

INDIAN METAL BUILDING FORUM

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RESOURCE CENTRE

Technical Knowledge Series

QA/QC GUIDANCE SERIES

NDT Requirements for Steel Building Fabrication

Non-destructive testing of welds in PEB and structural steel | Based on AWS D1.1 practice

Right Method
Qualified Personnel
Recorded Result

DOCUMENT NO:	IMBF-QC-001
SERIES:	Series B: QA/QC (IMBF-QC)
APPLIES TO:	Welds in PEB built-up members and structural steelwork
REFERENCE CODE:	AWS D1.1 Structural Welding Code: Steel
COMPANION TO:	IMBF-FAB-001 Welding Requirements

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A quick-reference summary. The contract specification, the approved QAP and the applicable code edition always govern.

A DOCUMENT CONTROL AND STATUS

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Technical review status

- ☒ Draft (compiled from code practice and a manufacturer fabrication plan; not yet reviewed)
- ☐ Technical Review
- ☐ IMBF Approved for Publication

Disclaimer

This document has been prepared by the Indian Metal Building Forum (IMBF) as an educational quick reference. It summarises common NDT requirements for welds in statically loaded steel building structures. It is not a code and is not an NDT procedure. It does not replace AWS D1.1, the referenced ASTM or Indian Standards, the contract specification, the approved Quality Assurance Plan (QAP) or a written procedure approved by an NDT Level III. Numerical values were written from code practice as commonly applied and from one manufacturer's procedures. They must be checked against the code edition and procedures named in the contract before use. IMBF does not accept responsibility for inspection or engineering decisions made solely on the basis of this document.

1 SCOPE AND BASIS

- **Covers:** NDT of shop and site welds in PEB built-up members and structural steelwork: visual (VT), ultrasonic (UT), magnetic particle (MT), dye penetrant (PT) and radiographic (RT) testing.
- **Basis:** AWS D1.1 for statically loaded structures, with ASTM E709 (MT), ASTM E165 (PT) and ASTM E94 (RT) as the method standards it refers to. Confirm editions against the contract.
- **Key rule:** under AWS D1.1, every weld is visually inspected. NDT beyond visual is required only where the contract documents specify it. The QAP must therefore state the method and extent for each joint type.
- **Order of precedence:** contract specification, approved QAP, approved NDT procedure, code, then this guide.

2 CHOOSING THE METHOD

Method	Finds	Typical use in steel buildings	Limits
Visual (VT)	Surface defects, profile, size	All welds, full length, before any other NDT	Surface only; depends on access and light
Magnetic particle (MT)	Surface and slightly sub-surface cracks, lack of fusion at toes	Fillet and partial-penetration welds; end plates, base plates, stiffeners, lifting lugs	Ferromagnetic steel only; shallow depth; paint thickness affects result
Dye penetrant (PT)	Surface-breaking defects only	Where MT is not practical; back-gouged roots; small attachments	Needs clean, smooth surface; temperature-sensitive; slow
Ultrasonic (UT)	Internal planar defects: lack of fusion, cracks, incomplete penetration; laminations	Full-penetration groove welds: flange and web splices, end-plate butt welds	Thickness about 8 mm and over; operator skill; geometry of joint
Radiography (RT)	Internal volumetric defects: porosity, slag; permanent image	Butt welds where specified	Radiation safety; access to both sides; poor on tight planar defects and on T-joints

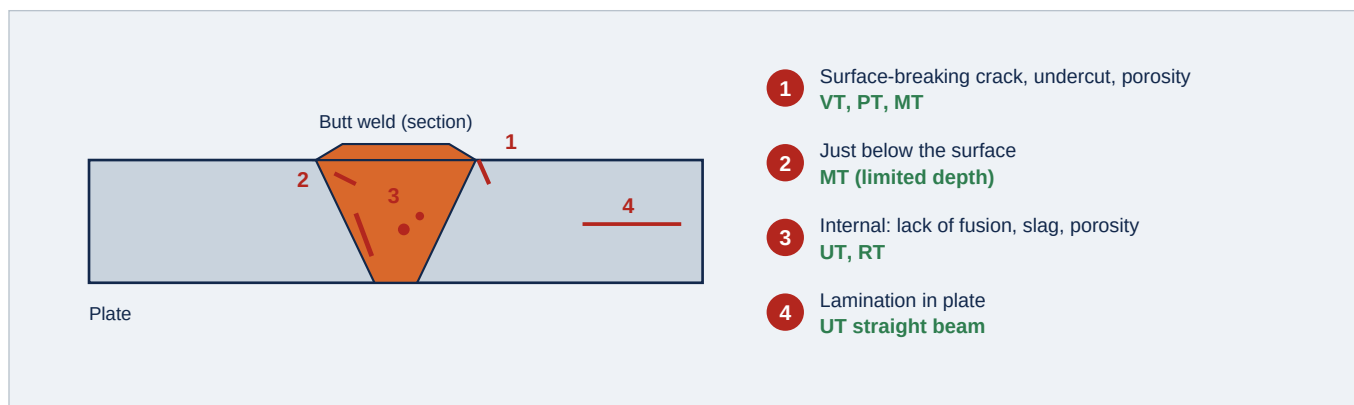


Figure 1. Which method finds which defect. Original IMBF schematic, not to scale.

3 EXTENT OF TESTING

The percentages belong in the contract and the QAP. The table shows the usual pattern, not fixed values.

Joint type	Usual method	Extent
All welds	VT	100 %
Full-penetration butt splices in flanges and webs; tension splices	UT (or RT where specified)	As stated in QAP; tension splices are commonly tested in full
Web-to-flange fillet or SAW welds of built-up members	VT; MT or PT on a sample	Sample percentage as stated in QAP
End plate and base plate welds	VT; MT or PT; UT where full penetration	As stated in QAP
Lifting lugs and temporary attachments carrying load	VT and MT or PT	Commonly 100 %
Plate under highly stressed T-joints (through-thickness load)	UT straight beam for laminations	Where specified

- **Spot (sample) testing:** if a sample shows a rejectable defect, test two more spots in the same weld segment. If either of those is rejected, test the whole segment.
- Define a "lot" or "segment" in the QAP (for example per member, per welder, per shift) so that the sample percentage has a clear meaning.

4 PERSONNEL AND TIMING

- NDT personnel are certified under the employer's written practice to ASNT SNT-TC-1A or an equivalent scheme such as ISO 9712.
- Level I may carry out tests under the supervision of a Level II or III. Only Level II or III may interpret results and sign reports.
- Certificates must be valid for the method used. Near-vision acuity is checked every year; colour vision at the interval in the written practice.
- Visual inspection is by a qualified welding inspector and is completed, and the weld accepted, before other NDT starts.
- Test after the weld has cooled to ambient temperature. For quenched and tempered high-strength steels, wait at least 48 hours after welding because of delayed cracking.
- Test before painting or galvanizing wherever possible.

5 ULTRASONIC TESTING (UT)

Item	Requirement
Application	Fusion welds in material from 8 mm to 200 mm thick. Thinner material needs a special procedure agreed with the engineer.
Equipment	Pulse-echo instrument with valid calibration certificate; straight-beam and angle-beam probes as in the procedure; IIW or equivalent reference block.
Periodic checks	Horizontal linearity after every 40 hours of instrument use. Gain control (dB) accuracy every 2 months. Probe internal reflections and wear checked at the procedure interval.
Calibration on the job	Sensitivity and sweep calibrated just before testing, at the place of testing. Re-check at least every 30 minutes, and whenever the operator, probe, cable, battery or power source changes.
Surface and couplant	Scanning surface free of spatter, loose scale, dirt and thick paint. Same couplant for calibration and testing.
Base metal	Scan the whole area the sound will pass through with a straight-beam probe first, to find laminations that would hide or deflect the angle beam.
Scanning	Each pass overlaps the last by at least 10 % of the transducer width. Scanning speed not over 150 mm per second. Scan from both sides of the weld where access allows.
Evaluation	Each indication is given a rating in dB from its level, the reference level and attenuation, and is accepted or rejected by rating and length, using the code table for statically or for cyclically loaded structures.
Marking	Rejectable indications marked on the weld over their full length, with depth noted.

6 MAGNETIC PARTICLE TESTING (MT)

Item	Requirement
Method	Wet or dry particles, continuous method, with an AC or half-wave DC electromagnetic yoke. Standard: ASTM E709.
Yoke	Pole spacing 75 mm to 200 mm. Lifting power checked at the working pole spacing: 4.5 kg for an AC yoke, 18 kg for a DC yoke. Check at least every 12 months and after any damage.
Field check	Verify field direction and strength with a pie gauge or other field indicator before each inspection.
Surface	Clean and dry; free of grease, loose scale, slag and spatter. Surface temperature 10 to 57 deg C for wet particles unless the product allows otherwise.
Technique	Test each area twice, with the field in two directions at right angles. Overlap successive positions by at least 25 mm.
Lighting	At least 1000 lux at the test surface for visible particles.
After testing	Remove particles. Demagnetise where residual field would affect later welding, machining or instruments.

7 DYE PENETRANT TESTING (PT)

Item	Requirement
Method	Visible, solvent-removable penetrant is usual in fabrication shops. Standard: ASTM E165.
Materials	Penetrant, remover and developer from one manufacturer's product family, within shelf life.
Surface	Weld and at least 13 mm each side clean, dry and free of scale, slag, paint and oil. Do not shot-blast or peen before PT: it can close surface cracks.
Temperature	Part and penetrant between 16 and 52 deg C, or as qualified in the procedure.
Dwell time	Penetrant left on for the time in the procedure; 20 to 30 minutes is used in the reference fabrication plan.
Removal	Wipe with dry lint-free cloth, then cloth lightly moistened with remover. Never spray remover directly on the surface.
Developing	Thin, even coat of developer. Interpret within the procedure window; 7 to 20 minutes is used in the reference plan.
Lighting	At least 1000 lux at the test surface.
After testing	Remove developer and penetrant residues before painting.

8 RADIOGRAPHIC TESTING (RT)

- Used only where specified, usually for butt welds. Standard: ASTM E94, with image quality indicators (IQI) to prove sensitivity.
- Each radiograph carries identification of job, member, weld, location and date, traceable to the report.
- Film density and IQI sensitivity must meet the code limits before the weld is evaluated.
- Radiation work in India is regulated by the Atomic Energy Regulatory Board. Sources, operators and site controls must comply; cordon the area and schedule exposures away from other work.

9 ACCEPTANCE, REPAIR AND RETEST

- **VT, MT and PT:** indications are judged against the visual acceptance criteria of the code. Cracks, lack of fusion and incomplete penetration are rejected. See IMBF-FAB-001 for the limits on undercut, porosity and undersize.
- **MT and PT:** rounded or linear indications over 1.6 mm are treated as relevant and evaluated; smaller ones are noted.
- **UT and RT:** acceptance by the code tables for the type of loading. Confirm with the engineer whether the structure, or part of it such as a crane girder, is cyclically loaded.
- Repair to an approved procedure and WPS. For cracks, find the extent by MT or PT and remove the crack plus 50 mm of sound metal beyond each end.
- Retest every repair by the same method and procedure that found the defect, and record it as a repair on the report.
- A weld is not painted or dispatched until its NDT is accepted.

10 WHAT AN NDT REPORT MUST SHOW

- Job, drawing, member mark, weld identification and location tested.
- Method, procedure number and revision, acceptance standard.
- Equipment and consumables: instrument and probe serial numbers, yoke, penetrant family and batch, calibration block.
- Material, thickness, joint type, surface condition, stage (as welded, after repair).
- Results: location, type, size and rating of each indication; accept or reject; sketch where needed.
- Date, name, certification level and signature of the technician, and review by the fabricator's QC and the client or third party.

11 NDT CONTROL CHECKLIST

Stage	Check	Status	Remarks
Planning	Method and extent for each joint type stated in the approved QAP	☐	
Planning	Written NDT procedures approved; acceptance standard agreed	☐	
Planning	Lot or segment for sample testing defined	☐	
Personnel	Certificates valid for the method; interpretation by Level II or III	☐	
Equipment	UT set, probes, yoke and light meter within calibration	☐	
Equipment	Penetrant and particle materials within shelf life; one product family	☐	
Before testing	Weld visually accepted; cooled; surface prepared	☐	
Testing	UT calibration checked before, every 30 minutes and after any change	☐	
Testing	MT field verified; two directions; overlap kept	☐	
Testing	PT temperature, dwell and developing times kept	☐	
Results	Rejectable indications marked on the member	☐	
Results	Sample-test rule applied when a defect is found	☐	
Repair	Repairs approved, made and retested by the same method	☐	
Records	Reports complete, signed, reviewed and traceable to each member	☐	

12 BASIS OF THIS GUIDE

Ref	Source	Used for
R1	AWS D1.1, Structural Welding Code: Steel (American Welding Society). Written from code practice as commonly applied to statically loaded structures; not checked line by line against a specific edition.	Requirement for NDT to be specified in the contract; personnel; UT checks and scanning; acceptance basis; sample-testing rule
R2	UT, MT, PT and weld repair procedures in the fabrication plan of a PEB manufacturer, working to AWS D1.1:2006 (supplied to IMBF).	UT thickness range and calibration intervals; MT yoke spacing, overlap and temperature; PT temperature, dwell and developing times; light level; repair
R3	ASNT SNT-TC-1A; ASTM E709, E165 and E94.	Named as the personnel and method standards; yoke lifting power
R4	Atomic Energy Regulatory Board (India).	Named as the regulator for radiography; no requirements quoted

Limits of this draft: table and clause numbers are not cited because AWS D1.1 was renumbered in its 2020 edition. Every value should be verified against the editions and procedures named in the contract by an NDT Level III before publication.

Final disclaimer. This IMBF publication is an educational quick reference. It is not an NDT procedure and is not a substitute for the applicable code, the contract specification, an approved QAP, certified NDT personnel or professional advice.