



PURPOSE

The purpose of this document is to provide the necessary guide lines for the minimum quality standards of items machined for Campbell Engineering Inc. by/for a vendor/customer.

SCOPE

This workmanship standard defines the information and practices, for Campbell Engineering Inc. and its vendors, for producing a finished good as requested by a customer. These standards will serve as the baseline requirements, in addition to any standards also provided by the customer’s drawing and workmanship standards. If there is a conflict between CEI’s standard and the engineering drawing, the customer’s standards and/or engineering drawing will supersede the standards.

RESPONSIBILITIES AND AUTHORITY

The Vendor is responsible for adhering to any specifications, made by the CEI or original Engineer/Customer, applicable to their services provided.

REQUIREMENTS

1. Compliance:

CEI is ISO 9001-2015 certified and follows strict guidelines to provide finished goods that align with customer expectations. All materials and processes must follow ROHS & REACH directives, which can be referenced for compliance.

2. General Shop Practices:

External/Internal Corners:

All internal corners shall have a radius up to a maximum of 0.010”, unless otherwise specified.

Edge Breaks:

All prints require edge breaks unless otherwise specified. External edge breaks should be broken between .004-.010” max.

The edge break may be in the form of a chamfer or radii or a combination of both in order to reduce manual deburring.



If the edge breaks are visible on a drawing but are not dimensioned, an edge break of 0.005-0.015 is permissible.

Edges after breaking must be free from burrs; the use of a buffing when is permissible, however, surface finish shall be maintained.

Parts which have edges called out "DO NOT BREAK EDGE" are required for customer specific requirements and may not be chamfered or sent through batch deburring.

Chamfers:

When specified on a drawing, chamfers may be at the intersection of two surfaces of any geometrical shape; the external edge of a cylindrical surface, the internal edge of a hole irrespective of the holes shape, or holes too large for counter sink tools.

On "Internal Thread" chamfers, the included angle shall be between 60 and 142°; the minimum diameter of the chamfer shall be equal to the pitch diameter of the thread and the maximum diameter of the chamfer shall be equal to the major diameter of the thread and the thread plus 0.030" for threads #8 (M5) and larger, and plus 0.010" for threads #6 (M4) and smaller, unless otherwise specified.

On "External Threads", chamfer angles shall be 45° ± 5°. The minimum length of the chamfer shall be equal to the depth (from the major to the minor diameter) of the external thread form. The maximum length of the chamfer shall be 0.015" larger than the minimum length for threads #8 (M5) and larger, and 0.005" larger than the minimum length for threads #6 (M4) and smaller, unless otherwise specified.

3. Dimensional Tolerances:

Interpretation:

Interpretation of dimensions and tolerances shall be in accordance with the Engineering drawings and references, notes and ASME Y14.5 2009/2018 unless otherwise stated in writing by the customer or originator of the print.

The designation of STK is understood to mean that the surface being dimensioned is acceptable with its stock finish and does not require machining.

When heat treat is noted in material block, part is hardened prior to machining. Otherwise part is typically heat treated after machining.

Flatness:

Machined surfaces shall be flat within the tolerances of the linear dimension of the drawing unless otherwise required by GD&T tolerance callouts.

Coaxiality:

The coaxiality of two or more surfaces of revolution on a common centerline shall be within 0.005 of an inch total indicator reading (TIR) for items up to 3 inches in diameter plus 0.002 inches per inch of diameter over 3 inches unless otherwise required by GD&T tolerance call outs.

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Position of Centers:

Positional tolerancing for symmetrical feature of differing sizes that share a common axis of Datum shall be maintained to 0.005" MAX for diameters 2.99 inches or smaller and 0.008" MAX for diameters 3.00 inches and larger unless otherwise required by GD&T tolerance callouts.

Roundness:

Cylindrical or conical elements shall be machined such that the major and minor diameters of any section at any point must fall within the specified diametrical tolerances in accordance with ASME Y14.5 2009/2018.

4. Drilled Holes:

The depth of a drilled hole, as specified on the drawing, shall be measured along the axis of the hole from the surface drilled to the depth of the full diameter exclusive of the drill point, unless otherwise specified. The depth of a hole drilled on a curved surface shall be measured from the centerline tangent line intersect, unless otherwise specified.

Unless otherwise specified, if a drill point is indicated on a drawing but not specified, the point can be from 90° to 180°, but will most likely fall in the 118°-140° range based on standard off the shelf tool geometry.

When a drawing calls out "DO NOT BREAK THRU" a drill point must be chosen which will not break through the part, but at the same time will not create a bulge due to pressure from the drilling process.

When a drawing calls out "FLAT DRILL", the drill angle must be 180° or machined with a square endmill.

Angularity of Drilled holes:

The angularity of all drilled holes shall be within the tolerance zone established by the center line position over the depth of the hole. The tolerance zone may be extended beyond the depth of the hole (above the reference plane) by special notations on the drawing.

Circularity (Roundness):

The deviation from roundness of a drilled hole shall not exceed the tolerances of the diameter unless otherwise specified.

Threaded Features:

Thread Relief: the width shall be between 1-1.5 threads, unless otherwise specified. On external threads the depth shall be a maximum of 0.015" deeper than the threads minor diameter. On internal threads the relief depth shall be a maximum of 0.015" larger than the threads minor diameter.

All internal threads shall be checked with GO/NO GO Gages or a mating part if gauge is not available and approved by customer to use. External threads can be checked with either GO/NO GO Ring Gages, Thread Micrometer, or Three Wire method.

Maximum allowable engagement of NoGo gage is 2.5 turns.

The internal thread length dimension indicated on the drawing, unless otherwise noted, is the minimum gauging length of the length of thread having full form, and its tolerance allows two additional fully formed

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threads, unless otherwise specified. Thread length is measured as the maximum depth that the last full form thread of a GO gage will thread in the part. GO gages with a pointed tip are not recommended for measuring thread depth.

When threads will be plated, threads shall be milled to the maximum thread pitch diameter in order to compensate for the plating build up. The NoGo gauge will be a go with a very snug fit.

Thread length is to include the entry chamfer, and its depth to a non-normal surface is measured as defined under the Drilled Holes description of Section 4. An additional length equal to at least six (6) times the thread pitch is allowable for the pilot drill and lead of the tap where hole depth permits without break-thru, unless otherwise specified.

If a GO gage is not available, or if the gage tip geometry does not allow it to thread to the bottom of a blind hole, a commercially available screw with its end ground flat to the last full form thread may be used as a depth gage. A new screw must be used for every job, and the screw must be discarded when the job is complete. When the ground screw method is used, the measured depth of thread may never be less than the nominal depth, even if the given tolerance is bilateral.

External thread length is to include the chamfer as defined under Chamfers in Section 2. If the thread contains a relief, the thread length dimension indicated on the drawing is the distance from the end of the threaded feature to the mating surface.

If the thread does not include a relief, the thread length dimension is to the last fully formed thread.

5. Material:

Material may not be substituted. Certifications for all materials used is to be provided upon delivery of order. For traceability purposes, a maximum of two lot numbers per Work Order is permitted. If the two lots do not fulfill the order, a new Work Order must be created to complete the quantity ordered.

6. Surface Finish:

Monitor the condition of tools as dull or chipped tools will leave heavy tool marks on a surface, which are more noticeable after plating. Excessive tool markings, visible chatter, and raised center marks, knicks and deep scratches from mishandling are not permissible.

Surface finish can be reworked using fine-grit sandpaper or Scotchbrite pads as long as dimensions remain within tolerance. If there is a situation where the surface finish of a part is questionable, notify customer to determine whether or not a finish is acceptable or not.

Unless otherwise specified on applicable drawing, EDM machined/cut surfaces consisting of a rough cut shall be considered finished and acceptable. Similar to above, whenever a surface finish is questionable, notify customer to determine whether or not a finish is acceptable or not.

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For surfaces which require grinding, either for parallelism of surface finish, an appropriate amount of material shall be left from the previous machining operation as to meet the final dimensional post grinding or lapping. Extra material should be between 0.002-0.003” for each side that requires grinding unless otherwise specified.

7. Plating and Anodizing:

Build-Up:

Excess build-up can affect the final dimension and must not exceed allowable thickness.

Discoloration/Staining:

Campbell Engineering is to be notified and direct any procedures to handle plating issues such as discoloration/bleeding/fading/etc. Do not rework parts without authorization as this may unnecessarily scrap the parts. Threads and dimension tolerances are at risk when reworked.

It is not acceptable to repair improperly black anodized areas with metal dye.

Surface appearance must be uniform and without variances such as discoloration/fading/staining/bleeding. Blind holes and threads that can trap debris must be thoroughly blown out between/after all plating steps. Parts must not be sticky or tacky indicating inadequate processing.

8. Part Handling and Protection:

Surface finish is critical for many parts and must be maintained throughout all stages of production. Transporting parts must be done so with care; placing protective material between parts and container to avoid scratching, avoiding parts from hitting each other. Use of trays and carts that will safely hold parts is also encouraged.

9. Quality Assurance Provisions:

First Article Inspection Reports may be required, and will be noted upon order. Certifications for material and outside processes are typically required with finished parts.

10. Preparation for Delivery:

Parts are to be packaged for protection from any functionality/cosmetic damages while being handled, transported, or stored.

Packaging instructions are listed on most engineering drawings. Refer to notes on drawings and/or specifications notated within the part file to ensure proper packaging. *NOTE: Vendors are not required to package parts according to the Engineering drawing as there are often subsequent operations/processes.

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