

# Best in class

To deliver a winning tanker, Boeing draws on a legacy of aerial refueling innovation and its experience across commercial and defense programs—and the skill and commitment of its employees

by Dan Beck

It's just another day for a fleet of tankers older than most of the men and women flying them.

Around the globe, U.S. Air Force flight crews are flying refueling sorties in aging Boeing-built KC-135 tankers. Ground crews at remote airfields work around the clock to keep them flying on essential missions, bringing fuel to the fight and supporting freedom in every part of the world. Altogether this day, as on every day, they will pump nearly 3 million pounds (440,000 gallons, or 1.7 million liters) of fuel to thirsty fighters, bombers, airlifters and other aircraft. That's more than 1 billion pounds (146 million gallons, or 550 million liters) of fuel a year.

Meanwhile, across Boeing, a team of employees is focused on replacing those

tankers that have now served for more than four decades. This team of engineers, technicians, analysts, accountants and aerial refueling experts are putting the finishing touches on Boeing's proposal to offer its NewGen Tanker to help the U.S. Air Force meet its aerial tanker needs and address the evolving threats of the next four decades.

"We have responded to the Air Force's new focus and needs by bringing together the best possible proposal team from both the defense and commercial airplane businesses of Boeing," said Dennis Muilenburg, president and CEO of Boeing Defense, Space & Security. "The NewGen Tanker team is drawing on thousands of years of employee experience in aircraft design, manufacturing, supply-chain management, cost accounting and program support,

**PHOTO ILLUSTRATION:** An artist's rendering of the Boeing NewGen Tanker. **BOEING**

“We’re partnering across the company as one team to produce the best tanker offering and help Boeing deliver a winning proposal.”

– Dennis V. Egan, 767-2CX deputy program manager, Boeing Commercial Airplanes

PHOTO: GAIL HANUSA/BOEING



“By offering a tanker that meets all technical requirements at the lowest price and risk, we’ll delight our customer.”

– Rick Lemaster, KC-X Proposal program manager, Boeing Defense, Space & Security

PHOTO: RICHARD RAU/BOEING



as well as an invaluable resource of first-hand, front-line service with the Air Force.”

The proposal team knows it must hold down costs, both for the development and production of these aircraft and for supporting them over the next half-century.

“Our Boeing team and our suppliers have been finding innovative ways to bring down cost to ensure the best price for the taxpayer,” said Jean Chamberlin, vice president and general manager of Boeing’s U.S. Air Force Tanker Program. “Our offering builds on our past success across all of Boeing to bring the best value and lowest possible price for our derivative aircraft programs, fighters, airlifters and rotorcraft. We know that we have to earn the honor of building these tankers.”

The deadline to submit bids was

extended by the Air Force by 60 days, to July 9, to allow EADS, the parent of Airbus, to bid on the tanker contract. EADS has said it will offer a tanker based on the Airbus A330 commercial jetliner. Air Force officials have said they plan to award a contract for an initial 179 tankers later this year.

With the NewGen Tanker, Boeing believes it has the right solution for the customer.

An aerial refueling tanker is essential to today’s military. Not only are tankers used to support U.S. missions around the globe by refueling other military aircraft, but they also play a significant role in allowing allied coalitions to meet threats. At the same time, they must perform multiple missions beyond refueling—including transporting cargo and passengers to and from remote



airfields, as well as carrying patients.

The fuel that enables air warriors to complete their missions has to be where they need it, when they need it. That means tankers often are close to the fight—and must be survivable and combat-ready.

“After six decades of building tankers for the warfighter, Boeing knows how to get them close to the fight, protect them in combat and get them safely home,” Chamberlin said. “The Boeing NewGen Tanker incorporates lessons learned from real-world scenarios in action around the world. It is equipped with multiple layers of protection for the aircraft and their crews, including countermeasures, situational awareness, covert lighting, threat avoidance, component hardening, redundancy and location, fuel-tank protection, and aircrew protection.”

Rick Lemaster leads Boeing’s proposal team. Boeing understands and accepts the Air Force’s requirements for its next-generation tanker, he said. “We listened and drew on the experience of generations of tanker pilots and operators. We put to work the best of Boeing’s military and commercial designers, engineers and managers on crafting a proposal that meets the service’s requirements, the end-users’ desires and the acquisition community’s fiscal safeguards.”

The result: the Boeing NewGen Tanker. It is a multi-role tanker distinguished by 21st-century technology, such as an advanced flight deck that was developed for the new 787 Dreamliner. Not only will the NewGen Tanker meet all 372 mandatory Air Force requirements, according to Lemaster, but it

will do so at the lowest risk to the customer and at the best value to the American people.

“Taxpayers are entitled to the best value—and to saving every dime in both the short and long term—on every government contract,” Mullenburg pointed out. “The tanker program should be no exception. The Boeing NewGen tanker meets or exceeds all of the requirements and has significant operational advantages at lower costs than a larger aircraft.”

As a medium-size tanker, based on the 767 commercial jet, the NewGen tanker will require fewer costly investments in existing bases to accommodate it than a larger plane would. It can be easily integrated into those bases, providing the Air Force more flexibility, agility and responsiveness for missions. And because of its size, the NewGen tanker will be more fuel-efficient than a heavier aircraft.

Boeing has been building military derivatives of commercial aircraft for more than a half-century—from tankers to *Air Force One*. The NewGen Tanker represents the culmination of that experience.

“The proven Boeing military-derivative capability of this team ensures low risk because we have shown over four decades that we know how to design and modify commercial aircraft for military applications,” Lemaster said. “And in the warfighting business, this kind of dependability is non-negotiable.”

The NewGen Tanker will be built using proven commercial aircraft manufacturing methods on an assembly line in Everett, Wash., one that uses Lean+ techniques and is compliant with U.S. export controls.

A similar in-line method is used in Renton, Wash., to manufacture the U.S. Navy’s P-8A Poseidon, a maritime patrol aircraft that is a military derivative of Boeing’s 737-800 commercial jet.

“The in-line production system allows us to provide a truly integrated approach for the customer,” said Elizabeth Lund, vice president and general manager, 767 program. “We’re really building on the lessons learned in the past on how to bring 10X and Lean+ practices to this effort. We believe this provides us with a real advantage in the competition.”

From Everett, the NewGen Tanker will be flown to Wichita, Kan., to be finished by Boeing teams there.

Senior Air Force leaders have been clear in their public statements that regardless of who wins the KC-X contract, they want a new tanker to meet multiple missions—and they need it soon.

“We could rest on Boeing’s past reputation for building the current U.S. tanker fleet and inventing boom technology, but we know that is not enough,” said Chamberlin. “While we have demonstrated Boeing’s ability to design, build, produce and maintain a large tanker fleet that will last for many decades, the future will confirm—if we are granted the honor and privilege of building these tankers—that Boeing can execute on our promises and provide a combat-ready, multi-role tanker on Day One.”

Boeing Commercial Airplanes President and CEO Jim Albaugh, who has experience leading tanker teams from both the defense and commercial sides of the company, believes there is one other thing that distin-



“I work with a great group of dedicated people who are committed to winning this program—and who are able to adjust to change while remaining focused on our customer’s needs.”

– Joyce Martin, senior manager, Finance, St. Louis

PHOTO: RICHARD RAU/BOEING



“We have to be a cohesive team to succeed, and we need to focus on understanding the military customer’s needs. That’s key.”

– Constantine (Dino) MacRis, 767 compliance coordinator, Everett, Wash.

PHOTO: GAIL HANUSA/BOEING

guishes this Boeing NewGen Tanker team: "Our employees and suppliers are key to delivering the fuel to the fight for servicemen and servicewomen," he said. "It is that investment, from the heart of everyone who will touch these planes, that will make it the greatest tanker in history." ■

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**PHOTO:** At the Wichita, Kan., site, Boeing employees Jack Reid (left) and Mike Greer work on a 767 international tanker for Italy.

BOB FERGUSON/BOEING



# Full service

## The Boeing-built KC-135 tanker is now in its fifth decade of service

For more than 50 years, no aircraft has been a more enduring symbol of Boeing's aerial refueling legacy than the KC-135 Stratotanker, and today a new generation of Boeing workers continues to support these tankers, which are operated by the United States and several international air forces.

The team at Boeing's Global Services & Support facility in San Antonio provides

programmed depot maintenance every five years to each U.S. Air Force KC-135, completely overhauling the aircraft.

"We want aircrews to know that when a plane leaves San Antonio it is ready to perform its mission here and abroad," said Mike Wright, the KC-135 program manager at Boeing San Antonio. "The men and women who perform these missions need to be focused on their mission and not the reliability of the aircraft; that's our job, one we take very seriously."

The San Antonio team has used Lean+ and employee involvement techniques to reduce cycle time and get KC-135s back to warfighters in record time. They also perform cockpit upgrades. Boeing engineers in Wichita, Kan., and

Oklahoma City provide design updates.

The KC-135 depot maintenance work will continue for another 10 years as part of a \$1.1 billion contract awarded to Boeing. By then, the KC-135 will have been in service for about six decades.

Boeing pilots flew the first KC-135 on Aug. 31, 1956, and the plane, designed and built by Boeing, entered service in 1957 at the height of the Cold War. Since then, the KC-135 has been the mainstay tanker during wars, conflicts and crises that have shaped history—and which continue to do so.

"There are always challenges supporting a 50-year-old airplane," Wright said. "But our team continues to support this aircraft flawlessly because they realize what is at stake."

—Jarrod S. Bartlett

**PHOTOS:** Steven Xaysiri, with the KC-135 Programmed Depot Maintenance program in San Antonio, preps a body skin of a KC-135 for installation. **LANCE CHEUNG/BOEING**

**(Insets, from left)** Refueling operator at work in a KB-29 during the 1950s. Boeing developed the world's first production aerial tanker, the KC-97 Stratofreighter. A KC-135A was the first jet-powered tanker for the U.S. Air Force. The B-29 was the first to employ the "flying boom" refueling system.

**BOEING ARCHIVES**



# A booming legacy

Boeing has long been a pioneer of in-flight refueling

by John Morrocco



Legend has it that the first aerial refueling occurred nearly 90 years ago, when a barnstorming pilot with a can of gas strapped to his back walked the wing of his biplane, stepped onto the wing of another plane flying in close formation and poured the contents of the can into the fuel tank.

Much has changed in the art of aerial refueling since those daredevil days—and Boeing has led the way.

Commercial companies and military strategists envisioned the potential for aerial refueling and sought more practical methods of delivering fuel to another aircraft in flight to increase its range. A number of experiments were conducted during the 1920s. One, in 1929, involved Boeing Model 40s and Douglas C-1 biplanes utilizing a 150-gallon (570-liter) fuel tank and 50-foot (15-meter) hose. Subsequent experiments conducted during the 1930s perfected aerial refueling hose systems. (For more about this 1929 flight, see the March 2010 issue of *Frontiers*: [www.boeing.com/news/frontiers/archive/2010/march/i\\_history.pdf](http://www.boeing.com/news/frontiers/archive/2010/march/i_history.pdf))

The rapid development of long-range aircraft with larger internal fuel capacities precluded the need for aerial refueling. The years immediately preceding and during World War II saw a succession of such

military aircraft, including Boeing-built B-17 Flying Fortresses and B-29 Superfortresses, which subsequently became the backbone of the new postwar Strategic Air Command.

The advent of the Cold War and the need for strategic long-range capabilities beyond the range of existing aircraft led Boeing to convert more than 200 Superfortresses into aerial refueling tankers. Dubbed the KB-29, these were the first full-time aerial refueling tankers to be operated by the U.S. Air Force. In 1949, a B-50 Superfortress named the *Lucky Lady II* took off from Carswell Air Force Base in Fort Worth, Texas, and became the first aircraft to fly nonstop around the world. It received three aerial refuelings from KB-29 tankers during the 94-hour flight.

In the 1950s, with the Air Force seeking a faster and more efficient method of transferring fuel, Boeing engineers developed the “flying boom,” a rigid telescoping system that could deliver fuel at a much higher rate than the smaller-diameter flexible hose system. The boom was equipped with two small wings at the end to allow it to be more easily guided to a connector on the receiving aircraft.

Boeing began converting existing bomber and transport aircraft into refueling tankers to meet a growing demand. The Boeing Stratofreighter, similar to the

passenger-carrying Stratocruiser, was adapted as an aerial refueler, with some 888 C-97 Stratofreighters built between 1947 and 1958. Most were outfitted with the flying boom and were designated the KC-97.

With the advent of the jet age, Boeing developed the KC-135, which took to the air for the first time in 1956, gradually replacing the propeller-powered KC-97. These “flying gas stations” could transfer fuel at a rate of 1,000 gallons (3,785 liters) per minute through their 47-foot-long (14-meter-long) booms. Based on the Dash-80 prototype and developed in parallel with the 707 commercial aircraft, more than 800 KC-135s were built during the next decade and several hundred are still in service today.

As those KC-135 tankers now are older than most of the men and women who fly them, the Air Force is looking for a replacement. Boeing is offering its NewGen Tanker, which will incorporate a number of innovations, including a cockpit that incorporates the advanced flight-deck displays of the new 787 Dreamliner.

Over the decades, Boeing innovations in tankers and refueling technologies have transformed the way aircraft operate—in ways that could not have been imagined by those barnstorming daredevils nearly a hundred years ago. ■

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“Incorporating lessons learned from other programs allows our team to look at the entire tanker manufacturing build process from an integrated perspective and make sure our efficiencies weave together seamlessly.”

– Jerry Lazar, U.S. Air Force Tanker Manufacturing Operations, Wichita, Kan.

PHOTO: BOB FERGUSON/BOEING



“In our weekly team meetings we focus on making processes work faster, better and more efficiently. It’s partly about Lean+, but it’s also about bringing people together. That’s a great asset for us on the 767 program.”

– Warren Pullig, Body Structures lead mechanic, Everett, Wash.

PHOTO: GAIL HANUSA/BOEING

# Supply in demand

A winning tanker bid by Boeing requires working together with a strong supplier team

by Doug Holmes

**B**oeing has some supply-side muscle on its side in the KC-X tanker competition.

In this case, it’s the 800 or so suppliers that Boeing is counting on to help it deliver a winning proposal to the U.S. Air Force.

“Our proven, nationwide network of commercial and defense industry suppliers is ready to help us provide the Air Force with a new-generation tanker at the lowest risk for the Air Force and the lowest cost for the taxpayer,” Dennis Muilenburg, president and CEO of Boeing Defense, Space & Security, said during a meeting with suppliers earlier this year in Washington, D.C. “Our partnership proves every day that we are greater than the sum of our parts.”

Recognizing the value suppliers bring

to its offer, Boeing is making sure they are actively engaged.

One of those suppliers is United Tool & Die Co. in West Hartford, Conn., which manufactures metal tubing for several Boeing commercial and defense programs. “Good communication will be absolutely critical to success,” said Gary Guyette, the company’s production manager. “I have a weekly teleconference call with Boeing, no matter how busy we are, to discuss our progress and requirements. The supply chain is integral to making sure that Boeing gets the parts and services it needs on a timely basis.”

Another supplier, Woodward Governor, based in Fort Collins, Colo., provides Boeing with aerospace motion controls for commercial aircraft as well as

international tanker, rotorcraft and weapon programs. “One of the main factors in having a well-functioning supply chain is having a collaborative relationship,” said Craig Scott, vice president of Aircraft Systems for Woodward Governor. “If it becomes one-sided and we don’t have the ability to work together, we cannot come up with the most cost-effective and best-performing solutions.”

Putting together a winning bid for the KC-X tanker competition will require the “absolute best” from not only Boeing but also its suppliers, according to Mark DeVoss, director of Supplier Management for Boeing Tanker Programs.

“To get the best results, we need to be as inclusive as possible,” DeVoss said. “We’re able to do that successfully



through events like our annual supplier conference in Washington, D.C., employee events at supplier facilities, and frequent communication and on-site visits.”

While a Boeing win will support thousands of jobs and help many local economies, the contract means a lot to Boeing’s supply base, too.

“This is a great opportunity to support the Air Force and the other services that will rely on tanker aircraft, and be part of something bigger than you,” said Bill Begert, vice president of Business Development and Aftermarket Services for Pratt & Whitney Military Engines. The company would supply the engines for Boeing’s NewGen Tanker.

“Pratt & Whitney engines have powered military aircraft reliably and safely for more

than 80 years,” Begert added, “so we look forward to teaming with Boeing to offer the Air Force an affordable, fuel-efficient and combat-ready aircraft that will greatly improve the United States’ aerial refueling capabilities.” ■

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**PHOTO:** Mechanic Michael Pitchford works on the deck of a 767 at the Everett, Wash., factory. BOB FERGUSON/BOEING



# ‘We’re all in this to win’

For Jean Chamberlin, leader of the company’s U.S. Air Force Tanker Program, the “One Boeing” approach on NewGen Tanker gives Boeing a critical competitive advantage.



PHOTO: GAIL HANUSA/BOEING

## How is the NewGen Tanker different from what we offered in 2007?

The most significant difference is that we have 50 additional requirements that are now mandatory, over and above our previous offer in 2007. We also have listened to our customer’s feedback from that offer and have made a number of improvements. The NewGen Tanker has an enhanced cockpit with large displays, and a more advanced aerial refueling system that does not require helmet-mounted displays but rather a direct 3-D view. We’ve taken the technology from a KC-135, where the

boom operator lies down in the back of the airplane and looks through a window to refuel the receiver, to the International Tanker, where you’re relying on a helmet-mounted display, to now—the 3-D flat screen.

## What do you want the team focused on?

The team is focused right now on making sure we understand our statement of work based on customer requirements; that we have properly estimated the resources required to execute that statement of work; and that we have



“To keep the 767 as affordable as possible, we’re implementing Lean+ efficiencies, including a new production line and additional design improvements to the 767 platform.”

– Elizabeth Lund, 767 vice president and general manager, Commercial Airplanes

PHOTO: GAIL HANUSA/BOEING



“We can deliver on our promises by ensuring that our Tanker Engineering team develops an offering that will excite our Air Force customer—and be executable.”

– Gregg Rusbarsky, U.S. Air Force Tanker Program chief engineer, Defense, Space & Security

PHOTO: RICHARD RAU/BOEING

developed an integrated schedule that has the proper flow time, handoff and margin that will allow us to successfully meet major milestones for flight and initial operational capability in the RFP [Request for Proposal].

#### How is the “One Boeing” approach being utilized on this program?

There are three key elements of our “One Boeing” approach on the NewGen Tanker. The first is the effort being led by Elizabeth Lund, vice president and general manager, 767 program, to keep the 767 as affordable as possible by putting more Lean+ efficiencies in place.

Second is our effort to streamline two separate certification steps as much as possible—one for baseline commercial

aircraft and one for aircraft with military equipment. We’re utilizing a “One Boeing” Test and Evaluation Organization to gather test data to satisfy FAA [Federal Aviation Administration] requirements for both certifications concurrently where we can. This will add efficiency to our test program, reduce test and certification cost, and help us deliver the FAA-certified tanker aircraft faster to the U.S. Air Force.

The third aspect of the “One Boeing” approach involves a single tanker team that I’m fortunate enough to lead. We’re already operating as a fully integrated team, with people across the company supporting the proposal effort. I’ve had the opportunity to walk the production line in the Everett, Wash., factory to see the men and women of the 767 program working hard to instill Lean+ and 10X processes into their systems. I’ve visited the office employees there as well as the employees in Wichita, St. Louis and Southern California who are spending countless hours to refine the proposal. On these visits one thing is clear: There is a shared commitment across The Boeing Company that we’re all in this to win it and to work together to make that happen.

#### How has your experience managing other programs prepared you for this job?

Serving as the program manager for C-17 for two and a half years was my introduction into the Air Mobility Command, which is responsible for providing airlift and tanker capability around the clock, all over the world. That assignment certainly prepared me to understand our customer,

their hierarchy, where the requirements are set and what their expectations are. My experience leading other development programs such as Comanche, B-2 and B-1—supporting development efforts through major design milestones like Preliminary Design Reviews or Critical Design Reviews and getting into first flight and production—was also valuable in terms of learning how you control change, decrease customer risk and cost, and build a relationship with the customer.

#### What leadership attributes are most important to successfully manage this team?

The most important leadership attribute in starting out a new team would be “charting the course”—making sure it starts and ends with the customer. Staying focused on what the customer has told us in terms of their needs and making sure we have an offer that meets their requirements. Another aspect of this is managing our supplier base. It is important to bring our suppliers in line and have their congressional constituents understand the importance of jobs in their district. A third aspect is being able to help employees see what “One Boeing” can do—working together despite geographic differences. One of the things making a big difference in our competitive advantage over any other contractor is our ability to bring our engineering, business and manufacturing teams together to leverage the lowest-cost offer, and thus minimize risk to shareholders. ■

*More information about Boeing’s tanker offering is available online:*

**UnitedStatesTanker.com** – Here you can take a virtual tour of the aircraft; keep up on the latest developments in the tanker competition, including the whereabouts of “BART,” Boeing’s traveling tanker demonstrator trailer; and order a “Fly Boeing Tankers” sticker to show your support.


**RealAmericanTankers.com** – View the site’s photo gallery featuring employees across the company who are working on the tanker program. Learn about key issues related to the program and how you can get involved.



GRAPHIC: ERIC GREER/BOEING

# Meet the New

The tanker Boeing will offer the U.S. Air Force integrates state-of-the-art technology and systems and builds on the company's rich legacy of air-refueling experience



A fuel receptacle allows the tanker to be refueled in flight so it can remain on station as long as necessary.

The tanker incorporates the advanced flight-deck displays of the 787 Dreamliner.

Armor and other protection measures make it safer to operate in a combat zone.

When the boom is not in use, a single aircraft can be refueled with the Centerline Hose and Drum unit.

# NewGen Tanker



The NewGen Tanker includes several advanced systems that are designed to meet the mission requirements of the future. Starting in the cockpit, the NewGen Tanker features electronic displays developed for the 787 Dreamliner. These four large screens provide the tanker crew with flight and navigation information and improved situational awareness. At the other end of the NewGen Tanker is a fly-by-wire refueling boom based on the proven KC-10 tanker boom. The NewGen Tanker boom simplifies refueling, with improved safety and reliability, while incorporating new technology. The boom operator in the NewGen Tanker will monitor a 3-D flat-screen display to perform air-to-air refueling operations.

GRAPHIC: ERIC GREER/BOEING

The refueling boom has improvements that make it easier to operate and more reliable.

Blended Winglets improve the tanker's range and performance.

Two aircraft can be refueled simultaneously from the refueling pods on the wings.