ABETECH STANDARD SPECIFICATIONS FOR SHEET METAL FABRICATION

Document Number: SM-SPEC-001
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1. PURPOSE

This document (this "specification") establishes the standard fabrication requirements for sheet metal parts ordered by Abraham Technical Services, Inc., d/b/a AbeTech (the "buyer") from external vendors. Parts shall be manufactured per the 3D STEP file provided with each order. This specification applies to all parts unless specific exceptions are noted on the accompanying Purchase Order (PO) or Part Specification Sheet (Appendix A).

1.1 Order of Precedence

1.1.1 The buyer's order consists of the following documents: the STEP model, the Part Specification Sheet, the Purchase Order, and this specification. By accepting a Purchase Order for the fabrication of sheet metal parts, the vendor agrees to comply with all terms, conditions, and requirements set forth in the foregoing order documents. Provisions in any vendor-related website, document, transmittal or communication that conflict with, add to, or otherwise modify any of the foregoing order documents are hereby rejected by the buyer and of no legal effect, regardless of the time of transmittal. Without limiting the foregoing, any and all purported disclaimers or limitations of express, implied, or statutory warranties are expressly rejected by the buyer.

1.1.2 In the event of any discrepancy between the STEP model, Part Specification Sheet, Purchase Order, or this specification, the vendor shall stop and notify the buyer before proceeding. The vendor shall not make assumptions or proceed based on its own interpretation.

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2. SCOPE

This specification covers:

- File Naming Convention
- Dimensional tolerances for sheet metal features
- Bend tolerances and requirements
- Hole size tolerances
- PEM / self-clinching hardware installation
- Welding requirements
- Standard finish requirements
- Material and traceability requirements
- Packaging and shipping requirements
- Inspection and quality requirements

3. FILE NAMING CONVENTION

All STEP files provided to the vendor shall follow this naming structure:

[Part Number] - [Description] [Material Grade Shorthand] - Rev [Revision Letter]

Example:
10045 - Mounting Bracket 304 SS - Rev B

3.1 The vendor shall verify that the file name revision matches the revision called out on the Purchase Order.
3.2 If there is a discrepancy, the vendor shall contact the buyer before proceeding with fabrication.
3.3 The material grade shorthand in the file name is for quick reference. If the shorthand is not clear, the vendor shall contact the buyer for clarification. Additional material details (temper, thickness, etc.) will be provided on the Part Specification Sheet (Appendix A) when applicable.

3.4 Part Marking

3.4.1 All parts shall be laser etched with the Part Number, Vendor Code, and Date of Manufacture. No other etching method (chemical etch, mechanical engraving, etc.) is permitted unless approved in writing by the buyer.

3.4.2 Font size shall be no larger than 0.25" (6.35 mm) tall.

3.4.3 Marking shall be located within 2.0" (50.8 mm) of a part edge or bend.

3.4.4 On formed parts, markings shall be placed on the interior (non-visible) surface whenever geometry permits.

3.4.5 Markings shall be placed on a non-cosmetic surface whenever possible. Laser etching on grain-finished stainless steel surfaces or other cosmetic surfaces requires prior written approval from the buyer.

3.4.6 The Vendor Code shall be assigned by AbeTech and communicated to the vendor prior to first production. The vendor shall use the assigned code on all parts and shall not substitute its own internal identifier.

3.4.7 Part marking is not required on parts that do not have a minimum flat surface area of 1.0" × 2.0" (25.4 mm × 50.8 mm) available for marking.

3.4.8 On parts where geometry limits available marking area but a 1.0" × 2.0" surface exists, the vendor shall place the marking in the best available location that meets the intent of 3.4.3 and 3.4.4 as closely as possible. If no suitable location can be identified, the vendor shall contact the buyer for disposition.

3.5 Common Material Shorthand Reference

Shorthand	Material
304 SS	304 Stainless Steel
316 SS	316 Stainless Steel
5052 AL	5052 Aluminum
6061 AL	6061 Aluminum
CRS	Cold Rolled Steel
HRS	Hot Rolled Steel
GALV	Galvanized Steel

4. STANDARD DIMENSIONAL TOLERANCES

Unless otherwise specified on the Part Specification Sheet, the following tolerances apply to all linear dimensions derived from the STEP model:

4.1 Unless otherwise specified, all dimensions are to be interpreted in the formed (final) condition of the part.

4.2 Linear Dimensions — Flat Features (Prior to Forming)

Feature	Tolerance
Linear dimensions ≤ 1.00" (25.4 mm)	± 0.010" (± 0.25 mm)
Linear dimensions > 1.00" to ≤ 6.00" (25.4–152.4 mm)	± 0.015" (± 0.38 mm)
Linear dimensions > 6.00" to ≤ 24.00" (152.4–609.6 mm)	± 0.020" (± 0.50 mm)
Linear dimensions > 24.00" (609.6 mm)	± 0.030" (± 0.76 mm)
Edge to hole / hole to hole (same flat face)	± 0.010" (± 0.25 mm)
Overall flatness (per 12" / 305 mm)	0.015" (0.38 mm)

4.3 Dimensions Across Bends (Formed Features)

Feature	Tolerance
Linear dimensions across one or more bends ≤ 6.00" (152.4 mm)	± 0.020" (± 0.50 mm)
Linear dimensions across one or more bends > 6.00" to ≤ 24.00" (609.6 mm)	± 0.030" (± 0.76 mm)
Linear dimensions across one or more bends > 24.00" (609.6 mm)	± 0.045" (± 1.14 mm)
Edge to hole / hole to hole across one or more bends	± 0.030" (± 0.76 mm)

4.4 Tolerance stack-up across multiple bends is cumulative. If tighter tolerances are required on specific formed dimensions, they shall be called out on the Part Specification Sheet.

4.5 Non-Circular Openings (Cutouts, Slots, Rectangles)

4.5.1 Non-circular openings such as slots, squares, rectangles, and irregular cutouts shall be held to the linear dimensional tolerances specified in Section 4.2.

4.5.2 Corner radii on non-circular openings shall be ± 0.010" (± 0.25 mm) unless otherwise specified on the Part Specification Sheet.

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5. BEND TOLERANCES AND REQUIREMENTS

Feature	Tolerance / Requirement
Bend angle tolerance	± 1°
Bend location tolerance	± 0.010" (± 0.25 mm)
Minimum inside bend radius (unless modeled otherwise)	1× material thickness
Bend line to edge of hole (minimum)	2.5× material thickness + bend radius

5.1 The vendor is responsible for calculating correct bend allowances and K-factors to achieve the dimensions shown in the STEP model geometry.
5.2 The vendor is responsible for compensating for material-specific springback to achieve final tolerances. This includes, but is not limited to, differences in springback between stainless steel, aluminum, and mild steel.
5.3 The vendor shall orient bends to avoid material cracking. If the STEP model geometry requires bending perpendicular to grain direction on materials prone to cracking (e.g., thin-gauge stainless steel), the vendor shall notify the buyer before proceeding. Grain direction requirements for critical applications will be called out on the Part Specification Sheet.
5.4 If the STEP model geometry results in a manufacturing conflict (e.g., minimum bend-to-feature distance violation), the vendor shall notify the buyer before fabrication.

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6. HOLE SIZE TOLERANCES

Feature	Tolerance
Punched / laser-cut holes ≤ 0.250" (6.35 mm)	± 0.005" (± 0.13 mm)
Punched / laser-cut holes > 0.250" (6.35 mm)	± 0.010" (± 0.25 mm)
Hole positional tolerance (features on same flat face)	± 0.010" (± 0.25 mm) true position
Hole positional tolerance (across one or more bends)	± 0.030" (± 0.76 mm) true position
Countersunk holes (angle)	± 2°
Countersunk holes (diameter)	± 0.010" (± 0.25 mm)
Tapped holes	Class 2B (inch) / 6H (metric) per ASME B1.1 / B1.13M

7. PEM / SELF-CLINCHING HARDWARE

7.1 General Requirements

7.1.1 PEM hardware (nuts, studs, standoffs, etc.) shall be installed per the hardware manufacturer's specifications (PennEngineering or approved equivalent).
7.1.2 Hardware type, size, and location shall be defined within the STEP model geometry. A Part Specification Sheet (Appendix A) is mandatory for any part that includes PEM hardware. The sheet shall include a PEM hardware schedule identifying each hardware

item, part number, quantity, and location reference to eliminate ambiguity between PEM installation holes and standard through-holes. A reference image or annotated model view shall be attached when the part includes multiple PEM locations.

7.1.3 All PEM hardware shall be installed after forming operations unless otherwise noted. The vendor may propose alternate installation sequencing (e.g., installing flush hardware before forming when proximity to bend lines requires it) with written approval from the buyer.

7.2 Installation Requirements

Requirement	Specification
Push-out force	Per PEM manufacturer minimum specification
Torque-out resistance	Per PEM manufacturer minimum specification
Perpendicularity of studs/standoffs	≤ 2° from true perpendicular
Minimum sheet thickness for hardware	Per PEM manufacturer recommendation
Hole preparation	Per PEM manufacturer recommended hole size

7.3 Common PEM Hardware Reference

The following are standard PEM types. The specific part number and location will be called out on the Part Specification Sheet.

Type	Designator	Example Format
Self-clinching nut	-S (steel) / -SS (stainless) / -A (aluminum)	S-M3-2, SS-M5-1
Self-clinching stud	FH / FHS / FHA	FHS-M3-10
Self-clinching standoff	SO / SOS / SOA	SOS-M3-10-6
Broaching nut	-B	—
Floating nut	AC / ACS	—
Panel fastener	PF	—

The vendor shall confirm PEM hardware compatibility with the specified material type and thickness prior to installation.

7.3.1 If incompatible, the vendor shall notify the buyer before proceeding.

8. WELDING

8.1 General Requirements

8.1.1 All welding shall be performed by qualified welders in accordance with AWS D1.1 (steel), AWS D1.2 (aluminum), or AWS D1.6 (stainless steel) as applicable to the material specified.

8.1.2 Weld type, location, and joint configuration shall be as indicated in the STEP model geometry and/or the Part Specification Sheet.

8.1.3 If weld details are not explicitly defined, the vendor shall contact the buyer for clarification before proceeding.

8.1.4 TIG (GTAW) shall be used for all cosmetic welds and critical joints. MIG (GMAW) is acceptable for non-cosmetic welds on mild steel and aluminum unless otherwise specified on the Part Specification Sheet. MIG on stainless steel requires prior written approval from the buyer. All other welding processes require written approval from the buyer.

8.2 Weld Quality

8.2.1 All welds shall be free of cracks, porosity, undercut, incomplete fusion, and excessive spatter.

8.2.2 Weld spatter shall be removed from all surfaces.

8.2.3 Welds shall exhibit consistent bead profile and uniform penetration.

8.2.4 Unless otherwise specified, welds shall meet AWS Class C (general service) visual acceptance criteria as a minimum.

8.3 Weld Penetration

8.3.1 Unless otherwise specified, welds on sheet metal parts are assumed to require full penetration appropriate to the material thickness.

8.3.2 Partial penetration welds are acceptable only when specified on the Part Specification Sheet.

8.3.3 Weld penetration requirements for structural weldments shall be explicitly defined on the Part Specification Sheet.

8.4 Weld Finish

8.4.1 Welds designated as cosmetic on the Part Specification Sheet shall be ground smooth and blended flush with the parent material surface.

8.4.2 Cosmetic welds on stainless steel parts shall be blended to match the surrounding in-line grain finish per Section 9.2.

8.4.3 Non-cosmetic welds shall be left as-welded unless otherwise noted, but shall still meet the quality requirements of Section 8.2.

8.5 Filler Material

8.5.1 Filler material shall be compatible with the base material and selected per AWS recommendations.

8.5.2 No dissimilar metal filler shall be used without written approval from the buyer.

8.5.3 Filler material certifications shall be available upon request.

8.6 Distortion Control

8.6.1 The vendor shall employ appropriate fixturing, sequencing, and techniques to minimize weld distortion.

8.6.2 Post-weld straightening is permitted provided it does not compromise material properties or introduce surface damage.

8.6.3 Finished weldments shall conform to the dimensional tolerances specified in Section 4.

8.6.4 If weld-induced distortion prevents compliance with standard tolerances, the vendor shall notify the buyer prior to shipment.

8.7 Post-Weld Treatment

8.7.1 Stainless steel weldments shall be passivated or pickled to restore corrosion resistance in the heat-affected zone unless otherwise specified.

8.7.2 Aluminum weldments shall be cleaned of all oxide discoloration and residue in the weld area.

8.7.3 Any additional post-weld heat treatment requirements will be called out on the Part Specification Sheet.

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9. STANDARD FINISH REQUIREMENTS

9.1 General Requirements (All Materials)

9.1.1 All edges shall be deburred and free of sharp edges (break edges 0.010"–0.020" / 0.25–0.50 mm).

9.1.2 Laser-cut edges: dross and slag shall be removed.

9.1.3 Surfaces shall be free of scratches, dents, tool marks, and other cosmetic defects visible at a distance of 24" (610 mm) under 50 foot-candles of diffused lighting.

9.1.4 Protective film (if applicable) shall remain intact through fabrication and shipping unless removal is required for hardware installation.

9.2 Stainless Steel Parts

9.2.1 All stainless steel parts shall receive an in-line grain finish (also referred to as a brushed or directional satin finish) unless otherwise specified on the Part Specification Sheet.

9.2.2 Grain direction shall run consistent and parallel to the largest visible face of the part. If no single face is clearly dominant (e.g., L-shaped or multi-plane parts with faces of similar size), the vendor shall confirm grain direction with the buyer before finishing. Grain direction may also be explicitly specified on the Part Specification Sheet.

9.2.3 The finish shall be uniform across all visible surfaces with no cross-grain scratches, swirl marks, or inconsistencies.

9.2.4 Typical grain finish target: #4 (120–180 grit equivalent) unless otherwise specified.

9.2.5 Grain finish may be applied before or after forming at the vendor's discretion. Regardless of sequence, the finish shall be consistent and uniform across all flat surfaces of the completed part. Bend radius areas may show disruption of the grain pattern and are exempt from the uniformity requirement of 9.2.3. If grain finish is applied prior to forming, the vendor shall perform any additional finishing work necessary after bending to ensure visible flat surfaces meet the required standard.

9.3 Aluminum Parts

9.3.1 All aluminum parts shall be cleaned and free from fingerprints, oil, residue, tool marks, scratches, and any other surface blemishes.

9.3.2 Parts shall be handled with clean gloves after final cleaning to prevent contamination.

9.3.3 Surfaces shall present a clean, uniform appearance consistent with mill-finish or better quality when inspected at a distance of 24" (610 mm) under 50 foot-candles of diffused lighting.

9.4 Additional Finishes

9.4.1 Any additional finish requirements (powder coat, anodize, plating, passivation, etc.) will be called out on the Part Specification Sheet.

9.4.2 Additional finishes are applied after all fabrication and hardware installation operations unless otherwise noted.

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10. MATERIAL AND TRACEABILITY

10.1 Material type, alloy, temper, and thickness are identified on the Part Specification Sheet.

10.2 The vendor shall use the specified material. No material substitutions are permitted without written approval from the buyer.

10.3 Mill certifications shall be available upon request.

10.4 Material grain direction is not controlled unless specified on the Part Specification Sheet.

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11. PACKAGING AND SHIPPING

11.1 General Requirements

11.1.1 All parts shall be packaged to prevent damage, contamination, and surface degradation during transit and handling.

11.1.2 Packaging method shall be appropriate to the material, finish, and quantity of parts being shipped.

11.2 Surface Protection

11.2.1 Finished stainless steel parts (grain-finished) shall be individually wrapped or separated with protective interleaving material to prevent surface-to-surface contact and scratching.

11.2.2 Cleaned aluminum parts shall be individually wrapped or separated with clean, non-abrasive interleaving material to prevent marking and contamination.

11.2.3 Parts with applied finishes (powder coat, anodize, plating, etc.) shall be packaged to prevent chipping, scratching, or abrasion of the finished surface.

11.2.4 Stacking of finished parts is not permitted unless adequate protective separation is provided between each part.

11.3 Labeling

11.3.1 Each package or container shall be labeled with the part number, revision, quantity, and Purchase Order number.

11.3.2 Mixed part numbers shall not be combined in the same package unless approved by the buyer.

11.4 Packing List

11.4.1 A packing list shall be included inside each shipping container referencing the Purchase Order number, part number, revision, and quantity contained in that specific container.

11.4.2 For multi-box shipments, each box shall contain its own packing list. One box shall be designated as the master and shall include a summary packing list for the entire shipment.

11.5 Shipping Terms and Damage

11.5.1 Unless otherwise specified on the Purchase Order, all shipments shall be FOB Destination. Risk of loss or damage remains with the vendor until parts are received and accepted at the buyer's facility.

11.5.2 The vendor is responsible for ensuring parts arrive in acceptable condition. Parts damaged due to inadequate packaging are subject to rejection.

11.5.3 The vendor shall file all carrier claims for parts damaged in transit. Replacement parts shall be shipped within a timeframe agreed upon with the buyer.

12. INSPECTION AND QUALITY

12.1 The vendor shall perform first article inspection (FAI) on the first production run or when a new revision is released, and provide results upon request.
12.2 The buyer reserves the right to perform incoming inspection on any delivered parts.
12.3 Non-conforming parts shall be segregated and reported to the buyer.
12.4 The vendor shall not ship non-conforming parts without written disposition from the buyer.
12.5 Model-based inspection methods are acceptable.

12.6 Certificate of Conformance (CoC)

12.6.1 The vendor shall provide a Certificate of Conformance with every shipment.
12.6.2 The CoC shall include, at a minimum: part number, revision letter, Purchase Order number, quantity shipped, material certification reference, a statement that all parts conform to the requirements of this specification and the applicable Part Specification Sheet, printed name and signature of the vendor's authorized quality representative, and date of certification.
12.6.3 Parts shipped without an accompanying CoC are subject to rejection and may be held at the buyer's facility without triggering the inspection window defined in Section
12.7.1 until a CoC is received.
12.6.4 Electronic CoCs in PDF format are acceptable. The CoC shall be emailed to the designated AbeTech Purchasing Manager or to the email address specified on the Purchase Order at or before the time of shipment.

12.7 Rejection and Rework

12.7.1 The buyer shall notify the vendor of any rejected parts within 15 business days of receipt. Notification shall include the part number, quantity rejected, and description of the non-conformance.
12.7.2 The vendor shall respond to rejection notifications within 5 business days with a proposed corrective action (rework, replacement, or credit).
12.7.3 Rework of rejected parts is permitted only with prior written approval from the buyer. Reworked parts shall be re-inspected and shall meet all original specification requirements.
12.7.4 Return shipping costs for rejected parts shall be the responsibility of the vendor.
12.7.5 Replacement parts shall be delivered within a timeframe agreed upon between the vendor and buyer, taking into account the urgency of the order

12.8 Quality Escalation

12.8.1 **First rejection:** The vendor shall provide corrective action and conforming replacement parts at no additional cost to the buyer.

12.8.2 **Second rejection (same non-conformance, same part number):** The vendor shall be placed on a formal corrective action plan. The buyer reserves the right to withhold payment for the affected order until conforming parts are delivered and accepted.

12.8.3 **Third rejection (same recurring non-conformance, same part number):** The buyer reserves the right to terminate the vendor relationship and recover reasonable costs associated with sourcing an alternate supplier, including but not limited to expedited procurement, tooling, and first article qualification at a replacement vendor.

12.8.4 Non-conformances that pose a safety risk (e.g., structural failure, incorrect material, compromised load-bearing features) may result in immediate disqualification of the vendor without the escalation steps defined in 12.8.1 through 12.8.3.

12.8.5 Escalation status is tracked per part number. Resolution of a corrective action plan to the buyer's satisfaction resets the escalation level for that part number.

13. DOCUMENT REVISION HISTORY

Rev	Date	Description of Change	Author	Approved By
A		Initial release		
B				
C				
D				
E				

13.1 Revision Control for Open Orders

13.1.1 Vendors shall always fabricate to the latest revision of this specification.

13.1.2 Upon receipt of a new revision, all prior revisions are obsolete.

13.1.3 If a new revision is issued while an order is in process, the vendor shall immediately notify the buyer and hold production until disposition is provided. The buyer will advise whether to continue with the current revision, switch to the new revision, or scrap in-process work. The vendor shall not incur additional costs related to revision changes without prior written authorization from the buyer.

14. GENERAL

14.1 All models, specifications, and related documentation remain the intellectual property of AbeTech and shall not be used for any purpose other than fulfilling authorized purchase orders. Additional confidentiality obligations are governed by the Non-Disclosure Agreement (NDA) between AbeTech and the vendor.

14.2 The order, including this specification, will be governed by and construed according to the laws of the State of Minnesota, without reference to the choice-of-laws doctrine of any state. All claims relating to or arising out of the order, or the breach of any terms and conditions of the order, whether sounding in contract, tort, or otherwise, will likewise be governed by the laws of the State of Minnesota, without reference to the choice-of-laws doctrine of any state.

14.3 Any dispute arising out of, relating to, or pursuant to the order will be venued exclusively in the Hennepin County District Court, whether or not such venue is or subsequently becomes inconvenient. The parties agree that the Hennepin County District Court will have personal jurisdiction over them and subject matter jurisdiction over all matters arising from or relating to the order.

14.4 In the event of any legal proceeding arising out of the order or its validity, interpretation, construction, performance, breach, enforcement, or remedies, the prevailing party will be entitled to recover from the non-prevailing party the prevailing party's reasonable attorney's fees and costs (including those on appeal and in connection with enforcing any order or judgment related to the order) and the non-prevailing party must pay such attorney's fees and costs to the prevailing party.

APPENDIX A — PART SPECIFICATION SHEET

The following Part Specification Sheet shall accompany STEP files to communicate part-specific requirements. This sheet is mandatory for any part that includes PEM hardware (per Section 7.1.2). For all other parts, the Purchase Order shall indicate whether a Part Specification Sheet is attached or not required. This sheet overrides the standard tolerances in this document where noted.

PART SPECIFICATION SHEET

Field	Entry
Part Number	
Description	
Revision	
Material (Alloy / Temper)	
Material Thickness	
Quantity	
Reference Image Attached	☐ Yes ☐ No

PEM Hardware Schedule:

Item #	PEM Part Number	Description	Qty per Part	Location Reference
1				
2				
3				
4				

Weld Requirements:

Weld ID	Weld Type	Cosmetic (Y/N)	Penetration (Full/Partial)	Process (TIG/MIG)	Notes
1					
2					
3					

Finish / Coating:

Finish Type	Specification / Color	Notes

Special Tolerances (override standard tolerances):

Feature / Dimension Description	Tolerance	Notes

Additional Notes / Special Instructions:

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End of Document — SM-SPEC-001