



Indian Oil Corporation Limited

**Panipat Hydrogen Generation Unit
Praxair India Private Limited**

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PROCEDURE FOR CONTROL DISTORTION / DIMENSION CONTROL / WELDING SEQUENCE

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1 SCOPE

This procedure is applicable Panipat_HGU Steel structural fabrication project at workshop.

2 PURPOSE

This purpose describes the distortion control and straightening of all parts during welding & dimension of the end product during fabrication, also describes the responsibility and activity for the dimensional control, measurement and tolerances to be complied for fabrication of structure.

This procedure describes the steps to be followed for repair of defects in structural welds.

3 DISTRIBUTION & INTENDED AUDIENCE

LEI: Linde Engineering India Pvt. Ltd
VE: Vishal Enterprise

4 ABBREVIATIONS

Abbreviations	Definitions
QA/QC	Quality Assurance/Quality Control
ASME	The American Society of Mechanical Engineers
AWS	American Welding Society
NDE	Non-destructive Examination
WPS	Welding Procedure Specification
PT	Penetrant Testing
MPT	Magnetic Particle Testing
HAZ	Heat Affected Zone

5 REFERENCE DOCUMENTS

SR. NO	DOCUMENT NAME	DOCUMENT NUMBER	LATEST REVISION
1	Inspection and Test Plan For Structural Steel Fabrication & Painting	0022MC5770 (RQSC-0001) W-TB 9219.001	01
2	Structural Welding Code – Steel	AWS D1.1	2020
3	Fabrication Specification – Structural Steel	&AG-(2910A70M)-W-SC 1901.001 (EN)	01

6 MEASURES AGAINST DISTORTION

Following measures must be taken for dimensional control:

- a) Efficient groove design
- b) Accurate estimation of weld shrinkage while working out on component dimension and intermediate tolerance
- c) Use of suitable & calibrated measuring devices
- d) Frequent and continuous In-process dimension checks
- e) Weld sequencing to minimize distortion affecting the dimension

7 DISTORTION CONTROL & STRAIGHTENING

- The damaged / distorted sections shall be visually inspected by QC engineer to ascertain the extent of damage and distortion.
- If the section is damaged beyond repair, the damaged portion shall be cut off and the straight portion only shall be used on the job.
- Rolled material before being laid off or work must be straightened within the tolerance allowed by Code.
- If the section is to be rectified, the straightening work shall be done systematically as described in below clauses or if required, as per the method statement for rectification.

- Sections may be straightened in cold condition by using weighing blocks, portable/stationary Jim screw or hydraulic jack / power press. Capacity of jack / press to be estimated by material thickness.
- For straightening any bent section, no direct hammering and cold forming by blows shall be used.
- Heavy section(s) where the thickness is beyond the capacity of a Jim screw / jack / press to straighten in cold condition; item may be heated uniformly by a blow torch (Mounted manifold type) / hand blow burner / electrical coil type at the area of bent to a maximum temperature of 550 Deg C and then pressed in a Jim screw or jacking arrangement / power press. The heating temperature to be monitored by using temple sticks.
- The bent section may be pressed in a Jim screw or power press or hydraulic jacking system in several stages depending on the amount of bent.
- After straightening in hot condition, the section shall be allowed to cool naturally. No forced cooling shall be adopted.

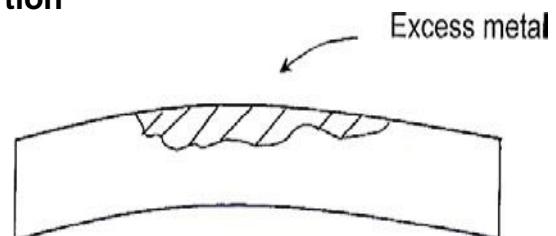
Straightening of Distorted parts due to welding:

- Distortion due to welding shall be minimized by providing pre-cambering in joint members during Fit-up, groove design, sequence of welding etc.
- Members distorted by welding shall be straightened by Mechanical means as described above clause or by application of a limited amount of localized heat as below.
- For heating, torch / burner / electrical coil shall be used. In any case, cutting torch shall not be used. While heating, the torch/burner must be continuously moving over the required area or heating arrangement may be made so that the heating is uniform and the whole area will attain the desired temperature at the same time for optimum result.
- The temperature to be measured by tempil sticks shall not exceed 550° C. The parts to be heated for straightening shall be substantially free of stress and from external forces, except those stresses resulting from the mechanical straightening method used for straightening method in conjunction with application of heat.
- Carry out the heat correction for all the areas of distortion and check the level after each location is cooled down. Repeat the process as required to achieve the desired straightness / final level. The section shall be allowed to cool naturally, and no forced cooling shall be adopted any time.
- In case of extreme distortion, the Item may be cut and replaced, if straightening is not possible.

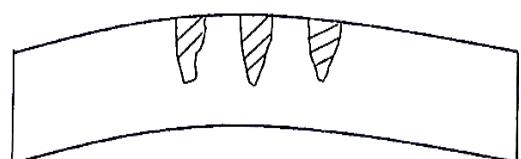
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- The tilting would depend on case to case basis, based on fillet weld size, the sequence of welding operation should be such that deflection of the member will always be within control during welding operations. Based on the deflection observed the welding sequence should be planned such that when welding complete. The members are perpendicular within the required tolerance and maintained in drawing.
 - The Distortion Correction for some items are as described below:

1. Wide Flange shapes for web distortion

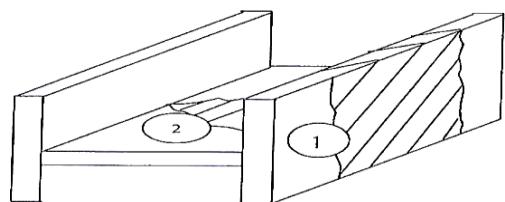
- i. Distorted I-beam after welding



- ii. This wedge section including
The flange is heated.

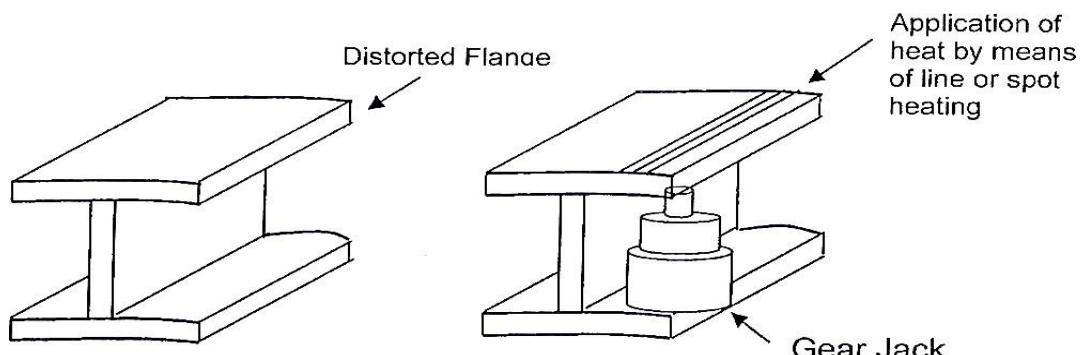


- iii. Heating shall be applied from
Sequence No. 1 towards
Sequence No.2



2. Distorted flange of I / H section

The distorted part shall be corrected by line heating or spot heating. Gear jack shall be used in conjunction with line heating if distortion cannot be corrected by heating alone and the amount of gear jacking is dependent on the length of distortion.



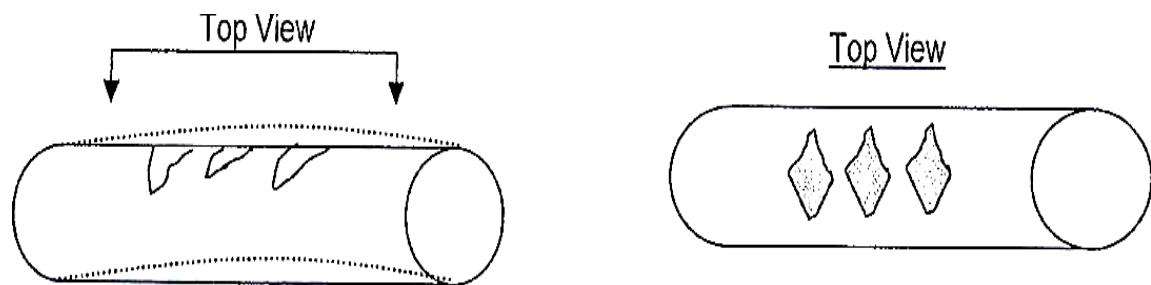
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Strong backs are used during the fit-up, during Fit-up once the offset is removed the strong backs are welded to hold the joint in position during the welding operation.

3. Tubular / Pipes:

Distorted or bent tubular / pipe

The distorted / bent part shall be corrected by line heating or spot heating i.e. triangle or diamond shape markings and allow the materials to cool to ambient temperature. Gear jack and lever blocks or concrete blocks shall be used in conjunction with fairing if distortion cannot be corrected by heating alone and the amount of gear jacking or concrete weight will depend on the condition of distortion.



- Welding sequence and procedures shall be such as to keep distortion and shrinkage within the dimensional tolerances specified in AWS D1.1 or the applicable Algerian codes and Standards.

8 DIMENSIONAL CONTROL

8.1 GENERAL

- **Out of Tolerance:** Nonconforming "As Built" dimension out of the allowable limits of approved drawings/ specified code / specifications.
- It shall be ensured by Execution Engineer that dimensions of all fabricated components, sub-assemblies and assemblies are within the tolerance range as specified in the relevant Engineering drawings/Codes/ Specifications.
- Checks at fit-up stage shall be carried out by QC Engineer to keep the final dimension under control. In case the dimensions are not within the limits of intermediate tolerances, corrective actions should be taken before proceeding further with fabrication. Special attention should be required for critical dimensions.
- Permanent reference marking should be pre-determined. All the time, dimensions should be controlled by taking measurements with respect to permanent reference marking, both during fabrication & erection.
- Dimensional inspection shall be carried out by QC Engineer as per approved Inspection and Test Plan and drawings.

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- Dimension reports shall be prepared by QC Engineer in prescribed formats. Dimensions measured on completion of all welding would be recorded as 'Final dimension'.
- If the post weld dimensions are not within the specified tolerance limits, the SQS (Site Query Sheet) should be raised by Execution Engineer seeking approval of the designer. If the deviation is approved by the designer, the achieved dimensions can be recorded as 'As-built', otherwise the job must be rectified.
- Dimensional corrections, especially if major, are to be carried out with approved procedure, in consultation with LINDE / TPIA. The criticality & volume of rectification / correction requiring procedure should be finalized in consultation with QC Engineer Fabrication.

8.2 DIMENSIONAL CONTROL INCLUDES CHECK ON FOLLOWING, AS APPLICABLE

- a) Linear & angular dimensions
- b) Slope and level
- c) Perpendicularity
- d) Circumference & Ovality
- e) Straightness
- f) Curvature
- g) Weld Joint Dimensions etc.

8.3 MEASURING INSTRUMENTS / DEVICES

- All Instruments to be used for dimension inspection shall be calibrated to achieve the high accuracy necessary to fabricate the structure within the tolerance limits (as specified in the respective drawings, codes and standards).
- Following are some examples of Instruments that can be used, as appropriate, for dimensional Inspection
 - a) Theodolite / Total Station
 - b) Leveling Instrument
 - c) Measuring tape
 - d) Right angle
 - e) Universal Gauge, Hi-Lo Gauge, Root gap gauge
 - f) Spirit level

g) Bevel protractor

8.4 FABRICATION TOLERANCES FOR STRUCTURE

- Fabrication tolerances shall be as per approved GA / General drawing or AWS D1.1 whichever is stringent.
- Dimension check before welding for stack & duct is carried out during fit-up stage which includes additional allowances (shrinkage & distortion). Final dimensional Inspection after completion of welding shall be carried out and records shall be prepared. Same shall be offered to LEI/TPI as per approved ITP.
- Straightness of tubular members/ beams etc. during fabrication shall be measured by using taut string stretched or theodolite or total station depend on the length of the item / member and measurement shall be made at multiple locations for establishing the deviation.