A) Prerequisite:

List of Minimum Equipments & Machines Required for FBW Plants (Mobile/Stationary)

I. Testing Facilities
   1. Transverse Load Testing Machine of 200t capacity.
   2. Hardness testing machine.
   3. USFD testing machine (preferably on line tester).
   4. Equipment for Macro and Magna flux examination.

II. Pre Welding Equipments
   1. Pre-straightening machine.
   2. Portable grinders.
   3. Shot blasting machines.
   4. Mechanical rolling system for feeding of single rails for welding.
   5. Abrasive rail cutting machines.

III. Post Welding Machines
   1. Weld stripping machine.
   2. Profile grinders.
   3. Post straightening machine.
   4. Equipment’s and fixtures for post weld controlled cooling.
   5. Equipments and fixtures, for post weld air quenching.
   6. Automatic weld recorders.
   7. Arrangements for availability of treated water for cooling system.

IV. Handling/Transportation and other Equipments
   1. Electric Hoists/Gantries in adequate numbers for unloading of single rails from wagons.
   2. Electric Hoists/Gantries in adequate numbers with centralised control panel capable of loading/handling of rails up to 20 rail panels.
   3. Motorized conveyor line for feeding and welding of rails.
4. Arrangement of stacking of single rails and 20 rail welded panels with capability of mechanical handling (capacity to handle to match with plant production).
5. Generating Diesel sets of adequate capacity for standby arrangements.
6. Independent water supply and water cooling system.
7. Provision of chilling plant for cooling of oil to maintain hydraulic pressure specially in summers.

V. About Welder and Plant:
1) Welding team to consist of one supervisor and two welders with valid competency certificates issued by the CTE.
2) QAP of each individual welding plant should be approved by RDSO as per Latest FBW Manual.
3) Periodical Inspection of Mobile FBW Machine shall be done 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.
4) Facilities for auto recording of weld parameters including final butting pressure shall be available in the machine.
5) Availability of sufficient stock of genuine spares.

VI. Suitability of Rails for Welding:
1) Rails should be of same section and metallurgy. Minimum length of the rail - 6.00 m
2) Outer edge of the hole (if unavoidable) nearest to the rail end should be at least 40 mm away from the end.
3) Rails should be ultrasonic tested and shall be free from cracks or other defects such as heavy corrosion pits.
4) Permissible vertical wear for 60kg rail is 8mm and for 52kg rail is 6mm. Permissible lateral wear for both 60kg rail and 52kg rail is 6mm. Rails with cyclic wear shall not be welded.
5) Height difference should not be more than (i) 1.2 mm for new rails (ii) 1.5 mm for D marked.
6) Difference in the width of rail heads shall not exceed (i) for new rails 1 mm and (ii) for old rail 2.0 mm. However, this should preferably be restricted to 0.5 mm.
7) Pre straightening of rails shall be done before welding.
8) End bend in vertical and horizontal plane shall not be greater than 0.7 mm on a 1.5 m straight edge.
9) Deviation from squareness at ends shall not be greater than ±0.5 mm.
10) Rails shall be free from chisel mark or defects of any type on bottom flange.

B. Procedure of Welding:
1) Electrical contact: i.e. Copper/Melloroy electrode in welding m/c must be cleaned by compressed air pistol.
2) Rail Alignment:-
   Rails should preferably be welded with brand marks on same side.
3) Welding Sequence:-
   i) Aligning
   ii) Initial burn off: Control shall be adjusted so that at the end of this phase, weld interface has good overall contact.
4. Arrangement of stacking of single rails and 20 rail welded panels with capability of mechanical handling (capacity to handle to match with plant production).
5. Generating Diesel sets of adequate capacity for standby arrangements.
6. Independent water supply and water cooling system.
7. Provision of chilling plant for cooling of oil to maintain hydraulic pressure specially in summers.

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2) Rail Alignment:-
   - Rails should preferably be welded with brand marks on same side.
3) Welding Sequence:-
   i) Aligning
   ii) Initial burn off: Control shall be adjusted so that at the end of this phase, weld interface has good overall contact.
iii) Preheating: Heat rail faces uniformly by flashes up to red hot stage.

iv) Flashing: Rail ends burn-off without short circuiting or giving rise to open circuit condition.

v) Forging: Rail ends are butted together to a stage of fusion under a heavy butting force whose magnitude depends on the make of welding plant.

vi) Recommended butting pressure:
   a) 72 UTS rails - 5kg/mm² on cross sectional area.
   b) 90 UTS rails & Head Hardened rails - 6 kg/mm² on cross sectional area.
   c) 110 UTS rails - 7 kg/mm² on cross sectional area.

vii) Stripping: Strip hot upset metal all-round rail section to ensure minimum grinding to achieve final finished profile. Air pressure and voltage/current recommended by manufacturer must be ensured throughout the welding cycle.

4. Post Weld Air Quenching Treatment for HH rails- As per annexure –II of Para 5.4 of FBW Manual

5. Post Weld controlled cooling treatment for 110 UTS rails- As per annexure – I of Para 5.4 of FBW Manual

6. Finishing of Joint- Profile grinding to the finishing tolerances as per table below

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Permissible tolerances (in mm)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>New rails</td>
<td>Old rails</td>
</tr>
<tr>
<td>(i)</td>
<td>Vertical misalignment</td>
<td>+0.3</td>
<td>± 0.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.0</td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>Lateral misalignment</td>
<td>±0.3</td>
<td>±0.5</td>
</tr>
<tr>
<td>(iii)</td>
<td>Head finishing on gauge side</td>
<td>±0.25</td>
<td>±0.3</td>
</tr>
<tr>
<td>(iv)</td>
<td>Finishing of top table surface</td>
<td>+0.2</td>
<td>±0.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.0</td>
<td></td>
</tr>
<tr>
<td>(v)</td>
<td>Web zone (under side of head, web, top of base, both fillets each side)</td>
<td>+3.0</td>
<td>±0.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.0</td>
<td></td>
</tr>
</tbody>
</table>

C. Post Welding:

Marking of Joints:

1. For stationary Plant
   Aluminum strip fixed with epoxy adhesive at web of rail beyond 300 mm from joint. 11 digit number – first four digits weld number, next two digits for month, next two for year and last three digits for welding plant number.

2. For Mobile Plant
   Aluminum strip fixed with epoxy adhesive at web of rail beyond 300 mm from joint. 14 digit number – first four digits weld number, next two digits for month, next two year of welding, next to for owner of plant, next to plant of that particular owner and next to for code of agency executed the work.
D. Testing

a. Testing for each FBW joint:
   (i) Visual Inspection
   (ii) Dimensional Check
   (iii) Ultrasonic Test (USFD)

b. Tests on sample joints -
   (i) Hardness Test - Hardness in HAZ shall not vary by more than 20 HB from parent rail.
   (ii) Transverse Test - As per Table below

<table>
<thead>
<tr>
<th>No.</th>
<th>Rail Section</th>
<th>Span</th>
<th>Min. breaking load</th>
<th>Min. def.</th>
<th>Frequency of testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60 kg (UIC), Grade-1080HH</td>
<td>1.25 m</td>
<td>115 T</td>
<td>30 mm</td>
<td>1 in 500</td>
</tr>
<tr>
<td>2</td>
<td>60 kg (UIC), Grade-1080Cr</td>
<td>1.25 m</td>
<td>110 T</td>
<td>12 mm</td>
<td>1 in 500</td>
</tr>
<tr>
<td>3</td>
<td>60 kg (UIC) 90 UTS</td>
<td>1m</td>
<td>150 T</td>
<td>20 mm</td>
<td>1 in 1000</td>
</tr>
<tr>
<td>4</td>
<td>52 kg 90 UTS</td>
<td>1m</td>
<td>115 T</td>
<td>20 mm</td>
<td>1 in 1000</td>
</tr>
</tbody>
</table>

Sample joints for first 1,000 joints welded by mobile FBW plant will be tested at frequency of 1 in 100 joints and sub sequently at a frequency of 1 in 500 joints.

(iii) Macro and Micro Examination Frequency
1: 5000 – Stationary Plant
1: 1000 – Mobile FBW Plant

E. Precautions to Avoid Defects:

1. Rail end faces and adjoining surface of rail profile all round shall be cleaned properly by portable grinders or brushing machine or shot blasting for 25mm width.
2. End squareness of rail end faces must be ensured.
3. Welding Parameters as standardized by RDSO shall be strictly maintained during welding.
4. Rail ends having cracks and other visible rolling defects should be cropped before welding.
5. Care should be taken that notches, dents or chisel marks are not formed on the rail surface during stripping and finishing by grinding.
6. Loose oxide/metal shall be cleaned by brushing the copper block (electrode) surfaces and the copper blocks shall be periodically reconditioned or replaced with new ones.
7. Suitably treated water should be used for cooling system.
8. Secondary output of current should be sufficient enough to achieve complete fusion of butting faces of rails.
9. Butting stroke should be sufficient for complete coalescence (not less than 12 mm).
10. Ensure uniform and smooth auto trimming of the squeezed out metal and complete grinding using profile grinder around the butt joint.
11. Minimum and nearly parallel Heat affected Zone of the joint should be achieved by setting the weld parameters.
12. For insitu FBW, trains should be passed after 20 minutes, after completion of trimming with proper packing and support below the joint.

For any suggestions, errors etc. please contact: mail@lracen.gov.in

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