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GOVERNMENT OF INDIA
MINISTRY OF DEFENCE

DEPARTMENTAL SPECIFICATION

ON

**COATED METALLIC ELECTRODES OF 18%Cr – 8%Ni
– 6%Mn FOR WELDING SPADE ARMOUR PLATES ON
FIGHTING VEHICLES**

(DS CAT No 3439-000007, -000008, -000009, 000083, -000084)

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रक्षा मंत्रालय (डी.जी.क्यू.ए.)
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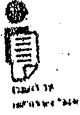
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No. 0003/CQAM/DC/TC

Dated 24 July'2013

To All Concerned Establishments

DC COPY : FORWARDING OF

Reference : This Controllerate letter of even No. dated 21 Sept 2004

A copy of DC No. 200-MS dated 23.07.2013 is furnished here with in respect of revised Specification No. CQA(M)-57 -2013 (supersedes CQA(M)-57 -2002).

Kindly acknowledge receipt.

(V K S Balyan)
 SSO-I
 For Controller

(DC No. 200-MS dated 23.07.2013)

S L N o.	Authority	Previous DC Reference	Specification	Remarks
1	0003/CQAM/DC/TC dated 23 July'2013	DC No. 158- MS dated 18 Sept 2004 (issued vide 0003/CQAM /DC/TC dated 21 Sept'2004)	CQA(M)-57-2013 (Supersedes CQA(M) 57-2002) Departmental Specification On COATED METALLIC ELECTRODES OF 18 % Cr- 8 % Ni-6 % Mn FOR WELDING SPADE ARMOUR PLATES ON FIGHTING VEHICLES (DS CAT No 3439-000007, -000008, -000009, -000083, -000084)	Revision of Specn. CQAM-57: CQA(M)-57-2013 (Supersedes CQA(M) 57-2002)

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**DEPARTMENTAL SPECIFICATION FOR COATED METALLIC
ELECTRODES OF 18%Cr – 8%Ni – 6%Mn FOR WELDING
SPADE ARMOUR PLATES ON FIGHTING VEHICLES**

0.0 FOREWORD

- 0.1 This specification has been prepared by Controllerate of Quality Assurance (Metals), Ichapur, on behalf of Director General Quality Assurance, Ministry of Defence, New Delhi.
- 0.2 This specification supersedes Specification No. CQA (M)-57-2002 edition.
- 0.3 This specification shall be used for Type approval of electrodes, tender enquiry, procurement and Quality Assurance of the electrodes covered by this specification.
- 0.4 The supply of electrodes against this specification shall be primarily subject to Type Approval of Vendor's electrodes under offer. Once Type approved that particular brand is considered to have been accorded Brand Approval for regular bulk supplies in future.
- 0.5 This specification is broadly divided in two parts- Part (A)-Procedure for Type Approval of electrodes Part (B)- Procedure for QA for bulk supplies against Type Approved electrode brands & procedure for re-approval of approved brands.
- 0.6 This specification should be used for procurement of electrodes for manufacture of Armour Fighting Vehicles by semi automatic welding. Enquiries regarding this specification relating to any technical or other contractual condition shall be referred to the Controller, Controllerate of Quality Assurance (Metals), Ministry of Defence (DGQA), Government of India, P.O. Ichapur-Nawabganj, Dist 24 Parganas (North), West Bengal, Pin – 743 144.
- 0.7 This specification is approved by the Controller, Controllerate of Quality Assurance (Metals), Ministry of Defence, DGQA, Govt. of India and is mandatory for use in Defence Service. The information contained in this specification is not to be communicated either directly or indirectly to press or any person not authorized to receive it.
- 0.8 This specification is the property of the Ministry of Defence and must be returned to the Controller, Controllerate of Quality Assurance (Metals), Ichapur, on demand.
- 0.9 This specification is a live document and is therefore likely to undergo changes. Any major change in the specification should have the approval of

Controller, CQA(Metals), Ichapur. Therefore the specification issued holds good only for the supply order for which it is issued.

- 0.10 Copies of the specification can be obtained from the Controller, Controllerate of Quality Assurance (Metals), P.O. Ichapur-Nawabganj, Dist 24 Parganas (North), West Bengal, Pin - 743 144.

1.0 SCOPE

- 1.1 This specification relates to the supply, quality assurance and procurement of coated metallic electrodes of 18% Cr - 8%Ni - 6%Mn type, intended for welding armoured vehicles in the flat and / or vertical and overhead positions. The electrodes as per CQAM-57 will be used when mentioned in the relevant drawings/ specifications for fabrication of fighting vehicles.
- 1.2 For the purpose of this specification the following expressions shall have the meaning as under
- 1.2.1 'Quality Assurance Authority' shall mean the Controller, Controllerate of Quality Assurance (Metals), Ministry of Defence (DGQA), Government of India, P.O. Ichapur-Nawabganj, Dist 24 Parganas (North), West Bengal, Pin - 743 144.
- 1.2.2 'The Manufacturer' shall mean the person or persons, firm or firms, company or companies who have contracted to manufacture and supply the electrodes to which this specification applies.
- 1.2.3 'The Quality Assurance Officer' shall mean the Quality Assurance Officer nominated by the purchaser for undertaking inspection of coated metallic electrodes.
- 1.3 All welding terms used in the specification shall have the meaning assigned to them in IS specification No. IS 812 (latest edition)
- 1.4 The Type approval of an electrode brand for procurement against this specification is given in two stages, the first being referred to as 'Tentative Approval' and the second as 'Full Approval'. Type approval is given by a Standing Task Force as per SOP (Standard Operating Procedure) Doc CQAM/QA-3/SOP/I (Rev-00) dtd 01.06.2012 issued by CQA(Metals). Firms intending to obtain Type approval of any of their electrode brands (hereafter referred as Brand Approval) as per CQAM-57 shall approach Secretary, Task force, HVF, Avadi.
- 1.4.1 'Tentative Approval' is granted when the electrode has been shown to comply with the requirements of this specification and permits the use of the

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- electrode in any one factory on work the nature of which must be agreed by the Controller CQA(Metals), Ichapur.
- 1.4.2 'Full Approval' is granted to an electrode that has received 'Tentative Approval' subject to its satisfactory performance in the production of armour assemblies as permitted in clause 1.4.1 over a probationary period sufficient for adequate experience to be gained in confirming its suitability for welding armour. Full approval permits the unrestricted use of the electrodes on work for which its type and class is specified.
- 1.5 The procurement of electrodes against this specification shall be done from manufacturers of approved brands only. List of approved brands shall be available with CQA (Metals), Ichapur.

2.0 RELATED SPECIFICATIONS AND DOCUEMNTS

- 2.1 Reference is made in this specification to:

S.No.	Specification No.	Title
(i)	IS-812 (latest edition)	Glossary of terms relating to welding and cutting of metals
(ii)	JSG-9515:10-2010	Homogeneous Machinable Armour Plates: 4mm To 85mm Nominal Thickness
(iii)	CQAM/QA-3/SOP/I (Rev-00) dtd 01.06.2012	Standard Operating Procedure for Brand Approval of Welding Consumable as Per Specification No. CQA(M)-55, CQA(M)-57 & CQA(M)-59
(iv)	IS:1608 (Latest edition)	Indian Standard Metallic Materials –Tensile testing at ambient temperature.
(v)	IS:1757 (Latest edition)	Indian Standard Metallic Materials –Impact Testing at ambient temperature

- 2.2 Copies of Indian Standards can be obtained on payment from Bureau of Indian Standards 9, Bahadur Shah Zafar Marg, New Delhi-110002.
- 2.3 Copies of JSG-9515:10-2010 can be obtained on payment from The Director, Directorate of Standardisation, Ministry of Defence, 'H' Block, DHQ PO, New Delhi-110011.
- 2.4 Copies of CQAM/QA-3/SOP/I can be obtained from Controllerate of Quality Assurance (Metals), Ministry of Defence (DGQA), Government of India, P.O. Ichapur-Nawabganj, Dist 24 Parganas (North), West Bengal, Pin – 743 144.

PART (A) - TYPE APPROVAL

3.0 GENERAL REQUIREMENTS

- 3.1 The manufacturer shall provide the following when submitting the electrodes for Type approval by the Controllerate of Quality Assurance (Metals), Ichapur upon recommendation by the Task Force.
- 3.1.1 Sufficient electrodes shall be submitted to Secretary, Task Force, HVF, Avadi at free of cost for conducting tests as mentioned in clause 9.0 and sub-clauses.
- 3.1.2 Complete directions for the operation of electrodes including the optimum current and range of currents, to be used for each position of welding for which approval is required together with a detailed description of any special technique required.
- 3.1.3 (a) A statement giving details of the nominal outside diameter of coating for each size of electrode.
(b) The range of chemical composition of core wire used.

4.0 MATERIAL AND WORKMANSHIP

- 4.1 Materials and workmanship used in the manufacture shall be such as to produce finished electrodes meeting the requirements of this specification.

5.0 DIMENSIONAL TOLERANCE

- 5.1 The electrodes shall be supplied in sizes and lengths corresponding to those stipulated in Table 1.

Table - 1.

The nominal diameter of the electrode determined by the diameter of the core wire (d) in mm	The nominal length of the electrode (L) in mm.	Length of the grip end in mm \pm 5
2.5	250	20
3.15	300	25
4.0	350	25
5.0	350	25
6.0 and above	350	25

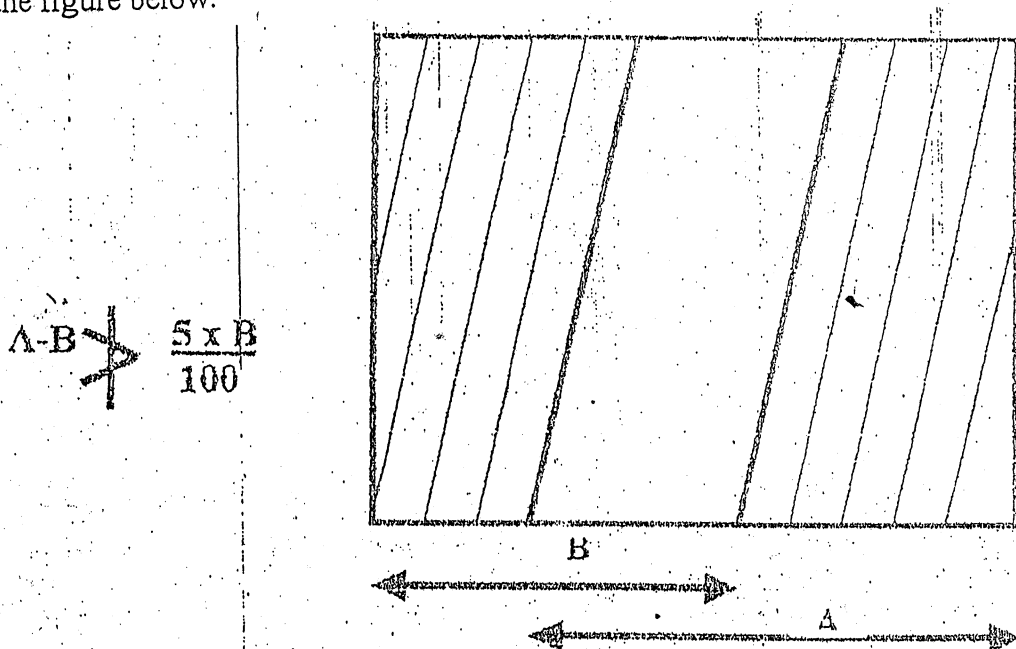
Note :- If required by the customer/manufacturer, different sizes of electrode may be established after obtaining prior concurrence of the "Quality Assurance Authority".

- 5.2 The diameter of the core wire (d) shall not vary more than \pm 0.05 mm from the standard size specified. The length (L) shall not vary more than \pm 10mm from that of specified.

- 5.3 The grip portion of the electrode (1) shall be free from covering as given in Table-1 for making contact with the electrode holder.
- 5.4 The arc end of each electrode (1) shall be sufficiently bare to permit easy striking of the arc. The distance from the arc end to the first point where the full cross-section of the covering prevails shall not exceed the diameter of the core wire. However, for electrodes larger than 3.2 mm, the core wire shall not be exposed around more than half the circumference at a distance of 3.2mm or more from the arc point.

6.0 CONCENTRICITY OF COATINGS (COVERING)

- 6.1 The covering shall be concentric to the extent that for all sizes of electrodes the maximum core-plus-one covering dimension (A) shall not exceed the minimum core-plus-one-covering dimension (B) by more than 5% as determined in accordance with the requirements of clause 6.1.1 and shown in the figure below.



measured as follows :-

- 6.1.1.1 Sufficient coating shall be removed from one side of the electrode to permit micrometer measurement and care shall be taken to ensure that no metal is removed from the core wire. The core-plus one covering dimension (the diameter of the core wire plus the thickness of the coating on one side of the wire) shall be measured with a micrometer.

6.1.1.2 The coating shall then be removed from the opposite side of the core wire at a point, adjacent to the place where the coating was previously removed and a similar measurement made.

6.1.1.3 Two more pairs of core-plus-one covering measurements shall be made on axes at angles of 60° and 120° from the former measurement. The pair of measurement which show the greatest variation shall be used to calculate the percentage difference in concentricity for compliance with the requirements of clause 6.1

6.2 Thickness of Coating

6.2.1 The manufacturer shall report the nominal outside diameter of the coating for each size of electrode when samples are submitted for approval. The outside diameter of the coating shall not vary subsequently by more than $\pm 5\%$ from the nominal diameter reported.

6.2.2 The diameter of the coating shall be measured with a micrometer at angular intervals along the length of the electrode.

6.3 Hygroscopic Property

6.3.1 Hygroscopic property of the coating shall be such that under normal condition of usages, the coating shall show no permanent injury, as for instance, blistering or spearing during the welding operation.

6.4 Strength and Condition of Coating

6.4.1 The physical condition of the coating shall be to the entire satisfaction of the Quality Assurance Officer i.e. freedom from scabs, blisters, pack marks, bruises or other surface defects. Further more, it shall be adequately robust and shall adhere sufficiently to the core wire to withstand normal handling without chipping, flaking or cracking during transit and after receiving the drying treatment prior to use.

6.4.2 When used with currents within the ranges recommended by the manufacturer, the coating shall not flake during welding even after approximately half the electrodes has been consumed and allowed to cool.

6.5 Consumption of Coating

6.5.1 The coating shall be such that it will fuse uniformly without spearing, cupping or burning too rapidly.

6.6 Operation characteristics

6.6.1 The electrodes must be easy to operate and capable of maintaining a steady arc with freedom from slag interference when used within the recommended current range on either AC with minimum open circuit voltage of 80 Volt or on DC with minimum open circuit voltage of 50 Volt.

6.6.2 The slag derived from the electrode must be easy to control during the welding operation and shall be readily removed by hand tools to reveal a clean metal surface.

7.0 CONDITIONS OF SUPPLY OF CORE WIRE

7.1 Surface and Internal Imperfection.

7.1.1 The surface of the wire shall be free from scale, pitting, grease, shell and other harmful defects which would interfere with uniform performance of the electrode, before being made into electrode.

7.1.2 The wire shall be sound internally. The method of determining the internal soundness of the wire to be as agreed between the supplier and the Quality Assurance Authority.

7.2 Uniformity

7.2.1 The wire shall be uniform throughout its length and truly circular.

7.3 Chemical composition of Core wire

7.3.1 The core wire used for manufacturing the electrodes should be of austenitic SS type and the chemical composition of all weld metal deposit should satisfy the requirements of clause 9.1.1. The steel maker's declared chemical analysis of the core wire shall be made available to the Quality Assurance Officer.

8.0 ACCEPTANCE

8.1 All the test requirements of this specification as given below (clause 8.1.1 to 8.1.6) form the basis for acceptance of the electrode. Test details and acceptance standards for these tests are given in clause 9.0. Besides, any other tests as called for by the Task force/ Controllerate of Quality Assurance (Metals), Ichapur and other requirements regarding size (clause 5.0), quality of covering and core wire (clause 6.0 and 7.0) should also be met.

8.1.1 Chemical Composition of the deposited weld Metal.

8.1.2 All weld tensile test.

8.1.3 Impact test.

8.1.4 Resistance to Hydrogen Induced cracking test in the junction of HAZ

8.1.5 Resistance to Weld metal cracking test.

8.1.6 Ballistic Test.

9.0 TESTS AND ACCEPTANCE STANDARDS

9.1 CHEMICAL COMPOSITIONS OF THE DEPOSITED WELD METAL

9.1.1 The chemical composition of deposited weld metal shall conform to the requirements as follows :-

Elements	Wt(%)	Elements	Wt(%)
Carbon	0.13 Max	Chromium	18.50 - 21.50
Silicon	0.50 - 1.20	Nickel	8.50 - 11.00
Manganese	4.80 - 7.00	Sulphur	0.02 Max
Phosphorous	0.04 Max	--	--

9.1.2 The details of test and method of selection of test sample are specified in appendix 'A'

9.2 ALL WELD METAL TENSILE TEST.

9.2.2 The tensile test specimen made from the weld deposit shall yield results conforming to mechanical properties requirements as prescribed below :-
Tensile Strength - 540 MPa (min) (55.0 Kgf / mm²)
Elongation % (on 5.65 So) - 25 (min)

9.2.3 The details of the test and method of preparation of test samples are given in Appendix 'B'

9.3 IMPACT TEST

9.3.1 The impact test specimens from the weld deposit shall yield results conforming to the property requirements as given below when tested at room temperature :-
'V' Notch Charpy Impact Value - 8 K.gm (Min) at room temp.

9.3.2 The details of the test and method of preparation of test samples are given in Appendix 'B'.

9.4 RESISTANCE TO HYDROGEN INDUCED CRACKING TEST AT THE JUNCTION OR HEAT AFFECTED ZONE

9.4.1 This test is carried out in order to determine the resistance to cracking at the junction of heat affected zone (HAZ) of the armour. Electrodes of size up to 6mm dia shall be subjected to R.D. Rigid Butt Joint test. Electrodes of size above 6 mm will be subjected to the Modified Reeve Test. Procedures for these tests are given in Appendices 'C' and 'D' respectively.

9.4.2 The weld test specimens shall upon examination be free from cracks or other open defects affecting the strength.

9.5 RESISTANCE TO WELD METAL CRACKING TEST.

9.5.1 The test shall be carried out in order to assess the susceptibility of the weld metal to 'Hot Cracking'. Electrodes of size up to 6mm dia. shall be subjected to 'Swinden Tied Tee Test'. Electrodes of sizes above 6mm dia shall be subjected to the standard 'Heavy Tee Test'. Procedures for these tests are given in Appendices 'E' and 'F' respectively.

9.5.2 The weld test specimens shall upon examination be free from cracks or other open defects affecting the strength of weld.

9.6 BALLISTIC TEST PROCEDURE, ACCEPTANCE CRITERIA AND RESULTS

The size and the preparation of welded Ballistic test plates is given in the attached sketch as specified by the Soviet Specialist (Fig 8)

The test plates will be Spade M1 Armour Plate of 80mm thick.

9.6.1 The plates to be fired are to be positioned vertically so that the impact angle of the shot is 0 degree. The gun is to be positioned at 100 meters away from the plates to be fired using conditioned ammunition 100mm AP/T so as to give impact velocity of 325(+15 & -05) m/s at the time of hitting. At least two fair conditional damages of BTPs, welded by one end with same types of electrode are required by using 100 mm Field gun.

9.6.2 The Ballistic tests to be witnessed by the members of the task force at PXE, Balasore and the detailed test results to be forwarded by PXE, Balasore to all the members of the task force.

9.6.3 EVALUATION CRITERIA OF PROOF RESULTS

Evaluation of rigidity and soundness of welded plates under testing is based on the following resulting damage factors:

9.6.3.1 The hit is considered fair only if the centre of the damage is within ± 50 mm of the weld seam axis.

9.6.3.2 Length of cracks (Destruction) of welded seams after each hit should not exceed 250mm and after three hits should not exceed 750mm, a weld soundness criterion and the damage is considered acceptable

9.6.3.3 Kerosene should not seep through the damaged zone for 15 minutes and the damage is considered acceptable.

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- 10.2.1 The bulk supplies shall be subject to inspection and testing by the Quality Assurance Officer nominated by the Quality Assurance Authority.
- 10.2.2 The core wire used in the manufacture of 18% Cr – 8% Ni – 6% Mn type electrodes employed in the production of armour fighting vehicles shall be subjected to spot check analysis at the discretion of the nominated Quality Assurance Officer after being made into electrodes.
- 10.2.3 The electrode manufacturers will indicate to the Quality Assurance Officer the system and method of quality control which has been used previously in their respective works to check and control the purity of raw materials, consistency of mixing, analysis of coating concentricity & uniformity of coating, efficiency of drying, running properties of electrodes and batch segregation. The system will be agreed between the manufacturer and the Quality Assurance Officer, who shall be given adequate facilities to satisfy himself that the firm carry out the regular test as agreed upon, proper records are kept and the results are consistent.
- 10.2.4 The Quality Assurance Officer shall select sufficient electrodes from the stack of electrodes offered for inspection and will carry out tests as specified in clause 9.1 (Weld pad Chemistry), 9.2 (All weld Metal Tensile Test) & 9.3 (Impact Test) as stipulated above under column 9.0 in order to ensure that the electrodes conform to the requirements of this specification.
Note :- All the tests mentioned in clause 9.0 will be carried out for granting brand approval of an electrode as specified in clause 5.1.
- 10.2.5 A batch of bulk of electrodes for testing will be as under :-
- 10.2.5.1 Batch Size :-
A day's production at firm's premises or quantity 30,000 Nos., which ever is less.
- 10.2.5.2 Sample Size :-
- | | | | |
|-----|---------------------|---|------------------------|
| i) | 4.00 mm dia & below | - | 3 pkts for each Batch. |
| ii) | 5.00 mm dia & above | - | 2 pkts for each Batch. |
- 10.2.6 All approved brand electrodes will be tested at CQA(Metals), Ichapur or its authorised establishment / laboratory during execution of supply orders from Ordnance Factory.
- 10.2.7 Firms who are regularly supplying the products need not be evaluated for their products for re-approval. But the firms who have not executed a single supply order during last 3 yrs, need to be evaluated for their products for re-approval. In such cases all the tests except ballistic test are to be done. For the purpose no testing charge will be levied from the firms although adequate quantities of electrodes will be submitted free of charge by the firm for necessary testing.

10.2.8 CQA (Metals), Ichapur or his authorised representative have the right to draw samples at any stage of the production for evaluation of the product.

10.2.9 Retest

If any test fails, two additional tests of that particular test, as taken from the original test assembly or from new test assembly, shall be performed and the results of both shall meet the requirements prescribed for the test. In case either of two additional tests fails, the Quality Assurance Officer will refer the matter to the Quality Assurance Authority for official investigation. In this event, the acceptance of electrodes at the works of the manufacturer concerned shall be reviewed and the approval and / or acceptance of the particular brand failing shall be reconsidered.

11.0 REAPPROVAL OF BRANDS

Approved brands which have not been procured by fighting vehicle manufacturers for 03 years or more shall be considered for re-approval when such brands are intended for supply by the concerned firms. In such cases all tests as per Clause 9.1, 9.2, 9.3, 9.4 & 9.5 except ballistic tests shall be conducted. The results duly recommended by CQA(HV) Avadi shall be sent to CQA(Met) for consideration of re-approval.

12.0 STANDARD PACKAGES AND MARKINGS :-

12.1 Electrodes shall be suitably packed to afford sufficient protection against injury to the coating by mechanical or atmospheric action during normal conditions of transport and storage. The weight of package of each size of electrodes shall be as agreed upon between the manufacturer and purchaser.

12.2 All approved brands of electrodes shall be identified by a distinctive coating or tip colour to be agreed between the manufacturer and the Quality Assurance Authority or the electrode name may be printed legibly on the coating in order to distinguish the electrodes from other brands supplied by the same manufacturer and also from brands supplied by different manufacturers.

12.3 Each package of electrodes shall be clearly marked with the manufacturer's name and the brand of electrode. The label should also indicate the recommended current and current range, the size of electrode, the quantity and the date of manufacture. Each package shall also bear a clearly marked batch number by which the electrodes can be traced back to the coating mix employed in their manufacture.

Appendix 'A'

PROCEDURE FOR SAMPLING AND TESTING OF CHEMICAL
COMPOSITION OF DEPOSITED METAL

A.1 PREPARATION OF WELD METAL PAD

A.1.1 Description

A.1.2 For chemical analysis of the electrode, deposits made in the down hand position shall be built up on flat surface of mild steel bar or plate of 20mm thick by deposition of a sufficient number of multi-run layers to produce a pad approximately 80mm long X 25mm wide X 25mm high. The arc voltage and average current for each size of electrode shall generally be as follows :-

Electrode diameter (in mm)	Average Arc Current (in Ampere)	Maximum Arc Voltage (in Volt)
2.50	60 to 80	24
3.15	90 to 110	25
4.00	120 to 140	26
5.00	160 to 180	27
6.00	220 to 240	28
8.00	350 to 400	30

A.1.3 All traces of slag shall be removed carefully after each run has been deposited. After depositing each layer, the pad shall be immersed in water for 30 seconds.

A.2 MACHINING

A.2.1 After removal of all trace of slag by chipping and brushing from the weld pad (and grinding if necessary), the top surface (approximately 1.0 mm) shall be machined off and discarded. Weld pad may thereafter be finished machined to make suitable for Chemical analysis on the weld surface by D.R. spectrometer. Sample for chemical analysis by wet method may be obtained by machining/ drilling but no way metal shall be removed within 10mm from base plate. Min. weight of the sample for wet analysis shall be 85 gms.

A.3 CHEMICAL ANALYSIS

A.3.1 Chemical analysis shall be done by any suitable method as agreed upon between the manufacturer and the QAO.

**PROCEDURE FOR PREPARATION OF ALL WELD METAL
TENSILE AND IMPACT TEST SPECIMENS**

B.1 DEPOSITION

B.1.1 All weld test assembly shall be prepared as per Fig. 1(a) using mild steel plates of 20.00 mm thickness and backing plate of 10.00 thickness. The assembly shall be prepared after giving a minimum of three surfacing layers on inner edges of plates and on the top surfaces of the backing plate with the electrodes to be tested. The built up plate edges and the surface of backing plate should be subjected to machining after which the thickness of the built up layers should not be less than 2.5 times the diameter of the electrode to be tested. The plate shall be welded in the flat position and they shall be sufficiently restrained during welding to prevent warping more than 5 degrees. Test plates shall not be straightened after welding.

B.1.2 Each run of weld shall be deposited from end to end without interruption and the direction of welding shall be reverse for each alternate run. Weld shall be deposited with the value of welding current to the extent of 85-80% of the maker's recommended optimum current at normal travel speed and with a minimum weaving. Each electrode should be used completely as far as possible. The width of each bead should not be more than 4 times the diameter of the electrodes being tested. Care shall be taken for deposition and removing the slag to obtain a sound weld, free from porosity, trapped slag or other such defects.

B.1.3 During welding of the test assembly, the temperature of the assembly measured at a distance of 25mm from the weld at the mid-length of the test plate, should be between 16^oC and 150^oC before deposition of next run.

B.1.4 The assembly shall be allowed to cool in air only till a temperature of less than 150^oC is attained. The machining shall be done only after the assembly has cooled down to the room temperature in normal atmosphere.

B.2 MACHINING

B.2.1 One tensile and three impact test specimens shall be cut as shown in Fig 1a from each test assembly. Three such test assemblies shall be prepared during approval testing of electrode and one test assembly shall be prepared for testing against supply order. While machining test pieces, weld metal of surface layers should not be utilised.

B.2.2 All weld Tensile and Charpy Impact test pieces shall be machined from test assembly as per Figs 1(b) & 1(c) respectively. The dimensions of tensile and Charpy Impact test pieces are shown in Figs 2(a) & 2(b) respectively in accordance to the requirement of IS: 1608 (latest edition). & IS: 1757 latest edition)

PROCEDURE FOR R.D. RIGID BUTT JOINT TEST

C.1.0 DESCRIPTION OF TEST

C.1.1 The R.D. rigid butt joint test is a restrained plate weld test to establish the susceptibility of the electrode to induce 'cold cracking' in the heat affected zone. The two plates butt closely together at each end of a specially prepared vee. The degree of restraint is governed by the width of the rest plates behind the joint. This has been standardised at 115mm for both initial approval and check production testing. CQA(Met) reserves the right to either increase or decrease the restraint by modifying the plate width or composition of test plates. The two plates are prevented from angular distortion by being firmly holding down to a base plate jig. A general view of the test set up is given in Fig3 and dimensional drawing is given in Fig 3(a).

C.1.2 The main base plate is made from 25mm thick alloy steel to specification JSG-9515:10-2010 of tensile strength 110 Kgf /mm² and hardness about 300 HB. The intermediate backing plate is made of the same material and has a copper backing bar (water cooled) with a longitudinal machined groove inserted in the centre of one side in order to allow correct penetration into the root of the vee when welding the test piece. The restraining bars are machined from a steel of tensile strength 86 Kgf / mm² and dimension 25mm wide x 50 mm deep shaped at each end to drop over 25mm diameter mild steel studs. The assembly is tightly held by 25mm diameter nuts.

C.2.0 PREPARATION

C.2.1 The test plates shall be prepared by gas cutting or machining two piece, each 300 mm X 115 mm and then gas cutting a bevelled portion along the central, 150 mm on one of the long sides of each plate which shall be transverse to the main rolling direction. The angle of bevel shall be 30° to the normal edge. The abutting faces shall be rough ground and finished on a surface grinder so as to leave a root gap of 1.60 mm when set up and to ensure intimate contact between the abutting faces. The corners at the end of the bevels shall then be ground smooth and round. The oxides shall be slightly filed and brushed (by wire brush) from the remainder of the joint face. The sharp feather edge shall also be removed by light filing but care must be taken to avoid the formation of any appreciable root face.

C.2.2 After the plates have been prepared, they shall be set in the jig with paper (total thickness 0.16 mm to 0.18mm) between them and the loose backing plate. (The purpose of the paper is to prevent too rapid heat transfer from the test plates to the jig). The assembly bolts shall be tightened to ensure that the test plates are abutting tightly. Nuts then shall also be tightened firmly and the assembly bolts slackened off. Care must be taken in setting up to ensure that the groove in the loose plates is immediately beneath the joint in the test plates.

When set up, the paper beneath the test plates must be dry and away from the joint for a distance of 19mm each side.

C.3.0 STANDARD PROCEDURE

- C.3.1 The temperature of the whole test piece, welding jig and room in which the work is carried out, shall lie between 16°C to 27°C. Further the ambient temperature shall not fall below 16°C during the next 5 days.
- C.3.2 The weld layers shall be deposited in the test groove using the least value of the heat input (V X I) / S that will give satisfactory bead profile.
- C.3.3 A time interval of exactly 5 minutes shall be maintained between runs. All traces of slag must be thoroughly removed after the first minute of this interval.
- C.3.4 Care must be taken to prevent excessive penetration on the first runs though lack of fusion is equally to be guarded against. Ideal penetration is indicated in Fig. 4(A) while 4(B) and 4(C) show example of insufficient and excessive penetration.
- C.3.5 On all runs care must be taken to ensure that deep penetration is not made into the parent plate. Care must be taken on the last run to obtain correct fusion of the top edges, since it is undesirable to have either overlap or traces of a notch. The reinforcement at the centre of the weld should be of the order of 0.8 mm to 1.6 mm above the plate. The drawing in Fig 4(A) indicates a satisfactory welded profile.
- C.3.6 After completion of the test weld and before 3 minutes have elapsed, the complete jig with test plates clamped in position, must be lagged with a dry asbestos blanket and covered with a dry felt sheet. It is then left undisturbed for 24 hours in a draught free place where the temperature does not fall below 16°C. At the end of this time the clamping nuts should be slackened and the test weld taken out and left undisturbed for a further 5 days in a draught free atmosphere where the temperature does not fall below 16°C. If, after 5 days no obvious cracks are visible, the weld shall be removed by longitudinal cuts at each side so as to leave 87 mm width of blank plates each side. These cuts must be made in such a way that no excessive heat reaches the heat-affected zones of the weld and may be made with either a slitting wheel or by means of an oxy-acetylene flame – cutting machine, provided in the latter case that the weld is immersed in water while the cut is made. Cross section shall then be made at points 37mm, 75mm, and 115mm from the start of the first run.
- C.3.7 Three faces of the two sections removed shall be surface grounded and polished for micro-examination and later for reference as follows The details of sectioning is depicted in fig 4(D) :-

Section 37 mm from start of first run	A Face
Section 75 mm from start of first run	B Face
Section 115 mm from start of first run	C Face

C.3.8 These sections shall be examined for cracks by the following methods:-

C.3.8.1 Visual examination and if crack free

C.3.8.2 Under the microscope at a magnification of not less than 50 X.

C.3.9 The electrode under examination shall be considered to have failed in the test should any cracks be present which are not considered directly attributable to faulty welding technique. If it is considered that a crack is due to faulty welding technique, that test shall be discounted and a repeat test made.

C.4.0 ASSESSMENT OF RESULTS

C.4.1 Approval Testing:-

For the purpose of approval testing it is required that the electrode shall be capable of passing the test on 115 mm width on spade M-1 steel to specification JSG-9515:10-2010 or an equivalent severity of test on any other plate which has been standardised by the CQA(Metals), Ichapur. Two tests shall be carried out at the specified width and the electrode shall be considered satisfactory if it passes both the tests. If failure in either should occur which is not directly attributed to faulty welding technique, two further test pieces shall be welded, both of which must be satisfactory if the electrode is to be passed.

C.4.2 For check inspection testing one test shall be done at the standard conditions. If failure should occur which is not directly attributed to faulty welding technique, two further test pieces shall be welded, both of which must be free from cracks if the electrodes are to be passed.

C.4.3 During check inspection testing, the Quality Assurance Officer shall select four 4mm and twelve 5mm electrodes from the same packet or batch as those under test, and hold these for re-approval testing should the tests carried out under clause C.4.2 fail.

C.5.0 SUMMARY OF STANDARD CONDITIONS :-

Thickness of test Plates.	:	14 mm / 16 mm
Composition of test plates	:	As per specification JSG-9515:10-2010
Width of test Plates –		
Approval testing	:	115 mm
Check testing	:	115 mm
Root gap	:	1.6 mm
Included angle of bevel	:	60 degree

CQA(M)-57-2013
(Supersedes CQA (M)57-2002)

- Total thickness of insulating paper : 0.16 mm to 0.18 mm
- Welding parameters (current, voltage and speed) : To correspond to the least value of heat input which gives a satisfactory bead profiles
- Direction of welding : Each run commence at crater of previous run
- Time interval between runs : 5 minutes
- Time between welding and removal of test plate from Jig : 24 hours
- Time between removal from jig and sectioning : 5 days
- Magnification for micro-examination : 50 X (minimum)

Appendix 'D'

PROCEDURE FOR REEVE FILLET WELD TEST

D.1.0 DESCRIPTION OF TEST

- D.1.1 The reeve test consists of a lap fillet weld between two plates, restrained by welds, anchoring one plate to the other clamping both plates by bolts to a heavier and more rigid base plate. This fillet weld test is designed to induce cold cracking in the heat-affected zone.
- D.1.2 The assembly is illustrated in Fig. 5 from which it will be seen that the permanent base plate consists of a plate 80mm X 450mm X 450mm drilled with six holes. The two 80 mm thick plates are gas cut to sizes of 250 mm X 175 mm and 150 mm X 125 mm respectively and drilled from the same jig as the base plate. The main rolling direction of the test plate shall be transverse to the test weld.

D.2 PREPARATION

- D.2.1 All scales shall be removed from the vicinity of welds and a good fit between the plates assured (by grinding, if necessary) such that any gap along the test joint shall not exceed 0.5 mm. The test plates should be assembled on the jig and the nuts tightened. After preheating the assembly to 100⁰C to 150⁰C the welds of 12 mm leg length shall be deposited in the flat position to the sequence as shown in the fig. The rear weld first and then the two side welds from the rear towards the test-weld. The whole assembly shall then be allowed to cool to an ambient room temperature of 15⁰C -27⁰C and the nuts re-tightened.

D.3 STANDARD PROCEDURE

- D.3.1 With the assembly at 15⁰C -27⁰C it should be positioned at 45⁰ for the test weld to be deposited in the flat position.
- D.3.2 When testing 10mm diameter electrodes, the current setting shall be 450 amps. throughout and the root run shall be deposited to form a 12 mm fillet. After a five minutes interval during which time the slag shall be carefully removed from the weld, the second run shall be deposited in the opposite direction to bring the fillet size up to approximately 21 mm. A similar time interval of five minutes shall be left before third run is deposited in the same direction as the first to bring the fillet leg length up to 26 mm.

D.3.3 If 8.0 mm dia. electrodes are being tested, the current setting shall be 350 amps throughout and the root run deposited to form a 11mm fillet. After a five minutes interval during which time the slag shall be carefully removed from the weld, the second run shall be deposited in the opposite direction so as to bring the fillet size up to approximately 18 mm. A similar time interval of five minutes shall be left before the final run is deposited in two passes side by side, both passes to be in the same direction as the first run to bring the fillet length up to 26 mm. The minimum time interval should be observed for slag removal between two passes which should be deposited with the same electrode.

D.3.4 After welding, the assembly shall be protected from draughts and allowed to cool to a room temperature of 15⁰C -27⁰C. Further, the ambient temperature shall not fall below 15⁰C prior to sectioning the test pieces. 24 hours after welding, the test pieces shall be unbolted and left for a further period of five days before being sectioned. Three sections shall be taken by sawing from the test weld. These sections shall be at the mid point at 38 mm from each side of it and shall be examined for cracks by following methods.

D.3.4.1 Visual examination and if crack free.

D.3.4.2 Under the microscope at a magnification of not less than 50X

D.4 ASSESSMENT OF RESULT

D.4.1 The standard plate to be used for approval or check testing shall be a 80 mm thick Cr-Mo Armour steel to specification JSG-9515:10-2010 or any steel assessed by the Controllerate of Quality Assurance (Metals), Ichapur as having the same weldability characteristics.

D.4.2 For approval testing, each size of electrode submitted over 6 mm shall be submitted in duplicate and must pass each test without cracking. Any crack which is considered to be due to faulty welding technique shall invalidate that test and a repeat test shall be done.

D.4.3 For check inspection testing, one test shall be done under the standard procedure with 10 mm dia electrodes. If this size is not in current production any size above 6 mm may be used. If the test is satisfactory, the large gauge electrodes of this type shall be passed. If any cracks are present not due to faulty welding, two repeat tests shall be done, both of which must be satisfactory for the electrode to qualify.

Appendix 'E'

PROCEDURE FOR PREPARATION OF SWINDEN TIED TEST

E.1.0 DESCRIPTION OF TEST

E.1.1 The Swinden Tied Tee Test is a restrained fillet weld test to establish whether the deposited weld metal is susceptible to 'Hot cracking'. The test piece illustrated in fig 6 is in the form of Tee joint with a backing bar.

E.1.2 The leg and base plates of the Tee are formed of 14mm thick Cr-Mo armour steel to specification JSG-9515:10-2010. The test piece is 150mm long and the horizontal base is 90 mm width while the vertical leg, which is finally tracked in position along the center line of the horizontal, is welded to the horizontal plate by means of two 6.0 mm fillet weld (A & B of Fig. 6)

E.1.3 All scale is removed by grinding from the vicinity of the test welds and the lower edge of the vertical plate is ground so as to make as close fit as possible with the horizontal plate. The vertical plate is clamped firmly in position, tacked at each end and the clamps then removed.

E.2.0 STANDARD PROCEDURE

E.2.1 The temperature of the test piece immediately prior to the deposition of the first test weld and the room in which the work is carried out shall lie between 15°C -27°C.

E.2.2 The two test welds shall be laid in the 'Flat' position with an interval of 10-12 seconds between the breaking of the arc on the completion of run 1 and the re-striking of the arc for run 2. During the interval, the test piece shall be turned and tilted in the opposite direction so that run 2 is commenced opposite to the crater of run 1 and proceeds to the opposite direction. A new electrode shall be taken for the second run.

E.2.3 It is emphasised that the time interval is most critical and must be maintained within the limits stated.

E.2.4 The size of the test weld is also important and care must be taken to ensure uniformity with 5.00 mm electrodes. A fillet size 8 mm to 9mm should be obtained.

E.2.5 While the test is most suited to 5 mm electrodes, it may also be used to test 4 mm and 6 mm electrodes without serious alteration of the procedure. In the case of 4 mm electrode, a fillet size just under 8 mm and in case of 6 mm electrode, a fillet size of approximately 9 mm should be obtained.

E.2.6 The approximate testing currents are as follows :-

4 mm	-	160 amps.
5 mm	-	200 amps.
6 mm	-	240 amps.

E.3.0 ASSESSMENT OF RESULTS

E.3.1 At the standard test current, a satisfactory electrode is required for welding to prepare test samples without any cracks in the weld metal, other than a crater crack.

E.3.2 For approval testing two test samples shall be welded at the standard testing current. Three cross-sections shall be taken from each at points 25mm, 65mm and 100 mm from the start and examined for cracks by the following methods

:-

- a) Visual examination and crack free
- b) Under the microscope at a magnification of not less than 50X.

E.3.3 For check inspection testing, one test shall be done at the standard condition and sectioned for the examination of cracks. If any cracks are present in the weld metal other than a crater crack, two further test pieces shall be welded, both of which must be free from cracks if the electrodes need to be qualified.

Appendix 'F'

PROCEDURE FOR STANDARD HEAVY TEE TEST

F.1.0 DESCRIPTION OF TEST

F.1.1 The standard 'Heavy Tee Test' is a restrained fillet weld test to establish whether the deposited weld metal is susceptible to 'Hot Cracking'. The test piece illustrated in Fig 7 consists of a base plate 300mm long x 125mm wide x 80mm thick of chemical composition as per specification JSG-9515:10-2010 and a vertical leg of 50.0mm thick armour steel of the same type 260mm long x 80mm high. The abutting faces of the test piece are ground so as to ensure a close fit with not more than 0.5mm gap at any point. Both plates are de-scaled in the region of weld.

F.1.2 A full 20mm tack weld is made at each end of the vertical leg with 6mm electrodes. Particular care shall be taken with both these welds, since if they should fracture during the deposition of the main restraint weld, the test is invalidated owing to the gap which appear on the side of the test weld.

F.2.0 STANDARD PROCEDURE

F.2.1 The whole test piece shall be at room temperature (15°C to 27°C) immediately prior to the deposition of the main restraining weld. The test piece shall be positioned at 45° for 'flat' welding and a 12mm fillet is deposited on one side of the vertical leg using a 10mm dia electrode at a current of 500 amps. One complete electrode shall be consumed in the 260mm run length. After an interval of one minute, during which time the slag shall be cleaned off this weld, a second run shall be deposited in the opposite direction so as to bring the size of the fillet up to 22mm, the current used being again 500 amps.

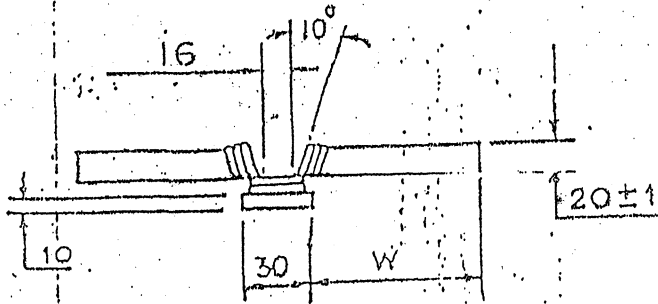
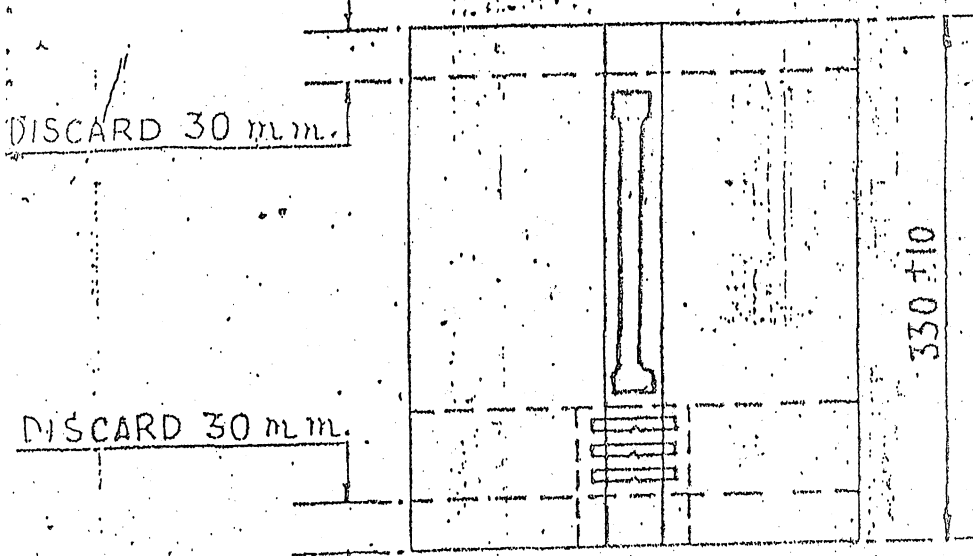
F.2.2 45 seconds interval shall then be allowed between the final breaking of the arc on this restraining weld and the commencement of the test weld. During this time, the test piece shall be turned over and positioned at 45° in the opposite direction. The test weld shall then be laid with the electrode under test under the standard condition detailed below and in the opposite direction to the final run of the main restraining weld.

F.2.3 For 10mm dia. Electrodes, the standard size of test welds is 12mm welds with 12mm leg length and for 8mm diameter electrodes, the standard size is 10mm leg length. The standard testing currents are 550 amps and 450 amps respectively, for the two electrode sizes.

F.3.0 ASSESSMENT OF RESULT

- F.3.1** Under the standard conditions specified above, a satisfactory electrode is required for welding to prepare test samples without any crack outside the crater.
- F.3.2** For approval testing, two tests shall be done and transverse section taken in each side of the centre for examination for cracks by following methods:-
a) Visual examination, and if crack free.
b) Under the microscope at magnification of not less than 50 X.
- F.3.3** If any cracks are discovered on the surface other than a crater crack or in a section of the weld metal of either test, the electrode shall be considered as having failed unless there is reason to suspect that a welding defect initiated the crack, in which case a repeat test shall be done.
- F.3.4** For check inspection testing, one test shall be done under the standard procedure with 10mm diameter electrodes. If this size is not in current production, any size above 6mm may be used. If the test is satisfactory, the large gauge electrodes of this type shall be passed. If failure should occur which is not directly attributed to faulty welding technique, two repeat tests shall be done, both of which must be free from cracks, on both the surface outside the crater and in the sections of the weld metal, for the electrode to get qualified.

FIGURES TO APPENDIX - B



DIA. OF ELECTRODE (m.m.)	W (mm)
2.5, 3.15	80
4.0	100
5.0, 6.0	120
8.0 & ABOVE	150

FIG. 1 (a): TEST ASSEMBLY FOR ALL-WELD TENSILE & IMPACT TEST

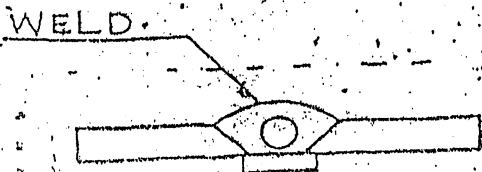


FIG. 1 (b): LOCATION OF TENSILE TEST PIECE

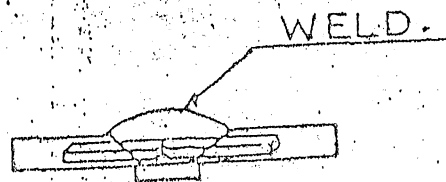


FIG. 1 (c): LOCATION OF CHARPY IMPACT TEST PIECE

FIGURES TO APPENDIX-B

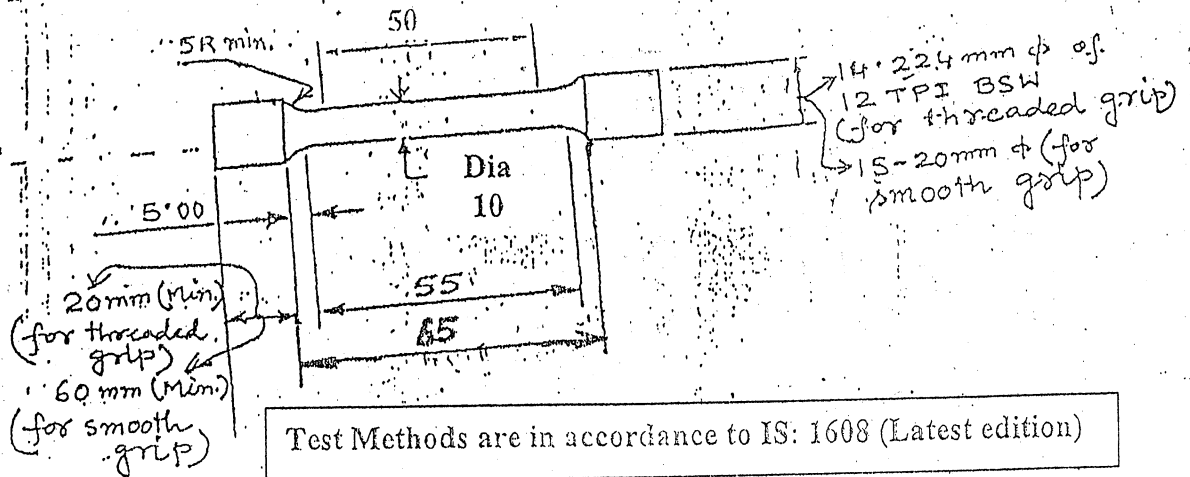


FIG. 2(a)

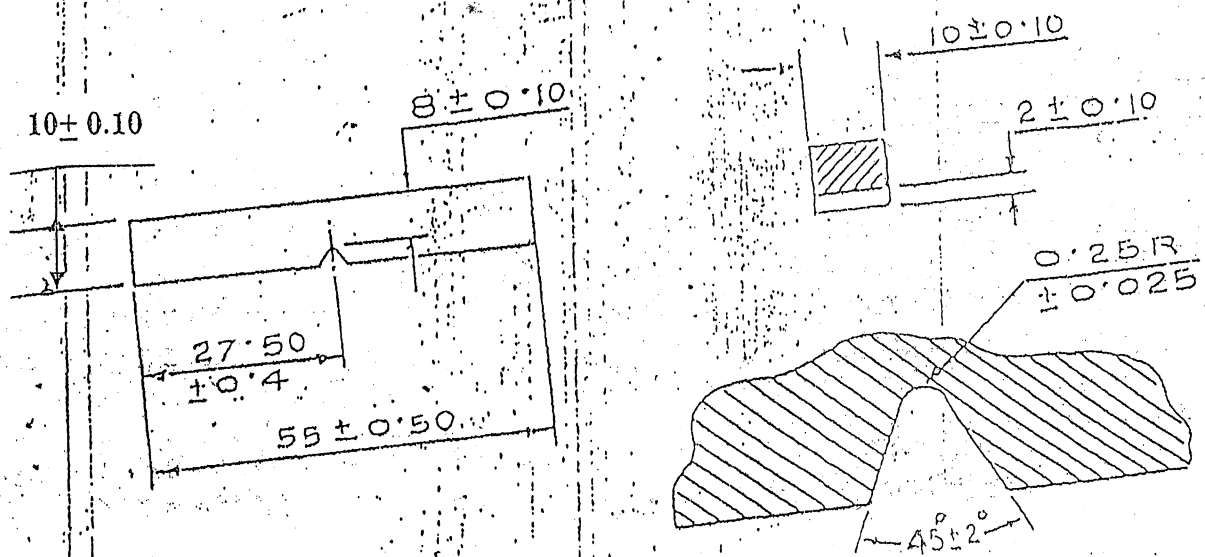


FIG. 2(b)

ALL DIMENSIONS ARE IN mm

DRG. NO. 1159/CQAM/89

FIGURES TO APPENDIX - C

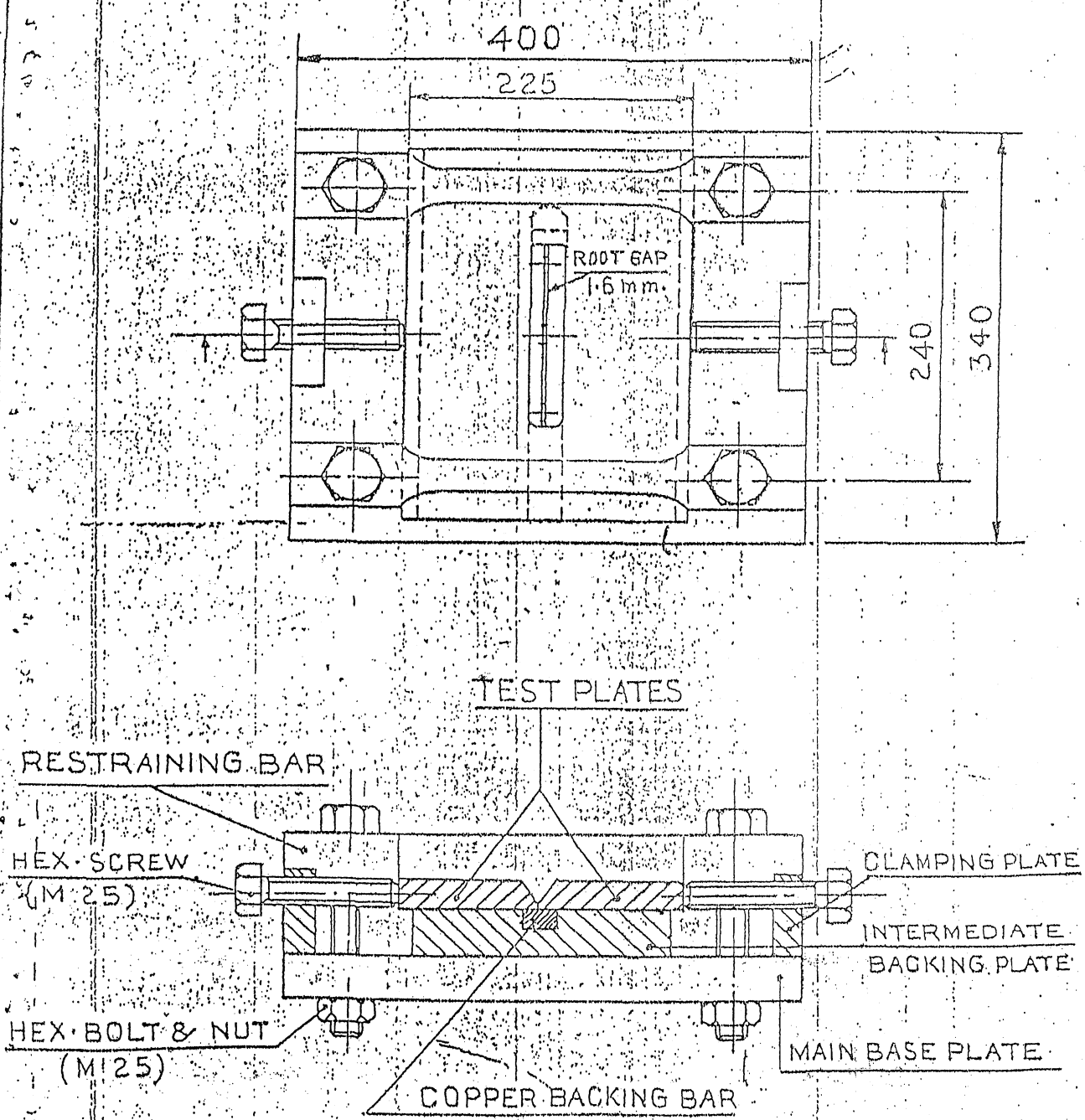


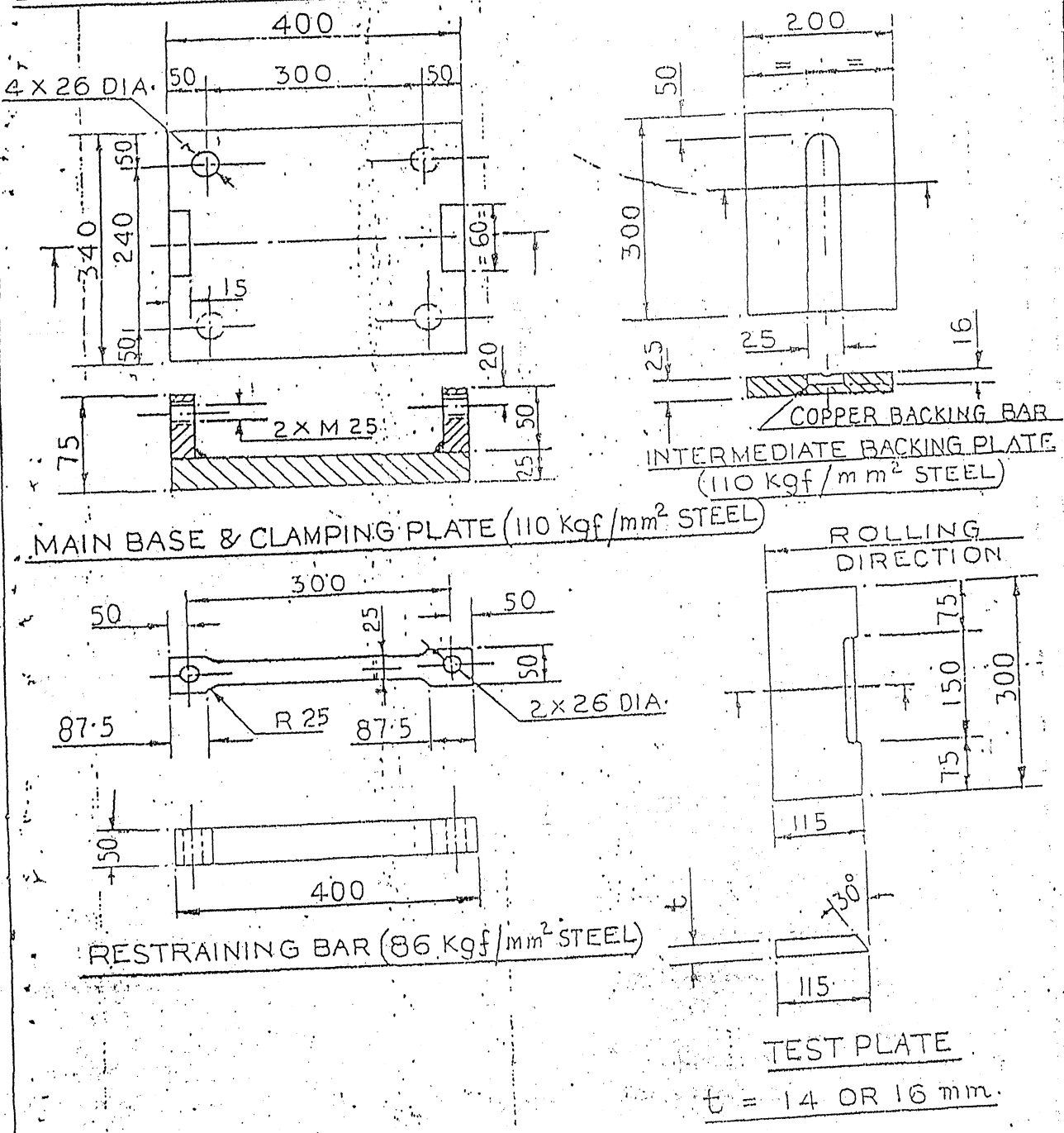
FIG. 3: R. D. BUTT JOINT TEST ASSEMBLY

DIMENSIONS ARE IN MILLIMETRES

DRAWN: - COPY	CHECKED: -
TRACED: <i>[Signature]</i>	DRG. NO. 115 CQAM/89

FIGURES TO APPENDIX - C

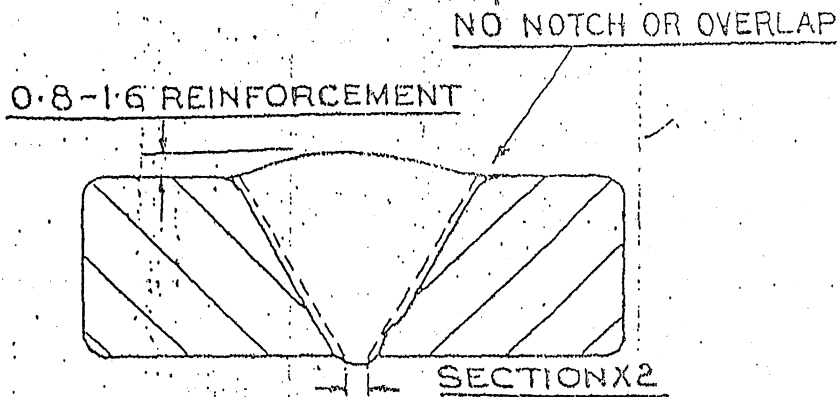
DIMENSIONAL DRAWING OF R.D. BUTT JOINT TEST ASSEMBLY



DIMENSIONS ARE IN MILLIMETRES
 FIG. 3 (a)

DRAWN:- COPY	CHECKED:-
TRACED:- <i>[Signature]</i>	DRG. NO. 1153/CQAM/89

FIGURES TO APPENDIX-C



WIDTH OF ROOT NOT APPRECIABLY INCREASED FROM ORIGINAL
1.6 GAP SHOWING IDEAL PENETRATION

FIG 4(A) TYPICAL CONTOUR OF GOOD SECTION

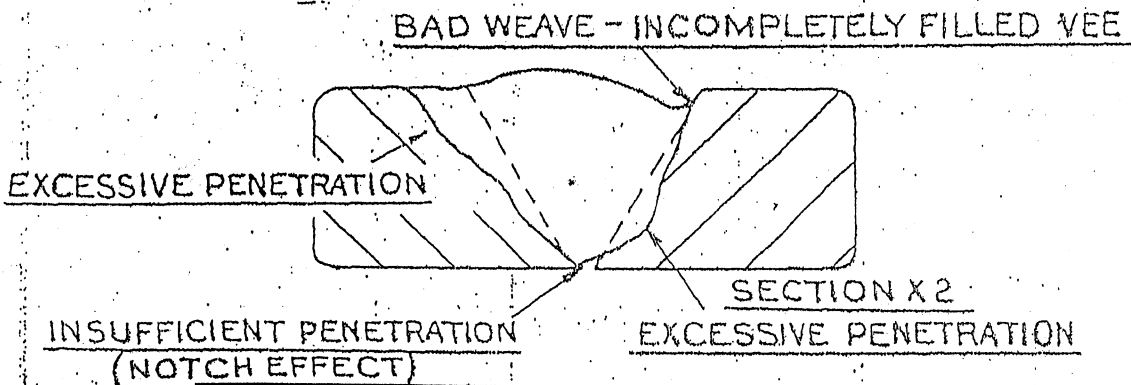


FIG 4(B) CONTOUR OF VERY POOR SECTION

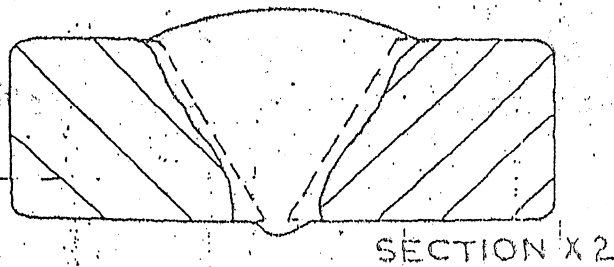


FIG 4(C) EXCESSIVE ROOT PENETRATION

FIGURES TO APPENDIX -C

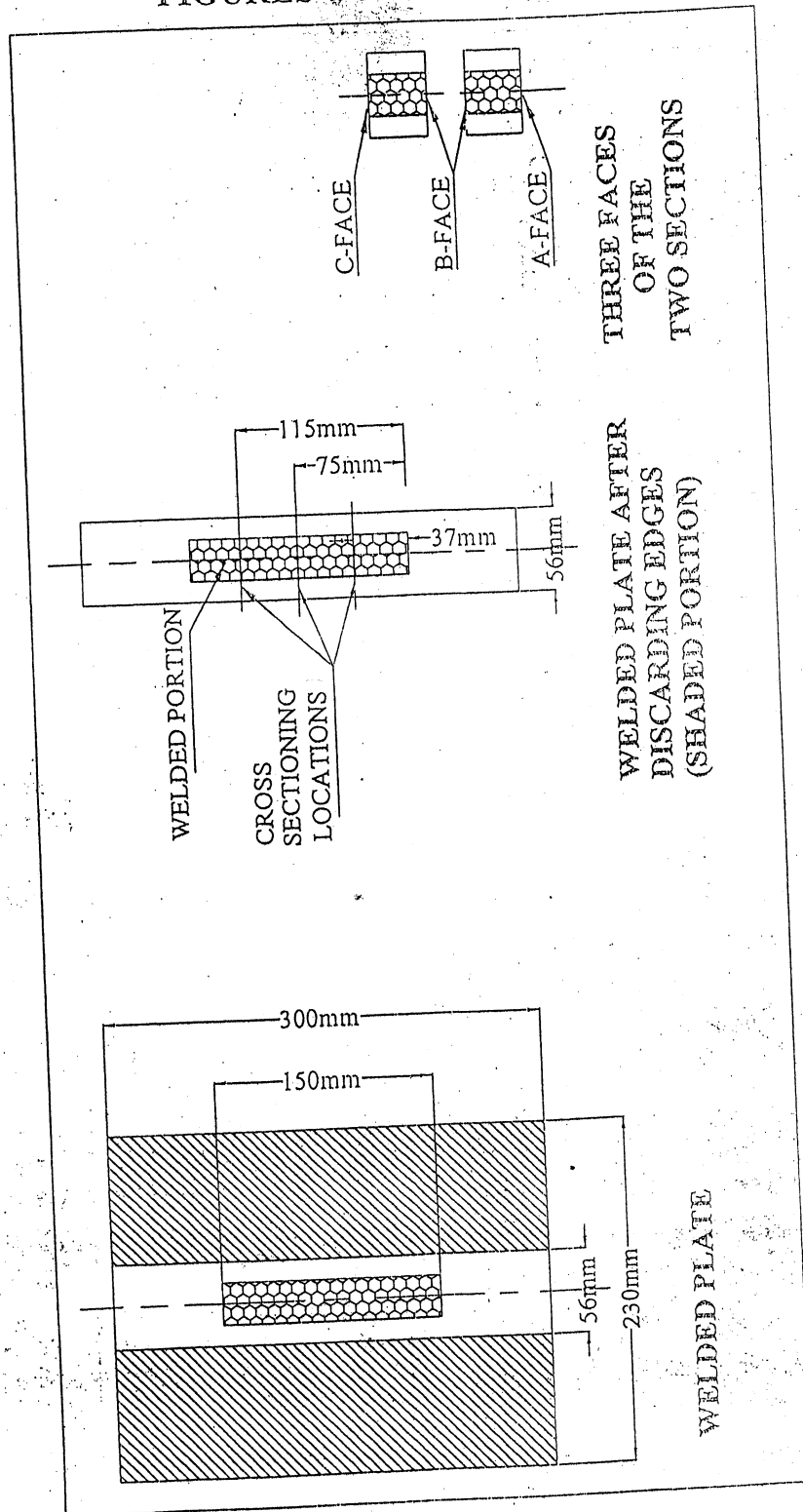
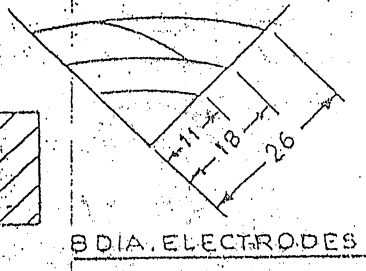
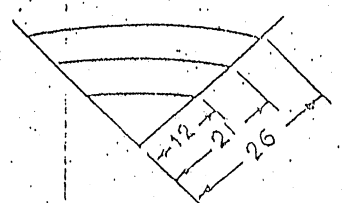
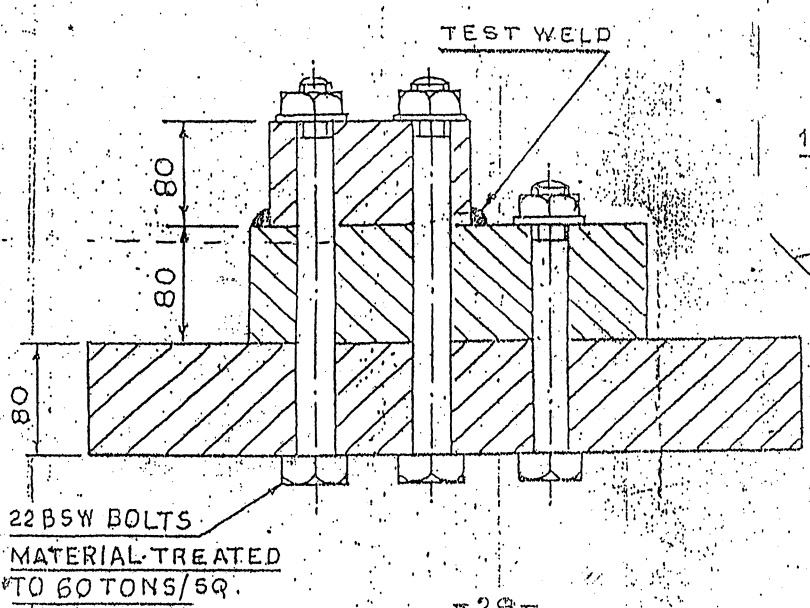
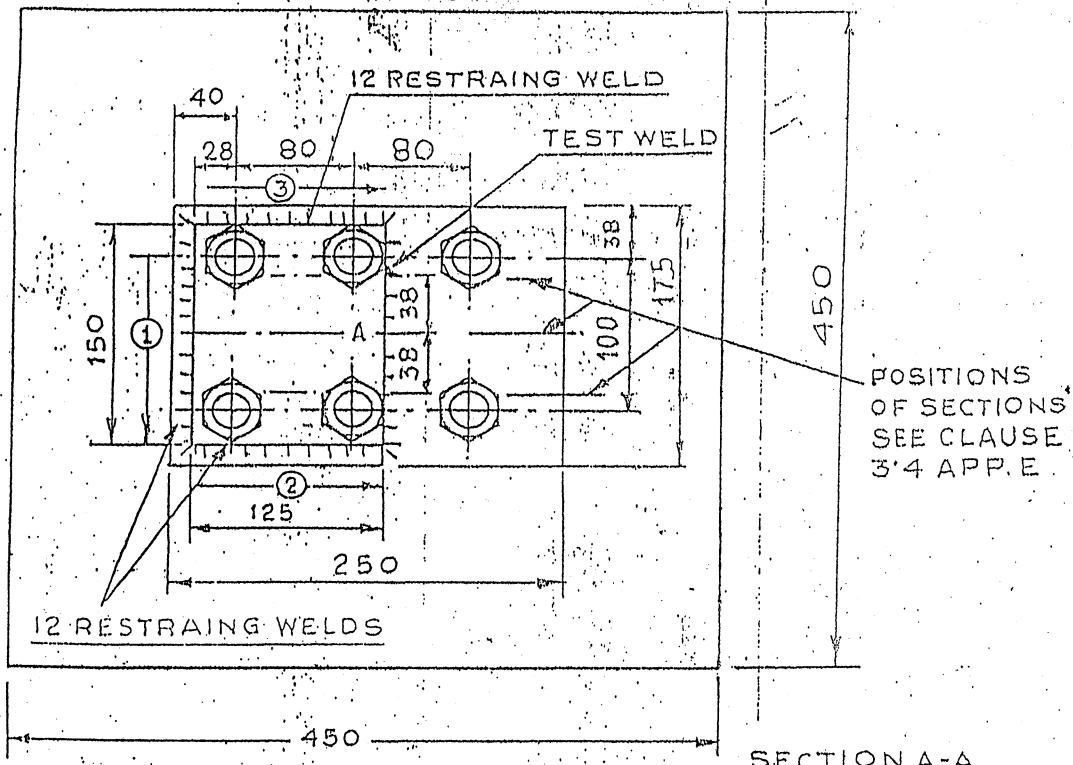


FIG- 4(D) PROCEDURE OF SECTIONING FOR MICRO-EXAMINATION

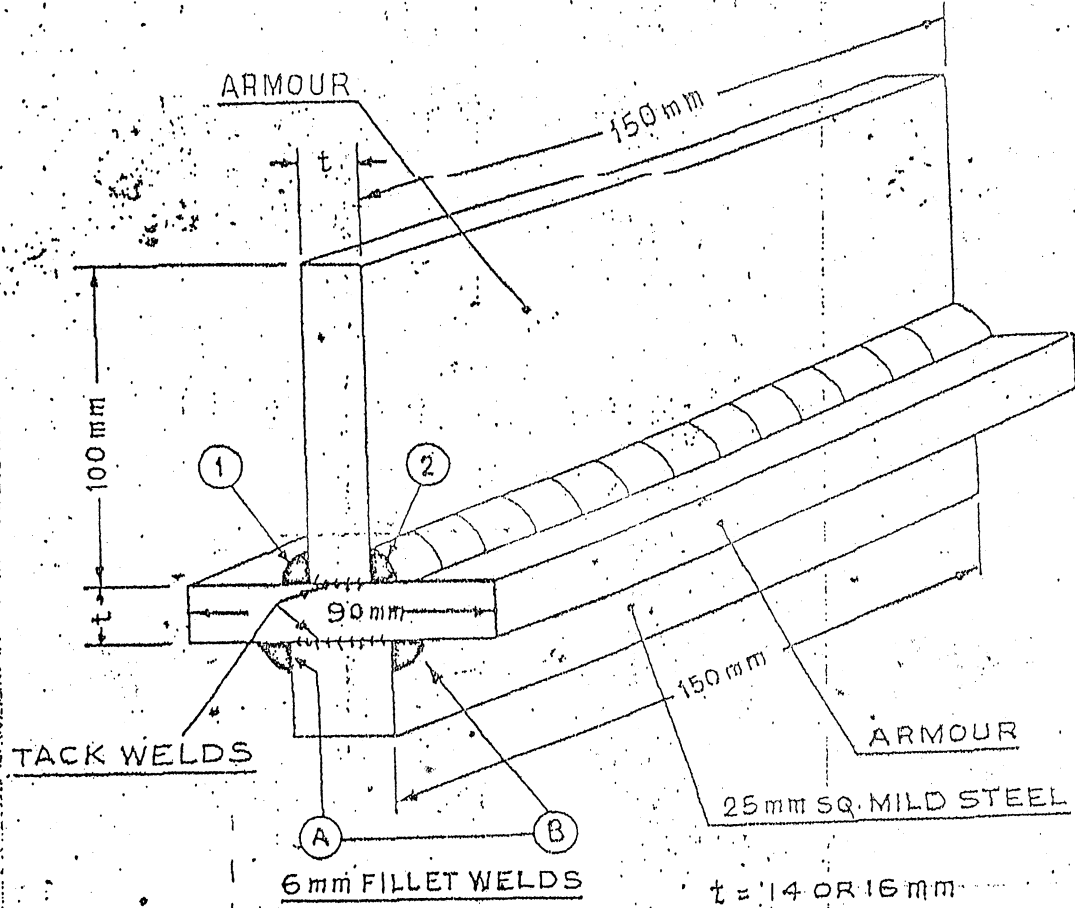
FIGURE TO APPENDIX-D



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FIG 5: REEVE FILLET WELD TEST

FIGURE TO APPENDIX - E



SIZE OF TEST FILLETS

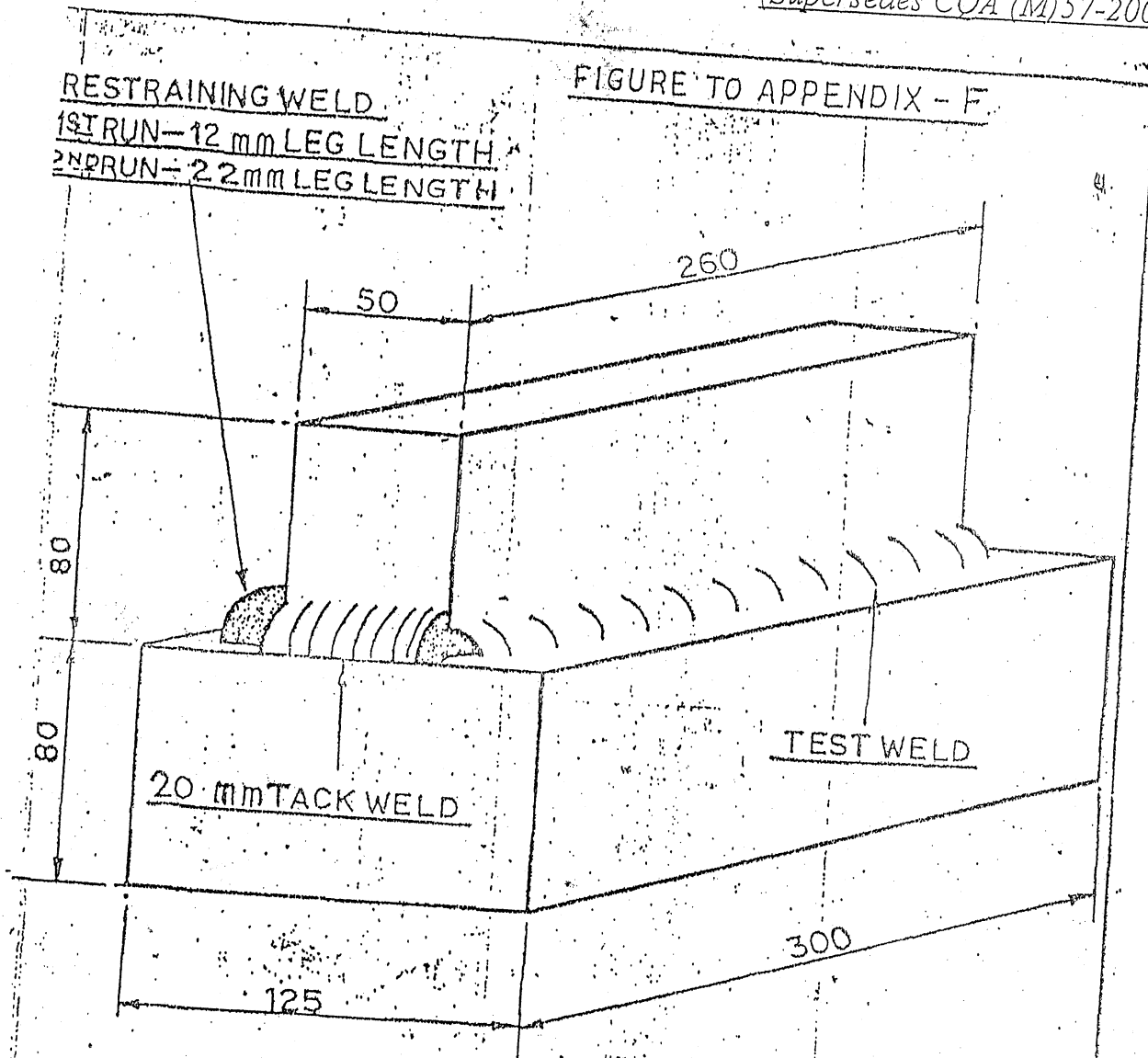
① & ②

- 5 mm ϕ ELECTRODES 8 mm TO 9 mm
- 4 mm ϕ ELECTRODES 8 mm MINUS
- 6 mm ϕ ELECTRODES 9 mm.

FIG. 6: SWINDEN TIED TEE TEST

DRG. No.
 1099/CIM/87

FIGURE TO APPENDIX - F



TEST WELD SIZE
10 mm DIA. ELECTRODES - 12 mm LEG LENGTH
8 12 17 22 27 30 35 40 45 50

FIG. 7: HEAVY TEE TEST

COMPONENTS & PLATES ASSEMBLY FOR BALLASTIC TESTING

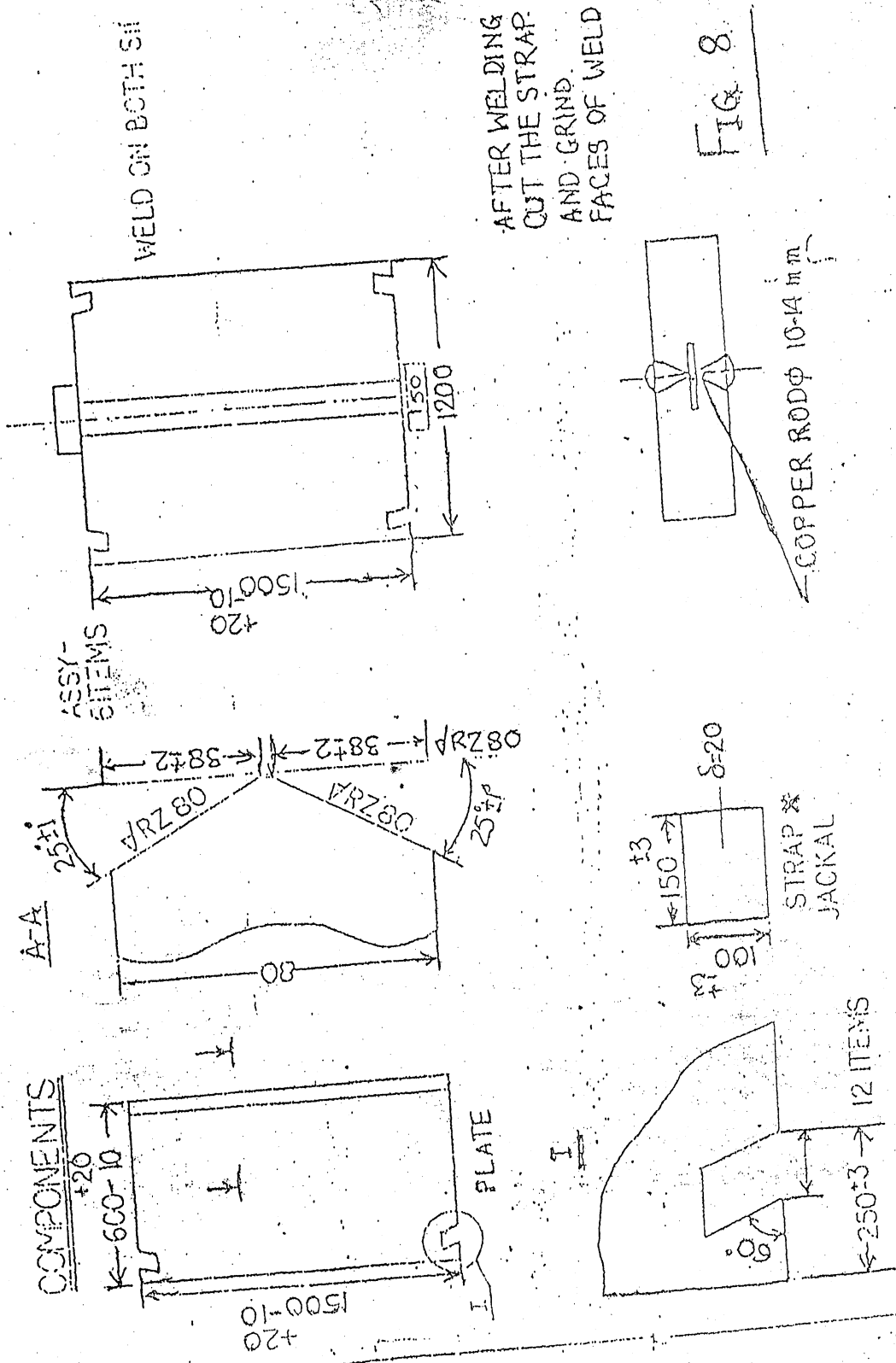


FIG. 8

FIG- 8