



**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**

**Indian Railway
Standard Specification
for
Fusion Welding of Rails
By Alumino – Thermic Process**

**Serial No. IRST-19-2012
(Incorporating up to A&C Slip No. 2 of June' 2015)**

**RESEARCH DESIGNS & STANDARDS ORGANISATION
LUCKNOW – 226011**



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INDIAN RAILWAY STANDARD SPECIFICATION FOR FUSION WELDING OF RAILS BY ALUMINO – THERMIC PROCESS

Serial No. IRS T-19-2012

FOREWORD

This specification is issued under the fixed serial No.T-19. This was originally adopted in 1961 and was revised in 1965, 1984 and 1994. Since then, number of amendments have been made in this specification on account of technological improvements in the AT welding process. Besides this, R&D work was undertaken on upgraded AT welding technology. This fourth revision includes current technological improvements in the AT Welding process and additional provisions for implementation of upgraded AT welding technology with superior weld performance on Indian Railways.

1.0 INTRODUCTION

- 1.1** The soundness of the welds produced by alumino – thermic process depends on the quality of (a) alumino-thermic mixture hereinafter referred to as the 'MIXTURE' and (b) the technical control exercised during the preparation for and the execution of the welding by this process.
- 1.2** The quantity of the 'MIXTURE' required for welding one rail joint shall be called a 'portion'.
- 1.3** A batch shall consist of a number of 'portions' manufactured from similarly and simultaneously treated raw materials.
- 1.4** 'Portions' manufactured by agencies approved by RDSO and accepted by nominated inspecting authority shall only be used.
- 1.5** Except for welds executed for laboratory evaluation and acceptance test, all welds shall be executed under the supervision of personnel possessing valid competency certificate either from RDSO or from Thermit Portion Plant, Northern Railway, Charbagh, Lucknow or Thermit Welding Centre, (TWC), South-Central Railway, Vijayawada
- 1.6** No changes in weld design, range of weld metal chemistry, its acceptance tests and the methods of welding shall be made without the consent of the approving authority. Approving Authority shall mean Director General, Research, Design & Standards Organization (Ministry of Railways), Manak Nagar, Lucknow – 226011 or his representative.
- 1.7** The numerical values may be rounded off as per IS:2.

2.0 SCOPE

2.1 This specification is for A.T. Welding of rails to IRS Specification T-12 and UIC Specification 860-0, Alloy Steel Rails, viz., Chrome Manganese and Chrome-Vanadium and Head Hardened rails.

2.2 This Indian Railway Standard covers:-

- a) Technical requirements for thermit portions and welded joints including various acceptance tests.
- b) Procedure for approval of Alumino-thermic “portion manufacturers”
- c) Procedure for approval of A.T. Welding Supervisors, Welders and contracting firms.
- d) Acceptance tests for in-situ and cess Alumino Thermic joints.
- e) Procedure for approval of alumino thermic portion manufacturers with upgraded alumino thermic welding technology.

2.3 Reference Documents: This standard refers to the following Indian Standards of the Bureau of Indian Standards. These should be available at the manufacturers works for reference.

- | | |
|----------------------|---|
| (i) IS:2 | Rules for rounding off numerical values |
| (ii) IS:187 | Cotton long cloth |
| (iii) IS:9738 | Polyethylene bags for general purposes |
| (iv) IS:2500 (Pt. I) | Sampling inspection tables:
Part I inspection by attributes and by count of defects. |
| (v) IS:1500 | Method for Brinell hardness test for metallic materials. |

PART A : TECHNICAL REQUIREMENTS FOR THERMIT PORTIONS

3.0 SUPPLY OF THE “PORTIONS”

3.1 The ‘portions’ shall be submitted for acceptance batch wise as per one of the following two provisions:

- a) A batch shall consist of 300 portions or part thereof manufacture on the same day from similarly and simultaneously treated raw materials.
- b) For the manufacturers having ISO:9000 certification, a batch may consist of 600 portions or part thereof manufactured on the same day from similarly treated raw materials and processing and mixing of all ingredients being done completely under automation by four feeder channels. (The nature and category of complete automation and process control will be certified by the inspecting authority for permitting such batch). However, if automatic working of any of the four feeder channels gets stopped, the batch size shall revert back to 300nos.

Batch numbering shall be given year-wise in six digits code, whose first two digits will indicate two digits of the year of manufacture and the balance 4 digits, the serial number of the batch. The batch number at the beginning of each year shall, therefore, commence from 0001.

3.2 Every portion shall be packed in a moisture proof bag of Polyethylene to IS:9738, “Indian Standard Specification for Polyethylene bags for general purposes” Grade HM HDPE of 150 micron thickness which should be sealed so as to make it airtight. The Polyethylene bag should then be packed in a heavy duty bag made of New cloth to IS:187. The open end of the cloth bag shall be stitched and sealed in such a manner that there is no access to the ‘portion’ without damaging the bag or breaking its seal.

3.3 Following particulars shall be indicated on two similar labels – One placed inside the Polyethylene bag containing the portion and the other outside with the seal on the bag:-

- i) Batch No.
- ii) Portion No.
- iii) Date of manufacture
- iv) The section of rail to be welded
- v) The grade of rail to be welded
- vi) Welding technique
- vii) Automatic Tapping/ Manual Tapping
- viii) Insignia of the firm
- ix) Any other information

3.4 In order to have ease in identification of portions of various rail sections & grade as well as various techniques in field by welder, the packing of portions shall be done as under :

3.4.1 52 Kg & above Rail Sections:

- (i) The portion of 52 Kg and above rail sections shall be packed in bags of different colour as per Rail Grade. The colour of bags containing portions shall be as per table below:

S. No.	Rail grade	Colour
1.	72 UTS	Red
2.	90 UTS	Green
3.	110 UTS (Chrome Manganese & Chrome – Vanadium)	Black
4.	110 UTS Head Hardened	Yellow

- (ii) The insignia of the firm and rail Section (52Kg/ 60 Kg etc.) should be printed in contrast colour on the exterior of the cloth bag of above mentioned colour so that it is clearly visible.
- (iii) Till the portions with manual tapping system are being supplied, such portions shall be marked with Bold Letter “M” on the bag in same colour as used for marking the Rail Section. The letter size indicating Rail section & Tapping System shall be of minimum 150 mm high. The marking on Bags will be done on both the faces as per following example :

52Kg (M): for 52 Kg Rail Section with Manual Tapping System

52 Kg: for 52 Kg Rail Section with Automatic Tapping system

3.4.2 Rail Sections below 52 Kg:

The portions for Rail section below 52 Kg i.e. 90R, 75R & 60R shall be packed in White bags. The Insignia, Rail section shall be marked as per the colour scheme for the rail grade given at Para 3.4.1 (i).

- 3.5** The bags containing portion shall be packed in a sturdy wooden/ Heavy duty corrugated card board /Metallic container. No container with the portion bags shall weigh more than 60 kg. Any bag of ‘portion’ found damaged at the time of delivery shall NOT be accepted.

The container should have a coloured strip of 75 mm width printed at the middle of the box as per the colour scheme given in the Para 3.4 above. The colour strip shall run at the centre of faces having lesser area & top of the container. The insignia of the firm, rail section and tapping system should also be printed on the exterior of the container on the other two faces having larger area. The rail section and tapping system (‘M’ for Manual tapping system) be printed in letters of 25 mm width (minimum) having overall 150mm height (minimum).

4.0 ACCEPTANCE TEST:

Two portion shall be randomly selected per batch and weight of each portion shall be within $\pm 0.25\%$ of the approved weight of the portion which shall be recorded by the inspector.

One portion shall be utilized for execution of test weld as per approved parameters for AT Welding technique. While executing the test joint, characteristics of the alumino-thermic reaction, i.e. whether it is quiet, normal or boiling shall be observed and if the reaction is found to be boiling, the batch shall be rejected. The reaction and tapping shall be within 20 ± 3 seconds for manual tapping. In case of A.T. welding technique with Auto tapping thimble/ One shot crucible, the reaction and tapping time shall conform to the tapping time range approved for the particular AT welding technique, as indicated in approval certificate and QAP of Firm. Following tests shall be conducted for assessing the quality of portion :

- i) Ultrasonic test on test weld as per Annexure-1.
- ii) Checking of weld metal dimensions of test weld with approved weld metal dimensions of that particular AT Welding technique.
- iii) Mechanical and metallurgical test as per Para 4.2.
- iv) Weld metal chemistry test as per Para 4.1.

4.1 Weld Metal Chemistry Test:

Full chemical analysis is to be conducted on the rail weld running surface at 10mm away from the weld transverse axis. The chemical composition of the steel so determined shall conform to the following:

Grade of rail	C%	Mn%	+Si% (Max)	S% (Max)	P% (Max)	V%*	Mo%*	Al% (Max)	Cr% (Max)	Cu %	Ni%
90 UTS / Head Hardened rail	0.5 - 0.7	0.80-1.30	0.5	0.05	0.05	0.10 - 0.15	0.10 - 0.25	0.05 - 0.60#	0.2	--	--
72 UTS	0.4 - 0.55	0.80-1.20	0.5	0.05	0.05	0.10 - 0.15	0.10 - 0.25	0.05 - 0.60#	0.2	--	--
110 UTS	0.6 - 0.8	0.80-1.20	0.5-1.10	0.025	0.025	0.2 (max)	0.2 (max)	0.05 (max)	0.8-1.2	--	--
90UTS/ NCC rail	0.6 - 0.8	0.80-1.30	0.1-0.5	0.04	0.05	--	0.25 (max)	0.02-0.60	0.50-0.65	0.3-0.4	0.25-0.40
90UTS/ Cu-Mo rail	0.6 - 0.8	0.80-1.30	0.1-0.5	0.04	0.05	--	0.20-0.30	0.02-0.60	--	0.25-0.35	--

* Either Vanadium or Molybdenum may be used as grain refiner.

For plants having automated portion manufacturing and weighing facilities for all ingredients including alloying elements, Al% range may be taken as 0.02%-0.60%, with RDSO's approval.

+ In case single shot crucible is used, the maximum limit of Si% may be taken as 1.2.

4.2 Mechanical and Metallurgical tests on test welds

4.2.1 Two new rail pieces of same section and grade, each approximately 750mm long, shall be used to make test weld joint. The welded joint shall be made as per the technique offered by the manufacturer. The rail table and sides of rail head shall be finished to the geometrical tolerances specified in Clause 18.1.

4.2.2 Hardness test

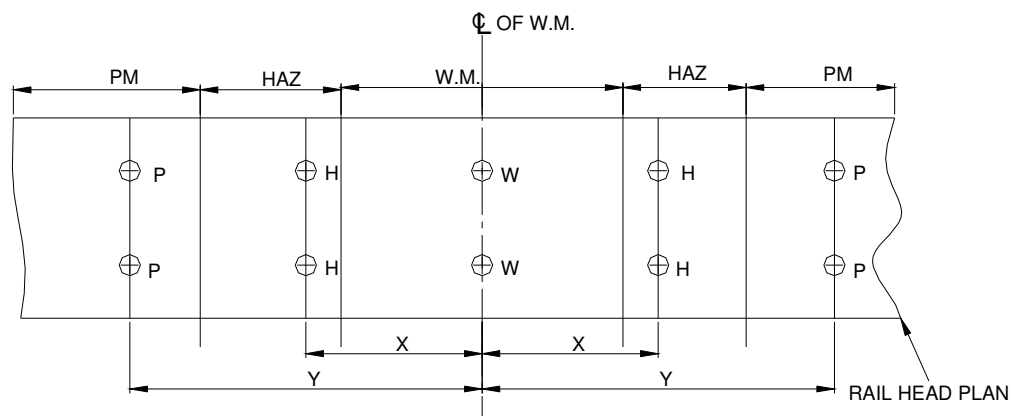
Brinell hardness test shall be carried out at the welded zone, heat affected zones and parent metal of the rails in accordance with IS:1500, " Method for Brinell Hardness test for steel". The test shall be done on the top surface of the head of the test weld with a ball of 10 mm dia and a test load of 3000 kg maintained for 10 secs.

The average hardness values of different rail chemistry is given in Table 1A for reference –

Table - 1A

Type of rail	72 UTS rail	90 UTS rail	UIC Cr-Mn or Cr-V alloy steel rail	Head Hardened rail
Average Hardness(BHN)	229	265	311	341

Fig.1



The average hardness number (of two readings) determined for the weld metal (WM), heat affected zone (HAZ) and parent metal (PM) at location shown as 'W' 'H' & 'P' respectively in fig. 1 shall be as per table – 1B given below :

Note:

- (i) For 25mm gap SKV welding & for any preheating device used.
(Air-petrol/ Compressed Air Petrol/ Oxy-LPG)
X = 40 mm
Y = 100 mm
- (ii) For 50mm gap combination joint welding & for any preheating device used.
X = 60 mm
Y = 120 mm
- (iii) For 75 mm wide gap welding & for any preheating device used
X = 80 mm
Y = 150 mm

Table 1B

S.No.	Rail Section/Chemistry	Hardness BHN	
		Weld Metal (W)	Heat affected zone(H)
1.	72 UTS rail of all sections with normal & wide gap	229 + 20 - 0	± 20 of actual parent metal hardness (location 'P')
2.	90 UTS rail of all sections with normal & wide gap	265+ 30 - 0	„
3.	52 kg (90 UTS) Vs 90R (72 UTS) combination joint with 50mm gap	265+ 30 - 0	„
4.	60 kg (90 UTS) Vs 52kg (90 UTS) combination joints with 50mm gap	265+ 30 - 0	„
5.	60kg H.H. rail	321 (min.)	Not less than [actual parent metal hardness (Location 'P') – 100] BHN
6.	UIC Cr-Mn or Cr-V alloy steel rail	311 + 20 - 0	± 20 of actual parent metal hardness (location 'P')
7.	60Kg/ 110 UTS	320 + 20 - 0	± 20 of actual parent metal hardness (location 'P')
8.	60Kg/ 90UTS/ NCC rail	265 +30 - 0	± 20 of actual parent metal hardness (location 'P')
9.	60Kg/ 90UTS/ Cu-Mo rail	265 +30 - 0	± 20 of actual parent metal hardness (location 'P')

4.2.3 Transverse breaking load test

4.2.3.1 The test weld shall be supported on cylindrical or semi cylindrical supports having a distance of one meter between them from centre to centre. The weld shall be at the centre of the span and loaded in such manner that the foot of the rail is in tension. The diameter of mandrel and the supports shall be between 30 to 50mm. The load shall be gradually increased (rate of loading shall not exceed 2.5 t/sec) till rupture occurs. The test weld shall withstand minimum transverse breaking load as indicated in column 4 of Table-2. The deflection at centre at the actual transverse breaking load shall not be less than that specified in column 5 of **Table-2**.

TABLE – 2

S. No.	Rail type	Rail Section	Min. transverse breaking load in tones	Min. deflection in mm at the centre at the actual transverse breaking load
1.	2.	3.	4.	5.
A.	72 UTS to IRS T-12 for normal gap welding & wide gap (75 mm) welding	60R	50	15
		75R	55	15
		90R	65	15
		52Kg	85	18
		60 Kg	95	18
B.	90 UTS to IRS T-12/UIC 860-0 or equivalent for normal & wide gap(75mm) welding	75R	60	15
		90R	80	15
		52kg	90	15
		60 kg	115	15
C.	110 UTS rail to IRST-12 for normal & wide gap (75mm) welding	52kg	95	10
		60kg	120	10
D.	Combination joint (50mm gap)	*52kg (90 UTS)/ 90R (72 UTS)	70	15
		60kg (90 UTS)/ 52kg (90 UTS)	90	15
E.	Head Hardened Rails to IRS T12 for normal gap welding	60kg	115	12
F.	90UTS/ NCC rail to IRST-12 for normal & wide gap (75mm) welding	60Kg	115	15
G.	90UTS/ Cu-Mo rail to IRST-12 for normal & wide gap (75mm) welding	60 Kg	115	15

* 90 UTS portion should be used in 52kg /90 R combination joints.

4.2.3.2 If the fracture does not occur through weld, a slice shall be cut transversely at the weld and etched in boiling 1:1 Hydrochloric acid for about 20 minutes to determine casting defects if any.

4.2.3.3 The fractured surface of the weld, or in case where macro - etching is done on transverse section through the joint, shall not show defects such as blow holes, porosity and inclusions etc. having individual size greater than 2mm dia. There shall not be more than three defects of size ≤ 2 mm dia. The distance between two defects of size ≤ 2 mm dia. shall not be less than 20mm. The macro - etched transverse section shall not show cracks of length 2mm or greater. The defects should not be interconnected and none of these shall extend upto the outer surface of the weld. There shall not be any lack of fusion and clustered porosities. The fractured surface shall also not show the presence of accretions or mirror like surface and shall be crystalline in appearance.

For A.T. welds of 110UTS rails, 90UTS/NCC rails, 90UTS/Cu-Mo rails, fractured surface or in case where macro etching is done on transverse section through the joint, shall not show defects such as blow holes, porosity and inclusions etc.

4.3 Rejection of Batch

If the results of any of the tests referred to in clause 4.1 and 4.2 are found to be unsatisfactory, the batch will stand rejected.

5.0 DISPOSAL OF REJECTED BATCH:

In the event of a batch failing to comply with the requirement of Para 4, the manufacturer will dispose off the rejected portions by igniting off the portions and converting them into metallic form at a safe place in presence of RDSO officials. The rejected batch shall be kept separately duly marked "Rejected" on each pack in red. Proper record of disposal shall be maintained.

Any other process proposed to be adopted by the firm for disposal of the rejected batch, shall have prior approval of RDSO.

6.0 ACCEPTANCE

6.1 Acceptance shall be done batch wise. Every individual batch that satisfies the conditions prescribed in this specification shall be accepted. Each bag containing the portion shall be sealed by the manufacturer and the container shall be suitably stamped/sealed by the Inspecting Officer. The stamp/seal shall be such that it shall not be possible to open the container without breaking stamp/seal.

6.2 The manufacturer shall dispatch the accepted portions immediately to the consignee so as to reach consignee within 30 days from the date of issue of inspection certificate.

7.0 DISPOSAL OF REJECTED PORTIONS

In case the batch fails to meet the requirements of clause 4, it shall be rejected. The rejected portions shall be separately stored and a proper accountal shall be kept. The disposal of these rejected portions shall be advised to the Inspecting agency.

8.0 TESTING FACILITIES

The manufacturer shall, at his own expense, supply all labour, materials, consumables, rail pieces and appliances for testing, both for initial tests and retests as may be carried out in presence of the Inspecting Officer, in his own premises or at any other acceptable place in accordance with this specification.

9.0 INSPECTION OF PREMISES AND RECORDS

The purchaser or the Inspecting Officer shall have free access to the premises of the manufacturer at all reasonable times. They shall be at liberty to inspect all the records and the manufacture of 'portions' at any stage.

PART B: APPROVAL OF “PORTIONS MANUFACTURERS”

10.0 The approval of ‘Portion manufacturer’ shall be given separately for each rail section/grade/chemistry of rail and for each technique of welding.

10.1 The variants for various parameters of A.T. welding technique are given below. Permitted combination of following variants shall be treated as a welding technique.

S.No	Parameter	Variants		
1.	Rail section/ grade/ chemistry	Rail section/ grade/chemistry chosen shall be as per their respective latest version of IRST-12.		
2.	Parameters forming Technique of welding	Pre-heating system	Air-petrol (Manual pressurization) @	Compressed Air petrol/ Compressed Air LPG (Mechanical pressurization) or similar
3.		Pre-fabricated mould	2 piece mould @	3 piece mould
4.			Manually pressed	Core shooted
5.		Tapping system	Manual tapping @	Auto tapping
5.	Parameters forming Technique of welding	Crucible system	Multiple use	Single shot #

@ To be considered for rail sections lower than 52 Kg with grades lower than 90UTS only.

Single shot crucible shall be considered only with pre-fitted Auto tapping thimble.

10.2 For upgraded A.T. welding techniques offered in reference to clause 22 Part E of IRST-19 specification, approval shall be given to AT welding technique for each rail section/grade/chemistry separately irrespective of the other variants chosen.

11.0 For the purpose of approval, the following definitions shall apply.

11.1 “Portion Manufacturer” shall mean the organization manufacturing the ‘portion’. In addition, the “Portion Manufacturer” may execute A.T. Welding of rail joints by his technique.

11.2 “Approving Authority” shall be Director General, Research Designs & Standards Organization, Ministry of Railways, Manak Nagar, Lucknow – 226011 or his representative.

12.0 PROCEDURE FOR APPROVAL OF “PORTION MANUFACTURERS”

- 12.1** The application for approval shall be submitted by the “Portion Manufacturer” to the Approving Authority, indicating the rail for which portion is being offered and the welding technique.
- 12.2** The application for approval shall be submitted by the firm as per procedure given in “General guidelines for vendor approval” (latest version) issued by Track Design Directorate.
- 12.3** The payments shall be made by means specified in “General guidelines for vendor approval” (latest version) issued by Track Design Directorate.
- 12.4** If the information submitted by the applicant is prima facie found to be satisfactory, the approving authority shall inspect the premises of the applicant for assessment. If the assessment is satisfactory, firm shall offer the AT welding technique for evaluation along with internal test results of AT welding technique offered in prescribed proforma. Lab evaluation will be carried out after internal test results are found satisfactory on scrutiny.

12.5 Tests and trials for approval of “Portion Manufacturers”

12.5.1 The Portion Manufacturer shall manufacture a batch of 150 ‘portions’ at his own cost. Samples shall be drawn at random by the Approving Authority and their weight be recorded. The weight of the portions shall be within $\pm 0.25\%$ of the average weight. Following laboratory tests shall be carried out at the manufacturer’s work premises or at a laboratory mutually agreed upon between the manufacturer and the approving authority.

- i) Weld metal chemistry test shall be conducted on six randomly selected test joints as per clause 4.1.
- ii) Twelve tests weld joints shall be made as per clause 4.2.1. While executing the test joints, characteristics of the aluminothermic reaction, i.e. whether it is quiet, normal or boiling shall be observed and if the reaction is found to be boiling, the technique shall be rejected. The reaction and tapping shall be within 20 ± 3 seconds for manual tapping.

The reaction and tapping time for A.T. welding technique with Auto tapping thimble/ one shot crucible, shall conform to the tapping time range indicated in respective QAP.

The joints shall be subjected to following tests:

- a) Ultrasonic test on all the joints as per procedure laid down at **Annexure-1**.
- b) Brinell Hardness test on all the joints as per clause 4.2.2.

- c) Transverse load and deflection test as per clause 4.2.3 on six randomly selected joints.
- d) Macro examination shall be undertaken on deep etched longitudinal section across the weld on the remaining six joints. This examination shall not reveal any lack of fusion or cracks. The Macro examination shall not show defects such as blow holes, porosity and inclusions etc. having individual size greater than 2mm dia. There shall not be more than three defects of size $\leq 2\text{mm}$ dia. The distance between two defects of size $\leq 2\text{mm}$ dia. shall not be less than 20mm. The macro - etched transverse section shall not show cracks of length 2mm or greater. The defects should not be interconnected and none of these shall extend upto the outer surface of the weld. There shall not be any lack of fusion and clustered porosities.

For AT welds of 110UTS rails, 90UTS/NCC rails, 90UTS/Cu-Mo rails, macro examination on deep etched longitudinal section across the weld shall be carried out on the remaining six joints. This examination shall not reveal any lack of fusion, cracks and clustering of defects, irrespective of any sizes at any place.

For confirming any defect found in macro examination, magnetic crack detection test should also be carried out.

- e) **Microscopic examination:** Samples for microscopic examination shall be taken and prepared in accordance with **Annexure-2**. The structure of the fusion zone shall conform with that defined by the supplier, which shall not contain martensite or bainite examined at x 100 magnification. The visible heat affected zone shall not contain any bainite or martensite examined at x 100 magnification. The structure shall be recorded.
- f) For AT welds of 110UTS rails, 90UTS/NCC rails, 90UTS/Cu-Mo rails, samples of microscopic examination shall be taken and prepared in accordance with **Annexure –2** of this specification. The structure of the fusion zone shall conform with that defined by the supplier which shall not contain martensite examined at x 100 magnification. The visible heat affected zone shall not contain any martensite examined at x 100 magnification. The structure shall be recorded. ASTM grain size number shall not be less than 3.

12.5.2 Rejection of A.T. Welding Technique

If the results of any of the tests referred to in clause 12.5.1 fail to meet the requirements of the test, the technique shall be rejected. The technique can be reoffered by the firm as per provisions of 'General guidelines for vendor approval' (latest version) issued by Track Design Directorate.

- 12.6** The approving authority shall have free access to the premises of the portion manufacturer at all reasonable times. The portion manufacturer shall furnish all the technical data to the approving authority as and when call for.

13.0 FATIGUE TEST

13.1 Fatigue testing of thermit welding technique shall be arranged by the manufacturer at his own expense. Following principle shall be followed:-

- i) For 90UTS metallurgy – Anyone section out of 52kg/60kg (when both the sections have been developed the lighter section should be selected for fatigue testing).
- ii) For 72 UTS metallurgy – Anyone section out of 90R/52kg (when both the section have been developed the lighter section should be selected for fatigue testing).
- iii) Development of any other A.T. Welding technology such as wider gap, gas heating, Chrome Manganese/Head Hardened rails shall also be got separately fatigue tested before standardisation. However, one section for one technique shall be required to be fatigue tested.

13.2 The weld samples shall be tested in a recognised laboratory/test centre for which prior approval of RDSO shall be necessary.

13.3 Following scheme shall be followed for fatigue testing of thermit welded rail joints:-

- i) Three weld samples shall be made in presence of RDSO representatives.
- ii) The weld samples shall be made with one meter long new rail pieces to have an overall length of 2.0m. The rail and joint shall be ultrasonically tested.
- iii) Testing shall be done for stress ranges of tensile 20 kg/mm^2 to compressive 4 kg/mm^2 (these are the stresses on the bottom surface of rail foot). The test frequency shall be any one frequency between 8.33 Hz to 12 Hz.
- iv) A joint shall be deemed to have passed if it withstands a minimum of 2 million cycles.
- v) The technique shall be deemed to have cleared fatigue test if all the three samples pass the above test.

13.4 Rejection of A.T. Welding Technique :

If the results of Fatigue test referred to in clause 13.3 fail to meet the requirements of the fatigue test, the technique shall be rejected. The technique can be reoffered by the firm as per provisions of 'General guidelines for vendor approval' (latest version) issued by Track Design Directorate.

14.0 FIELD TRIALS

- 14.1** Subject to the results of the tests in clause 12 and 13 being satisfactory, service trials for a period of one year or till passage of 10 GMT traffic over the joint, whichever is earlier, shall be undertaken on 50 to 100 trial joints welded using the above batch of portion. For the purpose of field trials, an order shall be placed by the nominated Zonal Railway on the manufacturer for supply of portions as well as welding of trial joints. The trial joints shall be distinctly marked by painting letter “T” on the web of the rail beyond 300mm from the joints. During execution of trial welding at site, spoilt joints, if any, shall be cut and re-welded by the contractor at his own expense.
- 14.2** All the trial joints shall be ultrasonically tested soon after welding as per procedure at Annexure –1. Upto a maximum of 2 % defective welds shall be cut and re-welded by the manufacturer at his own expense. If more than 2 % joints are found defective, the trial shall be discontinued considering the technique to be unsatisfactory. All the defective joints shall be removed from track by the manufacturer at his own expense.
- 14.3** Failure of more than 2% joints during service trial will render the technique unacceptable.

15.0 REQUIREMENTS FOR UPGRADATION TO APPROVED A.T. WELDING TECHNIQUES

- 15.1** Up gradation to pre-heating system, tapping system, pre-fabricated mould and crucible system in **already approved A.T. welding techniques**, shall require assessment as described hereinafter. The basic technique and upgrades are defined in Table 4 below:

Table 4

S.No.	Parameters	Basic technique	Offered upgrade to basic technique	Remarks
1	Pre-heating system	Air petrol mixture with manual pressurisation	Compressed Air-petrol (mechanised pressurization), Oxy LPG, Oxy Propane or similar/superior	i) One or more upgrades can be offered simultaneously. ii) There shall be no change in weld metal dimensions in up-graded technique over approved limits for basic technique.
2	Tapping of molten metal	Manual tapping	Automatic tapping	
3	Type of Pre-fabricated mould	Two piece manufactured by manual pressing	Three piece manufactured by manual pressing, Three piece manufactured by core shoot technology (Machine pressing)	
4	Crucible system	Multiple use crucible	Single shot crucible	

15.1.1 Three piece mould shall be manufactured as per the “Specification of 3-Piece Pre-Fabricated Mould Manufactured by A.T. Portion Manufacturers for use during A.T. Welding of Rails” given at **Annexure -3**.

15.2 For approval of process up-gradation, the requirements of lab test (as per para 12.5), and fatigue test (as per para 13) shall be fulfilled for each rail section/grade separately.

15.3 The execution and evaluation of field trial joints as per para 14 shall be undertaken post approval i.e. after the approval has been granted to the up-graded technique based on evaluation as per para 15.2 above. The approval shall be reviewed on fulfillment of GMT/Duration criteria for trial joints as prescribed in para 14.1 and continuation of the approval shall be subject to the performance of trial joints being found satisfactory as per para 14.2 & 14.3.

16.0 PART C: PROCEDURE FOR APPROVAL OF A.T. WELDING SUPERVISORS AND WELDERS

16.1 For the purpose of approval, the following definitions shall apply:-

“Welding Supervisor” shall mean an individual engaged with portion manufacturer with adequate knowledge and competence for supervising and executing Alumino Thermic welding of rail joints.

“Welder” shall mean an individual with adequate skill and competence for executing Alumino Thermic welding of rail joints at site.

The approval of welding supervisors/welders for execution of Alumino – Thermic welds at site shall be given separately for the following categories of welding techniques:-

- a) Welding of 72 UTS and 90 UTS rails with standard gap.
- b) Wide gap welding.
- c) Welding of 110 UTS and Head Hardened rails.

16.2 Competency certificates for welding supervisors and welders of the zonal Railways shall be issued by the Thermit Portion Plant of Northern Railway at Lucknow or Thermit Welding Centre, (TWC), South-Central Railway at Vijayawada. Competency certificates for welding supervisors and welders of firms shall be issued by DG (M&C) RDSO, Lucknow.

16.3 Test weld joints will be made using any rail section at the discretion of the approving authority. Welding supervisors/welders found competent shall be deemed to be fit for A.T. welding of all rail sections for the particular category as per clause 16.1. For execution of test weld joints, the welding supervisor/welder desirous of obtaining approval shall have to utilise his own welding team, rails, implements and ‘portions’ procured from approved manufacturers.

16.4 The firm shall pay, in advance, charges for certification of supervisors/welders as per rates decided by RDSO for this purpose. Payment should be made through demand draft drawn in favour of Executive Director (Finance), RDSO, Manak Nagar, Lucknow – 226011.

16.5 Six test welds shall be made by the welding supervisor/welder and his team for the particular category of welding technique (as per clause 16.1) for which approval is sought. Following tests shall be carried out at the sponsoring firm’s works premises or at RDSO, Lucknow:-

- a) Ultrasonic testing as per procedure mentioned at **Annexure-1**. Failure of more than one test weld will disqualify the welding supervisor/welder.
- b) The ultrasonically sound joints will be subjected to following tests:-
 - i) Brinell hardness test on all the test welds as per clause 4.2.2.
 - ii) Transverse load and deflection tests on any three test welds as per clause 4.2.3.
 - iii) Magnetic crack detection and macro examination of remaining three test welds longitudinally sectioned across the weld as per clause 12.5.1 (ii) (d).
 - iv) Visual examination and joint geometry as per clause 18.1 and 18.2 respectively.

16.6 If the test results are satisfactory, a provisional competency certificate, valid for two years, shall be issued to the welding supervisor/welder on behalf of the sponsoring firm. The provisionally approved welding supervisor/welder's competency shall be re-assessed by RDSO/TPP, Lucknow/TWC, Vijayawada after two years of issue of competency certificate valid for five years.

16.6.1 For the purpose of reassessment, the welding supervisor/welder shall submit, to the approving authority, the following details duly countersigned by the concerned Assistant Engineer of Zonal Railway: -

- a) A record of joints welded/supervised by him.
- b) No. of joints failed in service.

16.6.2 Based on the above details and personal interview, the approving authority will issue competency certificate. Fresh competency certificate will have to be issued whenever there is a change in the process of welding or when a person who has been earlier trained and issued with a final competency certificate has not been executing welding for a period of more than 2 years or the work done by him has been rated as unsatisfactory.

16.6.3 Renewal of competency certificate will be made based on performance or actual testing.

16.6.4 Following methodology shall be used for issuing the Identification Code Number for welders /supervisors of Railway or firm:

- a) Certificate number for welder/supervisors of Zonal Railway

The format for the certificate number of the welder/supervisor of the Zonal Railway shall be as follows:

A	A	B	B	B	C	C	C
---	---	---	---	---	---	---	---

- b) Certificate number for welders/supervisors of portion manufacturers and welding contractors.

The format for the certificate number of the welders/supervisors of the portion manufacturers and welding contractors shall be as follows:

A	A	B	B	B	C
---	---	---	---	---	---

where,

A	A
---	---

Code number for the agency to which the welder/supervisor belongs i.e.

00 for AT portion manufacturing firms

01 for departmental welders

02-99 for welders of welding contractors. The codes shall be allotted for different contractual agencies undertaking AT welding of rails (other than portion manufacturers)

B	B	B
---	---	---

Specific person number (from 001 to 999) The specific person number will be continuous for a Zonal Railway/Firm.

- c) For para 16.6.4 (a) i.e. for welders/supervisors of Zonal Railways: First two/three initials of the Railway to which the supervisor or welder belongs.

or

For para 16.6.4 (b) i.e. for welders/supervisors of portion manufacturing firms and welding contractors: Code allotted for the portion manufacturing firms, for whom welders/ supervisors of portion manufacturing firms and welding contractors are approved.

Alphabetic codes allotted to the portion manufacturing firms are given below:

ITC =T, **HTI**=H, **OTPL**=O, **SIRIL**=S, **RMPL**=R, **IEA**=F, TPP(**NR**)=N

In case of welders belonging to the welding contractors, this code will signify the portion manufacturing firm for which the competency certificate of welder is valid.

For example, 01001ECo would indicate a departmental welder/supervisor of East Coast Railway with specific person number 001. Similarly, 00001T would indicate a welder/supervisor with specific person no. 001 of portion manufacturer whose code is 'T' i.e. ITC. 02001H would indicate a welder, belonging to welding contractor whose code is 02, having specific person number of 001 and having competency for welding with portion/technique of portion manufacturing firm with code 'H'.

The Organization issuing competency certificates shall ensure that there is no duplication of the Identification Code Number.

An annual list of valid competency certificates will be circulated by the organisation issuing the competency certificates to the zonal railways. Zonal Railways should constantly update and maintain the list of supervisors and welders along with their identification code number. Annual list of approved AT welders of different firms and validity of competency certificates may be seen on web site www.rdso.indianrailways.gov.in under button activity of Metallurgical & Chemical Dte.

PART D: ACCEPTANCE TEST OF JOINTS WELDED AT SITE

17.0 EXECUTION OF WELDS AT SITE

17.1 Alumino - thermic welding of rails shall be executed at site only under the direct supervision of welding supervisor and by certified welder, both having valid competency certificate issued by RDSO/TPP, Lucknow/Thermit Welding Centre (TWC), Vijayawada (See Part 'C').

17.2 All Alumino – thermic welding work shall be executed with the use of weld trimmer and profile grinder. Additionally, rail tensors shall be used wherever work is done on welded rails.

Note: In case of welding of old rails dispensations for not using weld trimmers and profile grinder shall be obtained from Chief Engineer.

18.0 ACCEPTANCE TESTS

18.1 Visual examination

All the welded joints shall be cleaned and examined carefully to detect any visible defect like cracks, blow holes, shrinkage, mismatch, surface finish (smooth surface finish required) etc. Any joint which shows visible defect shall be declared defective.

The bottom of the joint shall be checked by feeling with fingers as well as inspected with the help of a mirror for presence of `fins` at the parting line of the mould. If fin is observed in any joint, the joint shall be declared defective.”

18.2 Joint Geometry

All the finished welded joints shall be checked to ensure that the joint geometry is within the following tolerances:-

i	Vertical misalignment	+1.0mm -0.0mm	(Measured at the end of 1m straight edge) (Fig.18.2 (a))
ii	Lateral misalignment	± 0.5 mm	(Measured at the centre of 1m straight edge) (Fig.18.2 (b))
iii	Head finishing on sides	± 0.3 mm	On gauge side (Measured at the centre of 10cm straight edge (Fig.18.2 (c))
iv	Finishing top table surface	+0.4mm -0.0mm	(Measured at the end of 10cm straight edge) (Fig.18.2 (d))

Note: Dispensation for joint geometry, in case of old rails may be permitted by Chief Engineer. The details of geometry of each joint shall be jointly signed by the firm's and railway's representative and kept as a record. Any joint found not conforming to the above stipulations shall be cut and rewelded, free of cost, by the firm.

18.3 Ultrasonic testing

All the welded joints shall be ultrasonically tested by the Railways as per the procedure given at **Annexure –1**.

This testing shall be completed as early as possible after welding but before the welding team leaves welding site. All the joints which are found to be defective shall be cut and re-welded by the firm at its own cost.

Where one bad joint is required to be replaced by two new joints, the entire cost of both the joints shall be borne by the firm. Such re-welded joints shall also be tested ultrasonically and if found defective, shall again be cut and re-welded free of cost. However, cumulative number of AT welds defective in ultrasonic testing and in other criteria shall be limited to as per clause 19.1.

For upgraded AT welding techniques approved in terms of Part E of IRS:T:19:2012, cumulative number of failed AT welds in ultrasonic testing and in other criteria shall be limited to as per clause 19.1.1

18.3.1 Defective/ Fractured joints:

In case, cumulative number of AT welds failed in criteria given in clause 19.1/19.1.1 exceed stipulated percentage in respective clauses, following action shall be taken :

- Action as per contract conditions be initiated.
- Railway shall be at liberty to suspend further welding.
- The details of welds executed against a particular contract, % defective /fractured welds against total no. of welds executed be compiled as per the following format :

S. No.	Name of welding agency/ welders	Total no. of welds for which contract was awarded (Rail section wise)	No. of welds executed against a particular contract	No. of fractured welds and their % w.r.t. (3)	No. of USFD defective welds and their % w.r.t. (3)	Total % defective/fractured [(5)+(6)]
(1)	(2)	(3)	(4)	(5)	(6)	(7)

- iv) All defective joints shall be broken with the help of Jim crow in presence of firm's representative and a joint report be prepared. Defects observed on fractured faces shall be recorded in form of photograph/ sketch.
- v) Sectional DEN/Sr. DEN shall carry out investigation/analysis for all in track fractured joints and joints broken as per iv) above. Information shall be compiled in the format indicated below :

S. No.	K m/ Post	Rail section/ UTS	Year of rolling	Joint no. (marking punched on the weld)	USFD defective joints (in Initial acceptance testing)			Fractured joints	Remarks
					Probe *	Peak pattern (travel & peak height) *	Defects observed (if any) on fractured faces of defective AT welds (broken with the help of Jim crow)	Defects observed on fracture faces (if any)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

* If defective in flange testing, supporting calculation be also enclosed in terms of Note in Chapter 8 of 'Manual for Ultrasonic testing of rails and welds, Revised 2012'.

- vi) The investigation report prepared by sectional DEN/ Sr. DEN be sent to Executive Director/Track-I, RDSO, Lucknow through Chief Track Engineer for appraisal and suggesting further action.
- vii) The defective joints taken out of track and fractured joints be preserved for undertaking investigation by RDSO, if required.

18.4 Sample Test Joint:

One out of every 100 joints welded per batch shall be selected at random by the purchaser or by the inspecting officer within one month of welding and subjected to hardness and transverse test as per clause 4.2 and the joint shall comply with the provisions laid down therein.

18.4.1 In the event of the failure of sample test joint in any of the requirements of this specification, the Railway will be at liberty to suspend further welding. However, two more randomly selected joints from the same lot of 100 joints shall be subjected to re-tests as per clause 4.2. Both the joints should clear all the tests. If the report is also not satisfactory, further welding of joints shall be suspended until the firm has examined the welding technique and satisfies the requirements of Clause 4 by welding one test joint. The clearance for re-commencement of welding shall be given by RDSO.

19.0 GUARANTEE

19.1 Rail joints welded by a firm shall be guaranteed against failure which includes failures in execution, acceptance, acceptance & regular ultrasonic testing and during service up to 2 years from the date of welding the joints in track or from the date such welded joints made 'in cess' and inserted in the track are open to traffic. Any such welded joints which fail in the criteria given above within the guarantee period shall be re-welded free of cost by firm as per stipulations of clause 18.3.

However, cumulative number of failed AT welds including rewelded joints in criteria given above up to 2 years, shall not exceed 2% of the total quantity of joints in a particular contract. A penalty of three times the rate of supply and execution of joints shall be payable by the firm for each joint failing in above criteria.

19.1.1 For upgraded AT welding techniques approved in terms of Part E of IRS:T:19:2012, the joints welded by a firm shall be guaranteed against failure which includes failures in execution, acceptance, acceptance & regular ultrasonic testing and during service up to 120GMT or 3 years whichever is earlier, from the date of welding the joints in track or from the date such welded joints made 'in cess' and inserted in the track are open to traffic. Any such welded joints which fail in the criteria given above within the guarantee period shall be re-welded free of cost by firm as per stipulations of clause 18.3.

However, cumulative number of failed AT welds including rewelded joints of upgraded AT welding technique in criteria given above up to 120GMT or 3 years whichever is earlier, shall not exceed 0.4% of the total quantity of joints in a particular contract. A penalty of three times the rate of supply and execution of joints shall be payable by the firm for each joint failing in above criteria.

19.2 In case of failure of sample test joints (refer Clause 18.4), the period of guarantee for 100 joints represented by the sample joint shall be extended for a further period of one year. In case of failure of joints or joints exhibiting signs of failure by cracking within extended period of guarantee, the joints shall be re-welded free of cost by the supplier as per stipulations of clause 18.3.

19.3 The welded joints with the extended period of guarantee shall be punch marked 'X' on the right of markings for month/year in addition to the markings prescribed in Clause 20. Such marked joints shall be kept under careful observation by the purchaser.

20.0 MARKING

Each joint shall have a distinctive mark indicating month, year of welding, agency and welder/supervisor identification code number (as appearing on his competency certificate) at non-gauge face side of AT weld on head as given below :

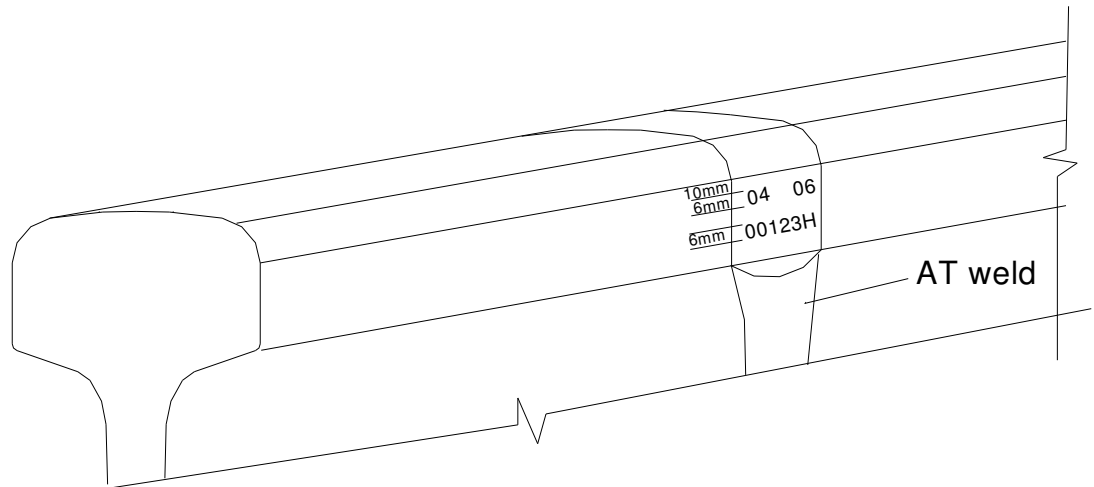


Figure : Location of marking on non-gauge face of welds

M	M
---	---

Month

Y	Y
---	---

Last two digits of year

A	A	B	B	B	C	C	C
---	---	---	---	---	---	---	---

(Identification code)

where,

A	A
---	---

Code number for the agency to which the welder/supervisor belongs i.e.

00 for AT portion manufacturing firms

01 for departmental welders

02-99 for welders of welding contractors. The codes shall be allotted for different contractual agencies undertaking AT welding of rails (other than portion manufacturers)

B	B	B
---	---	---

– Specific person number (from 001 to 999) The specific person number will be continuous for a Zonal Railway/Firm.

C – For welders/supervisors of Zonal Railways: First two/three initials of the Railway to which the supervisor or welder belongs

or

For welders/supervisors of portion manufacturing firms and welding contractors: Code allotted for the portion manufacturing firms, for whom welders/ supervisors of portion manufacturing firms and welding contractors are approved.

Alphabetic codes allotted to the portion manufacturing firms are given below:

ITC =T, HTI=H, OTPL=O, SIRIL=S, RMPL=R, IEA=F, TPP(NR)=N

In case of welders belonging to the welding contractors, this code will signify the portion manufacturing firm for which the competency certificate of welder is valid.

The marking should be embossed on the non gauge face side of AT weld by punching after finishing of the weld in letters/digits of 6mm height located as indicated in Figure.

In addition to this, alphabetic code allotted to portion manufacturing firm as per a) above e.g. T, H, N etc. and year of manufacture (last two digits of the year) shall also be embossed on the mould to appear on web collar.

For example, 01001ECo would indicate a departmental welder/supervisor of East Coast Railway with specific person number 001. Similarly, 00001T would indicate a welder/supervisor with specific person no. 001 of portion manufacturer whose code is 'T' i.e. ITC. 02001H would indicate a welder, belonging to welding contractor whose code is 02, having specific person number of 001 and having competency for welding with portion/technique of portion manufacturing firm with code 'H'."

21.0 WITHDRAWAL OF APPROVAL OF PORTION MANUFACTURER/ WELDING SUPERVISOR/ WELDER FROM APPROVED LIST

The approving authority can delete the name of any Portion Manufacturer/Welding Supervisor/Welder from the approved list based on complaints regarding the performance.

22.0 PART E: APPROVAL OF PORTION MANUFACTURERS FOR UPGRADED A.T. WELDING TECHNOLOGY

22.1 The approval of Portion Manufacturer for upgraded A.T. welding technology, under this part shall cover firms falling in following categories and having/ intending to have in India manufacturing facilities for portion and consumables and other infrastructural facilities for training of welders and execution of welds. However, the firm should have manufacturing facilities for portion & consumables and other infrastructural facilities for training of welders & execution of welds as laid down in 'Item specific guidelines for vendor approval/extension of approval for manufacturing of AT portion and execution of AT joints (Documents no. TDG0017, Rev.01)' with latest correction slips in India before applying for registration of their firm for approval for manufacturing of AT portion and execution of AT welds of rail.

22.1.1 Category-I Global Firms

22.1.1.1 The firm shall be manufacturer of portions and consumables such as moulds, crucible, luting paste, auto thimble etc.

22.1.1.2 The firm must have a proven international technology, which shall mean that at least 10000 welds must have been executed using the technique on high speed passenger carrying lines (160km/hour and higher) or lines carrying axle loads of 25tonnes and higher in at least three countries. Certificates in this regard from relevant railway systems shall be furnished.

22.1.1.3 The firm shall have produced and supplied at least 1 million welding kits for various alumino-thermic welding processes.

22.1.1.4 The firm shall possess sound technical and R&D credentials.

22.1.1.5 The firm shall possess necessary infrastructure namely manpower and machinery for undertaking execution of welds on Indian Railways.

22.1.1.6 A certificate regarding having complied less than 0.4% failure rate during execution, acceptance, acceptance ultrasonic testing and in service up to 120GMT or 3 years whichever is earlier (this includes weld failures and welds declared defective during regular ultrasonic testing up to three years of installation) from Railway system satisfying speed /axle load criteria given at Para 22.1.1.2, is to be furnished.

22.1.2 Category-II

22.1.2.1 Indian firms, having technical collaboration with global firms fulfilling requirements mentioned for Category-I in Para 22.1.1 for manufacturing of portions and consumables, training of welders and execution of welds subject to the condition that the global partner firm categorically gives undertaking regarding sharing of responsibility towards maintaining required standards of consumables, welders and welds and fulfillment of service performance requirements of welds with their Indian counterpart.

22.1.3 Category-III

22.1.3.1 Firms not meeting requirements of Category I & Category II above, but having experience of manufacturing, supplying and executing at least ten thousand AT welds on track having speed of 100Kmph or more and axle load of 20.32t or more. Approval to such firms shall be on provisional basis for three years with condition that such firms shall be eligible to get order up to maximum 25% and 40% of tendered quantity, if the offer is received from single firm and more than one firm respectively, besides fulfilling other provisions contained in this Part.

22.2 “Approving Authority” shall be Director General, Research Designs & Standards Organisation, Ministry of Railways, Manak Nagar, Lucknow – 226011 or his representative.

22.3 The approval of ‘Portion manufacturer’ shall be given as per clause 10.2 of this specification.

22.4 The welding techniques shall be suitable for axle loads of 25t (freight services at maximum speed of 100kmph)/18.8t (passenger services at maximum speed of 150kmph). Operation of 32.5t axle load freight trains and passenger trains upto 200kmph is also contemplated. Separate techniques can be offered suiting to various combination of axle loads and speeds.

22.5 PROCEDURE FOR APPROVAL OF PORTION MANUFACTURERS:

22.5.1 The application for approval shall be submitted by the firm as per procedure given in “General guidelines for vendor approval” (latest version) issued by Track Design Directorate.

22.5.2 The documents to be submitted by firm in support of credentials shall be as per the requirement of the category in which firm has offered for approval. Further clearance will be given to firm only after the credentials are fulfilled. If in case, documents are found incorrect at any stage of approval/ after approval, the approval process shall be discontinued/approval shall be withdrawn.

22.5.3 After credentials are found satisfactory based on records submitted by firm, the applications shall be submitted by firm as per procedure given in “General guidelines for vendor approval” (latest version) issued by Track Design Directorate.

22.5.4 The payments shall be made by means specified in “General guidelines for vendor approval” (latest version) issued by Track Design Directorate.

22.5.5 If the information submitted by the applicant is prima facie found to be satisfactory, the approving authority shall inspect the premises of the applicant for assessment.

22.5.6 If the assessment is satisfactory, firm shall be advised to offer their welding technology along with complete details of the process and process parameters e.g. rail section/chemistry, type of preheating, type of crucible used, type of mould, tapping system, weld metal dimensions, weld metal chemistry, fusion width, extent of HAZ, hardness profile etc. The firm shall have freedom to offer any type/combination of improved preheating system, mould, crucible and tapping system. After receipt of process details and range of various parameters, firm shall be advised for execution of joints for lab evaluation. During this process the parameters advised by firm shall be verified. In case there is variation, the parameter values obtained during lab evaluation shall be treated as final and frozen for reference.

22.6 TESTS AND TRIALS FOR APPROVAL OF 'PORTION MANUFACTURERS

22.6.1 The Portion Manufacturer shall manufacture a batch of minimum 50 portions in presence of RDSO representatives at his own cost. Sample portions required for execution of AT welds for lab tests including fatigue test, shall be drawn at random from above mentioned batch by the Approving Authority and their weight be recorded. The weight of the portions shall be within $\pm 0.25\%$ of the average weight.

22.6.2 Following laboratory tests shall be carried out at the manufacturer's works premises or at a laboratory mutually agreed upon between the manufacturer and the approving authority.

22.6.2.1 Twelve test weld joints shall be made as per technique offered by the manufacturer. For preparing these joints, two new rail pieces of same section and grade, each approximately 750mm long shall be used. The rail table and size of rail head shall be finished. The weld joints shall be subjected to following tests.

22.6.2.1.1 Ultrasonic test on all the joints as per procedure laid down at Annexure-1. Welds should not have defects.

22.6.2.1.2 Brinell hardness test on all the joints as per clause 4.2.2. The hardness profile obtained shall be recorded. Hardness profile other than Clause 4.2.2 may be permitted, provided-

- a) Firm shall provide proof of present use of proposed hardness profiles on railway network having mixed traffic elsewhere in the globe along with certificate of satisfactory performance from user Railways.
- b) Firm shall give undertaking that wear on the welds up to traffic equivalent to the half life of rails shall remain controlled to the extent so as to not require replacement of weld on this account.

- 22.6.2.1.3** Transverse load and deflection test as per clause 4.2.3 on six randomly selected joints.
- 22.6.2.1.4** Weld metal chemistry test shall be conducted on six randomly selected test joints on the rail weld running surface at 10mm away from weld transverse axis and composition of steel shall be determined for carbon, manganese, silicon, sulphur, phosphorous, vanadium, molybdenum, aluminium & chromium etc.
- 22.6.2.1.5** Macro examination on deep etched longitudinal section, across the weld on the remaining six joints shall be conducted. This examination shall not reveal any lack of fusion or cracks. Other welding defects, e.g. porosity, inclusions etc. in the weld area in longitudinal section shall be recorded in % of weld area. The size of any individual defect shall also be recorded. For confirming any defect found in macro examination, magnetic crack detection test may also be carried out.
- 22.6.2.1.6** Microscopic examination: Samples for microscopic examination shall be taken and prepared in accordance with Annexure-2. The structure of the fusion zone and visible heat affected zone shall conform with that defined by the supplier at x 100 magnification.
- 22.6.2.1.7** Any other specific parameter having bearing on performance of welds in service shall also be specifically brought out by the firm along with methodology for measurement/assessment of the same. Such parameters shall be measured and recorded.
- 22.6.3 Fatigue Test**
This shall be undertaken as per Para 13 of Part B of specification.
- 22.6.4 Provisional Approval**
- 22.6.4.1** In case of results of above tests are satisfactory, the firm shall be granted provisional approval for a period of 3 years for execution of welds on the revenue track.
- 22.6.5 Field Trial**
- 22.6.5.1** First 1000 joints, executed as part of first contract by the firm using portions of batches duly inspected and passed by RDSO representative, shall be monitored as part of field trial. These joints shall be ultrasonically tested soon after welding and periodically as laid down in USFD Manual as per procedure at Annexure –1. The joints shall exhibit less than 0.4% failure rate during execution, acceptance, acceptance ultrasonic testing and in service up to 120GMT or 3 years whichever is earlier. This includes weld failures and welds declared defective during regular ultrasonic testing up to three years of installation. The data of failure rate will be obtained from concerned CTE of the Railway.

- 22.6.5.2** If percentage of defective welds including failures exceeds 0.4% at any stage, the trial shall be discontinued considering the technique to be unsatisfactory. The defective welds, shall be removed from the track, cut and re-welded by the manufacturer at his own expense.
- 22.7** The approving authority shall have free access to the premises of the portion manufacturer at all reasonable times. The portion manufacturer shall furnish all the technical data to the approving authority as and when call for.
- 22.8** A Bank Guarantee for an amount equal to 30% of the cost of contract, apart from the usual performance guarantee, will have to be submitted by the firm as guarantee against fulfillment of guaranteed service life by the executed welds within one month from the award of the contract. This bank guarantee will be released after successful service life of 120GMT or completion of three years, by the executed welds, whichever is earlier.
- 22.9** Acceptance test of joints welded at site shall be as per Part-D of this specification.
- 22.10** The firm will be required to provide training to Indian Railway welders in India free of cost for undertaking emergent repair welding on Indian Railway network using approved AT welding technique of the firm as per requirement. A certificate shall be issued by the firm to the successful welders. These trained welders shall be then required to obtain competency certificates from TPP/Lucknow and/or TWC/Vijayawada for execution of welds on Indian Railway track using firm's approved technique.

**PROCEDURE FOR ULTRASONIC TESTING OF ALUMINO- THERMIC
WELDED RAIL JOINTS**

1.0 SCOPE:

This procedure covers the requirement of ultrasonic testing of Alumino- thermic welded rail joints by hand probing immediately after execution of the weld.

2.0 APPARATUS REQUIRED:

2.1 EQUIPMENT:

Any RDSO approved model of ultrasonic equipment for Alumino-thermic welded rail joints as per RDSO specification No. M&C/NDT/129/2005 or its latest version along with rig for tandem testing.

2.2 PROBES: The following probes having Lead zincronate- titanate crystal shall be used for Ultrasonic testing of Alumino-thermic joints.

- a) Normal (0°) 2 MHz, 18 mm. ϕ Double crystal.
- b) 70°/2 MHz, 20mm.dia. or 20mm.x20 mm. (square)crystal size, Single crystal - 1 no.
- c) 45°/ 2 MHz, 20mm.dia. or 20mm.x20 mm.(square) crystal size, Single crystal – 2 no.

2.3 CABLES: Co-axial cable for each probe shall be used .The length shall not be more than 2.0 meter.

2.4 COUPLANT:

Soft grease to RDSO Specification No.WD-17-MISC.-92 or WD-24 Misc.-2004/ any thick oil of high viscosity grade (having viscosity grade of 150 cst or more) is to be used as couplant while undertaking hand probing of AT welds. The list of approved vendors for soft grease to above mentioned specification is issued by Quality Assurance (Mechanical) Directorate of RDSO bi-annually. The same is available on website of RDSO www.rdsso.indianrailways.gov.in.

3.0 GENERAL CONDITION:

After execution of AT weld, welded zone shall be dressed properly to facilitate placement of probes and to avoid incidence of spurious signal on the screen. The top of rail head surface shall be dressed to obtain reasonably flat and smooth surface. The flange of the weld up to a distance of 200 mm. on either side of the weld collar shall be thoroughly cleaned with a wire brush to ensure freedom from dust, dirt, surface unevenness etc.

3.1 VISUAL EXAMINATION:

All the welded joints shall be cleaned and examined carefully to detect any visible defects like cracks, blow holes. Any joint which shows any visible defect shall be declared defective.

4.0 SENSITIVITY SETTING PROCEDURE:

4.1 STANDARD TEST RAIL:

The sensitivity of the ultrasonic equipment shall be set with the help of a standard AT welded rail piece of 600 mm (300 mm rail each side of joint) length having a simulated flaw at standard locations as shown in **Fig. 1**.

5.0 0°/2 MHZ, DOUBLE CRYSTAL NORMAL PROBE:

This scanning is used to detect Porosity , Blow hole, Slag inclusion in head and up to mid web of the AT welded joint.

5.1 CALIBRATION: Following procedure shall be adopted for calibration of 0° 2 MHz double crystal probe:

- i. Select range 300 mm with range control key.
- ii. Select Mode T-R i.e. Double Crystal mode.
- iii. Set Delay 0.
- iv. Set Probe Zero 0.
- v. Feed longitudinal wave velocity (5920 m/s) / Press measure 0 key.
- vi. Feed angle 0°.
- vii. Connect 0° Double Crystal probe and put it on IIW (V1) Block after applying couplant at 100 mm width side.
- viii. Set first reflected peak at 3.3 div. using probe zero. Place Gate over it and read the beam path, depth shall be 100 mm.
- ix. Second reflected peak will appear at 6.7 & third peak at 10.0.
- x. If last peak is not at 10.0, velocity may be adjusted to set the last peak at 10.0 (if velocity control available).
- xi. The equipment is calibrated for 300 /200 mm Longitudinal wave for 0° Double Crystal probe.
- xii. To verify the calibration, put probe on top of rail head, the back peak position will be at 5.2 for 52 Kg. rail & at 5.7 for 60 Kg. rail.

5.2 SENSITIVITY SETTING:

Place 0° normal probe on test rail. The reflection from 3 mm dia. hole in head of standard AT welded rail test piece shall be set to 60% of full screen height by suitable manipulation of gain control.

5.3 TEST PROCEDURE:

The probe shall be placed on the head of the AT welded joint ensuring proper acoustic coupling. The probe shall be moved on the weld centre to scan the weld area.

5.4 DEFECT CLASSIFICATION:

- a) For any flaw signal obtained by normal probe from the head region,
 - i) Flaw signal 40% and above and up to 60% to be declared as **DFWO**.
 - ii) Flaw signal above 60% to be classified as **DFWR**.
- b) For any flaw signal obtained by normal probe from web or foot location,
 - i) Flaw signal of height more than 20% from the web or foot and up to 40% to be classified as **DFWO**.
 - ii) Flaw signal of height more than 40% from the web or foot or more to be classified as **DFWR**.

6.0 70°/ 2 MHZ (HEAD SCANNING):

This scanning is used to detect lack of fusion, porosity, blow hole, slag inclusion, cracks in head of AT welded joint.

6.1 CALIBRATION:

Following procedure shall be adopted for calibration of 70° 2 MHz single crystal probe:

- i. Select range 165 mm with range control key.
- ii. Select Mode T+R i.e. Single Crystal mode.
- iii. Set Delay 0.
- iv. Set Probe Zero 0.
- v. Feed Shear wave velocity (3230 m/s) / Press measure 70 key.
- vi. Feed angle 70°.
- vii. Connect 70°/2MHz Single Crystal probe and put it on IIW (V1) Block after applying couplant and direct the beam towards 100 mm curvature.

- viii. Move the probe slightly to and fro to get maximize signal.
- ix. Using probe zero set this peak at 6.0 or by using gate read beam path 100 mm.
- x. To verify the calibration, Direct the probe towards 25 mm curvature and maximize the peak.
- xi. Put the gate on this peak, the beam path shall be 25 mm.
- xii. The equipment is calibrated for 165 mm shear wave.

6.2 SENSITIVITY SETTING:

Connect the 70°/ 2 MHz by means of co- axial cables and select **(T+R)** mode. Place the probe on the railhead directing the beam towards 3-mm. dia.-drilled hole in the head of the standard AT welded test piece (**Fig.1**). Move the probe in longitudinal direction on the rail so that reflection from the hole is obtained. Now set the height of the reflected signal to 60% of full screen height by suitable manipulation of the gain control . This gain shall be used for testing.

6.3 TEST PROCEDURE:

Place the probe on the rail head on one side of the AT welded reinforcement and move toward the weld in zigzag manner. This exercise shall be repeated 2-3 times. The same shall be carried out from both sides of the weld.

6.4 DEFECT CLASSIFICATION:

- i) A welded joint showing moving signal of 40% or more and up to 60% of FSH shall be classified as **DFWO**.
- ii) A welded joint showing moving signal of more than 60% of full screen height to be classified as **DFWR**.
- iii) A bunch of moving signals less than 40% and more than 10% shall also be considered as defective weld & to be declared as **DFWR**.

7.0 FLANGE TESTING BY 70°/2 MHZ, 20 MM X 20 MM SINGLE CRYSTAL PROBE:

This scanning is done for detecting lack of fusion, porosity, blow hole, slag inclusion in flange of AT weld.

7.1 RANGE CALIBRATION:

The equipment shall be set for a depth range of 165 mm shear wave.

7.2 SENSITIVITY SETTING:

70°/2MHz, single crystal probe shall be connected to the socket available in the ultrasonic equipment. The selector switch shall be set to single crystal mode. Move the probe towards the 3mm. dia hole drilled in the middle of flange of the AT weld

(**Fig. 1**) and manipulate gain control to obtain a maximum signal height 60% full screen height on the screen.

7.3 TEST PROCEDURE:

70° probe shall be placed on the flange at a suitable distance (180mm.) corresponding to position 'L' in **Fig. 2** such that ultrasonic waves are directed towards the weld. The probe shall thereafter be moved slowly in a zigzag manner towards the weld. Similar testing shall be carried out from 'C' and 'U' region as shown in **Fig. 2**.

7.4 DEFECT CLASSIFICATION:

- i) A welded joint showing flaw echo of 40% vertical height or more and upto 60% is to be declared as **DFWO**.
- ii) A welded joint showing flaw echo of more than 60% vertical height is to be declared as **DFWR**.

8.0 45° / 2MHZ PROBE:

8.1 45° / 2MHZ PROBE (AT WELD FOOT SCANNING):

This scan is used to inspect the clustered defects/ micro porosities and half moon shaped defect at the bottom of weld foot. (**Fig. 5**)

8.1.1 RANGE CALIBRATION: Following procedure shall be adopted for calibration of 45° 2 MHz single crystal probe:

- i. Feed range 275 mm with range control key.
- ii. Select Mode T+R i.e. Single Crystal mode.
- iii. Set Delay 0
- iv. Set Probe Zero 0
- v. Feed Shear wave velocity (3230 m/s)
- vi. Feed angle 45°
- vii. Connect 45°/2 MHz Single Crystal probe and put it on IIW (V1) Block after applying couplant and direct the beam towards 100 mm curvature.
- viii. Move the probe slightly to and fro to get maximize signal.
- ix. Using probe zero set this peak at 3.6 or by using gate read beam path 100mm.
- x. To verify the calibration, Direct the probe towards 25 mm curvature and maximize the peak.
- xi. Put the gate on this peak, the beam path shall be 25 mm.
- xii. The equipment is calibrated for 275 mm shear wave.

8.1.2 SENSITIVITY SETTING:

Place 45°/2MHz probe on the rail head surface at a distance equal to height of rail from the centre of the AT weld (**Fig. 5**). Select T+R single crystal mode. Move the probe 20mm either side of this position (probe index marking) to pick up half-moon crack in the central region of weld reinforcement as shown in **Fig 6**. This exercise shall be carried out two- three times from each side of the weld and signal from simulated flaw should appear at a distance of approximately 400mm for 52-kg rail. This distance will vary with respect to rail section height. The signal so obtained shall be adjusted to 60% of full screen height by manipulating the gain control .

8.1.3 TEST PROCEDURE:

The probe (45°/2MHz probe /single crystal) shall be placed on the rail head at a distance equal to height of the rail from the centre of AT weld (Probe index marking) under test with same sensitivity as per **para 8.1.2** above. This testing technique will scan the bottom of the weld in the central zone. The probe shall be moved 20 mm on either side of the probe index marking. The scanning shall also be repeated from other side of weld with beam directing towards the foot region of the weld.

8.1.4 DEFECT CLASSIFICATION:

Any flaw signal obtained by this probe of 20% height or more shall be classified as defective AT welded joint (**DFWR**).

8.2 45°/ 2MHZ SINGLE CRYSTAL PROBE (TANDEM PROBE SCANNING):

The tandem probe rig scan on the rail table by 45° probe is used to detect any vertically oriented defect like lack of fusion in the rail head, web and foot region below web.

8.2.1 RANGE CALIBRATION:

The equipment shall be set for a depth range of 275 mm as per **Para 8.1.1** above. The equipment shall be set in T/R (Double Crystal mode) by selector switch.

8.2.2 SENSITIVITY SETTING:

Place the tandem rig on the rail head and attach 45° probes such that the beam direction is as shown in **Fig. 7**. Adjust the height of reflected beam received by receiver probe (Rx) to 100% of full screen height. Increase the gain further by 10 dB. This gain shall be used for normal testing of AT weld by this set up.

8.2.3 TEST PROCEDURE:

Place the tandem rig on the rail head under test as shown in **Fig. 8**. The datum line of the rig shall be in line with centre line of weld. Test the weld with sensitivity setting as mentioned in **para 8.2.2** above. This exercise shall also be repeated from other side of the weld.

8.2.4 DEFECT CLASSIFICATION:

Any flaw signal of 40% of full screen height or more shall be classified as **DFWR**.

9.0 PROCEDURE FOR INITIAL AND PERIODIC ULTRASONIC EXAMINATION OF 75MM GAP AT WELDED JOINTS

9.1 STANDARD TEST SAMPLE:

The sensitivity of ultrasonic equipment shall be set with respect to AT weld standard test sample of 1.5m length having a simulated flaw at standard location as shown at **Fig. 3**.

9.2 SENSITIVITY SETTING:

The signal from the simulated flaw of 3mm dia. hole in the head shall be set to 60% of full screen height with 0°, 2 MHz and 70°, 2 MHz probes for detection of discontinuities in the rail head. For Flange testing a signal from a saw cut of 30mm in the weld metal in the flange 15mm away from the edge of the weld collar as per **Fig. 3** shall be set to 60% of full screen height using 70° 2 MHz probe.

9.3 DEFECT CLASSIFICATION:

- a) Head - With 0° & 70° probes, rejection criteria will be same as for 25mm gap AT weld joint. (**Para 5.4 and Para 6.4 respectively**)
- b) Flange- With 70° / 2MHz probe, any moving signal of height more than 20% of the full screen height shall be treated as defective weld (**DFWR**).

10.0 INITIAL USFD TESTING OF AT WELDS AND SUBSEQUENT TESTING WITHIN THE GUARANTEE PERIOD OF CONTRACT:

10.1 A thermit welding done in situ shall be joggled fish plated with two clamps till tested as good by USFD.

10.2 The defective joints (**DFWO** or **DFWR**) based on the criteria mentioned in preceding paras shall not be allowed to remain in service for initial USFD testing of AT welds and subsequent testing within the guarantee period of contract and these joints shall be cropped, re-welded and tested again. The re-welded joints shall be scanned ultrasonically again with the same set of acceptance criteria to ensure freedom from any harmful defects.

Note: GUIDELINES FOR THE OPERATORS:

- a) The correctness of angles and index marking of the probe shall be ascertained before testing. Only probes meeting the specified values shall be used during testing.
- b) Mere appearance of moving signal during flange testing of weld shall not be the criterion for rejection of a joint. These signals may come from the geometry of the flange weld reinforcement. Therefore, while declaring a joint defective in flange testing, operator shall ensure that signals are flaw signals and not the signals coming due to geometrical configuration of the weld. Following method shall be adopted for taking decision in this regard :
 - (i) Horizontal distance of flaw shown on screen of the equipment shall be observed.
 - (ii) Measure the actual distance from probe index to confirm if the flaw signal is coming from the weld collar/reinforcement or from the weldment. (**Fig.4**)
- c) Oil or grease shall be used for proper acoustic coupling instead of water for AT weld testing. Operator shall use the same couplant during testing and setting the sensitivity.
- d) More than one **DFWO** defect in one weld shall be classified as **DFWR**.

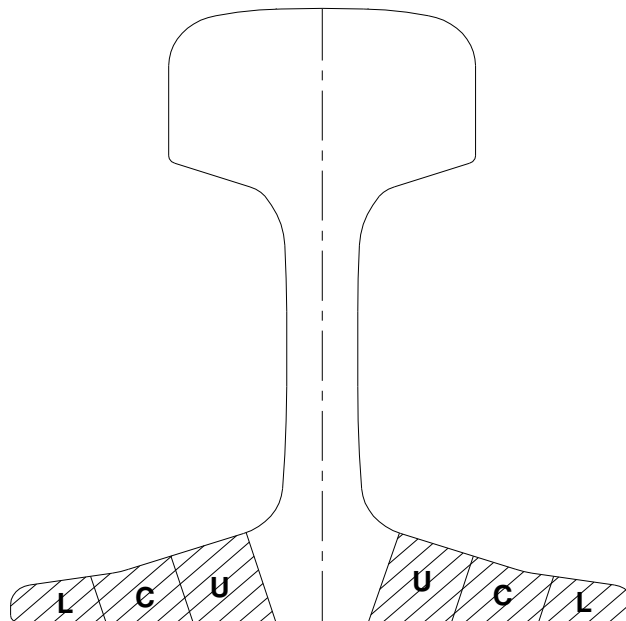
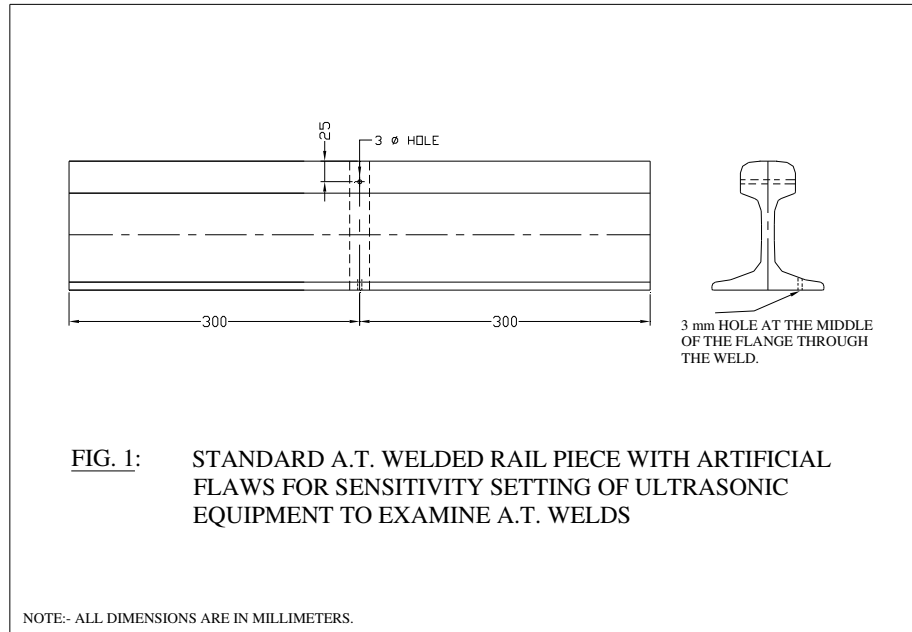


FIG. 2: SKETCH SHOWING THE LOCATION OF FLANGE OF RAIL FOR ULTRASONIC TESTING WITH 70°, 2 MHz, (20mm CIRCULAR OR 20mm X 20mm SQUARE CRYSTAL) ANGLE PROBE

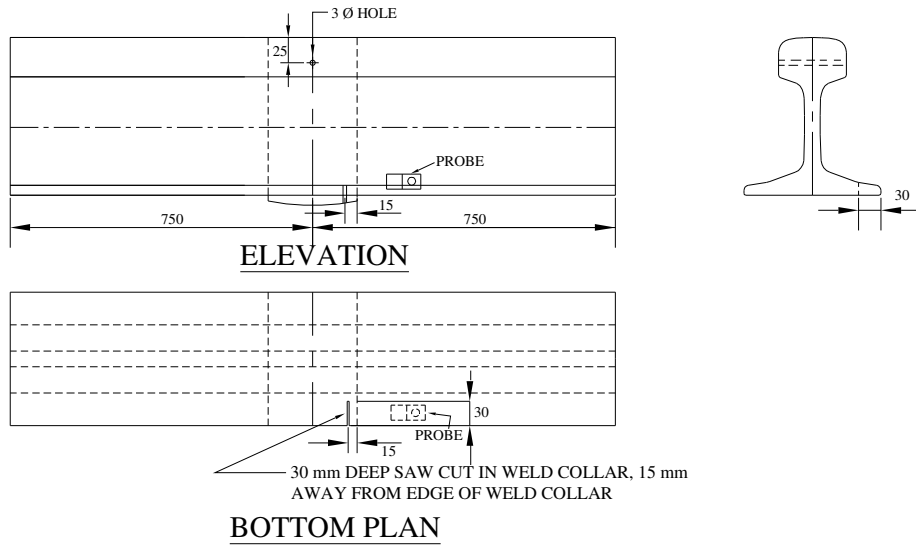


FIG. 3: STANDARD A.T. WELDED RAIL PIECE WITH ARTIFICIAL FLAWS FOR SENSITIVITY SETTING OF ULTRASONIC EQUIPMENT TO EXAMINE 75 MM WIDE GAP A.T. WELDS

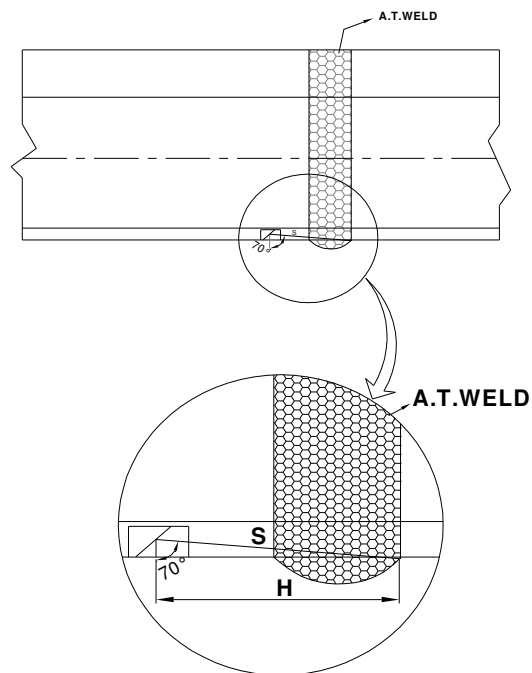
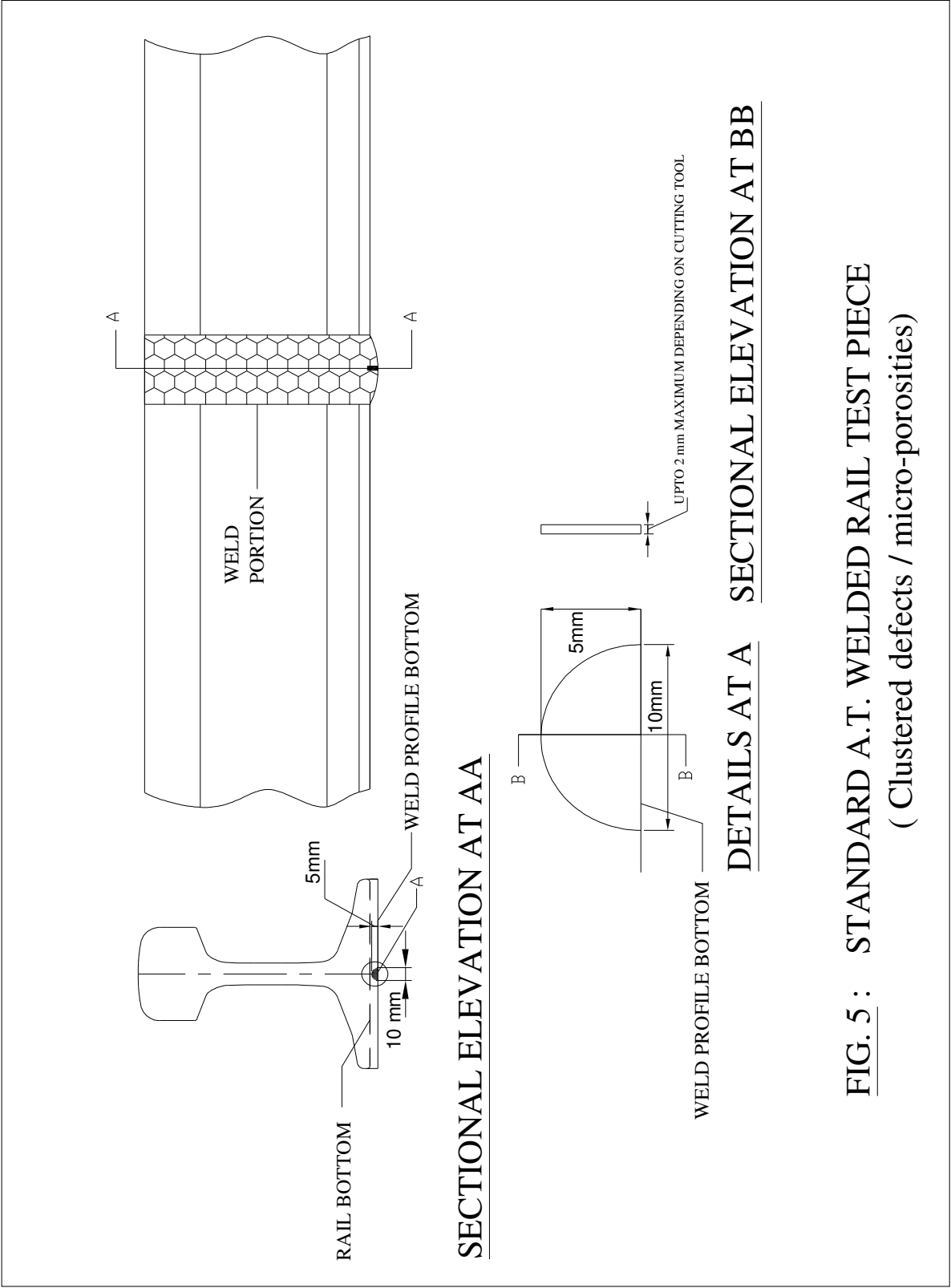
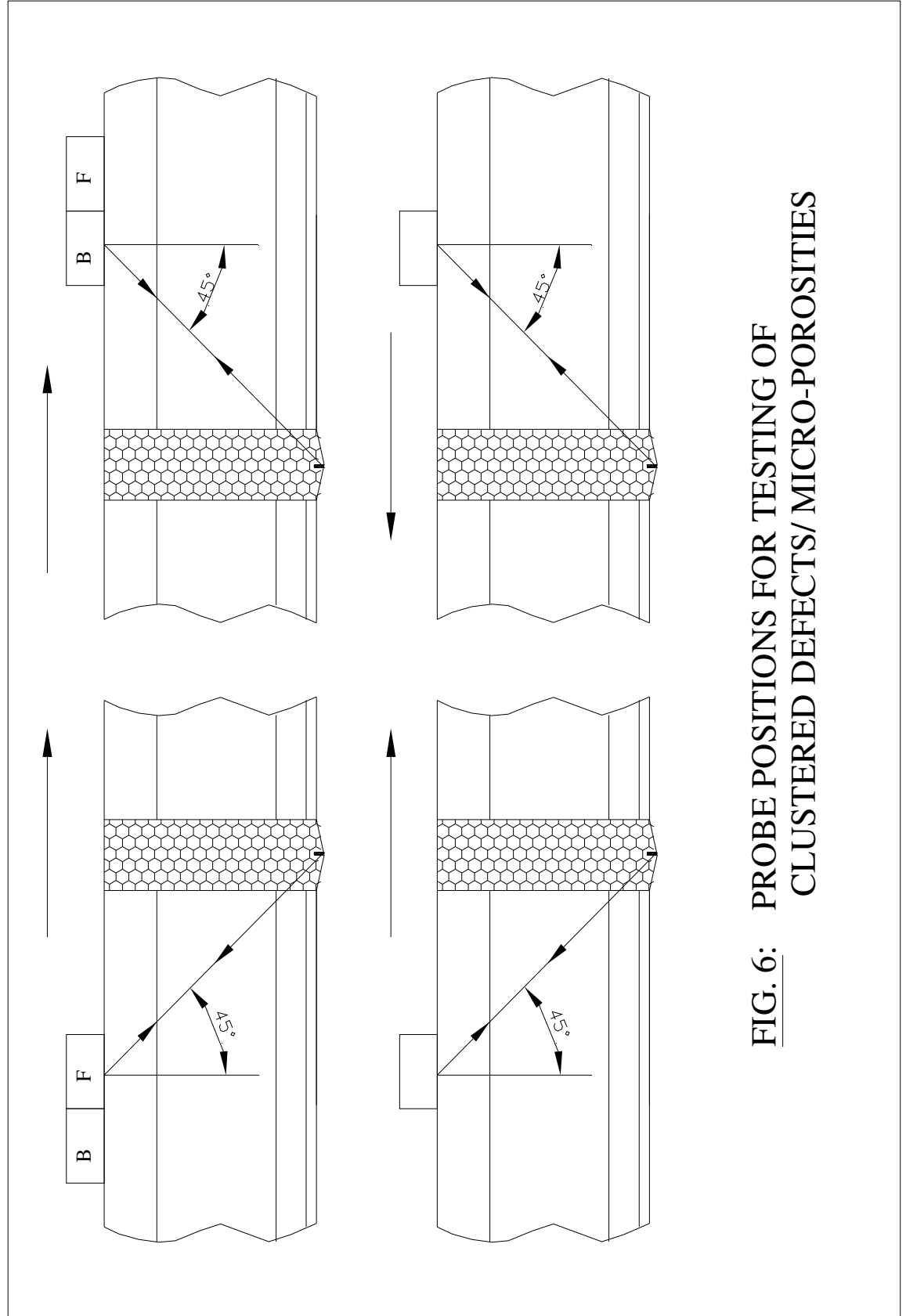


FIG. 4 : TESTING OF BOTTOM FLANGE OF A.T. WELDS USING 70° PROBE.





**FIG. 6: PROBE POSITIONS FOR TESTING OF
CLUSTERED DEFECTS/ MICRO-POROSITIES**

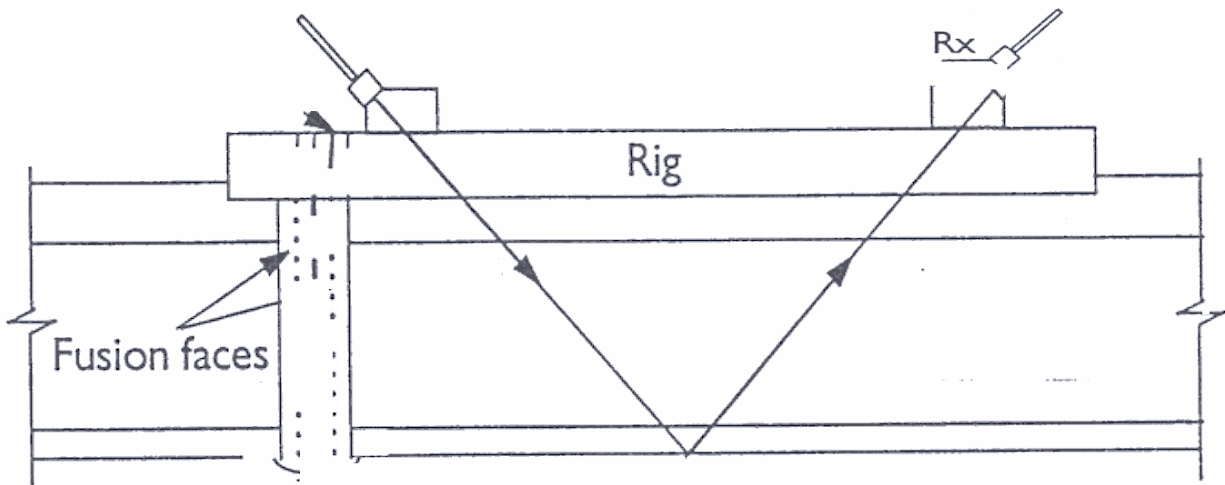


Fig. 7 : Sensitivity setting using 45° tandem probe

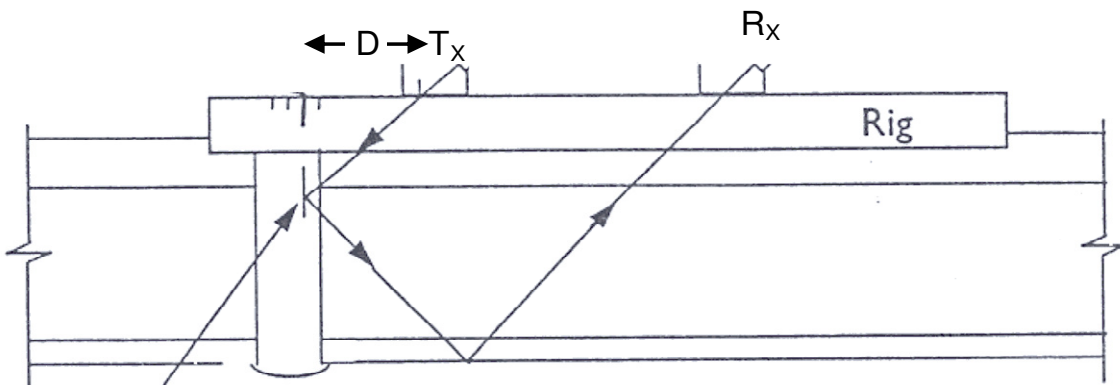


Fig. 8 : AT weld testing using 45° tandem probe

ANNEXURE-2

PROCEDURE FOR MICROSCOPIC EXAMINATION OF THE VISIBLE HEAT AFFECTED ZONE AND FUSION ZONE OF WELDS

Samples for microscopic examination shall be taken in accordance with Figure given below. The samples shall be prepared and etched in 2% Nital.

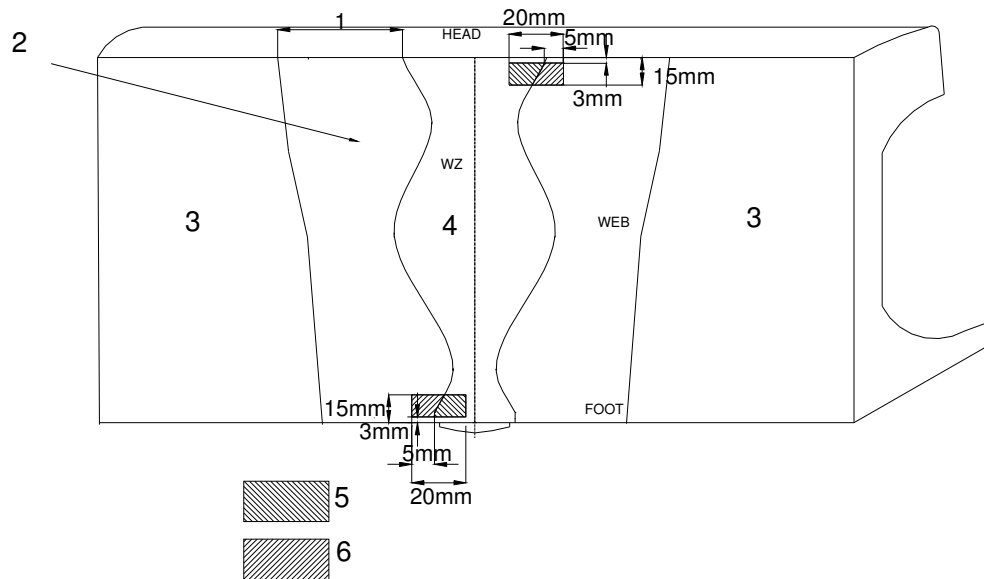


Figure-Scheme for taking samples for microscopic examination

Key

1. Width of the visible heat affected zone to be measured at the weld longitudinal centre line of the running surface.
2. Visible heat affected zone.
3. Unaffected parent rail.
4. Weld fusion zone.
5. Area of fusion zone to be examined microscopically.
6. Area of visible heat affected zone to be examined microscopically.

**SPECIFICATION OF 3-PIECES PRE-FABRICATED MOULD MANUFACTURED BY A.T.
PORTION MANUFACTURERS FOR USE DURING A.T. WELDING OF RAILS
AS PER IRST-19- 2012**

0.0 FOREWARD:

0.1 Indian Railways have introduced Alumino-thermic welding of rail joints since five decades. The mould required for accommodating molten thermit steel around the joint to make a bond between the rails, was earlier made of green sand. Due to introduction of short preheating process in eighties, the moulding practice was switched over to prefabricated sodium silicate dry sand mould or Pre-Fabricated Mould (PFM) with an intention to minimize the welding time and bring improvement in quality of joint.

Earlier 2 pieces PFM were used in Indian Railways. The main drawback of 2 pieces PFM was the appearance of Fins at the bottom of AT joints. To overcome this AT welding defect a new 3 pieces PFM has been developed as per the figure given in Fig.1. Third bottom piece of one set-3 pieces PFM during AT welding shall not result the bottom fin. However care must be taken during fitment of 3 pieces PFM so that the two parting line at the rail flange edges are avoided.

1.0 SCOPE: This standard includes basic requirements & quality control of raw materials required for moulding, manufacture of moulds, quality control during manufacture and of finished product and packing conditions for use during A.T. welding of rails of different sections as per IRS-T-19- 2012. This standard shall be applicable for A.T. Portion manufacturers.

2.0 REFERENCES:

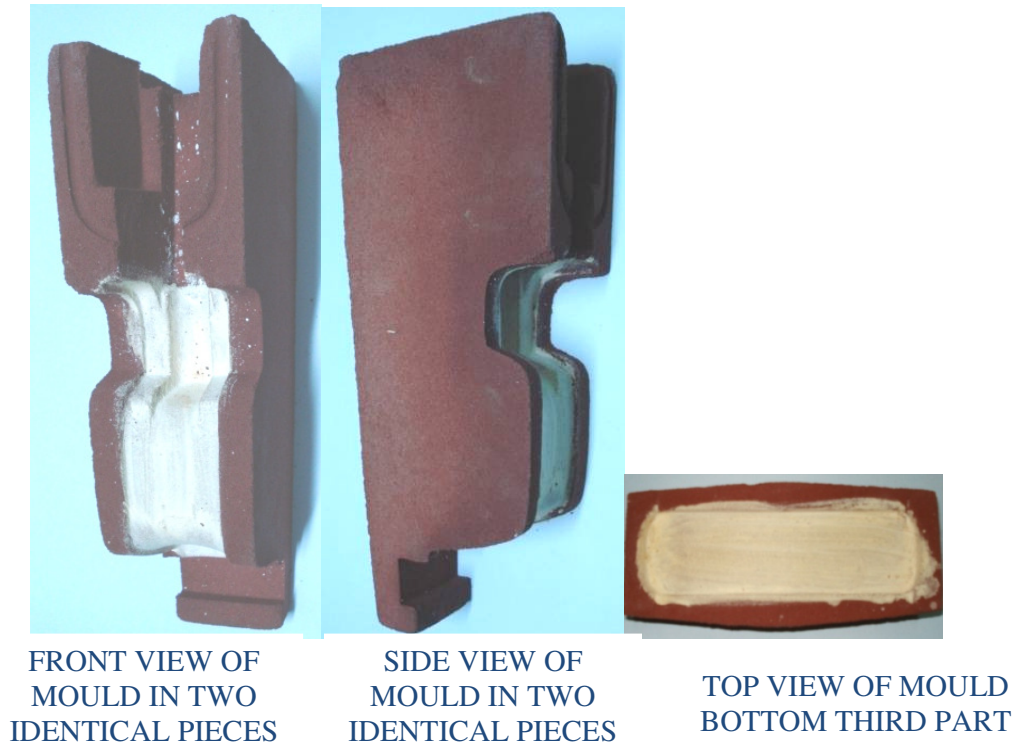
While preparing this standard following specifications have been referred to:

IRST-19-2012 IRS Specification for fusion Welding of rails by Alumino-thermic process
IS:1918-66 (Reaffirmed 2003) Method of physical tests for foundry sands.
IS:1987-2002 Specification for High Silica sand for use in foundries.
IS:6773-78 (Reaffirmed 2003) Specification for Sodium Silicate for use in foundries.
IS:10091-81 (Reaffirmed 2003) Specification for Iron Oxide Powder for use in foundries.
IS:2-1960 (Reaffirmed 2006) Rules for rounding off numerical values.
IS:12446-2007 Specification for Bentonite for use in foundries.
IS:10033-1992 (Reaffirmed 2003) Zircon and Graphite based core and mould washes
IS:307-1966 (Reaffirmed 2006) Carbon-di-oxide gas of commercial grade
IS:9738-2003 Polyethylene Bags for General Purposes
IS: 11099-1984 (Reaffirmed 2005) Universal Sand testing machines.

In future the latest publication of above specification may be consulted by the users.

3.0 ARRANGEMENT OF 3 PIECES PFM

One set of PFM shall comprise 3 pieces of moulds (2 Parts are in identical shape & sizes placed side by side and 3rd part is placed at the bottom) as per following sketch:



The above figure is indicative only.

Fig-1

4.0 RAW MATERIALS:

4.1 HIGH SILICA SAND:

- 4.1.1 The silica sand shall be of appropriate grade in respect of chemical composition & grain fineness as per IS: 1987-2002. The grade used as per requirement of firm shall be indicated in QAP of firm. The grain shape shall be mostly of sub angular to rounded shape.
- 4.1.2 The manufacturer shall keep record/ inspection certificate of high silica sand, being used in the production as per IS-1987-2002 with proper traceability. The manufacturer should also carry out its own inspection check on the Silica sand and proper record shall be maintained with traceability.

4.2 SODIUM SILICATE:

- 4.2.1 Sodium silicate used as a binding agent for pre-fabricated mould shall be of appropriate grade as per IS:6773-1978 (Reaffirmed 2003). The grade used as per requirement of firm shall be indicated in QAP of firm.
- 4.2.2 The manufacturer shall keep record/inspection certificate of sodium silicate, being used in the production as per IS:6773-1978 (Reaffirmed-2003) with proper traceability. The manufacturer should also have its own inspection check on sodium silicate batch wise as per Appendix-I and proper record shall be maintained with traceability.

4.3 IRON OXIDE:

- 4.3.1 Iron oxide is added to the sand mixture to increase the hot strength of the mould. The iron oxide shall be free from clay and in powder form. Iron oxide to IS:10091-81 (Reaffirmed-2003) shall be used as Iron Oxide ingredient.
- 4.3.2 The manufacturer shall keep record/inspection certificate as per IS-10091-1981 (Reaffirmed-2003) with proper traceability of Iron oxide, being used in the production.

4.4 CARBON DI-OXIDE GAS:

Carbon-di-oxide gas shall be of commercial grade to IS:307-66 (Reaffirmed 2006). The manufacturer shall keep record of Carbon-di-oxide gas, being used in the production as per IS-307-66 (Reaffirmed 2006) with proper traceability.

4.5 MOULD WASH:

- 4.5.1 To achieve good finish of the weld surface, mould wash shall be used. It shall be alcohol base Zircon wash Gr. ZA to IS: 10033-92 (Reaffirmed 2003) (See Appendix- II).
- 4.5.2 The manufacturer shall keep record/inspection certificate of mould wash being used in the production as per IS-10033-92 (Reaffirmed 2003) with proper traceability. The manufacturer shall also have its own inspection check of mould wash batch wise as per Appendix -II and proper record shall be maintained with traceability.

5.0 PRODUCT CHARACTERSTICS:

- 5.1 The mould shall be manufactured by no-bake, sodium silicate process using detachable pattern and shall be suitable for welding the required rail section.
- 5.2 The dimension of the mould shall be such as to give required weld metal geometry of the joint approved by RDSO. The mould shall fit properly with the rail and in the mould shoe.
- 5.3 The mould may be suitably reinforced for adequate stiffness and stiffener design & location shall be a part of the drawing.

6.0 PRODUCT TRACEABILITY:

The insignia containing firm's code allotted (IIC=T, HTI=H, OTPL=O, SIRIL=S, RMPL=R, IEA=F as per AT welding Manual) and year of manufacture shall be embossed in the mould during manufacture for identification.

7.0 QUALITY CONTROL:

- 7.1 Quality control shall be carried out in two stages:
 - a) Inspection during manufacture.
 - b) Inspection of the finished mould.
- 7.2 **Inspection during manufacture.**
 - 7.2.1 Firm should have a Quality Assurance Plan duly approved by the competent authority.
 - 7.2.2 Firm shall keep all the records of quality checks of all incoming raw materials as mentioned in Cl. 4.0 of this specification. The process control activities shall also have necessary inspection record as per the approved QAP.
 - 7.2.3 The proportion of the ingredients, pressure and time of passing of CO₂ gas should also be checked.
 - 7.2.4 The dimensions of the pattern for its conformity to the drawings of approved weld design should also be checked. All the measuring instruments shall be maintained in functional order.
 - 7.2.5 Record of important parameters like moisture content, permeability, hardness and compressive strength (As per IS: 11099-1984- Reaffirmed-2005) of test block of 50x50 mm for every batch i.e. Muller/ Mixer batch of production shall be maintained.

7.3 Inspection of the finished mould.

7.3.1 For Inspection of finished mould, the Batch size shall be production of each day subject to maximum of batch size of AT welding portion of firm+5%, which shall be included in QAP of firm.

7.3.2 The mould should be sound and it should not break during transit under normal condition. The name of the test and their frequency, to be carried out on finished mould by the manufacturer at their own and by purchaser or nominated agency shall be as under:

S.N.	Test	Sample size	Remarks
1.	Visual Examination	1% of Batch size rounded off to next higher number	As per para 7.3.3
2.	Dimensional check	2% of Batch size rounded off to next higher number	As per para 7.3.4
3.	Ringling Test	1% of Batch size rounded off to next higher number	As per para 7.3.5
4.	Hardness Test	1% of Batch size rounded off to next higher number	As per para 7.3.6
5.	Internal surface of mould for proper mould wash	1% of Batch size rounded off to next higher number	As per para 7.3.7
6.	Weld metal dimensions	1 per Batch, to be checked along with AT welding Portion inspection.	As per para 7.3.8

The tests shall be carried out at manufacturer's premises. If any test is conducted by outside approved agency, the cost of the test is to be borne by the manufacturer.

7.3.3 Visual Examination:

The prefabricated mould shall be checked visually for any visible imperfection, such as surface condition etc.

7.3.4 **Dimensional check:** Dimensional check shall be carried out on 2% of the moulds for their conformity to the respective drawing, fitment with rail end and in mould shoe.

The weld profile dimension achieved in AT weld using developed 3 pieces PF mould should confirm to the approved weld profile dimension. Dimension of 3 pieces PF mould as width and depth at respective web, foot and bottom which affect the weld profile dimension of AT weld will be indicated in QAP of firm and the same shall be standardized during approval. The location of weld profile dimension shall be as per Appendix- III.

7.3.5 Ringing Test: Ringing Test shall be carried out by using a small and light hammer made of 10 mm steel rod for checking soundness and degree of ramming during manufacture. The mould shall have characteristic ringing sound and shall not break.

7.3.6 Hardness Test:

Hardness Test shall be carried out on the plane surface of the mould using a duly calibrated core hardness tester (scratch type). The min. hardness value for a silicate carbon-di-oxide hardened mould shall be 70. The hardness test shall be carried out as per Cl.26 of IS: 1918-66 (Reaffirmed 2003).

7.3.7 Internal surface of mould for proper mould wash:

Surface finish shall be checked on the moulds for uniform and sufficient coatings as per Cl.7.3 of APPENDIX-II.

7.3.8 Weld dimensions: Dimensional check shall be carried out on the finished rail joints using mould pairs for conformity of the approved weld profile dimension of respective AT portion manufacturer.

7.3.9 All requisite Testing facilities to Inspecting officials shall be provided by the manufacturer at their own cost. The Inspecting officials shall have free access at manufacturer's works in working hours to assess the quality of manufacturing process.

7.3.10 The manufacturer shall provide test results of raw materials and the batches offered for inspection to the Inspecting officials.

8.0 SHELF LIFE:

Shelf life of mould should be 9 months minimum from the date of manufacturing.

9.0 PACKING:

9.1 Each prefab mould shall be individually packed and sealed in polyethylene bags made out of polyethylene conforming to IS: 9738-2003 Grade HM HDPE of 150 micron thickness or as prescribed by IRS-T-19-2012.

9.2 A pair of such packed moulds shall again be packed in carton paper boxes confirming to IS:2771(Second Revision). Proper sealing shall be done on each carton.

9.3 Each carton shall be clearly marked giving manufacturer's name, date of manufacture and rail section, batch number for easy identification.

REQUIREMENTS FOR SODIUM SILICATE

Extracts from **IS: 6773-1978** (Reaffirmed -2003)

Cl.4.2 The material shall comply with the requirements given in table 1.

Sr. no.	Characteristic	Requirement	Method of Test (Ref to Clause No. in Appendix A of IS:6773-1978)
i)	Total soluble silica (as SiO_2), percent by mass		A-3 and A-5
ii)	Total alkalinity (as Na_2O), percent by mass		A-4 and A-5
iii)	Mass ratio of total soluble silica (as SiO_2) to total alkalinity (as Na_2O)		A-6
iv	Relative density at 20°C		--
v)	Total invert sugar contents, percent		A-7

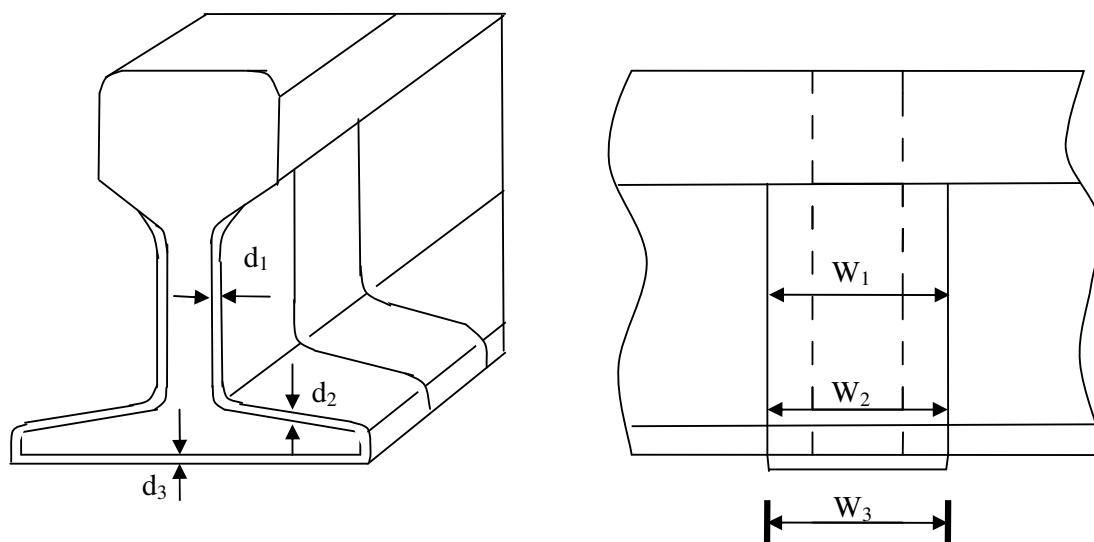
Cl. 7.1(c) Date of manufacture and date of expiry, if any.

REQUIREMENTS FOR ALCOHOL BASE ZIRCON WASH

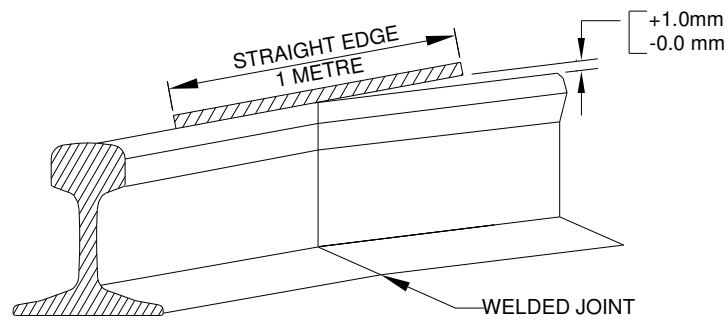
Extracts from IS: 10033-1992 (Reaffirmed-2003)

- Cl.5 **Condition of the material:**
The material shall be of uniform nature free from lumps whether in powder paste or in ready to use form.
- Cl.6.1 **Chemical composition of Zircon-wash Gr-ZA:**
When tested in accordance with IS: 10085-1982, the ZrO_2 content of ZA grade wash shall not be less than 60 percent.
- Cl.7.3 **Coating Quality:**
Wash when prepared and applied as per the recommendation of supplier shall be of the following quality:
- a) The wash shall give an uniform coating free of cracks before and after baking.
 - b) The dried coating shall be hard enough so that by scratching with nail, the coating does not peel off or by gentle rubbing material is not transferred to the finger.
 - c) Alcohol base coated surface after ignition shall be free from wet patches in the surface.
- Cl.11.1 The bags or the containers shall be marked with manufacturer's name, production batch No., date of manufacture and date of expiry.

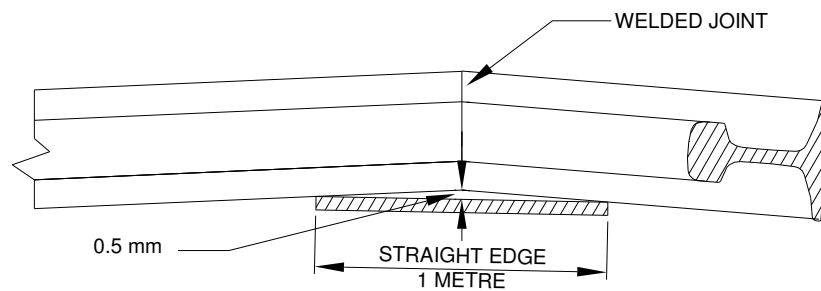
LOCATION OF APPROVED WELD PROFILE DESIGN/ DIMENSION



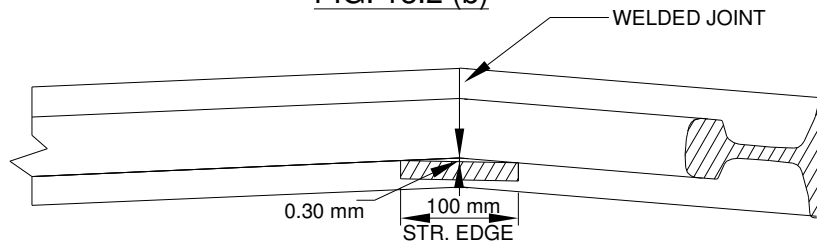
W_1 = Width at the centre of web at the location of d_1 as shown in Fig.
 W_2 = Width of reinforcement at foot at the location of d_2 as shown in Fig.
 W_3 = Width of reinforcement at bottom of flange at the location of d_3 as shown in Fig.
 d_1 = Thickness of reinforcement at web
 d_2 = Thickness of reinforcement at foot
 d_3 = Thickness of reinforcement at bottom of flange
 All dimensions measured in mm.



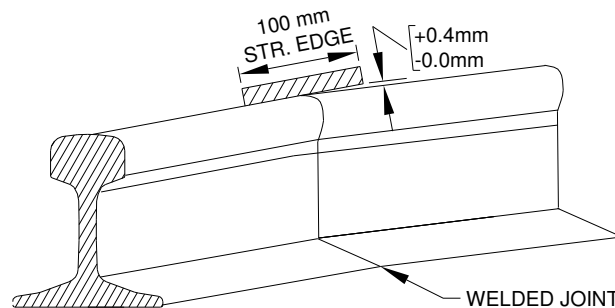
TOLERANCE FOR VERTICAL MISALIGNMENT OF WELDED JOINT
FIG. 18.2 (a)



TOLERANCE FOR LATERAL MISALIGNMENT OF WELDED JOINT
FIG. 18.2 (b)



TOLERANCE FOR FINISHING ON SIDES OF HEAD OF WELDED JOINT
FIG. 18.2 (c)



TOLERANCE FOR FINISHING TOP TABLE SURFACE OF WELDED JOINT
FIG. 18.2(d)