

1 Areas of application and purposes

This standard applies to the vacuum components defined in standard LHH-N 120.001. It serves to achieve and maintain a surface finish suitable for vacuum applications, in particular surface cleanliness.

The standard contains specifications for the design, manufacture, packaging, transport, testing and assembly of the above-mentioned parts.

2 Cleaning procedures

Depending on the use of the vacuum components in the various vacuum areas (specification in accordance with standard LHH-N 000.320), different cleaning procedures are necessary. These are specified in Table 1 depending on the material and the surface treatment "blasting". The differences in terms of material are primarily due to corrosion resistance to final rinsing with water after blasting (risk of rust formation). The individual steps of the cleaning process (cleaning procedure) are explained in chapter 3 below.

Table 1: Cleaning processes depending on vacuum range, etc.

Vacuum range according to LHH-N 000.320	Material	Incl. blasting	Without blasting
GV / FV	All materials	Degreasing Rinsing CW Drying Blasting	Degreasing Rinsing CW Drying
HV1	Steel, ferritic	Degreasing Rinsing CW Drying Blasting	Degreasing Rinsing CW Drying
	Other corrosion-resistant materials	Degreasing Rinsing CW Drying Blasting Rinsing CW Drying	

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HV2	Only corrosion-resistant materials	Degreasing Rinsing CW Drying Blasting Rinsing CW Rinsing DIW Drying Wipe test ²⁾	Degreasing Rinsing CW Rinsing DIW Drying Wipe test ²⁾
HV3	Only corrosion-resistant materials	Degreasing Rinse CW Drying Cleaning heating ¹⁾ Blasting Rinsing CW Rinsing DIW Drying Wipe test ²⁾ Cleaning heating	Degreasing Rinsing CW Rinsing DIW Drying Wipe test ²⁾ Cleaning heating
UHV			

- 1) Optional if necessary to remove manufacturing-related contamination
- 2) Wipe with a white, lint-free cloth (soaked in ethanol), drill holes and threads with lint-free cleaning sticks (soaked in ethanol). As an alternative to the swabs, the holes can be filled with ethanol and blown out using a white, lint-free cloth. No residue should be visible on the cloth or cleaning swabs.

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3 Cleaning procedure

The cleaning sequences carried out in accordance with this standard begin after component manufacture and the necessary checks.

3.1 Blasting

Depending on the desired effect, this involves cleaning, strengthening or roughening blasting.

See LHH-N 120.030 for more information.

After blasting, the surface must be dedusted with oil-free compressed air¹.

3.2 Water based cleaning methods

Water based cleaning is used for pre-cleaning, i.e. removing macro- and microscopic contaminants. A differentiation is made between degreasing and rinsing.

3.2.1 Degreasing

When degreasing surfaces, the material of the components must be taken into account when selecting the cleaner. Table 2 provides an overview of this.

Table 2: Cleaners for degreasing

Material type	Cleaner
Non-corrosion-resistant materials (e.g. steel)	Alkaline cleaner
Corrosion-resistant materials (e.g. CrNi steel, aluminium, aluminium alloys, non-ferrous metals, plastics)	Acidic cleaner
Hardened components (e.g. gear wheels)	Mixture of isoparaffinic hydrocarbons ()

¹ Compressed air according to ISO 8573-1:2010 [1:2:1]: The air must be dust-free (maximum particle size 0,1 mm at a maximum concentration of 0,1 mg/m³), dry (water maximum pressure dew point –40°C) and oil-free (maximum 0,01 mg/m³).

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If a bath is available, the components can be degreased in a cleaning bath using brushes or ultrasonic cleaning. From HV2 onwards, the use of ultrasonic cleaning in cleaning baths is mandatory.

When using cleaning baths, regular inspection and cleaning of these baths and replacement of the cleaning fluid is necessary in order to reduce recontamination. The frequency of bath treatment depends on the utilization of the bath and the quality of the pre-cleaning. Heavily contaminated components (dust, chips, coarse residues, etc.) should be rinsed with tap water to remove coarse contamination before cleaning in the bath. A cascade of cleaning baths can further improve the cleaning result.

It should also be noted that ultrasonic cleaning devices/systems are subject to wear and tear, which results in a decline in cleaning performance and must therefore be serviced regularly.

If no bath is available, the surfaces are cleaned with a brush and sponge. Alternatively, cleaning can also be carried out using a high-pressure cleaner. From HV2 onwards, a high-pressure cleaner must be used.

This is summarized in Table 3.

Table 3: Degreasing methods

Vacuum areas	Cleaning bath available	Cleaning bath not available
GV-HV1	Cleaning bath + brush Or ultrasonic bath	Sponge + brush Or high-pressure cleaner
HV2-UHV	Ultrasonic bath	High-pressure cleaner

After degreasing, it is necessary to rinse the components immediately with tap water to prevent the cleaner from drying.

3.2.2 Rinsing (CW / DIW)

Rinsing a component is used to remove loose contaminants and residues caused by the cleaners or blasting of the component. Components must always be rinsed after aqueous cleaning (degreasing) and, if necessary, before cleaning. Depending on the definition in Table 1, city water (CW) – normally tap water - or deionized water (DIW) must be used. For the final rinsing with deionized water, a conductivity of $\leq 10 \mu\text{S/cm}$ (according to ISO 3696/ASTM D1193 comparison limits) of the water must be maintained. This conductivity must be monitored. If the value limit is exceeded, the water quality must be restored and the rinsing process repeated (e.g. regenerate/replace water treatment cartridge).

Rinsing can be carried out using showers, high-pressure cleaners or steam jets. If a bath is available, rinsing can also be carried out in this.

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3.3 Drying

A clean environment must be ensured for the drying process.

During drying, a dry, oil- and dust-free air flow must be directed over the component surface. This can be achieved either with compressed air (for quality specifications, see section 3.1) or with warm or hot air. The drying result can be improved or accelerated by applying heat (e.g. infrared radiation to the component surfaces), taking into account the temperature resistance of the materials.

Holes, threads and undercuts must be blown out with oil-free compressed air (for quality, see section 3.1).

Alternatively, the components can also be dried in a suitable vacuum oven.

3.4 Cleaning heating (baking out)

Cleaning heating removes volatile residues at the molecular level, such as hydrocarbons and water. This step should only be carried out after thorough pre-cleaning with water and subsequent drying.

3.4.1 Cleaning heating for components in a vacuum oven

To remove the impurities mentioned above, the components are heated in a vacuum oven. The parameters of the vacuum oven can be found in table 4.

The residues (hydrocarbons, etc.) released from the component will eventually settle on the oven walls and in the vacuum pump. Therefore, regular thorough cleaning of the oven is necessary.

Table 4: Heating parameters for components in the vacuum oven

Parameter	Value
Approved vacuum pumps	Oil-free vacuum pumps
Pressure during heating	$< 1 \cdot 10^{-5}$ mbar
Temperature during heating	A temperature of 200-250°C is recommended. For temperature-sensitive components, use the maximum permissible temperature for the material.
Holding time	>2h (250°C) >3h (200°C) >6h (150°C) >12h (100°C)

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After cleaning and heating under vacuum, the components must be cooled to a temperature of <60°C before they come into contact with atmospheric oxygen/moisture. If the vacuum oven must be vented beforehand, this may only be done with an inert gas (e.g. nitrogen N5.0 or better) and the oven must remain closed until it has cooled to below 60°C.

3.4.2 Cleaning heating for vacuum chambers

The parameters defined in table 5 apply to the cleaning heating of the inner surfaces of vacuum chambers. Instead of placing the vacuum chamber in an oven, the chamber itself is set under vacuum and its inner surfaces are brought to a temperature as homogeneously as possible (e.g. with the help of heating sleeves).

The vacuum pump and measuring devices required for this must be connected with valves to prevent unnecessary venting of the vacuum chamber after heating.

Table 5: Heating parameters for vacuum chambers

Parameter	Value
Approved vacuum pumps	Oil-free vacuum pumps
Pressure during heating	< 1·10 ⁻⁵ mbar
Temperature during heating	80-150°C
Holding time (guideline values)	>6h (150°C) >12 hours (120°C) >24 hours (100°C) >48 hours (80°C)

The cleaning result must be qualified using residual gas mass spectrometry. The partial pressure for all masses greater than 50 amu must be less than < 1·10⁻¹¹mbar.

If the vacuum chamber meets the specification, it is kept under vacuum and disconnected from the test equipment.

If it is necessary to vent the vacuum chamber, the chamber surfaces must be cooled to a temperature of <60°C before they get into contact with atmospheric oxygen/moisture. If the chamber does not cool down under vacuum, it may only be vented with an inert gas (e.g. nitrogen N5.0 or better) and must remain closed until it has cooled down to below 60°C.

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4 Packaging, transport, assembly

This chapter deals with the handling of vacuum components after cleaning. The procedures differ depending on the vacuum range, as explained in more detail below.

For transport, components and vacuum chambers must be prepared in such a way that they are protected from damage, including their packaging. Depending on the transport method, additional protection against contamination may also be necessary (e.g. lorry transport on an open loading area or similar).

All packaging must be labelled with the vacuum range and the date of packaging.

4.1 Handling of GV, FV and HV1 components

After cleaning, the components must be packed in PE film or equivalent materials to protect them from dust. Sealing surfaces must be protected from damage and scratches. It is recommended that the parts only be handled with gloves to prevent recontamination.

Vacuum chambers should be sealed with blind flanges if possible and delivered under vacuum.

4.2 Handling of HV2, HV3 and UHV components

Components for the HV2, HV3 and UHV vacuum ranges require special care in handling to prevent recontamination. These are explained in detail below.

4.2.1 Packaging

HV2, HV3 and UHV cleaned components may only be handled with imprint- and powder-free gloves (clean and free of grease) after the cleaning process.

Special PE film that is suitable for clean rooms and free of release agents and slip agents (e.g. LDPE clean room film) must be used for packaging components. The film must not be reused and must have a thickness of at least 0.1 mm. Sealing surfaces must be protected from damage and scratches.

The components must be cooled (if necessary) and double-packed in the above-mentioned film with fresh desiccant. The inner film must be evacuated.

Vacuum chambers in these vacuum areas must be sealed with blind flanges and delivered under vacuum. Only Viton or metal seals are permitted as sealing material for the blind flanges. In this case, the following point 4.2.2 Assembly must be observed.

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4.2.2 Assembly

The purpose of vacuum-compatible assembly of modules / components / vacuum chambers is to achieve low-outgassing surfaces and to assemble sealing points in such a way that they can successfully perform a vacuum leak test. The following requirements are crucial for this:

In general, it is important to ensure that the workplace is very clean for assembly work. In particular, the following points must be observed:

- The surface of the work area and the preparation areas must not consist of absorbent or particle-generating materials (e.g. wood).
- The work surface must be dry and free of oil, grease and other lubricant residues.
- It must be cleaned again before starting assembly (e.g. with isopropanol or comparable cleaning agents).
- No work that generates contamination (e.g. grinding, welding, cleaning or painting) or pollutes the air (e.g. spraying with oiled compressed air or oil-containing agents) may be carried out in the immediate vicinity of the workplace.
- During work breaks, the components located on site must be protected against contamination (e.g. by covering them with foil).

In order to ensure vacuum-compatible assembly of assemblies / components / vacuum chambers, the following points in particular must be observed:

- The delivered HV2, HV3 and UHV-cleaned components may only be removed from their packaging (foil) shortly before they are needed for assembly.
- All components may only be handled with gloves to protect them from contamination by fingerprints. Only fingerprint-free and powder-free gloves (clean and free of grease) may be used for this purpose.
- Sealing surfaces of components – including the groove base of an O-ring groove – must be checked for contamination and scratches across the seal immediately before assembly. Small scratches must be reworked if necessary (e.g. with Scotch-Brite) and any contamination resulting from this must be removed (e.g. with isopropanol or comparable cleaning agents).

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5 Information in drawings

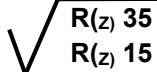
In addition to the information on surface roughness and leak rate, the surface cleanliness must be included in the drawing in the form of a cleaning note in accordance with this standard. The respective operating vacuum range must be specified and reference must be made to this standard. Baking and blasting must also be applied if the work sequences are necessary.

Example 1: Cleaning of a steel vacuum component for use in the HV1 range

Specification: **HV1-cleaned LHH-N 120.002**

Example 2: Cleaning of a vacuum component made of stainless steel for use in the HV3 range with additional blasting treatment to harden the surface

Specification: **HV3-cleaned LHH-N 120.002**

Hardened by blasting LHH-N120.030


The information must be provided near the title block.

6 References to other standards

LHH-N 000.320	Vacuum test method and leak rates
LHH-N 120.001	Terms and properties of vacuum components
LHH-N 120.030	Blasting

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