

Invest your money wisely
Subscribe

NewScientist “ I don't know what I would talk about in the pub without New Scientist! ”
Tom Wells, New Scientist subscriber

Subscribe to New Scientist Save over 70%



Space





Login

[Home](#) [News](#) [In-Depth Articles](#) [Blog](#) [Opinion](#) [Video](#) [Galleries](#) [Topic Guides](#) [Last Word](#) [E-Newsletter](#) [Subscribe](#) [Look for Science Jobs](#)

[SPACE](#) [TECH](#) [ENVIRONMENT](#) [HEALTH](#) [LIFE](#) [PHYSICS&MATH](#) [SCIENCE IN SOCIETY](#)

[Home](#) | [Space](#) | [Tech](#) | [News](#)

NASA's lunar impactor loses most of its fuel

Updated 21:35 26 August 2009 by [Rachel Courtland](#)
For similar stories, visit the [Solar System](#) and [Spaceflight](#) Topic Guides

NASA's moon-colliding probe LCROSS lost more than half its propellant late last week after a glitch caused it to repeatedly fire its thrusters to try to orient itself. But the spacecraft is still on track to complete its mission to slam into the moon's south pole in October.

The [Lunar CRater Observation and Sensing Satellite](#) (LCROSS) took off on 18 June and has been orbiting the Earth at about the moon's distance in preparation for a lunar collision on 9 October. NASA hopes the impact will excavate material from one of the moon's permanently shadowed craters, which could be rich in water that could supply future [lunar outposts](#) 🚀.

Mission managers made contact with the spacecraft on Saturday to conduct a 'cold-side bake'. This manoeuvre flips the spacecraft to allow the sun to heat up and vaporise any residual water on the 2400-kilogram upper stage of LCROSS's launch rocket, which will be sent crashing into the moon four minutes before the LCROSS spacecraft itself.

When the team made contact with the spacecraft, they discovered it had lost 140 kg of hydrazine propellant in the 20 previous hours, when the spacecraft was not in contact with Earth. The spacecraft's tank originally held 306 kg of fuel; 50 kg remain.

"It was pretty apparent that the thrusters had been firing for quite a bit," says LCROSS project manager Daniel Andrews of NASA's Ames Research Center in Moffett Field, California.

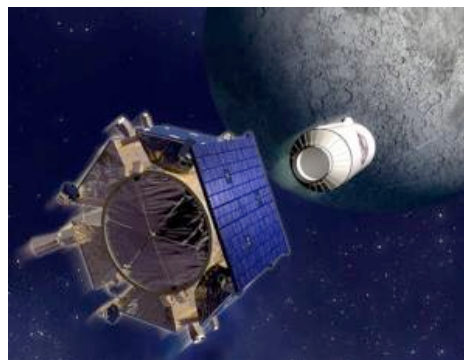
Noisy data

The fuel was lost after a fault in one of the spacecraft's data lines caused a change in the probe's control system. It switched from the craft's Inertial Reference Unit (IRU), which uses spinning gyroscopes used to gauge the spacecraft's orientation, to a less precise star tracker, which orients the probe by observing the position of stars.

The spacecraft made an effort keep up with these noisier star tracker data, causing it to rapidly burn through fuel to keep up with the heavily fluctuating numbers.

The switch was triggered by a change in an indicator used to monitor the health of the IRU. The fault, which lasted just one second, may have been a passing glitch. But mission operators have not been able to eliminate the possibility that there is a problem with the IRU."We're not 100 per cent

PRINT SEND SHARE



A glitch caused NASA's water-hunting LCROSS mission to lose more than half its fuel, but the spacecraft is still on track to collide with the moon (Illustration: NASA)

[Enlarge image](#)

ADVERTISEMENT

Look Who's Recruiting!
NewScientist Jobs

More [Latest news](#)

One partner stumbles in lunar probe pas de deux



18:50 01 September 2009
The first attempt to search for water ice on the moon

This week's issue

Subscribe



29 August 2009

ADVERTISEMENT

NewScientist
CALENDAR
2010
COMPETITION
a photographic competition from New Scientist

convinced that it isn't a sign the IRU is about to fail," Andrews says.

If the unit does fail, LCROSS can fall back on the star tracker for orientation information. The team is working on re-tuning the spacecraft so it does not respond as attentively to information from the unit.

The spacecraft has also been reprogrammed to switch from the IRU to the star tracker only if problematic signals last for at least five seconds, a change that should cut down on LCROSS's sensitivity to fleeting glitches.

Extra fuel

Despite the heavy fuel loss, LCROSS is still on track to conduct its water ice search. "It turns out we didn't need anywhere near that 300 [kilograms] to complete the mission. We just filled it up in case we had a bad day," Andrews told *New Scientist*.

LCROSS still has more fuel than the mission requires – about 10 to 20 kg extra, Andrews says. The exact cushion depends on how many other activities, such as turns to look at Earth, LCROSS will conduct before the collision.

Because the spacecraft is already on a ballistic trajectory to the moon, it should still be able to intersect the moon without using up any additional propellant. The remaining fuel is needed to trim the spacecraft's trajectory so that it hits the surface at the right place.

The team is expected to announce LCROSS's target crater about a month before impact.

If you would like to **reuse any content** from New Scientist, either in print or online, please [contact the syndication](#) department first for permission. New Scientist does not own rights to photos, but there are a [variety of licensing options](#) available for use of articles and graphics we own the copyright to.

Have your say

Comment title

Your name

Email

Website

Comment

[read all 14 comments](#)

Comments 1 | 2

Hydrazine Is Toxic

Wed Aug 26 18:38:32 BST 2009 by [egghead](#)

I sure hope they are planning on jettisoning the entire propulsion system, fuel lines and all, before impacting potential water-ice sources. Otherwise, they have eliminated the use of any water-ice found by contaminating it with hydrazine. I hope the scientists at NASA thought of this and are not banking on there being more pockets of water-ice, if



using two spacecraft flying in tandem has failed, and there will be no second chances, as one probe has since died

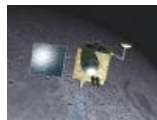
Best visions of the night sky



15:08 01 September 2009
Star trails, horse heads and shadowy moons, captured by stargazers across the world vying for the title of Astronomy

Photographer of the Year

India's first lunar probe fails after less than a year



20:16 31 August 2009
For as-yet-unknown reasons, the Chandrayaan-1 probe has lost radio contact with Earth less than 10 months after entering into orbit around the moon

California fire threatens historic observatory



17:21 31 August 2009

The 'Station Fire' that doubled in size overnight has not reached the summit of Mount Wilson, home to telescopes once used by Edwin Hubble, but the area is still at risk

[see all related stories](#)

Partners

We are partnered with Approved Index. Visit the site to get free quotes from [website designers](#) and a range of web, IT and marketing services in the UK.

Most read Most commented

[English is toughest European language to read](#)

[Winners wear red: How colour twists your mind](#)

[Tevatron tightens up the race for the Higgs](#)

[Microscopes zoom in on molecules at last](#)

[Why future astronauts may be sent to 'gravity holes'](#)

TWITTER

New Scientist is on Twitter



Get the latest from New Scientist: sign up to our Twitter feed

there are any at all.

[reply](#) [report this comment](#)

Hydrazine Is Toxic

Wed Aug 26 21:08:21 BST 2009 by **Troy H.**

It should be pretty apparent that they are trying to find a single source of water to prove that other sources probably exist in other locations.

Aside from that, they will have to aim at a fairly large permanently shaded region to be sure that they hit it, so any hydrazine that would be left would be minimal compared to the size of the area containing water. We are only talking about 50L of this stuff, most of which will be used positioning the spacecraft for the impact (so call it 10-20L). The hydrazine will dissipate quickly in a vacuum, which won't give it much chance to spread over the surface.

Finally, the entire spacecraft isn't crashing into the moon. It is sending an impactor, which probably won't contain any fuel.

[reply](#) [report this comment](#)

Hydrazine Is Toxic

Wed Aug 26 22:52:15 BST 2009 by **A Geologist**
<http://spaceflightnow.com/cross/090810bakeout/>

Yeah, as far as I can tell from other websites and this story, the fuel is contained on the LCROSS unit, which is tugging a (theoretically) empty Centaur rocket nose cone.

What worries me is that NASA left the probe out of contact for 20 hours this close to it's mission. Surely any probe at this stage should be treated like a new born baby and constantly monitored?

[reply](#) [report this comment](#)

Hydrazine Is Toxic

Fri Aug 28 00:29:36 BST 2009 by **anonymous**

"Finally, the entire spacecraft isn't crashing into the moon. It is sending an impactor, which probably won't contain any fuel."

That's not true. It is going to detach from the empty Centaur booster before the latter impacts, so that the LCROSS spacecraft itself can observe the plume at close range...then it ALSO impacts. The timing is to be arranged so that its sister craft LRO is nearby, orbiting over the impact site, watching both.

[reply](#) [report this comment](#)

[view thread](#)

So Whats Happening In October?

Wed Aug 26 23:49:29 BST 2009 by **Sleekmason**

The moon is going to get hit with an impactor in October. You guys crack me up. I was under the impression that we had pictures of ice on the moon. Are you going to make me go look for them? And impacts. . . The moon has had many, many impacts far stronger than a probe. Any water dispersed would have turned to ice on the surface, eventually evaporating. This story should go with the "laser reflectors" story(the story about laser reflectors mounted on the moon, so we can shoot lasers and measure the distance. Pretty cool how we thought so far ahead eh? Must be a pretty quick tracking system to hone in on a 2X2 square with no error. I guess Transits can't do the job anymore. Any construction worker will tell you that manual transits are far more accurate than their laser counterparts, approx. 1/8" for manual and 3/8" for laser over a 100 meter span. What a joke.) Oh well, doesn't really matter. I just don't see the point. Some other poster will undoubtedly spew the same drivel they always do when a poster points out truth. Find some other tact, as I am not paranoid (the favorite accusation), nor crazy, nor high, nor give a rats ass, as the true implications are that we are being protected. I'm just tired of the BS. So, Whats hitting the moon again? Why?

[reply](#) [report this comment](#)

This comment breached our [terms of use](#) and has been removed.

This comment breached our [terms of use](#) and has been removed.

This comment breached our [terms of use](#) and has been removed.

[view thread](#)

So Whats Happening In October?

Fri Aug 28 03:45:29 BST 2009 by **Dann**

"the story about laser reflectors mounted on the moon, so we can shoot lasers and measure the distance. Pretty cool how we thought so far ahead eh? Must be a pretty quick tracking system to hone in on a 2X2 square with no error..."

The idea of placing the first reflector on the moon *was* planning ahead. It only took five years or so before it was put to use.

A laser beam fired from earth will be around 6.5km wide by the time it reaches the moon, since there's no such thing as a perfectly parallel photon beam. That improves your odds of hitting a reflector

of any size considerably.

[reply](#) [report this comment](#)

[view thread](#)

140kg Cost - \$7m To Get There

Thu Aug 27 03:49:11 BST 2009 by **Marty**

"It turns out we didn't need anywhere near that 300 [kilograms] to complete the mission. We just filled it up in case we had a bad day,"

There are some figures around that say it costs around \$50000 to get 1 kilogram of payload to lunar orbit. (\$10000 to low earth orbit). So that lost 140kg cost \$7M in lost freight cost. I guess it is all contingency, and was already paid for the most part. But it is interesting that they effectively needed to pay \$7M insurance to cover the 1 second internal communications error, and not-as-well-fine-tuned-as-it-could-have-been attitude control system.

But that's cost of bleeding edge I guess.

[reply](#) [report this comment](#)

140kg Cost - \$7m To Get There

Fri Aug 28 06:07:40 BST 2009 by **AG**

ULA is not UPS, or \$ 7 Million in Hydrazine Insurance

NASA's Press Kit for the LRO / LCROSS mission reports the following relevant statistics:

LRO had a mass of 1,916 kg at launch

LRO project life cost is approximately \$500 million

LCROSS had a mass of 891 kg at launch, of which 306 kg is hydrazine; this doesn't include the bonus 2,366 kg mass of the empty Centaur upper stage.

LCROSS project cost is \$79 million plus.

The average cost to deliver a payload to lunar orbit may be on the order of magnitude of \$50,000 a kg, the incremental cost to launch an extra kilogram into lunar orbit is absolutely not \$50,000. The first kg has a hypothetical \$100,000,000 cost for the Atlas V (401) launch vehicle and related services, the next 2,806 kg are free, each additional kg does not cost extra until the mass of the mission exceeds the capacity of the chosen launch vehicle. Each kg less does not save any money unless the mass drops so much that a less capable launch vehicle is suitable. The smallest Atlas V 401 is likely the only launch vehicle that could accomplish this mission, the next smaller vehicle, the Delta II 792XH-10 has less than half the capability. Unless the mission's mass is more than halved, mass reduction saves no money.

Spacecraft mass is budgeted to the gram.

Hydrazine is a relatively common industrial chemical; it has an order of magnitude cost of \$25.00 per kg so an extra 140 kg would cost \$3,500.00, or approximately 1/20,000 of the LCROSS mission cost, this is cheap insurance. Mission planners, analysts, engineers,

and NASA likely spent much more on meetings deciding how much fuel mass to budget.

This is still a bone headed mistake that could have easily cost the mission and should have been planned for, a few software subroutines could have effectively stopped it from ever happening.

[reply](#) [report this comment](#)

140kg Cost - \$7m To Get There
Fri Aug 28 13:12:40 BST 2009 by **Kabe**

A most insightful post, thank you AG.

[reply](#) [report this comment](#)

[view thread](#)

[read all 14 comments](#)

Comments 1 | 2

All comments should respect the [New Scientist House Rules](#). If you think a particular comment breaks these rules then please use the "Report" link in that comment to report it to us.

If you are having a technical problem posting a comment, please [contact technical support](#).

[Back to top](#)

[Login for full access](#) [Login](#)

About us

- [New Scientist](#)
- [Advertise](#)
- [Recruitment](#)
- [Advertising](#)
- [Syndication](#)
- [Who's who](#)
- [RBI Jobs](#)

User Help

- [Contact Us](#)
- [FAQ / Help](#)
- [Disclaimer](#)
- [Ts & Cs](#)
- [Cookies](#)
- [Privacy Policy](#)

Subscriptions

- [Subscribe](#)
- [Renew](#)
- [Gift subscription](#)
- [My account](#)
- [Back issues](#)
- [Customer Service](#)

Links

- [Site Map](#)
- [Browse all articles](#)
- [Magazine archive](#)
- [NewScientistJobs](#)
- [The LastWord](#)
- [E-Newsletter](#)
- [RSS Feeds](#)

© Copyright Reed Business Information Ltd.