ज्ञान ज्योति से मार्गदर्शन

To Beam As A Beacon of Knowledge

Welding Techniques





November 2019

Indian Railways Institute Of Civil Engineering

Pune - 411001

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FOREWORD TO FOURTH EDITION

The book on 'Welding Techniques' was initially published in 1988, second edition of this books was brought out in 2006 and third revision was done in 2014 incorporating all new development in welding techniques.

This new book has now been updated considering the requirement of field engineers and incorporating all latest guidelines on Alumino Thermic Welding and Flash Butt Welding taking into account revised manual and specification of Alumino-thermic Welding and manual of Flash Butt Welding.

Efforts has been made to incorporate all topics in a chronological order so that field engineer executing welding may understand processes with logic behind each activity. Also paras on action to be taken in case of defective weld joint, sample test checks, procedure for awarding competency certificates, painting of welds and marking of welds are discussed in details.

I hope that, this new book revised by Shri Mahesh Dekate, Professor Procurement/IRICEN will be very useful for field engineers to improve quality of welding.

Pune
November 2019

Ajay Goyal
Director
IRICEN, Pune

FOREWORD FOR THIRD REVISION

The second revised version of book on 'Welding Techniques' was brought out by IRICEN in 2006. This third revision is being done to include major changes and new development taken place during last 8 years.

The book covers Flash Butt Welding, Alumino-Thermic Welding and Gas Pressure Welding with emphasis on the first two. Apart from dealing with the basics of these methods, it covers process details, quality control and new developments.

Over the years welding of rail has became an important aspect of track maintenance. Quality control of welding is a major challenge in improving maintainability of track.

It is hoped that the book will enable Railway Engineers to improve their understanding of rail welding.

Suggestions for improvement are welcome

October 2014

Vishwesh Chaubey
Director / IRICEN
director@iricen.gov.in

ACKNOWLEDGEMENT FOR THIRD REVISION

The second revised version of book on 'Welding Techniques' was brought out by IRICEN in 2006. The book was very popular among field engineers and gone out of print. The author, therefore, undertook the task of thorough revision the book duly incorporating the latest information on the subject.

A new chapter on Do's & Don'ts and check list has been added. This will help the field engineers in monitoring and improving quality of welding, which is very important to improve maintainability of track.

The author is indebted to the faculty members & staff of IRICEN for the support and assistance received from them in the course of bringing out the book. Special thanks are also due to shri Manoj Arora Ex Senior Professor/IRICEN for his valuable inputs in revising the book.

Above all, the author is grateful to Shri Vishwesh Chaubey, Director, IRICEN for the encouragement and guidance received from him in bringing out this book.

October 2014

N. C. Sharda
Senior Professor/Track-1
IRICEN

FOREWORD

The book on ‘ Welding Techniques’ was originally published in 1988 covering different methods for welding of rails, details of specific techniques and quality control aspects. The book was very popular amongst field engineers.

During this intervening period, some of the rail welding methods and specific techniques have undergone major changes. A number of new techniques have also been developed to meet the requirements of the field. It was, therefore, imperative to revise the book thoroughly so that it contains the updated information on the subject matter.

The book covers Flash Butt Welding, Alumino-Thermic Welding and Gas Pressure Welding with emphasis on the first two. Apart from dealing with the basics of these methods, it covers process details, quality control and new developments.

It is hoped that the book will enable Railway Engineers to improve their understanding of rail welding. At the same time, those who are not well conversant with rail welding, can also familiarize themselves with all facets of rail welding with the help of this book.

Shiv Kumar
Director
IRICEN

ACKNOWLEDGEMENT

The book on 'Welding Techniques' was first brought out by IRICEN in 1988 to acquaint the field engineers with various welding techniques available for welding of rails. Since then the welding techniques have undergone major changes and several new development have taken place in this area. The authors, therefore, undertook the task of revising the book duly incorporating the latest information on the subject.

The authors are indebted to the faculty members & staff of IRICEN for the support and assistance received from them in the course of bringing out the book. Our thanks are also due to Mrs Vidya Jamma, who did the word processing of the manuscript.

Above all, the authors are grateful to Shri Shiv Kumar, Director, IRICEN for the encouragement and guidance received from him in bringing out this book.

Abhai Kumar Rai
Professor/Works
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Professor/Computers
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CHAPTER I

ALUMINO THERMIC WELDING OF RAILS

1.1 Introduction

Alumino thermic welding is a process that produces coal escence of metals by heating them with superheated molten metal from an alumino thermic reaction between a metal oxide and aluminium. The alumino thermic process is extensively being used world overfor joining the ends of the rail. Alumino thermic process, known as Gold Schmidt process was developed in 1896 by a German chemist, Professor Hans Gold Schmidt. Alumino thermic process is based on the chemical reaction of iron oxide with aluminium. The reaction, being 'exothermic' is associated with heat generation. Depending upon the particular oxide of iron used as shown below, the reaction can liberate heat energy sufficiently high to even vaporize the resultant iron. However, heat losses, which invariably occur, ensure that iron in molten state is available. The reaction process can be described by the following equations:

$3Fe_3O_4 + 8Al = 4Al_2O_3 + 9Fe\ (3088^0C, 719.3\ kcal)$
$3FeO + 2Al = Al_2O_3 + 3\ Fe\ (2500^0\ C, 187.1\ kcal)$
$Fe_2O_3 + 2Al = Al_2O_3 + 2Fe\ (2960^0\ C, 181.5\ kcal)$

Different thermit welding processes may use any combination of iron oxide and aluminium as shown above, in different proportions, to achieve the objective of correct resultant temperature of molten metal of required quantity. After the exothermic reaction lasting a few seconds, approximately equal volumes of molten steel and liquid Al_2O_3 are separated at a temperature of about 2400^0C. Al_2O_3 (slag), being lighter, floats on top of the molten metal. The iron obtained from such a reaction is soft and is unusable as a weld metal for joining rails.

To produce an alloy of correct composition, ferro-manganese is added to the mixture together with pieces of mild steel to control the exothermic reaction and increase the recovery. Also by adding appropriate alloying elements and varying their quantities, the wear resistance of thermit steel can be largely matched to that of the various grades of rail steel to be welded. Thermit rail welding process being essentially similar to a foundry process, certain properties like complete slag exclusion within short time, better fluidity of molten metal etc. are also necessary which are achieved by further addition of certain compounds like calcium carbonate, fluorspar etc.

Precise weights of the constituents are necessary such that after reaction, there remains a small excess of aluminium in the weld metal(say 0.4% by weight). Too little aluminium in the mixture will result inoxidation and loss of carbon and manganese from the weld steel giving a weld-metal with poor wearing characteristics, and possibly a dangerously violent reaction due to the evolution of carbon monoxide. Excessive aluminium may lead to hardening and brittleness of the weld metal.

Such a ready made mixture of appropriate constituents in correct proportion and particle size is termed as 'Portion' and is specific to rail section, metallurgy of rails to be joined and the particular patented process adopted. Indian Railway Standard Specification of Fusion Welding of Rails by Alumino Thermic Process (IRS-T-19-2012) deals with technical requirements for Thermit welding like supply of the 'Portions', Acceptance tests, approval of 'Portion Manufacturers',disposal of rejected portions, procedure for approval of A.T. Welding supervisors and welders, acceptance test of joints welded at site etc.

1.2 Principle of alumino thermic welding of rails

The objective of the alumino thermic process is to apply it for joining two pieces of rail, end to end, by casting molten 'steel' into a refractory mould that has been placed around the spacing between the two rails. The ends of the rail must be

straight and the correct welding gap established. The rails must be properly aligned with the faces free of rust, dirt & grease. The rails must then be pre heated sufficiently to provide conditions for complete fusion between the molten steel and the base metal of rails to be welded.

Although thermit reaction is non-explosive, the presence of any moisture is not only detrimental to the success of the quality welding, but also potentially dangerous to the welders. During the solidification process of the molten steel, it is critical that no movement, shock or vibration occurs in the rail. The weld must be cooled prior to allowing any traffic to cross the completed weld or to release a hydraulic rail tensor if used during the welding process. For manufacturing good quality alumino thermit welds, RDSO has issued a 'Manual for Fusion Welding of Rails by the Alumino-Thermic Process', which should strictly be followed.

On Indian Railways Alumino-Thermic welding with short pre-heating process by using high silica sand mould (carbon dioxide dried) is being followed at present for welding rails of different chemistry and sections. Short pre-heating is mostly being done by air-petrol fuel mixture. Oxy-LPG and compressed air petrol fuel mixture are being developed as these techniques take less time for pre-heating the rail ends to desired temperature resulting in saving of block time with improved quality of joint.

1.2.1 Alumino Thermic Welding of Rails is carried out through any of the following means:

(a) RDSO approved portion manufacturing firms with their own portion, consumables, equipment and welders/supervisors. These welders/supervisors are certified by RDSO. The list of certified welders/supervisors is circulated by M&C Directorate of RDSO annually. In addition, such welders/supervisors carry a certificate issued by RDSO.

(b) Labour contracting firms with RDSO certified welders/ supervisors with portions and consumables of Thermit Portion Plant(TPP), NR, Lucknow. The list of such firms is circulated by M&C Directorate of RDSO annually.

(c) Departmental welders certified by TPP/Thermit Welding Center (TWC), Vijayawada with TPP portions.

(d) Departmental welders certified by TPP/Thermit Welding Center (TWC), Vijayawada with Portions, consumables and preferably equipment also, supplied by an RDSO approved portion manufacturer. This is applicable for 25mm gap welding only.

(e) The approval of welding supervisors/welders for execution of Alumino Thermic welds at site is given separately for the following categories of welding techniques:

i) Welding of 72 UTS and 90 UTS rails with standard gap.
ii) Wide gap welding.
iii) Welding of 110 UTS and Head Hardened rails.

1.3 Training and certification of welders of contracting firms:

1.3.1 Certification of Welders/Supervisors of Approved portion manufacturing firms is done by RDSO as per provisions of IRST-19-2012, Specification for Fusion Welding of Rails by Alumino Thermic Process.

1.3.2 Training and Certification of welders/Supervisors of labour contracting firms is done by RDSO as per provisions of IRST-19-2012, Specifications for Fusion Welding of Rails by Alumino Thermic Process.

1.4 Procedure for Training and Certification of Departmental Welders:

1.4.1 Thermit Portion Plant (TPP), Northern Railway, Lucknow and Thermit Welding Centre (TWC), South Central Railway, Vijayawada impart initial and refresher training to departmental welders and supervisors for execution of A.T. welds and issue necessary competency certificates to welders/supervisors whose training performance is found satisfactory.

Following training courses are organized by TPP& TWC for departmental welders and supervisors.

S.No.	Type of Course	Duration
1	Initial Course for Welders(TW1)	Two weeks
2	Refresher Course for Welders(TW2)	One week
3	Course for supervisors (TW3)	One week

Annual calendar of training courses are made by TPP & TW Cand advised to Zonal Railways by end of November every year for enabling zonal railways to send course-wise nominations. The Training module covers theoretical and practical aspects of various A.T. Welding Techniques developed by TPP, TWC and approved Portion Manufacturing Firms.

1.4.2 Procedure for awarding Competency Certificates to Departmental Welders:

The welders whose performance is adjudged satisfactory in initial course (TW1) is awarded Provisional Competency Certificate valid for executing 100 joints in presence of trained Supervisor. Provisional Competency Certificate is valid for executing 100 joints or six months whichever is earlier.

On execution of 100 joints in the field by the Welders or completion of six months from date of issue of Provisional Competency Certificate, whichever is earlier, the welder is deputed to TPP/Lucknow or TWC/Vijayawada along with one test piece (2m long having weld at the center), USFD testing reports of welds executed by him, working performance certificate of SSE/SE(P.Way) and relevant welding records as per proforma for thermit weld register (Annexure-1),duly signed by SSE/SE(P.Way) with counter signature of concerned DEN/ADEN. For the purpose of evaluation, the welder should have executed at least 50 welds.

If the defective weld percentage is less than 1% of the welds executed by the welder, the results of test weld and the

welder's performance in TW2 course is satisfactory then the welder will be given regular competency certificate valid for 2 years.

In case the welders fail to execute the minimum number of 50 welds within six months or is not certified successful by the TPP/TWC in the above manner, he is treated as incompetent. Then he will have to repeat the Module TW1 and the procedure described above.

The trained welders have to attend refresher course (TW2) within 2 years of issue of regular competency certificate. In case welders fail to attend the refresher course by the end of validity of their certificate, their competency certificate shall become invalid. The welders who attend TW2 course after expiry of the validity of their competency certificate but within three years of issue of competency certificate, will be permitted to attend TW2 course for revalidating their competency certificate. However, welders turning up for TW2 course after 3 years of issue of competency certificate have to attend initial course (TW1) again as fresher.

1.4.3 Procedure for awarding Competency Certificates to Welding Supervisors

Competency certificate to SE/SSE/JE(P.Way) is issued after successful completion of training course for Supervisors (TW3). On successful completion of this course (TW3), normally, the supervisors shall not be required to undergo this course again. However, the supervisors may be sent for TW3 course by Zonal Railway depending upon the performance of the Supervisor in the field.

1.5 Technique for welding : Welding techniques approved provisionally or for regular adoption by Railway Board/RDSO should only be adopted for welding of rails. Details of approved welding techniques and vendors, is available in 'Master list of approved vendors' issued biannually by Quality Assurance (Civil) Directorate of RDSO.

Significant advancements have taken place in pre-heating techniques, type of moulds, type of crucibles and process automation in the field of A.T. Welding. These advancements offer significant benefits in terms of service life of A.T. welds. In order to absorb these technological advancements, use of compressed air-petrol or better pre heating, single shot crucible, automatic tapping of molten metal and three piece moulds shall be increasingly used for rails of 52Kg and higher sectional weight with 90UTS and higher grades. Air-petrol pre heating with manual pressurization and/or manual tapping of molten metal and/or use of two piece moulds shall be phased out for such rails.

Thermit welding portions and consumables to be used for welding shall be from RDSO approved firms only. The list of RDSO approved firms 'Master list of approved vendors' is circulated by Quality Assurance (Civil) Directorate of RDSO, bi-annually.

1.6 Selection & Suitability of rails to be welded by Alumino Thermic Welding Process

1.6.1 To ensure longevity of Thermit weld, it is essential that only good quality rails are used for Thermit welding. Good quality rails means fulfillment of the following requirements:

- Rail wear (head & side) should be within permissible limits.
- Rail should be ultrasonically tested.
- Rail should not be twisted or warped.
- Rail ends should not be hogged or battered.
- Rail should not be corroded.
- Rail ends should not be flame cut.
- Rail ends should not have bolt holes within 40mm from the rail ends. If bolt holes are existing within this limit, then micro cracks on periphery of the hole will propagate in the weld metal and cause weld fracture.

1.6.2 New Rails to be welded shall have tolerances within limits as per **Table1** given below:

Table 1

SN	Grade of Rail	Rail Section	Head width	Height	Web thickness	End squareness	Flange width
1	Grade 880 (90 UTS)	52 kg	± 0.5 mm	+0.8 mm -0.4 mm	+1.0 mm -0.5 mm	± 0.6 mm	± 1.0 mm
		60 kg (UIC)					+1.2 mm -1.0 mm
2	Grade 1000 (100 UTS)	52 kg	± 0.5 mm	+0.8 mm -0.4 mm	+1.0 mm -0.5 mm	± 0.6 mm	± 1.0 mm
		60 kg (UIC)					+1.2 mm -1.0 mm
3	Grade 1080 Head hardened rail	52 kg	± 0.5 mm	+0.8 mm -0.4 mm	+1.0 mm -0.5 mm	± 0.6 mm	± 1.0 mm
		60 kg (UIC)					+1.2 mm -1.0 mm

1.6.3 Second hand rails:

Old serviceable rails are required to be welded for attending fractures, conversion of existing singlerails/short welded panels intoSWP/LWR/CWR or during secondary rail renewal.

While using second hand rail for A.T. Welding, following precautions are to be taken.

(i) Obsolete rail sections and rails older than 50 years shall not, normally, be welded.

(ii) It should be ensure that second hand rails have asubstantial rail life to make it a safe and economical proposal.

(iii) Rails shall be tested before welding, with ultrasonic flaw detector apart from visualinspection, so that rails having cracks and internal flaws are excluded from welding.

(iv) In order to achieve satisfactory running on welded rail panels, rails with excessivescabbing, wheel burns, corrugations and wear of rail seats shall not be used forwelding. The rail flange bottom shall be visually inspected to ensure freedom fromdefects like dent, notch, corrosion, etc.

(v) Even where cracks/flaws have not been detected during visual/USFD examination before welding, the ends of second hand rails should be suitably cropped so as to eliminate fish bolt holes and heat affected zone (HAZ) if any.

(vi) If rail ends do not have bolt holes, the ends may be cropped to a distance of 150mm for AT welds and 85mm for flash butt welds from the center of welded joint to eliminate HAZ.

(vii) The rolling marks on the web of rails shall be checked before welding to ensure that generally rails of different qualities are not welded together. However, in unavoidable circumstances, where rails of Grade 710 (72 UTS) rail chemistry and that of Grade 880 (90 UTS) chemistry are to be welded, the portion of Grade 880 (90 UTS) chemistry shall be utilised for welding.

Table 2

Rail Section	Normal height of newrail (mm)	Min. height of old rail(mm)	Width of head of new rail (mm)	Min. width of head of old rail (as measuredat the gauge corner)(mm)
60kg	172	163	72	66
52kg	156	150	67	61
90 R	143	139	67	61

(viii) Rails shall be free from corrosion or excessive wear. The height of rail and width of rail head shall not be less than the values as indicated in Table 2 given below.

(ix) For both new as well as second hand rails, before welding, it should be ensured that the end bends of the rails are within +0.5 mm, -0 mm in vertical and + 0.5 mm in lateral direction, when checked with one meter straight edge as shown in Fig. 1.1(a), (b) and (c).End cropping may be suitably increased so as toensure end bends within the permissible tolerances.

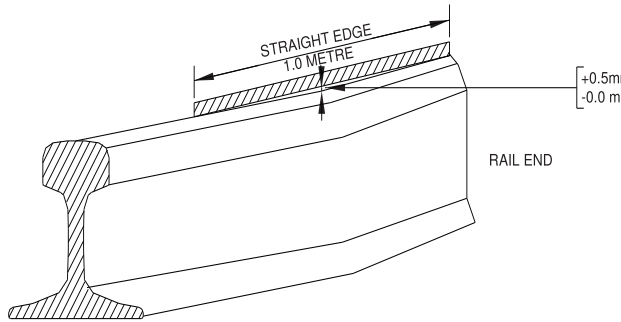


Fig. 1.1 (a) Tolerance on the End Bends in the Vertical Plane

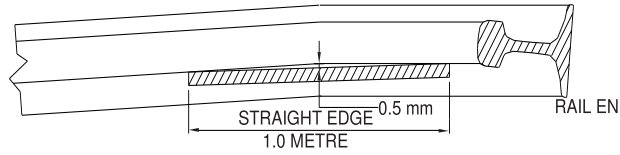


Fig. 1.1 (b)

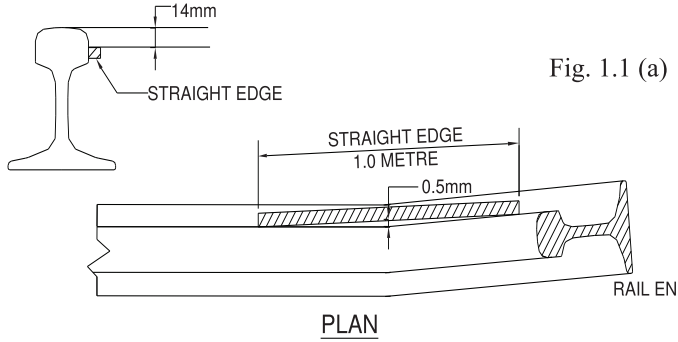


Fig. 1.1 (a)

Fig. 1.1 (c) Tolerance on the End Bends in the Horizontal Plane

Fig. 1.1 Tolerance on the End Bends ot the Rails

(x) The process has been approved for different rail 'sections' i.e.90R, 52kg, 60 kg etc. and 'type' i.e. MM, 90UTS, Chrome -Manganese& Chrome-Radium alloy steel (110 UTS) & head hardened rails. The process can, therefore, be used only for those rails for which the process has been approved as per section and type of rails.

(xi) No alumino-thermic welded joint shall be located closer than 4m from any other welded or fish plated joint.

1.7 Preparation of rail ends to be welded:

(i) The rail ends shall be cut by sawing or using abrasive disc cuter and not by flame cutting. Abrasive disc cutter should preferably be used for cutting the rails (Fig. 1.2). The squareness, evenness & verticality of rail cut depends solely upon the skill of the welder. With portable disc cutters, very little skill is required to produce a perfect cut. For achieving good quality weld such equipment is desirable.

Fig. 1.2 Abrasive disc cutter

(ii) Burrs/metal flow at rail ends, if any, should be removed by chiseling/grinding.

(iii) The rail end faces and the adjacent sides at foot (top & bottom),web and head up to 50 mm should be cleaned with wire brush or any suitable material to remove all dirt, grease and rust and wiped clean with kerosene.

(iv) The underside of rail foot of both the rail ends must be inspected for any crack. Sometimes rather than cutting the rail completely through its section, the welders use sledge hammer to separate the rail ends even when the rail foot has not been completely cut. This is a wrong practice which may damage the rail and finally the weld. If any defect is found on the underside of rail, the damaged portion of rail should be removed.

(v) Stipulated gap, as specified for a particular welding technique, must be ensured i.e. 25+-1 mm for normal gap and 50+-1mm/75+-1 mm for wide gap. The uniformity and verticality of the gap shall be measured by a gauge prior to welding. In case of wide gap of 50/75 mm welding, for repairing fractured/defective welds, it shall be ensured that the end faces are vertical. In LWR/CWR territory, hydraulic/mechanical rail tensor of suitable and approved design should be used for maintaining correct rail gap during welding.

(vi) Smaller or wider initial gap is created either due to poor cutting of rail ends or poor positioning of rail ends or because of contraction/expansion in LWR/CWR sections.

(vii) When the gap is narrow, the flow of the flame, for preheating the rail ends, will not be proper and may cause local melting. The observation of a melting rail head may even prompt executing the weld, even though the base of the web may not have been sufficiently pre-heated. Narrow or uneven gaps may reduce the flow of molten steel to the rail ends, thereby reducing the possibilities of achieving proper fusion.

(viii) When the gap is too wide, the rail ends come in contact with only the outer envelope of the pre-heating flame, thus leading to less pre-heating. Also, there may be a possibility of dipped weld because of shortage of metal.

(ix) In case of repair of fractured rail/defective weld with wide gap weld of 75mm, the rail shall be cut from center of rail fracture/defective weld 37-38mm each side for making suitable gap of 75mm, provided bolt holes do not fall within 40mm from cut faces.

Fig.1.3 Checking Gap

1.7.1 Preliminary work prior to welding:

(i) In case of in-situ welding the rail fastenings for at least five sleepers on either side of the proposed weld are required to be loosened. The sleepers adjacent to the joint to be welded also need to be shifted to obtain a clear working space of 250 mm on either side to accommodate the moulds, clamps, preheating equipment, etc. The rails are then properly aligned, both horizontally and vertically.

ii) When the welding work is carried out on cess, full rail length shall be leveled by supporting on at least ten wooden blocks on either side. The rails shall be properly aligned in horizontal and vertical direction and held in position.

1.8 Alignment of the rail ends before welding:

The rail ends to be welded shall be aligned in horizontal and vertical planes to the dimensional limits indicated below:

1.8.1 Lateral alignment : The two rail ends, after alignment shall be within +0.5 mm when checked with a 1.0 m straight edge at rail ends [Fig. 1.4 (a) & (b)]. Any difference in the widths of rail heads shall always be fully kept on the non-gauge side, correctly aligning the rail ends on the gauge face.

1.8.2 Vertical alignment : The joint shall be kept higher by 3 to 4 mm for 72 UTS rails and 2 to 2.4 mm for higher UTS rails when measured at the end of 1.0m straight edge (as a compensation against sagging caused by differential shrinkage on cooling) [Fig. 1.4 (c)]. This can be achieved by wedges applied on the rail supporting blocks on both sides of the joint.

The purpose of the alignment of the rail ends is to properly position the rail ends such that, after the weld has been completely cooled to ambient temperature, the welded joint is perfectly flat and straight, with no twist between the vertical axes of the rail ends.

Gap between rail ends may be rechecked after completion of alignment. Datum marks shall be made on foot of both rails as well as on joint sleepers in order to observe any longitudinal movement of rails. If excessive longitudinal movement occurs during pre-heating and produces a welding gap outside the prescribed limits, the welding of joint shall be temporarily abandoned and joint allowed to cool.

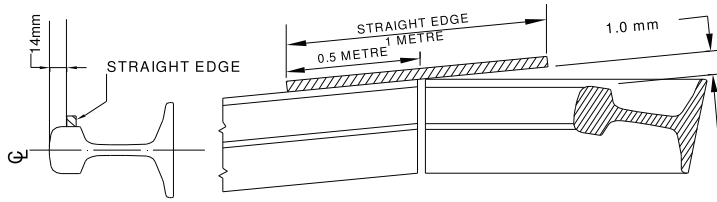


Fig. 1.4 (a) Tolerance for Lateral Misalignment at the Time of Welding

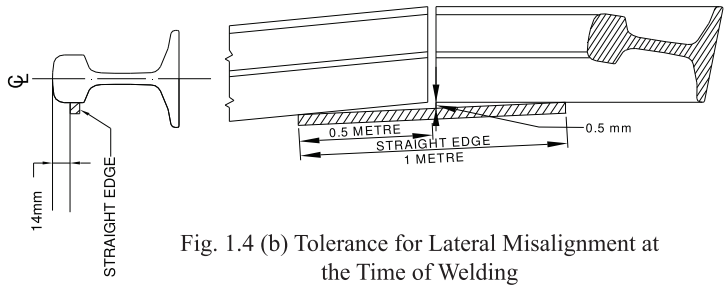


Fig. 1.4 (b) Tolerance for Lateral Misalignment at the Time of Welding

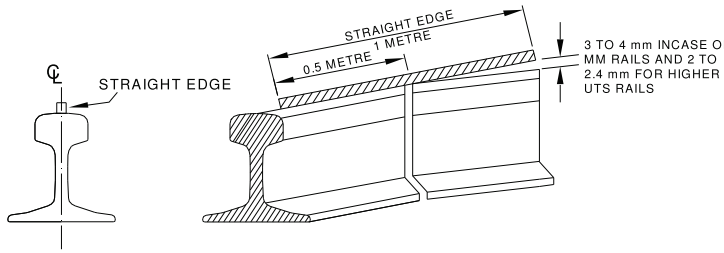


Fig. 1.4 (c) Tolerance for Vertical Alignment at the Time of Welding

Fig.1.4 Tolerances on rails joint at the time of welding

Fig.1.5 Checking alignment with straight edge

1.9 Fixing mould, mould shoes and Luting:

1. Only prefabricated moulds supplied by the A.T Portion manufacturer shall be used for welding. These are made by mixing high silica sand to IS:1987 with sodium silicate to the required consistency, followed by passage of carbon dioxide gas. The prefabricated moulds shall have adequate permeability for escape of mould gases and adequate reinforcement to avoid mould crushing during transportation and welding.

2. Three piece moulds (Fig. 1.5)supplied by A.T. portion manufacturer conforming to Specification of 3 piece Pre-fabricated mould manufactured by A.T. portion manufacturers for use during A.T. welding rails shall be used. Details given at Annexure -3 of IRS: T-19-2012.

3. Before mounting on the rail ends to be welded, each pair of moulds shall be examined for defects, dampness, cracks, blocked vents, etc. and defective moulds discarded. The prefabricated moulds shall be handled with care as they are fragile and liable to breakage.

4. During fixing the moulds, it shall be ensured that the center line of the rail gap coincides with the center line of the mould to avoid cross joint.

5. Mould shoe fixed with moulds should be of correct size and free from geometric distortions (Fig. 1.6).The mould jackets/shoes holding the pre-fabricated mould in a snug fit condition, after fixing, shall be tightened by the application of adequate pressure. Excessive pressure may cause breakage of mould and dropping of sand inside the mould cavity. Care shall be taken during application of adequate pressure.

6. It is essential for the moulds to fit flush to each other across the bottom of the rail flange which can be checked by feeling with fingers across the junction of the two halves of the moulds and by looking down the riser aperture. The moulds should touch the bottom of rail foot to ensure proper size of collar at the bottom which can be checked by feeling with fingers across

the junctions of the two halves and also by looking through the riser aperture. In case of three piece moulds, care should taken to ensure proper fixing of bottom plate to avoid formation of fin at the edges of bottom flanges of weld.

7. Moulds to be used shall be of correct size to that of rail section to be welded.

8. Moulds that are wet or have evidence, as having been wet should not be used. Dampness in moulds can lead to porosity and early fatigue failure of welds. As prefabricated moulds have a tendency to absorb moisture from the atmosphere, it should be ensured that moulds are well packed in moisture proof polythene bags. Damaged/broken moulds should be disposed off properly.

Fig. 1.6 Three piece Mould and Mould shoe fixed with moulds

9. After fixing the mould shoes, the junction of the mould and the gap between mould and the rail shall be packed firmly with luting sand (Fig. 1.7) to prevent leakage of liquid weld metal, starting from the underside of the rail foot and continuing on both sides towards the head of the rail, using only luting sand with minimum moisture content (6%) supplied for this purpose. To avoid any sand particle dropping into the mould, a luting cover may be placed over mould aperture. To protect the rail top table from metal splashes during reaction, the adjacent rail surface on either side of the moulds shall be covered with metal cover or smeared with luting sand up to15 cm on either side.

Fig.1.7 Luting of themould

Fig.1.8 Slag bowls

10. Slag bowls should then be fitted to the lugs on the outside of the mould shoes.(Fig.1.8)

11. The sand core (fitted with a metal ring) should then be placed in pouring aperture of the mould to ensure correct seating and then removed.

2.0 Crucible and Auto Thimble:

2.01 One shot crucible shall be used for welding of A.T. weld. One shot crucible is made from a refractory compound agglomerated by means of synthetic resin (Fig. 2.1). The thermic factor of this crucible is notably better than the conventional crucible and its use results in cleaner steel, consistent weld quality and light weight (14.5 Kg).One shot crucible is used only for one weld.

Fig. 2.1 One shot crucible

2.02 The need for accurate adjustment of crucible on its frame is eliminated. The one shot crucible comes from factory packaged with the portion, crucible and automatic thimble. By having a constant and reliable crucible to produce the weld metal, quality of the weld is increased substantially mainly because of the fact that the thermal balance of the alumino-thermic reaction always remains the same. This ensures a highly uniform tapping temperature, which is one of the key quality parameter for alumino-thermic welding as for any steel production process.

2.03 Auto Thimble or Self Tapping Thimble :

The self-tapping thimble is a fusible plug located by a refractory/magnesia sand body in the throat of the crucible. Its job is to hold the portion/weld metal in the crucible until such time as the reaction is complete with the slag separated, and then release it smoothly into the moulds through the pouring hole.

Auto Thimble is used with one shot crucible. The use of auto thimble ensures that the pouring commences at the correct temperature (Fig. 2.2). It allows tapping at pre-determined temperature thereby eliminating errors associated with manual tapping i.e. early or late tapping. In case of early tapping, slag may accompany weld steel. On the other hand, in case of late tapping, weld steel may loose heat which may cause inadequate fusion. With use of auto thimble safety of personnel is also ensured as no person is required near the crucible thus eliminating the chances of injury.

Self-tapping thimbles are designed to suit the portion heat and the pouring speed required for a process and so the correct thimble must be used. Otherwise an early/late tapping will result and overflowing or slow pouring may cause metal loss, reduced penetration or slag inclusions (due to turbulent fast pour or too slow pour).

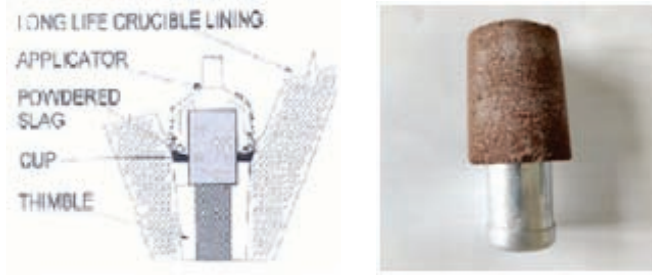


Fig. 2.2 Auto thimble or Self Tapping Thimble

2.1 Portion

2.1.1 The suitability of the 'portion' for the welding process in respect of the type and section of rails to be welded shall be ensured before commencing welding. Only RDSO certified/passed portions should be used for welding and supplied by RDSO approved firm only.

2.1.2 The acceptance slip' for the portion given by the RDSO shall be found inside the bag. RDSO's seal should be available on top of the bag. The portion should conform to IRS-T-19-1994.

2.1.3 The portion being hydroscopic in nature, should have double packing, first in a polythene bag and then in a cloth bag. Damaged/torn polythene bag may result in moist/damp portion and should not be used.

The presence of moisture in the portion, in the crucible or on the work pieces can lead to the rapid formation of steam when the reaction takes place. This may cause ejection of the molten metal from the crucible and may be fatal in addition to lowering the quality of weld. Therefore portion, crucible and moulds must be stored in dry places.

2.1.4 The portion should be poured into the crucible through fingers with a spraying action and striking the crucible wall so that the bottom plugging remains undisturbed. After filling, the portion should be heaped at the center of crucible and a small recess made at the top into which the igniter can be placed.

2.1.5 Portion should not be mixed with any foreign material or any amount of additional portion. The crucible cap should then be placed in position and an igniter (sparkler) hooked on to the crucible cap ready for use.

2.1.6 Particulars of portion contained in the acceptance slip such as Batch No., Portion No., Date of Manufacture, etc. should be recorded in a register kept for this purpose.

Fig. 2.3 (a) Portion, Luting sand, Crucible, mould & Igniter

Fig. 2.3 (b) Luting Sand

2.1.7 Shelf life of portion: No specific shelf life has been indicated for A.T. welding portions. Life of portions would depend on the quality of packing and storage condition. A.T. portion is sensitive to moisture. Once the portion absorbs moisture, the same cannot be removed even by drying as the ingredients react chemically. All such portion should not be used for welding.

If packing is intact and there is no entry of moisture, the portion can be used even after a long time.
However, following procedure may be adopted for permitting use of portions beyond two years after the date of manufacturing:

(a) One random sample per batch of 300 or part there-of may be drawn from the portions available in stores.

(b) The sample shall be tested for reaction test. If the reaction is normal, the batch represented by the sample can be used without further tests.

(c) In case the reaction is found to be quiet or boiling, a test joint should be made from one more sample selected from the batch. Following tests should be conducted on the test joints.

(i) Weld Metal Chemistry Test
(ii) Load deflection test

These tests should be conducted at Zonal CMTs organisation and/or at the Flash Butt Welding Plant. If the values obtained in above tests are within the specified values as given in para 4.1 and 4.2.3.1 of IRS:T-19-2012, the batch represented by the sample can be used otherwise batch should be rejected.

(d) The rejected portions are to be disposed-off by igniting five portions at a time in pit away from the store.

2.1.8 Storage and transportation of Portions:

'General guidelines for storage and transportation of A.T. Portion' representing best practices with respect to storage of materials are discussed below.

Stores should be dry, well ventilated, and where required light, power and running water should be available. In all cases building construction should be in compliance with the FIRE regulations applicable to the substances being stored. Consideration shall also be given to the relevant regulations issued in this respect. The appropriate notices should be displayed where material such as Thermit Portions and Igniters are stored.

Storage of Thermit Portions : Portions should be stored in a secure, non-combustible building. While it is preferable that they should be stored separately, they may be stored with other non inflammable materials, such as equipment and small tools, mould, luting sand in sealed bags, etc. in which case ideally they should be segregated. The store should be dry with ventilation to prevent excess humidity or dampness, and should be designated as a non-smoking area, with no naked flames. Portions must not be stored in the same building as explosive or flammable items (e.g. Fuel, fuel gases, igniters). The sealed boxes must not be opened until immediately prior to use. Any spillages should be immediately swept up and the material disposed in accordance with safety data sheets. Steel shovels should not be used on concrete floors, which might create a spark. Portions should be used in rotation i.e. first in-first out. Proper notices should be displayed inside and outside the building

together with the standard warning sign, which should read "Metallic Powder - In case of fire DO NOT USE WATER". The Local Fire Brigade should be informed of exact location of store and nature of contents. Only dry powder extinguishers of appropriate class should be used in the proximity of Thermit powders.

Storage of Igniters : Tubes of igniters should be stored in a locked steel cupboard, or other secure steel container. On no account must these be stored in the same building as the portions.

Transportation of A.T. Portion : A.T. Portion should not be transported in passenger coaches. The package containing igniters should be kept in tin cases/steel containers. Manufacturer of portion shall provide a sheet containing best safety practices with every package for guidance of the user covering various aspects in safe handling, storage, transportation and disposal of thermit materials.

2.2 Preheating

2.2.1 After fixing and luting of the moulds, the rail ends shall be uniformly pre-heatedthroughout the rail section with specially designed torch appropriate to the fuel mixture is used. Presently on Indian Railways,Air petrol mixture, compressed Air-petrol mixture and Oxygen-LPG preheating processesare being used.

Fig.2.3 Preheating

2.2.2 The flame shall be properly adjusted to achieve the desired rail temperature. The pre-heating shall be done from the top of the mould box for stipulated period for welding technique adopted, so as to achieve a temperature of around 600 $\pm$ 20 degree Centigrade. Compressor tank pressure and preheating time required for various preheating process are given in the following table 3.

Table 3

SN	Welding preheating process	Compressor tank pressure	Preheating time
1	Air petrol	7+0.70 kg/cm^2 (100+10 lb per sq in)	10 to 12 minutes
2	compressed Air-petrol	0.2 to 0.3Kg/cm^2	4.0 to 4.5minutes
3	Oxy-LPG		2.0 to 2.5 minutes
	Oxygen pressure	7.0-8.0 kg/cm^2	
	LPG pressure	2.0-2.5 kg/cm^2	

2.2.3 While pre-heating with Oxy-LPG burner, LPG supply should be opened first and the gas ignited, thereafter oxygen supply should be opened. While closing, oxygen supply should be stopped first followed by LPG supply. The burner shall be properly adjusted during preheating to ensure that the head, web and foot of both rail ends are heated uniformly.

2.2.4 Special emphasis shall be given to the tank pressure, efficiency of burner and flame condition for achieving required rail temperature within the stipulated time. From time to time or in case of any doubt with a view to maintain proper quality control, temperature measuring devices like optical pyrometer, contact type pyrometer or temperature indicating crayons may be used for measuring rail end temperature just after completion of preheating i.e. after removal of burner.

2.2.5 The pre-heating torches should not be bent or damaged or their holes blocked. Positioning of the pre-heating torch in the

mould box must be carefully adjusted because it affects the quality of pre-heating.The 'sand-core' must be held using tongs over the pre-heating flame above the moulds for 30 second to remove any mixture.

2.2.6 The welder performing the pre-heat must watch the entire pre-heating of the rail ends from start to completion. Rail ends and moulds must heat evenly. Uneven heat can cause internal cracking of the weld due to uneven cooling. In the event a portion of the rail head or rail face of either rail end is melted, the weld must not be executed.

During the pre-heating process, if there is breakage of the mould where a piece of the mould may break off and fall into the weld cavity. In such situation, welding should be stopped, the mould should be removed and disposed off properly and new mould installed. Care should be taken that escape of the gases from the riser holes of the moulds during the entire preheating operation is not obstructed.

2.3 Equipment, staff and Traffic block for welding:

The list for one set of A.T.welding equipment by short pre-heating process is given in Annexure 2. The composition of thermit welding team is given in Annexure 3. A minimum traffic block of 70-75 minute duration, depending upon the type of preheating technique adopted, should be obtained for complete operation of welding of first joint to ensure good quality of A.T. weld.

2.4 Execution of Welding:

After pre-heating the rail joint, the sparkler shall be ignited and inserted in the portion at the centre top to start the reaction. The reaction shall not be vigorous or boiling. By the time the reaction is complete, the burner shall be removed quickly and the gap closed with a dried sand core in case of central pouring to prevent loss of heat and turbulence during flow of metal.

2.4.1 Reaction time and tapping time:

In case the welding portion is heated in a separate magnesite lined crucible, the reaction is initiated using igniters inserted centrally in the thermit portion. The portion melts and the slag separates at the top, enabling tapping of the crucible to pour the molten metal into the mould.

Tapping time is very important for the final weld quality. Tapping time is defined as the total time, from the time the portion is ignited, till the molten weld metal begins to pour into the mould cavity.

It is important to select the correct tapping time as, both under timing and over timing of this operation affect the quality of weld. The tapping is to be done after the reaction is completed and the slag rises to the top. The reaction takes about 20 seconds. If tapping is done prematurely, slag separation will not be completed. Therefore slag may get entrapped within the weld metal. Aluminium content also will be high in such cases. If the tapping is delayed after the reaction time is over, loss of superheat takes place. Delayed tapping may thus result in lack of fusion. Off center pours will cause defective welds due to slag inclusion.

In case of manual tapping, the time period between removal of burner and tapping of metal should be as minimum as possible. After the reaction subsides, about 3 seconds shall be allowed for the separation of slag from the metal, which may be judged by looking into the crucible through colored glass to IS:5983 when manual tapping of molten metal is employed. Thereafter, the molten steel shall be tapped into the mould by striking the closing pin with a tapping rod. It is to be ensured that the crucible should not move during tapping and no turbulence occur while pouring.

In case of automatic tapping of molten metal, these aspects are taken care of automatically. Care shall be taken to ensure that the crucible does not move from its position during tapping. When pouring is over, the crucible and swivel stand shall be removed and kept aside without disturbing the joint.

If the reaction is found to be boiling, the metal shall be out-tapped. Vigorous reaction and loose closing of crucible may cause self tapping. In this case also, the metal shall be out tapped. If, in any case, self tapped metal enters the mould, the joint shall be rejected, cut and re-welded. In cases of out tapping, the joint should be cooled to ambient temperature and the process of welding restarted afresh. However, if temperature can be measured, the rail ends may be heated to an extent so as to achieve temperature of about 600 $\pm$ 20 degree Centigrade and welding of joint may be completed.

2.4.2 Pouring of metal from crucible:

The pouring of the molten metal has to be smooth and continuous. A bad tapping action or self tapping of the crucible, caused by inadequate insulation of the head of the mild steel tapping pen, may cause a turbulent intermittent pour, leading to oxidation of the weld metal. These oxides may form into “beads” or “plates”, both of which may cause weld failures in service.

2.4.3 Mould waiting time:

After pouring, crucible is lifted off and slag bowls are removed from the mould shoes. The mould shoes shall be removed just prior to completion of mould waiting time. Molten metal is allowed to cool and solidify with mould intact for a period of mould waiting time. The mould waiting time is generally 4 to 6 minutes for 25 mm gap joints and 12 minutes for 75 mm gap joints.

2.4.4 Trimming

After the mould waiting time has elapsed, the trimming should be done by using hydraulic weld trimmer of suitable and approved design without knocking out the mould. Mould from the top and sides is removed leaving at least 1mm excess metal on the rail table for removal during final grinding.

Latest approved suppliers of weld trimmers and rail profile weld grinders borne on approved list of Railway Board for small track machines may be referred to. In the eventuality of sudden failure of weld trimmer, manual chipping may be resorted to. In case of welding of old rails, if it is not possible to use weld trimmer due to flow of metal at rail head, manual chipping should be done.

During the trimming operation, it shall be ensured that the wedges used in aligning are in their proper places without loosening, and they are not removed for at least 20minutes after stripping or until removal of the insulation hood for controlled cooled joint. The runner and riser must not be removed until cold, and that too only by knocking towards the rail.

Fig. 2.4 Weld Trimming Operation

No welding shall be carried out if it is raining. In case, the rains start while the joint is under execution, immediate arrangement to adequately cover the site shall be made.

Welding crew members shall be protected during the ignition of the thermit portion and pouring of the molten steel by wearing welding gloves and welding goggles. During the initial violent phase of the reaction, all welding crew members must stand clear.

For upgraded A.T. Welding Techniques, approval letter issued to firms by RDSO, mentions the parameters such as preheating time, pressure, type of moulds, crucibles, tapping system etc. which may be ensured while welding.

2.5 Operations subsequent to welding:

2.5.1 Post weld cooling:

110 UTS alloy steel rail joints (chrome manganese and chrome vanadium type)are required to be slowly cooled immediately after trimming by fixing an insulation hood (Fig. 2.5) lined with asbestos, so as to control the cooling rate of the weld zone. The hood must be kept around the joint for at least 20 minutes.

In case of welding of head hardened rails, the average hardness of the HAZ of the rail becomes considerably less than the parent rail hardness. This lower hardness is due to transformation of rail steel occurring at cooling rate much lower than that achieved during the original head hardening operation. Such a hardness difference can lead to differential plastic deformation during wheel rail contact which may cause localized cupping. Head hardened rails, therefore, must be subjected to controlled quenching for a specific time by the arrangement approved for the technique.

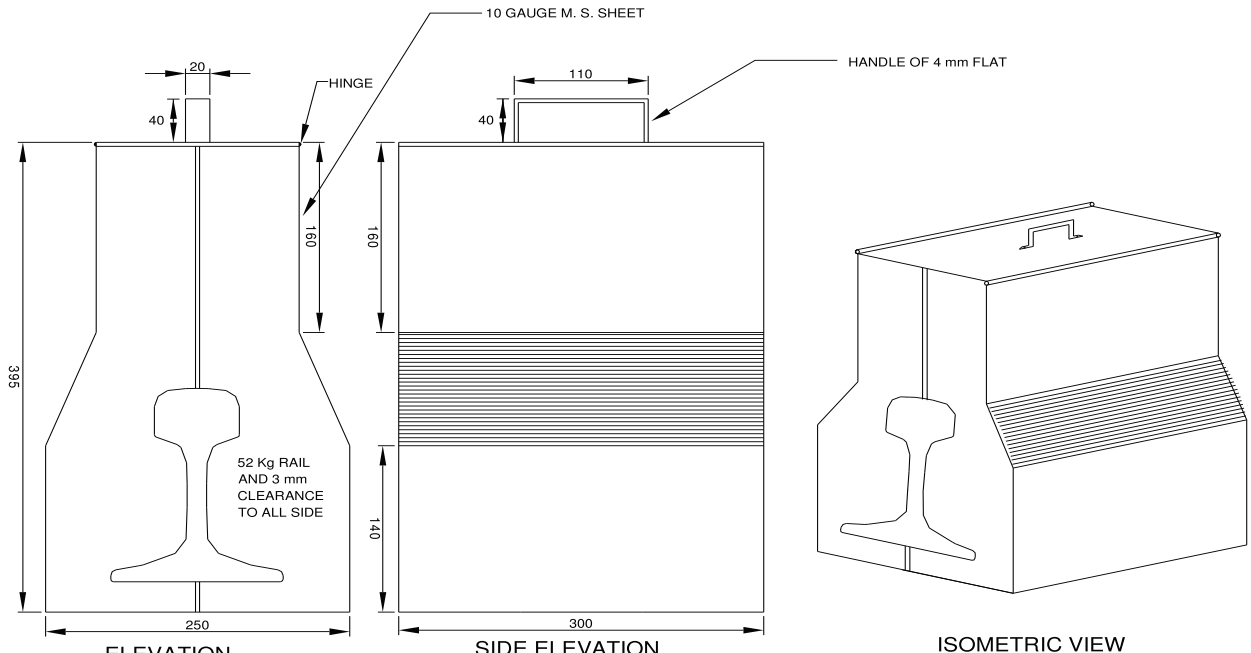


Fig. 2.5 Details of Insulation Hood

2.5.2 Grinding

After the excess metal is trimmed off, the grinding of the remaining metal on the rail table and the sides of the rail head shall be carried out only with rail profile guided grinding trolley of approved design. Use of hand files should not be resorted to except in unavoidable circumstances. In the case of in-situ joints, the grinding shall commence only after the sleeper fastenings are refixed, after the removal of wedges. The rail table shall first be ground down to original profile and checked by a one metre straight edge. This should be followed by grinding of the sides of the railhead. The accuracy of grinding shall be checked by using 10 cm straight edge. While grinding, only light pressure should be applied and grinding wheel should bemoved to and fro to avoid local overheating.

Fig.2.6 Profile Grinder

Fig.2.7 Finished weld

2.5.3 Surface finishing of welds:

Geometry of the running surface of welded joints is very important as any imperfection gives rise to the following bad effects:

(i) Higher stresses in rails and welds making them fracture prone
(ii) Damage to vehicle suspension
(iii) Pulverising of ballast
(iv) Damage to rubber pads/concrete sleepers
(v) Passenger discomfort

The defectively finished welds may be dipped, humped, or locally worn. These irregularities are either due to post grinding imperfections or due to use of weld metal of incorrect composition. These surface defects become more critical for higher speeds which demands higher standards of track surface. Track with poor rail geometry deteriorates faster than track with good rail geometry. This necessitates increased track maintenance frequency. Hence all out efforts shall be made to achieve high weld quality and geometry of rail welds.

2.5.4 Post weld packing of sleeper: Before the passage of traffic, the wedges used for aligning should be removed and joint sleepers which were shifted to obtain the clear gap of 250mm on either side shall be re-shifted to the original location and repacked. Packing of these re-shifted sleepers should be carried out gently and carefully.

2.5.5 Passing of traffic: The first train should be allowed to pass on the newly welded joint only after 30 minutes have elapsed since pouring of weld metal. Necessary speed restriction shall be observed until the grinding operation is over.

2.6 Acceptance tests:

2.6.1 Visual inspection: 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.

2.6.2 Dimensional Tolerances:

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

(i)	Vertical alignment	:	Variation not more than +1.0mm, -0.0mm measured at the end of one metre straight edge.
(ii)	Lateral alignment	:	Variation not more than +0.5mm measured at centre of one metre straight edge.
(iii)	Finishing of top surface	:	+0.4 mm, -0.0mm measured at the end of10cm straight edge.
(iv)	Head finishing on sides	:	+ 0.3 mm over gauge side of the rail head measured at the centre of 10cm straight edge.

The method of checking the geometry of welded joints is illustrated in Fig. 2.8

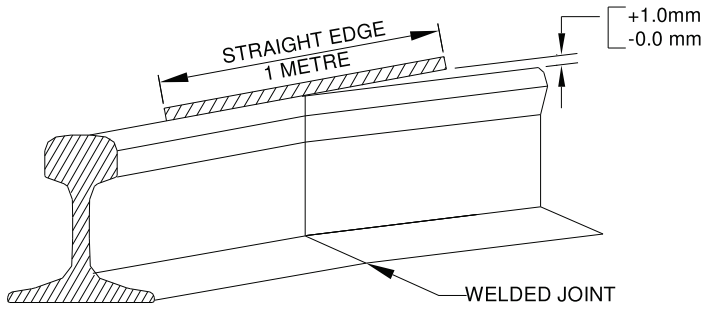


Fig. 2.8 (a) Tolerance for Vertical Misalignment of Welded Joint

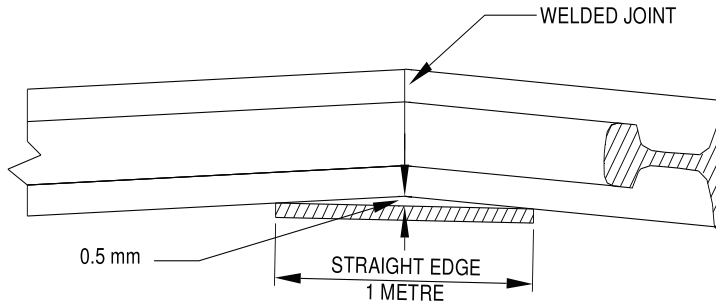


Fig. 2.8 (b) Tolerance for Lateral Misalignment of Welded Joint

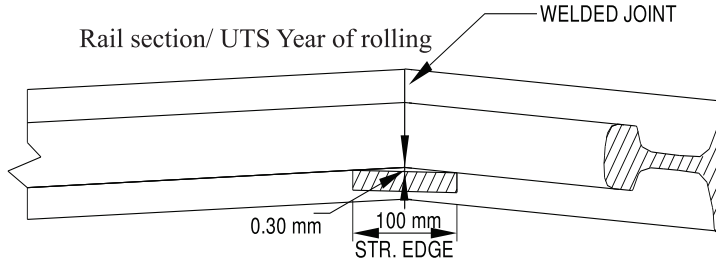


Fig. 2.8 (c) Tolerance for Finishing on Sides of Head of Welded Joint

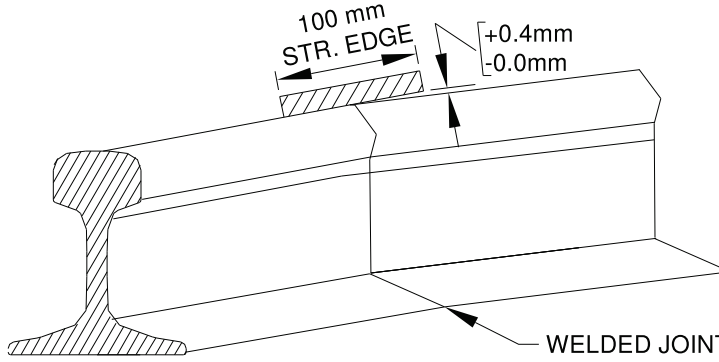


Fig. 2.8 (d) Tolerance for Finishing Top Table Surface of Welded Joint

Fig. 2.8 Tolerances of finished weld

2.6.3 Record of joint geometry : The details of geometry of each joint shall be jointly signed by the firm's and Railway's representative and kept as record. Any joint found not conforming to the above stipulations shall be cut and re-welded, free of cost, by the firm.

2.7 Ultrasonic flaw detection test : All the fusion welded joints shall be ultrasonically tested asper the provisions of 'Manual for Ultrasonic testing of rails and welds'. This testing shall be completed as early as possible but in any case before the welding team is shifted. A thermit welding done insitu shall be joggle fish plated with two clamps and supported on wooden blocks of300-450 mm length until tested as good by USFD.

2.8 Guarantee of welded joint:

2.8.1 Rail joints welded by a firm shall be guaranteed against failure which includes failures in execution, 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 given in para 2.8.3below.

However, cumulative number of failed A.T. welds including re-welded 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.

2.8.2 For upgraded A.T. 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 given in para 2.8.2 above.

However, cumulative number of failed A.T. welds including re-welded joints of upgraded A.T. welding technique in criteria given above up to 120 GMT 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.

2.8.3 Re-welding of defective joints:

i) All the joints found to be defective as per acceptance tests as given in paras 2.6 above and/or joints failed in guarantee period as specified in paras 2.8.1/2.8.2above will be cut and welded by the firm free of cost using their portions, equipment, labour and consumables.

ii) 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.

iii) All the re-welded joints should meet the acceptance tests as indicated in para 2.6.

2.9 Sample test joint:

2.9.1 One out of every 100 joints welded shall be selected at random by the purchaser or by the inspecting officer within one month of welding and subjected to hardness, transverse load/deflection tests and porosity as per clause 4.2 of IRS:T-19-2012 (reproduced partly as Annexure 8 for ready reference) and the joint shall comply with the provisions laid down therein.

2.9.2 If the sample test joint fails to satisfy any of the requirements of specification IRS:T19-2012, 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 retests as per clause 4.2 of IRS:T-19-2012. Both the joints should clear all the tests. If this report is also not satisfactory, further welding of joints shall be suspended until the firm's welding technique has been examined and the same satisfies the requirements of clause 4 of IRS:T-19-2012. The clearance for recommencement of welding shall be given by RDSO.

2.9.3 In case of failure of sample test joint, 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 para 2.8.3.

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 5.6. Such marked joints shall be kept under careful observation by the purchaser.

3.0 Action to be taken in case of Defective / Fractured joints:

In case, cumulative number of A.T. welds failed in criteria given in above clause 2.8.1/2.8.2 exceeds stipulated percentage in respective clauses, following action shall be taken:

i) Action as per contract conditions to be initiated.
ii) Railway shall be at liberty to suspend further welding.
iii) The details of welds executed against a particular contract, % defective /fractured welds against total no. of welds executed shall be compiled as per the format given in table 1.

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 the 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 given in table 2

vi) The investigation report prepared by sectional DEN/ Sr. DEN shall 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.

4.0 Painting of Thermit welds :

Painting of weld collar should be done on all welds to protect them against corrosion immediately after the welding. The procedure of painting and specification of paint is described below.

4.1 Procedure for painting of weld collar for Thermit Welded Rail joints to protect against normal corrosion

4.1.1 New Welded Joint :

A. Surface preparation

(i) Dust, loose rust and mill scale shall be removed by wire brushing.

(ii) Welded area shall be scrubed with water to make it free from slag and other water soluble compounds and then make it dry.

Table 1

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)

Table 2

S.No.	Km/ 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 A.T. 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 has also to be enclosed in terms of Note in Chapter 8 of 'Manual for Ultrasonic testing of rails and welds, Revised 2012'.

B. Painting Procedure

(i) One coat of ready mixed bituminous black paint is applied by brushing, conforming to IS: 9862-1981, on the welded area and 10cm on either side. Paint shall be lead free, acid, alkali, water and chlorine resisting.
(ii) After eight hours drying, a second coat of the same paint is applied.
(iii) Painting should be carried out by brush only.

4.1.2 Maintenance Painting (for Old Painted Joints)

A. Surface preparation

(i) Dust, dirt and flaked paint shall be removed from the welded joint by wire brushing.
(ii) Surface shall be cleaned with petroleum hydrocarbon or any other suitable solvent, if oil or grease is present to de grease the surface. Then it is allowed to dry.

B. Painting procedure

(i) One coat of ready mixed bituminous black paint is applied by brushing, conforming to IS: 9862-1981or bituminous emulsion to IRS: P-30-1996 on welded area and 10 cm on either side. Paint shall be lead free, acid, alkali, water and chlorine resisting.
(ii) If required, after eight hours of drying, a second coat of the same paint is applied.
(iii) Painting should be carried out by brush.

The list of approved manufactures for the above quality of paints is issued every year by the Director General (M&C), RDSO, Lucknow to Zonal Railways.

4.2 Procedure for painting of weld collar for thermit welded rail joints to protect against severe corrosion

4.2.1 New Welded Joints

A. Surface preparation

(i) Dust, loose rust and mill scale shall be removed by wire brushing.
(ii) Welded area shall be scrubed with water to make it free from slag and other water soluble compounds and then make it dry.

B. Painting procedure

(i) One coat of high build epoxy paint (two pack) is applied conforming to RDSO specification No. M&C/PCN-111/88 on the welded area up to 10 cm on either side.

4.2.2. Maintenance Painting (for Old Painted Joints)

A. Surface preparation

(i) Dust, dirt and flaked paint shall be removed from the welded joint by wire brushing.
(ii) Surface shall be cleaned with petroleum hydrocarbon or any other suitable solvent, if oil or grease is present to de grease the surface. Then it is allowed to dry.

B. Painting procedure

(i) One coat of high build epoxy paint (two pack) is applied conforming to RDSO specification No. M&C/PCN-111/88 on the welded area up to 10 cm on either side.

RDSO specification no. M&C/PCN-111/88 has been circulated vide RDSO's letter no. M&C/PCN/II/TR/3 dt: 13/14-5-1991

4.2.2 In service painting (maintenance painting) of Thermit welds should be carried as per following frequency:

(i) Once in four years in areas not prone to corrosion.
(ii) Every year at locations prone to corrosion as defined in para

249 (i) of IRPWM. The frequency may be increased depending on the site conditions.

(ii) On condition basis at locations which are prone to severe corrosion (areas of severe corrosion to be decided by territorial Chief Engineer/Chief Track Engineer).

5.0 Traceability & Marking of Welds:

5.1 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 A.T. weld on head as shown in Fig. 5.1 given below :

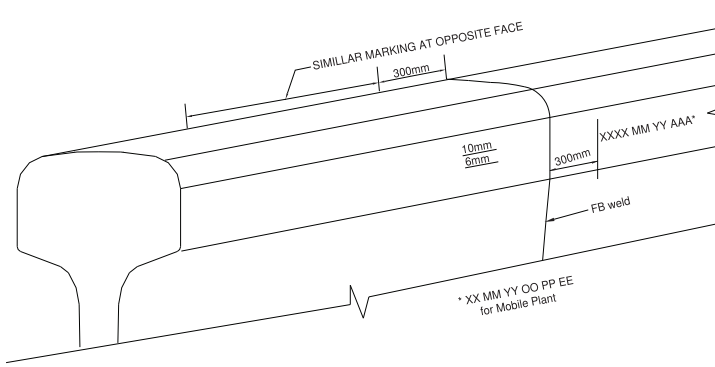
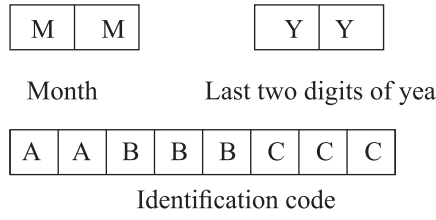


Figure 5.1 : Location of marking on non-gauge face of welds



Where,

A	A

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

00 for A.T. portion manufacturing firms
01 for departmental welders
02-99 for welders of welding contractors. The codes shall be allotted for different contractual agencies undertaking A.T. 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, **H**TI=H, **O**TPL=O, **S**IRIL=S, **R**MPL=R, I**F**A=F, TPP(**N**R)=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 A.T. 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 is02, having specific person number of 001 and having competency for welding with portion/technique of portion manufacturing firm with code 'H'.

5.2 Weld Records:

PWI shall maintain 'Thermit Weld Register' as per proforma given in Annexure 1.The welded joints shall be serially numbered in a kilometer. Repair welds/additional welds done at a later date may be given continuing weld number in that kilometer. For example, the last thermit weld number in a particular kilometer was 88 and subsequently a thermit weld has been executed, it shall be numberd 89, irrespective of its location in that kilometer.

6.0 AT welding for combination joint:

On every railway system, more than one rail section is used depending upon vintage of rails and type of traffic. Moreover, at times, rails of two or more cross sections are laid on the same route. Often, it is required to insert glued joints, points & crossings or SEJs of rails having different cross-section. Earlier combination fish plates were used for joining of rails having different cross-sections. But, the combination fish plates result in battering, hogging of rails ends and also require periodical watch & maintenance. An ideal answer to this problem is to replace the junction of different cross section of rails with forged junction of combination rails. But, these forged rails are required to be imported from foreign countries and which naturally cost much.

As an alternative, AT Welding technique for combination rail joint welding for different rail sections as given below has been developed.

60kg (90 UTS) with 52 kg (72UTS)
60kg (90 UTS) with 52 kg (90UTS)
52kg (90 UTS) with 90R (72UTS)
52kg (72 UTS) with 90R (72UTS)

Special pre-fabricated moulds are used for welding combination joints of different rail sections. The use of this welding technique has resulted in improved riding comfort and improved maintainability (Fig 6.1). The gap between rail ends is kept between 48-50 mm.

Fig. 6.1 Combination joint

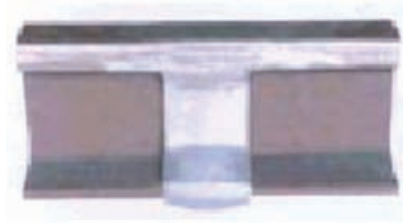


Fig. 7.1 Wide Gap Joint

7.0 Wide Gap (75 mm) Welding Technique:

AT present, the fractured rail/welds have to be replaced by long rail closure. This rail piece is inserted in the track after creating a gap of about same length and welded with the existing rail on both the ends. Thus, in order to remove one defective/fractured AT weld, two AT welds are created. The whole process of replacing the fractured/defective weld with closure rail piece involves considerable amount of man power and block time as well as wastage of rails. With the development of 75mm wide gap welding technique, the defective/fractured weld can be replaced with a single 75mm wide gap AT weld thus resulting in considerable saving of man power and block time required for execution of AT welds (Fig 7.1).

The major procedural difference between the standard 25mm gap welding and 75mm wide gap welding arise mainly due to larger quantity of thermit steel in later. Because of increased volume, the heat content of thermit steel is greater which leads to slower

solidification. Hence, temperature dependent post welding activities such as demoulding, trimming and grinding are slightly delayed. As a result, time required for execution of wide gap welding joint is slightly longer than one standard 25mm weld, but still lower than the time required for two 25mm standard weld.

Advantages of wide gap welding technique are as follows,

i) A single defective/fractured weld/rail can be replaced on one to one basis.
ii) It will not require insertion of a 6m rail piece.
iii) Less number of traffic blocks will be required.
iv) Lesser number of weld failures due to reduced number of welds hence improved safety.
v) Saving in requirement of joggled fishplates and wooden blocks.
vi) Substantial saving of manpower, material and increased availability of track for running of trains.

The Thermit wide gap (75 mm) welding process has been developed to replace defective welds of Alumino thermic, Flash butt and isolated rail defects. The thermit portion and the crucible are of a bigger size. The time for Preheating the rail ends are as follows.

Rail Section	Preheating Time	
	With Drum Vapouriser	With compressed Air Petrol Mix
60 kg	12 minutes	41/2 minutes
52 kg	10 minutes	4 minutes
90 R	8 minutes	31/2 minutes

The procedure involves removal of the defective weld, aligning and creating a gap of 75 mm $\pm$ 2 mm between the rail and fixing the requisite wide gap prefabricated mould around the rail gap. The remaining steps are same as the regular SKV technique.

ANNEXURE-1

PROFORMA FOR THERMIT WELD REGISTER

S.No	Date of welding	Location details					Rail		Bolt hole distance (mm)
		Block Stn.	Cess / Situ	Km TP	U/D	L / R	Sec-tion	UTS	
1	2	3					4		

Portion details				Welding details			
Agency code	Batch No.	Portion No.	Date of Manufac turing	Agency code	Process	Supervisor code	Welder code
5				6			

Weld No.	Block time		Date of finish grinding	Dimensional tolerances on finished joint				USFD testing after welding	
	From	To		On 1m		On 10cm		Date	Result (Pass/ Failed)
				Lateral	Vertical	Top	Side		
7	8		9	10				11	

In service failure details		Test joint date removed	Replacement Weld Reference				Sign. of PWI Welding	Date of sending test joint with reference
Failure			Weld1		Weld 2			
Date	Type		S. No.	Date	S. No.	Date		
12		13	14				15	16

Test joint results									Chainage of weld	Reference point for chainage
Date of receipt of results with referen ce	Hardness (BHN)			Transverse load		Porosity (%)	Date of marking 'X' for extended guarantee	Remarks		
	Rail	Weld	HAZ	Load	Deflection (mm)					
17									18	19

ANNEXURE-2

LIST OF EQUIPMENT FOR ALUMINO –THERMIC WELDING OF RAIL JOINTS BY SHORT PREHEATING PROCESS PER WELDING TEAM

S. No.	Description	Quantity		Life in terms of No. of joints
		Mass welding	Repair welding	
A.	**PRE-HEATING EQUIPMENT**			
A1.	**Air- Petrol Pre-heating**			
1.	Pressure tanks with pressure gauges* complete	2 Nos.	1 No.	500*
2.	Vaporisers (burner) complete	2 Nos.	1No.	500
3.	Nozzle prickers	4 Nos.	2 Nos.	50
4.	Nozzle keys	1 No.	1 No.	500
5.	Vaporiser stand	2 Nos.	1 No.	1000
6.	Goose neck attachment to vaporiser	4 Nos.	2 Nos.	50
A2.	**Compressed Air-Petrol Pre-heating**			
1.	Suitable compressor system* with pressure gauges**	2 Nos.	1 No.	Periodical maintenance half yearly* 500**
2.	Torch(Burner) complete	2 Nos.	1 No.	300
3.	Torch (burner) keys	1 No.	1 No.	500
4.	Torch (burner) stand	2 Nos.	1 No.	1000
5	Goose neck attachment to vaporiser	4 Nos.	2 Nos.	50
A3.	**Oxy- LPG Pre-heating**			
1.	Oxy- LPG torch (burner)	2 Nos.	1 No.	150-200
2.	Oxygen cylinder with pressure gauge	2 Nos.	1 No.	100
3.	LPG cylinder with pressure gauge	2 Nos.	1 No.	100
4.	Torch (burner) stand	2 Nos.	1 No.	500
5.	Connecting Hose pipe	4 Nos.	2 Nos.	75-100
B.	**OTHER EQUIPMENTS**			
1.	Crucible complete- Crucible shell* & Crucible lining**	2 Nos.	1 No.	*500 & **50
2.	Crucible caps	2 Nos.	1 No.	50
3.	Crucible forks	2 Nos.	1 No.	500
4.	Crucible stands	2 Nos.	1 No.	1000
5.	Crucible rings	2 Nos.	1 No.	500
6.	Mould pressure (clamp)	2 sets	1set	1000

S. No.	Description	Quantity		Life in terms of No. of joints
		Mass welding	Repair welding	
7.	Cleaning rod round	2 Nos.	1 No.	500
8.	Tapping rod	1 No.	1 No.	1000
9	Straight edge 1m long	2 Nos.	1 No.	--
10.	Straight edge 10 cm. long	2 Nos.	1 No.	--
11.	Aluminium/steel rod for thermal plugging	2 Nos.	2 Nos.	--
12.	Leather washers for pump	4 Nos.	2 Nos.	100
13.	Gap gauges and height gauge	2 Nos.	1 No.	--
14.	Filler gauge	2 Nos.	1 No.	--
15.	Tools for punching the marking	2 Sets.	1 Set	--
16.	Mould shoes	6 Pairs	2 Pairs	100
17.	Stop watch	1 No.	1 No.	--
18.	Pyrometer/Thermal chalk for measurement of rail temperature	1 No.	1 No.	--
19.	Wooden wedges for rail alignment	24 Nos.	12 Nos.	--
20.	First aid box filled with medicines bandages, cotton etc.	1 No.	1 No.	--
21.	Mirror 150 x 100mm with handle	2 Nos.	1 No.	--
22.	Tool box containing –			
i)	Hot sets (chisels) (for Emergency use only)	2 Nos.	2 Nos.	--
ii)	Funnel tin (for pouring petrol)	1 No.	1 No.	--
iii)	Adjustable spanner	1 No.	1 No.	--
iv)	Hammer 1 kg	1 No.	1 No.	--
v)	Sledge hammer double panel 5 kg.	2 Nos.	2 Nos.	--
vi)	Steel wire brush	1 No.	1 No.	--
vii)	Blue goggles	2 Pairs.	1 Pair.	---
viii)	Paint brush 50mm	1 No.	1 No.	--
ix)	Slag container (bowl)	2 Nos.	1 No.	500
x)	Asbestos gloves	4 Pairs.	2 Pairs.	500
xi)	Hose clips	4 Nos.	4 Nos.	--
xii)	Pliers	1 No.	1 No.	--
xiii)	Rail file 350x40x6mm (For Emergency use only)	4 Nos.	2 Nos.	--
23.	Weld trimmer(Cutter*)	1 No.	1 No.	100*
24.	Insulation hood for control cooling(for 110 UTS rail welding)	1 No.	1 No.	--
25.	Rail profile guided grinding trolley (Grinding wheel*).	1 No.	1 No.	50*
26.	To ensure quality, protective clothing, shoes gear & Leather gloves.			

ANNEXURE-3

COMPOSITION OF THERMIT WELDING TEAM (COMPRESSOR TANK- WISE)

Designation	Numbers
Welder Grade I/Grade II	1
Welder Grade III/Skilled Artisan	2
Helper Khalasi/Khalasi	5
Gangman	As per work load

Note: The composition of welding team has been framed taking into account that trimming and grinding operation would be done by weld trimmer and rail profile grinder.

■ ■ ■

CHAPTER II

FLASH BUTT WELDING OF RAILS

1.0 Introduction

Flash butt welding of rails has been the most popular methods of welding of rails in stationary depots all over the world. The strength of the welded joint made by this process is more compared to any other welding process.

Flash Butt Welding is being done on Zonal Railways departmentally, using Stationary Flash Butt Welding Plants of different makes. Mobile Flash Butt Welding Plants, capable of in situ Flash Butt Welding of rail joints, are also in operation on some of the Zonal Railways. On Indian Railways, FBW depots are at Mughalsarai (ECR), Meerut (NR), Gonda (NER), Arakkonam (SR), Moula Ali (SCR), Jharsuguda (SER), Sabarmati (WR) and mobile FBW plants working in stationary mode in Depots at Chalisgaon/Wahrora (CR), Subedarganj (NCR), New Bongaigaon (NFR/Con.) and Irarasi (WCR).

2.0 Manual for flash butt welding of rails

In order to regulate the method of flash butt welding of rails on Indian Railways a Code was brought out by RDSO in 1972 for practice of flash butt welding of rails. It was subsequently revised and brought out as 'Manual for Flash Butt Welding of Rails, 1996.'The Manual has been reprinted in Jan 2012 after incorporating Addendum and Corrigendum Slips.

3.0 Principle

The flash-butt welding process is a method of joining metals in which the heat necessary to forge the joint is generated by the resistance of the rails being welded to the passage of an electrical current. Unlike the Thermit and Arc welding

processes, no additional chemicals or metals are required and only parent metal is consumed during the welding cycle. A total length of approximately 25 mm to 35 mm depending on rail section is consumed per weld.

In the actual welding process, the two rail ends to be welded are firmly held by the clamps of the machine. One rail end is kept stationary while the other end can move. The rail ends are brought close to each other till they almost touch. Then the electricity is switched on and made to pass through the interface of the two rails. In the process heat is generated and flashing takes place. The movable end is then moved away and brought back after some time. This process continues for specified number of cycles as per pre-determined sequence and rate. When the temperature has riser to fusion limit, the rail ends are pressed together with application of force for welding of the rail ends.

4.0 Basic components of the machine

The basic components of a flash butt welding machine, in very simple terms, is as follows:

(1) A clamping mechanism to hold the rail being welded firmly in position.

(2) A forging mechanism which brings the rails into contact under low force during the initial heating stages of the weld cycle and a high force is applied to the rail interfaces near the end of the welding cycle to extrude all contaminations and consolidate the weld joint

(3) A transformer which reduces the mains supply voltage from 400/500 Volts to a suitable welding voltage between 4 and 12 Volts and make available sufficient current to heat the components being welded. The welding current required varies between 30,000 amps to 80,000 amps depending on cross sectional area of the rail being welded.

Fixed depot

Insitu FBW

Mobile depot

The various options to carry out flash butt welding of rails are:

i) Fixed depot
ii) Mobile depots
iii) In situ

5.0 Selection of rails to be welded:

Capacity of the individual plant will determine the heaviest section and type of rail that can be welded. New as well as released but serviceable rails of same type (section and metallurgy) shall only be welded together. Welding of rails of different sections & metallurgy shall not be attempted. It is preferable that rails rolled by the same manufacturers are

welded together. Minimum length of old but serviceable rails for welding shall be 6 meters. Old rails to be welded shall preferably be match marked before releasing from track to achieve maximum uniformity of profiles in weld zone.

6.0 Fish bolt holes:

Welded panels (10/20 rails) for laying long welded rails shall, as far as possible, be without fish bolt holes. If drilling of fish bolt hole is necessitated for the purpose of handling during end unloading; only the second fish bolt hole(one away from the rail end) need be drilled. In case, welding of new rails with fish bolt holes cannot be avoided, it shall be ensured that the outer edge of the hole nearest to the rail end is at least 40mm away from the end to be welded to avoid the heat affected zone of the weld extending up to the edge of the hole. All fish bolt holes shall be chamfered before welding. Ends of old rails with fish bolt holes/bond wire holes shall be cropped by a minimum length of 450mm before welding.

7.0 Ultrasonic testing of rails to be welded:

New and old but serviceable rails shall be free from internal defects. In the case of new rails, the ultrasonic testing is required to be done at the rail manufacturer's premises. Old but serviceable rails shall invariably be tested ultrasonically before they are taken to Flash Butt Welding Plants.

8.0 Suitability of rails for welding:

8.1 Old rails

8.1.1 Defective rails: Rails having cracks or other defects such as heavy corrosion pits or which are worn by more than2mm depth at rail seat and Rails with cyclic wear shall not be welded.

8.1.2 Permissible vertical wear of rails to be welded: The vertical wear in old rails to be welded shall be within the limits specified in Table-1 below.

Table-1

Rail Section	Standard height of the new rail	Minimum height of old rail
60kg	172.00 mm	164 mm
52 kg	156.00 mm	150 mm
90 R	142.88 mm	139 mm

8.1.3 Permissible lateral wear of rails to be welded: Old rails to be welded shall preferably show similar pattern of side wear and the minimum width of rail head shall be as specified in Table-2below.

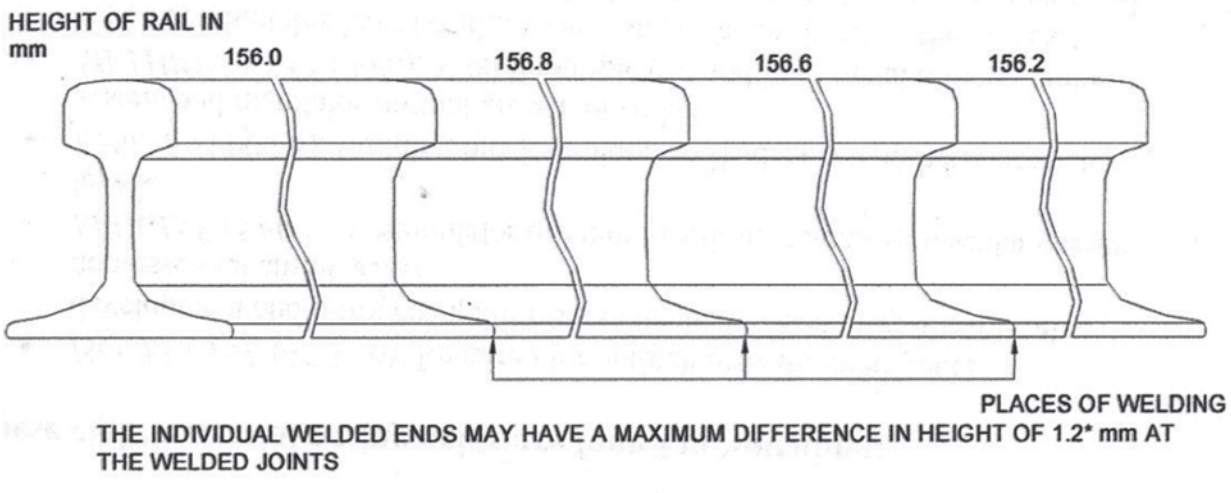
Table-2

Rail Section	Standard width of the head of new rail	Minimum width of head of old rail
60kg	72.00 mm	66 mm
52 kg	67.00 mm	61 mm
90 R	66.68 mm	61 mm

8.1.4 Difference in width of rail heads to be welded: The difference in the width of rail heads of two rails to be welded shall not exceed 2.0mm for old rails.

8.2 New rails:

8.2.1 Difference in height of rail ends to be welded: The individual rail ends for new rails may have a maximum difference in height of 1.2mm at the welded joints. Rails manufactured by SAIL with dispensations (having letter 'D' in the rolling mark), may have a maximum difference in height of 1.5mm.This is illustrated in Fig.8.1. The difference in height shall be transposed to the foot of the rail.



* FOR RAILS MANUFACTURED BY SAIL WITH DISPENSATIONS, THIS VALUE MAY BE 1.5 mm

Fig. 8.1 Sorting of Rails to be Welded

8.2.2 Difference in width of rail heads to be welded: The difference in the width of rail heads of two rails to be welded shall not exceed 1.0mm for new rails. New rails manufactured by SAIL with dispensations (having letter 'D' in the rolling mark) may have a maximum difference of 1.5mm in the width of rail heads.

For new rails, it is preferable to restrict the difference in width of rail heads to 0.5mm.Therefore in order to minimise the difference in head width of rail ends to be welded, actual head width of rails shall be checked using template shown in Fig. 8.2 (a), (b) & (c). The deviations shall be marked on the rail head so that rails with same or minimum relative deviations are selected for welding.

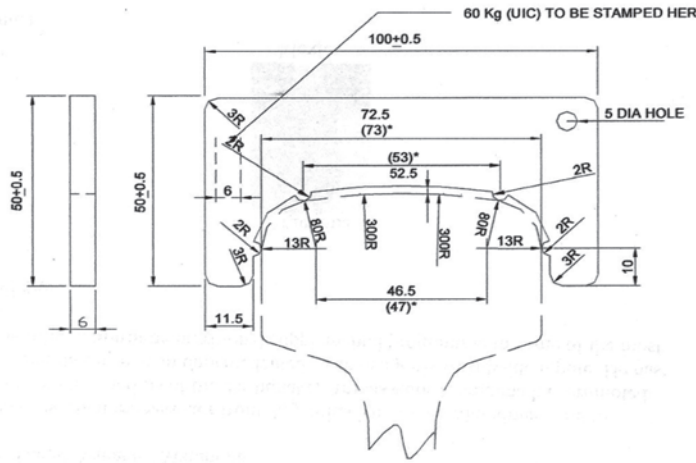


Fig. 8.2 (a) Head Width Checking Gauge For 60 Kg Rails

* Dimensions Shown in Brackets are for Rails Manufactured by SAIL with Dispensions.
All Dimensions are in Millimetres

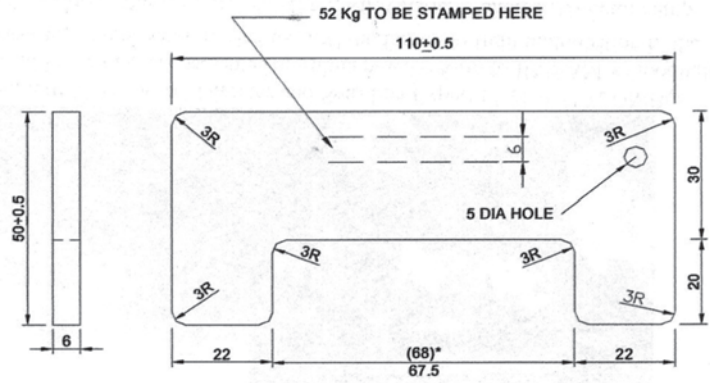


Fig. 8.2 (b) Head Width Checking Gauge For 52 Kg Rails

* Dimensions Shown in Brackets are for Rails Manufactured by SAIL with Dispensions.
All Dimensions are in Millimetres

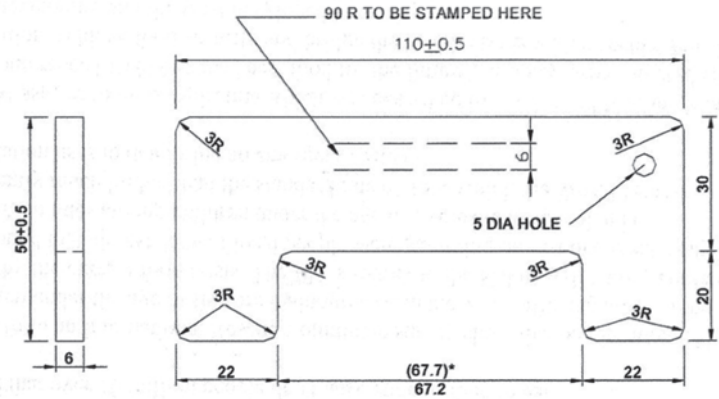


Fig. 8.2 (c) Head Width Checking Gauge For 90 R Rails

* Dimensions Shown in Brackets are for Rails Manufactured by SAIL with Dispensions.
All Dimensions are in Millimetres

8.3 Any difference in the widths of rail heads at the welded ends, in case of both new and old rails, as a result of rolling tolerances in case of new rail and wear in case of old rails, the rail ends shall be aligned in accordance with para 8.4 and 8.5 below.

8.4 In case of welding in depot, where it is not possible to determine the gauge face side exactly when laid in track, during setting up of rails, any difference in the width of rail heads at welded ends shall be transposed to one side of the head keeping the other side perfectly aligned. The aligned side of such welded panels shall be distinctly marked with green paint on the web at both ends of the panel. To facilitate pairing of panels, aligning on operator side as well as non-operator side may be resorted to.

8.5 In case of in-situ welding and in case where it is possible to exactly determine gauge face when laid in track, the rail ends shall be perfectly aligned to gauge face. Any step as a result of unequal head width due to rolling tolerances shall be ground out to slope not steeper than 1:500.

9.0 Rail End Geometry:

9.1 Rail ends to be welded shall meet following geometrical standards-

(a) End bends in the vertical plane shall not be greater than +0.7mm on a 1.5metre straight edge [Fig. 9.1 (a)]. Sagging ends not permitted.

(b) End bends in the horizontal plane shall not be greater than 0.7mm on a 1.5 metre straight edge [Figs. 9.1 (b) and (c)].

(c) Deviation of the end from the square not greater than +0.6mm [Fig. 9.1(d)].

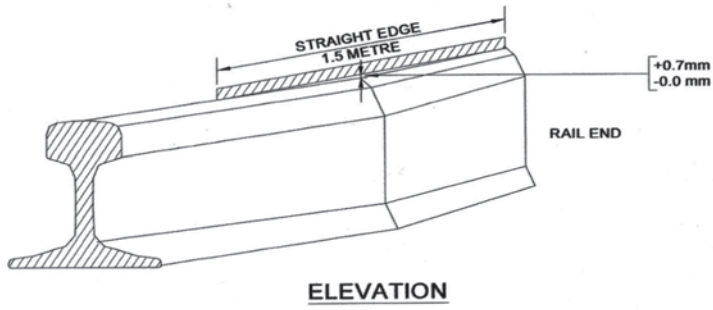
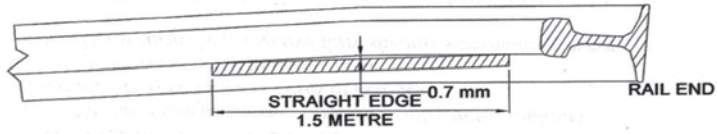


Fig. 9.1 (a) Tolerance on the End Bends in the Vertical Plane



PLAN

Fig. 9.1 (b)

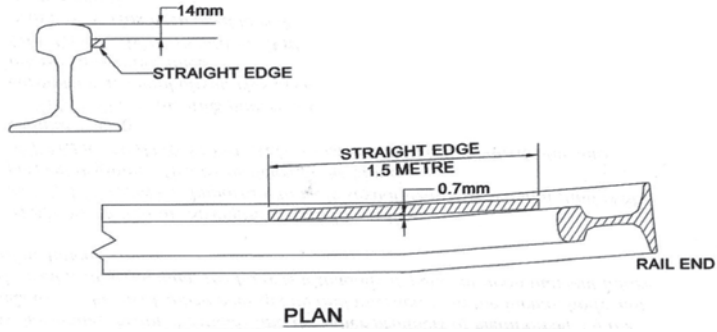


Fig. 9.1 (c) Tolerance on the End Bends in the Horizontal Plane

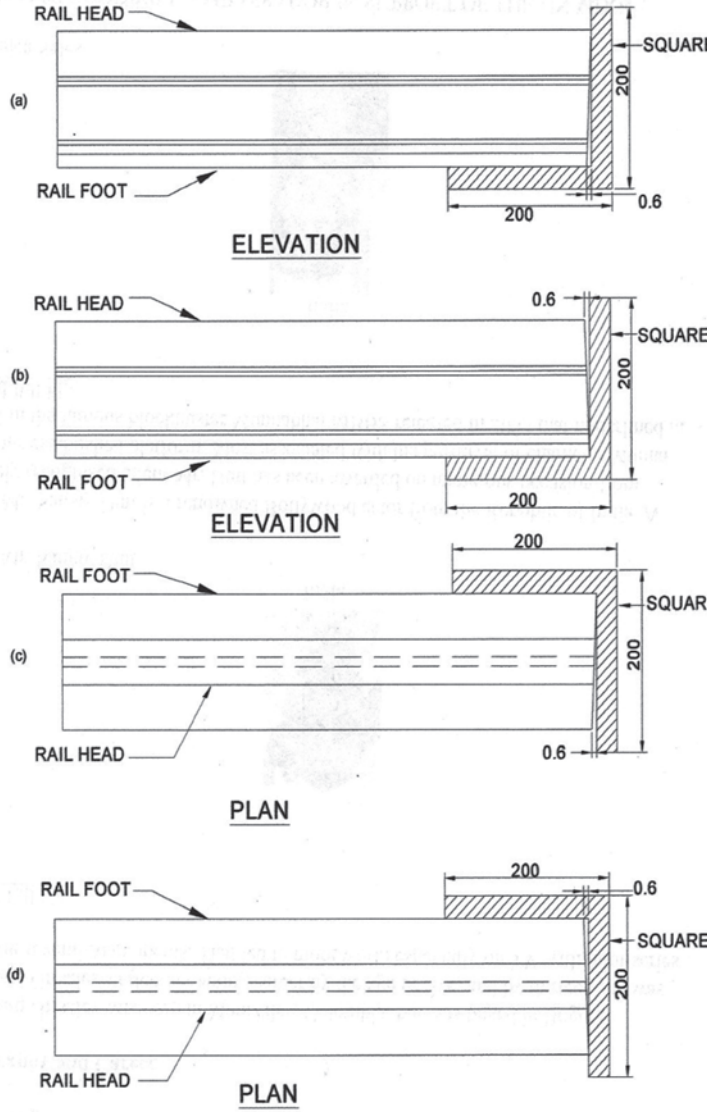


Fig. 9.1 (d) Deviation of the Rail End From the Square
All Dimensions Are in Millimetres

9.1.1 A thorough inspection is carried out at the plants with a view to avoid welding of rails with visible surface defects such as rolling/guide marks, wheel burns etc. Rail is also be inspected to ensure that there is no chisel mark or dent of any type on bottom flange of the rail as this constitutes the tension zone.

10.0 The rails rejected due to non-compliance of the above requirements of paras 8.1 to 9.1 shall not be welded. Such rails shall be marked and stacked separately for other uses.

11.0 Flash butt welding of rails at fixed depots:

At fixed site depots, the rail welding machine, together with ancillary equipment, is housed in permanent or semi-permanent buildings. Motorized conveyors transferring the rail from the incoming rail storage tables to the welding, stripping, grinding, pressing and inspection stations. A welding production line consists of a number of operational stations.

1) Rail Storage and transfer table
2) Rail straightening
3) Rail end cleaning
4) Welding
5) Stripping
6) Post weld treatment
7) Rail joint straightening
8) Rail head profiling
9) Inspection
10) Outgoing conveyor system.
11) Rake loading system

12. Preparation of rails to be welded:

12.1 Rail alignment:

12.1.1 The running surfaces of rails at interface are aligned carefully to avoid any 'step' defect generally keeping gauge face corner as reference line except as provided in 8.1.4, 8.2.2, 8.4 and 8.5.For the reason of asymmetry, rails should preferably be welded with brand marks on same side.

Rails not meeting the geometrical standards stipulated in clause 9.1 are to be rectified before welding using a pre-straightening machine so as to conform to the standards.

12.2 Rail end-cleaning:

Before welding, end faces of the rails to be welded and electrode contact locations are thoroughly cleaned of loose scales, rust, paint etc. by brushing and shot blasting/grinding to bare metal finish for good electrical contact to avoid arcing at the contact points on the rail and to eliminate the possibility of rail failure near joint due to Copper penetration and formation of brittle martensite structure. Cleaning of rail bottom is be ensured by placing a mirror and watching the cleaned surface. The electrode contact locations are marked with chalk on each rail end to be welded to serve as guidance for cleaning. Oil and grease, if present, are removed by Carbon Tetrachloride or Benzene. If any internal defect such as piping is noticed during end cleaning, the rail shall not be welded.

12.3 Welding:

12.3.1 Electrical contact:

The electrical contacts, i.e. Copper/Melloroy electrode in the welding machine must be cleaned by compressed air pistol to ensure freedom from loose oxides and other foreign matter so that no arcing takes place at the contact points on the rail and to eliminate the possibility of rail failure near joint due to Copper penetration and formation of brittle martensite structure. The electrodes must be replaced and machined whenever surface depressions exceeding 1mm in depth are formed due to wear. For this purpose, adequate spare electrodes should be kept in the plant.

12.4 Welding sequence:

The Stationary Flash-butt Welding Plants adopt following welding sequence:-

- Aligning (along with de-twisting, if possible)
- Initial burn off
- Preheating
- Flashing
- Forging (upsetting)
- Stripping

12.4.1 Initial burn-off: Relevant to the specifications of rail and welding machine, controls shall be adjusted so that at the end of this phase weld interface has good overall contact.

The mobile flash butt welders, however, give continuous flashing instead of initial burn off , preheating and flashing cycles separately. Air pressure and voltage/current recommended by the manufacturer must be ensured throughout the welding cycle.

12.4.2 Preheating: The rail ends are brought into contact to allow a low voltage high amperage current flow which preheats the rail ends. Lower voltages are preferred to minimize crater damage on the rail ends. The movable rail is alternatively moved backward and forward producing a series of electrical contacts with the fixed rail end. The objective is to heat the rail faces uniformly by flashes up to the red hot stage. The rail ends are brought in and out of contact for certain duration a number of times depending on the specifications of the welding plant, the section and the metallurgy of the rail. This pre-heating cycle is executed in a fully controlled automatic mode once the parameters are selected.

12.4.3 Flashing: Flashing consists of moving the rail in continuous manner initially at a fixed speed but during the last few seconds, at an accelerated rate. The flashing speed is so arranged that the rail ends burn-off without short circuiting or giving rise to an open circuit condition.

12.4.4 Forging (upsetting): Immediately following flashing, the pattern movement is accelerated so that the rail ends are butted together to a stage of fusion under a heavy butting force whose magnitude depends on the make of the welding plant. The welding current automatically gets cut off during the later part

of the forging operation. The joint should be left undisturbed in clamped position for ten seconds after the welding cycle.

12.4.5 The recommended butting pressure for different types of rails is indicated below:-

- 72 UTS rails – 5kg/mm^2 on cross sectional area.
- 90 UTS rails & Head Hardened rails – 6 kg/mm^2 on cross sectional areas.
- 110 UTS rails – 7 kg/mm^2 on cross sectional area.

The heaviest rail section which can be welded on plant should be decided on this basis. Welding of higher UTS and higher section rails on low butting load plant by increasing the number of pre-heats causes very pronounced heat affected zone (HAZ) and is detrimental to the service life of the joints.

12.4.6 Stripping

(i) Automatic stripper : A stripper, which may be integral with the welding plant or installed either just adjacent to welding machine or at 13/26 m distance from it, shall strip the hot upset metal all round the rail section in such a way that minimum grinding is required to achieve final finished profile at weld.

(ii) Manual removal of upset metal: Wherever automatic stripper is not installed, manual chipping using pneumatic chisel may be adopted. Recommended width of flat chisel is 50mm for removal of upset metal from junction of head & web and web &foot of the rail, half round chisel should be used. Care should be taken to ensure that chipping does not create any notches or under cutting. However, hot upset metal all round the rail shall be stripped.

(iii) Maximum thickness of trimmed upset for New & Old Rail shall be+ 3.0 mm &- 0.0 mm of the parent contour in Web zone (under side of head, web, top of base, both fillet each side)

13.0 Post weld heat treatment: 72 UTS and 90 UTS rails do not require any special post weld heat treatment. However, alloy steel rails of 110 UTS and head hardened rails need post weld heat treatment to ensure variation in hardness within acceptable limits in heat affected zone.

14.0 Weld parameters:

Welding parameters depend on section and metallurgy of rail to be welded. These are normally specified by the manufacturer of the welding plant. Before adoption, the welding parameters shall be got approved from RDSO.

14.1 Changing weld parameters arbitrarily like changing platen travel, increasing duration and/or number of preheat cycles so as to increase interface temperature to achieve fusion with lower butting pressure (wherever butting capacity of the plant is low) or to retain heat in weld for easy upset metal removal when stripping is done away from welding machine, are strictly prohibited.

15. 0 Post weld straightening:

A post straightening machine is installed at suitable distance from the welding machine for straightening the joint if required to achieve required geometrical tolerances in vertical/lateral alignment. It is desirable to do post weld straightening after the weld has cooled down to ambient temperature.

16.0 Water cooling:

Water spray cooling is done at such suitable distance from the welding plant where the temperature of the weld is not more than 350 degree Celsius which normally is achieved in 7-8 rail length.

17.0 Post weld Air quenching treatment for flash butt welding of 60 kg head hardened rails:

17.1 During welding of head hardened rails using the normal welding procedure, the average hardness of the HAZ of the rail becomes considerably less than the parent rail hardness. This lower hardness is due to transformation of rail steel occurring at a cooling rate much lower than that achieved during the original head hardening operation. Such a hardness difference can lead to differential plastic deformation during the wheel-rail contact which may cause localised cupping on the running surface at the welds. Head hardened rails, therefore, must be subjected to controlled cooling treatment (slack quench) to improve the sagging heat affected zone hardness.

17.2 A fabricated air quenching gadget as shown in Figure 17.1 shall be used for enhanced cooling of the rail joints made with head hardened rails. The length of this gadget is approx. 250mm and width 190mm. There are series of drilled holes of 3mm diameter in the gadget and their position is as shown in figure. The gap maintained between the inner faces of the gadget is approx.120mm which will enable gap of approx. 25mm between the rail head side surfaces and the gadget. This will result in efficient application of air quenching jet. Within one minute of welding, air quenching should be carried out while the rail surface temperature is in the region 900-950^{0}C. The air pressure should be approximately 2kg/cm^{2} and duration of application should be about 1 minute.

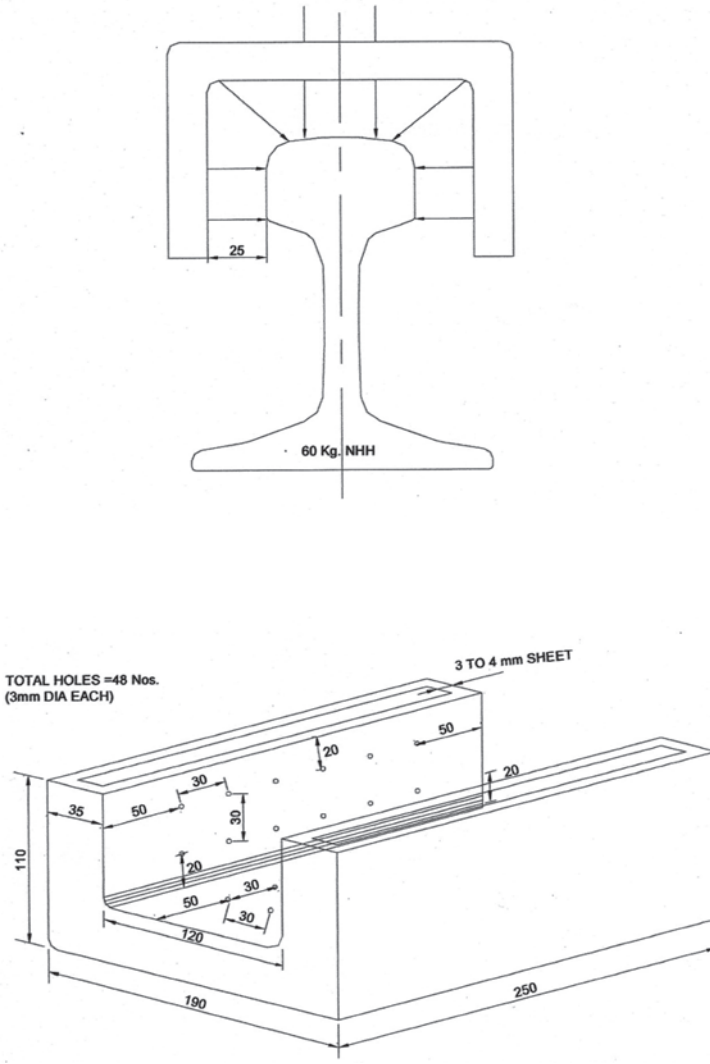


Fig. 17.1 Air Quenching Gadget for Enhanced Cooling of HH Rail Joints

18.0 Finishing:

18.1 The top, side and bottom surfaces of the rail head shall be ground smooth so that the weld surface is absolutely flush with the parent rail surfaces. Particular care is necessary to ensure that finish grinding does not burn or notch the rail surfaces.

Grinding shall be done preferably using a profile grinding trolley, in the absence of which manual grinding can be done using a cup14grinder. Depending upon whether it is done mechanically or manually, grinding may be done in stages.

After grinding, the top table and the sides of the rail head shall comply with the geometrical standards for new & old rails are as given below.

18.2 Finishing tolerances for welds with new rails:

(i) Vertical misalignment: +0.3mm &- 0.0 mm measured at the centre of a 1 m straight edge.

(ii) Lateral misalignment: +0.3mm measured at the centre of a 1 m straight edge.

(iii) Head finishing (in width): + 0.25 mm measured on the gauge side at the centre of a 10 cm straight edge.

(iv) Finishing of top table surface: + 0.2mm &- 0.0mm measured at the centre of 10cmstraight edge

(v) Web zone (under side of head, web, top of base, both fillet each side):+ 3.0 mm &- 0.0 mm of the parent contour

(vi) Upper sides, under surfaces and edges of rail foot shall be ground smooth. The edges of foot should be rounded and bottom of rail foot ground smooth without any minus tolerances to ensure proper seating on sleepers, unhindered movement of welded panels on end unloading rakes, avoid damage to elastic rail pads and eliminate stress riser.

18.3 Finishing tolerances for weld swith old rails:

(i) Vertical misalignment: $\pm$ 0.5mm mm measured at the centre of a 1 m straight edge.

(ii) Lateral misalignment: $\pm$ 0.5mm measured at the centre of a 1 m straight edge.

(iii) Head finishing (in width): $\pm$ 0.3 mm measured on the gauge side at the centre of a 10 cm straight edge.

(iv) Finishing of top table surface: $\pm$ 0.2mm measured at the centre of a 10 cm straightedge.

(v) Web zone (under side of head, web, top of base, both fillet each side): +3.0 mm & -0.0 mm of the parent contour

(vi) Upper sides, under surfaces and edges of rail foot shall be ground smooth. The edges of foot should be rounded and bottom of rail foot ground smooth without any minus tolerances to ensure proper seating on sleepers, unhindered movement of welded panels on end unloading rakes, avoid damage to elastic rail pads and eliminate stress riser.

(vii) The above tolerances are finished tolerances of welds inclusive of tolerances of rail.

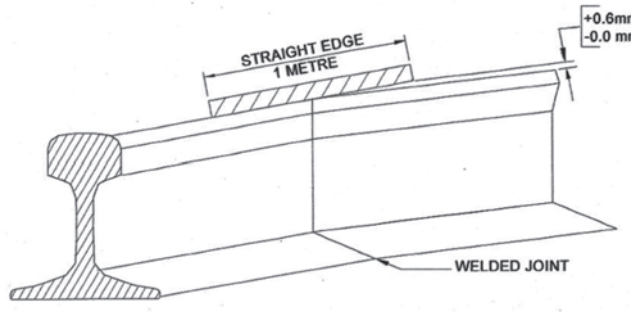


Fig. 18.1 (a) Tolerance for Vertical Misalignment of Welded Joint with New Rails

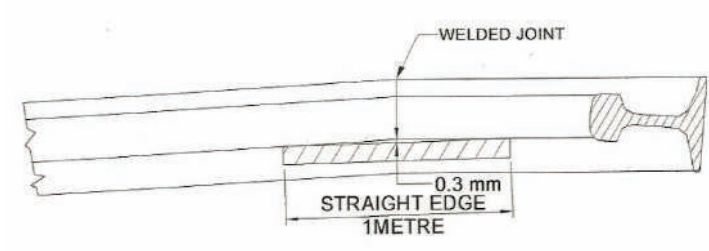


Fig. 18.1 (b) Tolerance for Lateral Misalignment of Welded Joint with New Rails

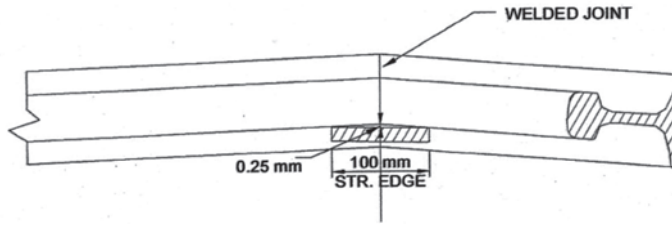


Fig. 18.1 (c) Tolerance for Finishing on Sides of Head of Welded Joint with New Rails

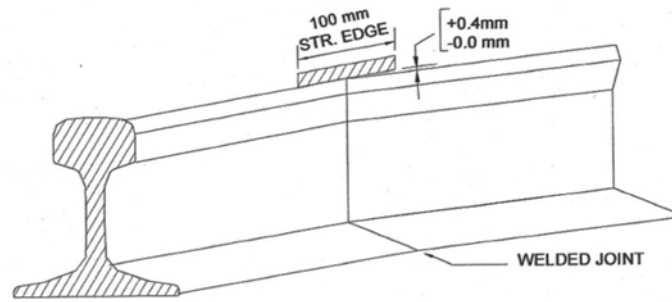


Fig. 18.1 (d) Tolerance for Finishing Top Table Surface of Welded Joint with New Rails

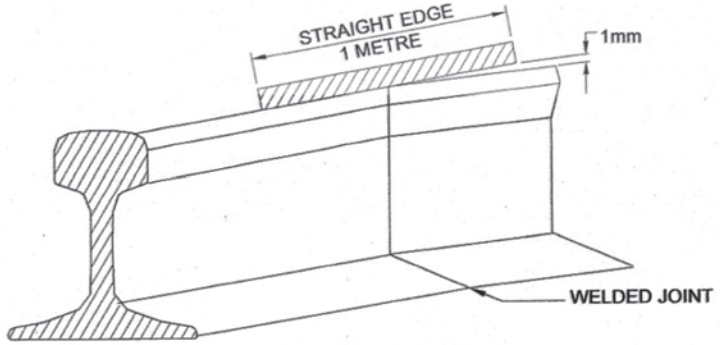


Fig. 18.1 (e) Tolerance for Vertical Misalignment of High Welded Joint with Old Rails

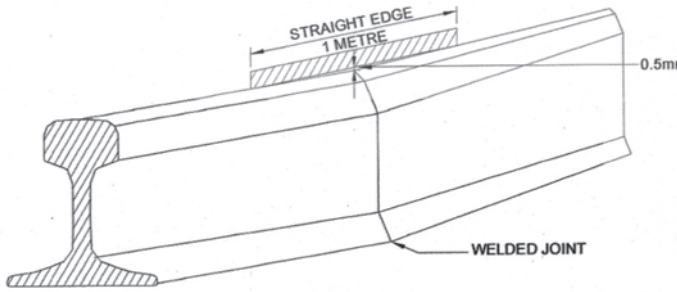


Fig. 18.1 (f) Tolerance for Vertical Misalignment of Low Welded Joint with Old Rails

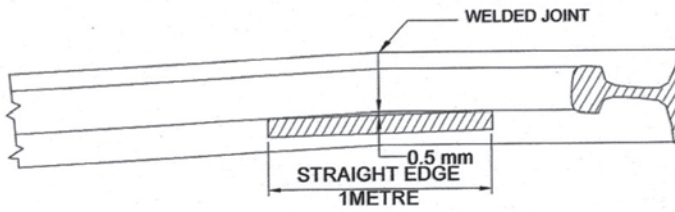


Fig. 18.1 (g) Tolerance for Lateral Misalignment of Welded Joint with Old Rails

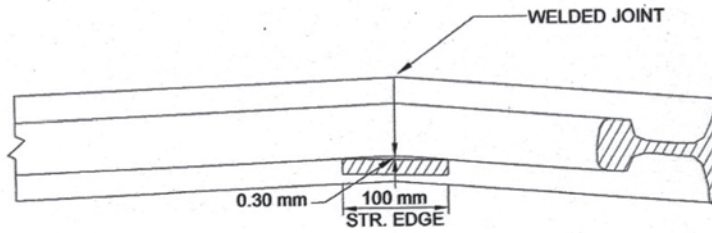


Fig. 18.1 (h) Tolerance for Finishing on Sides of Head of Welded Joint with New Rails

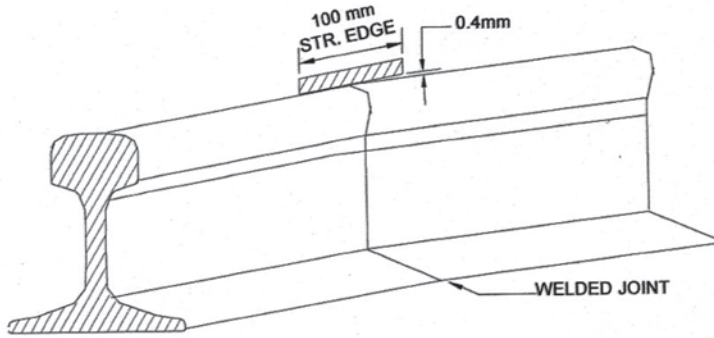


Fig. 18.1 (i) Tolerance for Finishing Top Table Surface of Welded Joint with Old Rails (High Joint)

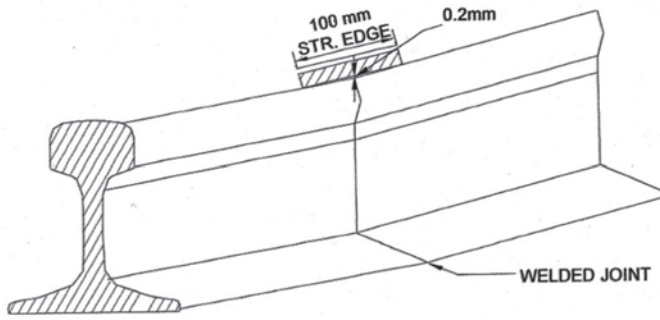


Fig. 18.1 (j) Tolerance for Finishing Top Table Surface of Welded Joint with Old Rails (Low Joint)

18.4 Areas to be ground smooth:

Upper sides, under surfaces and edges of rail foot shall be ground smooth. The edges of foot should be rounded and bottom of rail foot ground smooth without any minus tolerances to avoid damage to elastic rail pads and eliminate stress riser.

18.5 In case of in-situ welding with mobile f lash butt welding plant, profile grinding can be done in stages i.e. initial grinding and final grinding. Final grinding can be performed in track with rails fastened in position over a minimum length of three sleepers on either side of weld. Profile finishing of rail head shall be carried out and contained in shortest possible length but not greater than 400 mm on either side of weld. Profile finishing should not cause any thermal or mechanical damage to rail.

19.0 Marking of joints:

Every joint shall have distinctive mark indicating the weld number, month and year of welding and the code of the plant as shown below. The marking should be embossed on the gauge and non gauge face sides of the head of the rail and diagonally opposite to each other across the joint at300 mm away from the centre line of weld by punching after finishing of the weld without causing any damage to rail, in letters/digits of 6mm height, located as indicated in figure 19.1.

(A) For Stationary Plant:-

XXXX MM YY AAA

The first four digits indicate the weld number starting from 0001for first weld of every month, the next two digits month of welding followed by last two digits of the year of welding. The end letters shall be code of the Welding Plant. For example, 32810891 MGS indicates that the particular weld is 3281st weld of August1991 of Mughalsarai Flash Butt Welding Plant.

(B) For Mobile Plant:-

XXXX MM YY OO PP EE

The first four digits indicate the weld number starting from 0001for first weld of every month, the next two digits month of welding followed by next two digits of the year of welding. The letters OO denotes the code for owner of the plant, PP denotes the code for the plant of that particular owner and EE stands for the code of agency executed the welding work.

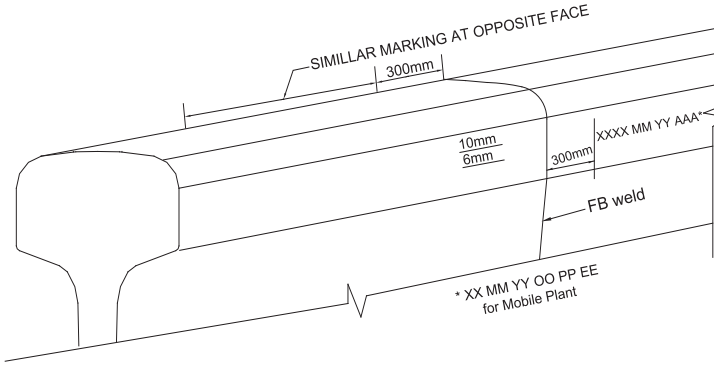


Fig. 19.1 Location of Marking of Weld

20.0 Record of welds:

Record of all the joints shall be maintained in a register as per proforma as given below. The register shall be signed daily by the welder at the end of the shift and shall be verified and countersigned by the supervisor incharge. For those welding plants which are equipped with Automatic weld recorder, the chart of the weld recorder shall be analysed every day with respect to voltage, current, upsetting force and platten travel for each weld. Any parameter not conforming with the standard parameter should be set right. The chart shall also be preserved in addition to the register to facilitate investigations in case of defective joint and joints failing in service.

Proforma for record of welds

MACHINE -

1. Date of welding
2. Shi ft (day/night)
3. Joint No.
4. Length of rail
5. Section of rail
6. Welding current (primary, amps)
7. Primary voltage (volts)
8. Clamping pressure Kg/cm2
9. Butting pressure Kg/cm2
10. No. of pre-heats
11. Pre-heating time On…….Off…….
12. Burn of f time (sec.)
13. Flashing time (sec.)
14. Post welding heat treatment i f any
15. Whether automatic weld record chart available
16. Remarks (Any change of voltage during welding etc.)
17. Signature of welder
18. Signature of Foreman

21.0 Testing of weld:

Acceptance test comprises of all the weld being checked by visual inspection, dimensional tolerances and ultrasonic test. Sample welds should be subjected to transverse bending test and detailed metallurgical tests in a laboratory as a quality assurance measure. Results of all the tests shall be maintained in register by the plant in-charge assisted by quality control supervisor. Details and method of conducting the tests are as follows:-

21.1 Tests for every joint:

21.1.1 Visual inspection:

After finish grinding, all welds shall be visually inspected for possible cracks, lack of fusion and other surface defects like

notching, damage in heat affected zone etc.Welds with visible defects shall be rejected.

21.1.2 Dimensional check:

All welds are inspected using standard 1m and 10cm straight edges and feeler gauges, as shown in figure 18.1 (a) to 18.1 (j) for compliance of geometrical standards as per para18.2 &18.3. Welds not meeting these standards, if rectifiable by grinding, can be re-ground, failing which they are rejected. Results are maintained as per proforma given below.

Proforma for dimensional check of welded joints (after finishing)

1. Date, month and year
2. Joint No.
3. Rail section
4. 1m straight edge Top/ LH/ RH
5. 10 cm straight edge Top /LH/ RH
6. Remarks
7. Signature
8. Summary – (at the end of the month)
   No. of joints welded during the month (Rail section-wise)
   No. of joints checked (Rail section-wise)
   No. of joints rejected (Rail section-wise)

21.1.3 Ultrasonic Test (USFD):

All welds are be subjected to ultrasonic testing for detecting presence of internal defects in the weld. This test can be done by installing an on-line USFD equipment or as an interim measure manually with portable USFD machine. Entire cross section of the rail i.e. head, web and foot are tested by trained personnel as per the procedure laid down for Ultrasonic testing of Flash butt welds in 'Manual for Ultrasonic testing of rails & welds' and its correction slips, issued by RDSO, Lucknow to detect internal flaws. Welds having defects are rejected. Results are maintained as per proforma given below

Proforma for ultrasonic testing of welded joints

Date/Month/year/Name of Operator Welding Machine USFD

1. Joint No.
2. Rail section & chemistry
3. Day Night shift
4. Result of testing
5. If defective, details of flaw Defective zone Flaw peak pattern Head/Web/Foot Probe Trace
6. Remarks
7. Signature

   Summary (at the end of the month)

   No. of joints welded during the month (Rail section-wise)

   No. of joints tested (Rail section-wise)

   No. of joints found defective (Rail section-wise)

Defective joints are distinctly marked and panels with defective joints are separately stacked. The defective joint are cut and removed before the panel is dispatched from the Flash Butt Welding Plant. Another panel of matching length are welded and the short panels(minimum 3 rail lengths) dispatched in pairs.

22.0 Test on sample joint:

22.1 Sample test joints are made on pieces of rails of similar section and conforming to the same specifications as the rails being welded. The length of each piece is not be less than 750mm.

22.2 Hardness test and Transverse bending test are carried out on sample test joint as per the procedure given in the 'Manual for Flash Butt Welding of Rails'. Frequency of testing for 60 kg (UIC) 90 UTS and 52 kg 90 UTS rails is 1 in 1000 joints for Stationary FBW Plant. For Mobile FBW Plant Frequency of testing for 60 kg (UIC) 90 UTS and 52 kg 90 UTS rails is 1 in 100 joints for first 1,000 joints welded and subsequently at a frequency of 1 in 500 joints.

22.3 These test shall also be carried out whenever there is a change in type of rail being welded. In case a sample joint does not comply with the requirements of the test, two more sample joints will be made and tested. If both the sample joints meet the requirements of the tests, welding may continue. In case of failure of any of the retest joints, RDSO should be consulted for investigation and fixing revised welding parameters.

23.0 Welding Team & competency for Mobile Flash Butt Welding Plant

23.1 Welding team may consist of one supervisor and two welders. The minimum educational qualification of supervisor is Diploma in Mechanical/ Electrical Engineering or BSc and that of welder is minimum class X or equivalent, passed. Zonal Railways ensure periodical training of welders and Supervisors of Mobile Flash Butt Welding Plants.

23.2 Test for competency certificate of welder of Mobile Flash Butt Welding Plant will be conducted by Zonal Railways as per FBW Manual and after satisfactory result, the competency certificate will be issued by Zonal Railways.

24.0 Upkeep and Maintenance of Mobile Flash Butt Welding Plants:

Quality and quantity of output of Mobile Flash butt Welding Plant depends on health of machine, therefore their proper upkeep and maintenance is utmost importance. Periodical maintenance of Mobile Flash Butt Welding Plants shall be done as per procedure and frequency laid down by OEM (Original equipment Manufacturer) with genuine spare part either supplied by OEM or procured from sources recommended by OEM.

24.1 Periodical Inspection of Mobile Flash Butt Welding Plant:

Mobile Flash Butt Welding Plant shall be inspected by OEM or his authorized representative at an interval of two years or execution of 20,000 joints whichever is earlier to conduct technical audit of its health. Maintenance is carry out in accordance with his advice.

25.0 Precautions to avoid defects in flash butt welded rail joints:

Following precautions shall be taken to avoid various defects in the welded joints:-

25.1 Oxide inclusion: The rail end faces and the adjoining surface of the rail profile to a width of about 25mm all round shall be cleaned properly by portable grinders or brushing machine or shot blasting to remove loose scale, rust, scabs, dust, paint etc. Oil and grease, if present shall be removed by Carbon Tetrachloride or Benzene.

25.2 Lack of fusion: Preheating cycle and time, flashing and butting stroke as standardised shall be strictly maintained during welding to avoid this defect.

25.3 Poor joints due to defect in rails: Rail ends having cracks and other visible rolling defects should be cropped before welding.

25.4 Notches and chisel marks adjacent to the weld joints: During stripping by chiseling and finishing by grinding, cares hould be taken that notches, dents or chisel marks are not formed on the rail surface as such flaws may act as stress raisers in service leading to premature failure.

25.5 Copper penetration/arching on rail foot bottom surface: During flash butt welding, the two copper blocks (electrodes)below the rails get worn out and grooved/dented due to rail movement. Besides this, after the flashing/burning off operations, lot of loose oxides of metal are deposited on the copper blocks. Due to the above reasons, current flow between the rail foot surfaces and the copper block is not continuous resulting in arcing and formation of local melting/denting and even copper penetration at the rail foot surface. Such affected area results in premature fracture. Therefore, after each operation loose oxide/metal shall be cleaned by brushing the copper block surfaces and the copper blocks shall be periodically reconditioned or replaced with new ones.

25.6 **Use of treated water for cooling system:** The pipes/tubes for circulation of water for cooling purpose are, generally, of small diameter. Due to presence of impurities in water, scaling on the inner side of the pipe takes place resulting in less circulation of cooling water and consequent problems. Therefore, suitably treated water should be used for cooling system. The welding plant should not be operated if the cooling system is nonfunctional.

25.7 End squareness of rail end faces must be ensured. Better weld strength with minimum value and nearly parallel shape of HAZ can be achieved using perfect matching of rail ends.

25.8 Secondary output of current should be sufficient enough to achieve complete fusion of butting faces of rails.

25.9 Butting stroke should be sufficient for complete coalescence(Not less than 12 mm).

25.10 Throughout uniform and smooth auto trimming of the squeezed out metal and complete grinding using profile grinder around the butt joint is essential.

25.11 Minimum and nearly parallel Heat affected Zone of the joint should be achieved by setting the weld parameters.

25.12 Facilities for auto recording of weld parameters including final butting pressure shall be available.

25.13 When welding is carried out in-situ, minimum 20 minutes time after trimming is required to pass train through the weld with proper packing and support below the joint.

26.0 **Procedure to be followed for approval of Quality Assurance Program (QAP) for Mobile Flash Butt Welding Plants:**

26.1 The mobile flash butt welding plants used on railways are mostly outsourced. In order to expedite the approval of QAP and minimize the time gap between award of contract and start of work, the following procedure shall be followed.

26.2 Submission of General Quality Assurance Programme:

26.3 The general QAP, in triplicate, containing the information as per Annexure-XI of Manual shall be submitted to RDSO by agency/ Plant owner separately for each Mobile Flash Butt welding Plant proposed to be deployed. Availability of Railways' order will not be required at this stage.

26.4 The complete QAP (excluding details of welding team, details of contract agreement and standardized welding parameters) so submitted by firm will be scrutinized and approved by RDSO after ensuring compliance of relevant provisions of this manual.

26.5 One approved copy of General Quality Assurance Programme will be returned to agency, which has approached for approval.

27.0 Approval of Welding Team:

27.1 Once the contract is awarded, the firm will approach concerned Zonal railway for approval of welding team.

27.2 The competency certificate to welding operators and supervisors will be issued by Chief Track Engineer of Zonal Railway after conducting necessary test as per Manual and other instructions on subject.

28.0 Submission of Final Quality Assurance Programme:

28.1 After agency has got the welding team approved by concerned Zonal Railway, the firm will undertake internal test to provisionally fix the welding parameters for rails of different sections/ metallurgy as required to be welded as per contract.

28.2 After completing above exercise, the agency will submit the final Quality Assurance Programme (Duly updating the earlier approved General QAP with details of welding team approved by Zonal Railway with competency certificates, proposed welding parameters as decided by firm during internal test and details of contract agreement) in

quadruplicate to RDSO through concerned Railway Administration for standardization of welding parameters and then approval of final QAP.

29.0 Standardization of Welding Parameters:

29.1 After final QAP submitted is found satisfactory during scrutiny, the standardization of welding parameter for concerned Rail section/ UTS as requested by agency/ zonal railway will be undertaken by RDSO.

29.2 The standardized welding parameters will be advised to agency/ zonal Railway.

30.0 Approval of Final Quality Assurance Programme (QAP):

30.1 After standardization of welding parameters, the standardized welding Parameters will be included in final QAP submitted.

30.2 The copy of final QAP approved by RDSO duly containing the standardized welding parameters shall be issued to the concerned railway and firm for undertaking the Flash Butt welding work as per provisions of FBW Manual.

30.3 The adherence to provisions of FBW Manual and QAP will be ensured by concerned Zonal Railway.

30.4 The Final Quality Assurance Programme (QAP) of a particular Mobile Flash Butt welding Plant need not be re-approved by RDSO unless there is major change in Quality Control setup or new type of rail to be welded or there is a revision/amendment to FBW Manual to provisions related to quality assessment of FB welds/procedure of welding/ methodology of standardization of welding parameters. In case of change of operator, Zonal Railways shall take action for approval of welding team and revised QAP incorporating the revised details shall be approved by Chief Track Engineers of Zonal Railways. The final decision whether there is major change in Quality Control setup or not will rest with Chief Track Engineers of Zonal Railway, where plant is being deployed.

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For any suggestions, errors etc, please contact
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