PRODUCT CATEGORIES and IMPACT LIMIT VALUES

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GOAL AND SCOPE

The goal of the present document is to help the organization requesting LEAF Hardware certification to identify the correct product category to which the product subject to certification belongs.

Product categories are classified depending on the different base materials and surface treatmennts.

Once the correct product category has been identified, the LCA practitioner (whether it is internal to the organization requesting certification or an external consultant) shall follow the requirements for that specific product category in terms of functional/declared unit and processes to be reported in the LCA report, in order to enhance compatibility between products belonging to the same product category. The LEAF TC is responsible for monitoring that the correct functional/declared unit and all the mandatory LCA processes have been included in the LCA study.

In addition, the limit values for the six impact categories described in Section 8.2. of the "LEAF Hardware Guidelines" document are reported for each product category. The LCIA phase of the LCA study shall provide output values for the six impact categories that are lower than the limit values for a specific product category in order to obtain the LEAF Hardware product certification.

Additional information about LCA requirements, impact categories' methods and general guidelines to perform an LCA study can be found in the "LEAF Hardware: General Requirements for Certification" available at www.leafoundation.org/documenti.

PRODUCT CATEGORIES

1. METAL HARDWARE MADE OF DIE-CAST ZAMAK

Die-cast Zamak metal hardware is obtained from die-casting melted Zamak ingots from a crucible into a mold where it solidifies as it rapidly cools down.

1.1. DIE-CAST ZAMAK + NICKEL PLATING + PRECIOUS METAL

This paragraph reports the requirements and limit impact values for metal hardware accessories made of die-cast Zamak and a subsequent surface plating treatment for the deposition of a Nickel layer with 10-13 µm thickness and a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness.

The die-cast metal hardware undergoes polishing after die-casting, degreasing in an utltrasound bath, pickling, neutralization and the other plating steps. After the final washing step, the plated metal hardware is dried in an oven.

Requirements:

• Functional/declared unit:	1 gram (g) of die-cast Zamak metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel Plating (10-13 µm thickness) and Precious Metal Plating (0.25-0.35 µm thickness).
LCA PROCESSES:	
Process phase: Zamak Die-Casting	
	• Zamak ingot consumption per metal accessory.
	• Recycled material in Zamak ingot (e.g., 50% of Zinc is recycled).
	• New ingots/recycled runners ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Zamak die-casting machine in kWh.
	• Energy consumption for Zamak die-casting machine chiller in kWh.

	• Number of die-cast accessories produced per minute.
	• Die-casting waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h

	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.119
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	1.7 – 4.68 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.57
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	2.52 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	6.2 E-03 – 1.7 E-4
Human Toxicity (UseTox2)	CTUh/kg	3.54 E-10

1.2. DIE-CAST ZAMAK + NICKEL-FREE PLATING + PRECIOUS METAL

This paragraph reports the requirements and limit impact values for metal hardware accessories made of die-cast Zamak and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness and a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness.

The die-cast metal hardware undergoes polishing after die-casting, degreasing in an utltrasound bath, pickling, neutralization and the other plating steps. After the final washing step, the plated metal hardware is dried in an oven.

Requirements:

• Functional/declared unit:	1 gram (g) of die-cast Zamak metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel Plating (10-13

	µm thickness) and Precious Metal Plating (0.25-0.35 µm thickness).
LCA PROCESSES:	
Process phase: Zamak Die-Casting	
	• Zamak ingot consumption per metal accessory.
	• Recycled material in Zamak ingot (e.g., 50% of Zinc is recycled).
	• New ingots/recycled runners ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Zamak die-casting machine in kWh.
	• Energy consumption for Zamak die-casting machine chiller in kWh.
	• Number of die-cast accessories produced per minute.
	• Die-casting waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory

	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.082
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	1.14 – 4.8 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.41
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	2.22 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	2.2 E-03 – 1.6 E-4
Human Toxicity (UseTox2)	CTUh/kg	3.0 E-10

1.3. DIE-CAST ZAMAK + NICKEL PLATING + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of die-cast Zamak and a subsequent surface plating treatment for the deposition of a Nickel layer with 10-13 µm thickness and a final varnish layer.

The die-cast metal hardware undergoes polishing after die-casting, degreasing in an utltrasound bath, pickling, neutralization and the other plating steps. After the final plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of die-cast Zamak metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel Plating (10-13 µm thickness) with final varnish layer.
LCA PROCESSES:	
Process phase: Zamak Die-Casting	
	• Zamak ingot consumption per metal accessory.
	• Recycled material in Zamak ingot (e.g., 50% of Zinc is recycled).
	• New ingots/recycled runners ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Zamak die-casting machine in kWh.
	• Energy consumption for Zamak die-casting machine chiller in kWh.
	• Number of die-cast accessories produced per minute.
	• Die-casting waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	

	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	

	• kg of varnish per kg accessory
	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)
	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.095
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	1.41 – 3.5 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.43
Ozone Depletion Potential (ODP)	kg CF-C11 eq.	2.07 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	4.6 E-03 – 1.3 E-4
Human Toxicity (UseTox2)	CTUh/kg	2.7 E-10

1.4. DIE-CAST ZAMAK + NICKEL-FREE PLATING + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of die-cast Zamak and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness and a final varnish layer.

The die-cast metal hardware undergoes polishing after die-casting, degreasing in an utltrasound bath, pickling, neutralization and the other plating steps. After the final plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of die-cast Zamak metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel-free Plating (3-4 µm thickness) with final varnish layer.
LCA PROCESSES:	

Process phase: Zamak Die-Casting	
	• Zamak ingot consumption per metal accessory.
	• Recycled material in Zamak ingot (e.g., 50% of Zinc is recycled).
	• New ingots/recycled runners ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Zamak die-casting machine in kWh.
	• Energy consumption for Zamak die-casting machine chiller in kWh.
	• Number of die-cast accessories produced per minute.
	• Die-casting waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	

	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	
	• kg of varnish per kg accessory
	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)
	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.053
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.78 – 2.9 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.25
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.47 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	1.3 E-03 – 9.6 E-5

Human Toxicity (UseTox2)	CTUh/kg	1.8 E-10

1.5. DIE-CAST ZAMAK + NICKEL-FREE PLATING + PRECIOUS METAL + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of die-cast Zamak and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness, a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness, and a final varnish layer.

The die-cast metal hardware undergoes polishing after die-casting, degreasing in an utltrasound bath, pickling, neutralization and the other plating steps. After the final plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of die-cast Zamak metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel-free Plating (3-4 µm thickness), Precious Metal Plating (0.25-0.35 µm thickness) with final varnish layer.
LCA PROCESSES:	
Process phase: Zamak Die-Casting	
	• Zamak ingot consumption per metal accessory.
	• Recycled material in Zamak ingot (e.g., 50% of Zinc is recycled).
	• New ingots/recycled runners ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Zamak die-casting machine in kWh.
	• Energy consumption for Zamak die-casting machine chiller in kWh.
	• Number of die-cast accessories produced per minute.

	• Die-casting waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)

	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	
	• kg of varnish per kg accessory
	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)
	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.109
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	1.61 – 5.9 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.51
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	3.01 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	2.8 E-03 – 2.0 E-4
Human Toxicity (UseTox2)	CTUh/kg	3.71 E-10

2. METAL HARDWARE MADE OF HOT-STAMPED BRASS

Hot-stamped brass hardware is obtained from hot-stamping of brass billets into a mold where it solidifies as it rapidly cools down.

2.1. HOT-STAMPED BRASS + NICKEL PLATING + PRECIOUS METAL

This paragraph reports the requirements and limit impact values for metal hardware accessories made of hot-stamped brass and a subsequent surface plating treatment for the deposition of a Nickel layer with 10-13 µm thickness and a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness.

The hot-stamped metal hardware undergoes polishing after hot-stamping, degreasing, neutralization and the other plating steps. After the final washing step, the plated metal hardware is dried in an oven.

Requirements:

• Functional/declared unit:	1 gram (g) of hot-stamped Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel Plating (10-13 µm thickness) and Precious Metal Plating (0.25-0.35 µm thickness).
LCA PROCESSES:	
Process phase: Brass Hot Stamping	
	• Brass bar consumption per metal accessory.
	• Recycled material in Brass bar (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass hot-stamping machine in kWh.
	• Natural gas consumption for Brass hot-stamping machine in Nm^3h.
	• Number of hot-stamped accessories produced per minute.

	• Energy consumption for trimming machine in kWh (including compressed air).
	• Number of accessories trimmed per minute.
	• Hot-stamping waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	

	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.075
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	1.16 – 9.52 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.38
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	2.09 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	4.0 E-03 – 3.8 E-5
Human Toxicity (UseTox2)	CTUh/kg	9.31 E-11

2.2. HOT-STAMPED BRASS + NICKEL-FREE PLATING + PRECIOUS METAL

This paragraph reports the requirements and limit impact values for metal hardware accessories made of hot-stamped brass and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness and a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness.

The hot-stamped metal hardware undergoes undergoes polishing after hot-stamping, degreasing, neutralization and the other plating steps. After the final washing step, the plated metal hardware is dried in an oven.

Requirements:

• Functional/declared unit:	1 gram (g) of hot-stamped Brass metal hardware and 1 square decimeter (dm^2) of

	surface treatment with Nickel-free Plating (3-4 µm thickness) and Precious Metal Plating (0.25-0.35 µm thickness).
LCA PROCESSES:	
Process phase: Brass Hot Stamping	
	• Brass bar consumption per metal accessory.
	• Recycled material in Brass bar (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass hot-stamping machine in kWh.
	• Natural gas consumption for Brass hot-stamping machine in Nm^3h.
	• Number of hot-stamped accessories produced per minute.
	• Energy consumption for trimming machine in kWh (including compressed air).
	• Number of accessories trimmed per minute.
	• Hot-stamping waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.

	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.067
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.98 – 2.87 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.27
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	2.08 E-09

Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	1.7 E-03 – 1.1 E-4
Human Toxicity (UseTox2)	CTUh/kg	2.2 E-10

2.3. HOT-STAMPED BRASS + NICKEL PLATING + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of hot-stamped brass and a subsequent surface plating treatment for the deposition of a Nickel layer with 10-13 µm thickness and a final varnish layer.

The hot-stamped metal hardware undergoes polishing after hot-stamping, degreasing, neutralization and the other plating steps. After the plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of hot-stamped Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel Plating (10-13 µm thickness) and final varnish layer.
LCA PROCESSES:	
Process phase: Brass Hot Stamping	
	• Brass bar consumption per metal accessory.
	• Recycled material in Brass bar (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass hot-stamping machine in kWh.
	• Natural gas consumption for Brass hot-stamping machine in Nm^3h.
	• Number of hot-stamped accessories produced per minute.
	• Energy consumption for trimming machine in kWh (including compressed air).

	• Number of accessories trimmed per minute.
	• Hot-stamping waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h

	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	
	• kg of varnish per kg accessory
	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)
	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.055
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.89 – 6.4 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.26
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.56 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	2.7 E-03 – 2.6 E-5
Human Toxicity (UseTox2)	CTUh/kg	6.46 E-11

2.4. HOT-STAMPED BRASS + NICKEL-FREE PLATING + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of hot-stamped brass and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness and a final varnish layer.

The hot-stamped metal hardware undergoes polishing after hot-stamping, degreasing, neutralization and the other plating steps. After the plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of hot-stamped Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel-free Plating (3-4 µm thickness) and final varnish layer.
LCA PROCESSES:	
Process phase: Brass Hot Stamping	
	• Brass bar consumption per metal accessory.
	• Recycled material in Brass bar (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass hot-stamping machine in kWh.
	• Natural gas consumption for Brass hot-stamping machine in Nm^3h.
	• Number of hot-stamped accessories produced per minute.
	• Energy consumption for trimming machine in kWh (including compressed air).
	• Number of accessories trimmed per minute.
	• Hot-stamping waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.

	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	
	• kg of varnish per kg accessory

	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)
	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.052
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.81 – 2.1 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.20
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.64 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	1.2 E-03 – 8.4 E-5
Human Toxicity (UseTox2)	CTUh/kg	1.57 E-10

2.5. HOT-STAMPED BRASS + NICKEL-FREE PLATING + PRECIOUS METAL + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of hot-stamped brass and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness, a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness, and a final varnish layer.

The hot-stamped metal hardware undergoes polishing after hot-stamping, degreasing, neutralization and the other plating steps. After the plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of hot-stamped Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel-free Plating (3-4 µm thickness), Precious Metal Plating

	(0.25-0.35 µm thickness) and final varnish layer.
LCA PROCESSES:	
Process phase: Brass Hot Stamping	
	• Brass bar consumption per metal accessory.
	• Recycled material in Brass bar (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass hot-stamping machine in kWh.
	• Natural gas consumption for Brass hot-stamping machine in Nm^3h.
	• Number of hot-stamped accessories produced per minute.
	• Energy consumption for trimming machine in kWh (including compressed air).
	• Number of accessories trimmed per minute.
	• Hot-stamping waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.

	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	
	• kg of varnish per kg accessory
	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)
	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.064

Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	1.00 – 2.5 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.24
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	2.01 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	1.5 E-03 – 1.0 E-4
Human Toxicity (UseTox2)	CTUh/kg	1.93 E-10

3. METAL HARDWARE MADE OF COLD-STAMPED BRASS

Cold-stamped brass hardware is tipically obtained from trimming of brass sheets the final form.

3.1. COLD-STAMPED BRASS + NICKEL PLATING + PRECIOUS METAL

This paragraph reports the requirements and limit impact values for metal hardware accessories made of cold-stamped brass and a subsequent surface plating treatment for the deposition of a Nickel layer with 10-13 µm thickness and a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness.

The cold-stamped metal hardware undergoes polishing after cold-stamping, degreasing, neutralization and the other plating steps. After the final washing step, the plated metal hardware is dried in an oven.

Requirements:

• Functional/declared unit:	1 gram (g) of cold-stamped Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel Plating (10-13 µm thickness) and Precious Metal Plating (0.25-0.35 µm thickness).
LCA PROCESSES:	
Process phase: Brass Cold Stamping	
	• Brass sheet consumption per metal accessory.
	• Recycled material in Brass sheet (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass col-stamping trimming machine in kWh.
	• Number of cold-stamped accessories produced per minute.
	• Cold-stamping waste processes per metal accessory

Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)

	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.067
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.95 – 9.34 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.33
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.79 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	4.0 E-03 – 3.6 E-5
Human Toxicity (UseTox2)	CTUh/kg	8.72 E-11

3.2. COLD-STAMPED BRASS + NICKEL-FREE PLATING + PRECIOUS METAL

This paragraph reports the requirements and limit impact values for metal hardware accessories made of cold-stamped brass and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness and a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness.

The cold-stamped metal hardware undergoes polishing after cold-stamping, degreasing, neutralization and the other plating steps. After the final washing step, the plated metal hardware is dried in an oven.

Requirements:

• Functional/declared unit:	1 gram (g) of cold-stamped Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel-free Plating (3-4 µm thickness) and Precious Metal Plating (0.25-0.35 µm thickness).

LCA PROCESSES:	
Process phase: Brass Cold Stamping	
	• Brass sheet consumption per metal accessory.
	• Recycled material in Brass sheet (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass col-stamping trimming machine in kWh.
	• Number of cold-stamped accessories produced per minute.
	• Cold-stamping waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory

	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.060
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.80 – 2.71 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.22
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.81 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	1.6 E-03 – 1.1 E-4
Human Toxicity (UseTox2)	CTUh/kg	2.1 E-10

3.3. COLD-STAMPED BRASS + NICKEL PLATING + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of cold-stamped brass and a subsequent surface plating treatment for the deposition of a Nickel layer with 10-13 µm thickness and a final varnish layer.

The cold-stamped metal hardware undergoes polishing after cold-stamping, degreasing, neutralization and the other plating steps. After the plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of cold-stamped Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel Plating (10-13 µm thickness) and final varnish layer.
LCA PROCESSES:	
Process phase: Brass Cold Stamping	
	• Brass sheet consumption per metal accessory.
	• Recycled material in Brass sheet (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass col-stamping trimming machine in kWh.
	• Number of cold-stamped accessories produced per minute.
	• Cold-stamping waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.

	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	
	• kg of varnish per kg accessory
	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)

	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.050
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.75 – 6.3 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.23
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.35 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	2.7 E-03 – 2.5 E-5
Human Toxicity (UseTox2)	CTUh/kg	6.06 E-11

3.4. COLD-STAMPED BRASS + NICKEL-FREE PLATING + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of cold-stamped brass and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness and a final varnish layer.

The cold-stamped metal hardware undergoes polishing after cold-stamping, degreasing, neutralization and the other plating steps. After the plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of cold-stamped Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel-free Plating (3-4 µm thickness) and final varnish layer.

LCA PROCESSES:	
Process phase: Brass Cold Stamping	

	• Brass sheet consumption per metal accessory.
	• Recycled material in Brass sheet (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass col-stamping trimming machine in kWh.
	• Number of cold-stamped accessories produced per minute.
	• Cold-stamping waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory

Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	
	• kg of varnish per kg accessory
	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)
	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.047
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.67 – 1.9 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.16
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.44 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	1.2 E-03 – 8.2 E-5
Human Toxicity (UseTox2)	CTUh/kg	1.53 E-10

3.5. COLD-STAMPED BRASS + NICKEL-FREE PLATING + PRECIOUS METAL + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of cold-stamped brass and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness, a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness, and a final varnish layer.

The cold-stamped metal hardware undergoes polishing after cold-stamping, degreasing, neutralization and the other plating steps. After the plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of cold-stamped Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel-free Plating (3-4 µm thickness), Precious Metal Plating (0.25-0.35 µm thickness) and final varnish layer.
LCA PROCESSES:	
Process phase: Brass Cold Stamping	
	• Brass sheet consumption per metal accessory.
	• Recycled material in Brass sheet (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass col-stamping trimming machine in kWh.
	• Number of cold-stamped accessories produced per minute.
	• Cold-stamping waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	

	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month

Process phase: Varnish	
	• kg of varnish per kg accessory
	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)
	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.058
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.83 – 2.4 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.20
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.78 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	1.5 E-03 – 1.0 E-4
Human Toxicity (UseTox2)	CTUh/kg	1.89 E-10

4. METAL HARDWARE MADE OF CNC MILLED BRASS

CNC-milled brass hardware is tipically obtained from milling of brass blocks into the final form.

4.1. CNC-MILLED BRASS + NICKEL PLATING + PRECIOUS METAL

This paragraph reports the requirements and limit impact values for metal hardware accessories made of CNC-milled brass and a subsequent surface plating treatment for the deposition of a Nickel layer with 10-13 µm thickness and a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness.

The CNC-milled metal hardware undergoes polishing after milling operations, degreasing, neutralization and the other plating steps. After the final washing step, the plated metal hardware is dried in an oven.

Requirements:

• Functional/declared unit:	1 gram (g) of CNC-milled Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel Plating (10-13 µm thickness) and Precious Metal Plating (0.25-0.35 µm thickness).
LCA PROCESSES:	
Process phase: Brass CNC Milling	
	• Brass block consumption per metal accessory.
	• Recycled material in Brass block (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass CNC-milling machine in kWh.
	• Number of CNC-milled accessories produced per minute.
	• Water consumption per accessory in m^3
	• Oil consumption per accessory in kg

	• CNC-milling waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)

	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.073
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	1.03 – 9.48 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.35
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.93 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	4.1 E-03 – 3.7 E-5
Human Toxicity (UseTox2)	CTUh/kg	9.09 E-11

4.2. CNC-MILLED BRASS + NICKEL-FREE PLATING + PRECIOUS METAL

This paragraph reports the requirements and limit impact values for metal hardware accessories made of CNC-milled brass and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness and a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness.

The CNC-milled metal hardware undergoes polishing after milling operations, degreasing, neutralization and the other plating steps. After the final washing step, the plated metal hardware is dried in an oven.

Requirements:

• Functional/declared unit:	1 gram (g) of CNC-milled Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel-free Plating (3-4 µm thickness) and Precious Metal Plating (0.25-0.35 µm thickness).

LCA PROCESSES:	
Process phase: Brass CNC Milling	
	• Brass block consumption per metal accessory.
	• Recycled material in Brass block (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass CNC-milling machine in kWh.
	• Number of CNC-milled accessories produced per minute.
	• Water consumption per accessory in m^3
	• Oil consumption per accessory in kg
	• CNC-milling waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory

Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.066
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.88 – 2.79 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.24
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.96 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	1.7 E-03 – 1.1 E-4
Human Toxicity (UseTox2)	CTUh/kg	2.2 E-10

4.3. CNC-MILLED BRASS + NICKEL PLATING + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of CNC-milled brass and a subsequent surface plating treatment for the deposition of a Nickel layer with 10-13 µm thickness and a final varnish layer.

The CNC-milled metal hardware undergoes polishing after milling operations, degreasing, neutralization and the other plating steps. After the plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of CNC-milled Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel Plating (10-13 µm thickness) and final varnish layer.
LCA PROCESSES:	
Process phase: Brass CNC Milling	
	• Brass block consumption per metal accessory.
	• Recycled material in Brass block (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass CNC-milling machine in kWh.
	• Number of CNC-milled accessories produced per minute.
	• Water consumption per accessory in m^3
	• Oil consumption per accessory in kg
	• CNC-milling waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.

	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	
	• kg of varnish per kg accessory

	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)
	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.052
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.77 – 6.1 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.23
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.39 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	2.3 E-03 – 2.5 E-5
Human Toxicity (UseTox2)	CTUh/kg	6.07 E-11

4.4. CNC-MILLED BRASS + NICKEL-FREE PLATING + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of CNC-milled brass and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness and a final varnish layer.

The CNC-milled metal hardware undergoes polishing after milling operations, degreasing, neutralization and the other plating steps. After the plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of CNC-milled Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel-free Plating (3-4 µm thickness) and final varnish layer.
LCA PROCESSES:	

Process phase: Brass CNC Milling	
	• Brass block consumption per metal accessory.
	• Recycled material in Brass block (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass CNC-milling machine in kWh.
	• Number of CNC-milled accessories produced per minute.
	• Water consumption per accessory in m^3
	• Oil consumption per accessory in kg
	• CNC-milling waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory

	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	
	• kg of varnish per kg accessory
	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)
	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.049
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.69 – 1.9 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.16
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.45 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	1.1 E-03 – 7.9 E-5

Human Toxicity (UseTox2)	CTUh/kg	1.49E-10

4.5. CNC-MILLED BRASS + NICKEL-FREE PLATING + PRECIOUS METAL + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of CNC-milled brass and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness, a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness, and a final varnish layer.

The CNC-milled metal undergoes polishing after milling operations, degreasing, neutralization and the other plating steps. After the plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of CNC-milled Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel-free Plating (3-4 µm thickness), Precious Metal Plating (0.25-0.35 µm thickness) and final varnish layer.
LCA PROCESSES:	
Process phase: Brass CNC Milling	
	• Brass block consumption per metal accessory.
	• Recycled material in Brass block (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass CNC-milling machine in kWh.
	• Number of CNC-milled accessories produced per minute.
	• Water consumption per accessory in m^3
	• Oil consumption per accessory in kg

	• CNC-milling waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)

	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	
	• kg of varnish per kg accessory
	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)
	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.060
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.85 – 2.3 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.21
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.79 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	1.4 E-03 – 9.8 E-5
Human Toxicity (UseTox2)	CTUh/kg	1.83 E-10

5. METAL HARDWARE MADE OF TURNED BRASS

Turned brass hardware is tipically obtained from turning brass bars with lathe machines into the final form.

5.1. TURNED BRASS + NICKEL PLATING + PRECIOUS METAL

This paragraph reports the requirements and limit impact values for metal hardware accessories made of turned brass and a subsequent surface plating treatment for the deposition of a Nickel layer with 10-13 µm thickness and a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness.

The turned metal hardware undergoes polishing after turning operations, degreasing, neutralization and the other plating steps. After the final washing step, the plated metal hardware is dried in an oven.

Requirements:

• Functional/declared unit:	1 gram (g) of turned Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel Plating (10-13 µm thickness) and Precious Metal Plating (0.25-0.35 µm thickness).
LCA PROCESSES:	
Process phase: Brass Turning	
	• Brass bar consumption per metal accessory.
	• Recycled material in Brass bars (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass turning machine in kWh.
	• Number of turned accessories produced per minute.
	• Water consumption per accessory in m^3
	• Oil consumption per accessory in kg

	• Turning waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)

	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.058
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.84 – 8.61 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.16
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.82 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	3.8 E-03 – 3.5 E-5
Human Toxicity (UseTox2)	CTUh/kg	8.53 E-11

5.2. TURNED BRASS + NICKEL-FREE PLATING + PRECIOUS METAL

This paragraph reports the requirements and limit impact values for metal hardware accessories made of turned brass and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness and a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness.

The turned metal hardware undergoes polishing after turning operations, degreasing, neutralization and the other plating steps. After the final washing step, the plated metal hardware is dried in an oven.

Requirements:

• Functional/declared unit:	1 gram (g) of turned Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel-free Plating (3-4 µm thickness) and Precious Metal Plating (0.25-0.35 µm thickness).

LCA PROCESSES:	
Process phase: Brass Turning	
	• Brass bar consumption per metal accessory.
	• Recycled material in Brass bars (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass turning machine in kWh.
	• Number of turned accessories produced per minute.
	• Water consumption per accessory in m^3
	• Oil consumption per accessory in kg
	• Turning waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory

	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.051
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.70 – 2.16 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.07
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.83 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	1.5 E-03 – 1.1 E-4
Human Toxicity (UseTox2)	CTUh/kg	2.07 E-10

5.3. TURNED BRASS + NICKEL PLATING + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of turned brass and a subsequent surface plating treatment for the deposition of a Nickel layer with 10-13 µm thickness and a final varnish layer.

The turned metal hardware undergoes polishing after turning operations, degreasing, neutralization and the other plating steps. After the plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of turned Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel Plating (10-13 µm thickness) and final varnish layer.
LCA PROCESSES:	
Process phase: Brass Turning	
	• Brass bar consumption per metal accessory.
	• Recycled material in Brass bars (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass turning machine in kWh.
	• Number of turned accessories produced per minute.
	• Water consumption per accessory in m^3
	• Oil consumption per accessory in kg
	• Turning waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.

	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	
	• kg of varnish per kg accessory
	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)
	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.043
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.68 – 5.7 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.11
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.36 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	2.6 E-03 – 2.4 E-5
Human Toxicity (UseTox2)	CTUh/kg	5.89 E-11

5.4. TURNED BRASS + NICKEL-FREE PLATING + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of turned brass and a subsequent surface plating treatment for the deposition of a Nickel-free layer with 3-4 µm thickness and a final varnish layer.

The turned metal hardware undergoes polishing after turning operations, degreasing, neutralization and the other plating steps. After the plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of turned Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel-free Plating (3-4 µm thickness) and final varnish layer.
LCA PROCESSES:	
Process phase: Brass Turning	
	• Brass bar consumption per metal accessory.
	• Recycled material in Brass bars (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).

	• Energy consumption for Brass turning machine in kWh.
	• Number of turned accessories produced per minute.
	• Water consumption per accessory in m^3
	• Oil consumption per accessory in kg
	• Turning waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.
	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory

Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	
	• kg of varnish per kg accessory
	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)
	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.040
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.59 – 1.52 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.06
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.42 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	1.1 E-03 – 7.9 E-5
Human Toxicity (UseTox2)	CTUh/kg	1.47E-10

5.5. TURNED BRASS + NICKEL-FREE PLATING + PRECIOUS METAL + VARNISH

This paragraph reports the requirements and limit impact values for metal hardware accessories made of turned brass and a subsequent surface plating treatment for the

deposition of a Nickel-free layer with 3-4 µm thickness, a Precious Metal layer (Gold, Palladium, or Palladium/Nickel alloy) of 0.25-0.35 µm thickness, and a final varnish layer.

The turned metal hardware undergoes polishing after turning operations, degreasing, neutralization and the other plating steps. After the plating steps, the plated metal hardware is varnished and dried in an oven.

This product category can be selected also for cataphoretic varnish coating.

Requirements:

• Functional/declared unit:	1 gram (g) of turned Brass metal hardware and 1 square decimeter (dm^2) of surface treatment with Nickel-free Plating (3-4 µm thickness), Precious Metal Plating (0.25-0.35 µm thickness) and final varnish layer.
LCA PROCESSES:	
Process phase: Brass Turning	
	• Brass bar consumption per metal accessory.
	• Recycled material in Brass bars (e.g., 70% of Copper is recycled).
	• New Brass/recycled Brass ratio at standard operating conditions (e.g., 40/60).
	• Energy consumption for Brass turning machine in kWh.
	• Number of turned accessories produced per minute.
	• Water consumption per accessory in m^3
	• Oil consumption per accessory in kg
	• Turning waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Plating	
	• DC rectifiers energy consumption in kWh/dm^2 for each plating bath.
	• Heaters energy consumption in kWh/dm^2 for each plating bath.

	• Pumping operations energy consumption in kWh/dm^2 for each plating bath.
	• Extraction system energy consumption in kWh/dm^2 for each plating bath.
	• Consumption of plating material and/or additives per dm^2.
	• Percentage of recycled material in plating material and/or additives.
	• Oven energy consumption in kWh per accessory
	• Water consumption per accessory
	• Emissions in air per metal accessory
	• Plating waste processes per metal accessory
Process phase: Wastewater	
	• Wastewater in m^3 per accessory
	• Cyanide destruction in kg of reagent (e.g. Sodium hypochlorite 15 %m/m) per accessory
	• pH regulators (e.g., Sulforic Acid 50 %m/m) per accessory
Process phase: Other Waste	
	• Spent plating baths in kg per accessory
	• Sludge from filter press in kg per accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process phase: Varnish	
	• kg of varnish per kg accessory
	• Oven energy consumption in kWh per accessory (for hsnd-spraying only)

	• Water consumption in m^3 per kg accessory
	• DC rectifiers energy consumption in kWh/dm^2 (for cataphoretic varnish only).

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.050
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	0.73 – 1.9 E-5
Water Deprivation Potential (WDP)	m^3 water eq.	0.07
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	1.75 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	1.3 E-03 – 9.7 E-5
Human Toxicity (UseTox2)	CTUh/kg	1.81 E-10

6. METAL HARDWARE MADE OF MIM STEEL

Metal Injection Molded (MIM) Steel is tipically obtained starting from a powder supply of mixed metals and waxes (polymers). The supply is melted and injected into molds to obtain the so-called "green" part. The green part is then generally solvent-dewaxed (with eater or organic solvent) and thermally de-waxed in a furnace to obtain a metal porous part called "brown" part. The brown part undergoes eventually sintering in a furnace to obtain the final metal accessory.

6.1. MIM STEEL + PVD (PHYSICAL VAPOUR DEPOSITION)

This paragraph reports the requirements and limit impact values for metal hardware accessories made of MIM steel and a subsequent surface PVD treatment for the deposition of a metat, metal nitride or metal carbide layer of 0.3-0.6 µm thickness.

The MIM metal hardware undergoes polishing, washing in an sonicated water, drying in oven and, eventually, the PVD treatment.

Requirements:

• Functional/declared unit:	1 gram (g) of MIM Steel metal hardware and 1 square decimeter (dm^2) of PVD surface treatment (0.3-0.6 µm thickness).
LCA PROCESSES:	
Process phase: Metal Injection Moulding of Steel	
-Injection	• Supply powder consumption per metal accessory.
	• Recycled material in supply powder (e.g., 90% of Iron is recycled).
	• Energy consumption for injection machine in kWh.
	• Energy consumption for injection chiller machine in kWh.
	• Number of "green" parts produced per minute.
-De-waxing	• Water/solvent consumption per accessory in m^3
	• Energy consumption for bath heating machine in kWh.

	• Energy consumption of furnace for thermal de-waxing machine in kWh.
	• Number of "brown" parts produced per hour.
-Sintering	• Energy consumption of furnace for sintering machine in kWh.
	• Technical gases consumption for sintering in Nm^3 per accessory.
	• Number of MIM steel accessories produced per hour.
	• MIM steel waste processes per metal accessory
Process phase: Polishing (Optional)	
	• Polishing time per metal accessory.
	• Polishing waste processes per metal accessory
Process phase: Pre-PVD	
	• Water consumption in m^3 per accessory.
	• Sonicator energy consumption in kWh per accessory
	• Pumping operations energy consumption in kWh per accessory
	• Oven energy consumption in kWh per accessory
	• Pre-PVD waste processes per metal accessory
Process phase: Water Regeneration System (Optional)	
	• Water flow in m^3/h
	• Efficiency in % (e.g., 80% of water is reused, 20% is waste)
	• Number of ion-exchange resins and lifespan (e.g., 2 cationic and 2 anionic resins, 24 months lifespan)
	• Acid for cationic resins regeneration in kg/month
	• Base for anionic resins regeneration in kg/month
Process Phase: PVD Treatment	
	• Source deposited in kg per accessory

	• Recycled material in source (e.g., 65% of Titanium is recycled).
	• Energy consumption of PVD machine (including pumping operations) in kWh.
	• Technical gas consumption for PVD treatment in Nm^3 per accessory.
	• Reaction gas consumption (if any) for PVD treatment in Nm^3 per accessory.
	• Number of PVD coatings produced per hour.
	• PVD waste processes per metal accessory

LIMIT VALUES FOR IMPACT CATEGORIES		
IMPACT CATEGORY	UNIT	LIMIT VALUES
Global Warming Potential (GWP)	kg CO_2 eq.	0.400
Resources Use Fossil (RUF) and Non-Fossil (RUnF)	(MJ – kg Sb eq.)	4.75 – 3.26 E-6
Water Deprivation Potential (WDP)	m^3 water eq.	0.15
Ozone Depletion Potential (ODP)	kg CFC-11 eq.	5.05 E-09
Ecotoxicity: Acidification potential (AP) and Eutrophication Potential (EP)	mol H+ eq. – mol P eq.	2.0 E-03 – 8.2 E-5
Human Toxicity (UseTox2)	CTUh/kg	1.4 E-10