FOR A QUIET LIFE... CALL THE EXPERTS

Richard Merhige, founder and president of AME, collects vibration data on a main engine foundation

Noise and vibration in a yacht's drive system are common problems that are best resolved during a refit. A good example of this occurred when a motor yacht with a composite plastics hull was undergoing an extensive refit and as part of the work the owners consulted Advanced Mechanical Enterprises (AME), of Fort Lauderdale, to address the vessel's history of severe noise and vibration.

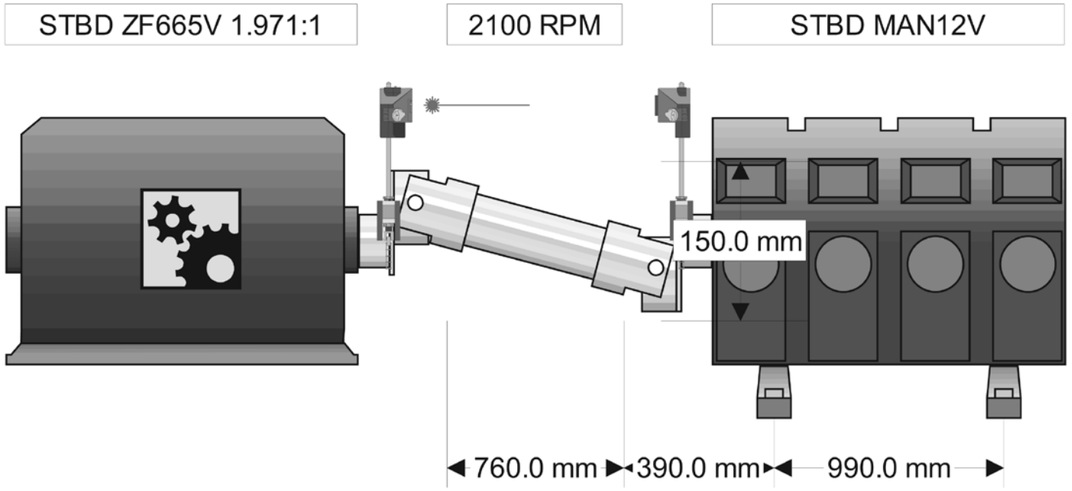
Vibration on yachts can have several causes, including uneven mount loading, flexible coupling problems, shaft misalignment and propeller issues. They can act independently of one another or in combination to make for a very uncomfortable trip at sea. The yacht in question, which is based in Washington DC, had been running in this condition for some time. In fact, according to the captain, the noise had become so bad that guests had sometimes taken to wearing ear defenders when in the saloon.

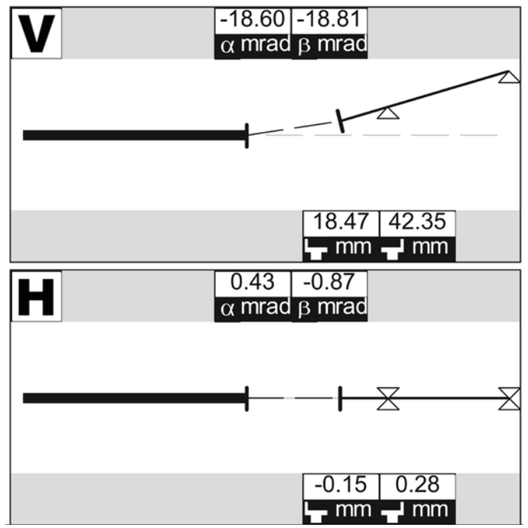
It was discovered that the vessel's considerable vibration was mainly due to poor shaft alignment and incorrect mount loading. The AME technicians, led by service manager Andy Lynskey, found that the gearbox was mounted on custom feet that provided insufficient support, and this resulted in mechanical looseness potentially causing misalignment under load due to the forces from the propeller.

If the gearbox is not sufficiently rigidly mounted, a lack of axial stiffness occurs that can cause excessive wear as a result of internal misalignment of the gearbox components. This condition can manifest itself as high gear tooth vibration – a very high-pitched whining sound. AME engineered new mounting feet which were sent for modification to a local affiliate engineering company as the work was beyond the capabilities of the yard where the vessel was being refitted. The feet were ultimately stiffened and their profile lowered to improve overall rigidity. The gearbox was then aligned to the stern tube using the Brunson Precision Optical Alignment Telescope, and the vessel was refloated to allow the shape of the hull to reset. The shaft alignment could then be confirmed using the Rotalign Ultra computerised laser alignment system. Once confirmed, the new mounts were secured in place with ChockFast Orange epoxy.

Next, the technicians focused their attention on the engine, in particular the GMB Cardan shafts (also known as a universal joint shafts). Contrary to popular belief, Cardan shafts do not simply fall into place and 'just take up' any misalignment. The alignment in both the vertical and horizontal planes is more critical than many realise. Cardan shaft tolerances are limited. Angles at either end should never be greater than 3.5 degrees and the differences in the angles should never be greater than 0.5 degrees between the two. Torsional equality must be maintained between the two joints or large-amplitude vibration will occur. However, the Cardan shaft angles must be at least one degree to allow for proper grease distribution within the joint for adequate lubrication. Laser alignment, using the state-of-the-art Rotalign Ultra system, ensures that the angles at each end of the shafts are the same. Both Cardan shafts were replaced with new ones and then laser-aligned. When the angles are not perfectly equal, vessels will experience a lot of noise and 'have the shakes', as did this yacht. Misaligned Cardan shafts result in both torsional and radial vibration, whereas proper alignment allows for vibration-free operation.

While the Cardan shafts were being sorted out, the engine was precision-aligned to the





The Rotalign Ultra computer displays a machinery graphic (above), while the result of the final laser alignment of the Cardan shafts in the horizontal and vertical planes is shown in the graphic on the left

All running gear components must be thoroughly inspected

gearbox with a computerised laser. This was done in conjunction with the replacement of the engine mounts with improved ones that provide more isolation, thereby increasing the stability of the engine while reducing vibration transmitted to the hull. These new Thrust Torque (TT) mounts by Dutch manufacturer Rubber Design were chosen with the help of the company's US distributor, Soundown, based on the mass and excitation vibration frequencies of the engine. They have a linear stiffness over a wide load range varying from compression (-) to extension (+), necessary to maintain the optimum isolation properties of the mass-spring system formed by the engine, gearbox and mountings. When the engine alignment was confirmed, ChockFast Orange epoxy was used to set the new mounts in place. High-tech vibration monitoring equipment was then used to sea-trial the vessel and record baseline data which can be used to diagnose any future problems.

In addition to the noise and vibration work, the yacht's comprehensive refit included extensive hydraulic replacements, exhaust modifications for the main engine and generators, and electrical and electronic modifications. Over the course of only 13 days AME technicians were able to drastically reduce noise and vibration while also improving performance and efficiency. The yacht is fully operational again, sailing around the north-eastern United States, and has picked up speed now that the engine doesn't have to overcome energy-sapping misalignment conditions. The most recent sea trial showed a 3 knot increase in speed, and the captain reports a significant reduction in noise and noticeably less vibration – thankfully, guests no longer have to wear ear defenders in the saloon. The captain has also scheduled a six month check-up on the vessel's drive-line to keep it in optimal shape – an arrangement that could benefit many other yachts.

'The logistics of the vessel's refit were challenging due to the rural location of the refit shipyard and limited availability of materials and vendors, but we overcame the space and time constraints and the results speak for themselves,' says Andy Lynskey.

An owner who is considering having a noise and vibration survey carried out should hire a company that has been in business for a good number of years and is preferably a referral. It should employ industry-certified engineers and technicians who obtain regular training to advance their skills and keep them abreast of developments, and it should be able to provide a history of positive results – any capable company will have a strong portfolio of final service reports from past jobs that detail findings, recommendations and results. It is also important to ask what equipment the company uses to perform technical services such as vibration analysis and laser and optical alignment. Does it use a laser bought from a local hardware store or is it a top-of-the-line, German-engineered product that is designed for the purpose of machinery alignment? Is the equipment routinely serviced and calibrated for optimal accuracy? Experience, education and quality equipment do not come cheap – if you receive a quotation that seems too good to be true, the chances are it probably is. For comprehensive, technical refits in particular, you will certainly get what you pay for.

The company should familiarise itself with the history of your yacht's noise and vibration, and ask questions such as: How long has the problem existed? Does it occur at only one speed or magnify as speed increases? Is it tied to another event such as a grounding? Has any service work recently been performed on the vessel? Depending on the answers, the technicians should recommend a sea trial so that further information, such as the frequency at which vibration occurs, can be gathered. This frequency can point to specific components such as shaft, propeller, gear teeth or an engine harmonic that could be the cause of the vibration.

After analysis of the data, recommendations can be made on how best to rectify the problems and the owner can be given estimates for repairs, along with the location of a suitable yard, if required. When work is completed and the sea trial shows favourable results, a periodic vibration survey is recommended to monitor machinery and catch defects before they cause unplanned downtime.

Using these parameters to select the right company for your refit will almost certainly provide excellent results.

Checks are made for machinery vibration being transmitted through the hull (left), and the Rotalign Ultra unit is fitted to a Cardan shaft (above)

The yacht's original engine mounts (above left) were replaced with Rubber Design TT3 mounts (left)