

Axon Cosmetic Inspection Guideline - Metal parts

Table of Contents	Overview	2
1. Purpose		2
2. Scope		2
3. Terminology		2
4. Related Documents		3
Responsibility		3
5. Roles Responsible for Completing the Procedure		3
6. Adherence to the Process		3
7. Process Updates & Continuous Improvement		4
Procedure		4
8. Surface Finish Classification		4
9. Viewing Distance and Conditions		5
10. Inspection Criteria		5
11. Appendix A: Definitions		9
12. Appendix B: Reference pictures of relevant cosmetic defects		12
Document History		18



Overview

1. Purpose

- 1.1. This document provides quantitative definitions and inspection methods for evaluating the cosmetic quality of metal parts in the absence of product-specific drawing callouts. It covers metal plate and sheet fabrication, laser and waterjet cutting, bending, punching, stamping, deep drawing, welding, threading, and machined parts. This document does not control metal casted parts and the defects associated with them. The goal is to ensure consistent cosmetic quality expectations across all fabrication methods and suppliers.
- 1.2. This document addresses cosmetic and visual appearance attributes exclusively. It does not govern, replace, or supplement dimensional, functional, or mechanical requirements. Thread pitch, thread class, dimensional tolerances, material properties, surface roughness (Ra), torque specifications, and all other functional requirements remain controlled by the engineering drawing and applicable referenced standards. In all cases the drawing takes precedence over this document.

2. Scope

- 2.1. This document shall be obtained from Axon SQ by the supplier once the Axon business of metal sheet fabrication, metal plate or laser cut part is awarded to the supplier. (This document will also be available on Axon.com)
- 2.2. Scope includes all new programs and sustaining programs.

3. Terminology

Term	Definition
SQ	Supplier Quality
POC	Point of Contact
Ra	Average Surface Roughness
HAZ	Heat affected Zone
FOD	Foreign Object Debris
EDM	Electrical Discharge Machining
AWS	American welding Society
ASME	American Society of Mechanical Engineers



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4. Related Documents

4.1. **External references** are cross referenced in initial release

No.	Title
1	ASME Y14.5
2	ISO 9013
3	AWS D1.1 / D1.3
4	ASME B1.1
5	ISO 3058

Responsibility

5. Roles Responsible for Completing the Procedure

Role	Responsibility
Supplier	Follow this procedure and consult SQ.
IQC/ OQC Inspectors	Refer this procedure while inspecting the parts
R&D/ Mechanical Engineer	Define grades on drawing, add a note on drawing to refer this SOP
Supplier Development Engineer/ SQ	Ensures use of this procedure in PPAP- appearance approval, and part qualification, and supports suppliers with cosmetic-grade assignment and anomaly disposition.
Quality Engineering (MQ/ PQ)	Refer this procedure in case of abnormalities noticed during assembly/ product review and help disposition the non-conforming conditions.

6. Adherence to the Process

Role	Responsibility
Supervisor/Manager	Monitor adherence, address deviations



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7. Process Updates & Continuous Improvement

- 7.1. The department responsible for the procedure (is supplier development engineering must review and update when process changes occur.

The changes to this procedure will be communicated through a training system, email communication. Training will be documented via training system and google form.

Team	Responsibility
SDE	Review and update the procedure as needed Communicate, document, and facilitate training for any changes

Procedure

8. Surface Finish Classification

PLEASE CONSULT YOUR SQ POC ON APPLICATION OF PART TO UNDERSTAND SURFACE FINISH CLASSIFICATION WITH RESPECT TO THE APPLICATION IN AXON PRODUCTS.

Grade 1: These parts are highest quality finish parts that show clean, shiny, and smooth cut with super fine edges with uniform appearance. These parts typically shall not show any discoloration due to fabrication processes. Additional efforts might need to be taken to mitigate manufacturing surface finish artifacts (i.e. assist gas for laser cutting, electropolishing for bright finish, tumble deburr for dull finish, etc.). These parts will be visible to end user during or after application. In some instances, these parts will penetrate human tissue.

Functionality - Projectile tips/spears. Minimal discoloration from heat affected zone required.

Grade 2: Grade 2 parts can easily be seen by end user after application and show clean, less reflective surface (not as shiny) OR functionally critical regardless of visibility. More tolerant of discoloration due to fabrication processes as long as it is not on a component that can be perceived as dirty/contaminated.

Functionality- Cosmetic components, projectile bodies, casings or functionally critical parts like pistons and insulators, etc.

Functionally critical parts assigned to this grade may not be downgraded to Grade 3 solely on the basis of limited end-user visibility.

Grade 3: Grade 3 finish allows more imperfections than grade 1 and 2 as the parts are often at the back or bottom from end users perspective. This finish is specified for surfaces not readily/ easily visible to the end user but viewed during assembly/ installation, surfaces which do not



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necessarily need high cosmetic finish as long as they do not impair the function, safety, structural strength, environmental, electrical or dimensional requirements of the part.

Functionality- captive screws, washers

Grade 4: Grade 4 finish allows more imperfections than grades 1,2 and 3. This finish is specified for interior surfaces not viewed as post assembly or during installation, surfaces that will be covered by another part when assembled, or surfaces which do not necessarily need high cosmetic finish and hidden to the end use. They can have most cosmetic imperfections as long as they do not impair the function, safety, structural strength, environmental, electrical or dimensional requirements of the part.

Functionality- Metal plates

9. Viewing Distance and Conditions

All viewing will take place with direct overhead lighting. In every case, parts will be held such that the light is not reflected directly on the viewer. Inspection time depends on the surface area being inspected.

Parts shall be inspected as suggested magnification in the table below. Magnification up to 20X may be used as needed to investigate suspected imperfections. Parts should be inspected under 1000 lux with consistent lighting to ensure accurate results while minimizing glare and shadows. This lighting level should allow for clear detection of defects and surface details, ensuring reliability in the inspection process.

Surface Grade	Inspection Range	Maximum Magnification
Grade 1	4x- 7.5x	20x
Grade 2	3x-4x	10x
Grade 3	1x-3x	5x
Grade 4	1x	3x

Table 1: *Inspection range per surface identification*

10. Inspection Criteria

Defects / types	Grade 1	Grade 2	Grade 3	Grade 4
Abrasion	None allowed	None Allowed	Abrasions allowed on non-visible areas, depth < 0.3mm.	Abrasions allowed on non-visible areas, depth < 0.5mm.



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Bends/ warping	None allowed	Dependent on part functionality	Dependent on part functionality	Dependent on part functionality
Blowout/ Crater	None allowed	None allowed	Blowouts or craters (<1mm) allowed on noncritical surfaces.	Craters allowed on internal surfaces, depth < 1mm.
Blister	None allowed	None allowed	Minor blisters on internal surfaces (<1mm in diameter).	Blisters allowed in internal areas, diameter < 2mm.
Burr	None allowed	None allowed	None allowed	None allowed
Chip	None allowed	None allowed	None allowed	None allowed
Dent	None allowed	None allowed	Dents <1mm in diameter allowed	Dents <2mm in diameter allowed
Discoloration	None allowed	None allowed	**None allowed	**None allowed
Distortion	None allowed	Dependent on part functionality	Dependent on part functionality	Dependent on part functionality
FOD	None allowed	None allowed	**None allowed	**None allowed
Fracture	None allowed	None allowed	None allowed	None allowed
Gouges	None allowed	None allowed	None allowed	None allowed
Grainy Coating / Orange Peel	None allowed	None allowed	None allowed	None allowed
Heat-Affected Zone (HAZ)	None allowed	None allowed	None allowed	None allowed
Laser Dross	None allowed	None allowed	Small dross up to 0.5mm allowed on internal surfaces of parts.	Laser dross allowed on internal surfaces, < 1mm.
Material Grain	Allowable but not detectable under the Grade 1 viewing distance,	Allowable and not detectable under the Grade 2 viewing distance, lighting, and	Allowable as long as it does not risk material failure	Allowable as long as it does not risk material failure



	lighting, and magnification defined in this SOP	magnification defined in this SOP		
Pit	None allowed	Small pits (<0.2mm in diameter) allowed on non-visible areas.	Minor pits (<0.5mm) allowed on internal surfaces.	Pits up to 1mm allowed on internal surfaces.
Rough edges (cutting vestiges included)	None allowed	None allowed	No rough edges, cutting vestiges < 0.5mm height allowed	No rough edges, cutting vestiges < 0.5 mm height allowed
Rust/ Corrosion	None allowed	None allowed	None allowed	None allowed
Spatter	None allowed	None allowed	None allowed	None allowed
Porosity	None allowed	None allowed	None allowed	None allowed
Scratches	None allowed	Scratch length < 2mm. depth < 0.1mm, 5 allowed per 2" *2" area	Light scratches allowed on internal parts, < 5mm in length, < 0.1mm in depth.	Scratches allowed on internal parts, up to 10mm in length, < 0.1 mm in depth.
Speck	None allowed	Small specks allowed in nonvisible areas, < 0.2mm in diameter.	Specks up to 0.5mm in diameter allowed on internal surfaces.	Specks up to 1mm in diameter allowed on internal parts.
Stress Marks (Forming)	None allowed	None allowed	None allowed	None allowed
Cross-Threading	None allowed	None allowed	None allowed	None allowed



Stripped / Torn Thread Flanks	None allowed	None allowed	None allowed	None allowed
Crushed / Rolled-Over Threads	None allowed	None allowed	None allowed	None allowed
Incomplete Thread Form	None allowed	None allowed	None allowed	None allowed
Thread Undercut / Relief Groove Damage	None allowed	None allowed	None allowed	None allowed
Galling / Cold Welding Evidence	None allowed	None allowed	None allowed	Consult Axon — acceptable only if mating function is confirmed unaffected
Missing / Wrong Thread Insert	None allowed	None allowed	None allowed	None allowed
Recess / Counterbore at Thread Entry	Chamfer or radius clean and uniform; no chipping	Chamfer or radius clean and uniform; no chipping	Chamfer or radius clean and uniform; no chipping	Chamfer or radius clean and uniform; no chipping
Tool Marks / Feed Lines	None allowed	None allowed	None allowed	Allowed if function unaffected
Chatter Marks	None allowed	None allowed	Minor periodic marks on non-critical surfaces	Allowed if function unaffected
Built-Up Edge / Material Smearing	None allowed	None allowed	None allowed	None allowed
Tearing / Plucking of Material	None allowed	None allowed	None allowed	None allowed
Work Hardening / White Layer	None allowed	None allowed	None allowed on mating/sealing	None allowed on mating/sealing



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(EDM/Grinding)			Surfaces; Consult Axon otherwise	Surfaces; Consult Axon otherwise
Delamination / Material Separation	None allowed	None allowed	None allowed	None allowed
Fixturing / Witness Marks	None allowed on visible or mating surfaces	None allowed on mating surfaces; faint marks acceptable on non-visible areas	Faint marks acceptable on non-mating surfaces	Acceptable on non-mating surfaces if function unaffected

Table 2: Inspection criteria for each grade per defects

****please consult Axon in case of anomalies**

11. Appendix A: Definitions

Abrasion: A surface imperfection that removes or displaces material, characterized by its large width and length relative to its depth.

Bends/ distortion: Deformation of part features

Blowout/ Crater: A void or crater along cut edge of part

Blister: The raised bumps in the surface, caused by air or solvent vapors forming within or under the coating.

Burr: Raised, rough, or sharp edges inherent in cutting operations such as sharing, blanking, punching, and drilling. Burrs will usually snag or tear a cleaning cloth.

Chip: This defect is defined as the loss of adhesion and the removal, usually in small fragments, of the surface coating resulting from impact by hard objects: can be called ding, or nick.

Dent: A surface depression caused by a blow or pressure from another object. Dents have no characteristic size or shape.

Discoloration: Any change from original color.

Distortion: Any warping, bending, or other distortions that can occur due to thermal stress during the fabrication process.

FOD: Foreign material debris: A substance foreign to the intended composition such as grease, tape, or dirt, sticky debris, shavings etc. * FOD also includes cleanliness - Parts should be clean with or without packaging, packaging should be tested and consulted with



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Axon PoC where applicable. **Fracture:** This defect is characterized by a tear, separation, or pulling apart from metal.

Gouges: Prominent impressions or deep scratches that penetrate and raise material.

Grainy Coating / Orange Peel: A "grainy coating" or "orange peel" on metal refers to a surface texture that resembles the bumpy skin of an orange, caused by inconsistent coating thickness, or poor surface preparation; in sheet metal, it can also occur due to excessive deformation during forming processes like deep drawing, where the metal grains deform unevenly.

Heat-Affected Zone (HAZ): The area around the cut edge that has been affected by the heat from the laser cutting process is known as the HAZ. A large HAZ can lead to material degradation, including oxidation, discoloration, or softening of the material. The width of the HAZ and the extent of its impact on the material's properties can be an important part of evaluating the finish.

Laser Dross: Excess material caused by remelt protruding from edges of laser cut feature.

Pinhole: Sharp, round or irregularly shaped depressions — randomly distributed over a surface and may range in size from those barely visible to those the size of a pinhead. These defects will sometimes have a residual varnish or some other solid in their centers surrounded by a hollow, halo-like space.

Pit: A pinhole bigger in size is called a pit.

Rough edges: Jagged or nonuniform edges alongside cut perimeter. Additionally, cutting vestige is positive bumps left after cutting where part is broken off from panel.

Rust/ Corrosion: Rust is the visible manifestation of corrosion of iron or iron alloys. This defect is usually seen as a reddish-brown coating, composed mostly of hydrated iron oxides formed on iron or its alloys, because of exposure to humid surroundings.

Spatter: Spatter occurs when molten material droplets are formed near the welding arc. It is usually caused by high currents, wrong polarity, or insufficient gas shielding.

Scratches: Metal expulsion that is not attached to the cut edge, but has attached itself to the surface of the material

Specks: Small particles of dust or debris embedded in the surface material. Specks may not be able to be removed by simple cleaning.

Stains: Soiled or discolored spot or blemish from fingerprints, etc. that may indicate contamination

Stress Marks (Forming): This type of defect usually occurs at the sharp corners and is characterized by stress cracking due to deformation.

Deburring: Depending on the material and application, some parts may require deburring (removal of sharp edges) after cutting.



Surface Treatment: Some laser-cut parts, particularly those made from metals, may require further surface treatments such as coating, painting, or galvanizing. Ensure that these processes are possible to maintain the quality of the cut edges and material.

Cross-Threading: Thread engagement where mating parts are misaligned, causing off-axis to contact that damages the thread form of one or both parts.

Stripped / Torn Thread Flanks — Thread flanks that are torn, deformed, or missing material, preventing proper load-bearing engagement with a mating fastener.

Crushed / Rolled-Over Threads: Thread crests or flanks plastically deformed from over-torque, impact, or improper handling, resulting in out-of-form thread profile.

Incomplete Thread Form: A thread that does not achieve full flank height across its profile, typically at the lead-in or run out turns.

Thread Undercut / Relief Groove: Damage — Damage to the intentional undercut or stress-relief groove at thread run-out, including nicks, cracks, or material removal beyond design intent.

Galling / Cold Welding Evidence: Adhesive metal transfer between mating thread surfaces caused by friction, visible as smearing or material pickup on thread flanks.

Missing / Wrong Thread Insert: Absence of a required threaded insert, or presence of an insert with incorrect thread size, type, or seating depth.

Recess / Counterbore at Thread Entry: Damage, chipping, or non-uniformity at the chamfer or spot face at the thread entry plane that obstructs fastener seating or tool access.

Tool Marks / Feed Lines: Spiral or linear surface patterns left by the cutting tool path, directly reflecting feed rate and tool geometry.

Chatter Marks: Periodic wave-like surface patterns caused by self-excited vibration between the cutting tool and workpiece during machining.

Dents: Surface depressions caused by impact or pressure from handling, fixturing, or tooling contact.

Built-Up Edge / Material Smearing: Workpiece material adhered to the cutting tool and re-deposited onto the machined surface, producing an irregular or smeared texture.

Tearing / Plucking of Material: Irregular surface ruptures where ductile material has been pulled up or folded rather than cleanly cut, typically from a worn tool.

Work Hardening / White Layer (EDM/Grinding): A thin, hard, and brittle surface layer produced by excessive heat or deformation during grinding or EDM, detrimental to fatigue life.

Delamination / Material Separation: Separation or lifting of material layers at or near the machined surface, indicating internal defects or excessive cutting forces.

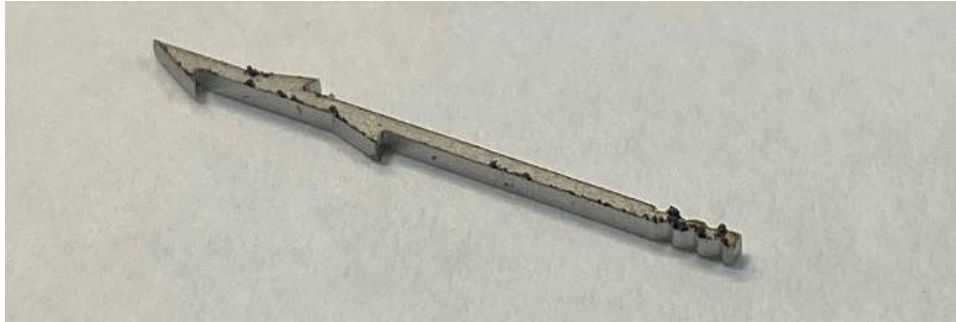
Fixturing / Witness Marks: Impressions or contact marks left on the part surface by work-holding jaws, clamps, or locating elements during machining.



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12. Appendix B: Reference pictures of relevant cosmetic defects

Laser dross:



Gouges:



Heat affected zone:



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Rough edges and burrs:



Burnt Corners:



Spatter:



Fracture:



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Scratches:



Orange peel:



No orange peel



Component with orange peel

Rust:



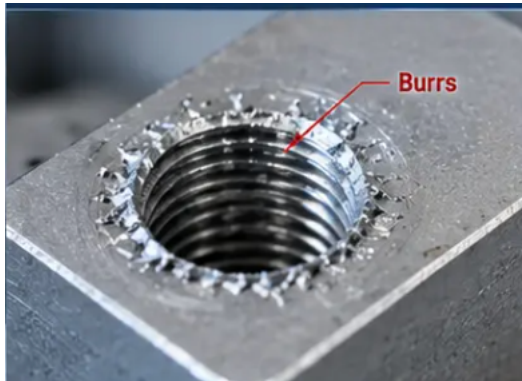
Cross-threading:



Stripped / torn thread flanks:



Burrs on thread flanks or crests:



Galling / cold welding:



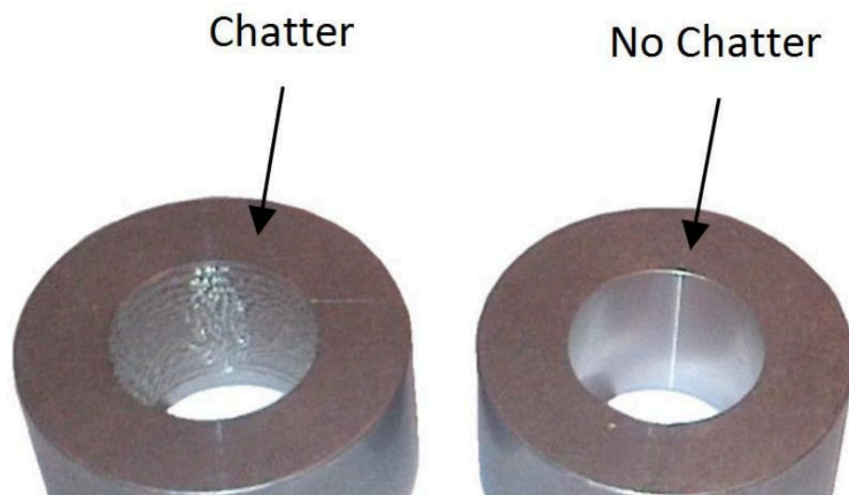
Incomplete thread form:



Misaligned, countersunk hole:



Chatter marks:



Document History

Revision	Date	Author(s)	Change Description	Approved by
1.0	7/19/2024	S. Pujari S. Driscoll, R. Morrison. P. De Schepper, B. Chinoy, M. Chen.	Initial Release	N. Shekarri, J. Groff

