

U**SNS** Howard O. Lorenzen (T-AGM 25) looks like a Navy ship. It is outfitted with Pentagon-furnished equipment and sensors, is sailed by Navy Military Sealift Command personnel, and is named after a Naval Research Laboratory engineer. It is however, an Air Force vessel.

Lorenzen reached initial operational capability in March 2014, not long after its predecessor, USNS *Observation Island*, was decommissioned after nearly 60 years at sea. In a world of proliferating missile threats, the missile defense mission is one of growing importance to the Air Force.

The vessel itself is not what's important, but what it carries is: an incredibly powerful radar, known as the Cobra King. It replaces the Cobra Judy radar that was hosted on *Observation Island*. Built by Raytheon, which declines comment about it, the radar defines the purpose of the program: ballistic missile treaty verification.

There's not much the Air Force will say about it, either. Service spokeswoman Vicki Stein said the service is "limited on what we can provide," but noted that Cobra King's mission originates from the Strategic Arms Reduction Treaty signed in 1991 between the United States and the Soviet Union after the fall of the Berlin Wall.

Officially, Cobra King's purpose is to monitor former Soviet missile testing for START verification purposes. Its secondary mission is to support domestic missile testing. Basically, Cobra King is an ever-vigilant watchdog, keeping an eye on ballistic missile tests around the world, by both allies and hostile nations, and on US tests.

Historically, missile tracking and telemetry has been an Air Force mission. Cobra King is part of the Air Force's broader Cobra family of radars—one that happens to be at sea. Air Force officials won't say exactly where and how Cobra King has been used, but with growing concerns about missile programs in North Korea, Iran, and other countries, the Pentagon places a high priority on having powerful missile-detecting assets in its arsenal.

Cobra Judy was involved in the high-profile shutdown of a defunct satellite that was expected to plummet to Earth in 2008. The US satellite, launched two years before, malfunctioned shortly after deployment, and the US opted to destroy it at high altitude rather than risk an unpredictable impact on the

Earth. Observers noted, however, that the satellite's destruction was also a not-so-subtle demonstration that the US could shoot down a satellite. The "clean" mission, which left no orbital debris, was a strong riposte to China, which had demonstrated an anti-satellite capability of its own in 2007. That event left a large and dangerous debris field in orbit.

LONG TIME COMING

The power of Cobra King is visible to the naked eye. At more than 200 tons, it's a big radar, just like the Cobra Judy. It's so big, it needs the 534-foot *Lorenzen* to carry it around the world.

The arrival of the radar has been a long time coming. The contract for *Lorenzen* was first awarded back in 2006 to VT Halter Marine, the ship was delivered in January 2012, and it finally became operational last year. It underwent contract trials off the coast of California in late 2013. The trials "exercised all aspects of the vessel and its systems, including main propulsion, damage control, supply, deck, navigation, habitability, electrical systems, and operation," according to an Air Force statement. The estimated cost of the Cobra King project is \$1.74 billion.

The most recent contract award on the program was \$9.8 million to Raytheon in February 2013, which covered an alternative architecture study in support of the Cobra King program.

The history of Cobra King stretches back to 1952, when Cobra Judy's host

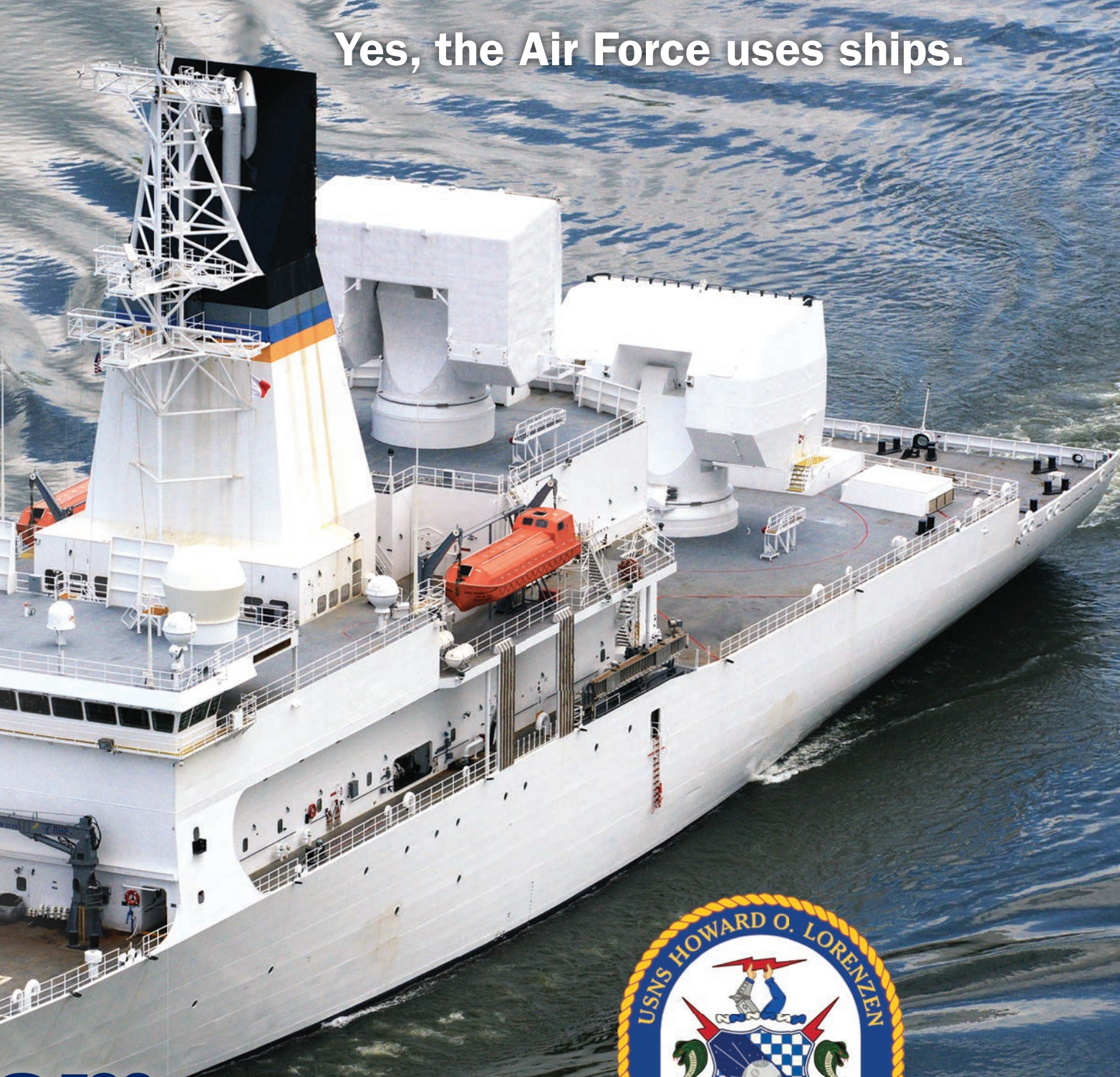
vessel, *Observation Island*, was laid down as a Mariner-class high-speed cargo ship with the designation EAG-154. It was called *Empire State Mariner* back then. In 1956, the ship was transferred to the Navy along with three other Mariners. It underwent a conversion to the first naval ship with a fully integrated fleet ballistic missile (FBM) system. In 1958, she was recommissioned as *Observation Island*. The Navy didn't make many engineering changes to the ship itself, but did make extensive alterations within the superstructure and hold areas to allow for the installation of the FBM system. After that, it conducted dummy missile launches and communications tests in the Atlantic. In 1959, *Observation Island* conducted the first at-sea launch of a Polaris submarine-launched ballistic missile and continued to support Polaris flights into the 1960s. President John F.



USAF Missile Defense—From the Sea

By Dan Taylor

Yes, the Air Force uses ships.



om



USNS Howard O. Lorenzen travels the Columbia River in the Pacific Northwest on the way to the Pacific Ocean.

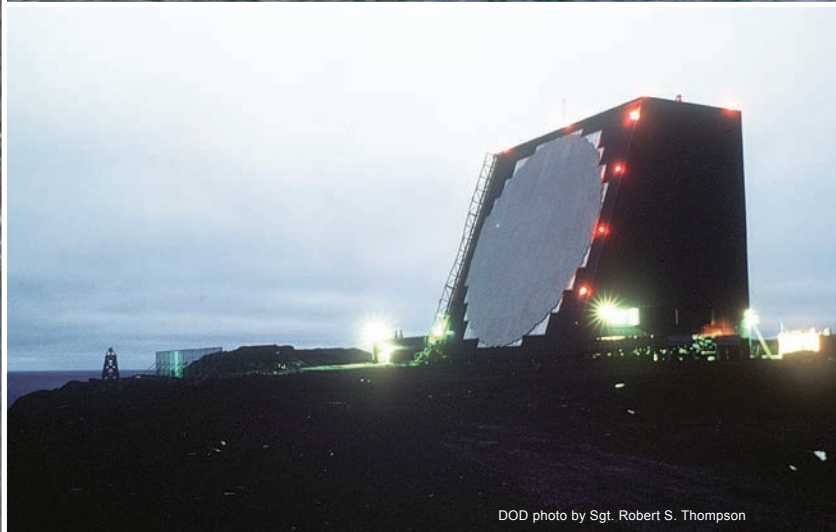
Oregon Military Department of Public Affairs photo by SSgt. Jason van Mourik



Military Sealift Command photo



USAF photo



DOD photo by Sgt. Robert S. Thompson

Kennedy observed a Polaris launch aboard *Observation Island* just six days before his assassination.

The vessel was sidelined in the early 1970s until the Navy reacquired the vessel in 1977 and transferred it to Military Sealift Command with the designation T-AGM-23. It wasn't until the early 1980s that Raytheon was tasked with developing Cobra Judy. In 1985, the company installed an X-band radar to complement the S-band phased array system on board. The upgrade was intended to improve the system's ability to gather data on a ballistic missile's terminal phase, creating the dual-band radar the Air Force prefers today.

DOUBLE THE CAPABILITY

The dual-band capability and its mobility are what make Cobra King such an asset to the Air Force. Actually, the Pentagon has bigger radars than Cobra King, even at sea: the massive Sea-Based X-band Radar (SBX-1) is built on a 50,000-ton drilling rig. But SBX-1 lacks those two key abilities.

Due to the fact that Cobra King is based on a ship, it can move fairly quickly to any part of the world, responding to crises as they emerge, whereas SBX-1 must be towed—slowly—to an operating location.

SBX-1 also only has an X-band radar, used for tracking multiple targets over a wide field. S-band, on the other hand, narrows down data collection to specific individual objects. The radars work very closely together.

The Air Force spokeswoman said S-band radar is specifically used to search and acquire the target, and then hand it off to the X-band, which provides high-resolution target characterization.

Cobra King will differ from the Cobra Judy in that it will both be more complex and easier to maintain.

"Cobra Judy required highly skilled engineers and technicians who could troubleshoot and repair faults to the component level," Stein said. "This required test equipment tools and skill sets. Even though Cobra King is significantly more complex, it is easier to maintain because it was designated with 'BIT' (built-in test) to facilitate the rapid troubleshooting, repair, and return to service of the radar."

In addition, operators and technicians can troubleshoot and replace components themselves, and spares are stored on the ship for nearly all components.

According to a chart provided by the Air Force, there are other key differences between the platforms. For

Left: USNS *Observation Island* conducts a Polaris missile test off Cape Canaveral, Fla. Top: *Observation Island* during a Cobra Judy exercise in 1981, after modifications to equip it with a phased-array radar turret. Above: *Cobra Dane*, a phased-array radar system specially constructed to detect ballistic missile testing on a Russian Siberian peninsula, in 1977.

example, if the Cobra Judy's S-band radar failed, the mission failed. However, with Cobra King, the X-band radar can continue to collect data even if the S-band radar isn't functioning. Also, Cobra Judy only provided standard definition, versus Cobra King's high definition. Cobra King can also track well over a thousand targets using both bands, versus only about 100 for Cobra Judy, and it can collect terabytes of data instead of only gigabytes.

There are also important differences between the vessels themselves. *Observation Island* relied on steam turbines, but *Lorenzen* uses modern diesel-electric engines. *Lorenzen* also requires a smaller crew: some 60 Navy personnel instead of 100. And at a lower operating cost, *Lorenzen* provides operational availability of more than 75 percent against an aver-



USAF photo

Cobra Ball—an extensively modified C-135B—is a measurement and signals intelligence collector designed to work in conjunction with Cobra Dane and Cobra Judy as they monitored Soviet ballistic missile testing.

age of 70 percent for *Observation Island*, according to the Air Force.

A UNIQUE PARTNERSHIP

The Air Force doesn't actually have any sailors, so the operation of *Lorenzen* necessitates a unique relationship between the Air Force and Military Sealift Command. According to the Air Force spokeswoman, Military Sealift Command has responsibility for operating and maintaining the ship, so an Air Force captain onboard can focus on operating the radar itself.

"The ship's captain is responsible for the health and welfare of the crew as well as navigation and maintenance of the ship," she said. "The mission crew is led by an Air Force captain who manages the mission and ensures the smooth operation of the mission systems." The captain is the only Air Force member onboard.

Eric Wertheim, an author and columnist for the US Naval Institute specializing in Navy and Air Force issues, said *Cobra Judy* "played a really important role in national security" by "[helping] with the collection of this high-resolution, accurate data that's needed for ballistic missile defense, treaty verification, and decision-making by leadership."

Now that the baton has been passed to *Cobra King*, the upgraded system will allow the Pentagon to develop "algorithms that would be required in case a shoot-down might be needed, and make sure countries we sign treaties with, or potential adversaries, that we understand their capabilities," Wertheim said.

The platform could be protected if necessary. It operates alone much of the time, though it may require support craft depending on how long it's at sea and if it travels close to hostile countries—not common in peacetime operations, said Wertheim.

The fact that MSC and the Air Force operate the vessel together is a "great example of jointness," he said. "It's really seamless."

MSC operates the vessel mostly at the behest of the Air Force, doing Air Force-sponsored missions.

"It's kind of a unique environment where one is responsible for making sure the ship is kept in shape, and the other making sure the systems are operating," Wertheim noted. "So the MSC is working to operate and navigate the vessel, and then they have military technicians and contractors maintain the radar." The naval personnel are essentially ensuring the ship can perform its Air Force mission.

SENSORS IN HIGH DEMAND

Tom Karako, a missile defense expert and visiting fellow at the Center for Strategic and International Studies, said the fact that the radar is dual-band indicates that its strategic use will primarily be ballistic missile tracking and discrimination. This means *Cobra King* will provide a mobile sea-based capability that fits in with a much larger suite of radars the Air Force and Missile Defense Agency operate.

Cobra King itself is part of the larger "Cobra" suite of sensors and radars.

■ *Cobra Dane* is a ground-based passive electronically scanned array located at an air station in Alaska. It was built in the 1970s and feeds data to the North American Aerospace Defense Command (NORAD) in Colorado.

■ *Cobra Ball* is an air-based asset, a measurement and signals intelligence collector installed in an RC-135S aircraft. Its job is to observe ballistic missile flights at long range.

■ *Cobra Eye* was also an air-based asset, installed on an RC-135X aircraft, and it was tasked with tracking intercontinental ballistic missile re-entry vehicles before the aircraft was later converted into another *Cobra Ball*.

Karako said that in missile defense, while the interceptor missiles themselves get most of the attention, sensors like *Cobra King* and other suites are of the utmost importance to the Air Force. This is especially true in light of the 2002 decision by the George W. Bush Administration to withdraw from the 1972 Anti-Ballistic Missile Treaty in order to protect against ballistic missile threats.

"We've seen an unprecedented upgrade in our historical radars, as well as an expansion of them," Karako said. "That quiet expansion of these radars and their improvements has been an unsung chapter of expansion of BMD capabilities."

Karako said while the development of better interceptors is certainly part of that effort, it's the power of the sensors themselves that has really provided a big boost in capability to the Pentagon.

"You see the MDA talking about long-range discrimination radar [LRDR] going to be put up in Alaska by 2020, and they're very keyed up on that specifically for discrimination [between missile targets], dealing with both current and next generation missile threats," he said.

Karako continued, "It's all about discrimination, whether it's something much smaller and more mobile like [*Cobra King*] that collects data and compiles it on a smaller scale, or something more powerful like SBX and LRDR."

The strategic usefulness of *Cobra King* and assets that complement it hinges on the sensors and radars, whether it's SBX, LRDR, *Cobra King*, or another suite of radars—especially as demand continues to outstrip supply.

"This network of evolving radar capabilities is going to be in high demand," Karako said. "The demand for missile defense assets is far exceeding the supply, and that goes for interceptors and it goes for radars, whether for the Air Force or for MDA. There continues to be a growing demand for extremely high resolution sensors, and I think this dual-band capability speaks to what it's going to be doing as part of that larger picture." ❊

Dan Taylor is a journalist, with seven years of experience covering the Pentagon, and an analyst specializing in defense acquisition and weapons programs. This is his first article for Air Force Magazine.

U **SNS** Howard O. Lorenzen (T-AGM 25) looks like a Navy ship. It is outfitted with Pentagon-furnished equipment and sensors, is sailed by Navy Military Sealift Command personnel, and is named after a Naval Research Laboratory engineer. It is however, an Air Force vessel.

Lorenzen reached initial operational capability in March 2014, not long after its predecessor, USNS *Observation Island*, was decommissioned after nearly 60 years at sea. In a world of proliferating missile threats, the missile defense mission is one of growing importance to the Air Force.

The vessel itself is not what's important, but what it carries is: an incredibly powerful radar, known as the Cobra King. It replaces the Cobra Judy radar that was hosted on *Observation Island*. Built by Raytheon, which declines comment about it, the radar defines the purpose of the program: ballistic missile treaty verification.

There's not much the Air Force will say about it, either. Service spokeswoman Vicki Stein said the service is "limited on what we can provide," but noted that Cobra King's mission originates from the Strategic Arms Reduction Treaty signed in 1991 between the United States and the Soviet Union after the fall of the Berlin Wall.

Officially, Cobra King's purpose is to monitor former Soviet missile testing for START verification purposes. Its secondary mission is to support domestic missile testing. Basically, Cobra King is an ever-vigilant watchdog, keeping an eye on ballistic missile tests around the world, by both allies and hostile nations, and on US tests.

Historically, missile tracking and telemetry has been an Air Force mission. Cobra King is part of the Air Force's broader Cobra family of radars—one that happens to be at sea. Air Force officials won't say exactly where and how Cobra King has been used, but with growing concerns about missile programs in North Korea, Iran, and other countries, the Pentagon places a high priority on having powerful missile-detecting assets in its arsenal.

Cobra Judy was involved in the high-profile shutdown of a defunct satellite that was expected to plummet to Earth in 2008. The US satellite, launched two years before, malfunctioned shortly after deployment, and the US opted to destroy it at high altitude rather than risk an unpredictable impact on the

Earth. Observers noted, however, that the satellite's destruction was also a not-so-subtle demonstration that the US could shoot down a satellite. The "clean" mission, which left no orbital debris, was a strong riposte to China, which had demonstrated an anti-satellite capability of its own in 2007. That event left a large and dangerous debris field in orbit.

LONG TIME COMING

The power of Cobra King is visible to the naked eye. At more than 200 tons, it's a big radar, just like the Cobra Judy. It's so big, it needs the 534-foot *Lorenzen* to carry it around the world.

The arrival of the radar has been a long time coming. The contract for *Lorenzen* was first awarded back in 2006 to VT Halter Marine, the ship was delivered in January 2012, and it finally became operational last year. It underwent contract trials off the coast of California in late 2013. The trials "exercised all aspects of the vessel and its systems, including main propulsion, damage control, supply, deck, navigation, habitability, electrical systems, and operation," according to an Air Force statement. The estimated cost of the Cobra King project is \$1.74 billion.

The most recent contract award on the program was \$9.8 million to Raytheon in February 2013, which covered an alternative architecture study in support of the Cobra King program.

The history of Cobra King stretches back to 1952, when Cobra Judy's host

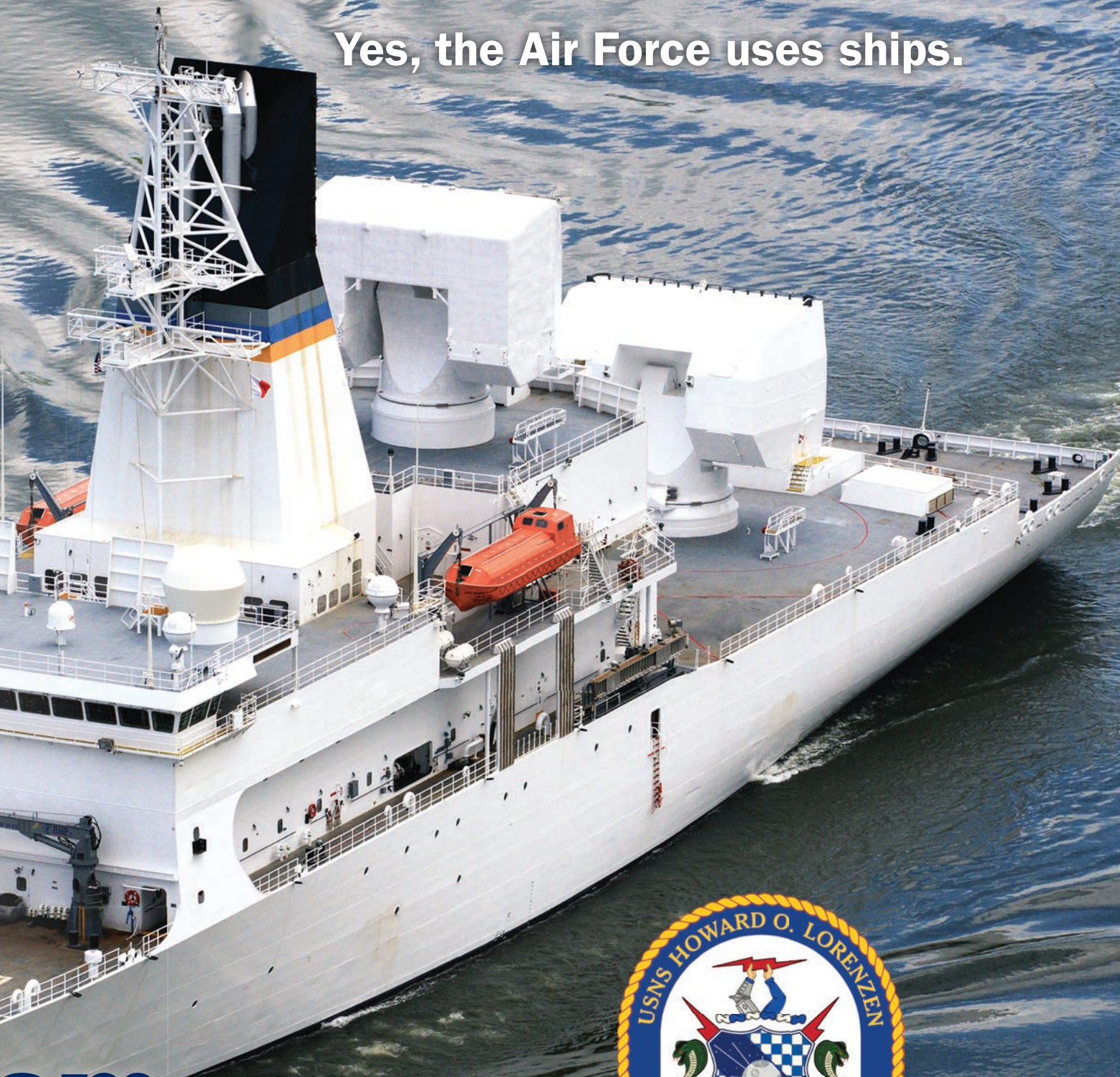
vessel, *Observation Island*, was laid down as a Mariner-class high-speed cargo ship with the designation EAG-154. It was called *Empire State Mariner* back then. In 1956, the ship was transferred to the Navy along with three other Mariners. It underwent a conversion to the first naval ship with a fully integrated fleet ballistic missile (FBM) system. In 1958, she was recommissioned as *Observation Island*. The Navy didn't make many engineering changes to the ship itself, but did make extensive alterations within the superstructure and hold areas to allow for the installation of the FBM system. After that, it conducted dummy missile launches and communications tests in the Atlantic. In 1959, *Observation Island* conducted the first at-sea launch of a Polaris submarine-launched ballistic missile and continued to support Polaris flights into the 1960s. President John F.



USAF Missile Defense—From the Sea

By Dan Taylor

Yes, the Air Force uses ships.



om



USNS Howard O. Lorenzen travels the Columbia River in the Pacific Northwest on the way to the Pacific Ocean.

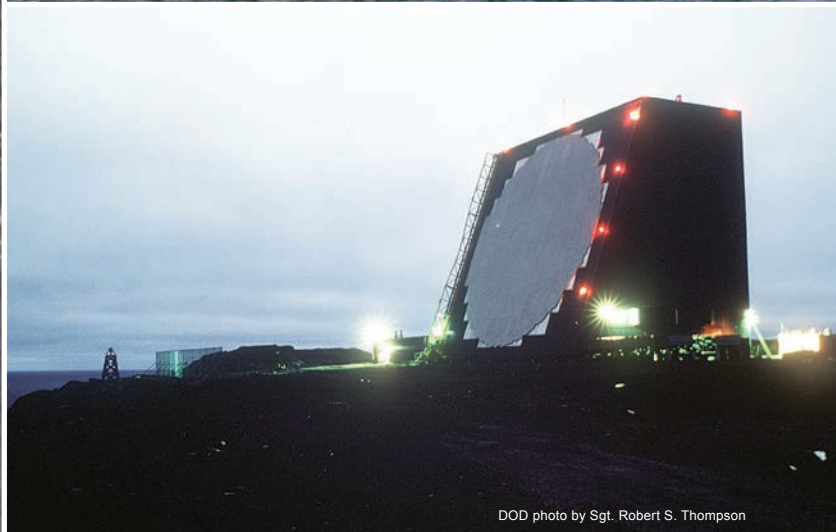
Oregon Military Department of Public Affairs photo by SSgt. Jason van Mourik



Military Sealift Command photo



USAF photo



DOD photo by Sgt. Robert S. Thompson

Kennedy observed a Polaris launch aboard *Observation Island* just six days before his assassination.

The vessel was sidelined in the early 1970s until the Navy reacquired the vessel in 1977 and transferred it to Military Sealift Command with the designation T-AGM-23. It wasn't until the early 1980s that Raytheon was tasked with developing Cobra Judy. In 1985, the company installed an X-band radar to complement the S-band phased array system on board. The upgrade was intended to improve the system's ability to gather data on a ballistic missile's terminal phase, creating the dual-band radar the Air Force prefers today.

DOUBLE THE CAPABILITY

The dual-band capability and its mobility are what make Cobra King such an asset to the Air Force. Actually, the Pentagon has bigger radars than Cobra King, even at sea: the massive Sea-Based X-band Radar (SBX-1) is built on a 50,000-ton drilling rig. But SBX-1 lacks those two key abilities.

Due to the fact that Cobra King is based on a ship, it can move fairly quickly to any part of the world, responding to crises as they emerge, whereas SBX-1 must be towed—slowly—to an operating location.

SBX-1 also only has an X-band radar, used for tracking multiple targets over a wide field. S-band, on the other hand, narrows down data collection to specific individual objects. The radars work very closely together.

The Air Force spokeswoman said S-band radar is specifically used to search and acquire the target, and then hand it off to the X-band, which provides high-resolution target characterization.

Cobra King will differ from the Cobra Judy in that it will both be more complex and easier to maintain.

"Cobra Judy required highly skilled engineers and technicians who could troubleshoot and repair faults to the component level," Stein said. "This required test equipment tools and skill sets. Even though Cobra King is significantly more complex, it is easier to maintain because it was designated with 'BIT' (built-in test) to facilitate the rapid troubleshooting, repair, and return to service of the radar."

In addition, operators and technicians can troubleshoot and replace components themselves, and spares are stored on the ship for nearly all components.

According to a chart provided by the Air Force, there are other key differences between the platforms. For

Left: USNS Observation Island conducts a Polaris missile test off Cape Canaveral, Fla. Top: Observation Island during a Cobra Judy exercise in 1981, after modifications to equip it with a phased-array radar turret. Above: Cobra Dane, a phased-array radar system specially constructed to detect ballistic missile testing on a Russian Siberian peninsula, in 1977.

example, if the Cobra Judy's S-band radar failed, the mission failed. However, with Cobra King, the X-band radar can continue to collect data even if the S-band radar isn't functioning. Also, Cobra Judy only provided standard definition, versus Cobra King's high definition. Cobra King can also track well over a thousand targets using both bands, versus only about 100 for Cobra Judy, and it can collect terabytes of data instead of only gigabytes.

There are also important differences between the vessels themselves. *Observation Island* relied on steam turbines, but *Lorenzen* uses modern diesel-electric engines. *Lorenzen* also requires a smaller crew: some 60 Navy personnel instead of 100. And at a lower operating cost, *Lorenzen* provides operational availability of more than 75 percent against an aver-



USAF photo

Cobra Ball—an extensively modified C-135B—is a measurement and signals intelligence collector designed to work in conjunction with Cobra Dane and Cobra Judy as they monitored Soviet ballistic missile testing.

age of 70 percent for *Observation Island*, according to the Air Force.

A UNIQUE PARTNERSHIP

The Air Force doesn't actually have any sailors, so the operation of *Lorenzen* necessitates a unique relationship between the Air Force and Military Sealift Command. According to the Air Force spokeswoman, Military Sealift Command has responsibility for operating and maintaining the ship, so an Air Force captain onboard can focus on operating the radar itself.

"The ship's captain is responsible for the health and welfare of the crew as well as navigation and maintenance of the ship," she said. "The mission crew is led by an Air Force captain who manages the mission and ensures the smooth operation of the mission systems." The captain is the only Air Force member onboard.

Eric Wertheim, an author and columnist for the US Naval Institute specializing in Navy and Air Force issues, said *Cobra Judy* "played a really important role in national security" by "[helping] with the collection of this high-resolution, accurate data that's needed for ballistic missile defense, treaty verification, and decision-making by leadership."

Now that the baton has been passed to *Cobra King*, the upgraded system will allow the Pentagon to develop "algorithms that would be required in case a shoot-down might be needed, and make sure countries we sign treaties with, or potential adversaries, that we understand their capabilities," Wertheim said.

The platform could be protected if necessary. It operates alone much of the time, though it may require support craft depending on how long it's at sea and if it travels close to hostile countries—not common in peacetime operations, said Wertheim.

The fact that MSC and the Air Force operate the vessel together is a "great example of jointness," he said. "It's really seamless."

MSC operates the vessel mostly at the behest of the Air Force, doing Air Force-sponsored missions.

"It's kind of a unique environment where one is responsible for making sure the ship is kept in shape, and the other making sure the systems are operating," Wertheim noted. "So the MSC is working to operate and navigate the vessel, and then they have military technicians and contractors maintain the radar." The naval personnel are essentially ensuring the ship can perform its Air Force mission.

SENSORS IN HIGH DEMAND

Tom Karako, a missile defense expert and visiting fellow at the Center for Strategic and International Studies, said the fact that the radar is dual-band indicates that its strategic use will primarily be ballistic missile tracking and discrimination. This means *Cobra King* will provide a mobile sea-based capability that fits in with a much larger suite of radars the Air Force and Missile Defense Agency operate.

Cobra King itself is part of the larger "Cobra" suite of sensors and radars.

■ *Cobra Dane* is a ground-based passive electronically scanned array located at an air station in Alaska. It was built in the 1970s and feeds data to the North American Aerospace Defense Command (NORAD) in Colorado.

■ *Cobra Ball* is an air-based asset, a measurement and signals intelligence collector installed in an RC-135S aircraft. Its job is to observe ballistic missile flights at long range.

■ *Cobra Eye* was also an air-based asset, installed on an RC-135X aircraft, and it was tasked with tracking intercontinental ballistic missile re-entry vehicles before the aircraft was later converted into another *Cobra Ball*.

Karako said that in missile defense, while the interceptor missiles themselves get most of the attention, sensors like *Cobra King* and other suites are of the utmost importance to the Air Force. This is especially true in light of the 2002 decision by the George W. Bush Administration to withdraw from the 1972 Anti-Ballistic Missile Treaty in order to protect against ballistic missile threats.

"We've seen an unprecedented upgrade in our historical radars, as well as an expansion of them," Karako said. "That quiet expansion of these radars and their improvements has been an unsung chapter of expansion of BMD capabilities."

Karako said while the development of better interceptors is certainly part of that effort, it's the power of the sensors themselves that has really provided a big boost in capability to the Pentagon.

"You see the MDA talking about long-range discrimination radar [LRDR] going to be put up in Alaska by 2020, and they're very keyed up on that specifically for discrimination [between missile targets], dealing with both current and next generation missile threats," he said.

Karako continued, "It's all about discrimination, whether it's something much smaller and more mobile like [*Cobra King*] that collects data and compiles it on a smaller scale, or something more powerful like SBX and LRDR."

The strategic usefulness of *Cobra King* and assets that complement it hinges on the sensors and radars, whether it's SBX, LRDR, *Cobra King*, or another suite of radars—especially as demand continues to outstrip supply.

"This network of evolving radar capabilities is going to be in high demand," Karako said. "The demand for missile defense assets is far exceeding the supply, and that goes for interceptors and it goes for radars, whether for the Air Force or for MDA. There continues to be a growing demand for extremely high resolution sensors, and I think this dual-band capability speaks to what it's going to be doing as part of that larger picture." ❊

Dan Taylor is a journalist, with seven years of experience covering the Pentagon, and an analyst specializing in defense acquisition and weapons programs. This is his first article for Air Force Magazine.

U **SNS** Howard O. Lorenzen (T-AGM 25) looks like a Navy ship. It is outfitted with Pentagon-furnished equipment and sensors, is sailed by Navy Military Sealift Command personnel, and is named after a Naval Research Laboratory engineer. It is however, an Air Force vessel.

Lorenzen reached initial operational capability in March 2014, not long after its predecessor, USNS *Observation Island*, was decommissioned after nearly 60 years at sea. In a world of proliferating missile threats, the missile defense mission is one of growing importance to the Air Force.

The vessel itself is not what's important, but what it carries is: an incredibly powerful radar, known as the Cobra King. It replaces the Cobra Judy radar that was hosted on *Observation Island*. Built by Raytheon, which declines comment about it, the radar defines the purpose of the program: ballistic missile treaty verification.

There's not much the Air Force will say about it, either. Service spokeswoman Vicki Stein said the service is "limited on what we can provide," but noted that Cobra King's mission originates from the Strategic Arms Reduction Treaty signed in 1991 between the United States and the Soviet Union after the fall of the Berlin Wall.

Officially, Cobra King's purpose is to monitor former Soviet missile testing for START verification purposes. Its secondary mission is to support domestic missile testing. Basically, Cobra King is an ever-vigilant watchdog, keeping an eye on ballistic missile tests around the world, by both allies and hostile nations, and on US tests.

Historically, missile tracking and telemetry has been an Air Force mission. Cobra King is part of the Air Force's broader Cobra family of radars—one that happens to be at sea. Air Force officials won't say exactly where and how Cobra King has been used, but with growing concerns about missile programs in North Korea, Iran, and other countries, the Pentagon places a high priority on having powerful missile-detecting assets in its arsenal.

Cobra Judy was involved in the high-profile shutdown of a defunct satellite that was expected to plummet to Earth in 2008. The US satellite, launched two years before, malfunctioned shortly after deployment, and the US opted to destroy it at high altitude rather than risk an unpredictable impact on the

Earth. Observers noted, however, that the satellite's destruction was also a not-so-subtle demonstration that the US could shoot down a satellite. The "clean" mission, which left no orbital debris, was a strong riposte to China, which had demonstrated an anti-satellite capability of its own in 2007. That event left a large and dangerous debris field in orbit.

LONG TIME COMING

The power of Cobra King is visible to the naked eye. At more than 200 tons, it's a big radar, just like the Cobra Judy. It's so big, it needs the 534-foot *Lorenzen* to carry it around the world.

The arrival of the radar has been a long time coming. The contract for *Lorenzen* was first awarded back in 2006 to VT Halter Marine, the ship was delivered in January 2012, and it finally became operational last year. It underwent contract trials off the coast of California in late 2013. The trials "exercised all aspects of the vessel and its systems, including main propulsion, damage control, supply, deck, navigation, habitability, electrical systems, and operation," according to an Air Force statement. The estimated cost of the Cobra King project is \$1.74 billion.

The most recent contract award on the program was \$9.8 million to Raytheon in February 2013, which covered an alternative architecture study in support of the Cobra King program.

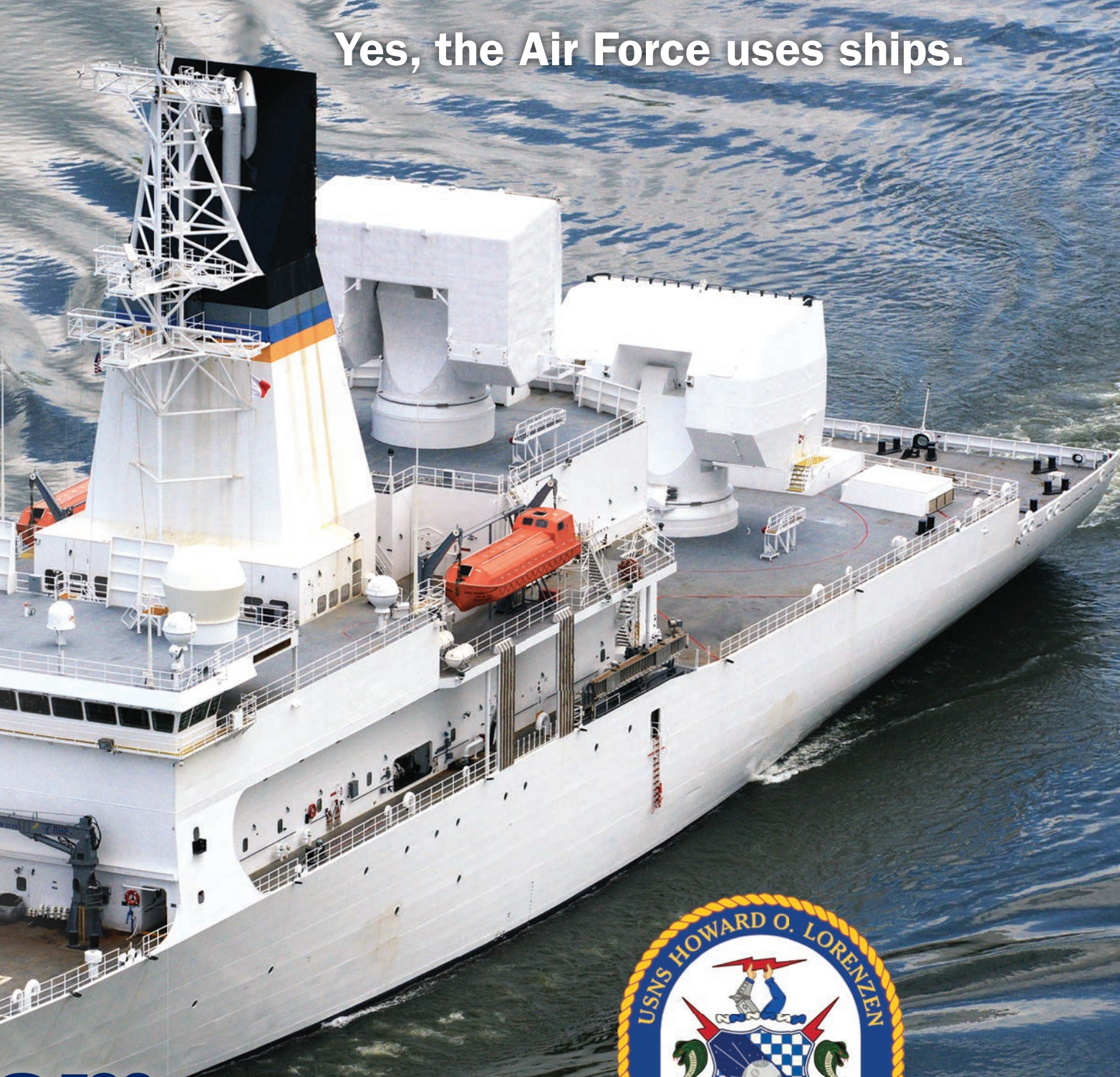
The history of Cobra King stretches back to 1952, when Cobra Judy's host

vessel, *Observation Island*, was laid down as a Mariner-class high-speed cargo ship with the designation EAG-154. It was called *Empire State Mariner* back then. In 1956, the ship was transferred to the Navy along with three other Mariners. It underwent a conversion to the first naval ship with a fully integrated fleet ballistic missile (FBM) system. In 1958, she was recommissioned as *Observation Island*. The Navy didn't make many engineering changes to the ship itself, but did make extensive alterations within the superstructure and hold areas to allow for the installation of the FBM system. After that, it conducted dummy missile launches and communications tests in the Atlantic. In 1959, *Observation Island* conducted the first at-sea launch of a Polaris submarine-launched ballistic missile and continued to support Polaris flights into the 1960s. President John F.

USAF Missile Defense—From the Sea

By Dan Taylor

Yes, the Air Force uses ships.



om



USNS Howard O. Lorenzen travels the Columbia River in the Pacific Northwest on the way to the Pacific Ocean.

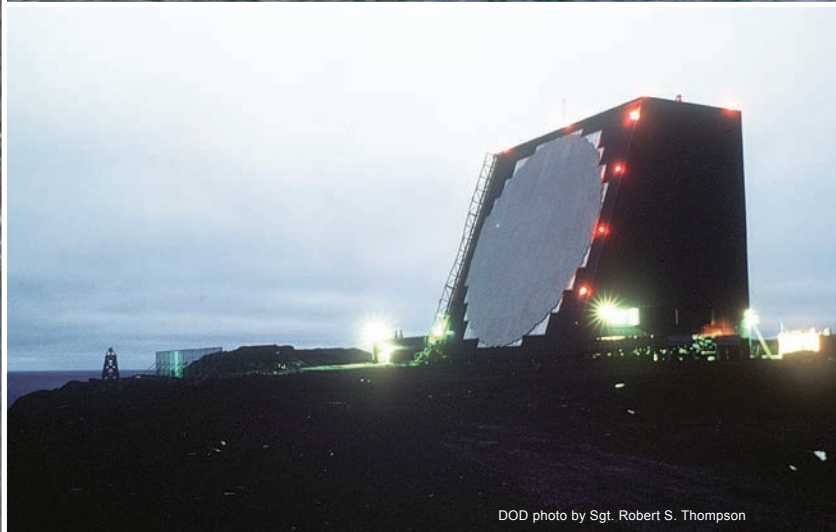
Oregon Military Department of Public Affairs photo by SSgt. Jason van Mourik



Military Sealift Command photo



USAF photo



DOD photo by Sgt. Robert S. Thompson

Kennedy observed a Polaris launch aboard *Observation Island* just six days before his assassination.

The vessel was sidelined in the early 1970s until the Navy reacquired the vessel in 1977 and transferred it to Military Sealift Command with the designation T-AGM-23. It wasn't until the early 1980s that Raytheon was tasked with developing Cobra Judy. In 1985, the company installed an X-band radar to complement the S-band phased array system on board. The upgrade was intended to improve the system's ability to gather data on a ballistic missile's terminal phase, creating the dual-band radar the Air Force prefers today.

DOUBLE THE CAPABILITY

The dual-band capability and its mobility are what make Cobra King such an asset to the Air Force. Actually, the Pentagon has bigger radars than Cobra King, even at sea: the massive Sea-Based X-band Radar (SBX-1) is built on a 50,000-ton drilling rig. But SBX-1 lacks those two key abilities.

Due to the fact that Cobra King is based on a ship, it can move fairly quickly to any part of the world, responding to crises as they emerge, whereas SBX-1 must be towed—slowly—to an operating location.

SBX-1 also only has an X-band radar, used for tracking multiple targets over a wide field. S-band, on the other hand, narrows down data collection to specific individual objects. The radars work very closely together.

The Air Force spokeswoman said S-band radar is specifically used to search and acquire the target, and then hand it off to the X-band, which provides high-resolution target characterization.

Cobra King will differ from the Cobra Judy in that it will both be more complex and easier to maintain.

"Cobra Judy required highly skilled engineers and technicians who could troubleshoot and repair faults to the component level," Stein said. "This required test equipment tools and skill sets. Even though Cobra King is significantly more complex, it is easier to maintain because it was designated with 'BIT' (built-in test) to facilitate the rapid troubleshooting, repair, and return to service of the radar."

In addition, operators and technicians can troubleshoot and replace components themselves, and spares are stored on the ship for nearly all components.

According to a chart provided by the Air Force, there are other key differences between the platforms. For

Left: USNS Observation Island conducts a Polaris missile test off Cape Canaveral, Fla. Top: Observation Island during a Cobra Judy exercise in 1981, after modifications to equip it with a phased-array radar turret. Above: Cobra Dane, a phased-array radar system specially constructed to detect ballistic missile testing on a Russian Siberian peninsula, in 1977.

example, if the Cobra Judy's S-band radar failed, the mission failed. However, with Cobra King, the X-band radar can continue to collect data even if the S-band radar isn't functioning. Also, Cobra Judy only provided standard definition, versus Cobra King's high definition. Cobra King can also track well over a thousand targets using both bands, versus only about 100 for Cobra Judy, and it can collect terabytes of data instead of only gigabytes.

There are also important differences between the vessels themselves. *Observation Island* relied on steam turbines, but *Lorenzen* uses modern diesel-electric engines. *Lorenzen* also requires a smaller crew: some 60 Navy personnel instead of 100. And at a lower operating cost, *Lorenzen* provides operational availability of more than 75 percent against an aver-



USAF photo

Cobra Ball—an extensively modified C-135B—is a measurement and signals intelligence collector designed to work in conjunction with Cobra Dane and Cobra Judy as they monitored Soviet ballistic missile testing.

age of 70 percent for *Observation Island*, according to the Air Force.

A UNIQUE PARTNERSHIP

The Air Force doesn't actually have any sailors, so the operation of *Lorenzen* necessitates a unique relationship between the Air Force and Military Sealift Command. According to the Air Force spokeswoman, Military Sealift Command has responsibility for operating and maintaining the ship, so an Air Force captain onboard can focus on operating the radar itself.

"The ship's captain is responsible for the health and welfare of the crew as well as navigation and maintenance of the ship," she said. "The mission crew is led by an Air Force captain who manages the mission and ensures the smooth operation of the mission systems." The captain is the only Air Force member onboard.

Eric Wertheim, an author and columnist for the US Naval Institute specializing in Navy and Air Force issues, said *Cobra Judy* "played a really important role in national security" by "[helping] with the collection of this high-resolution, accurate data that's needed for ballistic missile defense, treaty verification, and decision-making by leadership."

Now that the baton has been passed to *Cobra King*, the upgraded system will allow the Pentagon to develop "algorithms that would be required in case a shoot-down might be needed, and make sure countries we sign treaties with, or potential adversaries, that we understand their capabilities," Wertheim said.

The platform could be protected if necessary. It operates alone much of the time, though it may require support craft depending on how long it's at sea and if it travels close to hostile countries—not common in peacetime operations, said Wertheim.

The fact that MSC and the Air Force operate the vessel together is a "great example of jointness," he said. "It's really seamless."

MSC operates the vessel mostly at the behest of the Air Force, doing Air Force-sponsored missions.

"It's kind of a unique environment where one is responsible for making sure the ship is kept in shape, and the other making sure the systems are operating," Wertheim noted. "So the MSC is working to operate and navigate the vessel, and then they have military technicians and contractors maintain the radar." The naval personnel are essentially ensuring the ship can perform its Air Force mission.

SENSORS IN HIGH DEMAND

Tom Karako, a missile defense expert and visiting fellow at the Center for Strategic and International Studies, said the fact that the radar is dual-band indicates that its strategic use will primarily be ballistic missile tracking and discrimination. This means *Cobra King* will provide a mobile sea-based capability that fits in with a much larger suite of radars the Air Force and Missile Defense Agency operate.

Cobra King itself is part of the larger "Cobra" suite of sensors and radars.

■ *Cobra Dane* is a ground-based passive electronically scanned array located at an air station in Alaska. It was built in the 1970s and feeds data to the North American Aerospace Defense Command (NORAD) in Colorado.

■ *Cobra Ball* is an air-based asset, a measurement and signals intelligence collector installed in an RC-135S aircraft. Its job is to observe ballistic missile flights at long range.

■ *Cobra Eye* was also an air-based asset, installed on an RC-135X aircraft, and it was tasked with tracking intercontinental ballistic missile re-entry vehicles before the aircraft was later converted into another *Cobra Ball*.

Karako said that in missile defense, while the interceptor missiles themselves get most of the attention, sensors like *Cobra King* and other suites are of the utmost importance to the Air Force. This is especially true in light of the 2002 decision by the George W. Bush Administration to withdraw from the 1972 Anti-Ballistic Missile Treaty in order to protect against ballistic missile threats.

"We've seen an unprecedented upgrade in our historical radars, as well as an expansion of them," Karako said. "That quiet expansion of these radars and their improvements has been an unsung chapter of expansion of BMD capabilities."

Karako said while the development of better interceptors is certainly part of that effort, it's the power of the sensors themselves that has really provided a big boost in capability to the Pentagon.

"You see the MDA talking about long-range discrimination radar [LRDR] going to be put up in Alaska by 2020, and they're very keyed up on that specifically for discrimination [between missile targets], dealing with both current and next generation missile threats," he said.

Karako continued, "It's all about discrimination, whether it's something much smaller and more mobile like [*Cobra King*] that collects data and compiles it on a smaller scale, or something more powerful like SBX and LRDR."

The strategic usefulness of *Cobra King* and assets that complement it hinges on the sensors and radars, whether it's SBX, LRDR, *Cobra King*, or another suite of radars—especially as demand continues to outstrip supply.

"This network of evolving radar capabilities is going to be in high demand," Karako said. "The demand for missile defense assets is far exceeding the supply, and that goes for interceptors and it goes for radars, whether for the Air Force or for MDA. There continues to be a growing demand for extremely high resolution sensors, and I think this dual-band capability speaks to what it's going to be doing as part of that larger picture." ❊

Dan Taylor is a journalist, with seven years of experience covering the Pentagon, and an analyst specializing in defense acquisition and weapons programs. This is his first article for Air Force Magazine.

U **SNS** Howard O. Lorenzen (T-AGM 25) looks like a Navy ship. It is outfitted with Pentagon-furnished equipment and sensors, is sailed by Navy Military Sealift Command personnel, and is named after a Naval Research Laboratory engineer. It is however, an Air Force vessel.

Lorenzen reached initial operational capability in March 2014, not long after its predecessor, USNS *Observation Island*, was decommissioned after nearly 60 years at sea. In a world of proliferating missile threats, the missile defense mission is one of growing importance to the Air Force.

The vessel itself is not what's important, but what it carries is: an incredibly powerful radar, known as the Cobra King. It replaces the Cobra Judy radar that was hosted on *Observation Island*. Built by Raytheon, which declines comment about it, the radar defines the purpose of the program: ballistic missile treaty verification.

There's not much the Air Force will say about it, either. Service spokeswoman Vicki Stein said the service is "limited on what we can provide," but noted that Cobra King's mission originates from the Strategic Arms Reduction Treaty signed in 1991 between the United States and the Soviet Union after the fall of the Berlin Wall.

Officially, Cobra King's purpose is to monitor former Soviet missile testing for START verification purposes. Its secondary mission is to support domestic missile testing. Basically, Cobra King is an ever-vigilant watchdog, keeping an eye on ballistic missile tests around the world, by both allies and hostile nations, and on US tests.

Historically, missile tracking and telemetry has been an Air Force mission. Cobra King is part of the Air Force's broader Cobra family of radars—one that happens to be at sea. Air Force officials won't say exactly where and how Cobra King has been used, but with growing concerns about missile programs in North Korea, Iran, and other countries, the Pentagon places a high priority on having powerful missile-detecting assets in its arsenal.

Cobra Judy was involved in the high-profile shutdown of a defunct satellite that was expected to plummet to Earth in 2008. The US satellite, launched two years before, malfunctioned shortly after deployment, and the US opted to destroy it at high altitude rather than risk an unpredictable impact on the

Earth. Observers noted, however, that the satellite's destruction was also a not-so-subtle demonstration that the US could shoot down a satellite. The "clean" mission, which left no orbital debris, was a strong riposte to China, which had demonstrated an anti-satellite capability of its own in 2007. That event left a large and dangerous debris field in orbit.

LONG TIME COMING

The power of Cobra King is visible to the naked eye. At more than 200 tons, it's a big radar, just like the Cobra Judy. It's so big, it needs the 534-foot *Lorenzen* to carry it around the world.

The arrival of the radar has been a long time coming. The contract for *Lorenzen* was first awarded back in 2006 to VT Halter Marine, the ship was delivered in January 2012, and it finally became operational last year. It underwent contract trials off the coast of California in late 2013. The trials "exercised all aspects of the vessel and its systems, including main propulsion, damage control, supply, deck, navigation, habitability, electrical systems, and operation," according to an Air Force statement. The estimated cost of the Cobra King project is \$1.74 billion.

The most recent contract award on the program was \$9.8 million to Raytheon in February 2013, which covered an alternative architecture study in support of the Cobra King program.

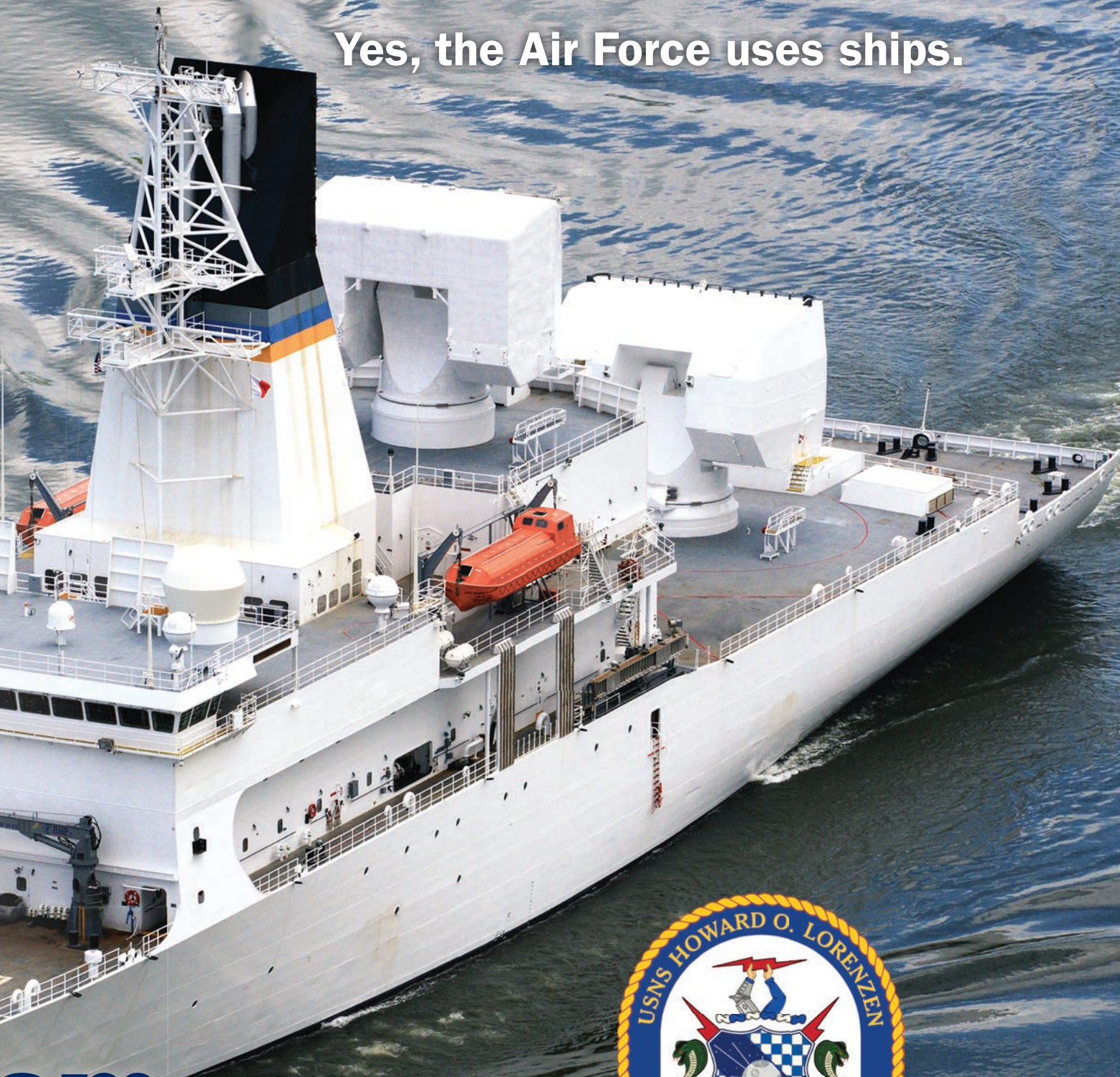
The history of Cobra King stretches back to 1952, when Cobra Judy's host

vessel, *Observation Island*, was laid down as a Mariner-class high-speed cargo ship with the designation EAG-154. It was called *Empire State Mariner* back then. In 1956, the ship was transferred to the Navy along with three other Mariners. It underwent a conversion to the first naval ship with a fully integrated fleet ballistic missile (FBM) system. In 1958, she was recommissioned as *Observation Island*. The Navy didn't make many engineering changes to the ship itself, but did make extensive alterations within the superstructure and hold areas to allow for the installation of the FBM system. After that, it conducted dummy missile launches and communications tests in the Atlantic. In 1959, *Observation Island* conducted the first at-sea launch of a Polaris submarine-launched ballistic missile and continued to support Polaris flights into the 1960s. President John F.

USAF Missile Defense—From the Sea

By Dan Taylor

Yes, the Air Force uses ships.



om



USNS Howard O. Lorenzen travels the Columbia River in the Pacific Northwest on the way to the Pacific Ocean.

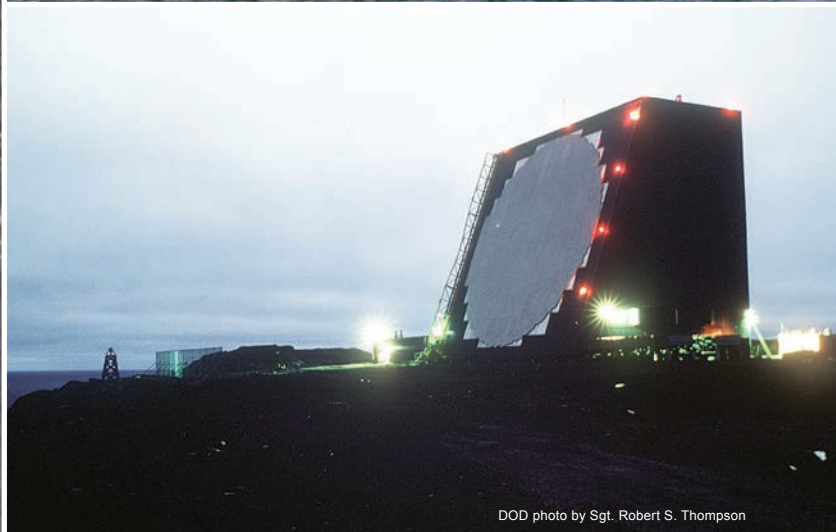
Oregon Military Department of Public Affairs photo by SSgt. Jason van Mourik



Military Sealift Command photo



USAF photo



DOD photo by Sgt. Robert S. Thompson

Kennedy observed a Polaris launch aboard *Observation Island* just six days before his assassination.

The vessel was sidelined in the early 1970s until the Navy reacquired the vessel in 1977 and transferred it to Military Sealift Command with the designation T-AGM-23. It wasn't until the early 1980s that Raytheon was tasked with developing Cobra Judy. In 1985, the company installed an X-band radar to complement the S-band phased array system on board. The upgrade was intended to improve the system's ability to gather data on a ballistic missile's terminal phase, creating the dual-band radar the Air Force prefers today.

DOUBLE THE CAPABILITY

The dual-band capability and its mobility are what make Cobra King such an asset to the Air Force. Actually, the Pentagon has bigger radars than Cobra King, even at sea: the massive Sea-Based X-band Radar (SBX-1) is built on a 50,000-ton drilling rig. But SBX-1 lacks those two key abilities.

Due to the fact that Cobra King is based on a ship, it can move fairly quickly to any part of the world, responding to crises as they emerge, whereas SBX-1 must be towed—slowly—to an operating location.

SBX-1 also only has an X-band radar, used for tracking multiple targets over a wide field. S-band, on the other hand, narrows down data collection to specific individual objects. The radars work very closely together.

The Air Force spokeswoman said S-band radar is specifically used to search and acquire the target, and then hand it off to the X-band, which provides high-resolution target characterization.

Cobra King will differ from the Cobra Judy in that it will both be more complex and easier to maintain.

"Cobra Judy required highly skilled engineers and technicians who could troubleshoot and repair faults to the component level," Stein said. "This required test equipment tools and skill sets. Even though Cobra King is significantly more complex, it is easier to maintain because it was designated with 'BIT' (built-in test) to facilitate the rapid troubleshooting, repair, and return to service of the radar."

In addition, operators and technicians can troubleshoot and replace components themselves, and spares are stored on the ship for nearly all components.

According to a chart provided by the Air Force, there are other key differences between the platforms. For

Left: USNS Observation Island conducts a Polaris missile test off Cape Canaveral, Fla. Top: Observation Island during a Cobra Judy exercise in 1981, after modifications to equip it with a phased-array radar turret. Above: Cobra Dane, a phased-array radar system specially constructed to detect ballistic missile testing on a Russian Siberian peninsula, in 1977.

example, if the Cobra Judy's S-band radar failed, the mission failed. However, with Cobra King, the X-band radar can continue to collect data even if the S-band radar isn't functioning. Also, Cobra Judy only provided standard definition, versus Cobra King's high definition. Cobra King can also track well over a thousand targets using both bands, versus only about 100 for Cobra Judy, and it can collect terabytes of data instead of only gigabytes.

There are also important differences between the vessels themselves. *Observation Island* relied on steam turbines, but *Lorenzen* uses modern diesel-electric engines. *Lorenzen* also requires a smaller crew: some 60 Navy personnel instead of 100. And at a lower operating cost, *Lorenzen* provides operational availability of more than 75 percent against an aver-



USAF photo

Cobra Ball—an extensively modified C-135B—is a measurement and signals intelligence collector designed to work in conjunction with Cobra Dane and Cobra Judy as they monitored Soviet ballistic missile testing.

age of 70 percent for *Observation Island*, according to the Air Force.

A UNIQUE PARTNERSHIP

The Air Force doesn't actually have any sailors, so the operation of *Lorenzen* necessitates a unique relationship between the Air Force and Military Sealift Command. According to the Air Force spokeswoman, Military Sealift Command has responsibility for operating and maintaining the ship, so an Air Force captain onboard can focus on operating the radar itself.

"The ship's captain is responsible for the health and welfare of the crew as well as navigation and maintenance of the ship," she said. "The mission crew is led by an Air Force captain who manages the mission and ensures the smooth operation of the mission systems." The captain is the only Air Force member onboard.

Eric Wertheim, an author and columnist for the US Naval Institute specializing in Navy and Air Force issues, said *Cobra Judy* "played a really important role in national security" by "[helping] with the collection of this high-resolution, accurate data that's needed for ballistic missile defense, treaty verification, and decision-making by leadership."

Now that the baton has been passed to *Cobra King*, the upgraded system will allow the Pentagon to develop "algorithms that would be required in case a shoot-down might be needed, and make sure countries we sign treaties with, or potential adversaries, that we understand their capabilities," Wertheim said.

The platform could be protected if necessary. It operates alone much of the time, though it may require support craft depending on how long it's at sea and if it travels close to hostile countries—not common in peacetime operations, said Wertheim.

The fact that MSC and the Air Force operate the vessel together is a "great example of jointness," he said. "It's really seamless."

MSC operates the vessel mostly at the behest of the Air Force, doing Air Force-sponsored missions.

"It's kind of a unique environment where one is responsible for making sure the ship is kept in shape, and the other making sure the systems are operating," Wertheim noted. "So the MSC is working to operate and navigate the vessel, and then they have military technicians and contractors maintain the radar." The naval personnel are essentially ensuring the ship can perform its Air Force mission.

SENSORS IN HIGH DEMAND

Tom Karako, a missile defense expert and visiting fellow at the Center for Strategic and International Studies, said the fact that the radar is dual-band indicates that its strategic use will primarily be ballistic missile tracking and discrimination. This means *Cobra King* will provide a mobile sea-based capability that fits in with a much larger suite of radars the Air Force and Missile Defense Agency operate.

Cobra King itself is part of the larger "Cobra" suite of sensors and radars.

■ *Cobra Dane* is a ground-based passive electronically scanned array located at an air station in Alaska. It was built in the 1970s and feeds data to the North American Aerospace Defense Command (NORAD) in Colorado.

■ *Cobra Ball* is an air-based asset, a measurement and signals intelligence collector installed in an RC-135S aircraft. Its job is to observe ballistic missile flights at long range.

■ *Cobra Eye* was also an air-based asset, installed on an RC-135X aircraft, and it was tasked with tracking intercontinental ballistic missile re-entry vehicles before the aircraft was later converted into another *Cobra Ball*.

Karako said that in missile defense, while the interceptor missiles themselves get most of the attention, sensors like *Cobra King* and other suites are of the utmost importance to the Air Force. This is especially true in light of the 2002 decision by the George W. Bush Administration to withdraw from the 1972 Anti-Ballistic Missile Treaty in order to protect against ballistic missile threats.

"We've seen an unprecedented upgrade in our historical radars, as well as an expansion of them," Karako said. "That quiet expansion of these radars and their improvements has been an unsung chapter of expansion of BMD capabilities."

Karako said while the development of better interceptors is certainly part of that effort, it's the power of the sensors themselves that has really provided a big boost in capability to the Pentagon.

"You see the MDA talking about long-range discrimination radar [LRDR] going to be put up in Alaska by 2020, and they're very keyed up on that specifically for discrimination [between missile targets], dealing with both current and next generation missile threats," he said.

Karako continued, "It's all about discrimination, whether it's something much smaller and more mobile like [*Cobra King*] that collects data and compiles it on a smaller scale, or something more powerful like SBX and LRDR."

The strategic usefulness of *Cobra King* and assets that complement it hinges on the sensors and radars, whether it's SBX, LRDR, *Cobra King*, or another suite of radars—especially as demand continues to outstrip supply.

"This network of evolving radar capabilities is going to be in high demand," Karako said. "The demand for missile defense assets is far exceeding the supply, and that goes for interceptors and it goes for radars, whether for the Air Force or for MDA. There continues to be a growing demand for extremely high resolution sensors, and I think this dual-band capability speaks to what it's going to be doing as part of that larger picture." ❁

Dan Taylor is a journalist, with seven years of experience covering the Pentagon, and an analyst specializing in defense acquisition and weapons programs. This is his first article for Air Force Magazine.