January 2000

SPACE TRACKS

A NAVAL SPACE COMMAND BULLETIN ON NAVAL SPACE ISSUES AND INITIATIVES

While the clutter of space debris in low-Earth orbit poses a growing threat to all satellites, of special concern is the protection of manned spacecraft, including the International Space Station (pictured in its completed configuration) currently under construction. NASA Illustration

Navy Employs Improved Space Debris Tracking Capability

Cover Story on Page 10

IN THIS ISSUE

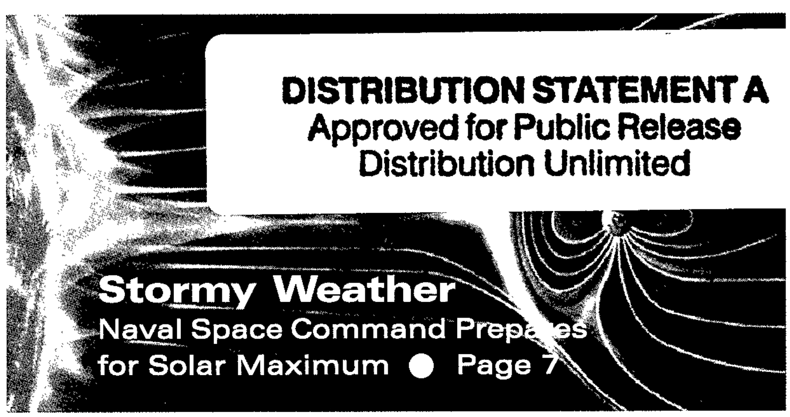
Navy Communications Satellite Successfully Launched ● Page 3

Mobile Satellite Services Hold Potential for Military ● Page 4

MUOS Addresses Mobile Warfighter Needs ● Page 5

Network Installation Doesn't Slow OPTEMPO ● Page 12

Navy Satellite To Chart Star Positions ● Page 16



Stormy Weather

Naval Space Command Prepares for Solar Maximum ● Page 7

NAVSPACECOM
DIRECTORY

Naval Space Command provides direct space support to Fleet and Fleet Marine Force operational units around the world, whether for routine deployments, exercises, or actions in response to a crisis situation. We take very seriously our duty of ensuring that our Sailors and Marines understand what products are available from space, how to access them, and how to exploit those products in the waging of war and peace.

❍ **Operational Status/Exercise Support Summaries**
Naval Space Command maintains a home page on the Global Command and Control SystemtTS) accessible to operational U.S. military forces worldwide at http://navspac1.navspace.navy.smil.mil or http://206.36.197.10.

❍ **Naval Space Operations Center** (540) 653-6500
Call Toll-Free at 1-888-404-6557. Source of space-related operational intelligence. Space reports and analyses are activated on request and are tailored to a deploying unit's operations and geographic area of movement. Tactical assessments of space system capabilities and vulnerabilities to potentially hostile space sensors are also available.

❍ **Naval Space Support Teams** (540) 653-6160
Naval Space Support Teams provide tailored information and training at all operational levels to include on-site training, exercise support, and staff augmentation.

❍ **Remote Earth Sensing Information Center** (540) 653-6520
Naval space Command employs imagery from remote Earth sensing satellites to support intelligence, planning, and operations. Our Remote Earth Sensing Information Center (RESIC) — formerly known as the MSI Cell — processes Landsat, SPOT, and Controlled Image Base (CIB) data in support of Fleet and Fleet Marine Force units. Hardcopy and softcopy products, specifically tailored to users' needs, are produced by RESIC and distributed to support forces participating in real-world crisis, operations, and exercises. RESIC products can be produced to support any of the following applications:

Planning	Intelligence Prep of the Battlefield
Target Area Analysis	Mission Rehearsal
Bathymetry	Amphibious Support
Order of Battle Disposition	Supplement MC&G Products
Change Detection	Trafficability
Broad Area Coverage	

Product requests can be submitted via GENADMIN message to: COMNAV–SPACECOM DAHLGREN VA//N313//, via facsimile to DSN 249-6167 or (540) 653-6167, via email to MSI@manta.nosc.mil, or via Naval Space Command's SIPRNET web page.

❍ **Internet On-Line Access**
Naval Space Command maintains a home page on the World Wide Web at URL http://www.navspace.navy.mil. Comments or requests for information may be forwarded to the Public Affairs Office via email to gwagner@ nsc.navy.mil.

NAVAL SPACE COMMAND

COMMANDER
Rear Admiral Thomas E. Zelibor

DEPUTY COMMANDER
Colonel John T. Hill

SPACE TRACKS

EDITOR
Gary R. Wagner

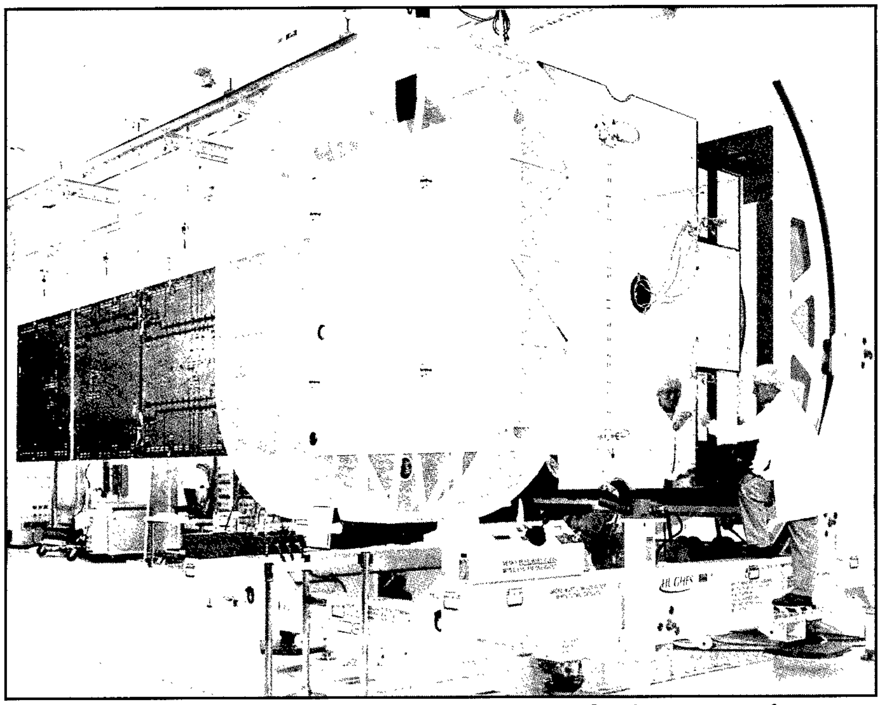
CONTRIBUTORS
Lt.Cmdr. J. J. Kinder
Lt.Cmdr. BrtBaldauf
Lt.Cmdr. Ray Lewis
JO2 Kaye Trammell
Thomas B. Sanford, Bonnie Watson
Jonathan P. Boers, Al Sapp

PRODUCTION
McDonald & Eudy Printers, Inc.
Temple Hills, Md.

CIRCULATION
B. J. Andersen, Susan Wright;
Administrative Support Branch

SPACE TRACKS is published four times a year in January, April, July and October as an official, authorized publication of Naval Space Command. Its purpose is to discuss naval space issues and initiatives, and promote a broader awareness of space support available to the naval warfighter. Information contained in Space Tracks does not necessarily reflect the official views of the U.S. Government, the Department of Defense, or the Department of the Navy. The editorial content is prepared by the Public Affairs Office of the Commander, Naval Space Command.

Address all correspondence to Editor, Space Tracks, Naval Space Command (Code 00P), 5280 Fourth St., Dahlgren, Va. 22448-5300; telephone (540) 653-6111, DSN 249-6111, FAX (540) 653-6108. Comments or queries may also be forwarded via email to gwagner@ nsc.navy.mil.



Deployment tests of a solar wing on the UHF Follow-On F10 spacecraft are conducted by Hughes Space and Communications Co. technicians. HSC Photo

Navy Communications Satellite Successfully Launched

The U.S. Navy's tenth UHF Follow-On (UHF F/O) communications satellite was launched from Cape Canaveral Florida's Space Launch Complex 36B on Nov. 23. The launch vehicle was an Atlas IIA with a Centaur upper stage that placed the 7,066-pound UHF Follow-On F10 communications satellite into an intermediate transfer orbit of 14,186 nautical miles apogee, 155 nautical miles perigee and an inclination of 27 degrees.

Subsequently, a team of Air Force, Navy and Hughes Space and Communications Co. (HSC) flight controllers located at the Air Force's 3rd Space Operations Squadron at Schriever Air Force Base, Colo., maneuvered the satellite into geosynchronous orbit over the Indian Ocean.

The Navy Communications Satellite Program Office (PMW 146) of the Space & Naval Warfare Systems Command (SPAWAR) in San Diego has overall responsibility for executing the procurement of the UHF communications satellites. In July 1988, a fixed-price contract based on competition was awarded to HSC to build the UHF F/O satellite constellation and place it in orbit. The initial agreement called for Hughes to build and launch one satellite, with options for nine more, for a total value of $1.9 billion.

In November, SPAWAR announced a $27.3 million fixed-price-option modification to the original contract to purchase an 11th UHF Follow-On communications satellite from HSC. This modification contains 12 option contract line items, which, if exercised, will bring the total cumulative value of the contract modification to $213,286,790. Currently, F11 is scheduled to carry UHF and EHF communications capability.

The UHF Follow-On communications satellite constellation is used to satisfy Department of Defense requirements for ultra-high-frequency (UHF), extremely-high-frequency (EHF), and Global Broadcast Service (GBS) communications, providing fleet broadcast to all Navy ships and command and control networks for selected aircraft, ships and submarines. Following the most recent launch, the UHF Follow-On constellation consists of eight modified 39-channel Hughes HS-601 satellites and one in-orbit spare.

The UHF F/O communications satellites replace the Fleet Satellite Communications (FLTSATCOM) spacecraft currently supporting the Navy's global communications network, serving ships at sea and a variety of other U.S. military fixed and mobile terminals. They are compatible with ground and sea-based terminals already in service.

Naval Space Command is the satellite communications systems expert (SSE) for the UHF Follow-On satellite constellation. The Naval Satellite Operations Center, a component of NAVSPACECOM headquartered at Point Mugu, Calif., executes spacecraft control, telemetry and monitoring for all spacecraft in the constellation once they complete on-orbit checkout and are ready for operational use.

The UHF F/O F10 satellite's solar array consists of two 34-foot solar wings that will generate at least 3,800 watts of power at the end of the spacecraft's service life. F10 is the third satellite to carry the high-capacity Global Broadcast Service payload consisting of four 130-watt military Ka-band transponders with three steerable downlink spot beam antennas and one steerable and one fixed uplink antenna. This antenna modification results in a 96 megabits-per-second (Mbps) capability.

The satellites transmit to small, mobile, tactical terminals. UHF satellites F2 through F9 are on orbit and operational. UHF F1 is functional, yet in an orbit that makes it unusable for its original purpose because of a launch vehicle failure. Satellites F8, F9, and F10 carry a Global Broadcast Service Ka-Band payload. The GBS capability provides high-speed, wideband, simplex broadcast signals to the warfighter. This interim GBS package will revolutionize communications for the full range of DoD's high-capacity requirements, from intelligence dissemination to quality-of-life programming. — *By Space and Naval Warfare Systems Command's Office of Congressional and Public Affairs*

Mobile Satellite Services for Naval Use

Commerical Systems Show Potential for Military Missions, But Fall Short In Meeting Requirements for Open-Ocean Coverage and Communications for Ground Units

By Thomas B. Sanford

Mobile Satellite Service (MSS) systems are satellite communications (SATCOM) systems, usually in low-Earth orbit (LEO), that are designed to provide voice, data or paging services via satellite to small, handheld terminals (telephones). Over the past several years, various companies have proposed and developed systems that may provide some or all of the above communications services. Several of these systems could be used to augment military communications systems for non-tactical purposes.

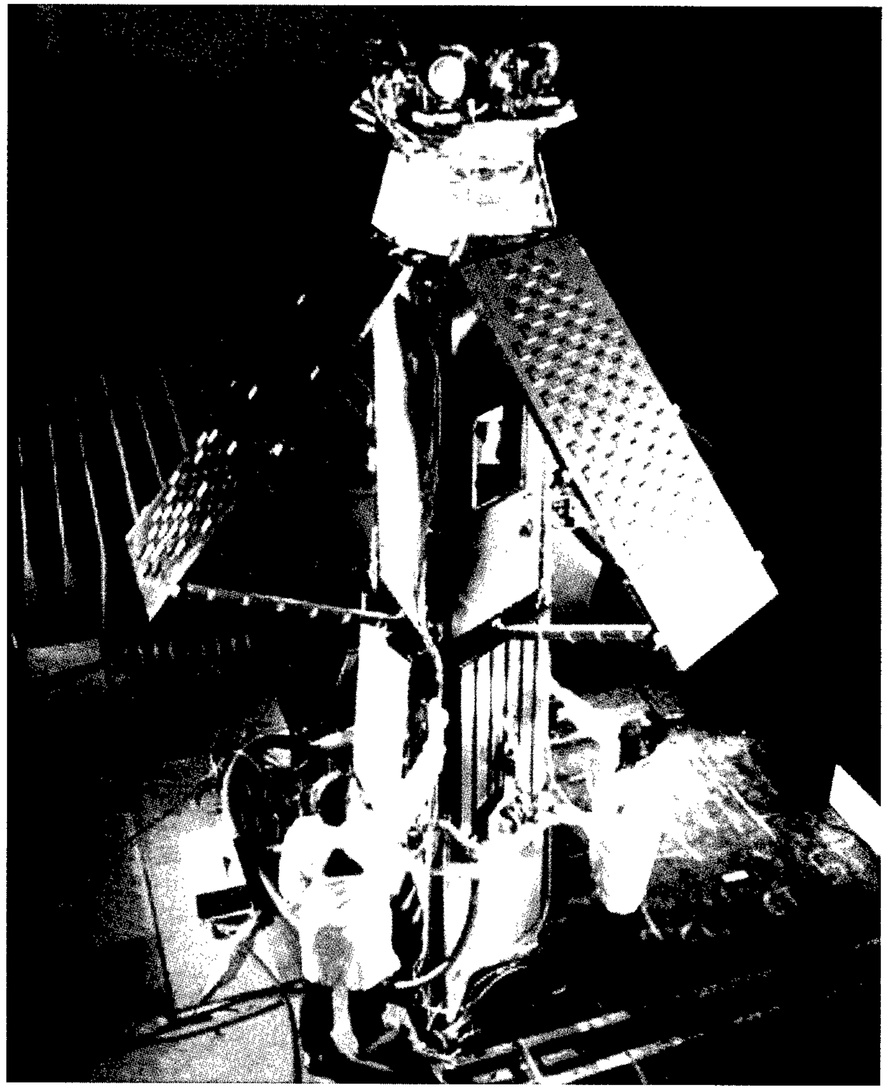
Military Requirements

There are many military requirements for SATCOM systems, including assured access, netted communications, joint interoperability, global coverage, communications-on-the-move, point-to-point and broadcast. The Department of Defense (DoD) examines emerging commercial SATCOM capabilities, and may increase the use of commercial systems in the future.

At present, operational and planned narrowband commercial SATCOM systems are not fully capable of meeting the above requirements, nor is there any great effort being expended by the involved companies to incorporate most of these requirements into their systems.

This is because these systems were designed for commercial (business) use, and not for military purposes. Most of the companies are willing to accommodate the government user, as long as extensive changes are not required to their system. Some of them are even willing to make requested changes to their systems, provided the government pays for the changes, and provided there are no conflicts with the needs of other customers.

MSS systems have been in the planning stages since the early 1990s. In April 1997, when the Joint Enhanced MSS (EMSS) Concept of Operations was approved, DoD had an agreement with Motorola to use the Iridium system. This agreement included the use of a DoD-owned gateway in Hawaii for all DoD Iridium communications, to allow military users to make secure calls without the fear of being geolocated.



Iridium satellites are the only MSS spacecraft currently operating that use crosslinks to help relay communications around the world. Photo Courtesy Iridium

Capabilities of MSS Systems

Of the cellular-telephone-like systems, Iridium was the first to launch satellites and to go operational. Iridium's potential usefulness derives from its use of satellite crosslinks, or intersatellite links, which are designed to allow a user on the ground to make telephone calls, or send low-speed data virtually anywhere in the world, providing the user has direct line-of-sight to a satellite. Crosslinks allow a signal to be sent from satellite to satellite until it reaches a point over a ground station nearest the call's destination, without relying on land-based telephone lines or cellular telephone sites. Iridium is the only current LEO MSS system that is designed to use crosslinks.

There is another type of MSS system that does not use crosslinks. This is known as a bent-pipe system. In this type of system, the user and a ground station (gateway) must both be in the footprint of the same satellite, thereby possibly limiting the system's ability to provide adequate coverage in some open-ocean regions.

When MSS systems were first envisioned, many people thought of them as a worldwide cellular telephone system. This image fit the marketing plans of at least one MSS provider but, in practice, cellular phones and satellite phones have a major difference.

MSS systems were designed to provide on-the-move communications capability for the business traveler. However, they require absolute line-of-sight to the satellite (this is more restrictive than cellular phones), making them unusable on many city streets (due to blockage from buildings), inside buildings (unless near a window, with a clear path to the satellite), or under dense jungle foliage.

Since most U.S. Navy surface ships have communications systems that provide greater capabilities than current MSS systems, shipboard use for MSS appears limited to search and rescue, emergency evacuation and disaster relief operations. Shore units that deploy personnel to remote locations may have greater use for these lightweight terminals to provide communications connectivity when no other means are available.

Current MSS Picture

The Department of Defense will continue to monitor the commercial MSS capabilities for potential usefulness to U.S. military forces. For the near future, commercial systems (e.g., INMARSAT and Iridium) will be used to augment military satellite communications systems. As the commercial sector matures and greater capabilities become available, DoD will explore the possibility of adapting new commercial systems for military use.

Author Thomas B. Sanford is a commercial SATCOM action officer in Naval Space Command's Plans Division at Dahlgren, Va.

UHF satellite communications work in harsh operational environments to support warfighters where they fight, on land or at sea. The joint community insists that MUOS must maintain those qualities. U.S. Navy Photo

By Al Sapp

No satellite system is designed to last forever. By 2007, Navy expects its newest UHF Follow-On (UHF F/O) satellite constellation to start to show its age.

Although the degraded health of the UHF Follow-On satellite constellation is several years away, Navy has already initiated work to study when and how to replace UHF F/O. In fact, Naval Space Command, with enthusiastic help from the joint community, is taking steps today to develop the requirements for a replacement system to UHF F/O called the Mobile User Objective System (MUOS).

Specifically, Naval Space Command is leading development of the MUOS Operational Requirements Document (ORD). The MUOS ORD shall state to the material developer and industry what the Department of Defense requires of the new satellite communications system.

By regulation, an ORD serves as the cornerstone document for any DoD program. In this case, the MUOS ORD contains the future narrowband satellite communication (SATCOM) operational requirements that, when met, will enable Sailors, Marines, soldiers and airmen to accomplish their respective missions during both war and peacetime.

Another UHF F/O "look-a-like" constellation won't satisfy future needs. Joint Vision (JV) 2010 doctrine, the U.S. military's better way to route the enemy, is not business as usual. Rather, JV2010 translates to a more dispersed, mobile and agile fighting force with greater demands on SATCOM services. Thus, what is needed is a satellite communication system better than UHF F/O that helps the warfighter dominate the future battle. MUOS shall answer that call.

The draft MUOS ORD contains operational performance requirements agreed upon by the joint community over a series of meetings held in Dahlgren, Va. In time, DoD shall acquire a system that meets the MUOS requirements.

Fielding System in 2007

Navy plans to start fielding the Mobile User Objective System in 2007. MUOS shall use technological innovations to service more users and provide a true "communications-on-the-move" capability. No matter what technology is employed, MUOS is required to maintain those positive capabilities associated with the UHF spectrum: communications in forested and urban terrain under adverse weather conditions.

The UHF communications signal is able to penetrate a double canopy for-

*(Please see **MUOS** on page 6)*

MUOS *(Continued from page 5)*

est or heavy rain to reach the satellite and, in turn, complete the link to the other user. With the traditional reliance upon UHF SATCOM, the warfighter has grown accustomed to communicating in all types of weather in which other types of SATCOM may prove unreliable.

Also, the U.S. military appreciates a radio, exemplified by UHF SATCOM, which functions under all types of combat whether in a heavily forested or urban environment. UHF SATCOM works in harsh operational environments and goes where the warfighter fights. The joint community insists that MUOS maintain those qualities.

Fixing Shortfalls

Yet, MUOS goes beyond simply perpetuating the virtues of UHF satellite communications. MUOS must fix some of the shortfalls of UHF F/O, such as insufficient capacity. People know a good thing when they see it. As a result, the demand for UHF F/O services is oversubscribed by 250 percent.

Analysis conducted by Naval Space Command shows that the demand for UHF type service is expected to increase. The Demand Assigned Multiple Access (DAMA) techniques and equipment offer considerable relief from the popularity of UHF SATCOM. Yet, MUOS takes the solution a step further by providing a capacity amount that is able to meet 100 percent of the forecasted demand for UHF in 2010.

Today, the military does not have a true communications-on-the-move UHF SATCOM terminal for the infantryman. Presently, a Marine must stop and orient the antenna on his PSC-5 Spitfire manpack terminal to talk on UHF SATCOM.

Once MUOS is fully fielded, a Marine may communicate on his handheld terminal while moving towards the objective. This is a dramatic change from today's cumbersome manpack terminals.

As the Department of Defense transitions from the UHF F/O constellation to MUOS, careful consideration must be given to the enormous investment made by all the services in acquiring UHF terminals prior to MUOS fielding. The bottom line is that MUOS must support interoperability between all users no matter what type narrowband SATCOM terminal is in use.

In summary, MUOS shall take advantage of advances in 21st century technology to give the warfighter a far more capable narrowband SATCOM system than UHF F/O. At the same time, MUOS shall maintain the all-weather and harsh operational environment capability found in the UHF SATCOM system today.

Naval Space Command takes its advocacy of Fleet requirements seriously and shall continue to lead development of the MUOS ORD until its final approval.

Author Al Sapp is employed by ARINC and supports Naval Space Command's Plans Division.

A critical requirement for the Mobile User Objective System will be to provide capabilities associated with the UHF spectrum: communications for ground forces operating in forested and urban terrain and under adverse weather conditions. U.S. Navy Photo

Contracts Awarded for MUOS Studies

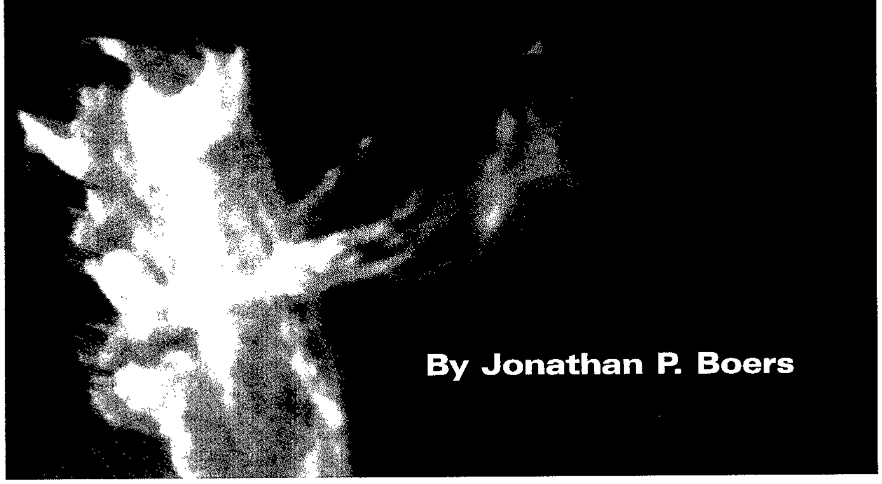
The Space and Naval Warfare Systems Command awarded four contracts in November valued at $700,000 each for Advanced Narrowband System/Mobile User Objective System concept studies.

Awards for the concept studies were made to Hughes Space & Communications Co. of Los Angeles, Lockheed Martin Missiles & Space of Sunnyvale, Calif., Raytheon Systems Company of St. Petersburg, Fla., and Spectrum Astro, Inc., of Gilbert, Ariz.

Advanced narrowband communications technology and the Navy's Mobile User Objective System (MUOS) will replace the current Navy Fleet Satellite Communications (FLTSATCOM) spacecraft and Ultra-High-Frequency Follow-On (UHF F/O) communications satellite constellations over the next two decades. These spacecraft currently provide narrowband tactical satellite communications to the Defense Department warfighter.

Solar Max

Naval Space Command Prepares to Maintain Satellite Tracking Through Forecasted Solar Storm



By Jonathan P. Boers

A major "solar storm" is forecast for Earth early this year. The event, also known as "Solar Maximum," can cause serious problems for radar, communications and space systems.

The sun continuously emits electromagnetic energy and electrically charged particles. Sometimes the flow of particles and energy increases dramatically and will cause disturbances in the near-Earth environment.

Western sunspot records start with the first telescopic observations by Galileo in 1611. It was found that the number of sunspots follows roughly an 11-year cycle, called the Sunspot or Solar Cycle. Generally, there is a four-year rise to a Solar Maximum, followed by a gradual seven-year decline to a Solar Minimum.

The last Solar Max was in July 1989 and was the third largest on record. The next Solar Max is projected to be in the early part of the year 2000.

Chaos in Space Object Catalog

There are two direct effects on the space object catalog from high solar activity.

First of all, the presence of free electrons in the ionosphere causes UHF and SHF radiowaves from spacetrack radars to be bent (or refracted), as well as slowed somewhat from the speed of light. This causes random errors in bearing and range data, which decreases the accuracy in orbit determination.

Once the catalog is degraded from the noisy radar data, the second effect kicks in. The extra energy deposited in the Earth's upper atmosphere heats the atmosphere, causing it to expand outward. Low Earth-orbiting satellites then experience denser air and therefore more drag than expected.

This drag decreases the object's altitude and increases its orbital speed. The result is that the satellite will be some distance below and ahead of its expected position when a ground radar or optical telescope attempts to locate it.

When this difference becomes large enough, sensors will not track the satellite at all and the object can no longer be maintained in the catalog.

The loss of the United States' Skylab space station was caused by solar activity. Geomagnetic activity was so severe, for such an extended period, that Skylab burned into the atmosphere years before it normally would have.

As NASA began to build its first Space Shuttle orbiters, the agency developed plans to use the space shuttle to reboost Skylab. However, it burned in years before the first orbiter left the ground.

1989 Solar Maximum

The Air Force's 55th Space Weather Squadron (55 SWXS) is the Department of Defense's designated lead in forecasting and warning of solar activity. Through a combination of ground and space-based sensors, they forecast future activity and report current and past activity.

The main gauge of solar activity for space object tracking is the hourly AP value. Normal solar activity will have an AP value of 25 or less. Any value above 25 is considered a solar storm.

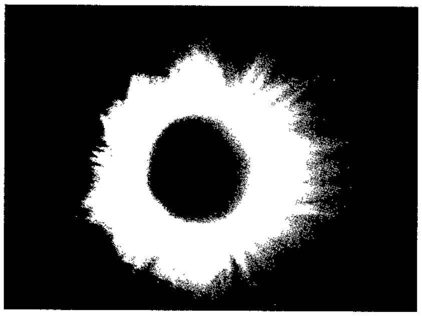
On March 13 and 14, 1989, the AP value jumped to over 100 for more than a day with a high of 388. This caused both the errors in tracking and the increased atmospheric drag on all satellites below 1,000 kilometers.

To cope with the storm, two strategies were employed. First, since data from Naval Space Command's space surveillance network, or "Fence," was not being identified automatically and was being placed on the database as "unknown," differential corrections could not be performed to update the orbits.

The normally tight association tolerances on the fence were loosened to associate the observations with the satellites. Also, every available orbital analyst at NAVSPACECOM pitched in to manually associate the observations that were obtained before the tolerances were relaxed.

The second strategy was to have the system perform automatic orbital updates as often as possible. The system being used to process observations in 1989 only updated orbits once per day, in a batch mode, under normal conditions. This was increased to twice and

*(Please see **Solar Max** on page 8)*



Solar Max

(Continued from page 7)

later three times daily until the atmosphere returned to normal.

The space object catalog was recovered and satellite orbits stabilized after about one week.

Prepared for Solar Max 2000

The two lessons learned from the 1989 storm were not forgotten: loosen tolerances and update frequently.

In 1995, Naval Space Command replaced its aging computing systems with the Naval Mission Processing System (NMPS). This system incorporates a new design that changes processing from large batch processing to near real-time processing.

Instead of waiting nearly an entire day between observation receipt and orbit update, the NMPS evaluates the need for correction within seconds of receipt. If a correction is needed, it is performed minutes later.

The tolerances for observation association are database fields and are easily updated and adjusted as needed.

As of the writing of this article, peaks as high as 293 have been endured without major impacts to the system. The more frequent orbital updates have proven enough to handle all the storms so far in this solar cycle.

The near-Earth space environment is neither empty nor benign. Solar activity can produce some significant and unpleasant impacts on satellites and their orbits. Through attention to lessons learned and sound system design, periods of high solar activity can be managed effectively.

Author Jonathan P. Boers is a mission analyst with Naval Space Command's NAVSPOC Operations Branch in Dahlgren, Va.

Solar Storms Have Wide-Ranging

By Lt.Cmdr. Brian K. Baldauf

While the Earth orbits our Sun at some 93 million miles distant, our planet, its fragile ecosystems and our technologies are nevertheless susceptible to dynamic fluctuations in energy released by the Sun.

Some major terrestrial results of solar variations are the aurora, proton events, and geomagnetic storms.

The aurora is a dynamic and delicate visual manifestation of solar-induced geomagnetic storms. The solar wind energizes electrons and ions in the magnetosphere. These particles usually enter Earth's upper atmosphere near the polar regions. When the particles strike the molecules of the thin, high atmosphere, some of them start to glow in different colors.

Aurorae begin between 60 and 80 degrees latitude. As a storm intensifies, the aurorae spread toward the equator. The aurorae provide pretty displays, but they are a visible sign of atmospheric changes that wreak havoc on technological systems.

Energetic protons can reach Earth within 30 minutes of a major flare's peak. During such an event, Earth is showered with highly energetic solar particles (primarily protons) released from the flare site. Some of these particles spiral down Earth's magnetic field lines, reaching the upper layers of our atmosphere.

One to four days after a flare or eruptive prominence occurs, a slower cloud of solar material and magnetic fields reaches Earth, buffeting the magnetosphere and resulting in a geomagnetic storm. These storms are extraordinary variations in Earth's surface magnetic field.

During a geomagnetic storm, portions of the solar wind's energy is transferred to the magnetosphere, causing Earth's magnetic field to change rapidly in direction and intensity.

Disrupted Systems

Communications. Many communication systems utilize the ionosphere to reflect radio signals over long distances. Ionospheric storms can affect radio communication at all latitudes. Some radio frequencies are absorbed and others are reflected, leading to rapidly fluctuating signals and unexpected propagation paths.

TV and commercial radio stations are little affected by solar activity, but ground-to-air, ship-to-shore, Voice of America, Radio Free Europe, and amateur radio are frequently disrupted. Radio operators using high frequencies rely upon solar and geomagnetic alerts to keep their communication circuits up and running.

Some military detection or early-warning systems are also affected by solar activity. The Over-the-Horizon Radar bounces signals off the ionosphere in order to monitor the launch of aircraft and missiles from long distances. During geomagnetic storms, this system can be severely hampered by radio clutter. Some submarine detection systems use the magnetic signatures of submarines as one input to their locating schemes. Geomagnetic storms can mask and distort these signals.

Navigation Systems. Systems such as LORAN and OMEGA are adversely affected when solar activity disrupts their radio wavelengths.

The OMEGA system consists of eight transmitters located throughout the world. Airplanes and ships use the very low frequency signals from these transmitters to determine their positions. During solar events and geomagnetic storms, the system can give navigators information that is inaccurate by as much as several miles.

If navigators are alerted that a proton event or geomagnetic storm is in progress, they can switch to a backup system. GPS signals are affected when solar activity causes sudden variations in the density of the ionosphere.

Impact on Earth and Space Environment

Satellites. Geomagnetic storms and increased solar ultraviolet emission heat Earth's upper atmosphere, causing it to expand. The heated air rises, and the density at the orbit of satellites up to about 1,000 kilometers increases significantly. This results in increased drag on satellites in space, causing them to change orbit slightly.

Unless low-Earth-orbit satellites are routinely boosted to higher orbits, they slowly fall, and eventually burn up in Earth's atmosphere. Skylab is an example of a spacecraft re-entering Earth's atmosphere prematurely as a result of higher-than-expected solar activity.

As technology has allowed spacecraft components to become smaller, their miniaturized systems have become increasingly vulnerable to the more energetic solar particles. These particles can cause physical damage to microchips and can change software commands in satellite computers.

Another problem for satellite operators is differential charging. During geomagnetic storms, the number and energy of electrons and ions increases. When a satellite travels through this energized environment, the charged particles striking the spacecraft cause different portions of the spacecraft to be differentially charged. Eventually, electrical discharges can arc across spacecraft components, harming and possibly disabling them.

Bulk charging (also called deep charging) occurs when energetic particles, primarily electrons, penetrate the outer covering of a satellite and deposit their charge in its internal parts. If sufficient charge accumulates in any one component, it may attempt to neutralize by discharging to other components. This discharge is potentially hazardous to the satellite's electronic systems.

Radiation Hazards to Humans

Intense solar flares release very-high-energy particles that can be as injurious to humans as the low-energy radiation from nuclear blasts. Earth's atmosphere and magnetosphere allow adequate protection for us on the ground, but astronauts in space are subject to potentially lethal dosages of radiation.

The penetration of high-energy particles into living cells, measured as radiation dose, leads to chromosome damage and, potentially, cancer. Large doses can be fatal immediately.

Solar proton events can also produce elevated radiation aboard supersonic aircraft flying at high altitudes over the polar caps. To minimize this risk, routine forecasts and alerts are sent through the FAA so that a flight in potential danger can alter its course and reduce altitude to minimize radiation exposure.

Electric Power

When magnetic fields move about in the vicinity of a conductor such as a wire, an electric current is induced into the conductor. This happens on a grand scale during geomagnetic storms. Power companies transmit alternating current to their customers via long transmission lines. The nearly direct currents induced in these lines from geomagnetic storms are harmful to electrical transmission equipment.

On March 13, 1989, in Montreal, Quebec, 6 million people were without commercial electric power for nine hours as a result of a huge geomagnetic storm. Some areas in the northeastern U.S. and in Sweden also lost power. By receiving geomagnetic storm alerts and warnings, power companies can minimize damage and power outages.

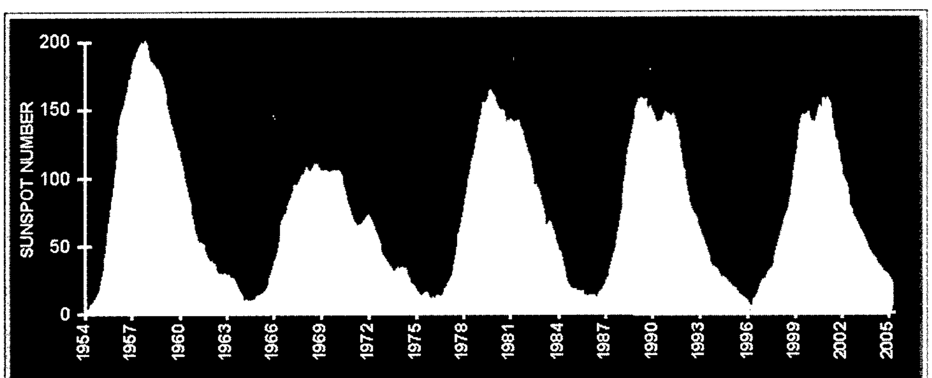
Climate

The Sun is the heat engine that drives the circulation of our atmosphere. Although it has long been assumed to be a constant source of energy, recent measurements of this solar constant have shown that the base output of the Sun can vary by up to two-tenths of a percent over the 11-year solar cycle.

Temporary decreases of up to one-half percent have been observed. Atmospheric scientists say that this variation is significant and that it can modify climate over time. Plant growth has been shown to vary over the 11-year sunspot and 22-year magnetic cycles of the Sun, as evidenced in tree-ring records.

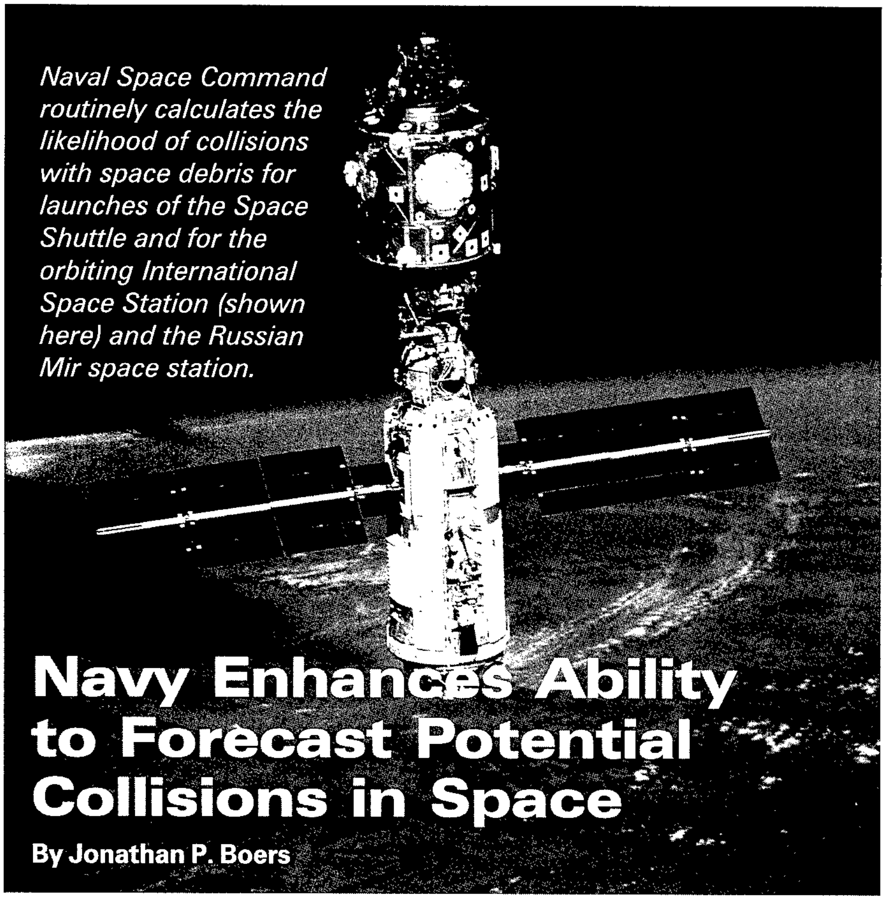
During proton events, many more energetic particles reach Earth's middle atmosphere. There they cause molecular ionization, creating chemicals that destroy atmospheric ozone and allow increased amounts of harmful solar ultraviolet radiation to reach Earth's surface.

A solar proton event in 1982 resulted in a temporary 70-percent decrease in ozone densities.



Sunspot activity roughly follows an 11-year cycle, characterized by a four-year rise to a Solar Maximum followed by a seven-year decline to a Solar Minimum. We are entering the peak of Solar Cycle 23 which is forecast in the graph above.

Author Lt.Cmdr. Brian Baldauf is the meteorology and oceanography officer for Naval Space Command's Plans Division. He compiled this article from various sources, including the Naval Research Laboratory, Space Environmental Center, and Air Force Space Command's 55th Space Weather Squadron (SWXS).



Naval Space Command routinely calculates the likelihood of collisions with space debris for launches of the Space Shuttle and for the orbiting International Space Station (shown here) and the Russian Mir space station.

Navy Enhances Ability to Forecast Potential Collisions in Space

By Jonathan P. Boers

Naval Space Command has maintained a catalog of all known space objects for almost 40 years. How the command does this is about to take a giant leap forward in sophistication and accuracy.

In July 1999, the command's Special Perturbations Catalog System (SPeCS) became operational. The near-Earth portion of the resident space object (RSO) catalog — about 3,500 objects — is now maintained to a level of accuracy previously possible only for a couple of satellites.

SPeCS will be able to maintain the entire resident space object SP catalog (about 9,500 objects) by mid 2000.

More Accurate Catalog

There are two methods for describing and predicting satellite orbits: general perturbations (GP) and special perturbations (SP). Theoretically all satellites travel along elliptical orbits. The GP method calculates a best-fit ellipse from using radar and optical observations.

In reality, satellites are affected by outside forces great enough to push the satellite many kilometers away from the predicted ellipse. These forces include atmospheric drag, lunar and solar gravity, irregularities of the Earth, ocean tides, sensor biases and several others. GP software attempts to model these forces, but its computational method is simplified and cannot account for all these factors.

The SP method goes to the other extreme by modeling as many of these forces as theory allows, no matter what the computing cost. The traditional SP method does not have enough computing power available to work more than a few satellites, and compromises were made to keep run times at a minimum. SPeCS uses the latest and most complete SP models available, running with enough computing power to process thousands of satellites at SP levels of accuracy.

To explain the difference in accuracy, consider satellite #22076 (common name "Topex/Poseidon"), a scientific satellite. This satellite is tracked by U.S. Space Command's Space Surveillance Network (SSN) radar sites, optical sites, and high-precision satellite LASER ranging tracking stations.

After incorporating LASER tracking data and the full force model SP method, satellite motion can be predicted to less than 1 meter. Using SSN data and the traditional SP method (Mission SP), prediction errors are 200 to 700 meters.

SpeCS (SPK) can process the same SSN data and generate predictions within 10 to 100 meters (SPK). This example represents "best case" since this satellite is well tracked. Most satellites are not as well tracked, so the results are proportionally less accurate.

SP processing produces improved state vectors and a covariance matrix. For the first time, we can send a customer a state vector and also quantify its accuracy.

Who are some of the potential users of this more accurate data? NASA, as a partner in the International Space Station (ISS) program, has documented a requirement for a SP catalog with covariance for all satellites with perigees (lowest point in the orbit) less than 600 kilometers (about 2,100 satellites). No human spaceflight missions are currently planned to go higher than these orbits.

In addition, the National Reconnaissance Office (NRO) stated a need for a complete SP catalog.

Finally, Naval Space Command is a potential customer for SP data in the operation of its space surveillance sensor known as the "Fence," which is composed of a network of space track transmitters and receivers across the southern continental United States.

The Fence will be upgraded in frequency and sensitivity over the next several years, significantly increasing the size of the space object catalog. To process the increased number of observations, more accurate predictions are essential and only achievable with a system that can maintain a SP catalog.

Evolution of Parallel Processing

Naval Space Command and the Naval Research Laboratory (NRL) have investigated and developed parallel process-

Lee Hurlock (foreground), an orbital analyst, discusses a display of predicted satellite conjunctions using the new special perturbations process with Wendy Brown, head of Naval Space Control Center (NSCC) analyst operations.

ing technology since 1991. The future of handling catalog growth depends on parallel processing. Serial machines capable of the estimated processing power are very expensive, while parallel processing uses many slower and less expensive processors to do the same job.

Initially, parallel processing was based on machines like NRL's Connection Machine CM-5. NRL paralleled two software applications (COMBO and SAD) that Naval Space Command used on serial processors. Jobs that previously ran for days were running in hours.

Then this technology changed course. Instead of purpose-built parallel processors, virtual parallel machines were created from existing workstations. Parallel Virtual Machine (PVM) is a software application that utilizes existing networked processors and logically creates a single virtual machine. A master program assigns tasks to slaves. When a slave finishes a task, another task follows.

Avoiding Space Collisions

COMBO (Computation of Miss Between Objects) computes how close a satellite's elliptical orbit approaches another selected satellite's ellipse. COMBO is used for collision avoidance for the Space Shuttle and the International Space Station (ISS).

After more than a year-and-a-half of on-orbit Shuttle flights, the shuttle has performed nine maneuvers to avoid cataloged objects predicted to penetrate a "safety box" whose parameters are 10 kilometers radial, 50 kilometers in-track, and 10 kilometers cross-track centered on the vehicle.

The parallel COMBO algorithm demonstrated at NAVSPACECOM used up to 22 medium-performance workstations to calculate conjunctions on all U.S. satellites of military interest against all cataloged objects for a period of seven days. The total process took less than one hour.

Identifying the Unknown

SAD (Search and Determine) is used by orbital analysts at NAVSPACECOM to associate uncorrelated targets (UCTs) and to generate possible element sets from the database of UCT observations.

The software generates candidate element sets from every possible pair of UCT radar observations and compares each candidate against the entire database of observations.

Parallel SP processing will allow Naval Space Command to maintain the entire catalog of Earth-orbiting satellites with an accuracy never before possible. As space becomes crowded, parallel SP processing will increase space flight safety and greatly facilitate satellite orbital planning.

Naval Satellite Operations Center Completes Y2K Certification

Two-Year Effort Culminates in Successful Checkout and Implementation of Compliant Software For All Mission-Critical Space Operations Functions

The Naval Satellite Operations Center (NAVSOC) updated the Naval Y2K Tracking System in June, reporting the successful completion of the five-phase Y2K management process for all four of the command's mission-critical systems.

The final step in this effort came with the successful installation of the Integrated Satellite Control System (ISCS) version 8.2 software on June 29.

Under the direction of commanding officer Capt. James Lyons and technical director for NAVSOC's Operations Directorate, Mike Crawford, the installation culminated an on-time, on-budget, two-year effort involving almost everyone at the command.

Financial and contracting personnel assured managed funds while software engineers constructed the program code. Satellite engineers and operators tested and verified the functionality of the code. Finally, facilities and maintenance personnel assured continued support and operations during critical system roll-over periods.

To consolidate efforts and reduce cost, the ISCS system Y2K management team combined Y2K tasks with system changes required for the commanding transition of the UHF Follow-On (UHF F/O) satellite constellation. In spite of the delay of the launch of UHF F/O Flight 10, NAVSOC maintained an ambitious schedule and completed the ISCS revisions on time.

The Y2K management process for ISCS proved to be an extensive effort. NAVSOC completed the Awareness Phase in June 1997 and the Assessment Phase in December 1997.

When the Renovation Phase was completed in August 1998, the work had really only just begun. After comple-

*(Please see **NAVSOC** on page 12)*

High OPTEMPO, Careful Planning And A New Information Network

By Lt.Cmdr. J. J. Kinder

In the United States Navy, a Ship of the Line will put into port to have a new combat system or vital command and control network installed. While in port, the ship lowers its operational readiness rating for a brief period while system engineers and technicians descend upon her and make quick work of installing a new electronic system.

This is to be expected for a Ship of the Line. Ship's company look forward to these periods in port. There is time to focus on repairs and the implementation of new capabilities. It is a welcome break in an otherwise heavy operational schedule, which is often measured in a term known as OPTEMPO.

Operational Tempo (OPTEMPO) is more simply put, "the time an operational unit spends away from homeport." Sailors often boast of high OPTEMPO when what they would really like to say is that they are performing their war-time mission 24 hours a day, 365 days a year.

Recently, Naval Space Command (NAVSPACECOM) matched that salty boast when it undertook a major network installation and never missed a commitment.

Following the trend set by the Fleet with its Information Technology 21 initiative, NAVSPACECOM set about to design a new command and control network that would take advantage of an existing infrastructure originally put in place to support the command's space control mission and basic office management applications.

The new network was named the Command and Control Network (C2 Network) due to its inseparable link to the primary mission functions of the command.

Integrating Old and New

The command's legacy system was a "secret high" network, which ran in a complex UNIX-based operating system environment. This made it cumbersome when dealing with other Fleet and space technology users.

Command users demanded a modern, easy-to-use network with common, yet powerful applications that were in use throughout the Department of the Defense. It had to allow users to communicate at both the classified and unclassified levels with users throughout the world.

In addition, the C2 Network would have to maintain its ability to communicate with the legacy system without a break in OPTEMPO.

Naval Space Command staff performed the majority of the design, procurement, installation and management of the C2 Network, with occasional assistance from experts in network configuration. System administrators attended various training opportunities while organizational charts were shuffled in order to adapt to the network capabilities.

In addition, the entire command had the opportunity to attend application software training to become familiar with new network tools.

Using the analogy of the Ship of the Line once more, a shipboard system engineer from Naval Sea Systems Command or Space and Naval Warfare Systems Command might expect several weeks of uninterrupted installation, integration and testing time with the ship pier side, and the ship's company available in direct support.

Naval Space Command enjoyed no such luxury as it wove the new network into the fabric of the old, while managing a complicated and integrated project task list that would make the most polished program manager cringe.

The new C2 Network was the brainchild of the Michael Carr, NAVSPACECOM technologies architect and his systems engineer Phong Hyung. Assisted by a score of headquarters civilian personnel, Sailors and a contract network

NAVSOC

(Continued from page 11)

tion of the development, checkout and implementation of the UHF F/O commanding changes in January 1999, NAVSOC engineers and technicians began the Y2K Testing Phase.

NAVSOC conducted Y2K operations with both UHF Follow-On and Fleet Communications Satellites (FLTSATs) through NAVSOC headquarters and remote sites and Air Force Satellite Control Network sites.

For test operations, ground system clocks were set to roll over through a sequence of critical dates: Dec. 31, 1999 to Jan. 1, 2000; Feb. 28-29, 2000; Feb. 29 to March 1, 2000; Dec. 30-31, 2000; and Dec. 31, 2000 to Jan. 1, 2001.

Developing exhaustive test procedures meant trial and error, but, with those procedures in place, the tests ran smoothly. The successful completion of the last test allowed Rear Admiral Thomas E. Zelibor, commander for Naval Space Command, to certify on May 24 that ISCS was Y2K-compliant for UHF Follow-On and FLTSAT operations.

Finally, NAVSOC prepared for the Implementation Phase. The command implemented the ISCS version 8.2 software at headquarters, Laguna Peak, Detachment ALFA, and Detachment CHARLIE on June 23. After a control period that verified continued successful operations, NAVSOC completed the Detachment DELTA site installation on June 29.

Naval Satellite Operations Center engineers completed the Y2K management process for three other mission critical systems at the command. The Navy Ionospheric Monitoring System (NIMS) Auxiliary Command and Monitoring System

Members of the technical staff who continue to oversee the development of the C2 Network include (front left to right) Dawn Lowe, DS2 Kevin Rawlings, Lt.Cmdr. J. J. Kinder, (back left to right) Phong Huynh, Beth Dickey, Steven Heinlein, Cliff Tichenor, ET1 Clayton Frayser, CTOC Kenneth Searles, and Michael Carr.

engineer, Carr steered this complex project through its course to completion.

Weekly network users meetings established an essential link to system users throughout the installation and integration phase of the project. User feedback was essential as the integration effort proceeded, providing new services while maintaining the old.

Garnering Feedback

The "users" meeting remained in place after project completion as a forum to better serve command-wide requirements and assist in future C2 Network development.

NAVSPACECOM has plans for additional improvements in the C2 Network as the command project management staff coordinates an upgrade to the network operating system, while installing enterprise systems management (ESM) software.

ESM technologies allow administrators to monitor the performance of the network, allowing corrective action to be taken before system users are impacted.

These baseline efforts will ensure that Naval Space Command's C2 Network stands ready to join the Navy/Marine Corps Intranet (N/MCI) as it moves toward its initial operational capability in December 2001.

Although the planning for the new network spanned a period of three years, the actual installation began in 1998 with command users migrating to the C2 Network over a very busy nine-month period.

To say the migration went smoothly would be understating the complexity of such an endeavor, but with the patience of the entire headquarters staff and the perseverance of the technical support staff, the C2 Network is now in place, operational, with no increase in staffing, no increase in the command ADP support budget, and no system down time that impacted the command's OPTEMPO.

Author Lt.Cmdr. J. J. Kinder is NAVSPACECOM's C2 Network Program Manager. He recently transferred from the Surface Warfare community to the Fleet Support community after serving as an executive officer for joint and combined exercises at U.S. Southern Command, and department head tours as chief engineer aboard USS Germantown (LSD 42) and operations officer aboard USS St. Louis (LKA 116).

(NACMS) checked out satisfactorily on Dec. 14, 1998. A dedicated satellite operator uses this system to perform commanding operations and telemetry monitoring for the NIMS satellites.

The Naval Satellite Operations Center's Y2K team ensured compliance in the FLTSAT EHF package operations centers (FEPOCs) on Feb. 11, 1999. The FEPOCs perform commanding operations and telemetry monitoring for the FLTSAT EHF packages on FLTSAT 7 and 8. These packages provide EHF communications for operational and RDT&E users.

The Navy EHF SATCOM Program (NESP) adaptation and ephemeris data support system (NAEDSS) met compliance criteria on April 13. The Naval Satellite Operations Center uses this system to provide adaptation and ephemeris data to Navy EHF communication users. The data is used throughout DoD by the AN/USN-38 EHF communications terminals.

In spite of the compressed time line to perform all stages of the Y2K certification due to the UHF Follow-On constellation turnover, the NAVSOC Y2K management team used planning and extensive coordination to ensure all systems met the demanding criteria.

NAVSOC also has developed contingency plans, some of which have been exercised in dress rehearsals. On July 27, NAVSOC complied with a congressional mandate that all Navy mission critical systems undergo operational evaluations by participating with U.S. Central Command in a successful Y2K exercise using UHF F/O and FLTSAT satellites.

While contingency plans are in place for all eventualities, NAVSOC personnel expect the Y2K rollover to be business as usual.

SPACE BILLETS

OFFICERS

The following is a partial listing of officer billets with space missions, whose incumbents are scheduled to transfer between May-December 2000. for specific billet information and actual availability dates, contact your detailer.

Billets With Subspecialty Code XX75 (Space Systems – General)

ACTIVITY	TITLE	BDES	BGRD	BSUB1	BSUB2	AVAIL
OPNAV	DIR NAVY SPACE SYS DIV	1050	CAPT	0075Q		0005
OPNAV	HD SPACE INFO TRANSFER	1050	CAPT	0075P		0006
USSPACECOM	CH READINESS	1050	CAPT	0075S		0007
NAVSOC	EXEC OFF	1000	CDR	0075S		0008

Billets With Subspecialty Code XX76 (Space Systems – Operations)

ACTIVITY	TITLE	BDES	BGRD	BSUB1	BSUB2	AVAIL
CNSC DET VB	AF EXCHANGE OFF	1000	LCDR	0076P		AVAIL
CNSC DET VB	AF EXCHANGE OFF	1000	LT	0076P		AVAIL
JNTSTF JCS WASH	ACTION OFF	1000	CDR	0076S		0004
USSPACECOM	V/DIR INTELL	1630	CAPT	0076S		0004
OSD	DEP DIR TECH COORD	1610	CDR	0076P		0005
USSPACECOM	MILSATCOM	1050	CDR	0076P		0005
USSPACE CB OPSTAF	MLS INT OFF	1700	LT	0076S		0005
USSPACE CB OPSTAF	SPACE CONTROL	1700	LT	0076S		0005
USSPACECOM	SPACE SYS OFF	1700	CDR	0076P		0005
USSPACE CD OPSTAF	SPACE CONTROL	1050	CDR	0076S		0005
USSPACECOM	BMD PLNS OFF	1000	LCDR	0076S		0006
OPNAV	OPINTEL MGT/N632 HD TENCAP	1610	CDR	0076S		0007
OPNAV	SPACE ACQ/N633D ASST IMAGERY	1630	LCDR	0076P		0007
CNSG FT MEADE	CLASSIC WIZ OPS	1610	LCDR	0076P		0007
USSPACECOM	MC&G OFFICER	1800	LCDR	0047P	0076S	0007
NAVSPACECOM	OPS/INTEL	1000	LCDR	0076S		0007
JNSTF JCS WASH	ACTION OFF	1000	CDR	0076R		0007
NSGCD DET POT DC	CLASSIC WIZ OPS	1610	LT	0076P		0008
NAVSPACECOM	PLANS & POLICY	1700	LCDR	0076P		0010
NAVSPACECOM	OPS/INTEL/NSST	1630	LT	0076S		0010
NAVSPACECOM	INTEL BRANCH HD	1630	LCDR	0076S		0010
USSPACECOM	CMD DIR	1050	CAPT	0076Q		0010
NAVSPACECOM	OPS/INTEL	1610	LCDR	0076P		0011
NAVSPACECOM	OPS/INTEL/NSST	1700	LCDR	0076P		0012

Billets With Subspecialty Code XX77 (Space Systems – Engineering)

ACTIVITY	TITLE	BDES	BGRD	BSUB1	BSUB2	AVAIL
SPAWAR SPTECH PG	DPJ ENGCOOR/HD ADV PROG DIV	1510	CAPT	0077P		0005
NAVSOC PT MUGU	ELX ENG/SAT MGR	1510	LT	0077S		0005
SPAWARSYSCOM	MAJ PJ MGR SEL/OM GLOBAL NAV	1510	CAPT	0077P		0006
NAVSPACECOM	SPACE PLANS DIV	1000	LCDR	0077P		0007
SPAWAR	SPACE PJ TECH	1510	CDR	0077P		0008
USNELMT DODPROJ	DIR OPS OSO	1050	CAPT	0077P		0008
USSPACECOM	ELEC ENG	1050	LT	0077S		0009

ENLISTED BILLETS

AT NAVAL SPACE COMMAND
DAHLGREN, VIRGINIA

Following is the allowance for enlisted personnel at Naval Space Command, Naval Surface Warfare Center Dahlgren Division, Dahlgren, Va. Dahlgren is located approximately 50 minutes from Washington, D.C., and three hours from Norfolk, Va. The base is also home to the Aegis Training & Readiness Center and the Navy's only active gun testing range. You will also find a small Navy Exchange, commissary, gymnasium, auto and wood hobby shops, year-round pool, library, chapel, theater, and numerous outdoor recreation facilities. If you would like more information about one of the Navy's "best kept secret" duty stations, or would like a welcome aboard package, feel free to contact Lt.Cmdr. Ray Lewis at DSN 249-5152 or commercial (540) 653-5152 (email address: lewis@nsc.navy.mil) or the Command Master Chief, ETCM Alan Kinder. Master Chief Kinder can be reached at DSN 249-6115 or commercial (540) 653-6115 (email address: akinder@nsc.navy.mil). If you are interested in receiving orders to Naval Space Command, contact your detailer.

CTA:		E7:1	E6:2	E5:2	E4:1
CTR:			E6:1	E5:2	
EA:		E7:1			
ET:		E7:2		E5:4	E4:2
EW:	E8:1			E5:2	E4:2
FC:			E6:1		
IS:		E7:1	E6:2	E5:4	E4:3
NC:		E7:1			
OS:		E7:3	E6:5	E5:3	E4:13
RM:		E7:2	E6:3	E5:9	E4:1
SK:				E5:1	
YN:			E6:1	E5:2*	

*One YN2 billet is TAR.

NEWS BRIEFS

New Chief of Staff Joins Naval Space Command Headquarters

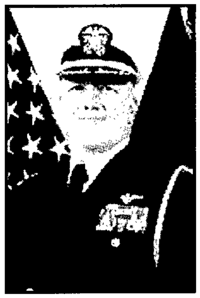
Captain Allen A. Efraimson assumed the duties as the Chief of Staff for Naval Space Command in September 1999. He comes to Dahlgren from a three-year tour as commanding officer of U.S. Naval Air Station Keflavik, Iceland.

A native of Syracuse, N.Y., he initially enlisted in the Navy as an aviation fire control technician. Serving with Attack Squadron VA-37, he completed cruises aboard USS *Kitty Hawk* and USS *Saratoga*.

He completed his enlistment in 1970 and attended Syracuse University, where he graduated with a bachelor's degree in management. Returning to the Navy, he attended Aviation Officer Candidate School in Pensacola, Fla., and was designated a Naval Aviator in October 1974.

Capt. Efraimson's next assignments were with Patrol Squadrons VP-56, which included deployments to Iceland and Sicily, and VP-30, where he was an instructor pilot and communications officer.

From April 1981 to June 1983, Capt. Efraimson was assigned as an exchange officer to 407 Squadron at the Canadian Forces Base in Comox, British Columbia. He was awarded the Canadian Maritime Air Group Commander's Commendation for his efforts in training pilots and flight engineers on the Aurora (CP-140) aircraft during his tour.


Capt. Efraimson

In July 1983 he reported for a two-year tour at the Bureau of Naval Personnel in Washington, D.C., as the enlisted aircrew and new construction rating assignment officer. Following refresher training at VP-30, he reported to Patrol Squadron VP-45 where he served as the safety/NATOPS officer and maintenance officer. During this tour he deployed to Bermuda and Sigonella. Upon completion of his tour with VP-45 in June 1988, he was assigned as the executive officer of U.S. Naval Air Station, Bermuda.

Capt. Efraimson assumed the duties of executive officer for VP-56 in October 1990 and subsequently served as the commanding officer of VP-45 until April 1992, deploying to Keflavik, Iceland.

He earned a master's degree in national security and strategic studies from the Naval War College in 1993 and then worked for three years at U.S. Space Command in Colorado Springs, Colo., where he served as a space defense director, mission director and chief of the European Command Joint Space Support Team prior to his assuming command at NAS Keflavik in July 1996.

Community Service Recognized

Fleet Surveillance Support Command (FSSC) was awarded the 1999 Commander Navy Region Mid-Atlantic's Community Service Award in November.

The citation recognized the command's Personal Excellence Partnership and Environmental Stewardship programs, which have been nominated for Navy-wide recognition.

FSSC, a component organization of Naval Space Command, is headquartered in Chesapeake, Va., and is charged with operating the Navy's Relocatable Over-the-Horizon Radar.

SPACE COURSES

Interservice Space Intelligence Operations Course (ISIOC)

The ISIOC is offered to military and civilian personnel (O-4 and below) at the SI/TK level, in all the armed services who work as space systems operators.

20 MAR - 31 MAR 00	05 JUN - 16 JUN 00
10 APR - 21 APR 00	10 JUL - 21 JUL 00
01 MAY - 12 MAY 00	07 AUG - 18 AUG 00
	11 SEP - 22 SEP 00

Interservice Space Intelligence Operations Senior Course (ISIOSC)

A condensed version of ISIOC, the ISIOSC is offered for senior officers, O-5 and above, also at the SI/TK level.

23 MAY - 26 MAY 00	29 AUG - 01 SEP 00

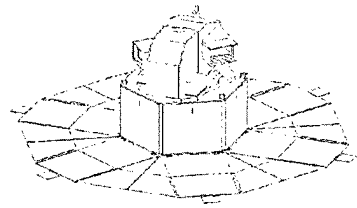
Interservice Space Fundamentals Course (ISFC)

The ISFC is offered to Army, Air Force, Navy and Marine Corps officers, enlisted personnel, and civilian employees entering nonoperator staff positions who need to be knowledgeable of space operations, activities and environment. This course covers a fundamental presentation of the physical environments of space and the potential effects on manned and unmanned space systems. ISFC is offered at the Secret clearance level.

13 MAR - 24 MAR 00	12 JUN- 23 JUN 00
17 APR - 28 APR 00	17 JUL - 28 JUL 00
15 MAY - 26 MAY 00	14 AUG - 25 AUG 00

All courses are conducted at the Air Education and Training Center, Colorado Springs, Colo., unless otherwise indicated. To obtain a quota, or for further information, contact Bonnie Watson at (540) 653-5151, DSN 249-5151, or email bdwatso@nsc.navy.mil. The following information is needed to obtain a quota: name, rank/rate, Social Security number, UIC, billet title, and phone/FAX.

Naval Observatory to Look to the Stars With FAME



The National Aeronautics and Space Administration (NASA) has selected the U.S Naval Observatory's Full-Sky Astrometric Mapping Explorer (FAME) satellite to be funded for launch in 2004. FAME is an optical space telescope designed to determine the positions, distances, motions, brightness, and colors of stars in our galactic neighborhood. It will observe and determine the positions of stars brighter than 15th magnitude, which are about 40 million stars.

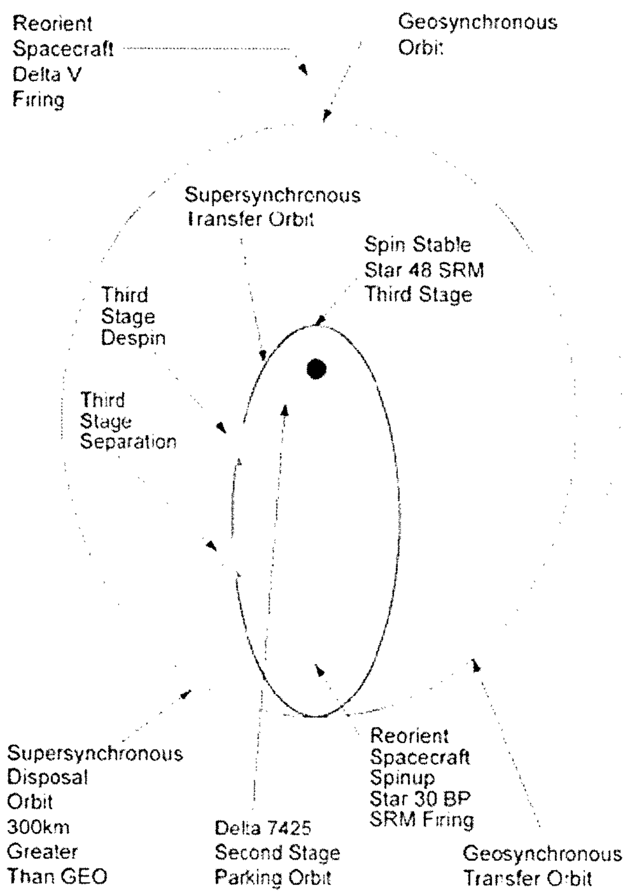
"FAME will provide a rich and unprecedented database for a wide range of studies in stellar astrophysics," says Dr. P. Kenneth Seidelmann, the Director of Astrometry at the Naval Observatory and the chairman of the FAME science team. "It will be the most accurate astrometric catalog in history."

Astrometry, the science of determining positions of stars, is the oldest branch of astronomy. Astrometric measurements will not only determine the positions of stars on the sky, but also the distances to stars by measuring their parallaxes. The parallax is the apparent change in a star's position due to the Earth's revolution around the Sun over the course of a year.

"Astrometric observations are fundamental measurements that are the foundation of almost all of astrophysics," says Sean Urban, a USNO astronomer.

FAME will be able to detect giant planets larger than twice the mass of Jupiter orbiting neighboring stars. By measuring the positions of stars over time, FAME will be able to detect the "wobbling" of stars due to companion objects such as other stars, brown dwarfs, and giant planets.

By directly measuring the distances to a special class of stars called Cepheids, FAME will improve our knowledge of distances to galaxies and our understanding of the size of the Universe. Cepheids are currently used for this purpose. However, distances to the Cepheids themselves are not known precisely; FAME will solve this problem. FAME will also be able to determine the amount of dark matter in the disk of our Milky Way galaxy by observing its gravitational influence on stellar motions.



"FAME will give us the ability to study the variability of a large number of Sun-like stars, enabling us to put the Sun's activity level in the context of other similar stars," says Dr. Scott Horner of the U.S. Naval Observatory. "This will indicate whether solar variability may change on long time scales, with possible implications for climate change on Earth."

FAME's innovative design uses a solar sail to utilize the pressure from sunlight to change the orientation of the spacecraft in order to scan the entire sky. The FAME telescope looks in two directions at once to achieve its high accuracy. It rotates with a period of 40 minutes.

The Naval Observatory, founded in 1830, is responsible for providing the Navy, the Department of Defense, and the public with astrometric and timing data. Its mission includes maintaining the Master Clock for the United States, providing precise time, measuring the Earth's rotation, determining the positions and motions of the Earth, Sun, Moon, planets, stars, and other celestial objects, and providing astronomical data.

The data from FAME will fulfill many needs of DoD, other government agencies, and the public at large for accurate astrometric data for the future. The accurate star positions from FAME will enable autonomous space navigation systems to determine the positions of future satellites with accuracies better than 1 meter. Precise timing information and astrometry (star positions) are the foundation of navigation and guidance.

More information on FAME can be found at the FAME web site http://www.usno.navy.mil/fame. — *By Naval District Washington Public Affairs (NWS)*

Cmdr. Patricia Cole Takes Charge of Fleet Surveillance Support Command

By JO2 Kaye Trammell

Command of Fleet Surveillance Support Command (FSSC) changed hands on Aug. 20 when Cmdr. Patricia Cole relieved Cmdr. Kevin Uhrich in formal ceremonies at the command's headquarters at Naval Security Group Activity Northwest in Chesapeake, Va.

Air Force Col. Joe Gorman, deputy director for the Joint Interagency Task Force East in Key West, Fla., was the guest speaker for the ceremony.

Cmdr. Cole joins FSSC from her previous assignment as fleet information systems officer for Commander Seventh Fleet embarked in USS *Blue Ridge* (LCC 19) in Yokosuka, Japan. Cmdr. Uhrich has transferred to the staff of Commander in Chief U.S. Atlantic Fleet in Norfolk, Va.

Originally from Little Rock, Ark., Cmdr. Cole graduated from the Naval Academy in 1982 and reported to her first assignment in Fighter Squadron 124 (VF 124) at NAS Miramar in San Diego, Calif. There she served as the Fleet Readiness Aviation Maintenance Personnel (or FRAMP) division officer, legal officer and AT/AE branch officer.

In September 1985 she was assigned to U.S. European Command in Stuttgart, Germany, where she worked in the Data Services Center and provided hardware and software microcomputer support to the headquarters staff.

Cmdr. Cole

She attended the Naval Postgraduate School, completing a master's degree in space systems operations (systems technology), prior to her next assignment with the Joint Defense Facility Nurrungar in Woomera, Australia. There, Cmdr. Cole was officer in charge of Naval Space Surveillance Center Detachment Echo, which provided the Fleet with tactical warning data derived from the Defense Support Program (or DSP) early warning satellite system.

In November 1991, Cmdr. Cole transferred to U.S. Space Command in Colorado Springs, Colo., where she directed space-based tactical operations. She was responsible for DSP tactical support for the Fleet and operational policy issues.

Subsequently, Cmdr. Cole studied Latin at the Defense Language Institute in Monterey, Calif. She was certified as a basic linguist and served as executive officer for Naval Support Activity, La Maddalena, Sardinia, Italy, prior to her latest tour with Seventh Fleet.

Patches Available

Naval Space Command patches are available for purchase. The embroidered emblem is 3½ inches in diameter. To order, write to Naval Space Command, Attn. Public Affairs, 5280 Fourth St., Dahlgren, Va. 22448-5300. Enclose check or money order, payable to "Naval Space Command," for $7 per patch (includes postage and handling).

Midshipmen Briefed on Naval Space Ops

Third-Class Midshipmen from the U.S. Naval Academy (Class of 2002) look over samples of space imagery during their visit to Naval Space Command last summer. Over 500 Mids toured Naval Space Command and the other commands at Dahlgren last summer as part of their Naval Tactical Training. They visited NAVSPACECOM, the Naval Surface Warfare Center Dahlgren Division, the Joint Warfare Analysis Center, and the Aegis Training and Readiness Center in four groups as part of their "Joint Week" itinerary which also included stops at Andrews Air Force Base and the U.S. Army Aberdeen Proving Ground in Maryland, as well as Marine Corps Base Quantico, Va.


EW1 Whiteman


CTR2 Munro


Teresa Watkins


Shirley Jones


Eric Brown


Mitchell Gallahan

NAVSPACECOM Salutes People of the Quarter

Quarterly performance awards for July through September 1999 were presented to the following command members.

Petty Officer 1st Class Sean E. Whiteman, an electronic warfare specialist, was selected as Sailor of the Quarter.

He was cited for his work as leading petty officer and acting leading chief petty officer for the command's Operations Division Training Branch. He was responsible for revamping the enlisted training program for the Naval Space Operations Center (NAVSPOC). The program includes formal classroom lectures as well as scenario and curriculum development.

He also began development of an online recurring training program for experienced space warning petty officers (SWPOs).

In addition, Whiteman volunteered for an assignment as the command's master-at-arms, and he served on the welfare and recreation committee as vice president.

Originally from Houston, Texas, Whiteman enlisted in January 1993. His Navy service has included two deployments on board USS John S. McCain from May 1994 to May 1999.

Petty Officer 2nd Class Lisa A. Munro was named Junior Sailor of the Quarter in recognition of her performance as the assistant leading petty officer for the Operations Division Training Branch. A cryptologic technician, Munro also contributed to the revised NAVSPOC enlisted training program and the SWPO on-line training program.

Munro has also taken on a number of volunteer assignments, serving as the leading petty officer in charge of the command's honor guard, as a participant in the Adopt-A-School program and as a coordinator for the command picnic.

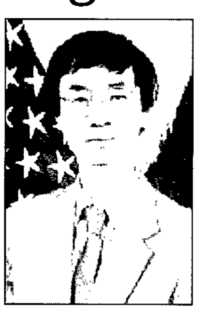
Originally from Denver, Colo., Munro enlisted in 1990. Her subsequent Navy assignments have been with the National Security Agency in Ft. Meade, Md., the Naval Computer and Telecommunications Station at Diego Garcia in the Indian Ocean, and with the Personnel Exchange Program in Gander, Newfoundland. She reported to Dahlgren in 1997.

Teresa P. Watkins was selected as the command's Senior Civilian of the Quarter. She was cited for her technical direction of the operating system upgrade to NAVSPACECOM's mission processing system. She guided modifications to the applications user interface and to all inter-process communication components. The successful upgrade affected more than 160 applications, over 75 workstations, and 22 application and network servers.

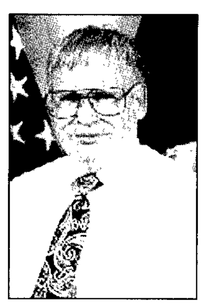
Watkins joined the Naval Space Surveillance Center at Dahlgren in 1988 and is currently assigned to NAVSPACECOM's Analysis and Software Branch. A native of Bogalosa, La., she has a

Civilian Length of Service Awards


Verna Spivey


Winston Chow


Rusty Thoemke


William Walker

30 Years

Verna Spivey

25 Years

Winston Chow
Rusty Thoemke
William Walker

20 Years

Marty McElhinney
Clinton Watson

10 Years

Amy Balmaz
Jerome Caudle
Paul Cox
Elmira Johnson
Tammy Hudson

bachelor's degree in physics and math from Mississippi State University in Starkville, Miss. Among her other awards, Watkins was the command's Civilian of the Year for 1993.

Shirley A. Jones, a supply technician in NAVSPACECOM's Supply Branch, was selected as Civilian of the Quarter in recognition of her "commitment to excellence" in her work area.

Specifically, in the third quarter of 1999, Jones processed over $7.3 million in both FY99 and FY00 transactions to greatly contribute to mission readiness and ensure the continuity of service contracts in support of critical mission areas. Her efforts to assist with 1999 fiscal year closeout helped the command achieve an overall obligation rate of 99.8 percent.

Eric M. Brown was named Operations Watchstander of the Quarter. He was cited for the "attention to detail" evident in his performance as a senior data analyst responsible for processing incoming observations from the naval space surveillance system.

A resident of Montross, Va., Brown joined Naval Space Command in January 1999 as a computer specialist. On board less than a year, he had already gained recognition as a top sensor data analyst in the NAVSPOC, evidenced in his error-free responses to support requests from U.S. Space Command.

In addition, his extremely high correlation rate on unidentified objects passing through the naval space surveillance system has helped improve the overall quality of the space object catalog and reduced the workload in the data analysis workcenter.

Mitchell W. Gallahan was named ADP Watchstander of the Quarter for his work in diagnosing a problem on the command's secure mail guard. Initiating non-routine corrective measures, he restored the system to normal operations and eliminated the need to recall senior personnel.

Additionally, his response to a malfunction in the command's mission system "event processor" restored normal operations within 12 minutes.

Sailors Aid Community in 'Day of Caring'

By JO2 Kaye Trammell

For two years, the Fleet Surveillance Support Command (FSSC) in Chesapeake, Va., has been a part of a mass volunteer effort — "Day of Caring" — sponsored annually by the local United Way.

The event solicits volunteers from all organizations and communities throughout the Norfolk-Hampton Roads region to come together for one day to help one another. Shelters, playgrounds and even personal residences receive the benefit of an entourage of volunteers armed with rakes, gloves and paint.

To increase participation in last year's event, FSSC joined forces with two other organizations of helpers to spruce up the residence of first-time homeowner Michelle Lassiter of Norfolk. After completing the Haven House shelter program, Lassiter was able to purchase a home of her own.

"When I came here a month ago," began Lassiter, "this house didn't look like this." She pointed toward the quaint two-bedroom home from the backyard where she was working. "It has come a long way," she said shaking her head in disbelief.

Lassiter is one of the many success stories of Haven House and Family Opportunities and Resources (or F.O.R.) Kids, Inc. As a single mother of an eight-year-old son, Lassiter found making ends meet a difficult struggle. The groups work to empower people like Lassiter by offering them a place to live, job skills and other important resources.

"I remember last year when I helped Day of Caring through the Haven House," said Lassiter. "I never thought one year later these people would come to my rescue and share this day with me."

Yet for the men and women of FSSC, there was nothing to it.

"I really wanted to come out to help," said OS2 Perselphonie Janrhett, an INTEL team member at FSSC. "When I found out we would be helping a single mother, like myself, I was even more ready to pitch in."

YNC(SW) Tony Dziadul joined Janrhett as a first-time volunteer. "It gives you a good feeling to see the homeowner's face at the end of the day. She [Lassiter] worked hard to make it this far. She and her (son) deserve this."

"Programs like this help foster better relations between the community," said Dziadul, a Norfolk Sailor for the past 10 years. "I believe in leading by example ... not just in the work center, but in the community."

John Cannon, FSSC's Environmental and Safety Manager, felt as if he owed Lassiter a note of thanks.

"I've learned the value of working as a team and helping someone achieve their dreams," said Cannon who spent the morning squinting in the bright sun as he trimmed Lassiter's trees. "It's a great feeling to help someone who is struggling to be a success. Working like this," he said gesturing to the busy volunteers in the yard, "is just an extension of the spirit of teamwork that we have at FSSC."

Author JO2 Kaye Trammell serves as the public affairs officer for Fleet Surveillance Support Command.

CALENDAR

Meetings & Symposia

West 2000, Feb. 10-11, San Diego, Calif. Sponsored by AFCEA and U.S. Naval Institute. Call (703) 631-6126.

Spacecomm 2000, Feb. 22-25, Colorado Springs, Colo. Sponsored by AFCEA Rocky Mountain Chapter. Call (719) 590-1051.

Virtual Government, Feb. 29-March 2, Washington, D.C. Sponsored by AFCEA International. Call (703) 631-6238.

International Communications Satellite Systems Conference and Exhibit, April 10-14, Oakland, Calif. Sponsored by American Institute of Aeronautics and Astronautics (AIAA). Call (800) 739-4424.

Spring Intelligence Symposium (Classified), April 26-27, Washington, D.C. Sponsored by AFCEA International. Call (703) 631-6250.

C2 Symposium, May 10-12, Quantico, Va. Sponsored by AFCEA Quantico-Potomac Chapter. Call (703) 784-2960.

International Conference on Remote Sensing for Marine and Coastal Environments, May 1-3, Charleston, S.C. Sponsored by ERIM International, NASA and NOAA. Call (734) 994-1200.

Global Air and Space 2000 International Business Forum and Exhibition, May 10-12, Washington, D.C. Sponsored by AIAA. Call (800) 739-4424.

Courses & Seminars

Following courses sponsored by the AFCEA Professional Development Center. Call (800) 336-4583, ext. 6135 or (703) 631-6135 or visit Web page http://www.afcea.org.

❍ The U.S. Intelligence Community: Who Does What, With What, For What? (Classified), Feb. 9-10, San Diego, Calif.

❍ Principles of Communications With Applications in Military Systems, Feb. 8-11, San Diego, Calif., and April 24-28, Fairfax, Va.

❍ C4ISR Architecture Framework Implementation, Feb. 8-11, San Diego, Calif., and May 2-5, Fairfax, Va.

❍ Digital Data Communications & Emerging Technologies, Feb. 29-March 2, Fairfax, Va.

❍ Military Satellite Communications (Classified), March 6-10, Fairfax, Va.

❍ Global Command and Control System (Classified), May 8-12, Fairfax, Va.

DEPARTMENT OF THE NAVY

Naval Space Command
5280 Fourth St.
Dahlgren, VA 22448-5300

Do Not Forward
Address Correction Requested

Official Business

THIRD-CLASS BULK RATE
POSTAGE & FEES PAID
DEPARTMENT OF THE NAVY
PERMIT No. 25