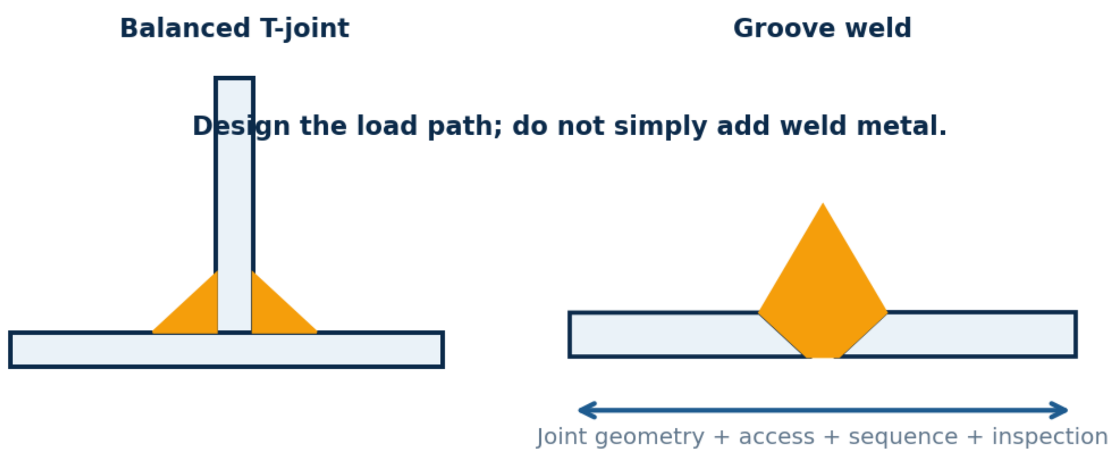
# KINGSFORM METALWORKS

ENGINEERING TOOLKIT

# WELDING
# DESIGN GUIDE

Joint selection, weld geometry, access, heat control, symbols, quality and inspection

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*Engineering reference only. The released drawing, governing code, qualified procedure and customer requirements remain controlling.*

01 SCOPE AND HOW TO USE THIS GUIDE

# Scope and how to use this guide

A practical DFM reference for fabricated frames, brackets, cabinets, tubes, sheet-metal assemblies and structural weldments.

**Use this guide before joint type, weld size, access, sequence, tolerance and inspection requirements are frozen.**

This guide connects product design intent with welding process capability. It focuses on joint geometry, load path, weld-metal volume, accessibility, fit-up, distortion, drawing communication and inspection planning. It does not replace structural calculation, a welding code, a WPS, welder qualification or production validation.

## Recommended use

1. Identify service loads, fatigue, sealing, corrosion, appearance and safety requirements.
2. Confirm the governing code, quality level and required procedure / personnel qualifications.
3. Choose the joint and weld process as a system: access, preparation, deposition, heat and inspection.
4. Dimension the final assembly from functional datums and specify only the weld information needed for control.
5. Review distortion, fixturing, sequence and inspection before quotation and first article.

## Contents



**Primary audience: product designers, purchasing engineers, quality teams and suppliers reviewing manufacturability before production release.**

02 DESIGN WORKFLOW AND REQUIREMENT HIERARCHY

# Design workflow and requirement hierarchy

A weld is a manufacturing process and a structural / functional feature - both must be defined.

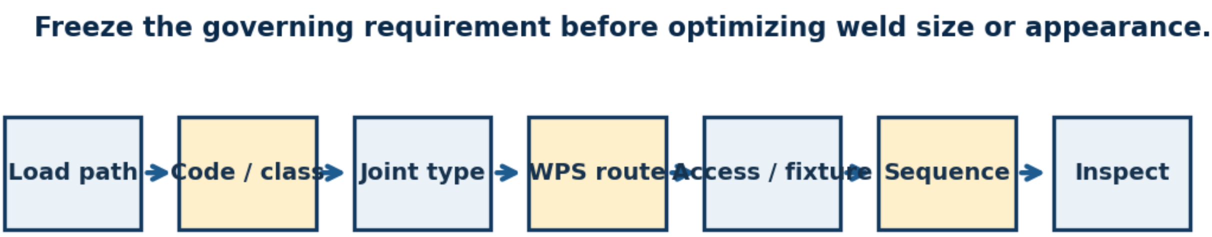


*Figure 1. A disciplined welding-design workflow prevents late changes to joints, access, WPS and inspection.*

| Decision layer | Questions to answer | Typical output |
|---|---|---|
| Function | What load, sealing, stiffness, alignment, fatigue life or cosmetic result is required? | Load path, service class and critical characteristics. |
| Contract / code | Which code, customer standard, quality level and documentation apply? | Applicable clauses, acceptance criteria and reports. |
| Joint design | Which joint transfers load with the least preparation, weld volume and distortion? | Joint type, weld side, size, length and preparation. |
| Production route | Which process, position, filler, shielding and access are realistic? | pWPS / WPS route and equipment assumptions. |
| Control plan | How will fit-up, heat, sequence, fixtures and inspection be controlled? | Work instruction, fixture concept, inspection and reaction plan. |

## Requirement hierarchy

- The purchase order and released drawing establish the contractual product requirement.
- The governing welding code controls design rules, qualification, fabrication and inspection within its scope.
- A WPS controls essential welding variables; a work instruction may add part-specific sequence and fixturing.
- A visual quality level describes permitted imperfections, not the structural adequacy of the joint.
- Customer-specific requirements override internal preferences when they are technically and contractually valid.

**Do not select a weld size from appearance alone. Required throat, penetration and length depend on the actual load case and governing design rules.**

03 JOINT TYPES AND LOAD PATH

# Joint types and load path

Joint geometry determines stress direction, fit-up sensitivity, weld access and inspection options.

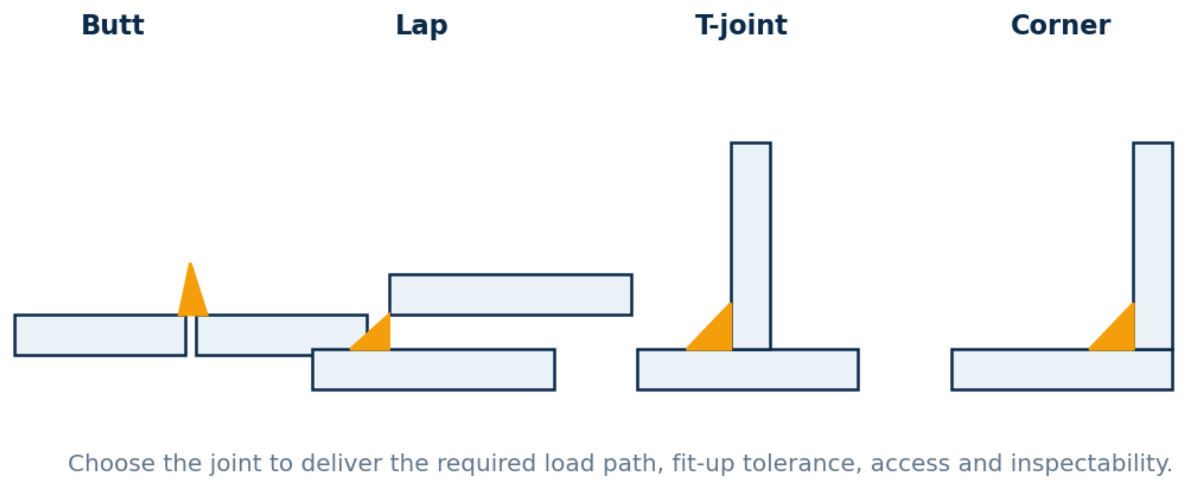


*Figure 2. Common welded-joint families used in fabricated metal products.*

| Joint | Advantages | Design risks / controls |
|---|---|---|
| Butt | Direct load path; flush surfaces; full penetration is possible. | Edge preparation, root control, alignment and access may increase cost. |
| Lap | Simple fit-up; useful for sheet and dissimilar thicknesses. | Crevice corrosion, eccentric load path, trapped finish and double thickness. |
| T-joint | Efficient for stiffeners, frames and brackets. | Fillet sizing, root fusion, access and angular distortion. |
| Corner | Useful for boxes, cabinets and closed sections. | Edge melt, penetration consistency, sealing and finishing access. |
| Plug / slot | Transfers load through overlap when edge welding is limited. | Hole geometry, fusion to lower sheet, access and inspection. |

## Load-path rules

- Align the joint so the principal load passes through the connected members with minimum eccentricity.
- Avoid terminating a stiff weld abruptly at a high-stress transition; smooth geometry and load transfer where fatigue matters.
- Provide adequate base-metal section around slots, holes and short returns; the weakest section may be the parent material.
- Use double-sided welds only when they improve load transfer or distortion control enough to justify access and cost.
- Do not rely on seal welds as structural welds unless both functions are explicitly designed and inspected.

**Fatigue-sensitive details require code-specific stress-category review. More weld metal can increase stiffness discontinuity and residual stress rather than improve fatigue life.**

04 WELDING PROCESS SELECTION

# Welding process selection

Choose a process that matches material, thickness, access, quality, volume and cosmetic expectations.

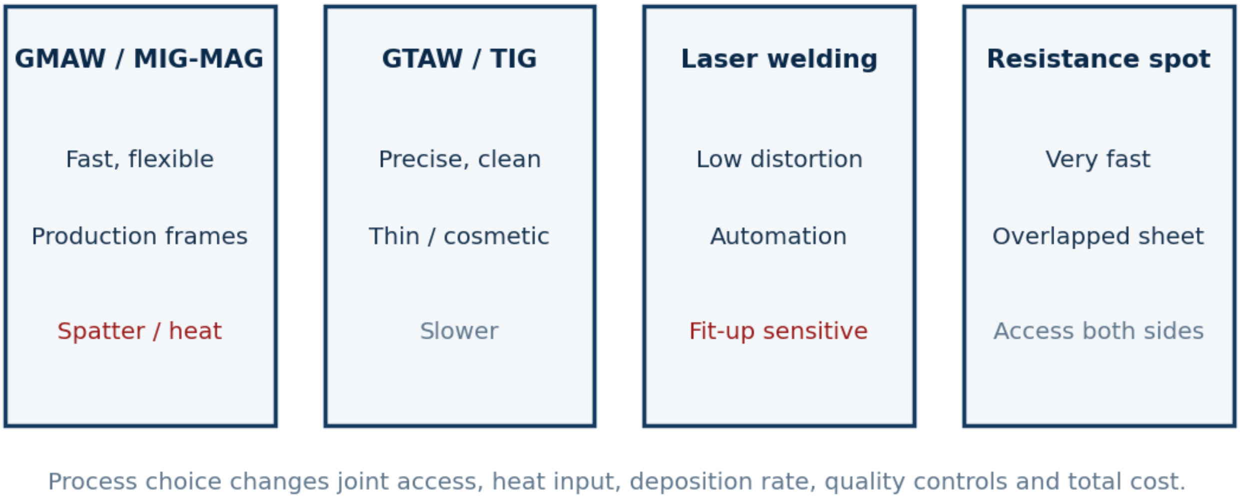


*Figure 3. Four commonly considered joining routes; each changes design constraints and control needs.*

| Process | Good fit | Design / production considerations |
|---|---|---|
| GMAW / MIG-MAG | Carbon steel frames, brackets, medium production and robotic cells. | Requires torch access, shielding protection, spatter control and parameter discipline. |
| GTAW / TIG | Thin stainless, aluminum, visible welds and lower-volume precision work. | Lower deposition rate; joint cleanliness and operator control are critical. |
| Laser welding | Automation, low distortion, narrow welds and high repeat volume. | Tight fit-up, stable seam location, safety enclosure and capital tooling. |
| Resistance spot welding | Overlapped sheet, enclosures, automotive-style production. | Electrode access both sides, flange width, shunting, indentation and electrode maintenance. |
| FCAW / SMAW | Heavier sections, site work and less-controlled environments. | Higher fume / slag burden, access for cleaning and larger heat input. |

## Selection inputs

- Material family and grade, thickness range, coating, joint position and required penetration.
- Batch size, deposition rate, automation potential, changeover frequency and operator skill.
- Visual acceptance, allowable discoloration, spatter, grinding and post-weld finishing.
- Heat-sensitive dimensions, nearby hardware, seals, adhesives, coatings or precision surfaces.
- Inspection access and the defect types that the selected method must prevent or reveal.

**The drawing should normally define the required joint and result - not force a proprietary process - unless the process itself is contractually necessary.**

05 FILLET WELD GEOMETRY AND SIZING

# Fillet weld geometry and sizing

Control effective throat and fusion - not just visible bead width.

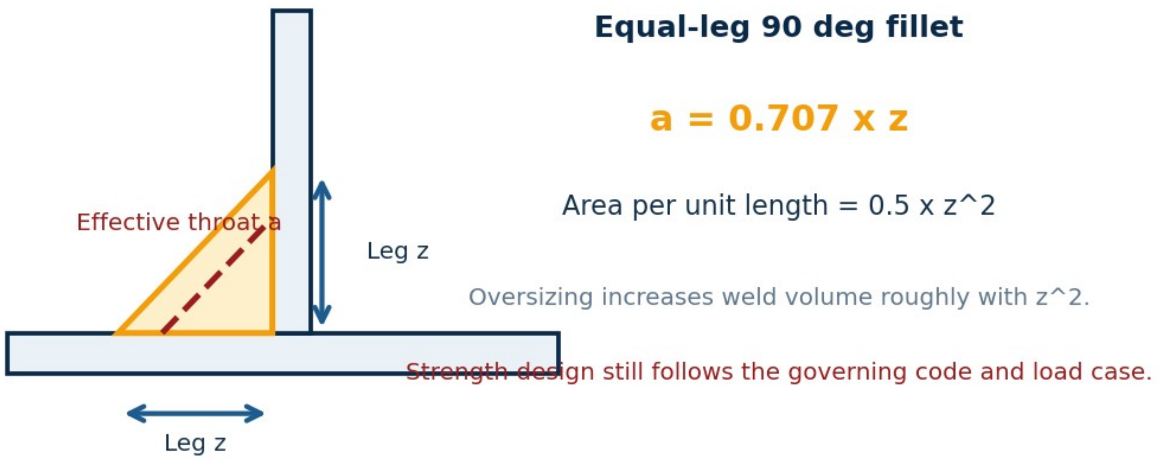


*Figure 4. Geometric relation for an equal-leg fillet in a nominal 90 deg T-joint.*

**GEOMETRIC RELATIONS - EQUAL-LEG 90 DEG FILLET**

$$a = 0.707 \times z$$

$$\text{Cross-sectional area per unit length} = 0.5 \times z^2 = a^2$$

*These are geometric relations only. Required weld strength, minimum size, maximum size and effective length are governed by the applicable design code and load case.*

| Control item | Design intent | Common failure |
| --- | --- | --- |
| Leg size z | Specified when the drawing / code uses leg-size notation. | Large convex bead can look oversized while effective throat remains inadequate. |
| Effective throat a | Shortest distance from root to theoretical face. | Root gap, poor fusion or joint angle can reduce effective load path. |
| Effective length | Length that develops the intended load transfer. | Very short welds and poorly designed starts / stops may be ineffective. |
| End returns | May distribute load or seal a termination. | Automatic all-around callout creates unnecessary heat and access problems. |
| Base-metal thickness | Must support the transferred load and local heat. | Weld is stronger than the thin connected sheet, causing tear-out or burn-through. |

## Cost and distortion rule

- For an equal-leg fillet, weld volume per length grows approximately with the square of leg size.
- A 40% increase in leg size nearly doubles idealized cross-sectional area before considering reinforcement.
- Oversized welds increase arc time, filler, shielding gas, heat, distortion, grinding and inspection burden.
- Specify the smallest code-compliant weld that satisfies strength, fatigue, sealing and fabrication requirements.

06 GROOVE WELDS, PENETRATION AND BACKING

# Groove welds, penetration and backing

Preparation geometry controls access to the root, weld volume and probability of complete fusion.

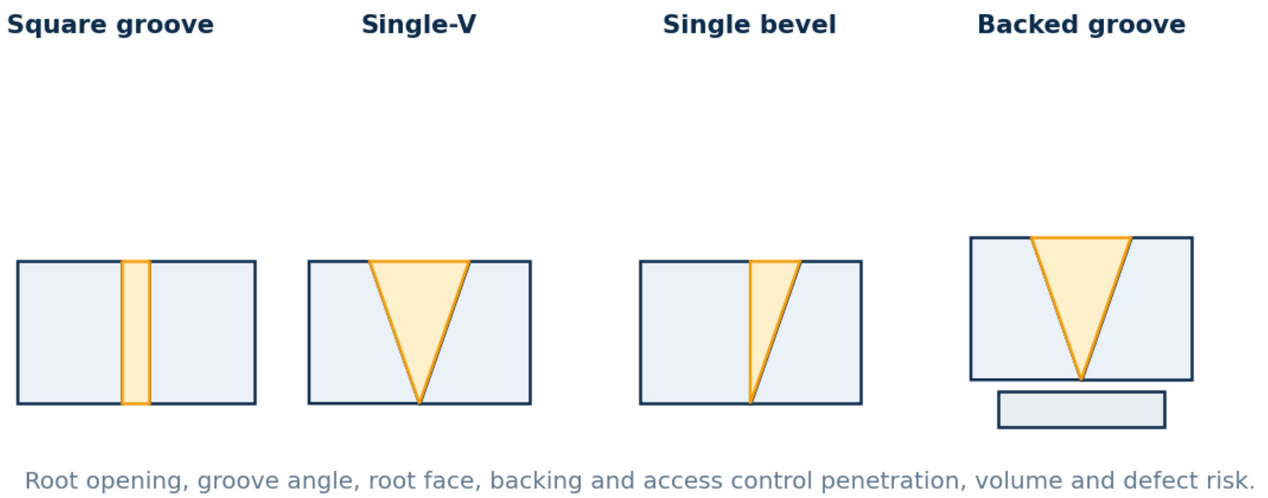


*Figure 5. Typical groove concepts; exact angles, root faces and openings are procedure-specific.*

| Feature | What it controls | DFM guidance |
|---|---|---|
| Groove angle | Electrode / torch access and weld-metal volume. | Use the minimum qualified angle that still permits reliable root and sidewall fusion. |
| Root opening | Root access, penetration and burn-through sensitivity. | Tolerance must match process, thickness, backing and fit-up capability. |
| Root face | Heat concentration and resistance to burn-through. | Too large can cause incomplete penetration; too small can melt away. |
| Backing | Supports root and may help achieve penetration. | Define permanent / removable backing, material, fit and post-weld treatment. |
| Back gouging | Removes incomplete root before welding the second side. | Provide access and specify required method / inspection when used. |
| Misalignment | Reduces effective section and changes root conditions. | Define allowable hi-lo / offset where function or code requires it. |

## Complete vs partial penetration

- Complete-joint-penetration (CJP) and partial-joint-penetration (PJP) are design / code concepts, not visual descriptions.
- A flush-ground surface does not prove penetration; internal quality needs procedure control and appropriate inspection.
- For fatigue or cyclic service, root profile, backing, termination and weld-access holes can govern performance.
- Closed sections may need vent / drain openings to avoid pressure, trapped liquids and unsafe coating or galvanizing operations.

**Do not write “full penetration” without a qualified joint detail, fit-up tolerance, welding procedure and inspection requirement that can demonstrate it.**

07 WELDING SYMBOLS AND DRAWING NOTATION

# Welding symbols and drawing notation

A symbol should communicate the required weld unambiguously without turning the drawing into a process script.

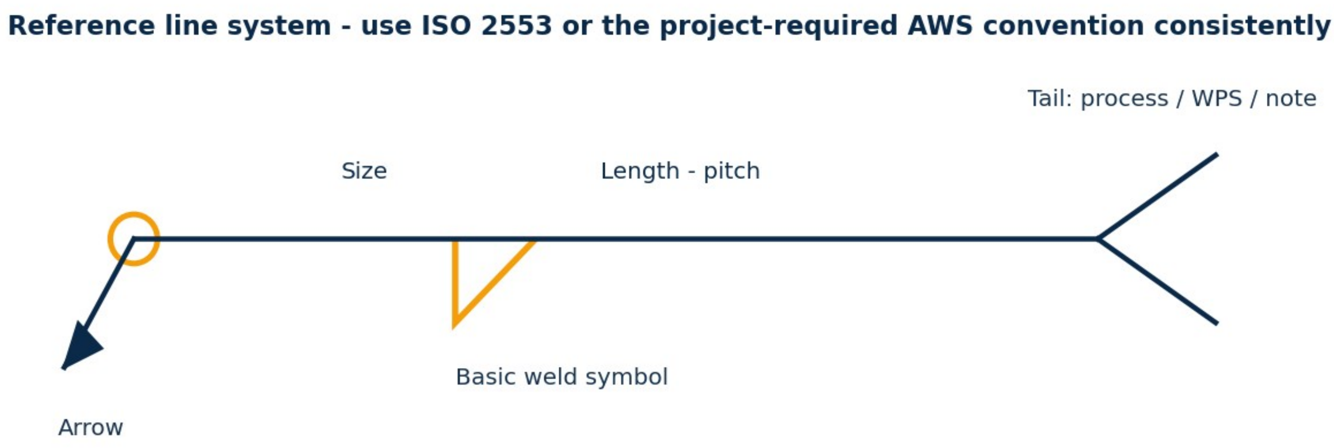


*Figure 6. Core elements of a welding-symbol system; ISO and AWS arrow-side conventions differ.*

| Symbol information | Typical content | Control note |
|---|---|---|
| Basic symbol | Fillet, groove, plug / slot, spot, seam, surfacing or edge weld. | Use the symbol system required by the contract. |
| Size | Leg, throat, depth of preparation or groove dimension. | State whether size is nominal, minimum or effective where required. |
| Length / pitch | Length of each segment and center-to-center spacing. | Do not omit the number / location of intermittent segments. |
| Contour / finish | Flush, convex, concave and permitted finishing method. | Grinding is not automatically required for a flush contour. |
| Supplementary symbols | All-around, field weld, backing, melt-through and others. | Use only when the joint truly requires the condition. |
| Tail | Process, WPS, quality, NDT or specification reference. | Avoid vague text such as “standard weld”. |

## Drawing discipline

- State whether the drawing follows ISO 2553 System A / B or an AWS convention; do not mix arrow-side logic.
- Dimension the joint preparation separately when it is a controlled machined / cut feature.
- Use detail views for dense joints, hidden sides, staggered intermittent welds or special terminations.
- Avoid duplicate notes that conflict with the symbol, WPS or weld map.
- Where welding is optional, specify the performance requirement and allow supplier DFM approval.

**ISO 2553:2019 defines symbolic representation on drawings and recognizes two global approaches for arrow-side designation.**

08 CONTINUOUS, INTERMITTENT AND SEAL WELDS

# Continuous, intermittent and seal welds

Use only the weld length needed for load transfer, sealing and stiffness control.

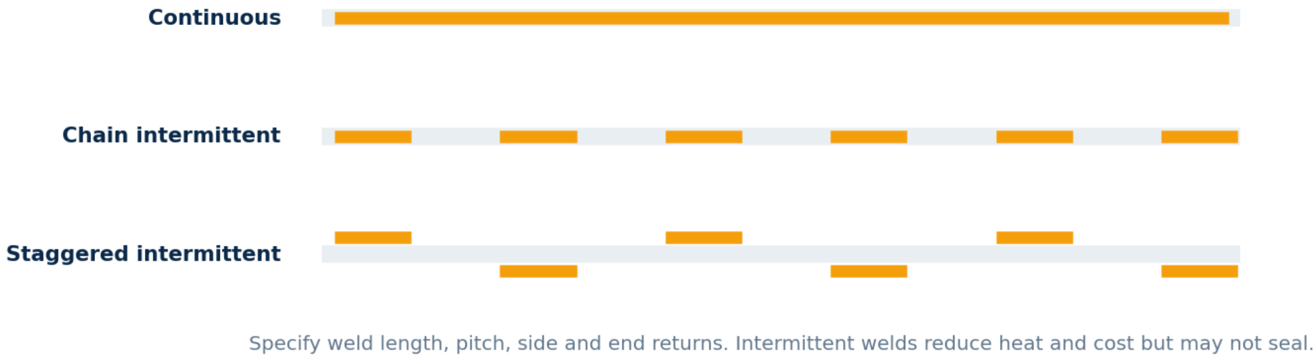


*Figure 7. Continuous, chain-intermittent and staggered-intermittent concepts.*

| Pattern | Good use | Risks / drawing controls |
|---|---|---|
| Continuous | Sealing, corrosion exclusion, stiffness or distributed structural demand. | Maximum heat, shrinkage and cost; define starts, stops and end returns. |
| Chain intermittent | Symmetric transfer along two sides; reduced heat and filler. | Specify side, segment length, pitch, count and end condition. |
| Staggered intermittent | Reduced local heat concentration and distortion. | Clear drawing needed to prevent wrong phase / side arrangement. |
| Tack welds as final welds | Low-load retention when code / product standard permits. | Must be sized, located and accepted as production welds - not temporary tacks. |
| Seal weld | Excluding liquids, dirt or crevice corrosion. | Can trap process fluids or gases; may create fatigue / coating concerns. |

## Intermittent-weld design checks

- Confirm that unwelded gaps do not permit corrosion, contamination, noise, movement or water ingress.
- Check local sheet buckling and load flow between segments, not only total weld length.
- Use balanced patterns on opposite sides when practical to reduce angular distortion.
- Avoid very short segments that are dominated by starts / stops and inconsistent fusion.
- Place the first and last segments to control edge peeling and joint opening.

**“Weld all around” is not a default quality instruction. It is a geometry and heat-input decision that must be justified by function.**

09 ACCESS, FIT-UP AND WELDING SEQUENCE

# Access, fit-up and welding sequence

A theoretically sound joint can fail in production when the torch, shielding gas, filler, operator or gauge cannot reach it.


*Figure 8. Deep pockets and narrow gaps restrict torch angle, viewing, gas coverage and inspection.*

| Access item | Design question | Practical control |
|---|---|---|
| Torch / electrode angle | Can the process reach the root and both toes at the required orientation? | Provide open side, removable cover, larger gap or alternate joint. |
| Travel path | Can the torch move continuously without collision or cable interference? | Model nozzle / gun envelope and robotic wrist if automated. |
| Shielding gas | Will walls, drafts or narrow pockets disrupt coverage? | Provide clearance, gas lens / nozzle selection and protected work area. |
| Fit-up | Can root gap, offset and contact be repeated through the batch? | Use locating tabs, stops, clamps and measurable gap criteria. |
| Cleaning | Can mill scale, oxide, coating, oil and slag be removed? | Design access before and between passes. |
| Inspection | Can the finished weld and adjacent material be viewed / tested? | Provide visual, probe, film or source access as required. |

## Sequence planning

- Define when components are tacked, verified, welded, cooled, unclamped, straightened, machined and finished.
- Keep critical datum surfaces accessible for fixture location and post-weld measurement.
- Avoid welding a closed cavity before venting, cleaning and internal corrosion protection are complete.
- Plan consumable changes, repositioning and part rotation so critical welds are made in stable positions where possible.
- Use supplier sequence trials for complex assemblies rather than relying on a generic note.

10 DISTORTION MECHANISMS AND CONTROL

# Distortion mechanisms and control

Weld-metal and heat-affected-zone shrinkage create angular change, bow, twist and residual stress.

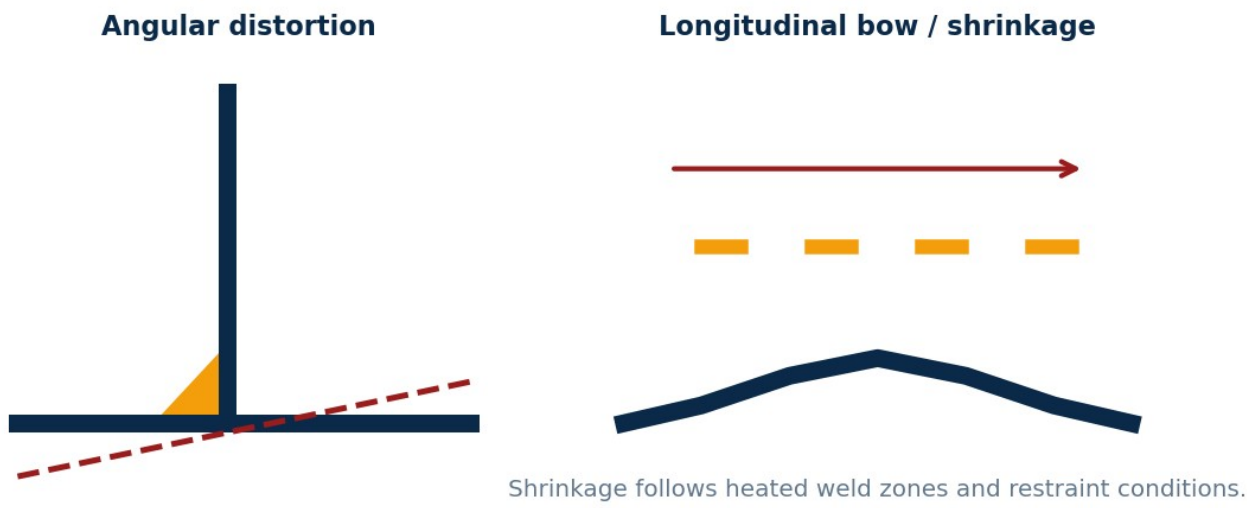


*Figure 9. Uneven shrinkage causes angular distortion and longitudinal bow.*

**HEAT-INPUT CONCEPT**

**Heat per unit length Q = efficiency x voltage x current / travel speed**

*Use consistent units. Heat input is only one variable; joint geometry, restraint, interpass temperature and deposition sequence also control distortion and metallurgical response.*

| Control method | How it helps | Risk / limit |
|---|---|---|
| Reduce weld volume | Less molten metal and shorter arc time. | Must still meet strength, penetration and code minimums. |
| Balanced welds | Opposing shrinkage moments can reduce rotation. | Requires access and can add total heat if overused. |
| Intermittent / skip sequence | Distributes heat and shrinkage. | Not suitable where continuous sealing is required. |
| Fixture / restraint | Holds geometry during welding. | Excess restraint can increase residual stress and cracking risk. |
| Preset / pre-camber | Offsets predictable shrinkage. | Requires stable, measured production behavior. |
| Low-heat process / faster travel | Reduces heated volume and cycle time. | Fit-up and process stability may become more demanding. |

**Post-weld straightening is a controlled manufacturing operation, not a substitute for sound joint, sequence and fixture design.**

# Thin sheet and low-heat joining

Thin sheet loses stiffness quickly when heated, making burn-through, oil-canning and flange rotation primary design risks.

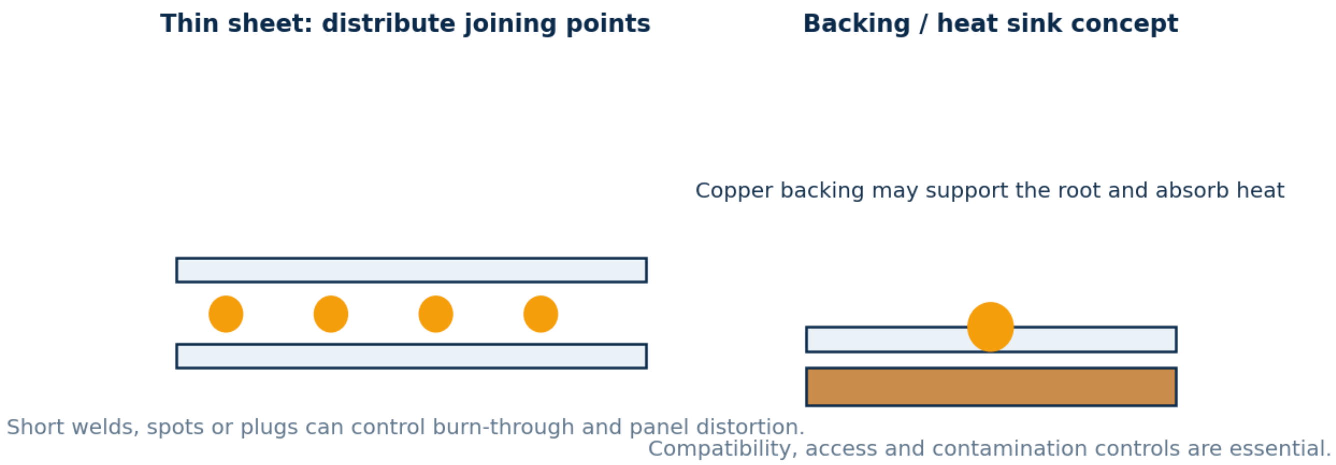


*Figure 11. Distributed joining points and backing concepts can reduce local heat and burn-through risk.*

| Design factor | Recommended direction | Avoid |
|---|---|---|
| Joint choice | Lap, flange, hem, spot, plug or short fillet when function permits. | Large open-root butt joints with uncontrolled gap. |
| Flange width | Provide electrode, nozzle, clamp and edge-distance space. | Narrow flanges that distort or prevent access. |
| Weld pattern | Short balanced segments, spots or plugs with validated spacing. | Long continuous seams on unsupported cosmetic panels. |
| Fit-up | Close, repeatable contact or a qualified controlled gap. | Variable gaps that change penetration and burn-through. |
| Backing | Copper / chill bars or sacrificial backing where compatible. | Uncontrolled contact, contamination or trapped backing. |
| Finishing | Minimize grinding and heat from cosmetic rework. | Specifying perfectly flush invisible welds without cost allowance. |

## Resistance and laser alternatives

- Resistance spot welding can join overlapped sheet rapidly when both sides are accessible and flange width is sufficient.
- Laser welding can reduce distortion but requires accurate seam location, fit-up and safety-controlled automation.
- Adhesive plus spot / rivet hybrid joints can improve stiffness or sealing, but cure, surface preparation and service temperature must be engineered.
- For coated sheet, confirm coating removal, fumes, electrode life, weldability and corrosion restoration.

**AWS D9.1/D9.1M:2018 is a sheet-metal welding code for nonstructural sheet-metal fabrications. Structural work may require another governing code.**

12 TUBE FRAMES, BOX SECTIONS AND FIXTURE STRATEGY

# Tube frames, box sections and fixture strategy

Frames require coordinated control of cut length, end preparation, squareness, weld sequence and final datums.

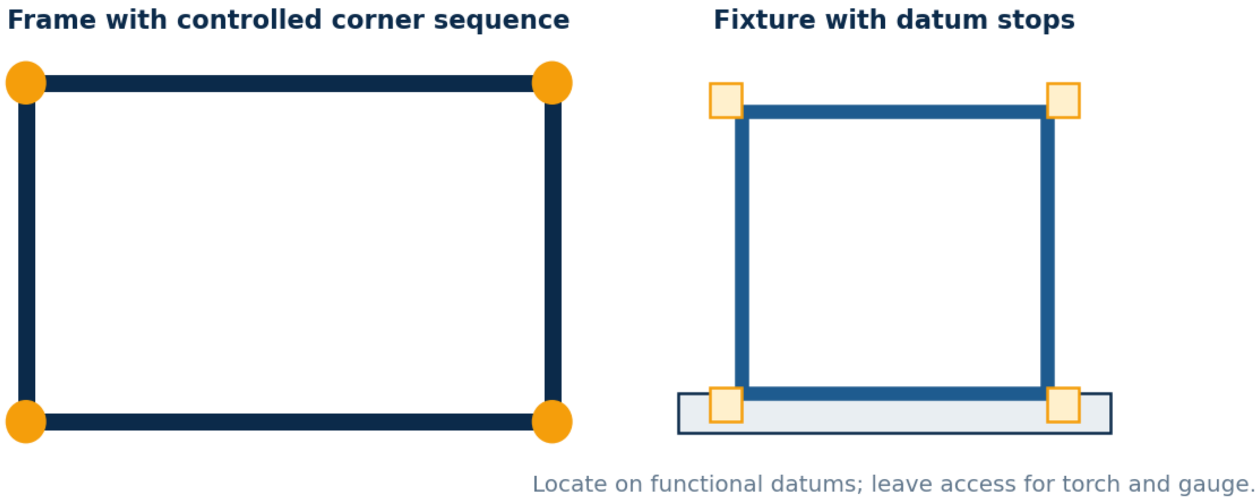


*Figure 12. Frame geometry is stabilized through sequence, datum stops, clamps and accessible inspection points.*

| Design item | Guidance | Reason |
|---|---|---|
| Tube miters / gaps | Define acceptable joint gap and corner condition. | Gap variation changes penetration, filler volume and frame size. |
| End caps / closed tubes | Provide vent / drain path before welding, coating or galvanizing. | Prevents pressure, trapped chemicals and hidden corrosion. |
| Tabs and slots | Use for location, not as the only final dimensional control. | Clearance, coating and cut tolerance affect assembly position. |
| Datum strategy | Locate the fixture from stable functional faces / holes. | Raw cut ends and flexible tube walls are poor repeatable datums. |
| Clamp placement | Place near the joint without blocking torch or gauge. | Controls lift and rotation while preserving access. |
| Final inspection | Measure diagonals, twist, flatness and interface features after unclamping. | Fixture condition can hide springback and residual distortion. |

## Frame-welding sequence

- Verify cut lengths, end angles, tube seam orientation and pre-weld squareness before full welding.
- Tack symmetrically, recheck diagonals, then weld in a balanced sequence from central / stiff regions toward free ends as appropriate.
- Delay cosmetic grinding and surface finishing until final geometry and weld quality are accepted.
- Where post-weld machining is required, provide machining stock and locate the weldment from machining datums.
- Define whether straightening is allowed and which dimensions are re-inspected afterward.

13 MATERIALS, PREHEAT AND DISSIMILAR JOINTS

# Materials, preheat and dissimilar joints

Base metal, thickness, restraint and service environment determine filler, heat control and post-weld treatment.

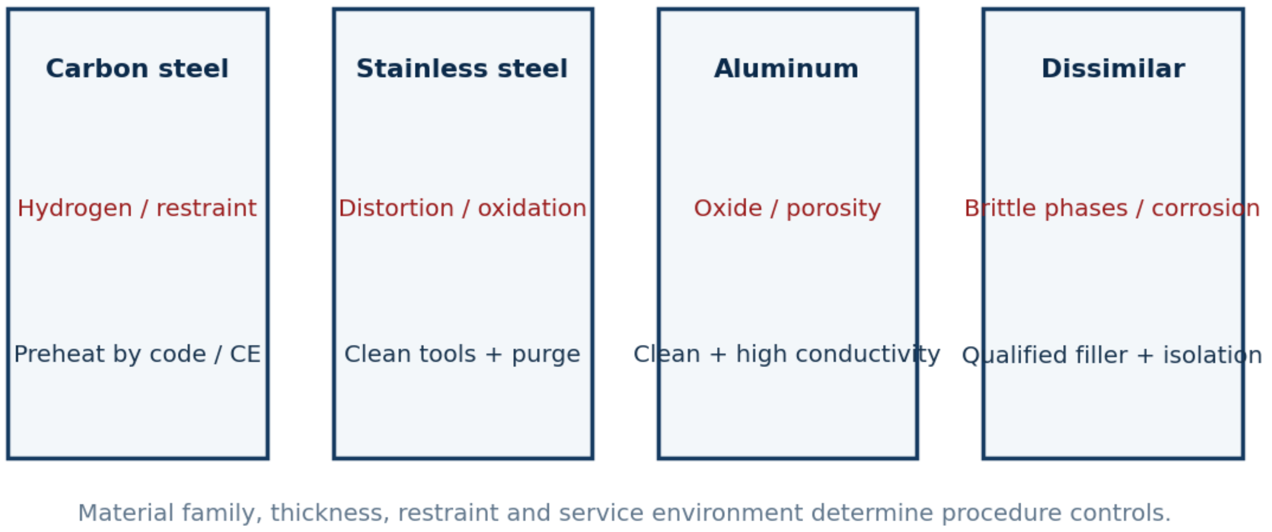


*Figure 13. Material families create different weldability, cleanliness, heat and corrosion constraints.*

| Material / condition | Primary design concerns | Typical controls to define |
|---|---|---|
| Carbon / low-alloy steel | Hydrogen cracking, hard HAZ, restraint, lamellar tearing in thick restrained joints. | Material group, carbon-equivalent review, consumables, preheat / interpass and hydrogen control. |
| Stainless steel | Distortion, sensitization, oxidation, ferrite / cracking balance and iron contamination. | Clean dedicated tools, heat / interpass control, shielding / purge and passivation restoration. |
| Aluminum alloys | Oxide film, porosity, high thermal conductivity, hot cracking and strength loss in HAZ. | Alloy / temper identification, cleaning, filler selection, joint gap and heat control. |
| Galvanized / coated steel | Fumes, porosity, spatter, coating damage and corrosion restoration. | Coating removal / ventilation plan, process trials and repair coating. |
| Dissimilar metals | Brittle intermetallics, dilution, thermal mismatch and galvanic corrosion. | Qualified transition / filler, isolation, seal / drain strategy and service review. |

## Preheat is not a universal number

- Preheat and interpass limits come from the governing code, qualified procedure, material group, thickness, hydrogen level, heat input and restraint.
- Excessive preheat can damage coatings, alter properties, increase distortion or reduce corrosion performance.
- Stainless and aluminum often require maximum interpass control rather than high preheat.
- Record temperature-measurement location, method and acceptance where it is a critical variable.
- Never substitute an approximate “equivalent grade” without reviewing mechanical, chemical, weldability and service requirements.

# Imperfections, quality levels and NDT

Quality acceptance combines the governing standard, joint purpose, inspection method and documented results.

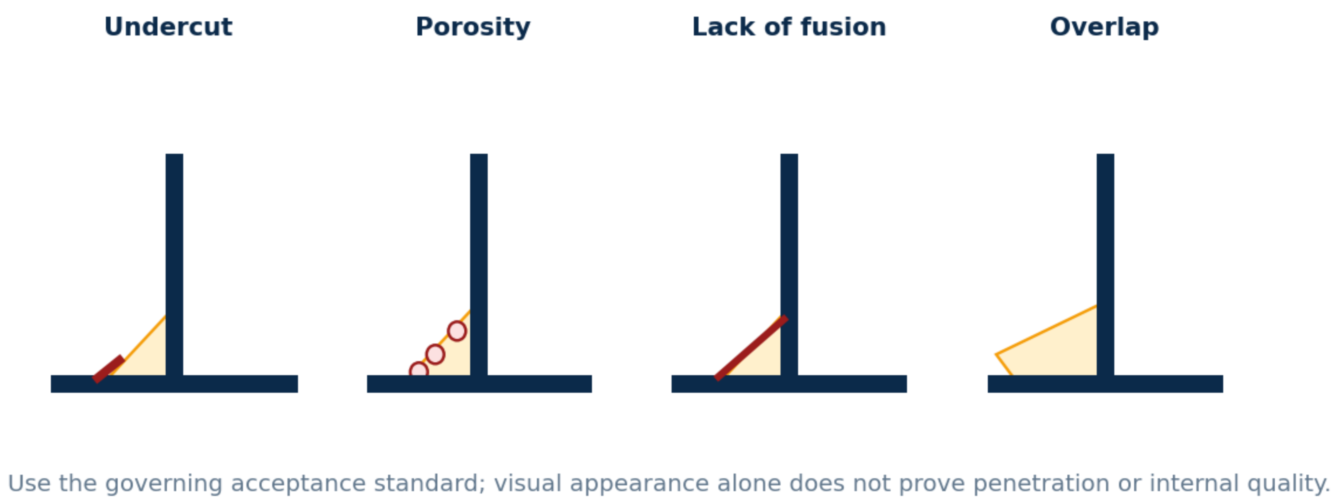


*Figure 14. Simplified examples of common surface / fusion imperfections.*

| Imperfection | Likely contributors | Design / control response |
|---|---|---|
| Undercut | High travel speed, arc position, excessive current or poor manipulation. | Avoid inaccessible toes; control procedure and acceptance level. |
| Porosity | Contamination, moisture, gas disruption or coated material. | Improve cleanliness, gas coverage, consumable storage and joint access. |
| Lack of fusion | Insufficient heat, poor angle, tight groove or inaccessible sidewall. | Improve preparation, access, WPS parameters and inspection. |
| Incomplete penetration | Root geometry, fit-up, backing or parameter mismatch. | Qualified joint detail and root inspection strategy. |
| Overlap / excessive convexity | Low travel speed, poor angle or excessive deposition. | Control bead profile and avoid specifying unnecessary weld volume. |
| Crack | Metallurgy, hydrogen, restraint, crater or hot-cracking condition. | Stop release; investigate material, procedure, sequence and repair controls. |

| Method | Primary detection | Key access / limitation |
|---|---|---|
| VT | Surface condition, profile, size, alignment and visible cracks. | Direct view, lighting, cleanliness and qualified acceptance criteria. |
| PT / MT | Surface-breaking discontinuities; MT is for ferromagnetic materials. | Surface condition, material compatibility and post-cleaning. |
| UT | Internal planar and volumetric indications. | Probe access, thickness, geometry and qualified technique. |
| RT | Internal volumetric image and joint record. | Radiation controls, source / detector access and orientation sensitivity. |

**ISO 5817:2023 defines quality levels B, C and D for specified fusion-weld imperfections. The levels address workmanship and do not by themselves prove fitness for service.**

15 DRAWINGS, TOLERANCES AND INSPECTION RECORDS

# Drawings, tolerances and inspection records

Control the finished weldment from functional datums while separating product requirements from procedure details.

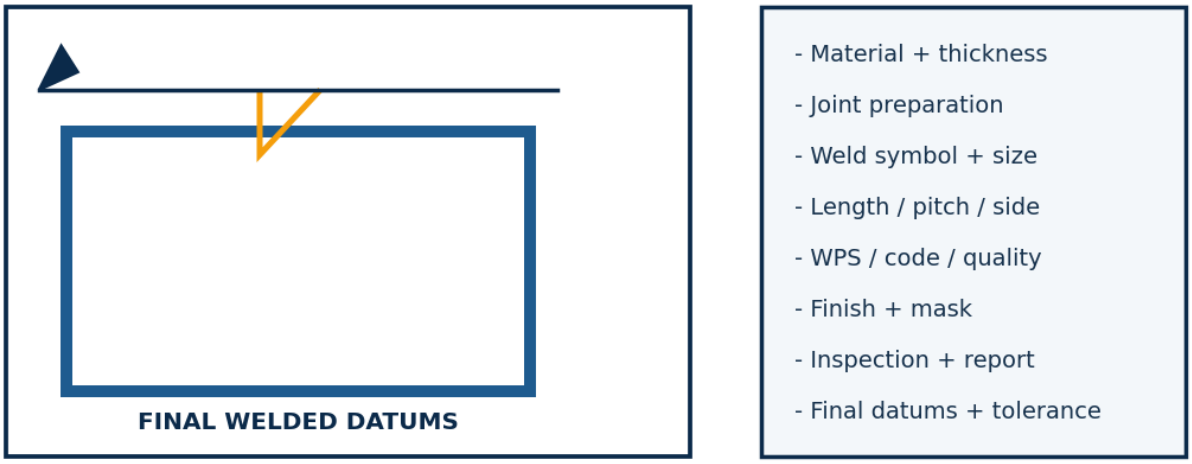


*Figure 16. A manufacturable weldment drawing identifies the joint, final datums, quality and inspection requirements.*

| Drawing / quality item | Minimum information | Common mistake |
|---|---|---|
| Material | Standard, grade, condition, thickness / section and permitted substitution. | Generic material family only. |
| Joint preparation | Groove angle, root face, root opening, backing and fit-up tolerance when controlled. | Calling for CJP without a producible joint detail. |
| Weld symbol | Type, side, size / depth, length, pitch, contour and supplementary symbols. | Conflicting symbol and text note. |
| Code / quality | Governing code, ISO 5817 level or customer acceptance requirement. | Writing “good weld” or “no defects”. |
| Final geometry | Functional dimensions and GD&T from stable final-assembly datums. | Dimensioning only individual cut parts while ignoring weld shrinkage. |
| General tolerance | ISO 13920 class or explicit tolerance block when applicable. | Using a precision-machining tolerance for the whole weldment. |
| Inspection | VT / NDT method, extent, stage, acceptance and report / traceability. | Requesting NDT without access or acceptance criteria. |

## Inspection planning

- Visual testing should cover joint preparation and fit-up before welding, in-process conditions where relevant, and the completed weld.
- Define weld maps or characteristic IDs so reports identify location, method, result, inspector and repair status.
- Use calibrated gauges appropriate to weld size, profile, undercut, misalignment and final assembly geometry.
- NDT acceptance levels and personnel qualification must match the adopted code / standard.
- Repair welding requires an approved method, reinspection and traceable closure.

**ISO 13920:2023 provides four general tolerance classes for welded constructions. Apply only the class stated on the drawing and use specific tolerances for functional features.**

16 WELDING DESIGN REVIEW CHECKLIST

# Welding design review checklist

Use before RFQ release and again before production drawing approval.

| No. | Release check | Category |
|---|---|---|
| 1 | Service loads, fatigue, sealing, corrosion and cosmetic requirements are identified. | Function |
| 2 | Governing code, quality level and customer requirements are stated. | Contract |
| 3 | Base-metal standard, grade, condition and thickness are complete. | Material |
| 4 | The joint provides a direct load path with acceptable eccentricity. | Joint |
| 5 | Weld type, side, size / penetration and effective length are defined. | Joint |
| 6 | Weld size is code-compliant and not unnecessarily oversized. | Cost |
| 7 | Root opening, groove, backing and fit-up tolerances are producible. | Fit-up |
| 8 | Torch, shielding, cleaning and inspection access are available. | Access |
| 9 | Starts, stops, end returns and intermittent patterns are explicit. | Symbol |
| 10 | All-around and continuous welds are justified by function. | Heat |
| 11 | Fixture datums match functional final-assembly datums. | Fixture |
| 12 | Clamp locations do not block welding or inspection. | Fixture |
| 13 | Tack, welding, cooling, unclamping and straightening sequence is planned. | Sequence |
| 14 | Heat input and distortion risk are reviewed for thin / flexible parts. | Distortion |
| 15 | Closed sections include vent / drain provisions where required. | Safety |
| 16 | Preheat, interpass and consumable controls are derived from qualified requirements. | Procedure |
| 17 | Coatings, contamination and corrosion restoration are addressed. | Finish |
| 18 | Dissimilar-metal compatibility and galvanic isolation are reviewed. | Material |
| 19 | Final dimensions and GD&T control the released welded state. | Drawing |
| 20 | Weld symbols use one consistent notation system. | Drawing |
| 21 | General weldment tolerance class is realistic and stated. | Tolerance |
| 22 | VT / NDT method, extent, acceptance and records are defined. | Inspection |
| 23 | Repair method, reinspection and traceability are controlled. | Quality |
| 24 | Packaging protects welds, finishes, machined faces and corrosion-sensitive areas. | Packaging |
| 25 | Open DFM risks are documented and approved before release. | Release |

**Release rule: unresolved code, load-path, access, material, WPS, distortion or inspection risks must be listed as open actions - not hidden in a generic weld note.**

17 STANDARDS, TECHNICAL SOURCES AND RFQ HANDOFF

# Standards, technical sources and RFQ handoff

Use controlled current editions and verify project-specific scope before release.

**ISO 2553:2019 -** Welding symbols and symbolic representation on drawings. Official source

**ISO 5817:2023 -** Quality levels B, C and D for imperfections in fusion-welded joints. Official source

**ISO 17637:2016 -** Visual testing of fusion-welded joints. Official source

**ISO 17635:2025 -** Selection of NDT methods and general rules for weld evaluation. Official source

**ISO 13920:2023 -** General tolerances for welded constructions. Official source

**ISO 15614-1:2017 -** Qualification of welding procedures by procedure test. Official source

**ISO 9606-1:2012 -** Qualification testing of welders for fusion welding of steels. Official source

**ISO 3834-2:2021 -** Comprehensive quality requirements for fusion welding. Official source

**AWS D1.1/D1.1M:2025-AMD1 -** Structural Welding Code - Steel. Official source

**AWS D9.1/D9.1M:2018 -** Sheet Metal Welding Code for nonstructural sheet-metal fabrication. Official source

**Standards define scope, qualification, fabrication and acceptance. They do not replace product-specific engineering, supplier DFM review, validated sequence or first-article evidence.**

## Minimum RFQ handoff

| File / information | Required content |
|---|---|
| 2D drawing | Material, final datums, joint details, weld symbols, tolerances, finish, inspection and revision. |
| 3D model | Final welded geometry and access-critical internal features. |
| Service requirement | Load direction, duty / fatigue, sealing, environment, safety and cosmetic class. |
| Welding requirement | Governing code, quality level, WPS / qualification expectations and NDT extent. |
| Volume and schedule | Prototype quantity, batch quantity, annual demand and target delivery. |
| Quality / traceability | FAI, material certificates, weld map, inspection reports and repair-control needs. |

## Contact KingsForm Metalworks

**Engineering RFQ:** info@kingsformmetalworks.com

www.kingsformmetalworks.com

*This guide is an engineering reference, not a warranty of manufacturability, structural adequacy or conformity. Final requirements must be confirmed against the released drawing, applicable code, actual materials, qualified welding procedure, competent personnel and supplier approval.*