Gate Valve Acoustic and Vibration Test

Introduction

John Worden and I have developed a procedure for recording and archiving the vibration generated within the GNB gate valves when the gate is actuated. The intent of the measurement is two fold; to store the vibration spectrum of each gate valve as a reference indicator of wear in future LIGO operations and to establish if there is a rapid deterioration of the valves after an initial 50 cycles during the valve acceptance tests. We expect that the gatevalves are sufficiently different that a cross comparison between valves will only make sense once we have made measurements over a group of valves and established the statistics. The gatevalve 17 tested first has an unusually quiet mechanism.

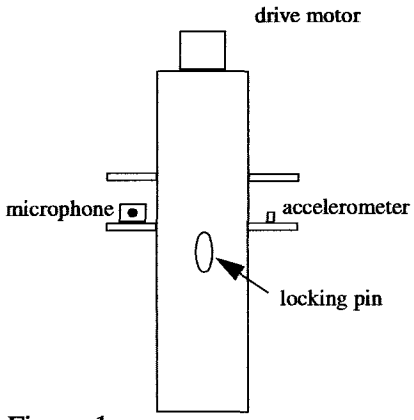

Figure 1

Technique

The valve was instrumented as shown in figure 1. A small Wilcoxon accelerometer with integral preamplifier and a Radio Shack VU meter are placed on the lowest stiffening ribs of the valve and held with doublesided sticky tape. The transducers are located 2 inches from the end of the rib on the side of the valve with the locking pin and about 1 inch from the main valve body. The accelerometer has a sensitivity of 10 volts/g and the VU meter was operated on the 80db setting giving 0.21 volts/dynes/cm^2 . The signals were recorded on a SONY model TCD-D7 dual channel digital tape recorder and then analyzed on an HP 35670A dynamic signal analyzer. Three spectra are taken: one of the ambient noise with the valve at rest, a second near the middle of the stroke while the gate is being lowered and a third when the gate is being raised. The spectrum analyser is set at 10 averages, a Hanning window, with the frequency range set between 1 Hz to 1.6 kHz. The input is ac coupled and with the low side of the input grounded. The spectra are written onto a floppy disk in ASCII and DOS format for easy transfer to computer storage. An alternative procedure would be to record the spectra directly on the HP dynamic signal analyzer without using the tape recorder.

Results

The first valve measured was GV 17 located at the beam tube termination in the y arm end station. The valve was so quiet in its operation that the microphone could not distinguish the motion above the ambient noise in the room even with the air conditioning turned off. The motion of the gate was clearly measurable by the accelerometer and stood well above the ambient acceleration background at the valve over much of the band between 1 Hz to 1kHz. Figure 2 shows the ambient acceleration and the acceleration during the up and down strokes. Figure 3 compares the spectra of the first and 51st cycle of the valve on a down stroke while Figure 4 compares the spectra for an up stroke. Although there is a measurable difference in the spectra at a few frequencies on the up stroke, the change (in our opinion) is not considered significant.

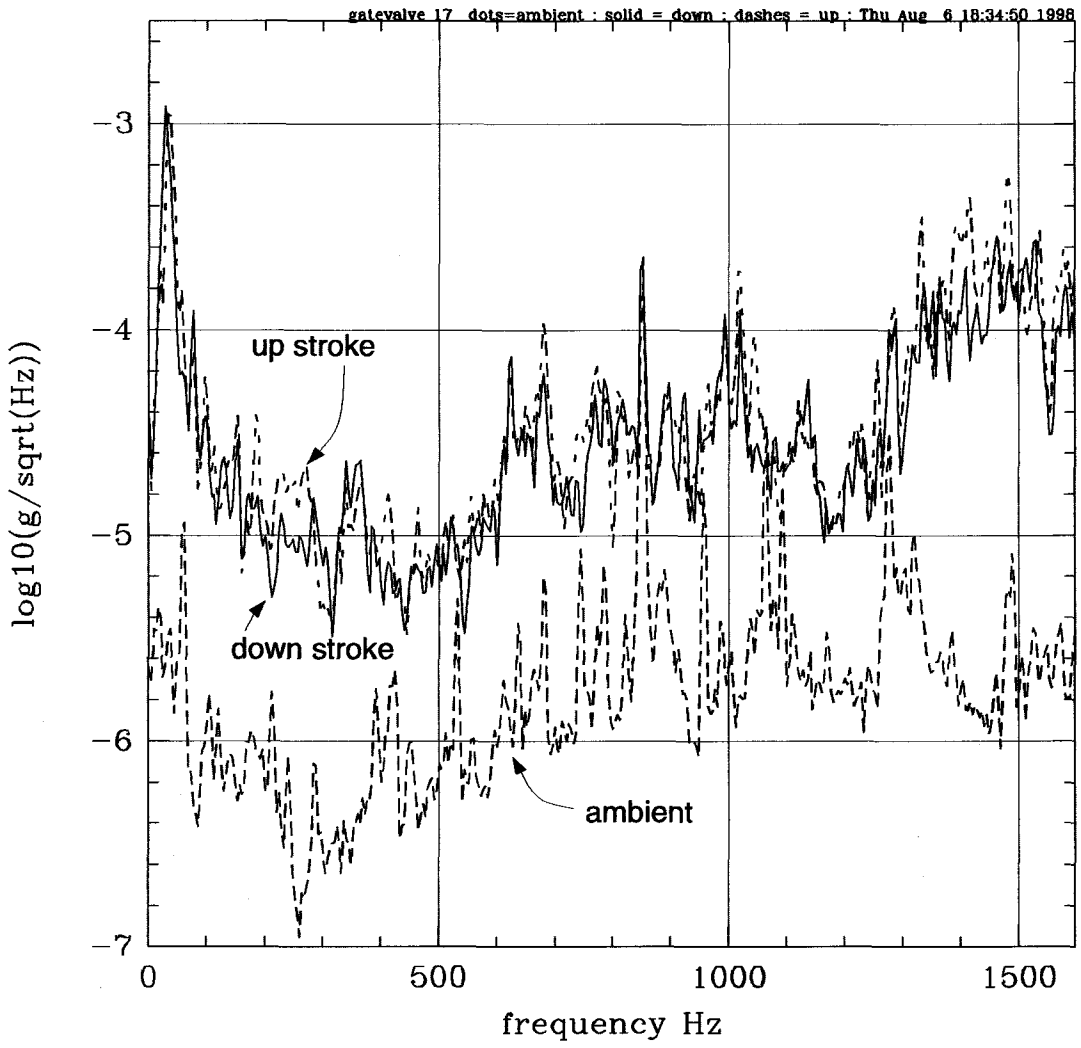

Figure 2 Accelerometer spectra from Gatevalve 17 before multiple cycling. The curve labelled ambient is the acceleration spectrum on the valve without motion of the gate.

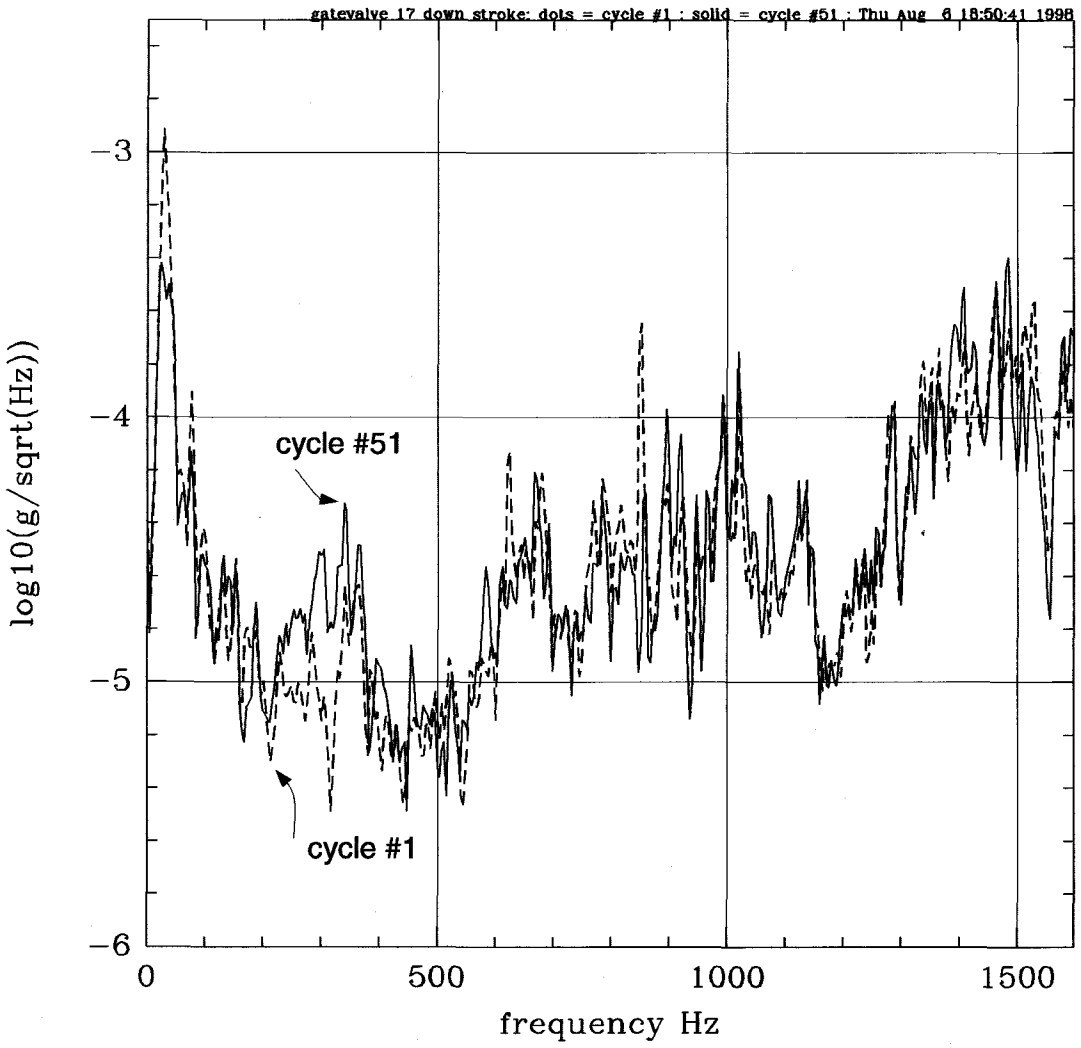

Figure 3 Acceleration spectra at the first and 51st cycle down stroke . The change in the spectrum is within the statistics of the gatevalve noise at different parts of the down stroke.

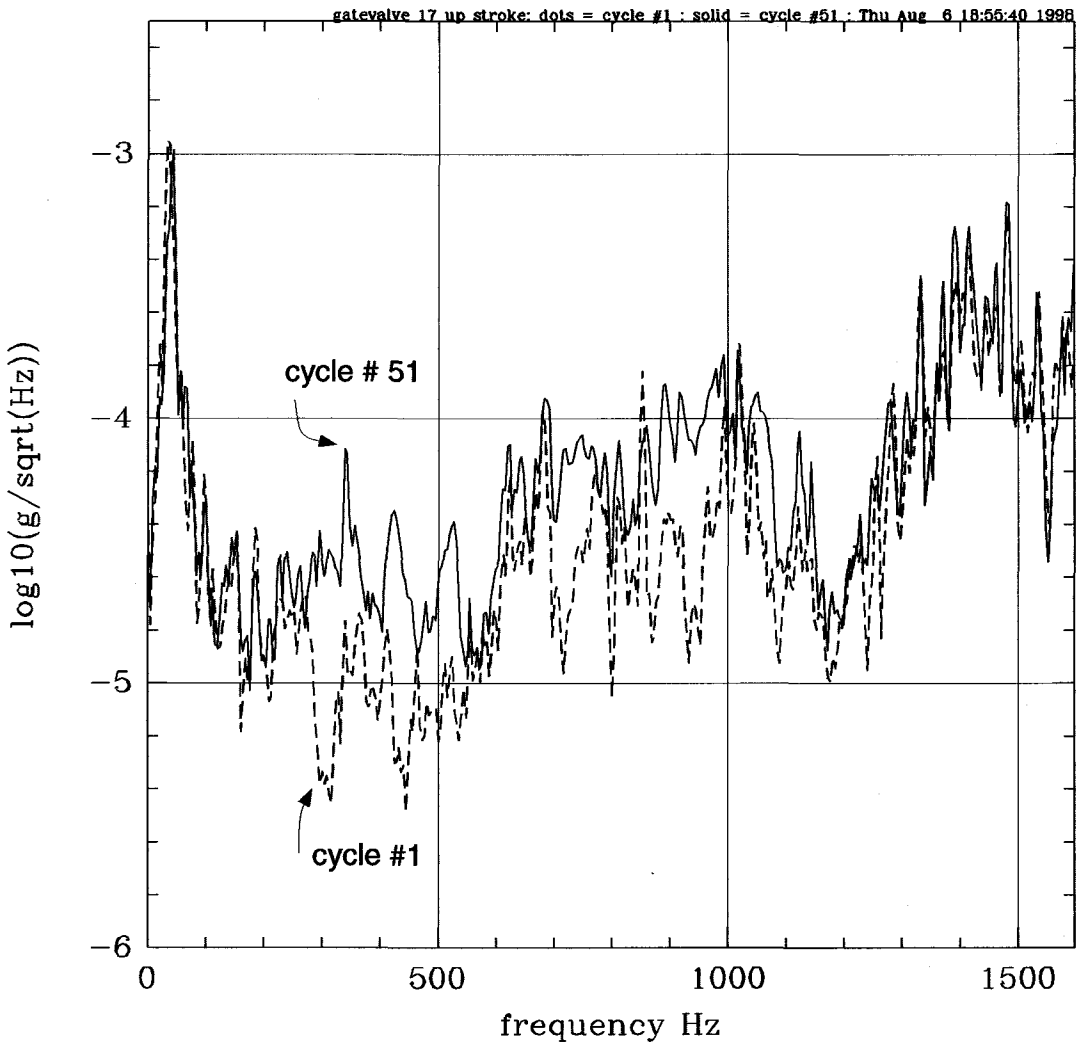

Figure 4 Gatevalve 17 acceleration spectra on the up stroke of the first and 51st cycle. The increase in the noise is larger than the statistics associated with different parts of the upstroke, however, the increase in the noise is not considered significant.