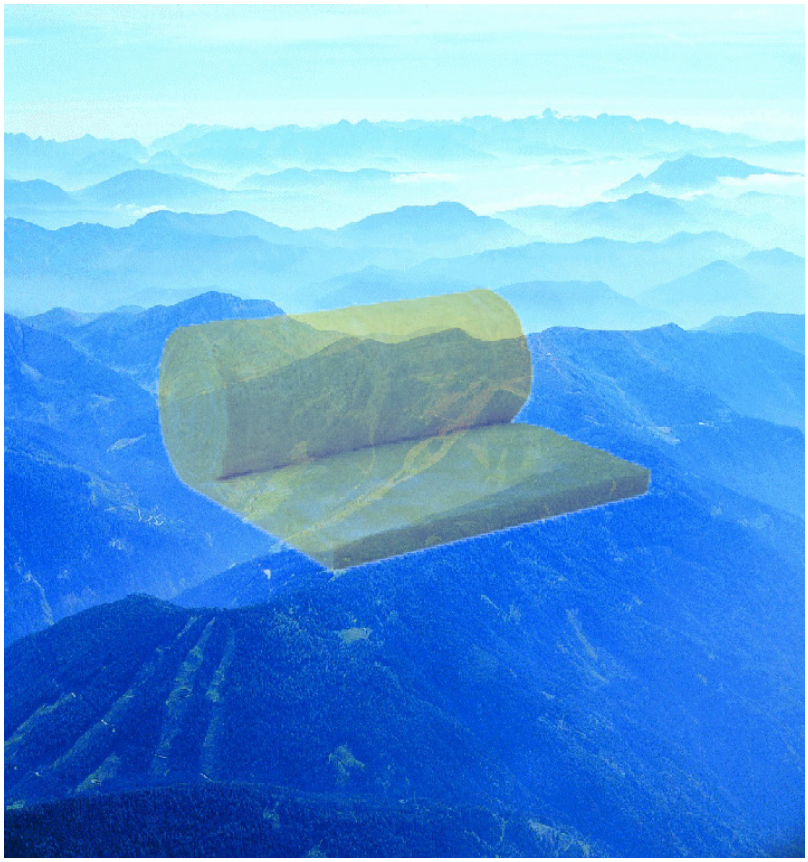
GLAUNACH

THE SILENCER HANDBOOK

INSULATION

SUPPLEMENTARY ACOUSTIC SHIELDING OF SILENCERS, PIPES & CO



There are two main motivations for adding insulation layers to blow-off installations: **Acoustic Insulation** & **Thermal Insulation**. Ideally, the same insulation should fulfil both purposes.

1. ACOUSTIC INSULATION

The key objective of acoustic insulation layers is to minimise the acoustic energy radiated by valve(s), the pipes leading to the silencers, and the silencer shells.

NOISE EMISSION OF BLOW-OFF INSTALLATIONS

Blow-off silencers reduce the sound power transported in the flowing medium. In addition, each valve and associated discharge piping radiates noise directly, which consequently is not attenuated by the silencer.

Literature knows a number of more or less accurate models for the prediction of noise generated by streaming gases and vapours. For noise generated in and by (relieve) valves, one of the most accurate standards is VDMA 24422:1989 [1)]. Supplementary, VDI 3733 [2)] discusses models for calculating the effect pipes have on the transport of that noise. Based on these, the following simplified table has been compiled to facilitate a quick estimate of the noise reduction caused by the presence of a 10 m long (blow-off) pipe between valve and silencer:

valve noise attenuation in a 10 m long pipe							
pipe diameter		*in-pipe pressure*					
mm	inch	4bar	9bar	14bar	19bar	24bar	29bar
40	1 1/2“	56	53	52	50	49	48
50	2“	54	51	50	48	47	47
65	2 1/2“	52	49	48	46	45	45
80	3“	51	48	46	45	44	43
100	4“	49	46	45	43	42	42
150	6“	46	43	41	40	39	38
200	8“	45	42	40	39	38	37
250	10“	45	42	40	39	38	37
300	12“	45	42	40	38	36	37
350	14“	44	41	40	38	37	37
400	16“	44	41	39	37	36	36
450	18“	44	41	39	38	37	36
500	20“	44	41	39	38	37	36
600	24“	43	40	38	37	36	35
700	28“	42	39	37	36	35	34
800	32“	41	38	36	35	34	33

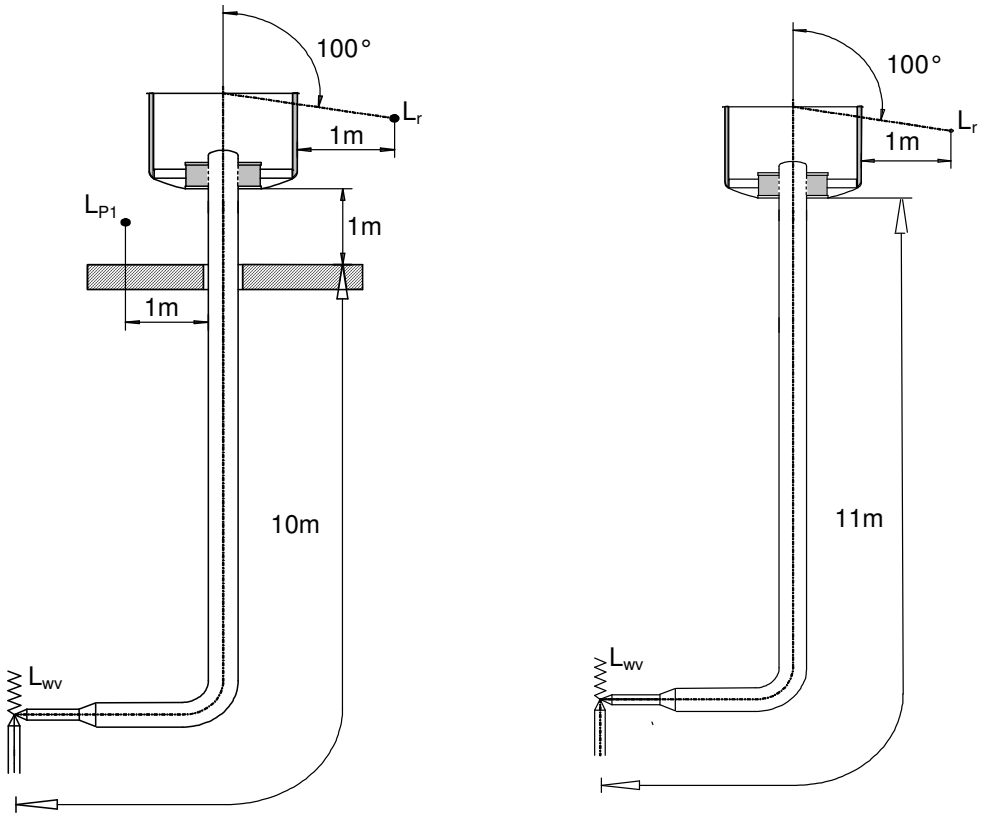
[1)] Verband Deutscher Maschinen- und Anlagenbau (German Engineering Federation): *Fittings - Guidelines for Noise Calculation: Control and Shut-off Fittings*, www.vdma.org

[2)] Verband Deutscher Ingenieure (Association of German Engineers): *Noise at Pipes*, www.vdi.de

For a quick estimate with an average accuracy of ± 2dB, it is often sufficient to rely on the parameters from the table; the exact assessment of the noise attenuation in the blow-off pipe behind the valve is rather complex and takes several parameters into account:

- inside diameter of the pipe
- wall thickness of the pipe
- length of the transmission area
- pressure inside the pipe
- density of the medium

The noise pressure level caused by a typical non-insulated blow-off pipe protruding from the roof of a closed structure (boiler house or the like) can be estimated for a observation point P1 at 1 meter lateral distance from the blow-off pipe by calculating the inside power level in the valve [1)] and subtract the noise attenuation in the pipe.



Example installations of a vent silencer connected to a relief or safety valve by a 11 m long blow-off pipe; left: in-house installation, providing protection against noise emissions; right: open installation

When looking at the same installation with a non-insulated blow-off pipe located outside, the effective pressure noise levels at the lateral measurement point P1 will be approximately 10 dB higher.

[1)] The inside sound power level of a valve can most conveniently be estimated using the formulas provided in Part I, Section 3 and Part IV, Section 1.4 of THE SILENCER HANDBOOK.

Example Calculation:

A valve installation designed for venting a maximum steam mass flow of 50 t/h (valve inlet temperature 500°C, valve upstream pressure 100 bar, permissible back pressure 9%, i.e. 9 bar) into the atmosphere through a DN 300 (12") blow-off pipe is equipped with a vent silencer reducing the power noise levels L_r at a reference point R to 96 dB(A).

According to the VDI estimate, the inner valve noise calculates as

$$L_{WV} = 17 \times \log(50) + 50 \times \log(273 + 500) - 15 = 158.3 \text{ dB(A)}$$

For a pipe diameter of 300 mm and 9 bar pressure, the valve noise table yields a noise reduction

$$Di \approx 42 \text{ dB}$$

The sound pressure level at the observation point at 1 m distance from the blow-off pipe is thus

$$\mathbf{L_{P1}} = L_{WV} - Di = \mathbf{116.3 \text{ dB(A)}}$$

The sound pressure level next to the non-insulated blow-off pipe is thus about 20 dB higher than at the silencer outlet …

Non-insulated blow-off pipes beneath the silencer require acoustic insulation to meet the noise requirements !

2. THERMAL INSULATION

Two factors may require a thermal installation of a silencer:

- In in-house installations, the blow-off pipe acts as thermal bridge between the boiler house and the outside, transferring heat over the blow-off pipe and the silencer shell. This may lead to increased climatisation expenses.
- A thermal insulation helps prevent freezing of collected precipitation and condensation in the silencer shell or the drain pipe [1)].

Long, non-insulated dewatering pipes are especially vulnerable to plugging by ice!

[1] Please note that the insulation can only reduce the temperature loss. If no thermal energy is transferred from the upstream part of the installation, the silencer might still require installation of a suitable heater.

3. INSULATION OPTIONS

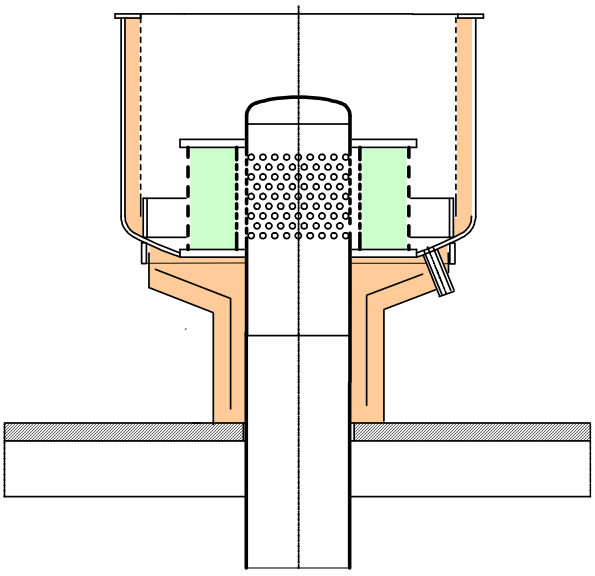
A suitably designed and implemented acoustic insulation of the blow-off pipe can reduce noise emissions by up to 20 – 30 dB. The optimal strength of the insulation depends mainly on the pipe diameter. In practice, a total thickness of 100 - 120 mm (4 – 5 inch) is usually sufficient; thicker layers rarely improve the noise reduction any further.

Our quotes will indicate whether the installation requires special insulation measures, and suggest a customised concept taking into account:

- **Silencer Design**: The noise attenuation requirements and the silencer design determine whether an extra insulation of the silencer shell is required.
- **Installation Conditions**: As outlined in Part VII – *Installation* of THE SILENCER HANDBOOK, vent silencers can be installed in various different ways. In either case, exposed blow-off pipes (for instance the section between the passage through the roof and the silencer) should be equipped with a sound-absorbing acoustic insulation. Besides reducing noise emissions from the blow-off pipe, this will help prevent rainwater from entering the building through the roof opening.
- **Thermal Expansion**: In many applications, both the silencers and blow-off pipe will be subjected to changing temperature. In such cases, the insulation must be designed to withstand both the occurring temperatures and the related thermal expansion movements.
- **Dewatering**: If the silencer is installed in a climatic zone where freezing may occur, the dewatering pipe should protrude only a few centimetres out of the insulation, or it should be connected to an in-house drain by a possibly short pipe arranged close to the insulation.

INSULATION OF EXPOSED BLOW-OFF PIPE

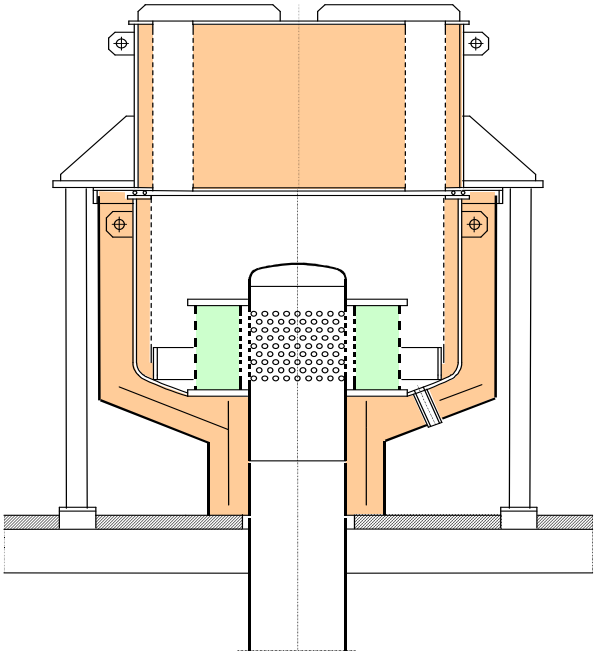
This basic insulation option covers only the exposed blow-off pipe:



External insulation of the blow-off pipe, installed between an eaves ring welded to the silencer shell and the roof

INTEGRATED INSULATION OF BLOW-OFF PIPE AND SILENCER SHELL

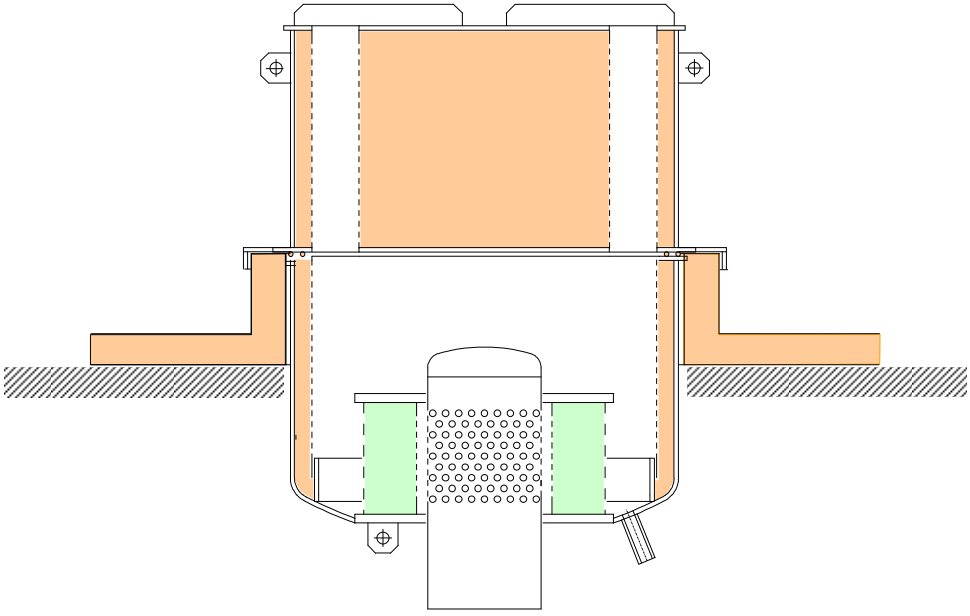
This design covers the entire external section of the blow-off installation, using a fully integrated external insulation of the external section of the blow-off pipe and the entire silencer shell exterior. This warrants a very high noise reduction.



Integrated external insulation of silencer shell and blow-off pipe, installed between a collar welded to the silencer shell and the roof

INSULATION OF A ROOF-INTEGRATED SILENCER INSTALLATION

This design has been specially developed for the insulation of a silencer integrated into a roof structure, providing outstanding noise reduction.



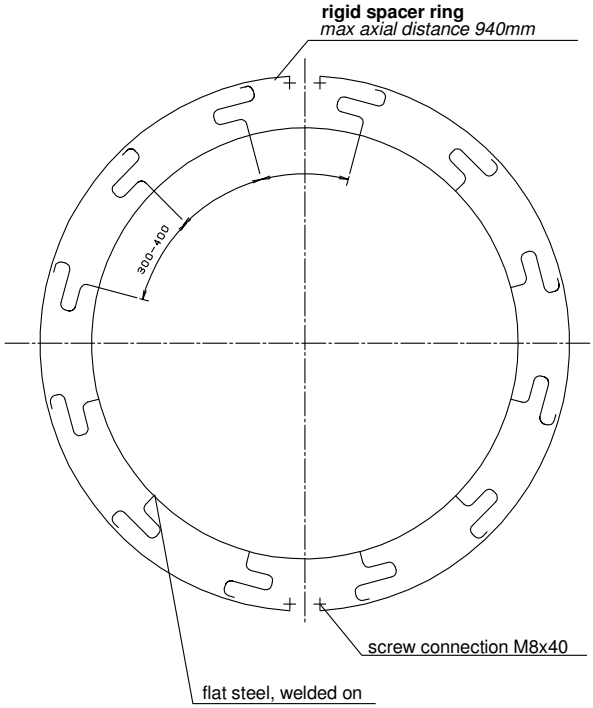
External insulation of the exposed section of a roof-integrated silencer shell, installed between a collar welded to the silencer shell and the roof

4. TECHNICAL SPECIFICATIONS

BASIC DESIGN

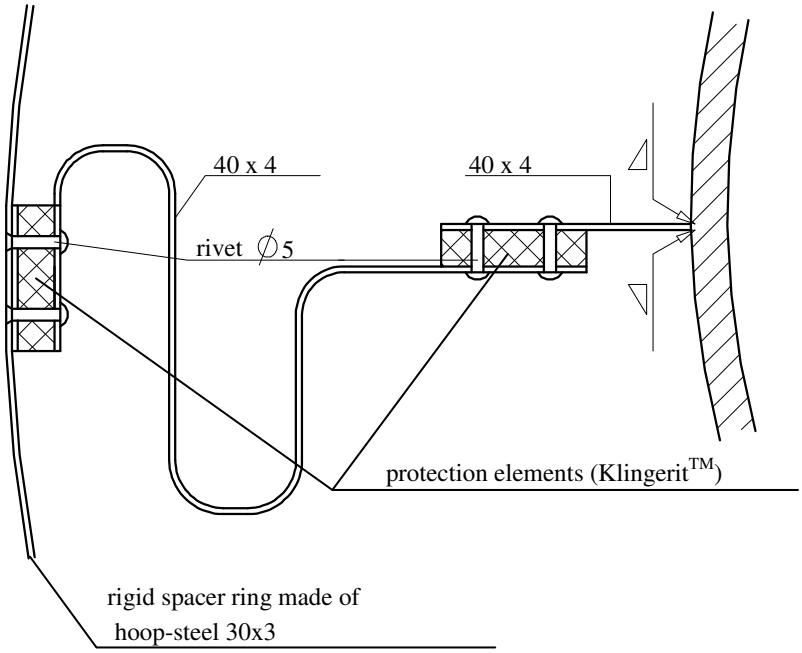
Suitable insulations consist of a robust combined steel / aluminium structure and highly durable mineral wool absorber mats. The entire cover is constructed so that no direct metallic contacts occur between steel and aluminium elements, giving the entire insulation an outstanding corrosion resistance and durability.

The insulation's substructure typically consists of rigid hoop-steel (30 x 3 mm²) spacer rings arranged at a maximum distance of 940 mm (37 inch) in axial direction. These are screwed or riveted to fixing clamps welded to the surface in regular angular intervals. For applications with operation temperatures exceeding 200°C (390°F), these clamps are S-shaped and thus capable of absorbing the full thermal expansion of the ducts.



Substructure layout of an external insulation, consisting of rigid spacer rings arranged in regular intervals along the axis of the insulated object, and connected to the pipe/shell by springy fixing clamps mounted on flat steel segments welded to the hull of the insulated object

The insulation layer itself consists of two layers of mineral wool, separated by an intermediate acoustic insulation layer. An external lining covering the entire insulation is fixed to the spacer rings or the clamps, with contact protection elements in between. This contact protection both prevents direct contact of steel and aluminium elements, and blocks the transmission of solid-borne vibrations and heat from the inner core (i.e. pipe or silencer shell) to the hull.



Layout of an S-shaped fixing clamp for high temperature applications

MATERIALS

Spacers and Support Structures: St 37.2 or an equivalent material

Insulating Materials: mineral wool mats with a minimum specific weight of 100 kg/m³, single-sided quilted on galvanized wire mesh.

NOTE: The used mats must be able to withstand long storage without change of quality. Mineral wool mats that have suffered a change of thickness because of moisture uptake or mechanical influences must not be installed.

Intermediate Layer: sound-deadened galvanised steel plates

NOTE: In cases where the insulation may be subjected to high temperatures, the sound absorbing layer may not consist of bitumen or similar substances

External Lining: seawater resistant aluminium sheet acc. to DIN 1745, both for external lining of a thermal insulation and combined thermo-acoustic insulation; typical materials include:

- AlMg3F23, half hard (*3.3535*)
- AlMgMnF23, half hard (*3.3527*)
- AlMgMnF23, half hard (*3.3528*)

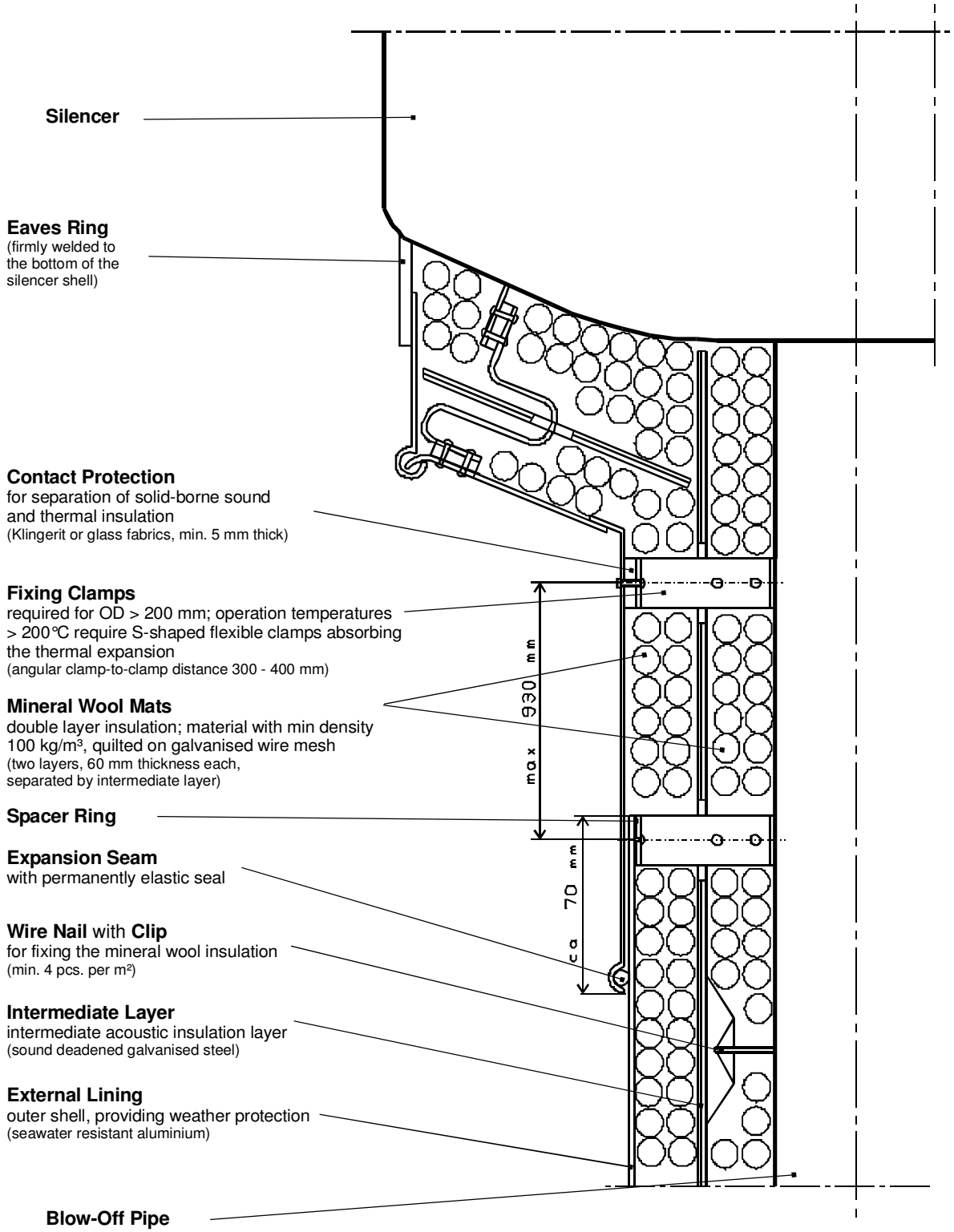
Sheet Metal Screws: thread-forming screws acc. to DIN 7513 and cylindrical sheet metal screws type B or BZ acc. to DIN 7971; both V2A (1.4300)

Contact Protection: Klingerit™ strips or glass fabrics, min. thickness 5 mm

INSTALLATION

The mineral wool mats must be cut to size and fixed firmly around the pipe / silencer shell using clips secured to wire nails (at least 4 per m²) welded onto the surface of the object to be insulated. Two 60 mm layers of the mineral wool are recommended, yielding an insulation thickness of 120 mm.

The external lining must be absolutely secured against slipping. To ensure expansibility, at least each second seam has to be formed as a stretch seam, and the aluminium sheets of the external lining must be overlapped as shown below:



Layout of a fully noise-decoupled double-layer thermo-acoustic insulation of a blow-off pipe between the roof surface and the silencer's eaves ring