Space Systems Company - Michoud Operations

LOCKHEED MARTIN

We never forget who we're working for.™

Mission Success Bulletin

August 12, 2004

Volume 23, No. 5

http://www.lockheedmartin.com/michoud/

ET teams make progress toward RTF

Editor's Note - Over the past year the NASA-Lockheed Martin Return to Flight (RTF) teams have made huge strides in preparing to return the Space Shuttle to safe flight. This special Return to Flight edition examines each team and tells the story of its progress.

1 Bipod Redesign

Freddy Ubas, Production Operations, performs a bipod -Y final closeout enhancement spray on a mock-up test panel.

Team Name & Leads: Bipod Redesign — **Matt Wallo** with **Faye Baillif** on spray process, LM and **Ken Welzyn**, NASA

Objective: Design, develop and verify ET bipod closeout area

How Team Accomplished Objective:

Initially, the bipod had five possible design options. Technical interchange meetings down-selected to the current design that removes the foam bipod ramps. To prevent ice formation, the fitting now rests on a copper plate containing heaters sandwiched between it and the tank.

Structural tests at Michoud verified the redesign's capability to withstand maximum loading. Two thermal tests at Eglin Air Force Base, Fla. verified the heater's ability to prevent ice formation. Ten wind tunnel tests at Arnold AFB Engineering Development Center, Tenn. demonstrated Thermal Protection Systems (TPS) closeout competence to withstand maximum aerodynamic loads without generating debris.

The team developed a two-step closeout process to improve the manual spray technique. The first TPS application is a wedge, sprayed before the bipod fitting is installed. After the fitting is attached, heaters, temperature sensors and wires are installed prior to the final spray. The team completed 22 wedge enhancement sprays on high fidelity mockups prior to down-selecting the optimized spray process prior to verification and validation activities.

ET hardware and test panels underwent four verification sprays and three validation spray sets; the final closeout operation completed 10 enhancement sprays. It takes approximately two days to prepare each panel for test sprays, while the actual spray takes seven to 15 minutes. Once the foam has cured, the panel and part are machined to engineering requirements, plug pull tests are conducted and the foam is dissected to record any findings. It takes approximately four hours to dissect the wedge and eight hours to dissect the final closeout.

Biggest Challenges: The bipod was the first redesign area to go through the Critical Design Review process, and reviewers from outside the ET project were interested in how the bipod and TPS would be certified and the processes controlled.

"Getting all the reviewers satisfied with our approach was a huge accomplishment for the whole ET project," stated Welzyn.

As the team became familiar with the spray equipment, members had to take corrective action to address problems such as temperature differences that occurred during the sprays.

"The ability and determination of our spray technicians enabled us to meet our schedule commitments," Baillif asserted. "Their dedication to Return to Flight is phenomenal."

Continued on Page 4

Powell and Harris appointed to new positions

Patricia Powell has been named director, Business Transformation & Best Practices. In the newly created position, Powell will be responsible for initiatives that cover transformation, cultural assessment, productivity improvement and Two-Way Communications as well as integration of LM21 and Best Practices. She will also direct the implementation of Enterprise Resource Planning. She began her Lockheed Martin career in 1980.

Powell

Richard Harris replaces Powell as director, Safety & Product Assurance. He is responsible for safety, reliability and quality assurance in the manufacturing of the External Tank. Harris who joined the corporation in 1975 previously served as manager, Program Development, in the Program Management & Technical Operations department. ■

Harris

Keeping their eye on the ball

Congratulations to the first "Keep Your Eye on the Ball" recipients! ET Vice President Ron Wetmore honored the employees for their dedication and focus to RTF. 1st row from left: Willie Scott, bellows; Dave Farin, Verification & Validation (V&V); and Ron Troxclair, Bldg 420 Mod Center. 2nd row: Brian Peterson, video support; Don Pittman, V&V; Terry Sherman, flange; Dawn Diecidue, technical presentations; Joe Johnson, camera; Wetmore; Marshall Byrd, vice president & general manager; and Jason Holbrook, bipod.

"Back to Work" quicker

With Revised Certification Process

To some it was just another Monday, but June 28 might become a milestone for Michoud Operations. On that day, months of effort paid off with the cutover to the newly revised Certification Process.

For four months the Certification Process Analysis Team, with help from over 100 employees, had worked to dramatically improve both the Certification Verification and Re-certification Authorization sub-processes.

The benefits of the revised Certification Process include simpler and easier paperwork that allows crews to begin work much faster. Instead of taking hours to verify certifications prior to beginning work, it now takes only half an hour.

"I like the new system," says **Troy Smith**, Production Operations. "You can go to work much faster with less down time for paperwork."

It is simpler and more accurate too, with real-time updates of the electronic eCard with current training data.

The revised Certification Process will assure Michoud Operations' product integrity, thereby maintaining customer confidence.

"It's a move in the right direction," declares **Lloyd Johns**, Production Operations. "It brings us back closer to being one company – one team." ■

Changes to Certification Verification sub-process:

- Re-classification of certifications into certifications and qualifications
- Electronic eCard for certification verification
- All employees stamping for the work they perform
- On the job training no longer performed on flight hardware

Changes to Re-certification Authorization sub-process:

- Mandatory five-day response for supervisors to submit the Re-certification/Re-qualification interview done with the employee
- Real-time update of electronic eCard by training officers

A comprehensive list of Frequently Asked Questions regarding the certification process may be found at: http://maflm503.maf.nasa.gov/train/ecard/output/web/faqs.asp

Strategic Plan presents three-tiered approach

Michoud Operations has outlined a Strategic Plan to accomplish existing program goals and meet future business objectives. The simple three-step road map charts the organizational course for success on programs from the External Tank today to space launch and exploration vehicles of tomorrow.

Mission 1 – the first step and highest priority – is to successfully return the External Tank to safe flight and fly-out the Space Shuttle with 100 percent Mission Success.

"Mission 1 has our total concentration and commitment. Returning the shuttle to safe flight is the number one priority – far and away above everything else."

– Marshall Byrd

Mission 2 is to support the country's space exploration vision and position Michoud to have a role in the next generation launch vehicle.

Mission 3 is to develop new skills, technologies and capabilities to support the first two missions in the plan. These two steps are to assure Michoud Operations' future role in America's space program.

"Mission 1 has our total concentration and commitment," says **Marshall Byrd**, Michoud vice president & general manager. "Returning the shuttle to safe flight is the number one priority - far and away above everything else. Our long-term success and livelihood hinge upon that simple fact. And to that end, we've made great progress."

Jeff Corbin, director, Business Development, notes that Mission 2 can position Michoud to be the future provider of large launch vehicles and aerospace structures. He believes a heavy-lift vehicle derived from the Space Shuttle could meet the future requirements.

"In order to support a mission to the Moon and then Mars, you've got to have a bigger vehicle than the launch vehicle options available today," Corbin says. "We have a discriminator in the size of our building, our facility and the $2 billion-plus of tooling we have to build very large space hardware."

Can a shuttle-derived vehicle (SDV) compete for a role in the national space exploration plan? Corbin says it can if it is able to fly at a significantly lower cost than today's shuttle. As yet, NASA has not yet released vehicle requirements for the Crew Exploration Vehicle (CEV), but Corbin surmises that a CEV could launch on a Lockheed Martin-built Atlas, a Delta or a SDV. Being competitive on cost will be critical.

Mission 3 – developing new technologies to support the first two missions – will force Michoud to focus on very specific opportunities. Corbin cites FALCON (Force Application & Launch from CONtinental U.S.) as an "exciting technology for us to develop our skills in vehicle and systems integration. It has a lot of characteristics of a launch vehicle and puts us in a position to have a bigger role in next generation technology."

He also points to the Joint Strike Fighter nacelle as a means of developing skills in composite design, manufacturing and analysis. A next generation launch vehicle (NGLV) like the CEV or the heavy lift launch vehicle NASA will need for lunar missions will require more composite parts than today's launch systems.

"But when you come down to it, tanks are us," he says. "Propellant vessels, propellant receptacles – that's the work we do. We build large tanks and have the capability to build large space vehicles. These are markets where we believe we have sustainable discriminators and a competitive advantage."

Friction Stir Welding (FSW) and advanced Fiber Placement are both technologies that are applicable both now and in the future on a NGLV. "But in order to be used, the technologies have to have a significant cost, performance or quality discriminator to leverage in the marketplace over other alternate processes. We are working through our IR&D program to demonstrate the benefits of both these manufacturing technologies," Corbin states.

By following the three-step Strategic Plan, Michoud will remain focused and on course for success. ■

Lockheed Martin completes first nacelle

Wayne Richmond, Program Management & Technical Operations, watches the Fiber Placement Machine lay down a tow on the composite tool-proof of the upper nacelle skin for the Joint Strike Fighter. Michoud Operations recently delivered the 140-pound tool-proof to Lockheed Martin Aeronautics in Fort Worth. Built to flight standards, the nacelle's construction takes approximately a month. Michoud will build three tool-proof articles and 22 flight demonstration units in the JSF design and development phase. Technicians are currently fabricating the first flight article in the National Center for Advanced Manufacturing.

Bipod redesign

Continued from Page 1

Status of Work: The TPS wedge spray is complete on ET-120. Installation of flight hardware (copper plates, heaters, temperature sensors and bipod fittings) has begun.

The final closeout spray is about to enter the verification and validation phase on ET-94, to be followed by application on ET-120.

Important Milestones: Work to be done includes final closeout spray verification and validation, bipod fitting assembly and final closeout installation on ET-120 and LH2 thermal and vacuum thermal test at MSFC.

2 LH2/Intertank Flange

Team Name & Leads: Liquid Hydrogen/Intertank Flange — **Eugene Sweet**, LM and **Steve Holmes**, NASA

Objective: Reduce or eliminate foam debris from flange area

How Team Accomplished Objective:

After nine months of effort to understand and replicate the root cause of foam loss during Space Shuttle ascent, the flange team at Marshall Space Flight Center and Michoud focused its efforts on three areas: filling external gaps around shims, stringers and butt splice plates used in making the Intertank; preventing liquid nitrogen (LN2) leakage past the flange bolts; and perfecting a new TPS external closeout process for the flange area.

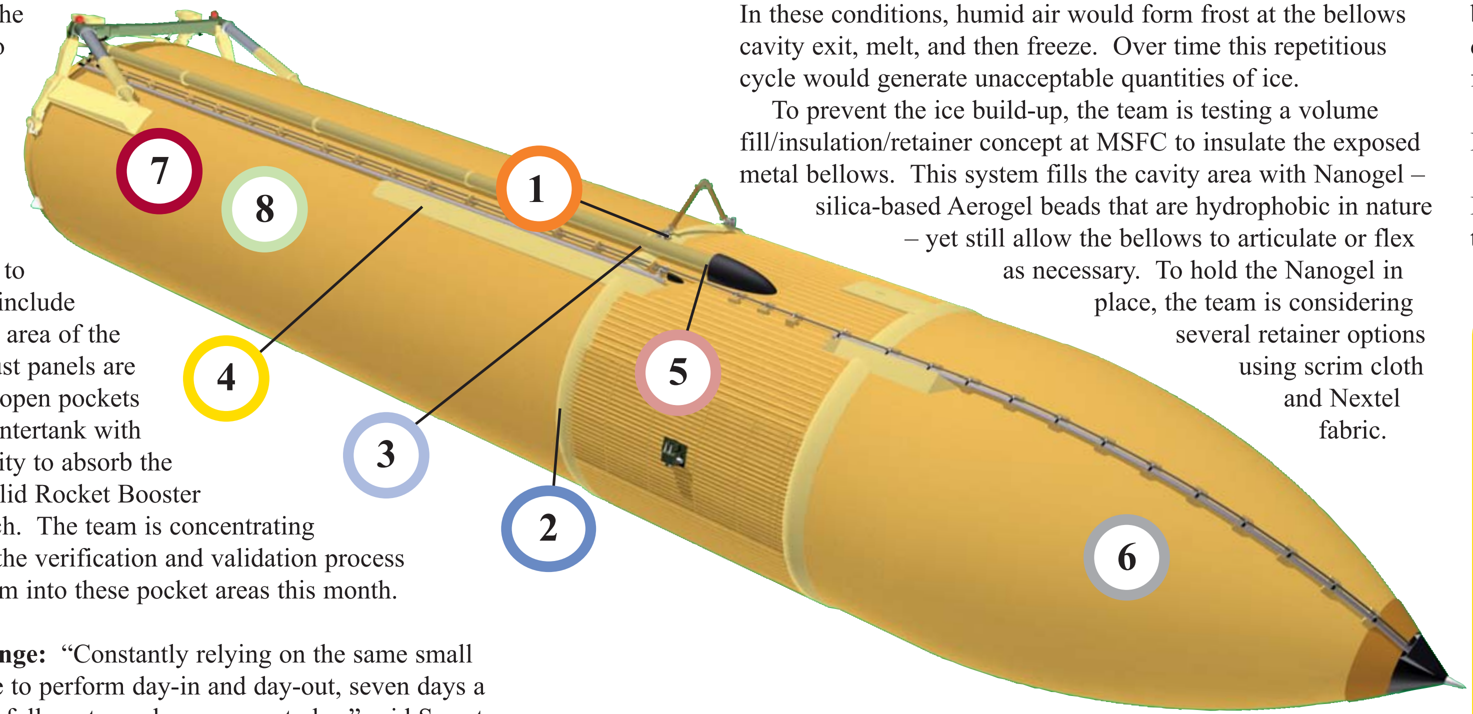
James Duke, Production Operations, cores a section in the TPS for a plug pull test following an upper flange closeout validation spray.

Using a process called point fill, technicians perfected the process of filling the gaps near the flange area.

During testing at MSFC, the team established that LN2 was leaking past the bolt threads and nuts on the Liquid Hydrogen Tank side of the flange. Reversing the flange bolts, applying Loctite® to the threads and closing out the area with TPS made for a better flange contact and greatly restricted LN2 leakage.

Finally, to improve the TPS closeout process on the flange, the team developed a three-part procedure. It begins with injecting the corrugated-like stringer panels with foam, followed by an improved spray technique for the upper and lower flange. Using a lower output gun, shortening the area the technicians are required to spray and using an improved hand-spray technique have greatly reduced defects on the flange TPS closeout. Verification and validation of the flange/stringer panels are complete, and the team is ready to apply its new technique on ET-120.

Recently, NASA expanded the debris zone from 65.5 to 112 degrees to include the thrust panel area of the Intertank. Thrust panels are machined with open pockets to provide the Intertank with additional rigidity to absorb the thrust of the Solid Rocket Booster Motors at launch. The team is concentrating on completing the verification and validation process of injecting foam into these pocket areas this month.



Biggest Challenge: "Constantly relying on the same small group of people to perform day-in and day-out, seven days a week to successfully get us where we are today," said Sweet.

Status of Work: The team has compressed its schedule to begin work on ET-120 by the middle of this month. Verification and validation of the new debris zone work is complete, and the team is preparing for a Production Readiness Review.

Important Milestones: Complete thrust panel injection/spray verification and validation by early August and prepare for ET-120 work to follow. ■

3 Liquid Oxygen Feedline Bellows

Team Name & Leads: LO2 Feedline Bellows — **Mark Pokrywka**, LM and **John Honeycutt**, NASA

Objective: Eliminate or contain ice build-up on the three exposed LO2 feedline bellows

How Team Accomplished Objective:

The team began by studying the open bellows design to understand when and at what conditions frost and ice would form. Using the study results, team members took a two-pronged approach to eliminate ice build-up. A majority of the ice formed when condensation running down the outside of the feedline came into contact with the cryogenic bare metal of the bellows.

The team eliminated this form of ice generation by extending the foam skirt around the bellows rain shield to help divert condensate. This foam feature is now called the "Drip Lip."

This configuration did not completely eliminate all frost and ice build-up. In testing, the team's worse case scenario occurred at temperatures above 50 degrees Fahrenheit with high humidity. In these conditions, humid air would form frost at the bellows cavity exit, melt, and then freeze. Over time this repetitious cycle would generate unacceptable quantities of ice.

To prevent the ice build-up, the team is testing a volume fill/insulation/retainer concept at MSFC to insulate the exposed metal bellows. This system fills the cavity area with Nanogel – silica-based Aerogel beads that are hydrophobic in nature – yet still allow the bellows to articulate or flex as necessary. To hold the Nanogel in place, the team is considering several retainer options using scrim cloth and Nextel fabric.

Biggest Challenge: Developing a retainer that keeps the Nanogel material in place without becoming an additional debris source.

Status of Work: Currently, the team has completed verification of the BX-265 spray portion of the Drip Lip and is proceeding with the validation process using the ET-94 test article.

Important Milestones: Following verification and validation, the team will release drawings to support the Drip Lip TPS application and proceed to ET-120 this month. ■

Technicians complete verification of the BX-265 hand-spray of the bellows "Drip Lip" on ET-94.

4 Protuberance Airloads (PAL) Ramps

Team Name & Leads: PAL Ramps — **Kevin Montelepre**, LM and **Matt Lansing**, NASA

Dual Objectives: To provide flight rationale supporting the baseline "use as is" plan for ET-120 PAL ramps, and also to develop, verify and validate an enhanced manufacturing process for manual PAL ramp sprays.

How Team Accomplished Objectives:

PAL ramps from ET-94, ET-123 and the forward 10 feet of ET-120 and ET-121 were dissected to collect data on the location, size and frequency of voids. The team tested the remaining 28 feet of the PAL ramp for voids using developmental Non Destructive Evaluation techniques.

A PAL ramp detail shown above in Building 420 will fly "as is."

Over a six-month period, the team performed seven enhancement sprays on high fidelity mock-ups in order to develop a new spray process. Technicians then dissected and carefully examined the mock-ups for voids. Results showed that the enhanced spray process produced fewer voids of a similar size compared to the previous process. However, both fell within the acceptable range.

A detailed comparison of all of the data gathered and analyses performed was presented at multiple NASA and Lockheed Martin technical and management reviews where the PAL ramps were approved to fly "as is" on ET-120 and ET-121. The enhanced spray process will be applied to future tanks including the ten-foot retrofits on ET-120 and ET-121.

Biggest Challenge: "Working with all members of the production and TPS spray team to understand both the intricacies and important details of the spray process," said Montelepre.

Status of Work: Preparing to begin the verification and validation phase prior to re-spraying the forward section of the LH2 PAL ramps removed from ET-120 and ET-121.

Continued on Page 6

Protuberance Airloads (PAL) Ramps

continued from Page 5

Important Milestones: Validation of forward PAL ramp on ET-120 by September 10; reapplication of ramp by September 30. ■

5 Enhanced In-Flight Imagery

Team Name & Leads: Enhanced In-Flight Imagery — **Angelo Greconia**, LM and **Mike Butler**, NASA

Objectives: Fly camera on the ET to provide improved imagery of possible debris shedding; reduce schedule impact by using the same design and hardware that flew on STS-112 in 2002

The ET camera is nested inside the LO2 feedline fairing.

How Team Accomplished Objective:
The camera team investigated several locations on the ET that would provide a good view and limit the potential of generating additional debris. Team members procured the original camera from another Lockheed Martin division and completed redesign activities. The camera will be located inside the LO2 feedline fairing and offer a view of the ET and Orbiter during flight. The team also revised and relocated original antenna locations to the -Z side of the vehicle.

Biggest Challenges: Replacing batteries in the electronics boxes due to aging issues and adding a protective cover to prevent debris from striking the camera lens. Due to TPS spray validation challenges using the new certification process, the camera team worked closely with the TPS Certification team to ensure that the manual spray closeout is repeatable and of the highest quality.

Status of Work: Most of the system is installed on ET-120. The team is currently validating the antenna TPS spray application and then will complete remaining camera qualification tests.

Important Milestones: A Critical Design Review of the system took place in 2003. The status was reviewed in early 2004. Since then the team completed engineering drawings, built hardware, tested and certified the hardware for installation on ET-120. The current plan is to install the camera fairing in Cell A and conclude functional testing of the system by early September. ■

6 Non-Destructive Evaluation (NDE)

Team Name & Leads: Non-Destructive Evaluation — **Warren Ussery**, LM and **Robert Thom**, NASA

Objective: Devise a method of detecting defects in complex areas of manually sprayed foam

How Team Accomplished Objective:
Detecting defects in manually applied ET foam present a unique challenge. The Non-Destructive Evaluation (NDE) Team investigated a dozen NDE inspection methods from industry and academia before selecting terahertz imaging and backscatter radiography.

Terahertz imaging is a form of radiation between microwave and infrared light, which penetrates foam and reflects off the tank's aluminum surface. Backscatter radiography shoots x-rays into the foam and interacts with foam molecules to produce a backscatter image of the defect.

The team initially established confidence in the new systems by testing a wide variety of samples with different defect types and sizes. Terahertz and backscatter were successfully used on ET-120 and ET-121 PAL ramps, with the results providing added confidence in the quality of the ramps.

Additional studies are planned to better define process reliability. Voids in the range of one-half to one-inch in diameter have been successfully detected using terahertz or backscatter NDE methods.

The team did find that terahertz imaging and backscatter radiography technologies require further refinement for detecting voids in thicker, more complex foam areas. As a result, the Return to Flight organization decided that NDE technology will not be used for acceptance of flight hardware for Return to Flight. That may change in the future as the technology improves.

Biggest Challenge: "The learning curve associated with these NDE methods has been a challenge to us," explained Ussery. "Neither terahertz imaging or backscatter radiography is commonly used in industry, and this has increased the difficulty in developing test methods and training operators."

Status of Work: Technicians have completed terahertz and backscatter inspections on both ET-120 and ET-121 PAL ramps.

Important Milestone: An inspection of ET-119 PAL ramps will be conducted in the future. ■

NDE backscatter radiography machine evaluating a PAL ramp.

7 TPS Certification

Team Name & Leads: TPS Certification — **Jeff Pilet**, LM and **Pat Rogers**, NASA

Objective: To reassess all TPS applications to ensure that adequate test verification is performed for all critical failure modes

How Team Accomplished Objective:
The team developed a comprehensive plan to review and document TPS verification data used to certify both structural integrity and debris generation potential. The plan included a detailed review of each failure mode, critical flight environments and all applicable test data.

This approach identified possible deficiencies or areas needing 'additional confidence' data. The biggest area of concern focused on understanding TPS internal defects and their potential to generate debris. To address this issue, the team gathered additional dissection data to characterize the internal structure of the TPS. Most of these dissections came from the ET-94 test article.

Next, the team initiated a test program to develop data on what type and size of TPS internal defect would be acceptable under new Space Shuttle Program debris requirements.

Development and successful execution of this plan led to several key programmatic decisions including approval of the redesigned bipod TPS and the fly "as is" determination for ET-120 PAL ramps.

Biggest Challenge: The tremendous amount of technical information and coordination between multiple disciplines, organizations, independent teams and management required to achieve consensus on the team's plan and rationale.

Status of Work: Currently, the team is reviewing and updating both stress analyses and hardware certification documentation to reflect the results of team assessment.

Important Milestones: Results of team assessment and analyses will serve as key information leading to successful completion of upcoming ET RTF Design Certification Review, now scheduled for September. ■

8 TPS Verification & Validation

Team Name & Leads: TPS Verification & Validation — **Michael McBain**, LM and **Scotty Sparks**, NASA

Objectives: To identify the scope of TPS process verification and validation efforts; to implement Integrated Process Control; to provide data, design requirements and results to certification and hardware design teams

How Team Accomplished Objectives:
The team identified RTF recommendations and prioritized work, concentrating on mandatory improvements to ET-120 and ET-121. Members also looked at items that were desired but not required on the two tanks, as well as longer-term TPS improvements.

Next, the team established prerequisites for TPS manual sprays, identified process verification and validation requirements and monitored their application for RTF. For example, a closeout spray requires a minimum of four successful verification and two successful validation sprays on a combination of high-fidelity mock-ups and flight hardware such as ET-94.

The team instituted Integrated Process Control for TPS processes for RTF redesign and is working a plan for tanks in production flow.

Some of the process control requirements include:
* Significant parameters and their verification
* A compliance matrix for recommendations
* A list of key personnel, materials and equipment
* All appropriate control documents such as the manufacturing process plan and drawings
* A spray schedule.

After establishing manual spray requirements, the team identified tests and dissections that would confirm the process used to certify TPS. Members followed up by conducting flight tank dissections, critical defect testing and fracture-based and margin assessments.

Biggest Challenge: "Getting the plan 'on the street,' coordinating with all the hardware teams and getting verification and validation implemented and completed," McBain said.

Status of Work: Completed 100 percent of ET-120 dissections by July. Complete nearly all of ET-94 and ET-121 dissections by the end of August.

Milestones: To complete verification of thrust panel near end of August, to have bellows in verification and to complete PAL ramp near end of August. ■

Milestones

Employees celebrating anniversaries with Lockheed Martin in August and September 2004

30 years
Janet Forest
Michael Herrmann
David Willick

25 years
George Bruder
William Burtch
Joseph Garcia
Martin LeCour
Raymond Scheuermann
Neil Sterling
Joseph Stumbo

20 years
Gilbert Atilano
Janice Capello
Galen Dempster
Michael Fisher
Sudhir Gopinath
Henry Irvin
Todd Jennings
Greg Lain
John Lancaster
Kevin Lowe
Shan McEvoy
Leon Morgan
Anthony Napolitano
Tommy Rose
Steve Stefancik
Terri Stewart
Ted Veazey
Wayne Waguespack

15 years
Michael Bankester
Herbert Bush
John Hale
Sybil Jolly
Terry Lee
Frederick Ogden
Bonnie Roper
Dwight Williams

10 years
Patricia Costantino
Roy Cusimano
Kurt Drilling
Kirk Drumm
Linda Eddy
Michael Fullagar
John German
Daniel Guarino
Connie Johnson
Harry Kerlec
Alexander Kooney
Rodney Miller
Joe Woods

5 years
Rachel Encalarde

Astronaut presents Snoopy awards
Terry Wilcutt who is scheduled to command the fourth RTF mission presented Silver Snoopies to William Torres (left) and Isolde Dagg of Program Management & Technical Operations and to Brian Gorr (right) of Safety & Product Assurance. Wilcutt cited Torres for his bipod ramp knowledge, Dagg for her technical oversight and Gorr for his performance as a safety staff engineer in support of RTF.

What's all this talk about FOD?

Foreign Object Debris (FOD) prevention has always been a priority at Michoud Operations, and with Return to Flight retrofit activities under way, it is now more critical than ever.

FOD Manager **Jim Louis** has instituted several new prevention steps, including annual FOD awareness training and the creation of the Foreign Object Incident Report.

The Michoud facility is now divided into three areas: FOD Awareness, Control and Critical. Employees in Control and Critical areas must use a personal pack to store employee badges or other items carried above the waist. Items that can't be removed such as eyeglasses must be secured with a tether.

FOD monitors responsible for regular inspections and reports will now support flight hardware areas. Soon, a system of tool inventory control will also be in place in Critical areas. All tools will be logged in and out of lockers, and employees will leave tool chits in place of the tools in use.

If a tool or personal item is lost, work will cease until the item is found.

Have you done your part to keep Michoud FOD-free? ■

Mission Success
Bulletin

Lockheed Martin Space Systems Company
Michoud Operations, Volume 23, Number 5
August 12, 2004

Editor: Harry Wadsworth

Graphics, Photography: Kevin Barré, Brian Combs, Britt Pitre, Hugh Webb & Horace Williams

Contributors: Kevin Barré, Brian Combs, Toni McCormick, Brian Peterson & Britt Pitre

Mission Success Bulletin is published by the Communications Department.

Lockheed Martin Space Systems Company
Michoud Operations
P.O. Box 29304
New Orleans, LA 70189-0304

Please send mailing updates to: **sharon.h.hansen@maf.nasa.gov**