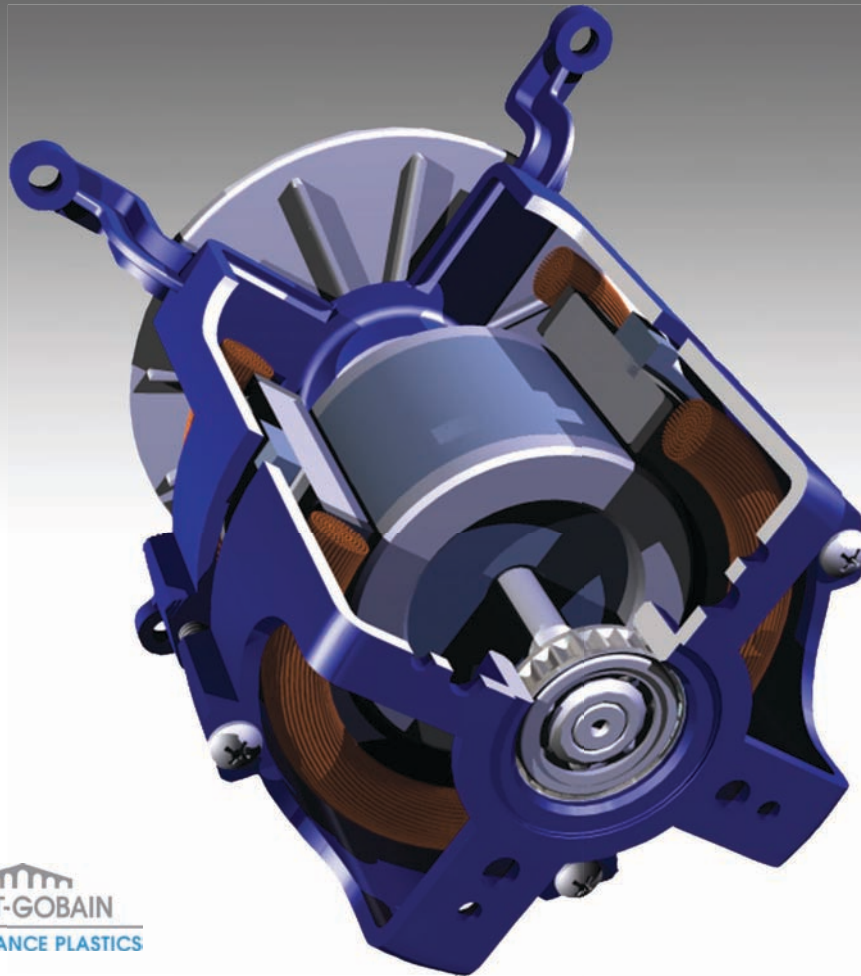


Message to Appliances:

Sssssh!  
**REDUCING Noise**  
**& Vibration in**  
 electric motors with tolerance rings



Stuart Kelly, Market Manager, Appliance and Electric Motors, Saint-Gobain Performance Plastics

One quick glance around a typical household reveals the ubiquity of fractional horsepower motors (FHPs). From refrigerators to vacuum cleaners, washing machines to coffee machines, low output electric motors drive the appliances that we use every day. Indeed, it is only in the automotive sector that FHPs are more commonly found.

Despite their varied uses and applications, the FHPs in homes share one common feature: the noise they create. The excessive motor vibrations produced by these appliances form an unwanted backdrop to domestic lives, potentially damaging health and creating irritating and disturbing noise pollution. This is no trifling matter: excessive noise and vibration have a proven negative impact on stress levels and

mood, as well as hearing. They place unnecessary strain on the body and mind. For example, the average vacuum cleaner produces volumes equivalent to a tractor at a 15 meter distance and has to be endured in a confined space, sometimes for prolonged periods – a potentially harmful 'noise dose'.

It is with this in mind that manufacturers of FHPs are increasingly focusing on compliance with noise, vibration and harshness (NVH) standards to ensure the health and safety of their customers. Alongside cost-competitiveness and efficiency, the reduction of NVH is one of the foremost concerns across all industries that utilise FHPs, presenting a real challenge to engineers.

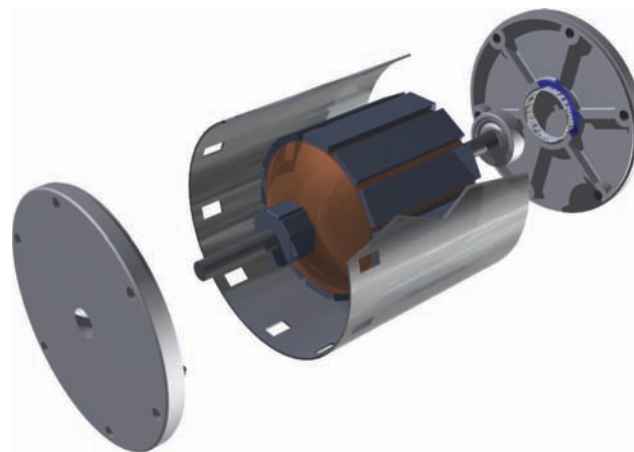
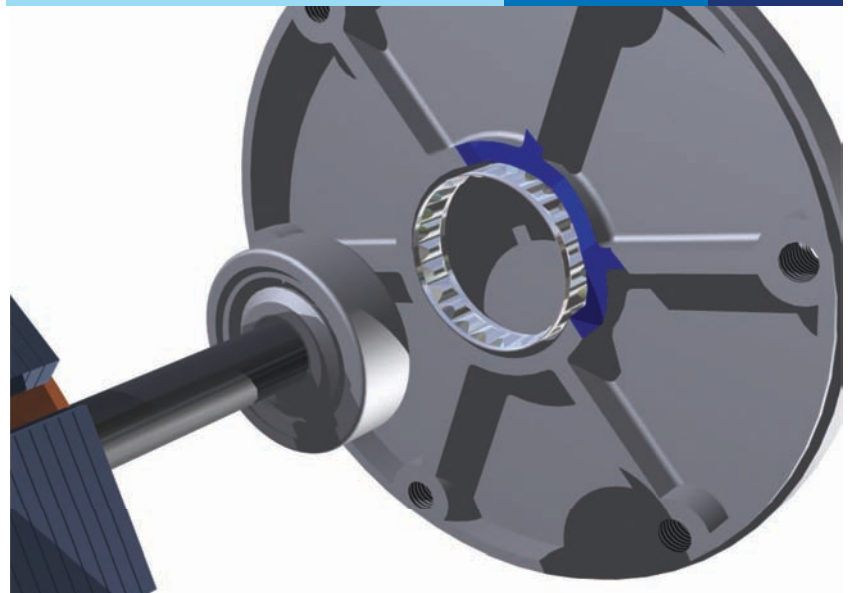
### Assessing the options

When looking to reduce NVH, a sensible and effective place for appliance engineers to start is with bearing mount solutions.

The bearing mount has a large impact on NVH in motorised applications that belies its small size. Manufacturers have three primary options when it comes to fixing a bearing in the correct position within FHP motors: press fit, adhesive solutions, or tolerance rings. All three options take a different approach toward noise and vibration reduction, with varying degrees of success.

Press fit and adhesive solutions, the most common bearing mounts found in FHP motors, are alike in their sole reliance upon stiffness and rigidity to fasten the bearing. Press fit, or interference fit as it is often referred to, literally presses the mating components together to create friction – so that one is interfering in the other's space. Adhesive mounting, normally seen as the cheap and easy option, uses unstable solvents to achieve the same join.

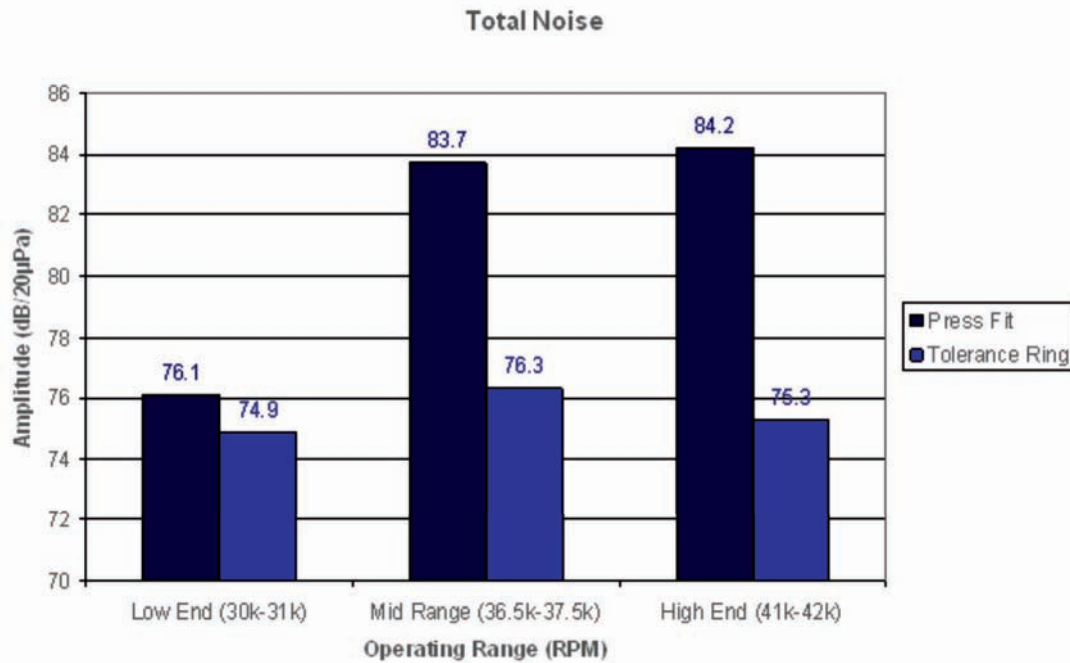
'Stiff' is a very appropriate adjective for both of these solutions – it describes both the nature of the join, and the inflexibility that undermines their effectiveness at NVH dampening. The stiffness of press fit and adhesive bearing mounts causes all vibrations from the motor to be passed through the assembly, without filtering of any sort. NVH levels, caused by energy in the system or misalignments, are not dampened. The result, in both cases, is a bearing mount that is unsuitable for modern requirements in



noise and vibration reduction. With adhesive and press fit, vibration causes energy wastage, unpleasant noise and increased wear – hastening the product's deterioration and deterring potential buyers. Additionally, both solutions require very precise tolerances in order to be fit for purpose, entailing an unnecessary machining cost during manufacturing.

### Tolerance rings provide a quieter way

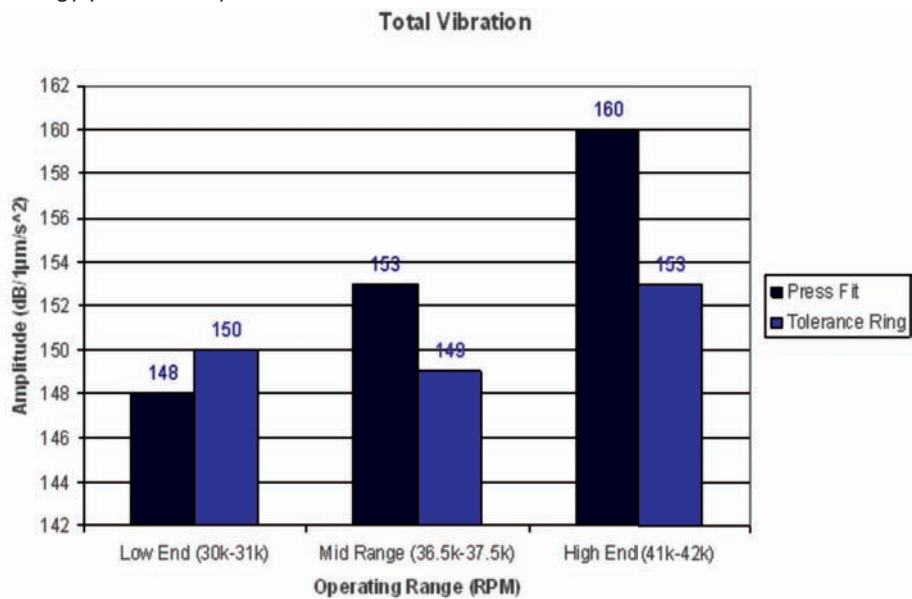
Tolerance rings take a different approach to the same engineering problem. Crucially, they affect both transmissibility and structure modification - two of the major ways to reduce noise and vibration. In a study comparing press fit bearing mounts with RENCOL® tolerance rings using the electric motor from a vacuum cleaner (turbine removed), tolerance rings consistently produced less total noise (75.3 dB at high end operating range compared to 84.2 dB for press fit mounts). Tolerance rings also performed better in regards to total vibration at all but low end operating ranges (153 dB at high end operating range compared to 160 dB for press fit).



In terms of transmissibility, tolerance rings are able to disrupt the path of vibration by acting as spring, thereby reducing transmissibility. To affect modification, engineers are able to alter and tailor the stiffness and dampening characteristics of the tolerance ring bearing mount within a FHP-powered application. Press fit and adhesive bearing mounts have poor transmissibility with very little damping.

Tolerance rings are high-quality steel, radially sprung, engineered fasteners that allow for an optimal joint between mating components. The key feature of a tolerance ring is the radial protrusions that run around its circumference, which effectively absorb more of the vibration energy produced by the FHP motor. By tackling the problem of vibration transfer between the bearing and product housing tolerance rings achieve significant noise reduction in motors of any speed, in terms of both peak and overall levels. Proven reductions in potentially harmful noise by the use of tolerance rings represents a real step forward in product quality, and hence consumer value.

The spring-like qualities of the ring, and the ability to perfect the thickness of material and geometry, allow manufacturers to alter the stiffness of the bearing mount to realise their optimum transmissibility ratio (ratios greater than one lead to amplification while ratios less than one conclude in effective isolation). Through this fine-tuning, manufacturers decrease the ratio of vibration output to input in the system. Equally, with the use of tolerance rings, product housing manufacturing tolerances can be relaxed for reduced manufacturing costs and motor and shaft bearing life increased. Unlike adhesive and press fit bearing, tolerance rings are specifically designed to limit the damage caused by excessive vibration.



The noise reduction and energy efficiency made possible by tolerance rings combine to create a unique selling point, especially for appliances incorporating AC (alternating current) and brush DC (direct current) motors, which have the biggest challenges with NVH. Increasingly, consumers of domestic appliances are basing their purchasing decisions on these environmental considerations. Particularly in the European Union, products are required to display technical information that specifies performance in energy efficiency and consumption, running costs and noise output - the most efficient products even carry the energy saving recommended logo. Tolerance rings can help manufacturers to achieve this sought-after status.

### Bearing the brunt

Whatever the domestic appliance, choosing the right bearing mount solution can pay rich dividends for those manufacturers who look to the finer details. As consumers pay more and more attention to the reduction of NVH, manufacturers must seek to confront a hazard the World Health Organisation has deemed the principal environmental nuisance in industrial nations.

Unlike alternative bearing mount solutions, tolerance rings are engineered to affect two of the principal sources of NVH: transmissibility and modification. Rather than having to accept the detrimental effects of excessive vibration and noise, home appliance manufacturers now have the option to tackle these health and safety issues head on, and meet the increasingly stringent demands of today's consumers.

### Sidebar: Exploring NVH

A quick review of NVH components and their negative effects:

Noise: Unwanted sound.

- Negative health effects
- Irritating

Vibration: The oscillating, reciprocating, or other periodic motion of a rigid or elastic body

- Wastes energy
- Creates noise
- Increases wear to static and moving parts

Harshness: Refers to treatments of transient frequencies or shock

- Premature failure of the assembly

### About the Author

Stuart Kelly is Market Manager for Appliances and Electric Motors for the Bearings and Tolerance Rings Business Unit of Saint-Gobain Performance Plastics, manufacturer of the RENCOL® line of tolerance rings and the NORGLIDE® line of bearings. He has a degree in HND Production Engineering from the University of West England and a Project Management Diploma from Lancaster University. He can be contacted at +44-117-9381700 or [stuart.kelly@saint-gobain.com](mailto:stuart.kelly@saint-gobain.com). For more information, please visit [www.bearings.saint-gobain.com](http://www.bearings.saint-gobain.com).

### Company information:

Saint-Gobain Performance Plastics is a global leader in the design, production and distribution of innovative, high performance materials. The Bearings and Tolerance Rings Group is a global division supplying high volume international Original Equipment Manufacturers (OEMs) in various markets including automotive, bicycles, solar and appliances.

Backed by a proud heritage of product innovation, technology, advanced materials and market leadership, the Bearings and Tolerance Rings Group are dedicated to using their extensive engineering expertise to deliver standard and custom solutions that meet the most demanding applications. Their innovative products include NORGLIDE® bearings, RENCOL® tolerance rings, SOLGLIDE® bearings, and NORSLIDE® cable liners. For further information please visit: [www.bearings.saint-gobain.com](http://www.bearings.saint-gobain.com)

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