकघर
नई दिल्ली-११००११

DIRECTORATE OF STANDARDISATION
DEPARTMENT OF DEFENCE PRODUCTION
MINISTRY OF DEFENCE
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RECORD OF AMENDMENTS

Amendment		Amendment pertains to S. No./Para No./ Column No.	Authority	Amended by	Signature & Date
No.	Date			Name & Appointment (In Block Letters)	

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0. FOREWORD

0.1 This Joint Services Specification has been prepared by Material Standardisation Sub Committee on the authority of Standardisation Committee, Ministry of Defence.

0.2 This conversion of this Joint Services specification is approved by the Ministry of Defence and based on CQA (Metals), Ichapur Departmental Specification CQA (M)-47 and CQA (M)-51.

0.3 This JSS 9515-021 : 2020 (First Revision):

a) was prepared in the year 2014.

b) is revision of JSS 9515-021 : 2014 and supersedes the same

0.3 The object of introducing this Guide on Homogenous Machinable Armour Plates is to embody a wide spectrum of Standard test procedures, test requirements, manufacture, Quality Control, Quality Assurance and procurement of rolled and heat treated Jackal Steel Armour plates of nominal thickness 4 mm -80 mm and Spade M1 and M2 steel Armour plates of nominal thickness 8 mm -85 mm and 86 mm -300 mm respectively.

0.5 Quality Assurance Authority for the item covered by this specification is the Controller, Controllerate of Quality Assurance (Metals) Ichapur-Nawabganj, 24 Parganas (North), West Bengal-743144 (Email : cqametichapur-dgqa@nic). Enquiries regarding technical parameters shall be addressed to the Quality Assurance Authority, while other enquiries shall be referred to:

The Director,
Directorate of Standardisation,
Ministry of Defence,
'H' Block, Nirman Bhawan PO,
New Delhi-110011.
Email : mssc.defstand@gov .in

0.6 Non-registered users can obtain the following on payment:

a) Copies of IS from:

Bureau of Indian Standards
Manak Bhavan
9, Bahadur Shah Zafar Marg
New Delhi-110002.

or

their regional/branch offices.

b) Copies of JSSs/JSGs from:

The Director
Directorate of Standardisation
Standardisation Documentation Centre
Room No. 05 'J' Block, Nirman Bhawan PO
New Delhi-110011.

0.7 Indian Standards (IS) which are related to this specification are available on:

Directorate of Standardisation Website,
www.ddpdos.gov.in
For registration visit our website.

0.8 This specification holds good only for the supply order for which it is issued.

0.9 Directorate of Standardisation Website - All the approved JSSs/JSGs are available on the Directorate of Standardisation Website ***www.ddpdos.gov.in***. Defence Organisations desirous of accessing a copy of this document are requested to approach the Directorate of Standardisation for obtaining user id/password to access the website.

1. SCOPE

This Joint Services Specification is meant to govern the requirement of composition, manufacture, quality assurance, ballistic test of rolled annealed or hardened and tempered armour plates for armour vehicles. This Joint Services Specification covers manufacture and supply of Jackal armour plates of nominal thickness 4 mm to 80 mm and Spade M1 and M2 steel Armour plates of nominal thickness 8 mm -85 mm and 86 mm -300 mm respectively.

2. RELATED SPECIFICATIONS

2.1 References are made in this specification to:

Table 1 Related Specifications

S. No.	Specification/ Documents No.	Nomenclature
a)	IS 228 (Part 1) : 1987 (Third Revision) Amd 1 Reaffirmed 2018	Methods of Chemical Analysis of Steels Part 1 Determination of Carbon by Volumetric Method (for Carbon 0.05% to 2.50%)
b)	IS 228 (Part 2) : 1987 (Third Revision) Reaffirmed 2018	Methods for Chemical Analysis of Steels Part 2 Determination of Manganese in Plain-Carbon and Low Alloy Steels by Arsenite Method
c)	IS 228 (Part 3) : 1987 (Third Revision) Reaffirmed 2018	Methods for Chemical Analysis of Steels Part 3 Determination of Phosphorus by Alkalimetric Method
d)	IS 228 (Part 6) : 1987 (Third Revision) Reaffirmed 2018	Methods for Chemical Analysis of Steels Part 6 Determination of Chromium by Persulphate Oxidation Method (for Chromium ≥ 0.1%)
e)	IS 228 (Part 8) : 1989 (Third Revision) Reaffirmed 2019	Methods for Chemical Analysis of Steels Part 8 Determination of Silicon by Gravimetric Method (for Silicon 0.05% to 0.50%)
f)	IS 228 (Part 9) : 1989 (Third Revision) Reaffirmed 2019	Methods of Chemical Analysis of Steels Part 9 Determination of Sulphur in Plain Carbon Steels by Evolution Method (for Sulphur 0.01% to 0.25%)
g)	IS 228 (Part 10) : 1989 (Third Revision) Reaffirmed 2019	Methods for Chemical Analysis of Steels Part 10 Determination of Molybdenum by Thiocyanate (Photometric) Method in Low and High Alloy Steels (for Molybdenum 0.01% to 1.50%)
j)	IS 1499 : 1977 (First Revision) Amd 1 Reaffirmed 2015	Method for Charpy Impact Test (U-Notch) for Metals
k)	IS 1500 (Part 1) : 2019 ISO 6560-1 : 2014 (Fifth Revision)	Metallic Materials Brinell Hardness Test Part 1 Test Method

Table 1 Related Specifications (Concluded)

S. No.	Specification/ Documents No.	Nomenclature
m)	IS 1608 (Part 1) : 2018 (Fourth Revision)	Metallic Materials-Tensile Testing Part 1 Method of Test at Room Temperature
n)	IS 4163 : 2004 (Third Revision) Reaffirmed 2017	Steel Determination of Content of Non-Metallic Inclusions-Micorgraphic Methods Using Standard Diagrams
p)	IS 4748 : 2009 (Second Revision) Reaffirmed 2017	Steels-Micrographic Determination of the Apparent G rain Size
q)	IS 13015 : 1991 Reaffirmed 2018	Steel Products-Macroetch Testing, Inspection and Rating-Specification
r)	GOST-B-21968-76	Shell Proof Armour Steel Plates
	ASTM Standards	
s)	ASTM-E-381	Standard Method for Rating of Macro Etched Steel
t)	ASTM-Desig-A435-74	Method for Ultrasonic Examination
u)	ASTM-A604	Method of Macroetch Testing of Consumable Electrode Vacuum Arc Remelted Steel Bar and Billets
w)	ASTM-E975-84	Practice for X-Ray Determination of Retained Austenite in Steel with Near Random Crystallographic Orientation
	Joint Services Specification	
x)	JSS 9515-022 : 2017	Ballistic Test for Homogenous Jackal Armour Steel Plates 4 mm to 22 mm Nominal Thickness

2.2 ASTM Standards are obtainable on payment from:

Book Supply Bureau,
A-68, South Extension Part-1,
New Delhi-110049.

3. MATERIAL (INSPECTION/QUALITY ASSURANCE/TESTING)

3.1 The steel/plate maker is to inform the Quality Assurance Authority when he is in a position to start work and to inform of all sub-contracts in connection with contract as soon as SOs are placed so that arrangements may be made for tests and Inspection/Quality assurance coverage.

3.2 The steel may be inspected at any time during manufacture and is subject to the approval of the acceptance by the Quality Assurance Authority/Inspecting Officer.

3.3 Casts are to be certified as complying with the specified composition and other test requirements as per this Guide by the Quality Assurance/Inspecting Officer/Authority. All tests as per this Guide are to be witnessed/carried out by the representative of the Quality Assurance/Inspecting Authority as decided by him.

4. COMPOSITION

4.1 The composition of the steel (ladle analysis) when analyzed in accordance with IS 228 shall conform to the following limits:

Table 2

a) Composition of Jackal Steel:

Elements	***Min* %**	***Max* %**
Carbon	0.28	0.33%
Silicon	0.55	0.75%
Manganese	0.75	1.00%
Chromium	0.75	1.00%
Molybdenum	0.25	0.35%
Sulphur	0.015% (*Max*)	
Phosphorus	0.015 % (*Max*)	
Zirconium	0.10	0.20%
Cerium	0.03	0.06%
Hydrogen	2.0 ppm (*Max*)	
Nitrogen	60 ppm (*Max*)	

NOTE - For Zirconium and Cerium element, method of estimation shall be got approved from the Quality Assurance Authority.

Table 3

b) Composition of Spade M1 Steel (‘1½ % Ni Cr Mo’ Steel):

Elements	***Min* %**	***Max* %**
Carbon	0.28	0.33%
Manganese	0.40	
Silicon	0.10	
Nickel	1.50	
Chromium	1.30	1.50%
Molybdenum	0.40	0.45%
Vanadium	0.08	0.12%
Aluminium	0.02	0.04%
Sulphur	0.010% (*Max*)	
Phosphorus	0.015% (*Max*)	
Hydrogen	2.5 ppm (*Max*)	

Table 3A

c) Composition of Spade M2 Steel ('3% Cr Mo' Steel):

Elements	***Min* %**	***Max* %**
Carbon	0.28	0.33%
Manganese	0.40	0.70%
Silicon	0.10	0.35%
Sulphur	0.015% (*Max*)	
Phosphorus	0.015% (*Max*)	
Chromium	3.10	3.50%
Nickel	0.60% (*Max*)	
Molybdenum	0.40	0.60%

4.2 On product analysis, the steel shall conform to the above limits with the variations being allowed as per table below:

Table 4

Elements	**Permissible Deviation Jackal Steel**		**Spade M1 & M2 Steel**	
	Over (*Max*) %	**Under (*Min*) %**	**Over (*Max*) %**	**Under (*Min*) %**
Carbon	0.02	0.00	0.02	0.02
Manganese	0.04	0.04	0.04	0.04
Silicon	0.03	0.03	0.03	0.03
Chromium	0.03	0.03	0.03	0.03
Molybdenum	0.02	0.02	0.02	0.02
Phosphorus	0.003	0.00	0.003	0.003
Sulphur	0.003	0.00	0.003	0.003
Nickel	-	-	0.03	0.03
Vanadium	-	-	0.01	0.01

4.3 The manufacturing method should be such that the gas content shall be minimum.

4.4 The manufacturer/steel maker will supply the report of ladle analysis/cast analysis to the Quality Assurance Officer.

4.5 Periodical check analysis for products shall be carried out at the discretion of Quality Assurance Officer.

4.6 The steel maker is not to introduce deliberately into steel any element without the agreement of Quality Assurance Authority and is to take all reasonable precautions to prevent such elements from being introduced from scrap or other materials.

5. MANUFACTURE

5.1 Jackal Steel Plate and Spade M1 and M2 Steel Plate

5.1.1 The steel is to be manufactured by electric arc furnace/open hearth furnace followed by vacuum degassing treatment, ESR process or any other process acceptable to the Quality Assurance/Inspecting Authority for which prior approval from Quality Assurance/Inspecting Authority is to be obtained.

5.1.2 Suitable measure is to be taken by the steel maker to avoid harmful defects such as seams, flaws, piping, cracks, segregation/banding, inclusions, surface defects etc. in the ingots.

5.1.3 Calcium silicide treatment shall be given in steel during ingot casting.

5.1.4 Ingots are to be cast wide end up with hot top in standard mould unless other methods are approved by the Quality Assurance Authority. The method of casting to be used is to be declared by the steel maker.

5.1.5 The ingots are to be kept in vertical position until completely solidified. The size, shape and method of production of the ingot are to be so selected as to minimize segregation and axial unsoundness.

5.2 Discard for Spade M1 and M2 Steel

5.2.1 Minimum 10% top and 5% bottom discards are to be given to ensure cleanliness and freedom from harmful defects.

5.2.2 *Discard for Jackal Steel*

Minimum 15% top below hot top and 10% bottom discards are to be given to ensure cleanliness and freedom from harmful defects like segregation, flakes, gas porosity, cracks, ring pattern, piping etc. This will be checked by taking sample from plates made from top of the ingot through macro etch test as per IS 13015 to the satisfaction of the Quality Assurance/Inspecting Officer. In addition, if required by the purchaser, the degree of severity of defects like freckles, white spot, radial mark, segregation and ring patterns shall be determined by macro etch test as per ASTM-A604 and shall not be more than ‘A’ for ESR steel and ‘C’ for non-ESR steel.

5.2.3 *Annealing of Plates*

After rolling of the plates, those shall be annealed as per Clause **6.2.1**. Necessary care should be taken to ensure that the plates are not heavily decarburized. The total decarburization (i.e. complete + partial) on both sides shall not be more than 8% of nominal thickness of plates. Hardness of the plates to be supplied in annealed condition shall be 220 BHN maximum.

5.3 Removal of Surface Defects

5.3.1 All harmful surface defects on billets/blooms/slabs are to be removed prior to rolling to final size to the satisfaction of the Quality Assurance Authority. However, removal of

surface defects by girding is allowed after soft annealing and shot blasting of plates prior to hardening and tempering, provided the thickness does not get reduced below the specified limit after removal of defects. Heat-treated plates shall be shot blasted/abrasive blasted. Surface of the shot blasted plates shall be free from cracks, laminations, blisters, rolled in scales, scab, pitting and other surface imperfections. Plates shall be adequately cleaned to enable inspection for surface defects.

5.3.2 Surface defects like pits, dents etc. may be removed by approved method so that the plate thickness is not reduced below the specified minimum. Surface defects like pits, dents etc. up to a depth of 5% maximum of the nominal plate thickness may be removed by grinding. Total surface area of such grinding would be restricted to 2% of the surface area of the plate (including both surfaces). A record is maintained on the extent and frequency of occurrence of such removal of defects causing reduction in thickness below the specified minimum. No extensive grinding is permissible on finally heat-treated plates. Visual laminar edge defects less than 6 mm long are acceptable. Laminar edge defects 6 mm long and over should be explored by Ultrasonic test on plate surface adjacent to the affected area. Edge defects that extend into the plates to an extent that they will result in rejectionable/non-acceptable defects according to the ultrasonic acceptance standards specified, shall be the cause for rejection of the plates.

5.4 Surface Treatment

Finally accepted plates will be painted with red oxide primer applied with protective coating**,** as agreed between the supplier and the purchaser.

5.5 Dimension and Tolerances

5.5.1 The Plates shall be rolled such that the heat treated plates/components and trimmed plates meet the dimensional requirement as per contract. Heat treated and flame cut plates/components should be burr cleaned and stress relieved before supply.

5.5.2 *Thickness*

5.5.2.1 Unless otherwise specified in the drawings, the thickness tolerance of the plates should be as per the table appended below:

5.5.2.2 *Thickness tolerance for spade M1 & M2 plates*

Table 5

Nominal Thickness (mm)	Tolerance (mm)	Width of Rolled Plate up to (mm)
8-10	+ 1.20, -0.00	1500
11-19	+ 1.30, -0.00	1500
20-24	+ 1.75, -0.25	1500
25-30	+ 1.75, -0.50	2200
31-49	+ 2.00, -0.50	2200

Table 5 (Concluded)

Nominal Thickness (mm)	Tolerance (mm)	Width of Rolled Plate up to (mm)
50-74	+ 2.00, -1.00	2200
75-85	+ 2.00, -2.00	2200
86-100	+ 2.00, -2.00	2200
101-150	+ 2.00, -3.00	2200
151-300	+ 2.00, -4.00	2200

NOTES

1. Positive limit of tolerance of plate thickness to be increased by 0.1 mm for each additional 100 mm of plate width, in case the plate width is more than one specified in above table.

2. The tolerances mentioned above are for general requirements, unless otherwise specified in the drawing or as agreed upon between purchaser and supplier.

5.5.3 *Tolerances for Jackal Plates*

5.5.3.1 *Thickness tolerance for jackal plates*

S. No.	*Thickness of Plates*	*Tolerance (mm)*
a)	4 mm and up to and including 6 mm nominal thickness	+ 0.70
		- 0.00
b)	Over 6 mm and up to and including 10 mm nominal thickness	+ 1.20
		- 0.00
c)	Over 10 mm and up to and including 20 mm nominal thickness	+ 1.30
		- 0.00
d)	Over 20 mm and up to and including 22 mm nominal thickness	+ 1.75
		- 0.25
e)	25 mm nominal thickness	+ 1.30
		- 0.60
f)	30 mm nominal thickness	+ 1.50
		- 0.80
g)	40 mm nominal thickness	+ 2.00
		- 1.00
h)	80 mm nominal thickness	+ 4.00
		- 2.00

NOTE - The plates of 4 mm to 10 mm thickness shall be sheared or flame cut. Plates 11mm thick and above may be flame cut to size. When plates are flame cut, the hard edge formed during the process must be softened or removed by an approved method, (a) if the edge is subsequently to be machined or (b) if softening is required by the drawings.

5.5.3.2 *Width tolerance for jackal plates*

S. No.	*Thickness of Plates*	*Tolerance (mm)*
a)	4 mm to 6 mm nominal	+10.0
		-0.00
b)	8 mm to 80 mm nominal	+50.0
		-0.00

5.5.3.3 *Length tolerance for jackal plates*

S. No.	*Thickness of Plates*	*Tolerance (mm)*
a)	4 mm to 6 mm nominal	+ 15.0
		- 0.00
b)	8 mm to 80 mm nominal	+ 75.0
		- 0.00

5.6 Flatness

5.6.1 Heat treated spade M1 and M2 plates/components must conform to the flatness tolerance specified on drawings and code of standard flatness tolerance for plates are as follows:

Code Letter	*Tolerance (mm)*
'A'	0.8 mm
'B'	1.75 mm
'C'	3.50 mm
'D'	5.25 mm
'E'	7.50 mm

5.6.1.1 The flatness of plates must be such that when laid down on a surface table the space between the plate and the table shall in no way exceed the specified tolerance over a length not exceeding 2000 mm in any direction. No corrugated or buckled plates are acceptable.

5.6.1.2 When the flatness tolerances are not stated on the drawing, plate shall conform to code 'D'.

5.6.2 Heat treated jackal plates must conform to the flatness tolerances specified on the drawing. A code of standard flatness tolerances for use in the drawing is given below:

Code Letter	*Tolerance*
'A'	0.80 mm
'B'	1.60 mm
'C'	3.20 mm
'D'	4.75 mm
'E'	6.35 mm

5.6.2.1 The flatness of the plates must be such that when laid down on the surface table, the space between the plate and the table must in no way exceed the specified tolerance over a length not exceeding 1820 mm in any direction.

5.6.3 Flatness tolerance of annealed spade M1, M2 and jackal plates may be relaxed up to 11.0 mm.

5.6.4 Where flatness tolerances are not stated in the drawing, plates shall conform to code 'D'. Any question relating to flatness is to be referred to the Quality Assurance Authority.

6. HEAT TREATMENT

6.1 The following heat treatment schedule is given as Guide lines to achieve the desired properties after heat-treatment of spade M1, M2 steel plates. The plates shall be oil quenched and tempered, the manufacturer shall determine the detailed procedure to produce plates meeting the mechanical property parameters.

6.1.1 *Soft Annealing*

Heated to 700°C at the rate of 20°C -25°C per hour and soaked for 12 hour to 14 hour. Furnace cooled at the rate of 20°C to 25°C per hour to 100°C and then air cooled. Hardness of the plates to be supplied in soft annealed condition will be 190 BHN maximum.

6.1.2 *Hardening*

Heating at the rate of 1½ minute/mm of thickness and soaking ½ minute/mm of thickness at 910°C. Total heating and soaking time should be 2 minute/mm of thickness.

6.1.3 *Quenching as per Following Schedule:*

Thickness Range	*Quenching Media*
8 mm -30 mm	Oil
31 mm -50 mm	Oil
51 mm -79 mm	Oil
80 mm -300 mm	Water

6.1.4 *Tempering*

Tempering at 640°C/680°C for 4 minute/mm of thickness and cooled in air.

6.1.5 *Stress Relief*

6.1.5.1 If the plates are to be stress relieved after final tempering, the stress relief temperature shall be at least 50°C below the final tempering temperature. Air-cooling shall be employed after stress relief.

6.1.5.2 The manufacturer shall maintain a record of heat treatment given to the plates including stress relief.

6.2 The following heat-treatment cycle is given as Guide lines to achieve the desired properties on heat-treatment of Jackal Plates.

6.2.1 *Annealing Cycle*

6.2.1.1 Heated upto 710°C to 720°C at the rate of 25°C to 30°C per hour. Soaked for 16 hour and cooled inside the furnace. Hardness after annealing may be checked. It shall be not more than 220 BHN.

6.2.2 *Hardening and Tempering*

6.2.2.1 *Hardening cycle*

a) Charge the plates at 900°C ±10°C.

b) Attain the temperature of 900°C.

c) Soak for a period of 1.0 minute/mm (Minimum 20 Minutes).

d) Oil Quenching:

1) Time from furnace to quenching allowed = 10 seconds.

2) Holding time in oil tank at the rate of 2 minutes/mm. (Stirring the oil-oil temperature not to exceed 60°C).

6.2.3 *Tempering Cycle for 4 mm -14 mm Thickness Plate*

Tempering should be done immediately after hardening. Expected hardness : 470-510 BHN.

a) Charge the plates at 250°C $^{+0°C}_{-10°C}$

b) Attain the temperature 250°C.

c) Holding Time:

1) For 4 mm to 6 mm thickness plate - 60 minutes on line tempering followed by air-cooling.

2) For 7 mm to 10 mm thickness plate - 60 minutes on line tempering followed by stress relieved for 150 minutes and air cooling.

3) For 11 mm to 14 mm thickness plate - 60 minutes on line tempering followed by stress relieving for 210 Minutes and air cooling.

6.2.3.1 *Tempering cycle for 15mm -22 mm thickness plates*

Tempering should be done immediately after hardening operation. Expected hardness 370 BHN -430 BHN.

a) Tempering temperature 500°C (to be charged at 500°C).

b) Holding temperature 4 min/mm thickness.

c) Air-cooling.

NOTE - Quality Assurance Agency to monitor the above in order to ensure that heat treatment cycle is strictly followed.

6.2.4 *Hardening and Tempering of Plates which are not to be subjected to Ballistic Test*

S. No.	*Hardness Range (BHN)*	*Hardening Temperature **	*Tempering Temperature @*	*Thickness of Plates*
a)	200-270	900°C	640°C - 680°C	4 mm to 30 mm
b)	230-285	900°C	630°C - 670°C	4 mm to 14 mm
c)	285-340	900°C	470°C - 630°C	4 mm to 80 mm

* Soaking Time - 1 minute/mm of thickness for plates up to 14 mm thick and 30 seconds/mm of thickness for plates of thickness 15 mm and above.

@ Soaking Time - 4-minute/mm for all thickness of plates.

7. ANALYSIS AND TESTING

7.1 Chemical Analysis

The manufacturer will supply the ladle analysis/cast analysis to the Quality Assurance Officer. One sample plate may be cut from each cast and subjected to chemical analysis at the discretion of Quality Assurance Officer. Chemical analysis of the sample shall conform to the chemical composition as per Clause **4**.

7.2 Ultrasonic Examination

Each plate shall be subjected to ultrasonic examination before final heat treatment as per Appx ‘A’.

7.3 Brinell Hardness Test

7.3.1 Every plate will be tested for Brinell hardness after final heat treatment. When tested in accordance with IS 1500 (Part 1), hardness values so obtained shall conform to the requirement mentioned below. Variation of hardness in single plate should not be more then 20 points. The test is carried out once every 2 meters of plate length at about 100 mm from each edge and also once at centre of head and as well as tail end of the plate. With plates of length less than 2 meters there will be at least one Brinell test every square metre of plate surface.

7.3.2 *Hardness Requirement of Spade M1, M2 Plate*

S. No.	*Condition of Plates*	*Thickness (mm)*	*Hardness (BHN)*
a)	Soft annealed	8-85	190 (*Max*)
b)	Hardened & Tempered	8-16	As specified in the Drawing/supply order.
c)	Hardened & Tempered	20-85	290-341
d)	Hardened & Tempered	86-100	321-377
e)	Hardened & Tempered	101-139	262-302
f)	Hardened & Tempered	140-179	248-285
g)	Hardened & Tempered	180-219	229-269
h)	Hardened & Tempered	220-250	217-255
j)	Hardened & Tempered	251-300	207 - 248

7.3.3 *Hardness Requirement of Jackal Plate*

S. No.	*Condition of Plates*	*Thickness (mm)*	*Tempering Temperature*	*Hardness (BHN)*
a)	Hardened & tempered for which ballistic test not specified	4-30	640°C - 680°C	200-270
b)	Hardened & tempered for which ballistic test not specified	4-14	630°C - 670°C	230-285
c)	Hardened & tempered for which ballistic test not specified	4-80	470°C - 630°C	285-340
d)	Hardened & tempered for which ballistic test specified	4-14	-	470-520
e)	Hardened & tempered for which ballistic test specified	15-22	-	370-430
f)	Soft Annealed	4-80		190 (*Max*)

7.4 Tensile and Charpy Impact Tests

7.4.1 Tensile and impact test pieces are to be so selected that each 10 tons of heat treatment material of a cast is represented by at least one set of test samples. Above samples are to be taken from the end of the plates corresponding to top end of the ingot. Tensile and Charpy test pieces are to be cut transverse to the rolling direction. When the thickness of the plate permits the test pieces shall be cut from a position midway between the axis and the surface of the plate. Each set of the test samples will comprise of the following test pieces:

a) Tensile Test Piece - 1 number.

b) Charpy Impact Test Piece - 3 pieces for room temperature and 3 pieces for -40°C for all thickness up to 300 mm.

NOTES

1. For Jackal Armour plates : tensile test, Impact test, Inclusion rating test, grain size, Retained Austenite content shall be conducted after final heat-treatment and batch wise for non-continuous process.

2. The method of selection of test piece may also be mutually agreed between the manufacturer and the Quality Assurance Authority.

7.4.1.1 Tensile test results when tested in accordance with IS 1608 (Part 1) and Charpy impact test results when tested in accordance with IS 1499 with 3 mm, 'U' notch shall meet the requirement of the following table. Flat tensile test pieces shall be prepared for thickness 4 mm to 14 mm.

Table 6

Type of Steel	**Hardness (BHN)**	**Nominal Thickness (mm)**	**Yield Stress MPa**	**Tensile Strength MPa**	**Elongation % on 5.65√So (*Min*)**	**R of A% (Min)**	**Charpy 3 mm 'U' Notch**	
							At Room Temperature Joules (*Min*)	**At -40°C Joules (*Min*)**
Spade M1 Plate	*****	**8-16**	-	-	-	-	-	-
	290-341	20-85	883 (*Min*)	981 (*Min*)	13.0	-	78.5	59
	321-377	86-100	-	925-1050	15.0		-	31.0
	262-302	101-139	-	880-990	15.0		-	35.5
	248-285	140-179	-	835-940	17.0		-	38.0
Spade M2 Plate	229-269	180-219	-	770-880	17.0	-	-	46.0
	217-255	220-250	-	725-835	18.0	-	-	50.0
	207-248	251-300	-	710-820	20.0		-	54.0
Jackal Plate	470-510	4-10	1420	1560	5 **	20 **	-	-
	470-530	11-14	1420	1560	8 #	30 #	10	5
	370-430	15-22	980	1180	9 #	35 #	30	20

***** As mentioned in the Drawing/Supply Order.

****** With flat tensile test specimens.

\# With round tensile test specimens**.**

7.4.2 *Tensile and Charpy Impact Retest*

7.4.2.1 *Tensile retest*

If the results of an original tensile specimen are lower than 2% of the required yield stress, tensile strength, elongation percentage and R% of A%, a retest on specimens selected from diagonally opposite corner of the same plate will be carried out. If any of the retest specimens does not meet the specified requirements, the lot/cast represented by the specimen shall be rejected. If the plates are separately heat treated, specimens from two fresh plates randomly selected from the cast may be retested in addition to the above. If any of the retest specimens does not meet the requirement, the lot/cast may be rejected.

7.4.2.2 *Charpy retest*

In the event a Charpy specimen does not meet the individual requirements, a retest of three specimens each from diagonally opposite corners of the same plate shall be permitted. If any of the retest specimens does not meet the requirement, the lot/cast represented by the specimens shall be rejected.

7.5 Inclusion Rating

At least one sample per cast will be selected for inclusion rating. Inclusion rating will be as per IS 4163 and should meet the following requirements:

Inclusion Type	*Rating*
Sulphide Type (A)	2 thin (*Max*)
Alumina Type (B)	2 thin (*Max*)
Silicate Type (C)	2 thin (*Max*)
Globular Oxide Type (D)	2 thin (*Max*)
Nitride Type	2 thin (*Max*)

7.5 Microstructure

Microstructure of fully heat-treated plates will exhibit tempered martensite structure with prominent accicularity for the plates tempered at lower temperature and comparatively lesser accicularity for the plates tempered at higher temperature.

7.6 Retained Austenite

For plates having thickness up to 14 mm, the volume fraction of retained austenite should be estimated in accordance with ASTM E 975-84 from two plates from each batch after tempering and it should not exceed 2.5%.

a) Grain Size - At least one test piece should be selected from each cast to ascertain the grain size of hardened & tempered plates. Grain size number should be 7 (minimum) as per IS 4748.

b) Fracture Test - Fracture test pieces are to be so selected that each 10 tons of heat treated spade M1, M2 material in a cast is represented by at least one set of test samples. Each set of samples will comprise of two samples cut from diagonally opposite corners of a plate. Test pieces are to be cut transverse to the rolling direction. Samples are to be taken from plates corresponding to top end of the ingot. While selecting samples it will be ensured that all the thickness (20 mm and above) rolled from a particular cast are covered over a period of time and 100% of the plates of thickness 80 mm to 300 mm are subjected to fracture test.

7.8 Dimension of Test Samples

a) Length - 200 mm (*Min*).

b) Width - Not less than 60 mm for thickness of plates up to 60 mm. For plate thickness above 60 mm, the width of the samples should not be less than the thickness of the plates.

c) Thickness - Same as thickness of the plate.

d) Depth of cut - Not exceeding $3/10^{th}$ of thickness.

7.8.1 Samples are to be fractured by applying static load and fractured faces are examined with nacked eyes in day light or artificial light and the results are interpreted as per Appx 'B'.

7.8.2 When the test specimen representing a lot of heat treated plates as per Clause **7.8** fails to meet the requirements, the lot is rejected. If the plates are separately heat treated, 100% of the plates from the lot/cast may be subjected to fracture test and only those failing to meet the requirement are rejected. The manufacturer may re-heat treat or re-roll the rejected lot to lower thickness. Re-hardening is permissible only once with any number of re-tempering. The manufacturer should keep the rejected lot duly identified separately from the acceptable lot until the rejected lots are withdrawn or demonstrated as meeting the requirement with double number of samples.

7.9 Decarburisation Test

7.9.1 Two samples (from diagonally opposite corners of plate) from a batch of 10 heat treated Jackal, Spade M1 & M2 plates having acceptable hardness for each thickness is to be tested for depth of decarburisation. The total decarburisation (i.e. complete plus partial) on both sides shall not be more than 8% of nominal thickness. More stringent requirements of decarburisation for very critical applications should be decided between the manufacturer, consignee and the Quality Assurance Authority.

7.9.2 If either of the samples fails to meet the requirement, 100% decarburisation test will be resorted to and the defective plates shall be rejected.

7.10 Weldability Test

7.10.1 Sampling criteria for weldability test requirements of spade M1, M2 (Up to 150 mm thick) plates shall be at the discretion of the Quality Assurance Authority.

7.10.2 Failure to comply with the requirements of relevant shall be the cause for rejection of the production plates associated with the test sample selected. At the discretion of the Approval Authority, two further tests may be carried out following failure of the initial tests. Both tests are required to be satisfactory.

7.11 Ballistic Test

7.11.1 Notwithstanding the compliance with the requirements of the foregoing paras, final acceptance of plates depends on the results of firing trial.

7.11.2 One ballistic test plate, from each cast is to be subjected to ballistic testing. The plate is to be selected from top part of the ingot. The test plate should satisfy the requirements of properties as per Clause **7**. Proof plates should be so selected that all the thickness meant for proof are covered in the period of time.

7.11.3 Size of ballistic test plate would be nominal thickness x 1220 mm x 1220 mm. Test plates may be selected from the heat treated batch or the same may be heat treated along with the production batch.

7.11.4 Lifting holes/cuts at the top two corners shall be provided in the test plate.

7.11.5 Thickness of the plates requiring ballistic test, procedure and interpretation of the test results are given in Appx 'C' for Spade M1, M2 plates and in JSS 9515-022 for Jackal plates. Jackal plates above 22 mm thickness are not to be ballistically tested.

8. MARKING

8.1 Each plate will be marked with Quality Assurance Officer's acceptance stamp, plate number and cast number which will relate to the corresponding assurance documents.

8.2 The following colour codes are to be adopted for identification of plates of different hardness/heat treatment conditions:

Table 7

S. No.	Heat Treatment Condition/Hardness	Colour Code
a)	Soft annealed plates to hardness 210 BHN (*Max*)	White Band
b)	Hardened and tempered to hardness 200-270 BHN	Yellow Band
c)	Hardened and tempered to hardness 230-285 BHN	Green Band
d)	Hardened and tempered to hardness 285-340 BHN	Blue Band
e)	Hardened and tempered to hardness 370-430 BHN	Black Band
f)	Hardened and tempered to hardness 470-530 BHN	Red Band

9. PRE-INSPECTION OF STORE/CONSIGNMENT

9.1 Manufacturers/contractors must satisfy themselves that the stores are in accordance with the terms of the contract and fully conform to the required by carrying out a thorough pre-inspection of each lot before actually tendering the same for inspection to the Quality Assurance Officer, nominated under the terms of the Contracts. A declaration/certificate by the contractor that necessary pre-inspection has been carried out on the stores tendered will be submitted along with the challan. The declaration will also indicate the features checked/tested and will have the test certificates attached to the challan/declaration.

9.2 If the Quality Assurance Officer finds that the pre-inspection of the consignment as required above has not been carried out, the consignment is liable for rejection.

10. QUALITY ASSURANCE

10.1 The Quality Assurance Authority is to be satisfied that all the requirements of the preceding clauses of this Guide have been met in respect of the plates submitted for inspection and testing.

10.2 Quality Assurance documents giving the following Information will be supplied to the consignee along with each consignment.

10.3 Cast No., Plate No., Cast analysis report, Copies of test certificates of tests mentioned in Clause **7**, Dimension and surface inspection reports and Quality Assurance Certificates/Inspection Note.

11. SUGGESTION FOR IMPROVEMENT

Any suggestion for improvement in this document may be forwarded to:

The Director,
Directorate of Standardisation,
Ministry of Defence,
'H' Block, Nirman Bhawan PO,
New Delhi-110011.

APPX 'A'
(*Clause* 7.2)

RECOMMENDED-PROCEDURE FOR ULTRASONIC EXAMINATION AND ACCEPTANCE STANDARD FOR ARMOUR STEEL PLATES

A-1. This Appendix covers procedure and acceptance standard for straight-beam, pulse-echo ultrasonic examination of rolled carbon and alloy steel plates to ensure freedom from gross internal discontinuities such as pipe, ruptures or laminations.

A-2. The manufacturer shall furnish suitable ultrasonic equipment and qualified personnel necessary for performing the test. The equipment shall be of the pulse-acho straight beam type. The transducer shall be 25.4 mm to 28.6 mm diameter or 35.4 mm square. The test shall be performed by one of the following methods, direct contact, immersion or liquid column coupling.

A-3. The examination will be carried out in an area free of operations that interfere with proper functioning of the equipment. The plate surface shall be cleaned and smoothened sufficiently to maintain a reference back reflection from the opposite side of the plate at least 50% of full scale during scanning.

A-4. Ultrasonic examination shall be made on either major surface of the plate. Acceptance of defects in close proximity may require inspection from the second major surface. Plates ordered in quenched and tempered condition shall be tested following heat-treatment.

A-4.1 A nominal test frequency of 2¼ MHz is recommended. Thickness, grain size of microstructure of the material and nature of the equipment or method may require a higher or lower test frequency. However, frequencies less than 1 MHz may be used only on agreement with the purchaser. A clear, easily interpreted trace pattern should be produced during the examination.

A-4.2 Examination will be conducted with test frequency and instrument adjustment that will produce a minimum 50% to a maximum 75% of full scale reference back reflection from the opposite side of a sound area of the plates.

A-4.3 Scanning shall be continuous along perpendicular grid lines on nominal 230 mm centres, or at the manufacturer's option, shall be continuous along parallel paths, transverse to the major plate axis, on nominal 100 mm centres, or shall be continuous along parallel paths parallel to the major path axis, or on 75 mm or smaller centres. A suitable couplant such a water, soluble oil, or glycerine shall be used.

A-4.4 Scanning lines shall be measured from the centre or one corner of the plate. An additional path shall be scanned within 50 mm of all edges of the plates on the scanning surface.

A-4.5 Where grid scanning is performed and complete loss of back reflection accompanied by continuous indications is detected along a given grid line the entire surface area of the squares adjacent to this indication shall be scanned continuously. Where parallel path

scanning is performed and complete loss of back reflection accompanied by continuous indication is detected, the entire surface area of a 230 mm by 230 mm square centered on this indication shall be scanned continuously. The true boundaries where this condition exists shall be established in either method by the following technique; Move the transducer away from the centre of the discontinuity until the heights of the back reflection and discontinuity indication are equal. Mark the plate at a point equivalent to the centre of the transducer. Repeat the operation to establish the boundary.

A-4.6 The following shall apply only if specified in the order: Instead of scanning procedure specified in Clauses **A-4** and **A-4.4**, and as agreed upon between manufacturer and purchaser, 100% of one major plate surface shall be scanned. Scanning shall be continuous along parallel paths, transverse or parallel to the major plate axis, with not less than 10% overlap between each path.

A-5. Any discontinuity indication causing a total loss of back reflection which cannot be contained within a circle, the diameter of which is 75 mm or one half of the plate thickness, whichever is greater, is unacceptable.

A-5.1 The manufacturer reserves the right to discuss rejectable ultrasonically tested plates with the purchaser with the object of possible repair of the ultrasonically indicated defect before rejection of the plate.

A-5.2 The purchaser’s representative may witness the test.

APPX 'B'
(*Clause* 7.8.1)

B. METHOD OF FRACTURE TEST

B-1. Fractured surface of the test samples are estimated in accordance with the following table and in conjunction with sketches attached as Appx 'B1'.

S. No.	*Type of Fracture*	*Number*	*Estimation of Fitness*
Fibrosity			
a)	Fibrous fracture	1	Fit
b)	Fibrous fracture with fine grained aggregates or zone of crystalline grains at area not more than 20% of fractured surface.	2	Fit
c)	Fibrous fracture with fine grained aggregates or zone of crystalline grains at area more than 20% of fractured surface.	3	To be re-heat treated
Fish Scale Fracture			
d)	Smooth fracture without any traces of fish scale	1	Fit
e)*	Closed fish scale fracture on the area up to1/3 of total area of fracture with 10 lines of open fish scale	2	Fit
f)*	Closed fish scale fracture occupying up to ½ of total area of fracture or opened and closed fish scale fracture on area up to 1/3 of total area of fracture. * Minor closed fish scales having lines not more than 2 mm long for plates up to 80 mm thick and not more than 3 mm long for 80 mm thick and above are allowed on the entire area of fracture.	3	Fit
g)	Closed fish scale fracture along the entire section of fracture and marks of opened fish scale fracture in the central zone on area up to1/3rd of total area of fractures or opened and closed fish scale fracture on area up to 2/3 of total area of fracture.	4	Fit
h)	Opened and closed fish scale fracture on the area above 2/3 of total area of fracture	5	To be rejected
Lamination			
j)	Smooth fracture without laminations	1	Fit
k)	Fracture with one large and two outlined laminations	2	Fit
m)	Fractures with three laminations or two laminations and two outlined laminations	3	Fit
n)	Fractures with three or four large laminations	4	Fit
p)	Fracture with five or more laminations	5	To be rejected

B-1.1 The entire area of fracture consists of the fractured area proper and the shear lip zone.

B-2. While estimating the fractured surface following indications should be taken into account.

a) Fibrosity

1) Crystalline Zones are clearly outlined fractured area which have crystalline structure and occupy more than 10 mm^2 each.

2) Fine grained aggregates or crystalline grains are located on the main dull fibrous background.

b) Fish Scale Fracture

1) Closed fish scale fractures are those which are short (up to 15 mm and inclusive) clear lines on the fractured surface oriented parallel to the surface of the plate and do not disturb the continuity of metal.

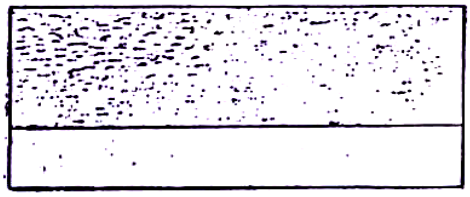
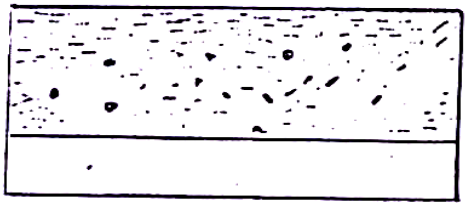
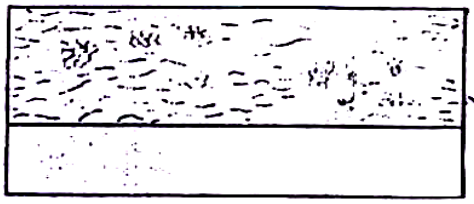
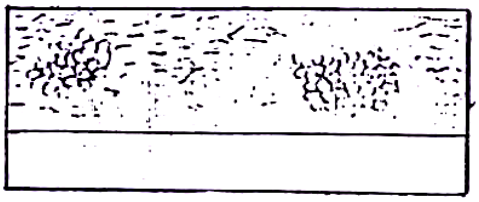
2) Opened fish scale fractures are short (up to and inclusive 15 mm) splitting lines oriented parallel to the surface of the plate and which disturb the continuity of metal.

c) Laminations

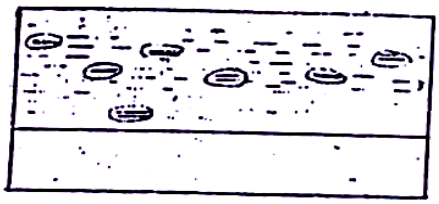
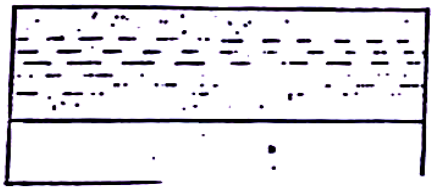
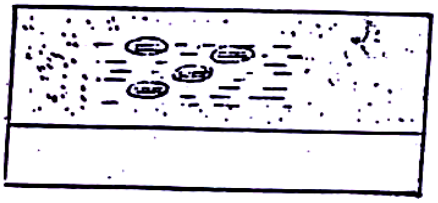
1 Lamination in general will mean a lamination of length more than 15mm oriented parallel to the surface of the plate and which do not disturb the continuity of the metal. The outlined laminations are light traces of lines of more than 15 mm length oriented parallel to the surface of the plate and which do not disturb the continuity of the metal. Large laminations are of length exceeding ⅔ of the width of fracture. Laminations which are found in layer of thickness not exceeding 5 mm are considered as single lamination.

APPX 'B1'

SKETCHES FOR PROPER INTERPRETATION OF FRACTURE TEST OF SPADE M – 1 PLATES

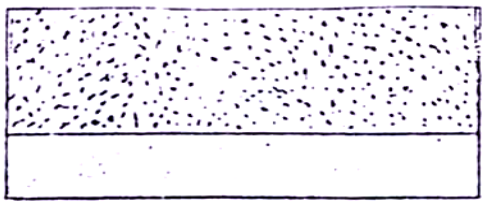
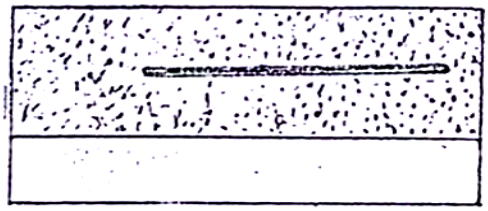
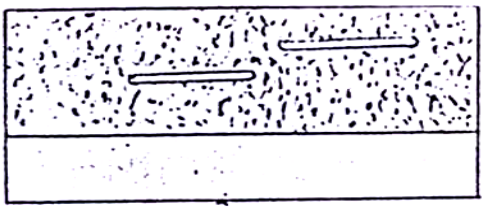
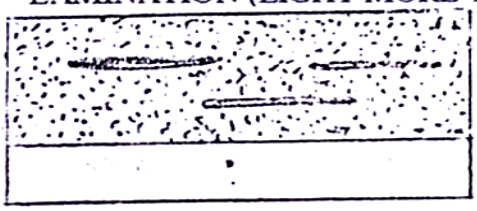
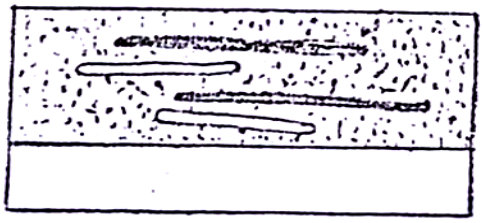
	TYPE OF FRACTURE	NUMBER	ESTIMATION OF FITNESS
	FIBRE		
1	 100 % FIBROUS FRACTURE	1	FIT
2	 FIBROUS FRACTURE WITH FINE GRAINED AGGREGATES OR CRYSTAL GRAINS AT AREA < 20% OF FRACTURE FACE	2	FIT
3	 FIBROUS FRACTURE WITH FINE GRAINED AGGREGATES OR CRYSTAL GRAINS AT AREA > 20% FRACTURE FACE	3	TO BE REHEAT TREATED
OR	 CRYSTALLISED ZONE --26-- CRYSTALLISED AREA>10mm^2		

APPX 'B1'

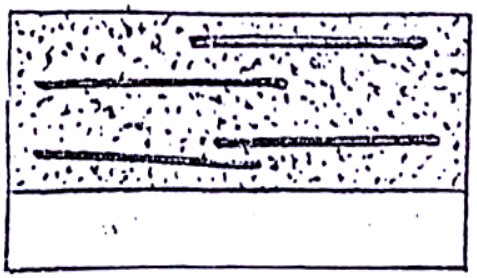
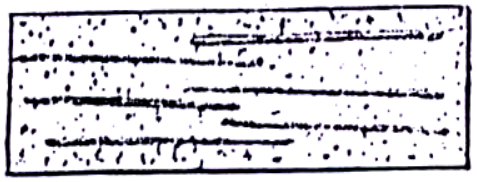
	TYPE OF FRACTURE	NUMBER	ESTIMATION OF FITNESS
	FISH-SCALE FRACTURE		
4	 SMOOTH FRACTURE WITHOUT ANY TRACES OF FISH SCALE	1	FIT
5	 CLOSED FISH SCALE FRACTURE ON THE AREA UP TO 0.33 OF TOTAL AREA OF FRACTURE UP TO 10 MARKS OF OPEN FISH SCALL (SPREAD OVER ENTIRE WIDTH)<10 NOS OPENFISH SCALE	2	FIT
6	 CLOSED FISH SCALE FRACTURE OCCUPYING UP TO 0,50 OF TOTAL AREA OF FRACTURE	3	FIT
OR	 OPENED AND CLOSED FISH SCALE FRACTURE ON AREA UP TO 0.33 OF TOTAL AREA OF FRACTRUE (WHICH MAY BE LOCATED ANYWHERE OVER THE FRACTURE)	3	FIT

NOTE: - OPEN FISH SCALE ≋ OPEN
CLOSED FISH SCALE — CLOSED

APPX 'B1'

	TYPE OF FRACTURE	NUMBER	ESTIMATION OF FITNESS
	LAMINATION		
9			
	SMOOTH FRACTURE WITHOUT LAMINATION	1	FIT
10			
	FRACTURE WITH ONE LARGE LAMINATION (>.66 OF FRACTURE WIDTH)	2	FIT
OR			
	FRACTURE WITH TWO OUTLINED LAMINATION (LIGHT MORE THAN 15 mm)	2	FIT
11			
	FRACTURE WITH 3 LAMINATIONS		
OR		3	FIT
	FRACTURE WITH TWO LAMINATIONS & TWO OUTLINED LAMINATIONS		

APPX 'B1'

	TYPE OF FRACTURE	NUMBER	ESTIMATION OF FITNESS
	LAMINATION		
12		4	FIT
	FRACTURE WITH 3 OR 4 LARGE LAMINATIONS		
13		5	DEFECT
	FRACUTE WITH 5 OR MORE LARGE LAMINATION		

NOTE: - OUTLINED LAMINATION: - LAMINATION WHICH HAS NOT VIRTUALLY OPENED UP AND APPEAR LIKE LARGE FISH SCALE.

APPX 'C'
(*Clause* 7.11.5)

BALLISTIC TEST OF SPADE M1, M2 PLATES

C-1. BALLISTIC TESTING OF ARMOUR PLATES OF SPADE M1, M2 WILL BE GOVERNED BY THE FOLLOWING TABLE

Thickness of Plate (mm)	Caliber of Projectile (mm)	Drawing No. of Projectile	Angle of Attack (Degree)	Striking Velocity in m/s (*Min*)	Remarks
20	12.7 B-32 bullet	3-016113 3-24465	35°	799.0	Nil
30	30 mm AP	AMK 613A	0°	445	Nil
40	30 mm AP	AMK 613A	0°	735	Nil
45	30 mm AP/T	AMK 613A	0°	830	Nil
50	30 mm AP	AMK 613A	0°	925	Nil
60	40 mm AP/T	DD (L) 12495 & US 9392120	0°	770	Nil
70	100 mm AP/T 105 mm FSAPDS	4-017070 or 2-011801 or 2-019268 -	0° 0°	410 ± 5 628	Nil Nil
80	105 mm AP FSAPDS/T	AMK 330A	0°	670	Nil
85	105 mm AP FSAPDS/T	AMK 330A	0°	690	Nil
130	105 mm FSAPDS/T	AMK 330A	0°	825	Nil

*For parts with hardness 311 BHN to 262 BHN.

C-2. For Ballistic Test of Jackal Plates, JSS 9515-022 may be referred.

C-3. Procedure for Conducting Ballistic Test on Armour Plates.

C-3.1 First shot is fired at a velocity 30 m/s more than that of stipulated minimum striking velocity as per table at Clause **C-1**. If the first shot results in a standard damage (acceptable damage), second shot is fired at a velocity 60 m/s more than that of first shot. However, in no case the charge weight to be used shall exceed the service charge weight.

C-3.2 If the first shot results in a non-standard damage (unacceptable damage), two more shots are fired at a velocity specified in table Clause **C-1**. If any one of the shots records standard damage at a velocity not less than the specified velocity as per Clause **C-1**, the plate will be considered balistically satisfactory provided the other shot does not record non-

standard damage at a velocity less than the specified minimum. If any shot records non-standard damage at velocity less than that of the specified, the plate will be rejected.

C-3.3 For 20 mm thick plates, standard damages with minimum of 7 (seven) numbers of record shot to be obtained.

C-3.4 Type of damage due to firing to be assessed in the following manner:

a) Standard Damage:

S. No.	*Type of Damage*	*Description*
a)	S1	No bulge or any other damage at the back of the plate
b)	S2	Smoot bulge at the back of the plate
c)	S3	Bulge at the back with radial lines of surface cracks which do not allow kerosene to leak

d) Non-Standard Damage:

S. No.	*Type of Damage*	*Description*
a)	NS1	Bulge with cracks at the back side of the plate which allow kerosene to leak
b)	NS2	Bulging plug outlined without penetration
c)	NS3	Bulge plug with tear along the circumference
d)	NS4	Detachment of chip of any size and weight from back while the shot has not penetrated the plate
e)	NS5	Through hole, shot passed through or plug knocked out
f)	NS6	Through hole with chip of any shape or depth detached from the back of the plate with one or more circular layer
g)	NS7	Development of cracks in the armour plate extending beyond the area of penetration of shot or the plate itself is broken

C-4. RECORD/NON-RECORD SHOT

C-4.1 Standard damage caused due to the shot fired at a velocity less than the specified minimum striking velocity is not taken into account and is called non-record shot.

C-4.2 Non-standard damage formed at a distance less than 2.5 calibre of shot from the edge of another damage or the edge of the plate is also a non-record shot.

C-4.3 Non-standard damage caused with a striking velocity less than the specified minimum velocity is a record shot i.e. the results to be taken into account.

C-4.4 Standard damage formed at a distance less than 2.5 calibre of shot from the edge of the another damage or the edge of the plate is a record shot.

C-5. RE-TESTING/REJECTION

C-5.1 On obtaining unsatisfactory result in ballistic test, double re-test may be carried out. One BTP may be cut from the mother plate from which the rejected BTP was taken and another BTP to be selected from the same cast. If on re-testing, the ballistic results are found satisfactory, the batch is accepted. If, however any one of the retest BTPs fails to meet the ballistic requirement, the producer may submit the batch after re-heat treatment. Re-hardening is allowed only once with any number of re-tempering.

C-5.2 The batch rejected due to unsatisfactory ballistic test results may be rerolled to lower thickness plates and submitted as a new batch.

APPX 'D'

FORMAT FOR FIRING TRIAL REPORT OF BALLISTIC TEST PLATES

Firing Trial Report of Plate No…….

A. Particulars of Suppliers

Steel Maker	Roller	Heat Treater	Nominal Thickness	Actual Thickness

B. Chemical Analysis

Cast No. C % Si % Mn % S % P % Ni % Cr % Mo % V % A1 % Zr % H2 (ppm)

Note. For Jackal Plates Cesium : 0.03-0.06 & Nitrogen 60 ppm to be checked.

C. Heat Treatment

	°C	Cooling Medium
Hardened at		
Tempered at		

D. Mechanical Test Result

Hardness (BHN)	Yield Stress (kg/mm^2)	Tensile Strength (kg/mm^2)	Elongation % on $5.65\sqrt{So}$	Reduction of area in %	Charpy 3mm U-Notch At room Temp. (Joules)	Charpy 3mm U-Notch At-40 °C Temp. (Joules)

E. Other Test Results

(a) Ultrasonic Test :

(b) Decarburisation/Percentage :

(c) Inclusion Rating :

(d) Grain size :

F. Firing Trial Results (Summary)

Resistance to penetration test attack Estimation of

V_{25}, mean

Speed VSPL Limit -

Assessed VSPL Limit -

Difference -

Result:

Behavior of target under attack

Face
Back

Date of firing
Date of Report

Signature……..

For commandant Proof Estt.

G. Final Sentence

Signature……
Quality Assurance Officer
for CQA (Metal), Ichapur

H. Detail Firing Trial Results

Round No.	Firing Distance	Ammunition Attack	Angle of Attack	Estimation of Penetration	Remarks