Weld Quality Control: NDT Methods for Pipes & Fabricated Steel Structures from China | Metal-Asia.pw

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Why Dedicated Weld Control Is Essential

Within the portfolio of China-origin metal products, **welded fabrications carry the highest risk profile.** Welded pipe (HS Code 7305, 7306), LGSF framing profiles, modular buildings, and sheet piles with interlock joints all demand rigorous weld quality verification — because **up to 70% of structural failures in fabricated steel originate at the weld joint.**

I personally investigated a warehouse construction failure in Central Asia where S350GD profiles from China contained interlock weld defects that compromised structural load capacity under snow load. Pre-shipment UT and PT inspection would have identified the issue months before erection.

This technical guide provides a complete framework for weld quality control in China-sourced metal products: defect classification, NDT method selection, inspection standards, and tailored control schemes for different product categories.

Classification of Weld Defects in China-Origin Shipments

Table 1. Weld Discontinuity Classification and Frequency

Defect Category	Defect Type	Designation	Root Cause	Frequency in China Supply	Criticality
Planar	Cracks (longitudinal, transverse, toe)	Crack	Incorrect WPS, rapid cooling, base metal non-conformance	5–8%	**Critical**
	Lack of Penetration (LOP)	LOP	Insufficient current, excessive travel speed, incorrect root gap	10–15%	**Critical**

Defect Category	Defect Type	Designation	Root Cause	Frequency in China Supply	Criticality
	Lack of Fusion (LOF)	LOF	Contaminated bevels, low temperature, poor preparation	8–12%	**Critical**
	Undercut	Undercut	Excessive current, improper technique	15–20%	Elevated
Volumetric	Porosity & blowholes	Porosity	Moisture, rust, contaminated flux/wire, gas evolution	12–18%	Elevated
	Slag inclusions	Slag Inclusion	Incomplete slag removal between passes	10–15%	Elevated
	Tungsten inclusions	Tungsten Inclusion	TIG electrode contact with weld pool	2–4%	Elevated
Geometric	Excessive reinforcement	Overreinforcement	Low travel speed, excessive filler metal	20–25%	Low
	Underfill	Underfill	High travel speed, insufficient filler	15–20%	Elevated
	Improper weld profile	Improper Profile	WPS/PQR non-conformance	10–15%	Low
	Burn-through	Burn-through	Excessive current, slow progression	5–8%	Elevated
Delayed	Hydrogen-induced cracking (HIC)	Delayed Cracking	Hydrogen embrittlement in high-strength steels	3–5%	**Critical**

Process-Specific Risks in Chinese Welded Pipe Production

- **HFW / ERW (High-Frequency Welded):** Most common for ø89–1420 mm pipe. Primary risk: incomplete root penetration and HAZ cracking.

- **SAW (Submerged Arc Welded):** Used for large-diameter line pipe. Risk: slag inclusions and porosity in multi-pass welds.
- **TIG / MIG / MAG:** Used for stainless pipe and special alloys. Risk: oxidation, lack of fusion, cooling cracks.

NDT Methods for Welded Joints: Complete Reference

Table 2. Full NDT Method Matrix for Weld Inspection

#	Method	Abbrev.	Detectable Discontinuities	Inspection Depth	Material Type	Standard
1	**Visual & Dimensional Testing**	VT	Surface defects: cracks, porosity, weld profile, undercut, dimensions	Surface	All weld types	GOST 13052, ISO 17637, AWS D1.1
2	**Ultrasonic Testing**	UT	Internal cracks, LOP, LOF, porosity, slag, laminations	2–10 m (frequency-dependent)	Welds ≥4 mm wall thickness	GOST 14782, ASTM E164, EN 1714
3	**Radiographic Testing**	RT	Internal porosity, cracks, slag, LOP, LOF, inclusions	Full wall thickness	All types, optimal 4–50 mm	GOST 7512, ASTM E94, ISO 17636
4	**Magnetic Particle Testing**	MT	Surface & near-surface (to 3 mm) cracks, LOF, undercut	0–3 mm	Ferromagnetic materials only	GOST 21105, ASTM E709, EN 1290
5	**Liquid Penetrant Testing**	PT	Open surface cracks, porosity, micro-cracking	0–0.1 mm (open surface only)	All materials	GOST 18442, ASTM E165, EN 571
6	**Eddy Current Testing**	ET	Surface cracks, HAZ wall thickness monitoring	0–3 mm	Tubing, thin-wall structures	GOST R 54801, ASTM E426, EN 1711

#	Method	Abbrev.	Detectable Discontinuities	Inspection Depth	Material Type	Standard
7	**Acoustic Emission Testing**	AE	Defect activity under load, crack growth monitoring	Full structure	Large vessels, pipelines, bridges	GOST R 54815, ASTM E569
8	**Infrared Thermography**	IR	Temperature field anomalies indicating hidden defects	Surface	In-service pipelines, furnaces	ASTM E1934
9	**Pneumatic / Hydrostatic Leak Testing**	LT	Through-thickness defects, leakage	Full wall thickness	Pipes, pressure vessels	GOST 3242, ASME V

Table 3. NDT Method Selection by Defect Type

Target Defect	Primary Method	Alternative	Not Recommended
Internal LOP	**UT**	RT	MT, PT
Internal porosity	**RT**	UT	MT, PT
Surface cracks	**MT** (ferromagnetic) / **PT** (all)	ET	RT (if crack is fine)
Slag inclusions	**UT**	RT	MT, PT
Lack of fusion	**UT**	RT	MT, PT
Undercut / underfill	**VT**	—	RT, UT
Leakage / through-wall	**Hydrotest**	Pneumatic test	All others
HAZ cracks	**UT** (angle probes)	RT	MT, PT

Weld Quality Standards for China-Origin Products

Table 4. Quality Classes per GOST, ISO, API, ASME, EN

Standard	Class / Category	NDT Requirements	Application
GOST 3242-79	Category I	100% RT or UT + 100% MT/PT + VT	Radiation-hazardous systems, cryogenic equipment
	Category II	100% UT + 25% MT/PT + VT	Pressure pipelines Class A/B, Vessels I/II
	Category III	50% UT + 10% MT/PT + VT	Pressure pipelines Class C, Vessels III

Standard	Class / Category	NDT Requirements	Application
	Category IV	VT + 10% UT	Pressure pipelines Class D, non-critical structures
ISO 5817	Level B (stringent)	Full NDT suite	High-integrity load-bearing structures
	Level C (medium)	Standard NDT suite	General load-bearing structures
	Level D (permissive)	VT + sampling UT	Non-critical structures
API 1104	Acceptance criteria	RT + UT per program	Oil & gas transmission pipelines
ASME Section VIII	UW-11, UW-52	Full / sampling RT	Pressure vessels
EN 1090	EXC2, EXC3, EXC4	UT/RT/MT/PT per program	Building and civil engineering steel structures

Inspection Schemes by Product Type

Scheme A. Pipeline Welded Pipe (API 5L, GOST 20295, EN 10208)

Stage	Method	Coverage	Acceptance Criteria
1. Bevel preparation incoming QC	VT	100%	No rust, oil, moisture; correct root gap
2. Root pass control	UT (straight beam)	100%	LOP ≤5% wall thickness; cracks — reject
3. Intermediate pass control	VT	100%	Slag removed; no cracks
4. Fill pass control	UT	100%	EN ISO 17640, Level 2
5. Cap pass control	VT + UT	100%	Weld profile per ISO 5817
6. Hydrostatic testing	Hydrotest press	100%	1.25×Pdesign, 10 min hold, no leakage
7. Geometry control	VT + weld gauges	100%	Reinforcement ≤3 mm; weld width per WPS
8. HAZ hardness control	Hardness testing	5%	HV10 ≤ 250 (carbon steels)
9. Final UT / RT	UT or RT	100%	GOST 14782 / GOST 7512
10. Marking & certification	—	100%	Each pipe: heat number, date, welder ID

Scheme B. LGSF Profiles & Modular Buildings (EN 1090, GOST R 54159)

Stage	Method	Coverage	Criteria
1. Welding preparation control	VT	100%	Bevels, gaps, tack welds
2. Sheet pile / profile interlock weld	UT	10% sampling	LOP, cracks — reject
3. External weld examination	VT	100%	ISO 5817, Level C
4. Profile geometry control	Templates, 3D scanner	100%	±1 mm deviation
5. MT surface crack detection	MT	100%	EN 1290
6. Destructive testing of witness coupons	Tensile, bend, impact	1 set per lot	WPS conformance

Scheme C. Stainless Steel Pipe & Fittings (ASTM A312, GOST 9940/9941)

Stage	Method	Coverage	Criteria
1. PMI base metal & filler metal	XRF/LIBS	100%	Conformance to AISI 304/316L/321
2. Welding preparation control	VT	100%	Cleanliness, gap, tack welds
3. TIG root pass	VT + PT	100%	No oxidation; full penetration
4. MIG/MAG fill passes	UT	100%	ASTM E164
5. Final liquid penetrant testing	PT	100%	No cracks, no porosity
6. Hydrostatic testing	—	100%	1.5×Pdesign, 10 min
7. Ferritometry	Ferritometer	10%	Ferrite 3–10% for duplex grades

Product Nomenclature with HS Codes: Welded Products Under NDT

Table 5. Welded Tubular Products & Fabricated Structures with HS Codes

#	Product	HS Code	Welding Standard	Mandatory NDT	Defect Risk
1	Welded pipe ø >406.4 mm (line pipe)	7305.31	API 5L, GOST 20295	100% UT + RT + hydrotest	Medium (8–12%)
2	Welded pipe ø ≤406.4 mm (general service)	7306.30	GOST 10704, EN 10219	Sampling UT + VT	Medium (10–15%)
3	Structural hollow sections (square/rectangular)	7306.61	GOST 13663, EN 10219	VT + sampling UT	Medium (10–15%)

#	Product	HS Code	Welding Standard	Mandatory NDT	Defect Risk
4	Water/gas pipe (WGP)	7306.30	GOST 3262	VT + leak test	Low–Medium
5	Welded sheet pile (Larssen)	7308	GOST 4781-85	VT + UT interlocks + dimensional	Medium
6	Welded fittings (elbows, reducers, tees)	7307	ASME B16.9, EN 10253	RT + UT + VT	Medium (10–12%)
7	Welded flanges	7307.21	ASME B16.5, GOST 12820	VT + UT weld	Medium (8–10%)
8	LGSF profiles (C-, U-, Z-sections)	7308	EN 1090	VT + sampling UT interlocks	Medium (6–10%)
9	Modular buildings (block containers)	7308	EN 1090	VT + sampling UT	Medium (8–12%)
10	Custom fabrications to drawing	7308	Per client specification	Per client ITP	Project-dependent

Common Problems in Chinese Welded Product Supply & Our Solutions

Problem 1: WPS/PQR Non-Conformance

Issue: Supplier declares TIG root + MAG fill procedure; actual production uses manual arc welding due to insufficient qualified welders.

Metal-Asia Solution: Weld shop audit — verification of certified WPS/PQR documents, welder qualification records (WQR), and real-time process surveillance.

Problem 2: Unqualified Welders

Issue: Lack of welder certification to international standards (ISO 9606, AWS D1.1). High staff turnover at Chinese mills.

Metal-Asia Solution: Verification of welder qualification certificates, on-site performance observation, witness coupon testing.

Problem 3: Non-Conforming Filler Materials

Issue: Use of uncertified, low-cost filler wire that does not match base metal chemistry.

Metal-Asia Solution: PMI analysis of filler materials; verification of wire and electrode certificates.

Problem 4: Absence of Post-Weld Heat Treatment (PWHT)

Issue: Many steel grades (particularly structural and heat-resistant alloys) require stress relief or normalization after welding. Chinese mills frequently skip this step to reduce cost.

Metal-Asia Solution: PWHT monitoring — verification of temperature charts; hardness testing in HAZ before and after heat treatment.

Problem 5: Falsified NDT Reports

Issue: Professional-looking UT/RT reports issued without actual inspection, or performed by unqualified personnel.

Metal-Asia Solution: Independent Level II inspectors conduct all NDT, separate from mill QC. Photo/video documentation of the inspection process. Cross-verification against mill-generated reports.

Service Pricing: Weld Inspection

Service	Method	Rate	Notes
Visual weld inspection	VT	$60/man-hour	Minimum 4 hours
Ultrasonic testing	UT	$150/man-hour	Level II certified inspector
Radiographic testing	RT	$200/exposure	Including processing and interpretation
Magnetic particle testing	MT	$120/man-hour	Including magnetic particles
Liquid penetrant testing	PT	$80/linear meter	Including penetrant and developer
Hydrostatic testing	—	$300/setup	Organization and supervision
HAZ hardness testing	HV/HRC	$5/point	Minimum 10 points
PMI base metal + weld metal	XRF/LIBS	$2/test	100% for stainless grades
Comprehensive weld report	—	$200–500	Volume-dependent
Weld shop audit	—	$800/day	Including travel expenses

How to Engage Our Weld Inspection Services

1. Send your specification to **zakaz@metal-asia.pw** or via WhatsApp
2. Specify: product type, applicable standard, quality category/class, lot volume
3. We prepare an NDT inspection program and formal quotation within 4 hours
4. Execute agreement; our inspectors deploy to the mill in China

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