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HMCS *Provider* Vibration Problem

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Soon after she commissioned in 1963, HMCS *Provider* suffered from severe hull vibrations when underway at high propulsion powers.

Alan Grundy, the civilian vibration engineer in NDHQ, made arrangements to conduct forced shaker trials in, I believe, Halifax. A mechanical shaker machine was mounted aft on the quarterdeck and some sort of deflection/velocity/acceleration instruments were installed in various locations over the length of the ship to determine the nature of the hull response. The results were compared with the vibrations at sea, and it was determined that the hull was being excited in its first horizontal mode. Additionally, the frequency matched the blade propeller frequency as the shaft revolutions approached full power.

The investigation then moved to an examination of the four-bladed propeller and the ship's wake into it. That's where I became involved. Model tests showed that the wake was very non-uniform and turbulent due to the underwater shape of the after part of the hull. Rather than narrowing gradually toward the stern to allow smooth water flow, the hull transitioned abruptly from a full profile to its final narrow profile in a very short distance. Clearly, as each blade rotated in its circular travel, there was a large variation in the produced thrust because of the great variation in the wake speed entering the propeller's path at the different positions of the blade's rotation. Each blade was seeing a change in wake from a positive to a negative speed of wake entry! As memory serves, the top shaft revolution was about 110 rpm. That would mean a pulsing action from the propeller at a frequency of about 440 cpm from the four blades. It turned out that the propeller pulse frequency was in exact tune with the frequency of the first horizontal mode of the ship's hull as determined by the shaker trial.

Grundy and I discussed possible remedies (not solutions) with senior engineering staff, with the obvious fix being to change the number of blades on the propeller to de-tune the synchronous effect with the hull. After some preliminary analysis I recommended a seven-bladed propeller. More blades, however, would mean a reduction in the propeller rpm and thus an increased torque on the shafting for the same power output. Our gearing and shafting expert, Don Nicholson, confirmed this would not be a problem. The LIPS propeller works in Drunen, Netherlands reviewed our work and agreed that the best remedy would be to increase the number of blades, but recommended a six-bladed propeller. This was subsequently ordered and installed. The fix was successful in eliminating the severe hull vibrations.

During our investigations I discovered that *Provider* was originally intended to have a nuclear propulsion plant. When that was dropped in favour of a steam plant, the hull was not broad enough to accept it. Apparently, instead of lengthening the hull to provide a fuller space aft, the length was kept unchanged and the existing full lines were extended farther aft, resulting in the final abrupt narrowing. As noted, it was this abrupt transition that was the source of the non-streamlined, turbulent wake. When the lines drawing was obtained it was observed that it had never been signed off. No one knew who had approved the change in *Provider's* after hull shape.

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