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LIFE (Living Interplanetary Flight Experiment)
Experiment Module Passes Vibration and Impact Tests

A special report by Planetary Society Member Mark Gelfand

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Planetary Society member and LIFE donor Mark Gelfand recently attended the vibration and impact tests of the Phobos LIFE capsule in central California.

The vibration test is designed to mimic conditions during the launch, and the impact test replicates the landing impact when the capsule returns to Earth. The studies ensure that even under extreme conditions the module will remain whole and the organisms will remain sealed in their bio-capsules.

Here he reports on what he saw….

The LIFE module
credit: Bruce Betts/The Planetary Society

Any component lofted into space must pass a stress test. Not just any kind of stress, but specified levels of vibration, shock, vacuum, temperature, or whatever is appropriate for the mission.

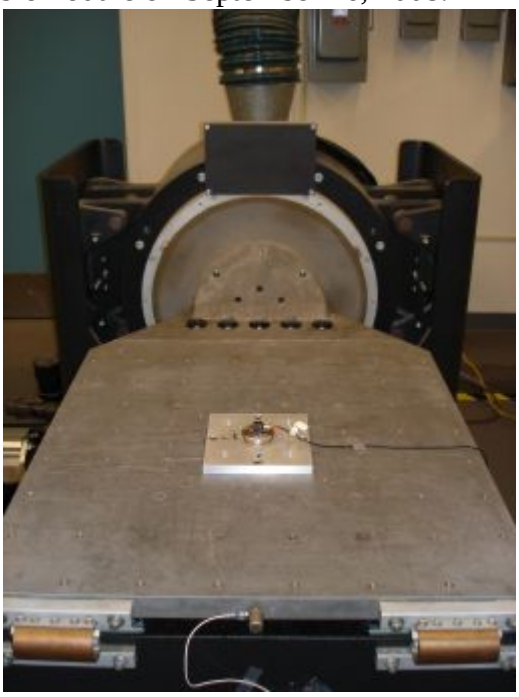
The Phobos Grunt mission planners in Russia had specified that our fragile LIFE module pass what originally seemed to be impossibly high vibration and shock tests. The test parameters corresponded to worst-case scenarios that could potentially occur during the launch phase and when landing on Earth.

The entire fate of our project depended on passing these tests.

So with some trepidation, I arrived at Stellar Exploration Inc. in San Luis Obispo, California. There I met some of the LIFE team members: Stellar founder Tomas Svitek and his engineers Chris Biddy and Brian Riskas; and Bud Fraze, LIFE's design consultant and wizard conjurer.

No longer were we looking at engineering drawings or physical mock-ups. Here was the real deal.

The LIFE module on the shake table at Cal Poly San Luis Obispo used for vibration testing of the Phobos LIFE biomodule on September 16, 2008.



The table essentially uses a large stereo speaker in the circular area at the back of this image to vibrate the table on a layer of oil using a pre-programmed vibration profile.
Credit: Bruce Betts/The Planetary Society

Bud carefully filled each of the 31 sample bio-capsules with a fluorescent test liquid, welding each shut with a homebrewed thermal welder. This created an extra level of caution – and test hurdle to clear – since the actual samples used in the real experiment will be dry. One by one, he placed the sealed capsules into a black Delrin carrier base, completing the titanium case assembly with shock pads, indium seal, Kapton tape, cleats, and safety wire.

Everything was designed and machined to fit perfectly. Bud, a veteran of U.S. space projects since the 1970s, had exploited his deep toolbox of “lessons learned”. During the course of the LIFE project, requirements were always changing, and problems were constantly exposed. The challenges were great, but summarily dealt with. Simple solutions usually proved better than over-engineering.

Time for the shake test, conducted in a lab at nearby Cal Poly (California Polytechnic University San Luis Obispo), and for more trepidation as we bolted our module onto a large vibration bed. A huge voice coil powerfully vibrated the module at frequencies to 1100 Hz, one dimension (X, Y, and Z) at a time. With earphones blocking out the table's roar, we silently watched our LIFE module undergo incredible shaking.

Afterwards, back in Stellar Exploration's lab, we waited nervously as Bud opened the module and shined in a UV black light. Voila! No glow from the test liquid filling the bio-capsules. They didn't leak. LIFE had passed the shake test.

The next day, back at Stellar's facilities, it was time for the shock test. Could LIFE survive an impact at the required 4000 *G*?

A projectile used in Phobos LIFE biomodule impact tests
This was fired from an air cannon to simulate potential impact during Earth landing. The Phobos LIFE biomodule (test article) is the titanium cylindrical object on the left end of the projectile.
Credit: Bruce Betts/The Planetary Society

Chris and Brian operated the air cannon, shooting a projectile of rolled-up corkboard and duct tape into a foam target. There was our LIFE module, riding at the tip of the projectile, smashing head-on into the target.

Lots of experimentation went into ensuring that the projectile would travel at more than 150 ft/sec into the target, with a stopping distance in the foam that would precisely achieve the required shock deceleration.

Pow! Smash! LIFE took the blow.

But the projectile velocity was just a bit slow. So a decision was made to refine a new projectile, and try again with the same biomodule.

Pow! Smash! LIFE blasted into the target again.

How could anything survive this punishment?

Tension showed on everyone's face as Bud opened the module, again illuminated the bio-capsules with black light, and – miracle of miracles – the capsules survived intact!

LIFE's amazing structural resiliency was proven.

Now it's time to prepare for the next steps: loading four identical LIFE modules with the internationally-selected extremophiles and Russian tundra soil, and then delivering the flight module to the Phobos Grunt project in Russia.

Like you, I can hardly wait.

Group picture of participants in Phobos LIFE final vibration and impact tests, September 17, 2008
The air cannon used for impact tests in foreground, and target in center. Back row (l. to r.): Andrea Carroll, Micah Gelfand, Evan Gelfand, Mark Gelfand, Chris Biddy, Charles Haycock, Tomas Svitek, Bruce Betts. Front row (l. to r.): Brian Riskas, Bud Fraze.
Credit: The Planetary Society