Acoustic Test on Satellites

At Present, there are almost 1,500 active satellites in orbit around our planet. We rely so much on satellites for many things in our lives, and we count on them to be durable and reliable. When satellites don't work properly, it can severely impact our lives. That's why it's so necessary to test each satellite properly before it gets launched into space. A satellite's working life is not easy. First, it must survive the extreme vibrations and acoustic levels of the launch. Then, as it quietly circles the earth doing its job, it has to operate in very harsh conditions. It must function in an almost complete vacuum, while handling high levels of electro-magnetic radiation and large fluctuation in temperatures. It's vital to test satellites properly. Governments or private companies that spend millions or even billions (dollars) a year on satellite technology need to know their investments will not evaporate because the satellite failed during / following launch.

When satellites are launched into space they are subjected to very high mechanical, thermal, electromagnetic and acoustic forces that may cause damage to electronic circuits, as well as to other components, thus jeopardizing their functioning. Satellites therefore undergo extensive stress tests before any space mission starts. To test their acoustic durability, satellites are often placed in a reverberant acoustic test facility (RATF), where they are subjected to extremely high sound pressure levels – the sound intensity and frequency range applied in this 'torture chamber' simulate real-world launch conditions.

The full satellite acoustic test is an important milestone in a satellite launch survivability verification campaign. The test is required to verify the satellite's mechanical design against the high-level acoustic loads induced by the launch vehicle during the atmospheric flight. During the test, the satellite is subjected to a broadband diffuse acoustic field reproducing the sound pressure loads during the launch. The test is commonly performed in a large reverberation room ensuring a uniform sound field around the satellite. The noise excitation is provided by low-frequency electro pneumatic airstream modulators or horns, complemented with additional noise generators for the higher frequencies. Automatic control systems provide an accurate and robust control of the reverberant sound field over a wide frequency range. The control systems generally consists of third octave PI (Proportional Integral) feedback controllers. The drive output of the control system is shaped at every control step based on the error between the target spectrum and the averaged spectrum measured from several control microphones inside the room. The tests last anywhere between 30 seconds and 120 seconds depending on whether it is a characterisation or acceptance test.

Strain gauges and accelerometers mounted in pre-specified locations record the response of the satellite during the acoustic test. The data is processed and the performance is checked either against design or with data from earlier tests to clear the satellite for launch.

Acoustic tests are mandatory for the satellites before the integration into the launch vehicle since it encompasses vibration tests and cannot be replaced by computational simulations.

References

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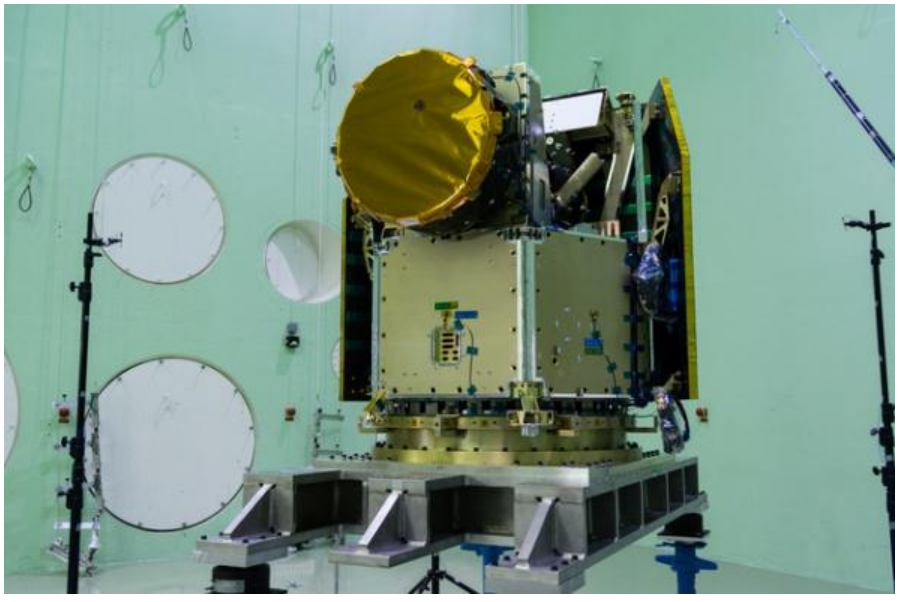
ISRO GSAT19 on Acoustic testing



The CHEOPS spacecraft on a ground support structure inside the Large European Acoustic Facility