



Noise, Vibration, and Harshness

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Background

Snowmobiles are very loud, unlike everyday passenger cars. This is because the exhaust systems for off-road vehicles are typically designed to maximize exhaust flow at the expense of muffling the noise. Also, noise from the engine, clutch, and track on snowmobiles is easy to hear, because body panels on snowmobiles are not very thick.

Introduction

The 2008 Noise, Vibration, and Harshness group is one of three sub-teams that worked on the University of Maine's Yamaha Phazer. The Phazer is a loud snowmobile, as far as snowmobiles go, because Yamaha designed it to be the ultimate budget performance sled. Unlike most sleds, the Phazer doesn't have a unified cowling or hood over the engine and drive train. Its body is just eight small plastic panels which snap together and clip onto the sled. These panels are thin and lightweight, which is good for snowmobile performance but offers little in the way of noise suppression.

Objective

The following were the team's primary objectives:

- Analyze stock Phazer to obtain baseline noise results
- Construct clutch cover as per CSC 2008 Rules
- Construct unified cowling pieces
- Line cowling and clutch cover with appropriate sound proofing
- Quiet exhaust noise while maintaining pleasing exhaust note
- Analyze modified Phazer to obtain new noise profile

Design

Testing – The stock Phazer was tested following the standard set in the SAE J192 test. In this test, the snowmobile is driven at full throttle for 150 feet, perpendicular to a sound meter located 50 feet away. The testing results showed an average noise level of 85dB, with 1000Hz as the peak frequency. The modified Phazer was tested following the same procedure in the same conditions and showed an average noise level of 72dB with 63Hz being the peak frequency.

Cowling – It was determined that the best way to suppress noise on the Phazer would be to replace the factory cowling pieces with larger, unified pieces. These larger pieces were constructed by modifying existing cowling pieces from a different Yamaha snowmobile as well as using composites to modify the larger pieces from the Phazer. The finished cowling pieces were lined with sound insulation consisting of two layers; one of vinyl and the other of open-celled foam.



Figure 1. 2007 Yamaha Phazer

Clutch Cover – A clutch cover was designed out of .090 inch aluminum and nylon belting, as specified in the SAE Clean Snowmobile Competition rules for 2008. The purpose of the cover is to contain the clutch in case of a catastrophic failure. A layer of sound insulation was applied to the inner surface of the clutch cover to help prevent reverberation and to block some of the clutch noise.

Exhaust – The original exhaust, while having a pleasing tone, was louder than necessary. As depicted in figure 3, the muffler was cut open and modified with fiberglass packing and additional muffling, all while keeping back pressure to a minimum. The exhaust outlet was directed downwards and fed into the tunnel in order to reduce the amount of noise allowed into the environment using surfaces in the tunnel to scatter the sound.



Figure 2. Clutch cover

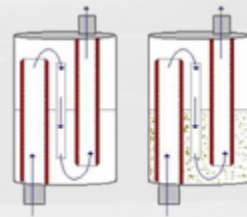


Figure 3. Muffler Diagram
Additional packing shown in yellow

Acoustic Material – Testing showed that the peak frequency of emitted noise from the snowmobile was 1000 Hz. To quiet the snowmobile, thin mass-loaded foam material was chosen because, according to in-house testing and manufacturer data, it performs the best at absorbing this frequency with the space constraints of the snowmobile. The specific material that was ordered is called Vcomp. Made by B-Quiet, Vcomp consists of open cell foam bonded to dense vinyl. When sound energy passes through this material, it is attenuated by the material's structure.

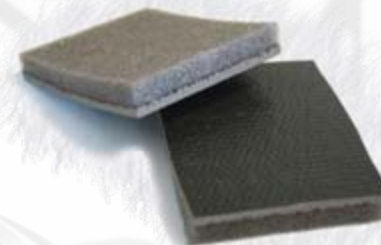


Figure 4. Vcomp

Results

- Test results of stock snowmobile: 85 dB at full throttle, 50 feet
- Aluminum/Nylon clutch cover fabricated and coated
- 1000 Hz identified as peak frequency in need of suppression
- Unified cowling constructed of composite material
- Sound proofing material applied to cowling
- Exhaust noise reduced while maintaining aggressive sound
- Noise Reduction from stock including engine control modifications: 10 dB

The Team



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