

NOISE & VIBRATION DESIGN GUIDANCE
FLEXIBLE CONNECTIONS
(Prepared by Noise Control Engineering, Billerica, MA)

Introduction

The purpose of this document is to provide design guidance for flexible connections in piping, HVAC, exhaust, electrical and shafting systems.

General Requirements, Piping systems

Flexible hose shall be installed on all piping that crosses a resilient mount interface. Synthetic reinforced flexible hose should be used wherever system requirements and regulatory bodies permit. The intent is to use as compliant a hose as possible based on system constraints.

A single or double arch type flex hose should be used. To obtain freedom of motion in two planes, flexible hose shall be installed in a dog leg or right angle configuration. The free length (that length of hose unconstrained by clamps, fittings, nipples, spiggots, etc.) shall be at least equal to 18.0 cm plus 4 hose diameters for each leg. While dog leg configurations are preferred, single right angle hose configurations are permissible provided they are at least equal in length to the dog leg configuration and the hose manufacturer's minimum bend ratio is not exceeded.

Critical (low noise systems) flexible hose installations shall have a heavy rigid pipe hanger support at the equipment end of the configuration attached to the equipment sub-base. For those systems that do not require resilient pipe hangers, a similar support shall be attached to the opposite side of the hose and be firmly attached to a structural frame. Resilient supports are to be attached to frames and never plate structures.

The use of a single length of flex hose is permissible for gage lines and shall be in a 90 degree, U or Z configuration.

Where required by regulatory bodies, flex hose shall have fire protection sleaving. Loose fitting flexible add-on non-metallic sleaving is the preferred method. When and where solid sleaving is required, it shall be arranged in such a manner as to not impede the free motion of the equipment under ship slamming conditions and shall not provide the opportunity for a shorting path between the mounted equipment and ship structure.

All hoses should be at least one size larger than the piping to which they are connected in order to match the inside diameters as closely as possible.

General Requirements, HVAC Systems

Resiliently mounted elements within a ducted system shall be connected to non-resilient parts of the system by flexible duct connections. Ducts containing fans, whether resiliently mounted or not, should be flexibly connected to their associated duct work. These flexible connections shall, as a minimum have sufficient flexibility to allow full and free motion of the duct under all ship operating conditions. These connections should be non-metallic where system requirements allow.

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Rat guards, if required, should not impede the free motion of the flexible connections. Care should be taken in their design and installation to ensure there is no metal-to-metal contact during maximum excursion of the equipment under ship slamming conditions.

Where break-out noise (the escape of noise from within the duct into the noise-sensitive compartment) could adversely affect a compartment's airborne noise level, special attention to the design of the flex connection is required.

Flexible duct connections shall not be used to correct for misalignment. Duct work and resiliently mounted equipment shall be aligned within 3 mm per 25 mm of flexible duct length as a minimum.

General Requirements, Exhaust Systems

Resiliently mounted exhaust systems shall be connected to their prime movers and between various parts of the system with flexible metallic bellows connections, or if water cooled, with a suitable rubber hose connection. Metallic bellows shall be of small corrugations, extremely flexible type such as Lo-Corr by Flexonics, or equal. They shall be of sufficient length to allow free motion of all resiliently-mounted elements under all ship conditions.

Particular care shall be exercised in the location of the bellows and the resilient supports of the system and system design to prevent the imposing of undue loads and torques on the bellows pieces due to ship motion and thermal loads. The first flexible joint should be located at the exhaust flange. Insulation in the way of bellows pieces shall be prevented from filing or jamming the corrugations.

Exhaust systems should be mounted resiliently to rigid ship structure, not to plates between stiffeners. Care should be taken to ensure that the exhaust system does not resonate and that the proper hot & cold loads are placed on the mounts.

General Requirements, Electrical Systems

As with piping and ductwork, wiring to resiliently-mounted equipment must be arranged in such a manner as to not restrain the equipment under any ship's motion. Wiring shall run in a 90 degree or Z configuration with a minimum free length of 30 cm for outside diameters of up to 20mm, 60 cm for diameters from 20mm to 40mm and 1m for diameters greater than 40mm. At least 75mm of slack should be provided to allow for motion of the equipment under ship slamming.

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General Requirements, Shafting Systems

Selection of proper coupling is determined by load carried by the shaft, by the angular and parallel misalignment that must be anticipated, and by the variation in the axial separation between the two coupled shaft ends. Reasonable standards for shaft balance, alignment, and runout should be invoked. The engine/gearbox manufacturer should supply guidance on these limits.