



Above: Technicians prepare to lift *Atlantis* off of its Shuttle Carrier Aircraft following a November ferry flight from Kennedy Space Center to Palmdale, Calif. Right: Manufacturing engineer Darrell Trojan, center, meets with members of his Palmdale, Calif., major modification team. Below: Mark Allison, a Boeing employee, examines the flight deck of *Atlantis*. The cockpit will change significantly during this major modification period with the installation of "glass cockpit" liquid crystal displays to replace the old mechanical cockpit displays.



Photos courtesy Boeing



Veteran mechanics, technicians, engineers enjoy keeping shuttle fit

By Bob Howard

[Editor's note: This article was originally printed in Boeing News.]

THERE'S MAJOR EXCITEMENT in the air at Boeing's Palmdale, Calif., Orbiter Major Modification Facility. And it's as welcome as the aroma of sage after desert rain. The space shuttle is here!

Atlantis is back in Palmdale for a series of major modifications and state-of-the-art improvements that will allow her to carry greater payload weight into orbit, navigate with unprecedented accuracy and give astronauts new, digital instrument displays with which to fly.

This team of veteran space mechanics, technicians, engineers and support staff is about to tackle one of the most ambitious shuttle modification and inspection periods to date. And, they can't wait to dive in.

Darrell Trojan's job as a manufacturing engineer means resolving work flow problems to help keep things running smoothly. To him working on the shuttle is the greatest thing going. "It's great because it's world renowned. You feel like somebody who's really in the middle of the ball game. It's a special piece of equipment," Trojan said.

"And it's unprecedented as far as its accomplishments go."

What's a major mod like? "It's constantly go," explains Jerry Stone who, with his team, will remove, inspect and reinstall 3,000 white insulation blankets covering the cargo bay interior. These blankets protect critical systems from the intensely hot and cold conditions of space.

What's his job like? "The days go by so fast I can't believe it. I love it," Stone says. "I really enjoy coming to work. I can look at that beautiful spaceship, and say, 'Hey, I did that.'"

Mark Allison soon will be hip deep in one of the most complex mods, changing from mechanical instruments to digital displays.

For Allison and team, their big moment is making the late April deadline for electrical powerup. "That's like one of the glory times," said Allison. "When you know you're done and you did a good job."

Neil McCabe is one of the team that is removing and rebonding 3,000 square feet of thermal protection system blankets to the vehicle's exterior. They will install a newer, lighter blanket material that will remove some 1,500 pounds from the spacecraft.

"Every day is a new adventure,

because of the complexity of the system," McCabe says. "It's all very interesting because of the interfaces between the different kinds and thicknesses of materials and the science of the TPS itself."

You can see Jeff Lewis light up when he talks about "pushing the button." Lewis often operates the crane to remove large parts from the shuttle—with, of course, all eyes on him. "Believe me, you've got to be smooth, in spite of the pressure," Lewis says. "But it's such a big thrill to me. What we do, the world sees it, and we take a lot of pride in that. We are the best of the best. We never forget we are preparing this vehicle for the next three years of service in space."

Jim MacCurdy is an electrical tech with experience all the way back to the *Enterprise*, which came before the first shuttle, *Columbia*. "Every time we hear something on the news, something that the astronauts are doing, we feel very much a part of it," MacCurdy says.

Mods are tough. It takes going the extra mile and it takes a lot of drive.

"Our job has been to prove we're the best place to do these mods," MacCurdy explains. "And we're not letting up now." □

Upgrade Downtime

Atlantis gets new cockpit, navigation systems during refit

By Alan Buis

[Editor's note: This article was originally printed in Boeing News.]

TWENTY SUCCESSFUL MISSIONS and more than 60 million miles under its belt, America's Space Shuttle *Atlantis* is back at the Boeing Orbiter Major Modification Facility for a nine-month, approximately \$70 million makeover highlighted by the installation of a new, state-of-the-art cockpit and a cutting-edge satellite-based navigation system.

During its once-every-three-year orbiter major modification, *Atlantis* will receive a comprehensive structural inspection and more than 100 modifications designed to reduce program maintenance costs and improve operations, safety and reliability. Included are upgrades that will enable *Atlantis* to support construction of the International Space Station.

This refurbishment will be the most extensive yet performed. *Atlantis*, arrived in Palmdale, Calif., atop a Boeing 747 Shuttle Carrier Aircraft on Nov. 14, is to return to Kennedy Space Center in August.

Under contract to United Space Alliance, a team of more than 350 Boeing technicians and engineers—many of whom built *Atlantis*—are literally taking apart and reassembling the vehicle. Inspectors will survey every nook and cranny of the 12-1/2 year-old ship, using their eyes, borescopes, X-rays, ultrasonic waves, and other techniques to search for possible fatigue, corrosion, or broken rivets or welds.

The maintenance period also provides NASA and USA an ideal opportunity to install major modifications aimed at better, safer and more efficient vehicle performance and expanded mission capabilities.

A highlight of this refit—*Atlantis*' second—will be the shuttle fleet's first installation of the Multifunction Electronic Display Subsystem, commonly called the "glass cockpit." MEDS will replace *Atlantis*' four existing cathode ray tube screens, mechanical gauges and instruments with full-color flat-panel displays like those currently in use on modern commercial and military aircraft. These glass screens—the only space-qualified, flat-panel displays in the world—also will provide shuttle crews with information such as attitude-display, Mach-speed and horizontal-situation indicators.

"The change to MEDS is necessary because present electro-mechanical devices are becoming obsolete and increasingly expensive to maintain," said Russ Turner, Boeing Reusable Space Systems vice president and general manager. "Besides reducing maintenance costs, MEDS will reduce vehicle weight and power consumption, improve shuttle reliability and performance and be capable of expansion for future applications."

When MEDS is installed, *Atlantis*' forward flight deck will have nine displays, while two MEDS displays will be installed in the aft flight deck to support payload operations. Information will be interchangeable between screens depending upon mission needs, allowing crews to

select the display format that best suits their needs. MEDS hardware was developed by Honeywell Satellite Systems Operations, Glendale, Ariz.

Atlantis also is set to become the first orbiter to be guided solely by satellite-based navigation. The current TACAN navigation system will be removed and replaced with a triply-redundant system that operates through signals from the Boeing-built Navstar Global Positioning System satellites, the world's most accurate navigation system. The three-string GPS system will provide accurate vehicle attitude and location data. It promises to reduce shuttle program costs by eventually allowing removal of several ground stations at KSC as well as at the trans-Atlantic abort landing sites, which are becoming obsolete and costly to maintain. Together with other planned navigation enhancements, the three-string GPS system could one day enable shuttle landings in poor visibility conditions.

An additional series of modifications will enable *Atlantis* to join sister ships *Discovery* and *Endeavour* in supporting International Space Station construction, which begins this summer. The docking system *Atlantis* has used for seven missions to Russia's Mir space station will be modified to become a fully functional airlock complete with space suit services and crew communications capabilities and will be relocated within *Atlantis*' payload bay to provide adequate structural clearance with the ISS exterior. Additional station-related modifications will increase the orbiter's cooling and power capacities to support station payloads and upgrade the ship's UHF space communications system.

Operational enhancements include increasing the vehicle's load carrying capability, a series of measures to reduce the orbiter's weight and upgrades to the ship's thermal protection system tiles and blankets.

Safety and reliability enhancements include provisions to protect the orbiter's cooling system and wing leading edges from space debris, a structural beef-up of the crew module floor and enhancements to the vehicle's auxiliary power units and hydraulic system.

For the first time ever, Boeing Palmdale orbiter modifications personnel also will perform preflight vehicle checkouts. The move is expected to reduce the time required to process the vehicle for its next flight by up to two months.

The fourth operational orbiter, *Atlantis* rolled out of the Boeing Palmdale facility on April 6, 1985, and made its debut flight on mission STS-51J on Oct. 3, 1985. Among its accomplishments have been five missions for the Department of Defense; deployment of the Magellan, Galileo and Gamma Ray Observatory spacecraft; and seven missions to dock with Russia's space station Mir. *Endeavour* docked with Mir last month.

Atlantis' next scheduled mission will be STS-92 in January 1999, an International Space Station assembly mission to deliver station hardware, including a DC-to-DC power conversion unit. □