Dimple Forming | Engineering Design Guide

DFM, tooling envelope, feature spacing and process verification | EPOC CRAFTER

Purpose: use this guide with the editable DFM & Tooling Clearance Workbook. An engineering calculation does not replace a supplier tooling drawing, forming trial, certified material record or part inspection.

Workflow at a glance

1 SPECIFY	2 CHECK	3 VALIDATE
Choose formed feature; define datums, material, hole and intended fastener.	Compute feature and tool-envelope clearances against selected CAD geometry.	Approve tool access, representative material trial, inspection and assembly fit.

1. Feature definition and terminology

A conical sheet metal dimple forms a seat around a pre-existing opening. The blank opening (pilot) and the finished throat are different dimensions. The formed flare OD and full tool envelope OD are also different; the latter includes working tooling or pressure contact that may be wider than the visible feature.

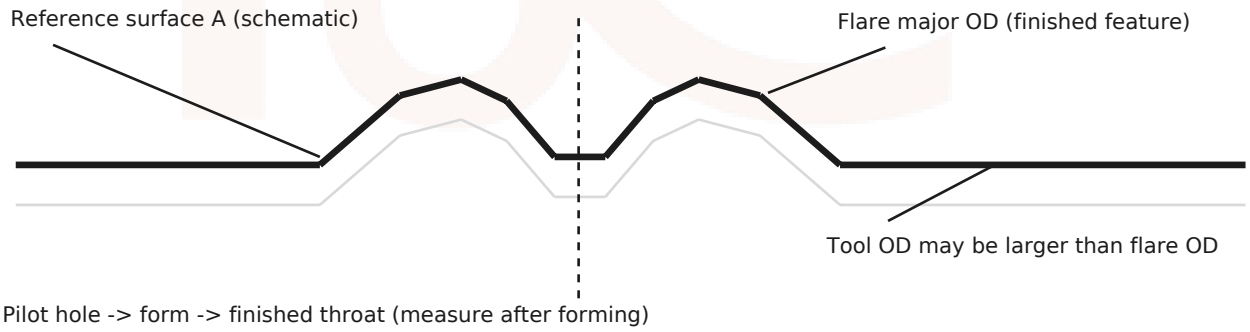


Figure 1. Conceptual cross-section. Geometry is not to scale; the released drawing controls the exact surfaces, radii, direction and datums.

Dimension	Design question	Source of authority
Pilot hole	What is the hole diameter before forming?	Blank/pilot process drawing

Dimension	Design question	Source of authority
Finished throat	What must clear the shank after forming?	Released part drawing / gauge plan
Flare major OD	What is the visible finished feature envelope?	Released drawing / sample approval
Seat angle / height	Where will the head make contact, relative to datum A?	Fastener spec + actual section
Tool envelope OD	Can the actual punch, die and pressure pad approach?	Supplier-specific tool drawing

2. Distinguish similar formed features

Feature	Functional intent	Main inspection risk
Conical flush-seat dimple	Flush countersunk head and local shape	Head seating, angle, root thinning
Circular emboss (no opening)	Local protrusion / stand-off / stiffness	Height, surface marks, flatness
Cylindrical extruded collar	Collar or thread engagement geometry	Wall thinning, collar cracks, ID/height
Machined countersink	Remove material for a conical seat	Remaining material, burr, seat position

Do not apply a conical seat-height calculation to a cylindrical collar or circular emboss. Each feature needs a section view with dimensioned shape and functional requirement.

3. Clearance calculations: keep two envelopes separate

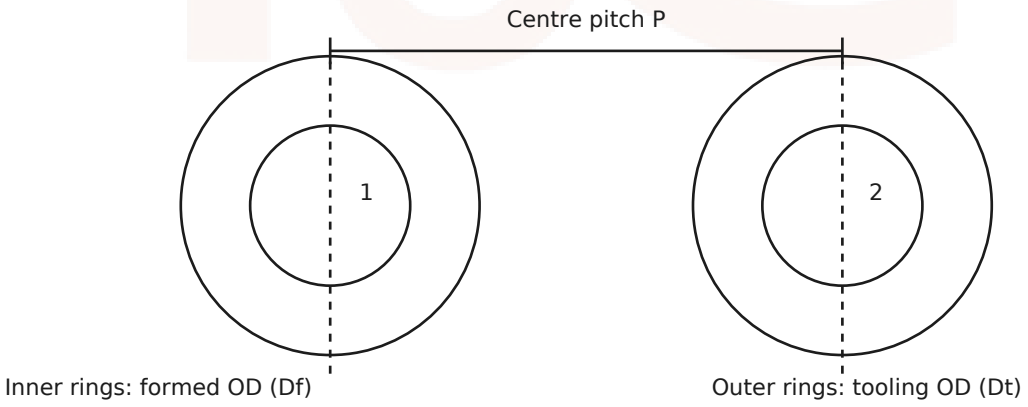


Figure 2. Center pitch P between two circular features. Inner circles represent part geometry and outer circles represent supplier tooling.

Check	Correct geometry formula	Interpretation
One feature to free edge	Centre-to-edge distance - Df / 2	Distance from formed outline to the straight edge
One tool to free edge	Centre-to-edge distance - Dt / 2	Clearance of circular tool projection
Two finished features	P - (Df1 + Df2) / 2	Physical clearance between formed rings
Two tool projections	P - (Dt1 + Dt2) / 2	Separation if tool envelopes must coexist
Dimple vs bend line	Centre-to-bend-line - Df / 2	Geometric distance only; bend zone additional

The equations above assume circular projections and a straight edge or defined center-to-center dimension. Irregular tools, approach angles, press throat, clamps, bending exclusion zones and sequential operations require a CAD/supplier-specific verification.

4. Material, edge preparation and formability

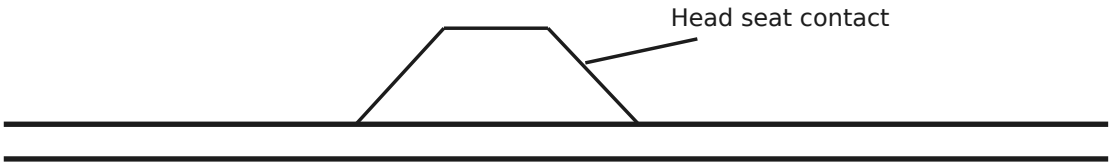
Specify the actual commercial alloy or grade, temper/condition, sheet thickness, coil lot and relevant rolling direction. Nominal elongation or yield strength is not a production dimple acceptance criterion. Use representative stock and an actual tool setup to establish capability.

Step	Risk to review	Evidence required
Pilot operation	Notches, slag, burr, material damage	Photo or gage record before forming
Deburring	Rim remains too sharp or uneven	Approved edge finish / visual check
Matched forming	Root tearing / unequal flange	Trial record, tool geometry, material lot
Post-form inspection	Reduced minimum thickness	Local-thickness measurement to approved limit
Post-bend / finish	Panel warp and witness marks	Flatness and cosmetic records

ISO 7438:2020 addresses metallic bend tests. Its test methodology does not establish a universal sheet metal dimple diameter, minimum pitch, allowable thinning percentage or forming setup.

5. Fastener selection and seat verification

Flush head fit must be inspected on the real assembly.



Face A / flush datum

Check the real screw or rivet standard, diameter, included head angle, head thickness, shoulder radius, shank clearance, projection below the sheet, contact band and orientation. Nominal angle agreement is only a screening criterion.

Review	Required question
Flush datum	Which finished face is the appearance / flushness datum?
Shank clearance	Does the finished throat clear actual shank and coatings?
Seat contact	Does the real head bear on the intended cone without rocking?
Panel stack	Does the head/formed underside interfere with the mating layer?
Assembly load	Is joint capacity separately verified for service loading?

The workbook provides a measured-flushness range comparison; it does not automatically PASS contact fit or joint strength.

6. Recommended forming and inspection route

Typical development route: blank cutting -> pilot hole -> edge preparation -> dimple forming -> bending -> straightening if permitted -> finishing -> dimensional inspection -> assembly. This is a planning route, not a universally fixed operation sequence.

Control gate	Hold point
Before forming	Material certificate, pilot edge, tool geometry and approved press setup
After forming	Throat, flare, thickness, seat angle, cracking and visual damage
After bending	Tool-access consequences, local flatness, panel warp and hole position

Control gate	Hold point
After coating	Surface thickness, fit, appearance and dimension effect
Assembly approval	Actual screw fit, flush datum, shank exit and mate interference

7. Defect modes and actions

Observed issue	Potential engineering contributors	Verify before changing process
Crack at root	Notched pilot, unsuitable temper, over-forming	Edge prep, material lot and representative root inspection
Minimum thickness fail	Increased forming strain or inappropriate radius	Tool drawing, blank size and local section measurement
Proud / sunken head	Wrong head, springback or incorrect seat geometry	Actual screw head and assembled A-surface reading
Panel bow / oil canning	Asymmetric strain, unsupported blank or sequence	Approved datum fixture and warp inspection
Tool collision	Envelope larger than visible flare or blocked backing	Full upper/lower tool CAD, fixture and press throat

8. Worked design example: 5052-H32 automation cover

Source: the published EPOC CRAFTER article "Sheet Metal Dimple Forming". These entries are example part specifications, not evidence of a real production lot or a verified available punch set.

Characteristic	Design / requirement
Cover, batch and stock	150 x 100 x 15 mm (one-sided fold), 200 pcs, 5052-H32 aluminum, t = 1.20 mm
Formed mounting features	4 positions; 3.0 mm pilot; 3.30-3.50 mm throat; 9.0 mm flare OD
Form profile	1.40-1.60 mm height; 90 deg seat; 0.5 mm tool nose radius
Tool projection	18.0 mm specified illustration; supplier actual tool to be verified
Position / access	20.0 mm center-to-free edge, 60.0 mm adjacent pitch, 18.0 mm center-to-bend
Functional / inspect	A-surface head flushness -0.10 to +0.10 mm; min root t = 0.95 mm
Panel / defect	Local flatness max 0.20; overall warp max 0.50; zero tears at 10x
Optional service check	20 N three-point support, <=0.80 mm loaded, <=0.10 mm residual

Computed screening	Arithmetic	Result
Finished edge gap	20.0 - 9.0/2	15.50 mm
Tool edge projection gap	20.0 - 18.0/2	11.00 mm
Pair finished-feature gap	60.0 - (9.0+9.0)/2	51.00 mm
Pair tool envelope gap	60.0 - (18.0+18.0)/2	42.00 mm
Bend-line feature gap	18.0 - 9.0/2	13.50 mm
Bend-line tool projection gap	18.0 - 18.0/2	9.00 mm
Minimum-thickness decrease fraction	(1.20 - 0.95)/1.20	20.83% at specified minimum

These calculated values are dimension checks, not production Pass/Fail. The example specification of 0.95 mm is a minimum finished thickness; actual reduction must be computed from measured original and formed thickness, not assumed from this limit.

9. Standards, documentation and engineering boundaries

Verified edition	Scope relevant here	Excluded inference
ISO 2768:2026	General size tolerance class limits within standard scope	Not a blanket general tolerance for location distances or formed CTQs
ISO 1101:2017	Geometric tolerance notation and interpretation	Does not create project-specific datum or tolerance numbers
ISO 13715:2017	Edge indications on technical documentation	Not a universal sheet-metal pilot burr acceptance
ASME Y14.5-2018 (R2024)	Alternative drawing GD&T framework	Not an automatic substitute for ISO GPS drawing controls
ISO 7438:2020	Metallic bend test method	Not a standardized production dimple forming test
ISO 10642:2026	Relevant countersunk head design reference	Does not set the -0.10/+0.10 project flushness band

Standard edition identifiers and scopes verified using official ISO and ASME public catalog information as of 21 November 2026. Proprietary tolerance tables are intentionally not reproduced. Review contractual drawing editions and obtain controlled standard texts where required.

Release rule: no unverified tooling is labelled "approved", no experimental data are invented, and no part is marked accepted until evidence is entered and independently reviewed.

10. Transfer package checklist

Included record	Required contents
Engineering drawing	Revision, dimensions, datums, formed feature sections, coating and acceptance criteria
3D model / flat	Release revision, original pilot geometry and formed model intent
Tooling record	Supplier tool ID, envelope, access, method, setup revision and approval evidence
Part inspection	Measured CTQ results, inspection method, gage calibration and photo/data IDs
Assembly check	Actual fastening hardware, head seating and flush datum readings
RFQ / approval	Quantity, scope, supplier clarification, ownership and approval record