Orbiter
January 2015

Countdown to Launch: The Launch Verification Matrix

by Lindsay Chaney
January 29, 2015

The Orbiter is publishing a series of articles that follow one launch through its preparation to when it lifts its payload to orbit. The payload, GPS IIF-9, is set to launch in March on a Delta IV launch vehicle. This article explains Aerospace's Launch Verification Matrix.

At the heart of what Aerospace does to assure the success of space missions is something called the Launch Verification Matrix (LVM).

"It's all the things we do to certify the spaceflight worthiness of a launch vehicle," said Bruce Mau, principal director of Launch Enterprise Engineering. "It's basically a big checklist we go through for every launch."

The checklist, which is hundreds of items long, includes all the analyses that are done for each launch, the hardware that goes through a pedigree review, the hardware that goes through less stringent reviews, and the software that is used in the launch vehicle. For every item on the LVM, there is a responsible person who checks that the item has been completed.

COUNTDOWN TO LAUNCH

The LVM changes slightly with each launch. For every rocket that launches, which includes all national security payloads, United Launch Alliance holds a meeting about a year before the launch date to specify the configuration of the launch vehicle and what hardware will be onboard. A few weeks later, Aerospace holds a configuration control review board for the Launch Verification Matrix at which it is decided what items will be included in the LVM.

"The items might be slightly different depending on things such as if this particular launch is a re-flight of a previous launch. In that case, some analyses would not have to be redone," Mau said.

The LVM was developed at Aerospace in the early 2000s with the goal of providing a "clean slate" process to review development, production, and preparation of the new evolved expendable launch vehicles (EELVs) — the Atlas V and the Delta IV families.

A new position was created to oversee development of the LVM — principal director, EELV Launch Verification — and Ray Johnson, vice president, Space Launch Operations, brought in Dr. Wayne Goodman to fill the position.

"We needed a disciplined process that exactly outlined every task that would be accomplished to verify the launch readiness of each vehicle," said Johnson. "Wayne led a core team that consisted of Dr. Mark Brosmer, Joe Tomei, and Randy Kendall, and they pulled together the extensive LVM."

"I started making a list of things that needed to be done," Goodman recalled. "When the list got to 10 pages, I switched to a spreadsheet. It soon became clear that this was too complicated for just a spreadsheet, so we created a database."

The task was harder and took longer than Goodman had expected, extending from 2001 to 2003. But the team finished in time to use the LVM for the first military EELV launch, the Defense Satellite Communications System mission aboard a Delta IV on March 10, 2003.

After that first launch, Goodman summarized the project, writing: "The Aerospace Corporation, in partnership with the EELV

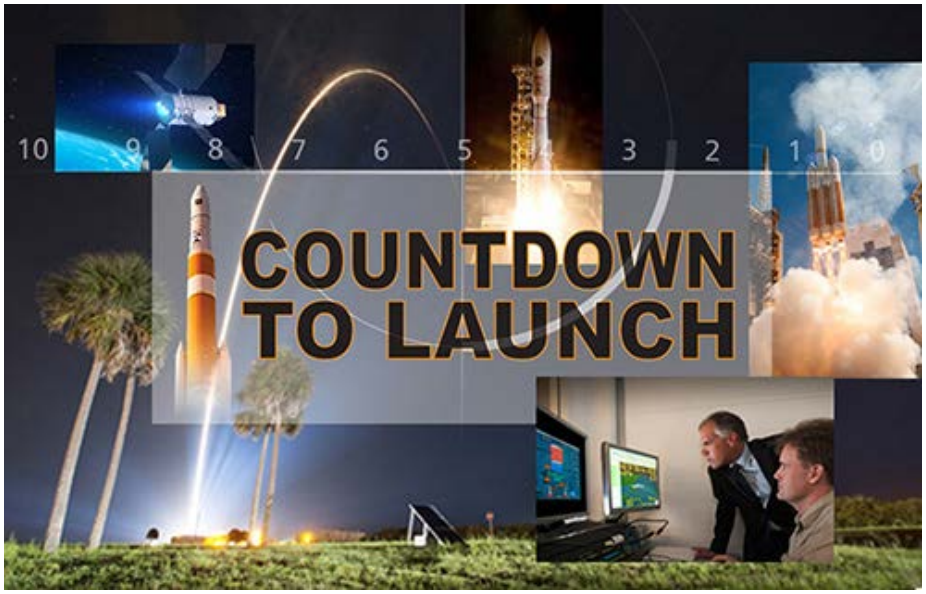
System Program Office (SPO), developed and implemented a comprehensive launch verification process, which included verification of requirements, design, hardware, software, mission analysis, environments, and launch processing. As part of this effort, Aerospace pioneered a Launch Verification Matrix database to track and document the vast array of verification activities performed by the government team."

He concluded: "For the first time in Aerospace's history, all launch verification tasks for a specific mission were documented in a single, highly structured medium."

Countdown to Launch: Aerospace in Action

by Laura Johnson
January 22, 2015

The Orbiter is publishing a series of articles that follow one launch through its preparation to when it lifts its payload to orbit. The payload, GPS IIF-9, is set to launch in March on a Delta IV launch vehicle. This article is an overview of Aerospace's role in a launch.



Graphic: Stuart Araki

3, 2, 1 … liftoff!
Excitement builds in the last few seconds before a rocket rips into the sky. But what happens before that? Rockets don't just appear at the pad an hour before the launch. There are preparations that are made days, months, and even years before a rocket is ready to fly.

Aerospace is dedicated to mission success, and provides a team of experts who go through a process step by step to ensure that each payload makes it successfully to where it's supposed to go.

"We provide an independent technical assessment of the launch readiness of launch vehicles that are used for national security missions," said Ray Johnson, vice president of Space Launch Operations.

It could be argued that Aerospace's assessment is redundant — after all, Aerospace is covering much of the same ground as the Air Force and the contractor. But it makes an impact.

"To err may be human but to check is engineering. The flight history clearly shows a significant improvement in reliability when one compares missions that have gone through the SMC/Aerospace mission assurance process to those that have not," said Dr. Ed Ruth, chief engineer for Space Launch Operations.

Reliability is important in a business involving expensive launch vehicles and payloads, and the Air Force values Aerospace's contributions.

"The ultimate go/no-go launch decision and flightworthiness certification rests with SMC, not Aerospace; however, the Air Force relies heavily on our readiness assessment in building confidence in its final decision," Johnson said.

YEARS
Therefore, as it has for many previous launches, Aerospace is performing mission assurance work for the launch of GPS IIF-9 on a Delta IV in March 2015. The process began several years ago, with the task of defining requirements.

There are basic requirements for any launch, plus specific requirements for the particular mission. Aerospace's integration team and the Air Force define everything from bolt patterns to special handling requirements, to what orbit the payload should go in.

During the next couple years, the mission profile is designed, and Aerospace continues to help ensure that the launch vehicle meets all requirements. This work has been completed for GPS IIF-9.

MONTHS
Aerospace also reviews the actual hardware, before, during, and after assembly. Some of these reviews are known as pedigree reviews, and are largely completed for GPS IIF-9.

Starting about six months out from the launch, the analysis teams kick into play. Aerospace does a series of analyses such as the loads analysis, propulsion analysis, slosh analysis, controls analysis, software analysis, space debris analysis, and collision analysis, among others. Aerospace plays a key role in this area, providing independent verification and validation of the contractor's tests.

Aerospace personnel are also present at the actual launch site, in this case at Cape Canaveral. As the launch vehicle is being prepared at the launch site, Aerospace will participate in many of the critical activities, providing another set of eyes to ensure that processes are completed correctly. The environment is very collaborative, with the Air Force, contractor, and Aerospace all working to identify and solve any problems that arise.

About a month before the launch, Aerospace personnel will hold a one-day review with the vice president of Space Launch Operations at Aerospace. Two weeks out another review will be held with the Aerospace president and CEO.

DAYS
Then, the Air Force will hold its Flight Readiness Review, to which Aerospace provides input. More reviews will be held at the launch site.

The day of launch, Aerospace will be there every step of the way, monitoring the activities both from the launch site and remotely via the Spacelift Telemetry Acquisition and Reporting System (STARS) lab.

The big moment comes – the rocket launches. But Aerospace still is not done. Within about half an hour of the launch, Aerospace will complete a short review of the data. This will be followed by a more detailed review over the next month.

Thus, Aerospace's role in a launch is extensive. The Orbiter will be following these various steps as the launch grows closer. Stay tuned to see in more detail what Aerospace does and how it supports the launch of GPS IIF-9.

Watch the video below to hear Ray Johnson's perspective on Aerospace's role

[Video Removed]

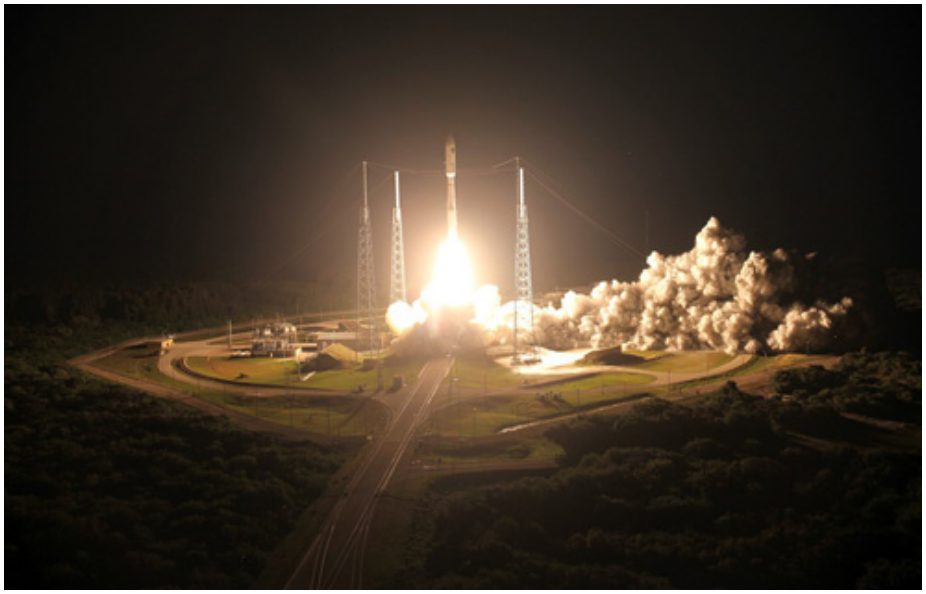
Most Powerful Atlas Launches Third MUOS

January 21, 2015

The Atlas Team started 2015 right with the successful launch of an Atlas V and its Mobile User Objective System (MUOS)-3 satellite, Ray Johnson, Vice President, Space Launch Operations, reported Wednesday morning from Cape Canaveral Air Force Station.

"Last night, the vehicle lifted off of the Cape's SLC-41 at 8:04 p.m. EST, 21 minutes into the launch window," Johnson said. "The delay was caused by concerns for high-altitude winds, and a range issue. Both issues were resolved and we proceeded with a near-flawless countdown and launch."

Johnson noted that "our postflight analysis indicates that the satellite was released right on target, and is performing as expected. Congratulations to both the Atlas Team and the MUOS-3 Team for this outstanding achievement!"



An Atlas V rocket launches the MUOS-3 satellite from Space Launch Complex 41 on Jan. 20. (Photo: United Launch Alliance LLC)

The Atlas V vehicle flew in the 551 configuration, with a five-meter fairing, five strap-on solid rocket motors, and a single engine in the Centaur second stage. It was the 200th flight of an Atlas-Centaur rocket, according to United Launch Alliance (ULA).

The launch also carried the heaviest payload ever for an Atlas V launch vehicle, ULA said in a statement. The Atlas generated more than 2.5 million pounds of thrust at liftoff to propel the nearly 7.5-ton MUOS-3 to orbit, ULA said.

The MUOS constellation, which will eventually include five satellites in geosynchronous orbit, provides upgraded military communications capabilities.

Betting the Earth: You Want a High Probability of Success

by Lindsay Chaney
January 15, 2015

Dr. William Ailor has been studying the physics of spacecraft and space debris reentering the Earth's atmosphere for more than 40 years. (Photo: Elisa Haber)

Armed with a Ph.D. in aerospace engineering from Purdue University, Dr. William Ailor began working at The Aerospace Corporation in 1974 and spent the next 15 years conducting performance analysis studies related to spacecraft reentry and reentry breakup.

As an undergraduate student at North Carolina State University, Ailor had switched engineering majors twice, starting in electrical engineering, then changing to nuclear engineering, and finally aerospace engineering. As a result, “I took a lot of engineering classes because each major had different required courses,” Ailor said. He also played clarinet in the school’s marching and concert bands. His musical career continues today with the Peninsula Symphonic Winds, where he is a clarinetist and president of the group’s board of directors.

In 1989 Ailor joined the chief engineer’s office and led the development and initial implementation of a plan to deliver electronic mail to all employees. He later led the organization that completed the implementation of the plan. During his time at Aerospace, Ailor has had leadership roles in a range of corporate initiatives, including developing the company’s first strategic plan, establishing the Aerospace Institute, establishing a systems engineering master’s degree program for Aerospace employees at the University of Southern California, and setting up the Center for Orbital and Reentry Debris Studies (CORDS). He was also responsible for revising corporate policies to allow employees who obtained patents while working at Aerospace to share in licensing revenues. This resulted in a significant increase in patents granted to Aerospace. Ailor himself is named on two patents for work at Aerospace, one for tracking space hardware as it falls to Earth and a second for measuring forces on a spacecraft as it reenters the atmosphere and breaks apart.

Currently a distinguished engineer in the Vehicle Systems Division, Ailor is the principal investigator for the design and development of the Aerospace Reentry Breakup Recorder (REBR), among other duties, which include serving as the principal engineer for CORDS.

Ailor and his wife, Barbara, reside in Palos Verdes Estates, where they are both active with the Palos Verdes Peninsula Land Conservancy, an organization that Ailor founded and was president of for 18 years. That organization has preserved 1,600 acres of open space.

In the following interview, Ailor discusses the origin and future of the IAA Planetary Defense Conference.

HOW IT STARTED

In 2003, the Space and Missile Systems Center had a readiness exercise about what it would do if an asteroid was headed toward the Earth. I was on the team that was brought in to work that problem with the Air Force and it became obvious that we really didn’t know much about this area at all.

At the end of the exercise, I thought a periodic conference would be a good way to stay informed. The idea was to have anybody in the world who was doing anything in planetary defense come to Anaheim and participate in this conference. We had around 100 people. Aerospace sponsored it. I chaired it. AIAA was a partner in it. This was in 2004. NASA was there. Air Force Brig. Gen. Pete Worden (now retired) was there and gave the closing keynote. Congressman Dana Rohrabacher gave

the opening keynote address.

WHAT HAPPENED NEXT

Go to www.pdc2015.org to register for the conference and get more information.

Based on the success of the first conference, we decided to keep the string of conferences going. The next one was in 2007 in Washington, D.C. At this point it occurred to me that this should have more of an international flavor, so I talked to the International Academy of Astronautics, of which I'm a member, and they agreed to take it under wing. It became an IAA-sponsored conference and in Spain in 2009, we had the first IAA Planetary Defense Conference. The second was in Romania 2011, and the third was in Flagstaff in 2013, and we're planning the fourth, which will be in Italy later this year. I've been chair or co-chair for all of these.

We have them every two years now and it's really grown. When we started we had Aerospace and AIAA as sponsors. For the 2015 conference we currently have 22 sponsors, including NASA, the European Space Agency, and the Russian space agency ROSCOSMOS.

It's amazing, now that we've had these conferences, the community is really moving along at a good clip and getting things done. For instance, when we had the 2004 conference, there wasn't even a phone number to call if an asteroid was discovered that could threaten Earth. There was no formal pathway to notify the White House. That was taken care of right after the conference.

FURTHER DEVELOPMENTS

As a result of being involved with the conferences, I was asked to be on Action Team 14 of the Science and Technology Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space. We wrote recommendations on how the world community should work together to discover threatening asteroids and, if a real threat is discovered, to do something about it. We put recommendations together that were presented to the Science and Technology Subcommittee.

In fact, we made the presentation on the same day that the asteroid entered and exploded over Chelyabinsk, Russia. We were in a meeting and the Russian representative was looking at his phone and suddenly said "aahrr." While the meeting was going on, he got updates on the damages. With that as background, the full body approved our recommendations.

The two recommendations they approved were, first they would establish something called the International Asteroid Warning Network to stitch together the various discovery entities, the telescope operators who look for asteroids. And second was the Space Mission Planning Advisory Group where spacefaring nations would work together to develop plans for missions to deflect an asteroid. Representatives of NASA, ESA (European Space Agency), the Russian space agency, the Indian Space Agency (ISRO), the Japanese Aerospace Exploration Agency (JAXA) and other space agencies were in the second group. Both of these had their first meetings in 2014. So, they're up and functioning.

PREPARING FOR A DISASTER

Next, I pulled together a team to look at how an asteroid threat and response would evolve, and invited experts from Aerospace, Lawrence Livermore National Labs, Sandia National Labs, Jet Propulsion Laboratory – anyone who would have any involvement in a real threat – to participate. Livermore because they deal with nuclear explosives, which might be an option. Sandia, because they're an expert in modeling explosions and the consequences — how big an area it's going to affect and so forth. JPL helped create a scenario that is realistic and consistent with what we might expect at this time.

This group has done two table-top exercises for FEMA. They're paid for by NASA, but they're delivered to NASA, FEMA, DOD, the White House and other government agencies that want to attend. It was primarily to acquaint FEMA with how an asteroid impact threat and disaster might evolve, so they could compare and contrast it with the types of emergencies they already deal with, like hurricanes, tornadoes, and earthquakes. We've done two of those and will probably do another one in 2015. A lot of these people come to the Planetary Defense Conferences as well.

WHAT WE KNOW ABOUT ASTEROIDS

Back in 1980, we knew about a few thousand asteroids; now we know about 200-some thousand. Fortunately, only a few of these might ever be a threat to Earth. The reason the number has grown so quickly is that we weren't really looking for them before. What we're finding now is that the greatest risk is from small asteroids that impact Earth much more frequently than larger ones. The Chelyabinsk event was caused by an asteroid maybe 20 meters in size, so we know even these small ones can do a fair amount of damage and right now we can't see them or we don't see them until late. We didn't see the Chelyabinsk asteroid coming at all.

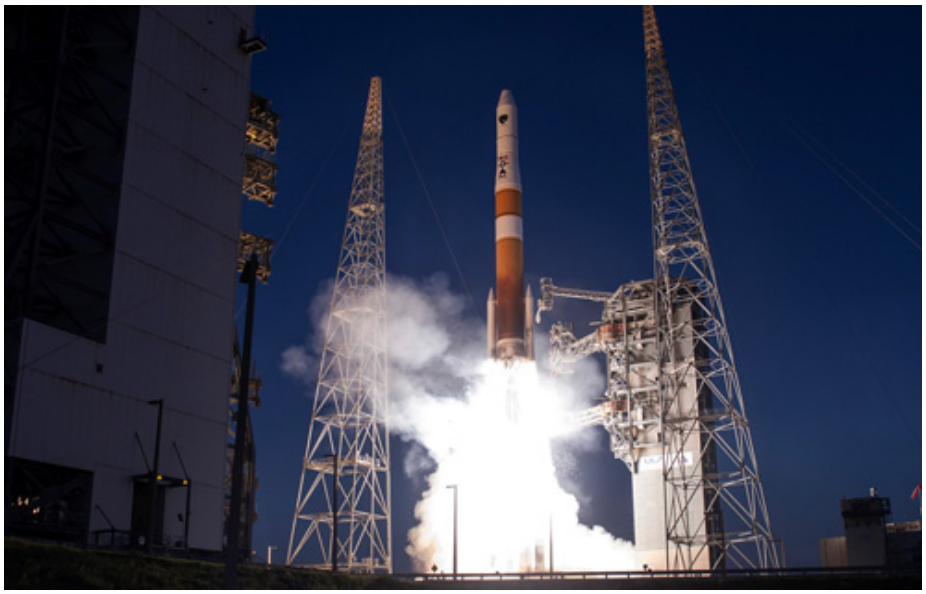
We have the technology to deflect asteroids. It's just that we may not be ready to do it. One of the things we proposed to NASA is to do a study on where is the boundary – if it's a month out, we probably can't do anything about it; if it's six months out, maybe we can; if it's two years out, we probably can. So what kind of resources does it take for each of those scenarios?

Many people say we can just launch a rocket. Well, you can't just launch a rocket. If you're betting the Earth on it, you want to make sure you have a high probability of success. Launch vehicles fail around one in a hundred and spacecraft can fail after launch. You have to design a system or campaign where you take into account the failure probabilities and maximize the chance that you're actually going to get one on target. How to deal with a short-warning event — it's a really interesting problem.

How Much Do You Know About Launches?

January 13, 2015

You work at a company that supports launches … but how much do you really know about the launch business? Take the following quiz to see how your knowledge stacks up.



A Delta IV rocket lights up the Florida Space Coast during an evening launch of the GPS IIF-6 satellite on May 16, 2014. (Photo: United Launch Alliance, LLC)

1. What is a payload fairing?

A. A small connector that attaches the payload to the rocket.

B. A decorative piece of metal that makes each rocket unique.

C. The nose cone used to protect the payload.

D. A status conference to determine how the payload is faring.

2. What is the most recent Atlas vehicle being used?

A. Atlas III

B. Atlas V

C. Atlas VII

D. Atlas X

E. Atlas ∞

3. Which of the following is not a launch site?

A. Schriever Air Force Base

B. Vandenberg Air Force Base

C. White Sands Missile Range

D. Cape Canaveral Air Force Station

E. Mojave Air and Space Port

4. What does SLC stand for?

A. SpaceLift Complex

B. Space Launch Compound

C. Space Launch Complex

D. Straight Lift Control

E. interStellar aLtitude MeChanism (Hey, nobody said acronyms have to make sense!)

5. Which SLC is used for Delta IV launches at Cape Canaveral?

A. SLC-14

B. SLC-37

C. SLC-41

D. SLC-100

6. What is a wet dress rehearsal?

A. When the rocket manufacturer tests the hardware at the factory.

B. A large teleconference in which the launch personnel walk through all the stages of the launch.

C. When the launch personnel run tests on the pad with fuel in the rocket.

D. When all the launch personnel show up wearing wet dresses, which is an old launch tradition.

7. Which of these is the name of a SpaceX launch vehicle?

A. Eagle 9

B. Hawk 9

C. Osprey 9

D. Falcon 9

8. How many space shuttles were there?

A. 1

B. 2

C. 3

D. 4

E. 5

9. How are Atlas V rockets assembled at SLC-41?

A. Horizontally

B. Vertically, and then transported to the pad

C. Vertically on the pad

Scoring

How many questions did you get right? Answer key is below. Tally your score and see where you fall on the following chart.

0-4 — Launch Ignoramus: Why such a low score? It's not rocket science … oh wait, maybe it is. Time to hit the books, because you got schooled!

5-8 — Launch Learner: Hmm, looks like you could afford to brush up on your knowledge.

9-12 — Launch Proficient : You know a lot about rockets, and are clearly qualified to work at The Aerospace Corporation.

13-15 — Launch Expert: You have this business down. Are you by any chance a rocket scientist?

D. Diagonally

10. How big is Vandenberg Air Force Base?

A. 10 acres

B. 500 acres

C. 16,000 acres

D. 100,000 acres

11. How tall was the Saturn V?

A. 191 feet

B. 214 feet

C. 363 feet

D. 392 feet

Coming Soon!

Regardless of your score on the quiz, would you like to learn more about launches?

The Orbiter will soon be running a series following one particular launch — GPS IIF-9 — and Aerospace's role in supporting it. Stay tuned!

12. Where are Delta IVs built?

A. Vandenberg, California

B. Denver, Colorado

C. White Sands, New Mexico

D. Decatur, Alabama

E. Nobody actually knows; the storks just bring them.

13. How long does it take the Delta Mariner cargo ship to transport a rocket from the ULA factory to Vandenberg Air Force Base?

A. 3 hours

B. 10 days

C. 22 days

D. 38 days

E. 52 days

14. When was the last flight of a Titan rocket?

A. 2002

B. 2003

C. 2004

D. 2005

E. 2006

15. The launch vehicle that put the first American, Alan Shepard, into space was a:

A. Titan

B. Atlas

C. Saturn

D. Redstone

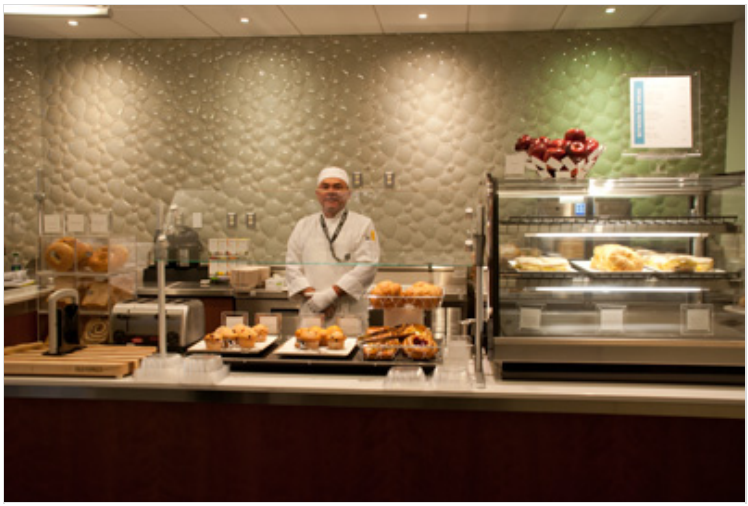
Answer Key

1. (C) The nose cone used to protect the payload.
2. (B) Atlas V
3. (A) Schriever Air Force Base
4. (C) Space Launch Complex
5. (B) SLC-37
6. (C) When the launch personnel run tests on the pad with fuel in the rocket.
7. (D) Falcon 9
8. (E) 5
9. (B) Vertically, and then transported to the pad
10. (D) 100,000 acres
11. (C) 363 feet
12. (D) Decatur, Alabama
13. (E) 52 days
14. (D) 2005
15. (D) Redstone

Chantilly Cafe Features Healthy Options

by Melissa Parsons
January 08, 2015

The much-anticipated Chantilly Campus Cafe is now open. (Photo: Melissa Parsons)



A Flik chef stands by to serve the breakfast crowd. (Photo: Melissa Parsons)

After much anticipation, the Chantilly Campus Café is now open for business.

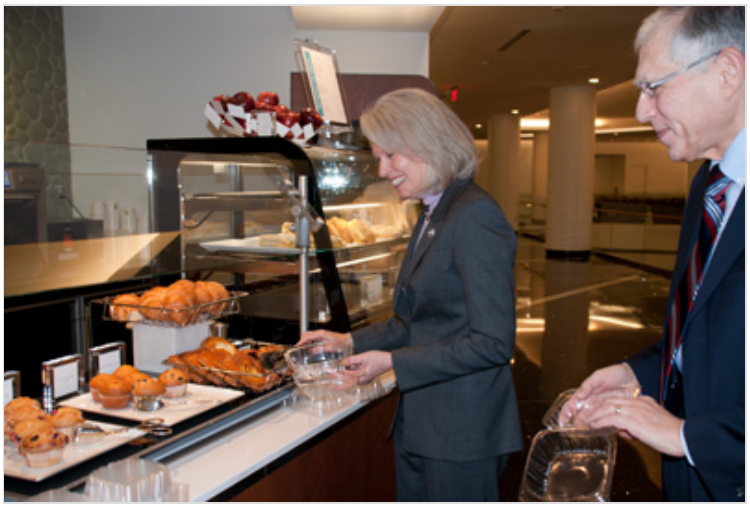
The new vendor, Flik, made a great first impression with reps on hand on Wednesday, Jan. 7, to greet employees and visitors as they entered the building.

Top Chantilly execs Cathy Steele and Dr. Mal De Ponte helped hand out reusable mesh bags containing goodies and coupons for future use. Each bag contained not only a snack and beverage, but useful information about the food vendor and its commitment to the health and well-being of Aerospace employees. Flik uses the freshest ingredients available and offers daily FIT menu items — items that are tested and analyzed by Flik chefs, and are required to meet a healthy criteria developed by registered dietitians.

Over the next few weeks, those visiting or working in the Chantilly Campus can look forward to such menu items as citrus scones, egg and spinach breakfast sandwiches, grilled chicken pesto flatbread with fresh mozzarella, made-to-order sandwiches, and daily hot meal offerings such as lasagna, gulf shrimp creole, and oven fried chicken. Prices range from $6 – $8 for sandwiches and main dishes, and sides are available for under $2.

If employees are looking for a quick snack or beverage, Flik is also offering a variety of “Grab and Go” menu items, allowing those customers to bypass the line and go straight to the cashier.

The new café will be open from 7:30 a.m. to 2 p.m. daily and is currently serving freshly brewed Starbucks coffee. All forms of payment except checks are accepted.



Cathy Steele chooses a pastry while Mal De Ponte decides what to eat. (Photo: Melissa Parsons)

January 2015 Anniversaries

by Carolyn Weyant
January 01, 2015

35 YEARS

Engineering and Technology Group: Rouh Bow, Peter Carian, David Gilmore, Michael Handelman, Ralph Herbert, Theodore Muelhaupt, Bill Williams

Space Systems Group: Ricardo Crespo, Leonardo Mendoza, Robert Tsutsui

Systems Planning, Engineering, and Quality: Ching Ho

30 YEARS

Civil and Commercial Operations: Gina Galasso

Engineering and Technology Group: William Krenz, Paul Massatt

National Systems Group: A Barnard

Operations and Support Group: Linda Burns

25 YEARS

Engineering and Technology Group: Diana Johnson, Lois Kumm

National Systems Group: Vicki-Lynn Agena

Operations and Support Group: Robert Foster, Elaine Harrell

Systems Planning, Engineering, and Quality: Frederick Stehle

20 YEARS

Engineering and Technology Group: Fernando Acevedo

National Systems Group: Lynette Tatman

15 YEARS

Civil and Commercial Operations: Francesco Bordi

Engineering and Technology Group: Patrick Chor, James Kirsch, Richard Lasota

Space Systems Group: David Christopher

10 YEARS

Engineering and Technology Group: John Bowers, Leia Bowers, Matthew Eby, Jeffrey Harbold, Shant Kenderian, Joseph Leong, James Lopresto, Brian McCarthy, Scott Peck, David Peters, Jeffrey Vance

National Systems Group: Donna Berninger, Robert Williams, Martha Wyckoff

Space Systems Group: John Fong, Jared Fortune, Darin McNeal, James Pauls

5 YEARS

Engineering and Technology Group: Sung Hong, Edward Laag, Sonny Yi

National Systems Group: Mark Rogers

Space Systems Group: Concezio Di Gregorio

January 2015 Obituaries

by Carolyn Weyant
January 01, 2015

Sincere sympathy is extended to the families of:

George Clark, member of the technical staff, hired July 10, 1961, retired Aug. 1, 1982, died Dec. 1.
Viola Goodwin, office support, hired Dec. 4, 1961, retired Dec. 1, 1980, died Dec. 2.
Thomas Hawk, member of the technical staff, hired June 2, 1969, retired Nov. 1, 1997, died Nov. 16.
Barbara Hendry, director of administration, hired Nov. 8, 1960, retired Sept. 1, 1987, died Nov. 20.
Edward Kukic, project engineer, hired April 11, 1966, retired May 1, 1991, died Nov. 25.
Charles Precious, manager, hired Jan. 23, 1962, retired Nov. 7, 1998, died Dec. 14.
Helen Rinaldi, secretary to VP-CFO, hired May 17, 1974, retired Sept. 1, 1995, died Nov. 8.
Richard Rountree, senior project engineer, hired Jan. 3, 1973, retired Oct. 1, 1996, died Dec. 7.
Theodore Stinis, member of the technical staff, hired June 19, 1989, retired March 1, 2000, died Nov. 23.

To notify Aerospace of a death and have it included in the Orbiter, please contact Cynthia Johnson in Human Resources at 310-336-5806.

January 2015 Notes

by Carolyn Weyant
January 01, 2015

Notes of appreciation to fellow employees and Aerospace for thoughtfulness and sympathy have been received from:

Gregory Furumoto, for the recent passing of his father, Augustine Furumoto.
Jeff Hall, for the recent passing of his father, “J.L.” Hall.
Miriam Nadel, for the recent passing of her mother, Beatrice Nadel.

To submit a note of appreciation to Aerospace, please contact Valerie Jackson in Human Resources at 310-336-0891.