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Kennedy Space Center photo

OSTM on its way

A JPL-managed oceanography satellite launched Friday, June 20 from Vandenberg Air Force Base on a globe-circling voyage to continue charting sea level, a vital indicator of global climate change. The mission will return a vast amount of new data that will improve weather, climate and ocean forecasts.

The Ocean Surface Topography Mission/Jason 2 satellite, a partnership of NASA and the French space agency, arced through the blackness of an early central coastal California morning at 12:46 a.m. PDT, climbing into space atop a Delta II rocket. Fifty-five minutes later, OSTM/Jason 2 separated from the rocket's second stage, and then unfurled its twin sets of solar arrays. Initial telemetry reports showed it to be in excellent health.

A forward-mounted camera system onboard the launch vehicle's second stage provided video of portions of the spacecraft's ascent. It was turned on right before launch, then off immediately after liftoff, then on again prior to spacecraft separation, when it was used to track spacecraft separation and deployment of the spacecraft's solar arrays.

Measurements of sea-surface height, or ocean surface topography, reveal the speed and direction of ocean currents and tell

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Goodbye, Ulysses

18-year mission has provided breakthroughs in solar studies

By Mark Whalen

It took a lot of patience on the part of scientists who developed the Ulysses mission to study the sun. First conceived more than 30 years ago but beset by several delays, Ulysses finally launched in 1990.

To be sure, Ulysses has provided a treasure trove of critical science over the years. But the original five-year mission, extended numerous times but now running low on power, will in the next few weeks likely come to an end. Looking back, mission leaders agree that Ulysses' early travails were well worth the wait.

"Ulysses' scientific achievements have been truly staggering and will leave an impressive legacy of solar exploration," said Project Scientist Ed Smith of JPL.

Though other solar missions have come along in recent years, Ulysses' vantage points over the poles of the sun have made it unique. The spacecraft's main objective has been to study the heliosphere, the region dominated by the solar wind.

"All previous measurements were made near the ecliptic plane and the sun's equator," said Smith. "Ulysses gave us a 3-D view of what the sun's neighborhood is like, studying for the first time how it varied from the equator to the poles.

"By going into the heliosphere, we have had access to processes occurring throughout the universe, including those that occur in interstellar space involving magnetic fields and particles," noted Smith. "The heliosphere is an analyzer of sorts—it's a good place to do science."

Ulysses and its suite of 10 instruments have provided numerous surprises for scientists. The spacecraft showed that dust flowing into the solar system from deep space was 30 times larger and heavier than astronomers suspected. Ulysses also revealed how the magnetic field emanating from the sun's poles varies over the sunspot cycle. The spacecraft detected helium atoms from deep space. It confirmed that the universe does not contain enough non-dark matter to eventually halt its expansion.

Also unexpected were the times Ulysses flew through the very long tails of several comets. Though Ulysses was more than 300 million miles from the nucleus of comet Hyakutake, the spacecraft crossed a well-defined comet tail.

JPL's Ed Massey, Ulysses' project manager, noted that due to the extremely small quantity and size of the particles in the tail, the spacecraft was never in any danger.

One of the first NASA missions that called for international participation, Ulysses has proven to be a model for collaborative scientific efforts between the United States and other nations.

JPL has led the mission for NASA, partnering with the European Space Agency, which provided the spacecraft. NASA provided the launch vehicle and upper stage boosters. Most of Ulysses' instruments are the result of European and American partnerships.

Nigel Angold, the European Space Agency's Ulysses mission operations manager who has led a team of about a dozen at JPL, said, "the mission could not have been done without the combination of NASA and ESA."

"It's been a great spirit of collaboration," Angold said. "What's impressed me is how the space science and operations communities come together and share our resources, even when the political environment is not so positive.

"The science operations were easy to manage," he added. "Unlike a lot of spacecraft, we got science data from our instruments simultaneously. There were no conflicts. All work was done in harmony and we didn't have to resolve problems among the science community.

"My job has been to maximize the return to the taxpayers of the U.S. and Europe, and I am proud that over the years we have managed to do that."

Continued on page 2

Ulysses *Continued from page 1*

Ulysses' original plan called for two spacecraft—one each from NASA and ESA—to be launched on the space shuttle and independently study the sun's north and south poles. NASA's spacecraft was canceled in the early 1980s. Following the Challenger disaster in 1986, Ulysses was mothballed for several years, after which a European investigation was added.

Following JPL's Magellan and Galileo missions, Massey said, Ulysses was scheduled as the third launch from the shuttle. It was sent out to Jupiter for a gravity assist to move the spacecraft's flight path downward and away from the ecliptic plane, putting it into a final orbit around the sun to take it past the south and then north poles.

Smith is also of the opinion that Ulysses has been a great example of why NASA should extend missions. "In 1994, when we wanted to study the approaching solar maximum but were at about the end of the primary mission, we went to NASA and convinced them to extend it. Today, the procedures for extensions are different, using a regular review cycle, so we really helped break some ground."

Although the spacecraft may soon say its goodbyes, Ulysses data will continue to be archived, with studies expected to continue for years.

"I will miss it," said Massey. "Ulysses has taken up about half of my working life. It's been a pleasure to work with such a group of highly dedicated people."

"I've thoroughly enjoyed my time at JPL," added Angold. "I very much appreciate that I've been made to feel welcome. As a foreigner in the U.S., that is a great pleasure."

"Even though this mission has lasted longer than we thought, I'm sorry it's coming to an end," said Smith. "I take pride in the fact that I've been the project scientist from the very first, and I'll also be there to turn the lights out."

Richard Hasegawa / JPL Photolab

Carol Lachata / JPL Photolab

Carol Lachata / JPL Photolab

"Ulysses' scientific achievements have been truly staggering and will leave an impressive legacy of solar exploration."

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Ulysses project scientist

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Ed Massey
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Nigel Angold
ESA Ulysses mission operations manager

OSTM *Continued from page 1*

scientists how much of the sun's energy is stored by the ocean. Combining ocean current and heat storage data is key to understanding global climate variations. OSTM/Jason 2's expected lifetime of at least three years will extend into the next decade the continuous record of these data started in 1992 by NASA and the French space agency Centre National d'Etudes Spatiales, or CNES, with the JPL-led TOPEX/Poseidon mission. The data collection was continued by the two agencies on Jason 1 in 2001.

The mission culminates more than three decades of research by NASA and CNES in this field. This expertise will be passed on to the world's weather and environmental forecasting agencies, which will be responsible for collecting the data. The involvement of the National Oceanic and Atmospheric Administration (NOAA) and the European Organisation for the Exploitation of Meteorological Satellites as mission partners on OSTM/Jason 2 helps establish this proven research capability as a valuable tool for use in everyday applications.

OSTM/Jason 2's five primary instruments are improved versions of those flying on Jason 1. These technological advances will allow scientists to monitor conditions in ocean coastal regions—home to about half of Earth's population. Compared with Jason 1 measurements, OSTM/Jason 2 will have substantially increased accuracy and will provide data to within 25 kilometers (15 miles) of coastlines, nearly 50 percent closer to shore than in the past. Such improvements will be welcome news for all those making their living on the sea, from sailors and fishermen to workers in offshore industries. NOAA will use the improved data to better predict hurricane intensity, which is directly affected by the amount of heat stored in the upper ocean.

OSTM/Jason 2 entered orbit about 10 to 15 kilometers (6 to 9 miles) below Jason 1. The new spacecraft will gradually use its thrusters to raise itself into the same 1,336-kilometer (830-mile) orbital altitude as Jason 1 and position itself to follow Jason 1's ground track, orbiting about 60 seconds behind Jason 1. The two spacecraft will fly in formation, making nearly simultaneous measurements for about six months to allow scientists to precisely calibrate the spacecraft's instruments.

Once cross-calibration is complete, Jason 1 will alter course, adjusting its orbit so that its ground tracks fall midway between those of OSTM/Jason 2. Together, the two spacecraft will double global data coverage. This tandem mission will improve our knowledge of tides in coastal and shallow seas, and internal tides in the open ocean, while improving our understanding of ocean currents and eddies.

CNES is providing the OSTM/Jason 2 spacecraft. NASA and CNES jointly are providing the primary payload instruments.

For more information on the mission, visit *http://www.nasa.gov/ostm.*

HELPING the HOME PLANET

Dimotakis describes challenges in global change, energy

Questions remain to be answered before global environmental trends including climate change can be forecast well enough to help guide long-term policy. And significant technical and other challenges must be met before energy alternatives to fossil fuels are developed that do not exacerbate greenhouse gas and other environmental effects.

Dutch Slager / JPL Photolab

That was the message of Paul Dimotakis, JPL's chief technologist, who gave an update on the Lab's Global Change and Energy Working Group in an all-hands meeting in von Karman Auditorium on June 9.

A year ago, JPL Director Charles Elachi asked Dimotakis to head the working group to seek out ways that JPL and Caltech could contribute their intellectual resources to help the world meet the challenges of global change and clean energy.

On the climate-change front, Dimotakis said that carbon dioxide now makes up 380 parts per million of Earth's atmosphere, a concentration increasing by 2 parts per million each year. However, researchers do not know how much carbon dioxide and other greenhouse gases the atmosphere and oceans can safely absorb.

"Ultimately, the deep oceans are the repository for carbon dioxide and other greenhouse gases," Dimotakis said. "But assessing how much the deep oceans can absorb and at what rate requires that we understand something about transfer and mixing across stably stratified interfaces. That is very difficult to model and simulate."

Recent reports issued by the multinational Intergovernmental Panel on Climate Change imply that if current emission rates can be cut by about three-quarters, "you're going to stabilize," he said. But "there is no scientific basis for this number today as nearly as we can tell," he added.

There are also difficult decisions ahead on what tradeoffs are acceptable in confronting climate change, Dimotakis noted. As sea levels rise and ocean-storm intensities increase, low-lying island group nations such as Kiribati in the Pacific and the Maldives in the Indian Ocean "will be the first to suffer." The nation of Bangladesh on India's northeastern border, for example, may well be next. Dimotakis said that some reports suggest that the world may consider a loss of perhaps 1 percent in global Gross Domestic Product acceptable in response to climate change. Unfortunately, such losses are not uniformly distributed across the globe. "The GDP of Bangladesh is less than 1 percent of the world's, with that of Kiribati and the Maldives even lower. So one way of accepting a 1 percent loss would be if we decided that it's OK to write off such nations. Is that OK? I don't know."

Whatever the appropriate levels turn out to be, some limits will be necessary. "We're going to have to change our energy-power production system; industrial, residential, and commercial energy use; as well as space heating and transportation, within something like 10 to 20 years," or perhaps face far more serious consequences in 40 years, he said. "So time is of the essence."

To answer the question of how much carbon dioxide the atmosphere and oceans can safely absorb, Dimotakis said researchers need to improve their understanding through improved models informed by data. He said JPL "should be very proud because it is responsible for a very large fraction of the observational data from space that pertain to climate—remarkable science and technology achievements."

On the energy front, Dimotakis noted that today fossil fuels provide about 13 terawatts—or 13 million million watts—constituting 86 percent of the world's power appetite. "That is 13,000 San Onofre nuclear power plants," he said. Just to convert all electrical generating plants from fossil fuels within 30 years would require a San Onofre–scale plant every three days; emphasizing a point similar to one made by Prof. Nate Lewis of Caltech. If additional plants were built to, say, allow all automobiles and other fossil-fuel users to rely on electricity, it would require a plant per day. "At the moment it takes 20 years to license a nuclear power plant in the United States."

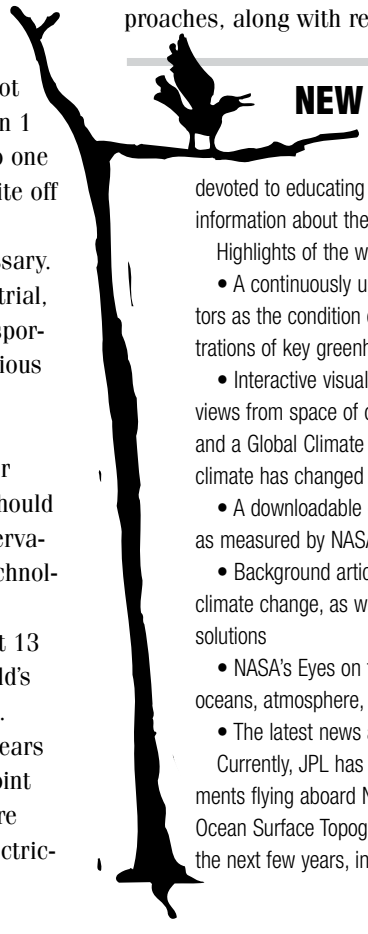
The first and cheapest thing to do, said Dimotakis, is energy conservation.

"The lowest-cost and lowest-carbon-emitting power plant is one you don't need to build," he said, which Lewis also emphasized in a recent presentation at JPL. "In fact, if in the United States you increased your efficiency at 2 percent a year or so, one would not to have to build anything new."

He noted that Californians use half the national average of electricity per person. "This is not because we have a better climate. It is because in 1972 California started mandating refrigerator efficiencies and other electricity-conservation measures. As a result, since 1972, California has not increased kilowatt hours consumed per person per year, whereas the rest of the country has continued to go up."

Solar energy is promising, with solar thermal a rising contender, but it would be difficult to make a significant change in energy generation using the most-common photovoltaic technology today that requires a more than three-year energy payback period, he said. "If you have a very aggressive national program and increase such photovoltaic installations by 30 percent per year, each year's cells will just be making the energy for next year's cells, and at the end of 10 years you will not have produced a net kilowatt hour." Newer technologies such as vacuum-based thin films on glass may be more successful by offering a shorter energy payback period, but at the expense of lower efficiency, requiring more land for the same energy produced.

Dimotakis also touched on carbon sequestration—using technology to find ways to remove carbon dioxide from the atmosphere. "We don't know how to do that quite yet," he said. "It may be a mix of underground and undersea approaches, along with reforestation."



NEW SITE FOCUSES ON CLIMATE CHANGE

JPL's new Global Climate Change website *[http://climate.jpl.nasa.gov],* devoted to educating the public about Earth's changing climate, provides easy-to-understand information about the causes and effects of climate change and how JPL studies it.

Highlights of the website include:

- A continuously updated snapshot of Earth's health, built from data on such climate indicators as the condition of ice sheets, global average temperatures, sea-level change and concentrations of key greenhouse gases
- Interactive visualizations of current climate data, including a Sea Level Viewer that provides views from space of ocean surface topography data and related phenomena such as El Nino; and a Global Climate Change Time Machine that takes users back in time to see how Earth's climate has changed in the past, and how it is projected to change in the future
- A downloadable desktop widget that allows users to track key indicators of climate change as measured by NASA satellites
- Background articles on the evidence, causes and effects, and uncertainties of global climate change, as well as links to selected resources that provide information about possible solutions
- NASA's Eyes on the Earth: An overview of ongoing JPL missions to study our planet's oceans, atmosphere, land, ice and biosphere
- The latest news and features from JPL on climate change research

Currently, JPL has six dedicated Earth science spacecraft in orbit, with another five instruments flying aboard NASA's Terra, Aqua and Aura spacecraft. In addition to the newly launched Ocean Surface Topography Mission/Jason 2, several more missions are planned for launch in the next few years, including the Orbiting Carbon Observatory, set for launch in January 2009.

News Briefs

Proposals awarded to JPLers

Numerous JPL researchers have been named as principal investigators on recently awarded proposals through the NASA Solicitation and Proposal Integrated Review and Evaluation System.

JPL won eight of the 21 proposals in the Instrument Incubator Program for innovative measurement techniques that have the highest potential to meet objectives and measurement capability requirements, as identified in the 2007 National Research Council decadal survey for Earth Science. The selections, funded for three years, will tie to future decadal survey missions. JPL will be awarded approximately $28 million.

The winners are:

Dave Diner, "Shortwave Infrared Polarimetric Imager for Aerosol and Cloud Remote Sensing;"

Steve Durden, "A Multi-Parameter Atmospheric Profiling Radar for Ace;"

William Folkner, "Laser Ranging Frequency Stabilization Subsystem for Grace II;"

Lee-Leung Fu, "Ka-Band Synthetic Aperture Radar Interferometry Studies for the Surface Water and Ocean Topography Mission;"

Simon Hook, "HyTES: A Hyperspectral Thermal Emission Spectrometer for High Spatial and Spectral Thermal Infrared Science;"

Bjorn Lambrigtsen, GeoStar technology development and risk reduction for Precipitation and All-weather Temperature and Humidity mission;"

Stan Sander, "Panchromatic Fourier Transform Spectrometer Instrument for the Geostationary Coastal and Air Pollution Events Mission;"

Paul Stek, "A Scanning Microwave Limb Sounder for Studying Fast Processes in the Troposphere."

In proposals selected for funding in the Near Earth Object Observations program, Steve Ostro is principal investigator for "Radar Reconnaissance of Near-Earth Asteroids." The proposed targets mostly are potentially hazardous asteroids not previously detected with radar, for which the FY 2008-2010 radar opportunity is the best for decades to centuries.

In the Planetary Astronomy Program, winners are:

Bonnie Buratti for "Photometry of Small Bodies in the Outer Solar System," proposed to observe outer solar system bodies to derive the surface properties of satellites and Kuiper Belt objects;

Mark Hofstadter for "Multi-Wavelength Imaging of Uranus and Neptune: Probing Tropospheric and Stratospheric Structure and Variability," which will use six different ground-based observatories to observe the two planets;

Stephen Lowry for "Formation and Evolution of Small Solar System Bodies," which will study changes in bodies' rotation rates, increase understanding of the physical nature of cometary nuclei and various solar system evolutionary processes, and perform detailed observations of cometary and asteroidal targets of spacecraft missions;

Glenn Orton for "Evolution of the Physical and Chemical State of Jupiter's Atmosphere During a 'Global Upheaval,'" which will observe cloud, temperature and compositional properties and examine the Jupiter's Great Red Spot and Little Red Spot;

Ostro, who was also named to lead "Radar Investigation of Main-Belt Asteroids," which will use the upgraded Arecibo telescope.

In the Mars Fundamental Research Program, Nathan Bridges will lead "Extracting Science From Rock Abrasion Tool Grinds" to establish correlations between the tool's specific grind energy measurements and more traditional, lab-measured rock strength parameters. Michael Mischna will lead "Paleoatmospheric Collapse and the Climate History of Mars" to reexamine the dynamics controlling heat transport and ice sheet formation processes using, for the first time, a model capable of resolving them.

In the Cryosphere Program, Eric Rignot was named to lead "Rheology and Stability of Larsen C Ice Shelf in Response to Climate Change," a remote-sensing and numerical-modeling study of Larsen C to determine its state of health and stability in response to climate warming.

For more information, visit *http://nspires.nasaprs.com.*

Praise for ephemeris website

Jon Giorgini of the Solar System Dynamics Group has been awarded the prestigious Harold Masursky Award by the Division of Planetary Sciences of the American Astronomical Society.

This award is given for "meritorious service to planetary science" and honors individuals who have rendered outstanding service to planetary science and exploration through engineering, managerial, programmatic or public service activities. Giorgini's award is due largely to his development and maintenance of the Horizons online system *(http://ssd.jpl.nasa.gov/?horizons)* that provides ephemeris information for many spacecraft and all the planets, natural satellites, comets and asteroids of the solar system.

Earlier this year, Giorgini was awarded the Ed Stone Award for the best JPL science research paper of 2007, one of two JPL awards.

Honors for video production

Shari Asplund, a member of JPL's Solar System Exploration Education and Public Outreach Forum, is a co-winner in an awards program sponsored by the International Academy of the Visual Arts as producer/writer for the video "Unlocking Mysteries of the Solar System."

Asplund and Rich Goldberg of the Applied Physics Laboratory won an Award of Distinction for an update of a Discovery Program overview video, originally produced in 2002. More than 9,000 entries were received for the annual Communicator Awards competition.

Passings

Gerald Bunce, 78, a retired group supervisor in the former Prototype and Mechanical Fabrication Services Section, died Feb. 26.

Bunce joined JPL in 1969 and retired in 1993. He is survived by his son, Timothy.

William Cason, 73, retired from the former Institutional Data Systems Section, died March 1.

Cason worked at JPL from 1974 to 1990. He is survived by his wife, Janine.

Robert Gardner, 86, retired from the former Ground Data Systems Section, died March 2.

Gardner worked at the Lab from 1952 to 1986. He is survived by daughters Pamela Gardner and Cynthia Hathaway, son-in-law George Hathaway, granddaughters Sage and Brook, and sister Betty Ann.

Steven Tyler, 61, a senior systems engineer in the Planning and Execution Systems Section, died March 14.

Tyler had worked at the Lab since 1979. He is survived by his wife, Terez, and son James.

Dorothy Labbe, 87, died April 10. She worked at JPL from 1968 to 1978.

Rex Brinkworth, 74, a retired mechanical and electrical engineer, died April 23.

Brinkworth worked at JPL from 1973 to 1995. He is survived by his wife, Marilyn, and children Adam, Candle and Kyle.

Carl DeForrest, 75, retired from the former Network Engineering and Distributed Systems Technology Section, died April 26.

DeForrest joined JPL in 1966 and retired in 1998. He is survived by his wife, Nancy, sons Lloyd, Ron and Keith, and daughter Nicole. Burial was at Riverside National Cemetery.

Forrest Merchant, 80, a retired senior publications editor for the Deep Space Communications Network, died May 9.

Merchant joined JPL in 1978 and retired in 1992. He is survived by children Gail, Brian, Karen and Deborah.

James Layland, 67, retired manager of the Telecommunications and Data Acquisition Office's planning office, died May 29.

Layland joined the Lab in 1965 and retired in 2005. He contributed technically in areas of signal detection convolutional codes, decoding and radio metrics, and led activities that defined the Deep Space Network configurations that supported the Voyager spacecraft during its encounters with Uranus and Neptune. In 1982, Layland received NASA's Exceptional Service Medal for Deep Space Network technical planning.

Layland is survived by his wife, Charlotte; son James and daughter Charlotte Ann; and grandchildren Evelyn, James, John and Jarrett.

Services were held at St. Bede's Catholic Church in La Canada.

Hugo Wahlquist, 78, a retired section manager and senior research scientist, died June 14.

Wahlquist, who joined the Lab in 1956, had an international reputation for work in soliton theory, general relativity and differential geometry, and cosmology. He served two terms on the editorial board of the Journal of Mathematical Physics. He also did experimental work, using the International Ultraviolet Explorer spacecraft to observe quasars and leading the search for low-frequency gravitational waves with the Cassini spacecraft. He managed the former Space Physics Section from 1982-84 and was a senior research scientist until his retirement in 1996.

Wahlquist is survived by his lifemate Melanie Savage; daughters Lynne, Leslie and Dana; and granddaughters Lindsey, Leah, Amanda, Cady, Maddie and Emma.

A memorial service is scheduled for Saturday, July 12, at 3 p.m. at Neighborhood Church in Pasadena.

Letters

Thank you, JPL, and my colleagues on the Mars Science Laboratory business team for the beautiful plant I received at the passing of my mother.

Neal Gates

My daughter and I would like to express our appreciation to our friends and co-workers for their outpouring of support and expressions of sympathy during this most difficult time after the recent passing of my mother (and grandmother). The beautiful flowers, your cards and the JPL plants were truly appreciated. Your thoughts and prayers have been a comfort and a blessing to us. Sincerely,

Karen and Leslie Callum

I would like to thank the ERC for the beautiful plant sent to my home after the recent passing of my beloved father. I would also like to thank all my colleagues for their kind words of comfort and support. Finally, I want to mention that the green plant the ERC sent to me 22 years ago when my grandmother (my father's mother) died is now a huge, lush, 10-foot tree in my living room! Sincerely,

Bonnie J. Buratti

Thank you to my JPL family for the prayers, cards and flowers during my father's (Jack Wager) illness and following his death. Your support and encouragement made a difficult time in the life of my family much easier to bear.

Randy Wager and family

I want to thank my friends and colleagues in Section 335 for their thoughts, condolences and kind words after the passing of my mother. Thanks also to JPL for the beautiful plant; it, too, was much appreciated.

Jim Zumberge

Retirees

The following JPL employees retired in July:

Conrad Foster, 50 years, Section 333; Thomas Duxbury, 42 years, Section 460; Carol Hix, 38 years, Section 1852; Sien-chong Wu, 32 years, Section 335H; Dennis Flower, 30 years, Section 8720; NT Brady, 29 years, Section 3451; Terry Martin, 29 years, Section 3222; Paul Firnett, 28 years, Section 316H; John Huang, 28 years, Section 337E; Sharon Mondrala, 24 years, Section 112; Deanne Stuhr, 13 years.

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