

**LASER INTERFEROMETER GRAVITATIONAL WAVE
OBSERVATORY**

- LIGO -

**CALIFORNIA INSTITUTE OF TECHNOLOGY
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Hydrostatic testing results of bellows for the HEPI actuator
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A test arrangement was designed to measure the slightest yielding of the bellows at any location. A total of six bellows were tested with water and nitrogen. Three were made with 304 SS and three of 17-7 PH. The bellows were welded to two flanges simulating the respective actuator parts. These plates were held apart with spacers at the correct spacing. This assembly was filled with water and placed in an enclosed container which was 95% filled with water. This was done for thermal stability and to increase the sensitivity of the test. A very sensitive pressure gauge, 0 to 40 inches of water, was connected to the chamber. As the pressure was increased inside the bellows, it expanded, thus displacing the volume in the chamber and increased the external pressure which was read on the gauge. The 304 SS bellows were tested in increments of 20 PSI and the 17-7 PH bellows were tested in increments of 50 PSI.

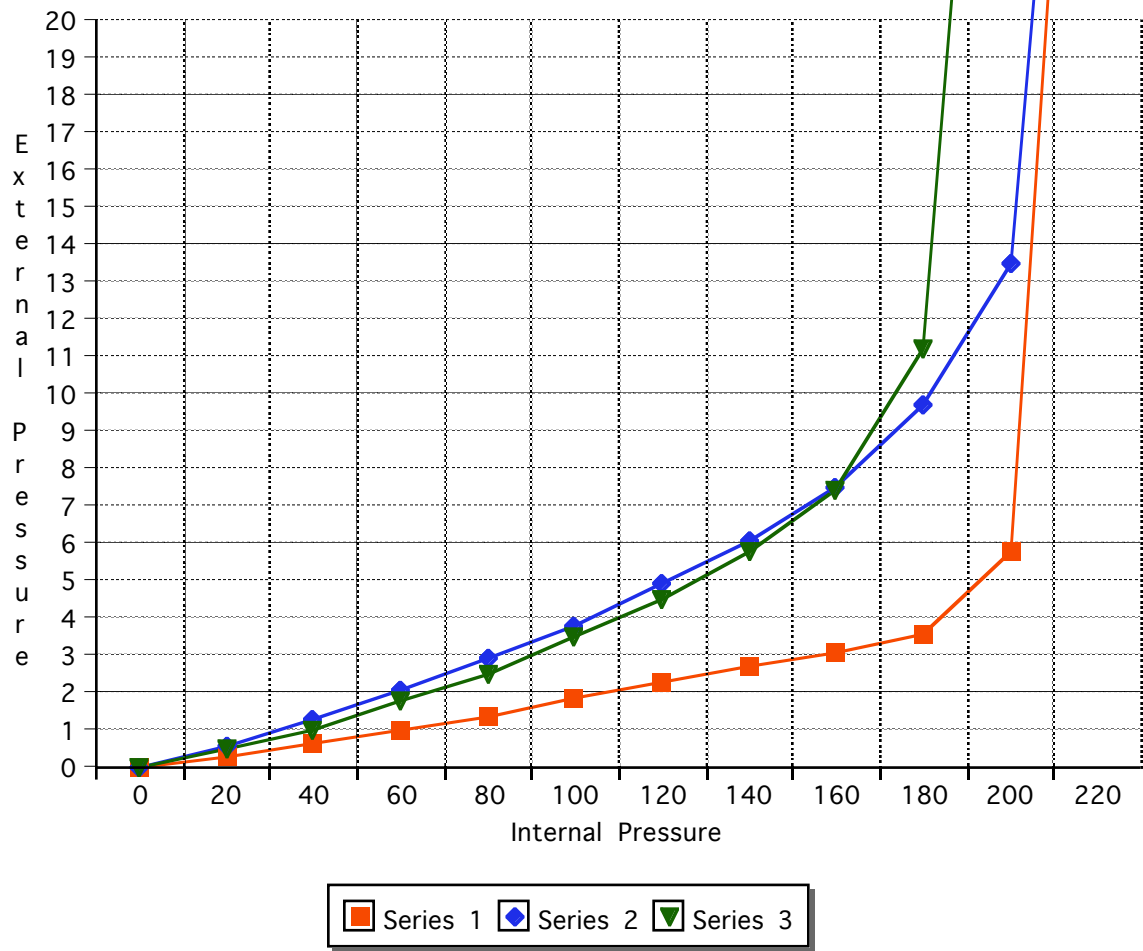
Here are some notes on the Heat treating of the 17-7 PH bellows at Ameriflex. *The bellows were taken to 1400 F for 90 minutes and then cooled to 0 C for 30 min. At this point they were returned to Ameriflex upon which a final set was done. Then the bellows were brought to a temperature of 1050 F for 90 minutes then cooled to room temperature. This completes the heat treating. This procedure is referred to as TH-1050. The hardness after heat treating to TH-1050 is RC 38 to 44 which brings the tensile yield to 170,000. Ameriflex used the TH-1050 heat treat opposed to other hardnesses because of their past experience with another product they manufacture.*

There are other heat treat schedules that will result in a higher yield strength. See the following link. <http://www.sousacorp.com/material.htm>

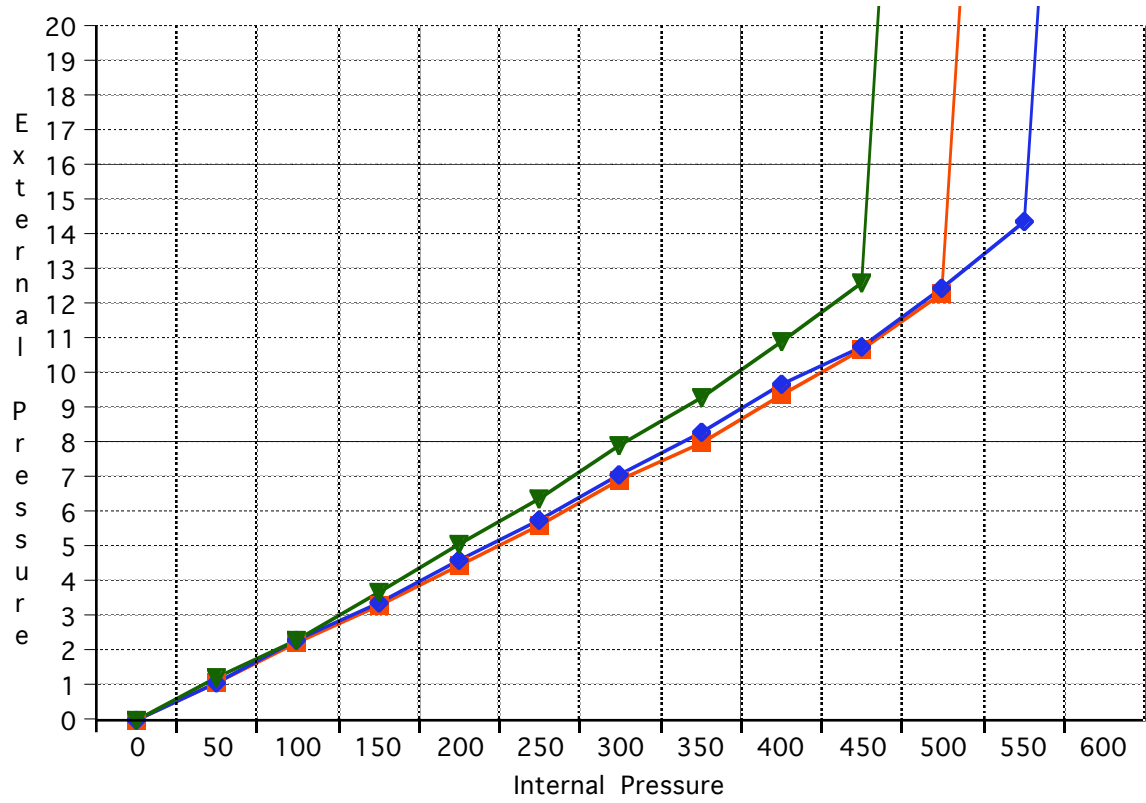
NOTE: The actual value of the external pressure relative to the internal pressure is different for each test. This is because of the different amount of water in the chamber for each test. It was very sensitive to the remaining volume of air and no matter how accurate it was filled to, there seemed to be a slight difference.

Following are the results of the test.

304 SS Bellows Pressure Test



17-7 PH SS Bellows Pressure Test



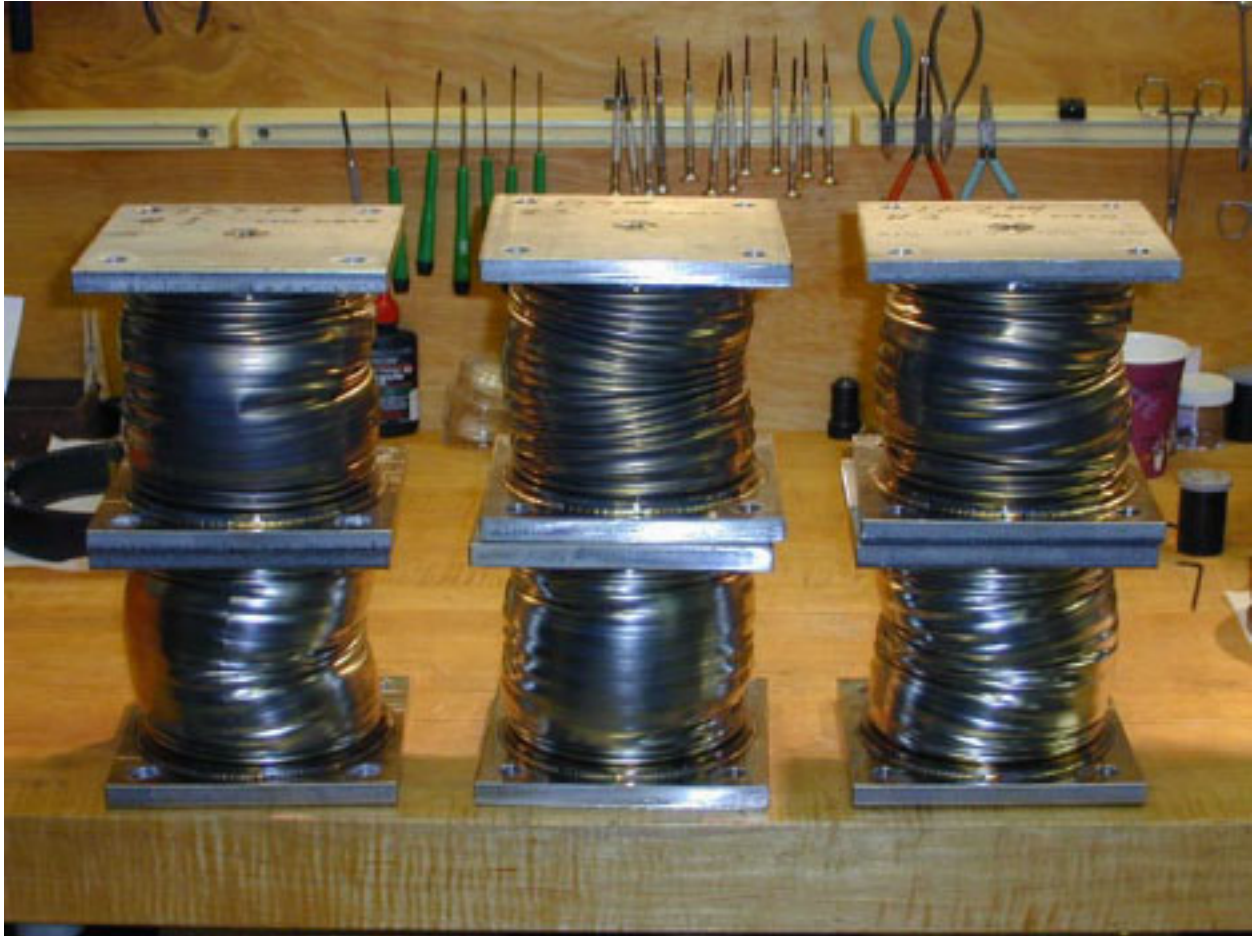
Series 1 Series 2 Series 3



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The bottom bellows are 304 SS and the top bellows are 17-7 PH.