

**Science and Instrumentation at
Los Alamos National Laboratory**

**Testing to Assure
NASA Mission Success**

TEACHER GUIDE

BACKGROUND INFORMATION

Testing to Assure NASA Mission Success is a ten-minute educational video that illustrates the need for testing onboard instruments prior to a spacecraft launch. The Genesis spacecraft launched in August 2001 on a mission to collect and return minute samples of solar wind. Onboard the Genesis spacecraft, there are three instruments from the Los Alamos National Laboratory in Los Alamos, New Mexico: the ion and electron monitors, and the solar wind concentrator. The video program takes the viewer inside the laboratory where scientists analyze the effects of launch vibrations, extreme variations in temperature, and potential micrometeoroid impact on the Genesis spacecraft instrumentation while in the harsh environment of space. The video is suitable for public and educational audiences. This teacher guide and accompanying student activity are appropriate for middle and high school students and aligned to the *National Science Education Standards*.



Los Alamos National Laboratory

The Genesis Instrument Team at Los Alamos National Laboratory

These educational materials are intended to supplement the video for classroom use. This teacher guide accompanies the Genesis mission video, *Testing to Assure NASA Mission Success: A Look Inside Los Alamos National Laboratory*, which is available on the Genesis mission Web site, on VHS, and on CD-ROM with accompanying teaching materials. The learning strategies shown here focus on engaging the students before, during, and after the video. The video is 10 minutes in length. If you engage the students with the strategies listed here, the total experience may take about 45 minutes.

NATIONAL SCIENCE STANDARDS ADDRESSED
(Source - *National Science Education Standards*)

Grades 5-8

[Science as Inquiry](#)

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

[Physical Science](#)

- Properties and changes of properties in matter
- Transfer of energy

[Science and Technology](#)

- Understandings about science and technology

[Science in Personal and Social Perspectives](#)

- Science and technology in society

[History and Nature of Science](#)

- Science as a human endeavor

**Grades 9-12**[Science as Inquiry](#)

Abilities necessary to do scientific inquiry
Understandings about scientific inquiry

[Physical Science](#)

Structure and properties of matter

[Science and Technology](#)

Understandings about science and technology

[History and Nature of Science](#)

Science as a human endeavor

MATERIALS

For the class:

- Video: *Testing to Assure NASA Mission Success: A Look Inside Los Alamos National Laboratory*
- Computer with projector or television with video cassette recorder

For each group of two or three students:

- Butcher paper

For each student

- Student Activity, "[Testing to Assure NASA Mission Success](#)"
- Copies of the Roger Wiens [Interview](#)

PROCEDURE

1. Begin the class by asking the students to work in small groups. Distribute a sheet of butcher paper to each group. Ask students to think about examples or items that are part of consumer product testing. Ask them to write down each item noting the type of testing that is completed. Provide some examples using the teaching tip below.
2. Next, ask students to think about the question that was being asked for that particular test. Have them write the question down on the butcher paper. Provide some examples using the teaching tip below as a starting point.

Teaching Tip

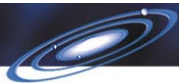
Provide some examples of consumer product testing for procedures one and two. Here are some starters:

Consumer product test: Testing the absorbency of different brands of paper towels
Question: Which brand of paper towel absorbs the most water?

Consumer product test: Testing how long batteries last
Question: Which brand of nine-volt battery lasts the longest?

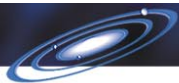
Consumer product test: Finding the optimum amount of laundry detergent needed to removing stains
Question: What is the optimum amount of laundry detergent needed to remove grass stains?

Consumer product test: Finding out how long sun lotion lasts
Question: How long does sun lotion last before it needs to be reapplied?



3. Have each group share some of the examples listed on their butcher paper. Once each group has had an opportunity to share, explain that different kinds of questions suggest different kinds of scientific investigations. Ask students what all of these examples have in common.
4. Next, ask students for examples of how mathematics would be used to quantify any of the results from these tests.
5. Distribute the [student activity](#) sheet to each student in the class. Explain that they will be viewing a short video that shows examples of scientists testing instruments similar to those used on NASA's Genesis spacecraft. As they view the video, have the students list the item being tested on the left-hand side of the chart. Tell the class not to fill in the rest of the chart until after they view the video.
6. Play the video *Testing to Assure NASA Mission Success: A Look Inside Los Alamos National Laboratory*.
7. Review the first column titled "Item Being Tested" with the class. Student responses should include the instrument grid, monitors, concentrator grid, and concentrator.
8. Replay the video; this time instruct students to look at how each item is being tested, and why it is being tested. Have students complete the second and third columns on the chart. You may want students to work in groups on this part of the video.
9. Have students or members of each group share some of their responses. Use the following chart as an aid to this review.

Item Being Tested	How the Item is Tested	Why is the Item Tested?
Instrument Grid	The grid was shot with a gun. The bullet hole was examined.	To simulate the damage of a micrometeoroid in space impacting the instrument grid, and the extent of the damage.
Electrostatic Monitors: Genesis Electron Monitor (GEM), Genesis Ion Monitor (GIM)	Vibration Test: The monitors were subjected to a large amount of acoustic energy to shake the monitors.	To simulate the large amount of vibration that occurs during the launch of the Delta II rocket with the Genesis spacecraft. The test ensures that the instrument can survive the shock of launch (ground to orbit).
Concentrator Grid	The grid is dipped into liquid nitrogen. At a temperature of very cold temperature (-197 degree Celsius).	The difference in temperature from room temperature to liquid nitrogen is the same as from the sunlit and dark surfaces of an object in space. The scientists wanted to make sure that the grid wires did not shrink or become damaged during the large temperature differences in space.
Concentrator	It was tested with computer software to simulate the particles entering the concentrator and finding out where they end up.	Since this is the first time a solar wind concentrator has been used for a NASA mission, and it is impossible to simulate solar wind in the laboratory, computer software was used to model the ion trajectories.



10. Review the second and third columns with the students. Remember the above chart represents possible responses. Student responses will vary.
11. Have students work in groups to answer the questions on the second and third pages of the student activity sheet. Close the class by reviewing these questions:
 - a) Read the Roger Wiens interview (<http://www.genesismission.org/people/Wiens/indexWiens.html>). What is his educational and professional background? (e.g. academic, interests, motivation)? (Information on Roger's background and interests are found in his response to the question, "What kind of education and career path led you to become a scientist?")
 - b) Describe some of the team members at Los Alamos National Laboratory that have worked on these tests for Genesis instrumentation. (Some of this information can be found in Roger's response to the question, "What is your everyday work life like?")
 - c) Read about the Los Alamos National Laboratory at <http://www.lanl.gov/worldview/organization/>. Write a description of the laboratory based on this text. (Students should include the main ideas provided in the background. (including Department of Energy (DOE) laboratory managed by the University of California, etc.)

The testing that occurred on these instruments varied based on the types of instruments that were going to be used. Since the ion and electron monitors have flown on other missions, all of the testing that was done was completed on a preflight model. Since this is the first time that the concentrator has been used in a mission, three models were built and tested. First a prototype concentrator was built and placed into a vacuum chamber to test and to verify that the electronics performed properly. Next the engineering model was built and subjected to the environmental conditions of space, using a vibration chamber and a thermal vacuum chamber. Finally, the flight model was built that was integrated with the Genesis spacecraft.

- d) What might have happened if the scientists at Los Alamos National Laboratory had gone to a flight model for the concentrator rather than the prototype and engineering models? (By testing the concentrator in stages, scientists could determine early on if there was a problem with the instrument itself or the instrument in the conditions of space. If the scientists went straight to the flight model, and had a problem, they would be uncertain if the problem was with the instrument or the environmental conditions. Also, if the flight model was damaged during the testing, this would impact the entire mission.)
- e) How is technology being used to assist with the tests? (For the concentrator grid tests, the grid wires are analyzed under a scanning electron microscope. Using this very highly powered microscope allows scientists to detect even small changes that may have occurred as a result of the tests. Vacuum chamber and computer simulations were used to simulate solar wind interacting with the concentrator.)
- f) Explain how these instruments are being used to either collect solar wind or monitor the regime of solar wind. (On the video, students heard that Los Alamos is responsible for three instruments: the ion spectrometer, the electron spectrometer sometimes called the monitors, because they are checking the solar wind in real time, and also the solar wind concentrator, which is a brand new kind of instrument.) See also: <http://www.genesismission.org/mission/craft/index.html> This Web page will locate and give you a visual of these instruments on the spacecraft. Then see: http://www.genesismission.org/educate/scimodule/CollProcess/CollProcess_pdf/ConcentratorST.pdf This file is a student text about the Genesis solar wind concentrator.
- g) What will these solar wind samples returned by Genesis tell us about our solar system? (See Roger's interview response to the question, "What new science understanding will the Genesis mission provide? Why is this important?" and from the video we heard that Genesis is scheduled to bring back pieces of the sun. Scientists will learn about the elements that were present at the time our solar system formed.)
- h) What questions do you still have about testing instruments that are used in space exploration? (Questions will vary. Encourage students to e-mail these questions to [contact us](mailto:contact@genesismission.org).)

URLs

<http://www.consumerreports.com>

Click on A to Z index for consumer product testing reports by Consumer Reports



http://www.genesismission.org/educate/scimodule/CollProcess/CollProcess_pdf/ConcentratorST.pdf

Student text on the Genesis Solar Wind Concentrator

<http://www.genesismission.org/mission/craft/index.html>

Location of these instruments on the spacecraft

<http://www.genesismission.org/people/Wiens/indexWiens.html>

Roger Wiens interview

<http://www.lanl.gov/worldview/organization/>

Background information about Los Alamos National Laboratory