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ON OUR COVER—Mission capabilities of today's B-52s go many important steps beyond those of the earlier Stratofortresses. A major part of the updating takes place in the electronic heart of the bomber. For more news about modernization see page 12.

PHOTO CREDITS — Thomas Cusick (cover, 12, 13); William Sheil (6, 7); United States Air Force (8, 9); Vernon Rutledge (10); Byron Wingett (14); Paul Wagner (15).

THE BOEING COMPANY
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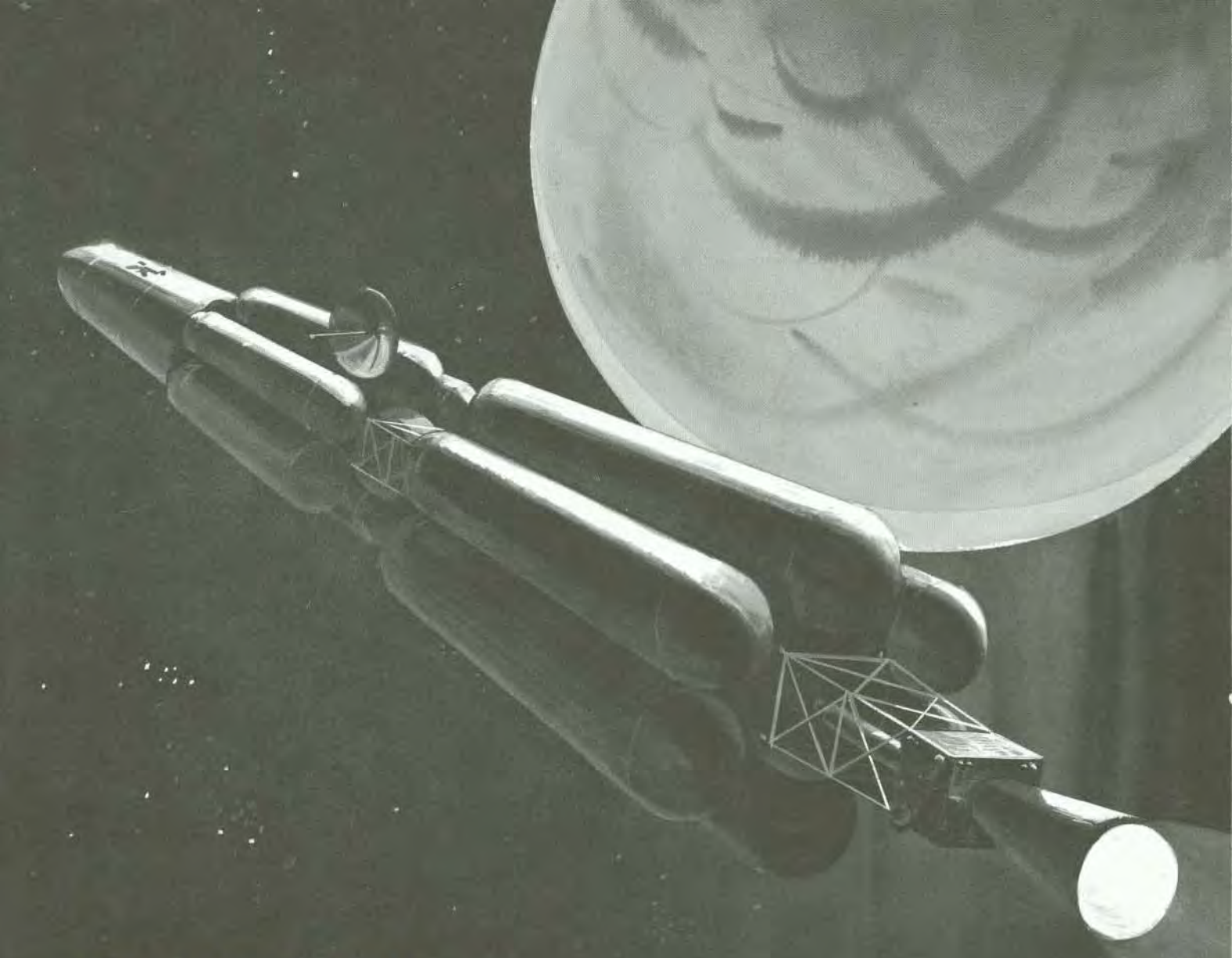
THE BRIEFING

Boeing's Industrial Products Division had its name changed last month to Turbine Division, to place more emphasis on the company's development, manufacture and sale of small gas turbine engines. The Turbine Division, located in Seattle, employs 1,200 persons. Major production programs include turboshaft engines for an U. S. Navy anti-submarine helicopter, and powerplants for a special-purpose military vehicle. Under development is a new series of turbine engines of 400 to 550 horsepower.

Manufacturing facilities of the Turbine Division include precision gear-making equipment and an aluminum foundry. Boeing turbine activity dates from 1943. The company pioneered the majority of the world's small gas-turbine applications in the aircraft, industrial, marine and vehicular fields.

Maynard L. Pennell was elected a vice-president of The Boeing Company at a recent meeting of the board of directors. Pennell was appointed assistant director, new product development, Airplane Division, and will continue as program director of the supersonic transport program. He joined Boeing in 1940. In 1946, as head of commercial project development, he began studies which determined the feasibility of commercial jet transports. He served as senior project engineer on the 707 jet prototype and was named chief engineer — aircraft in 1953. In 1956 he became chief engineer of the former Transport Division and later director of engineering.

Sales of Boeing jetliners continue at a brisk pace. A total of 60 airplanes were ordered by nine airlines in June, July and part of August. There also were sales of two jetliners in May which were not recorded in this column before now. The sales include one 727 each to Ansett-ANA and Trans-Australia Airlines; four 707-320Cs to Continental Airlines; a 720B to Pakistan International Airlines and four of this type to Western Air Lines. Pan American Airways added another long-range -320B and TWA ordered six -320Bs plus six more 727s. National Airlines bought an additional three 727s for its fleet and five of these planes were purchased by Pacific Southwest Airlines. Northwest Airlines ordered two more 707-320Cs and placed the first airline order for three of the new Model 727Cs (see article about the 727C on page 11). On August 19 United Air Lines ordered 25 additional 727s.



Boeing study looks ahead to

NEXT STOP: MARS

By HAROLD CARR

THE magnitude, complexity and problems of manned interplanetary flight are formidable, but a small group of advanced space planners at Boeing believe the chances of man reaching Mars will be as certain as tomorrow morning's daylight or this month's full moon.

Such space missions have been under study for two years in the advanced concepts group of Boeing's advanced space systems organization. Personnel in the group say emphatically: "We should be able to lick all the technical problems of a manned interplanetary trip by the late 1970s. We think it's a safe bet we can put a man on Mars in the 1980s."

Manned interplanetary trips are the ultimate in present-day thinking. Boeing's advanced concepts group also is studying a variety of advanced orbital operations. The ideas developed in these areas also should apply to future manned and unmanned planetary missions.

The concept of an orbital way station from which men could assemble and service space vehicles headed for the moon or the planets is one idea being examined.

A NASA Saturn 5 rocket (Boeing is helping to build it) is looked upon as the type of booster which could lift the way station into orbit around the earth. Orbiting stations of various sizes are under consideration. A station small enough to be sent up with one booster shot is a possibility.

A larger way station could be sent up in sections to meet and be joined while in orbit. Once it is assembled and circling the earth in

a regular pattern, the way station would serve as a residence for personnel and as an assembly and launching facility for vehicles going on into space.

A Mars vehicle (fuel tanks, crew cabin, engine, Mars landing craft and other items) could be boosted to the way station in sections, using a number of Saturn 5 rockets. The Mars vehicle would be assembled, fueled and checked out for launching. Astronauts would go aboard. Then the vehicle would be edged away from the way station and its engine started.

Way station personnel probably would be transported to and from earth by a hypersonic-speed reentry spacecraft. Boeing and NASA designs for such vehicles were discussed in the June, 1964, *Boeing Magazine*.

Steve Ragar, program manager on the orbital way station study, says: "We believe the way station concept is significant because it would make possible the assembly and firing of very large spacecraft beyond the influence of most of the earth's gravity. Far less energy would be needed to send such a vehicle on a space trip from the way station than from earth."

THE ADVANCED concepts group was awarded a 10-month study contract by NASA to investigate the orbital launch facility idea. Last month, the group was awarded a nine-month, $100,000 contract from NASA for the study of manned interplanetary support mission requirements.

Space flight studies under way at Boeing are based on three types of missions: fly-bys to Mars and Venus, or possibly to both during one flight; flights ending in orbits around Mars or Venus, and manned landings on Mars.

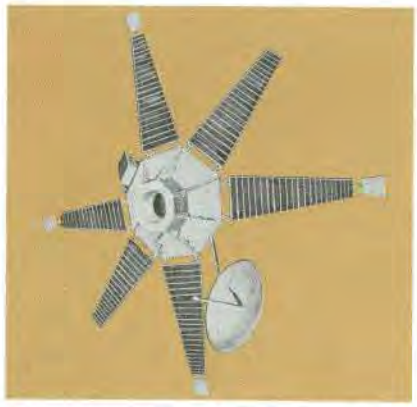
A crew of from three to eight is being studied for these flights, with the exact number dependent on the type of mission. More information on equipment necessary to support man on extended space trips is needed before crew size can be accurately predicted.

Some of the questions to be answered are: What effect will prolonged trips under low gravity conditions have on man? What control of space radiation hazards will be needed? How will astronauts respond physically and psychologically to the long-term, cramped conditions in a spacecraft?

It is estimated that a complete manned interplanetary spacecraft, which would be much larger than any now in existence, could weigh from 500,000 pounds to more than six million pounds, depending on mission and propulsion system.

A major problem is the development of an adequate powerplant for the Mars vehicle. Boeing is examining various types of propulsion systems, including chemical, nuclear, and nuclear-electric rockets.

Why go to Mars first? Because scientists believe there is some life there. Seasonal color variations indicate the possibility of a low form of plant life on Mars; polar masses, thought by some to be ice, are clearly visible.



Mariner spacecraft is scheduled to take close-up photographs of Mars.

The possibility of life on Mars in some form we know lends romanticism to the first manned deep-space project. The minimum distance to Mars is 35 million miles; the maximum is 250 million miles. Astronauts can look forward to a round-trip ride of from 300 to 1,000 days, again depending on the type of mission and the spacecraft's flight path. The time spent at the planet will vary from a brief fly-by mission to perhaps a year-long exploration.

Scientists believe there is very little oxygen on Mars in comparison to earth, so it appears that the first human Mars explorers will have to carry their own atmosphere with them. Also, there is a fluctuation of surface temperature from 200 degrees below zero to approximately 85 degrees F, according to the best information now available.

In order to keep the crew size realistic, each astronaut will probably have to be a jack-of-all-trades.

ALTHOUGH they will be rocketing through space at thousands of miles an hour for long periods of time, crew members will be kept busy conducting various space experiments, maintaining the spacecraft, making minor trajectory adjustments, and continually checking the spacecraft equipment which keeps them alive.

One idea about rendezvous and landing on Mars is that approximately 40 million miles from earth the spacecraft will go into orbit around the planet. The astronauts would transfer into their landing craft, which then would be detached from the spacecraft. Retro rockets could be used to land, and later to launch the craft from Mars. The spacecraft would make the return trip to the orbiting way station.

The first step in obtaining information about Mars is scheduled for November, 1964, when a Mariner spacecraft should be launched for an unmanned picture-taking fly-by mission. More sophisticated Mariner fly-bys are planned for 1966 and early 1969. The fact that Mars orbits closest to earth approximately every two years determines the most favorable times for launching space probes.

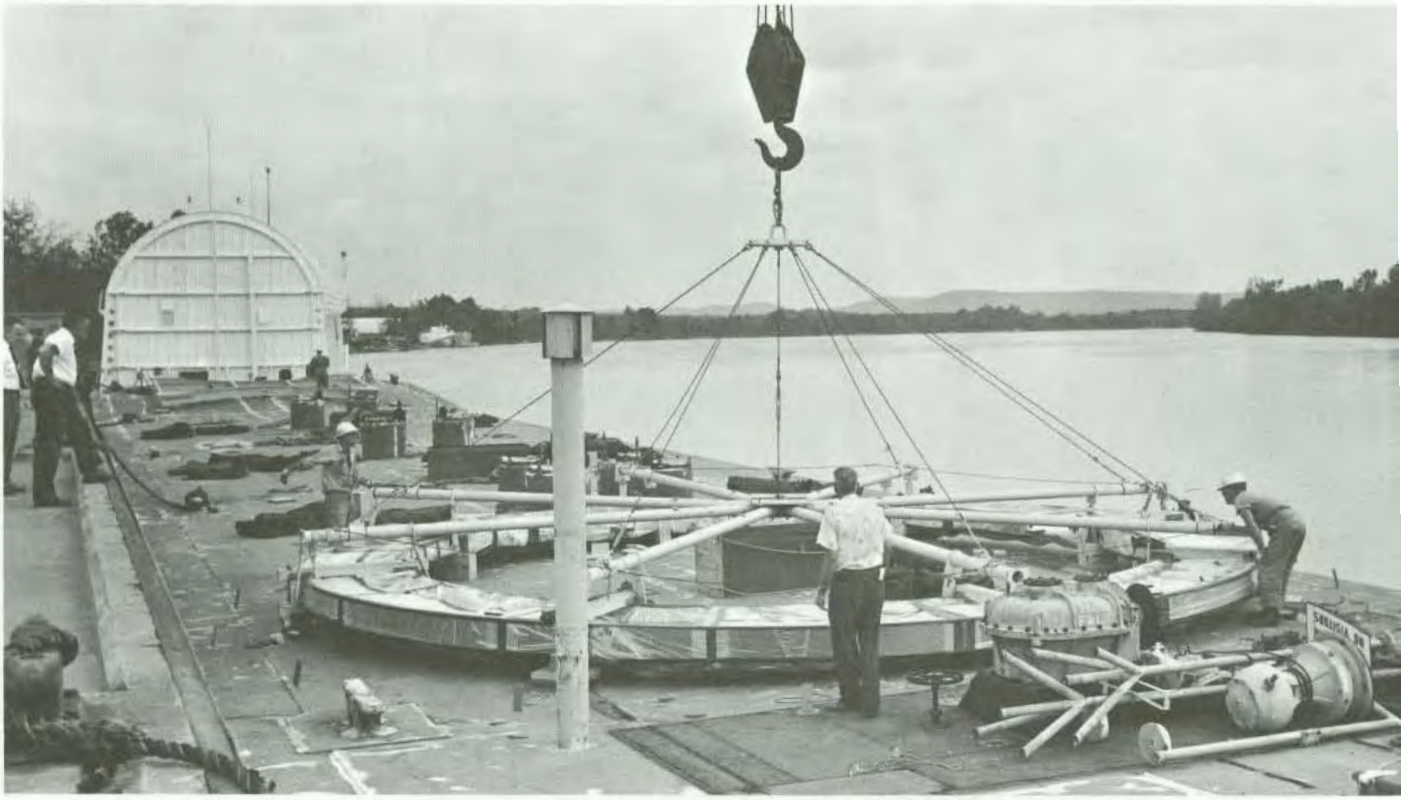
The Voyager, a possible follow-on project of Mariner, may make interplanetary probes to Mars in the next decade. Voyager would land on Mars with instruments designed to detect biological life form.

Before man first steps on Mars, deep-space probes to Jupiter, largest of the planets and 390 million miles from earth, probably will be under way.

It is in this context that Boeing's planners are studying manned interplanetary flight. The challenges of developing technology to make these flights possible are great, but not insurmountable.

The Tennessee River is part of nearly 10,000 miles of inland waterways connecting 20 states.

The 10 Dyer *crewmen eat in shifts.*



Saturn Y ring is unloaded at Huntsville.

Barges are lifted in Wheeler Lock.

Dyer *deckhands secure lines at Pickwick Lock.*

Towboats and barges move Saturn parts

UP THE RIVER TO THE MOON

By WILLIAM B. SHEIL

WHENEVER the word is passed through the towns along the Mississippi and Tennessee rivers that a "moon barge is comin' 'round the bend," 20th century Huck Finns flock to the water's edge to savor the excitement of the moment. Grownups as well as children respond with eager curiosity to this new evidence of the progress of man's greatest adventure, the exploration of space.

An important part of that adventure begins in New Orleans, Louisiana, where Boeing is building the S-1C first stage booster for the National Aeronautics and Space Administration's Saturn 5/Apollo moon rocket. The initial boosters will be static fired and tested at NASA/Marshall Space Flight Center in Huntsville, Alabama.

Because of the tremendous size of the booster, 138.5 feet in length and 33 feet in diameter, it is impossible to ship most of its parts by air, highway or rail. So ol' man river is handed the job, just as it has been given so many other chores in American history.

DIXIE'S riverboats dominated its transportation a century ago. Until after the Civil War, the South's rivers were its principal arteries of trade and travel. From 1875 onward, however, paddlewheelers were slowly driven out of business by railroads. Then towboats came along, capable of pushing long strings of barges and competing with the railroads for bulk freight.

The great paddlewheelers all but passed from the river scene by the turn of the century. The only long-distance craft of this kind still navigating the Mississippi, Ohio and Tennessee rivers is Cincinnati's colorful Delta Queen.

Powerful turbo-charged, radar-guided towboats, some valued at more than a million dollars, now dominate the rivers. Pushing grain, coal, petroleum and other commercial barges, these modern work boats transport billions of dollars worth of commodities annually. Typical of this modern fleet is the Igert Towing Company's boat, the *Bill Dyer*. During an average month this sturdy vessel logs more than 5,000 miles on America's inland waterways. Much of its time is spent on the Tennessee, one of the three rivers traveled by the moon barge.

OF ALL THE cargo the *Dyer* moves, none generates more excitement than rocket sections. On a recent trip the moon barge carried a deck load of Saturn parts—two 33-foot Y-ring supports, weighing 15,359 pounds each, and a 33-foot inter-tank weighing 14,660 pounds.

"Space rockets are comparatively new cargo for us," said Captain Russell McElrath, the *Dyer's* skipper. "But all hands are proud to help put a man on the moon."

Woody Griffin, McElrath's relief pilot, a 38-year tugboat veteran, noted that interest in the moon barges takes a spurt every time the U.S. fires another rocket into space. "Even the muskrats have one eye cocked up to see what we're toting," he said.

By water it is 1,240 miles from New Orleans to Marshall. The average Mississippi River work boat, pushing about a dozen barges with miscellaneous cargo, covers the 869 miles up the Mississippi from New Orleans to Cairo, Illinois, in about 10 days. At Cairo, a principal port on the mid-Mississippi, the moon barge is transferred to an Ohio River towboat heading for Paducah, Kentucky, 47 miles to the east, where the Ohio meets the Tennessee. At Paducah a Tennessee River towboat takes charge of the barge and pushes it 324 miles up the Tennessee to Huntsville. The *Bill Dyer* has its headquarters in Paducah.

Juanita Melton of the Dyer *is called "the best cook on the river."*

The Tennessee Valley Authority has developed the Tennessee River System for navigation, flood control and generation of power. Nine multi-purpose dams create a series of stair-step slack-water lakes with a minimum depth of 11 feet from the mouth of the river at Paducah to Knoxville, Tennessee, a distance of 650 miles.

Kentucky Lock, at the first of these steps, is 22 miles upstream from Paducah. The locking process takes about 45 minutes. During that time the tow is secured in the lock and then lifted up by millions of gallons of water to the level of the slack-water lake. At Kentucky Lock this means a 56-foot rise, from 303 feet above sea level to 359 feet.

FOR THE next 200 miles the *Dyer*, traveling a little faster than 9 miles an hour, moves past several of the old landings bearing such colorful names as Sarah's Garter and Petticoat Riffle. Just below Pickwick Lock, in southern Tennessee, there is a beautiful plantation which has been preserved as a museum. General Robert E. Lee made his headquarters there during the battle of Shiloh.

Pickwick is the first of three dams within the next 70 miles combining to eliminate the once famed but treacherous shoals which barred navigation for so many years in northern Alabama. Following a 55-foot lift at Pickwick, the *Dyer* proceeds to Wilson Dam near Muscle Shoals, Alabama. There it is lifted another 94 feet.

At Wheeler Dam, 16 miles east of Wilson, a 48-foot stair-step occurs, giving the moon barge a total boost of 253 feet in the 253 miles from Kentucky Lock to Wheeler.

As one of the *Dyer's* deck hands said, "That rocket we're carrying is already closer to the moon."

Blastoff will be from Cape Kennedy.

AIR FORCE TESTS NEW MISSILE

By ROBERT KNOLL

Differences between Minuteman 1 (above) and Minuteman 2 (below) are considerable, particularly in performance.

THE FIRST firing of a Minuteman 2 intercontinental ballistic missile is scheduled to be made soon for the Air Force by a Boeing test crew from refurbished silo number 32 at Cape Kennedy, Fla. In flight the new missile is not expected to appear much different than its predecessor. But Minuteman 2 packs more muscle, as big brothers should.

Confidence that the solid-fueled Minuteman will continue to be the backbone of the Air Force's deterrent missile force led to the advanced model, soon to be in production assembly at Ogden, Utah. The result of evolution rather than revolution in design, Minuteman 2 has greater range, payload and accuracy; more flexible targeting, and increased chance of surviving an attack.

THE NEW missile (officially LGM-30F), a 60-footer, is longer than the Minuteman 1 missiles (LGM-30A and LGM-30B). Most distinguishing feature of Minuteman 2 is its larger second-stage engine. With more fuel and higher thrust, this stage will boost Minuteman 2 past the 6,300-mile range of Minuteman 1.

Use of microminiature electronics in the Minuteman 2 guidance and control system has increased the system's capacity while reducing component sizes and weights in the same size body. For example, a new digital computer contained in the missile is about one-fourth the size and one-half the weight of earlier models, but has double the memory capacity.

The new guidance and control design provides an increase in missile accuracy, as well as increased target-selection capability. In addition, the Minuteman 2 computer's extra capacity is used to perform monitoring and control functions formerly handled by ground equipment.

A new power supply set for the Minuteman 2 underground silo not only provides regulated power to the missile during the time it waits in readiness in the silo, but detects any out-of-tolerance condition of power supplies and reports them to the computer in the missile. The computer responds to this information according to its program, either shutting down the system or turning on a warning light and buzzer in a manned launch-control center, some distance away.

SAC missile combat crews should welcome the comparative roominess of the underground Minuteman 2 launch-control center, which will be installed at the bases. The new center will be larger and will contain a two-aisle equipment room, a bunk and an enclosure for an individual wash basin and toilet. The center also will contain an environmental-control unit, which in Minuteman 1 installations was located in the separate launch-control equipment building. The Minuteman 2 launch-control center and launch-control equipment building are both designed better to withstand a nuclear blast.

Only minor changes will appear above ground at the Minuteman 2 launch-control area. One exception will be a large rectangular area which will be outside the security fence and will be enclosed by ordinary farm-type fencing. The transmit/receive antenna for the radio launch-control system will be buried at one end of the enclosure, and the other end will be a heliport. At each Minuteman 2 launch site the antenna enclosure outside the security fence will be square, with no provision for a heliport.

Below ground at each launch site, the launcher-equipment building will have a capsule form and a blast door, blast valves and shock-mounted floor. In the launcher, physical change will not be so obvious. In the upper level of the equipment room, electronic racks will look different; the collimator bench will be much smaller, the sighting tube will be located opposite the personnel hatch and there will be only one alignment-reference mirror. On the lower level, the motor-generator set will be replaced by solid state converters. The number of electric batteries will be reduced from 12 to 10.

Mobile support equipment will be essentially unchanged for Minuteman 2. The same basic equipment will be required at the Minuteman 2 support base, but new test gear will be provided to check out all of the new operational electronic equipment.

Minuteman 2 is first scheduled for Wing 6, centered at Grand Forks Air Force Base, North Dakota, where 150 launch sites and 15 launch-control centers of the new design are under construction.

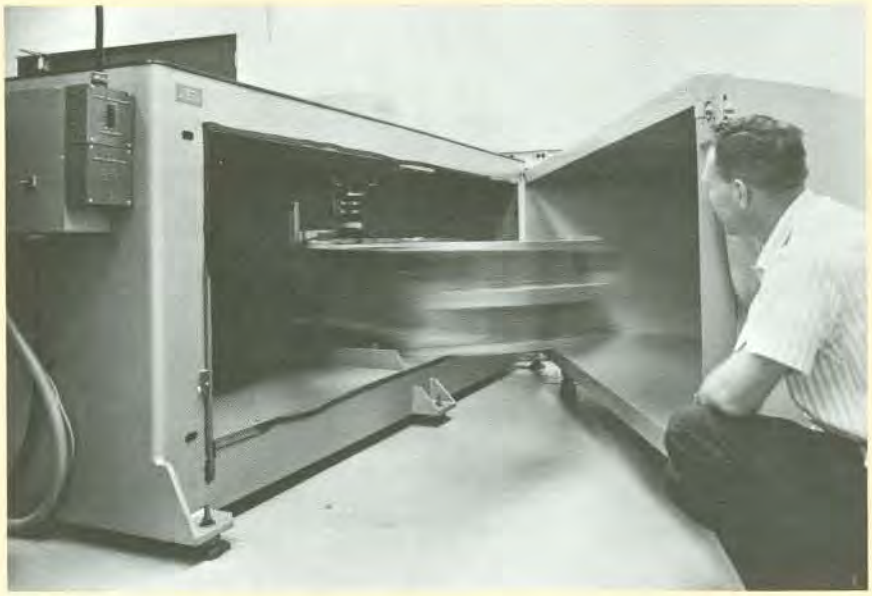
Designers of the Minuteman 2 system looked ahead further than Wing 6, however. Every feature of the improved Minuteman is compatible with the Minuteman 1 system now in use by SAC at Wings 1 through 4 (600 missiles) and at Wing 5, where 200 missiles are being emplaced and checked out by Boeing.

THE REASON for compatibility of the two systems became apparent with recently announced Air Force plans to replace many Minuteman 1 missiles in present installations with Minuteman 2 missiles. Only relatively simple alterations of existing silos, transporters and other equipment will be required.

Minuteman 1 and Minuteman 2 squadrons will be integrated into a single system by connecting their communications and control systems, thus greatly enhancing the targeting flexibility of the force as a whole. When each Minuteman 1 missile reaches the end of its operational life it will be removed from its underground silo and fired at Vandenberg AFB, Calif., for system testing and for training of SAC missile combat crews. The missiles thus fired will be systematically replaced by Minuteman 2 missiles.

Launching of the first Minuteman 2 operational test missile, though a significant milestone, is only one step in a test program to assure maximum quality, reliability and performance. Additional flight tests, with special instrumentation, are scheduled at Cape Kennedy. Inert missiles, such as No. 060 pictured on this page, will be assembled, transported and put through many tests at Cape Kennedy and in Seattle. Later a number of launchings of fueled missiles will test a complete operational system at Vandenberg AFB.

Centrifuges spin HiBEX missile components to simulate stresses of rapid blastoff and quick maneuvers.



Unusual equipment is built to test missile components.

SHAKE WELL BEFORE USING

BOEING'S long experience pioneering test equipment is proving invaluable in the HiBEX program, for which the company is prime contractor. When the Advanced Research Projects Agency selected Boeing to develop a new high-acceleration experimental missile booster, it set forth test specifications unattainable with any available equipment.

To test components such as gyros, tape recorders and electronic flight-control assemblies for the HiBEX and anticipated programs, Aero-Space Division structures laboratories engineers developed devices able to exert internal forces hundreds of times that of gravity. Tests will ensure that HiBEX components being assembled by Boeing and subcontractors can withstand the simulated shocks of instantaneous blastoff and quick maneuvers. Until now, equipment could not provide adequate punishment to test today's rugged components.

One machine, the structural-test centrifuge, is a powerful, electrically driven whirlygig which can make a relatively light instrument package suffer the effects of having its weight increased to 40,000 pounds. Engineers accomplish this with a mechanical vibrator which they attach to one end of a long steel arm.

A similar device, more sensitive than the first, is a modified commercial centrifuge. This machine checks the stamina of delicate guidance equipment. It spins a package at 420 rpm so unerringly that a whirling part will maintain its intended path with an accuracy of one part in 200,000. Such control ensures the ability to measure accurately the performance and reliability of HiBEX guidance components.

SHAKING parts to simulate their punishment in a missile launching is done by an electromagnetic vibrator to which test specimens are secured. In building this device, engineers modified a commercially available vibrator originally designed to be driven by 15,000 watts of power. The rebuilt vibrator is driven by a 175,000-watt amplifier. Beefed-up parts in the vibrator enable it to shake test specimens twice as hard as any machine available on the market.

The new test facility was built with Boeing funds for about $22,000. The do-it-yourself approach enabled the company to get exactly the equipment needed and to get it quickly. It also saved about $122,000, compared to having the equipment built outside the company.

In addition to HiBEX research, the equipment has been used in Minuteman and bioastronautics studies, and is available for other Boeing work.

Airlines flying the new 727C will benefit by

QUICK CARGO CASH

By JAMES BOYNTON

THE NEW Boeing 727C jet transport will enable airlines to make a profit on a number of routes now showing a loss. This neat stroke of business can be accomplished by loading the C-Jet with cargo as well as passengers, to get that all-important extra buck.

In less than two hours the 727C may be converted to carry passengers only, cargo only, or a combination of both. Galleys, seats, hatracks and cargo-handling equipment may be removed or installed.

An all-passenger configuration has 94 mixed-class seats. A combination configuration provides for 52 passengers and their baggage, plus 24,000 pounds of cargo on four pallets. The all-cargo configuration carries 36,750 pounds on eight pallets.

The 727C has the same large forward cargo door (91 by 134 inches) as the long-range Boeing 707-320C convertible cargo-passenger jet, as well as the same cargo pallets and handling system. Cargo may be transferred from one aircraft to the other without reloading the pallets.

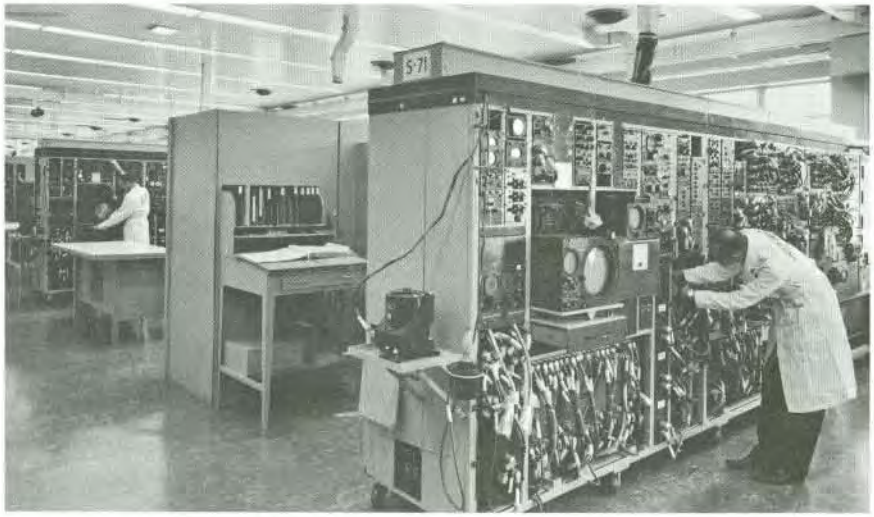
Use of the 727's integral rear-entry stairs makes the main cabin easily accessible for passenger loading and unloading when the forward part of the cabin is being used for cargo.

Like the standard 727, the 727C can be operated from 5,000-foot runways. The plane can carry 30,000 pounds 1,900 miles or 36,750 pounds more than 1,500 miles.

The 727C has a maximum gross takeoff weight of 160,000 pounds—8,000 pounds heavier than the standard 727. Installation of the forward cargo door and strengthening of the main deck and floor beams were the only major changes required to convert the standard 727 to C-Jet configuration. The airplane systems and components — their reliability proved in the day-to-day operation of the standard 727s in airline service — have been retained in the new airplane.

First delivery of a 727C is scheduled for April, 1966, to Northwest Orient Airlines.

Drawing shows how passengers and cargo will be loaded simultaneously aboard Northwest's 727C.



B-52 electronics technicians average more than 10 years experience.

Heading reference system is tested on concrete-and-granite base.

Certain B-52 equipment is tested in this environmental chamber.

Electronic teams take care of the

NEW HEART FOR THE B-52

By DARRELL BARTEE

MODERNIZATION in the electronic heart of the Boeing B-52 Stratofortress is a major factor in making the airplane one of the world's most up-to-date weapon systems. Next June the durable bomber will have a record of 10 years of service with the Strategic Air Command, but the airplane's capabilities, thanks to continuous up-dating, will sharply exceed those of the original article.

The electronic improvements cover a wide spectrum of target-hitting devices; better equipment for navigation and piloting, and communication units to provide instant world-wide voice contact. The total of these and other changes create an almost-new airplane. Further refinements are planned for the future.

Extent of B-52 improvements is most noticeable in the electronic shops at the company's Wichita Branch. Technicians here are responsible for check-outs of the electro-mechanical hearts of the bombers that come to Wichita for modernization and maintenance. Theirs is the high-voltage part of the mod effort at the Kansas plant, in which the Air Force contracts for varied programs of refinement and up-dating. This year by the end of July, 216 of the Stratoforts had been through Wichita modification programs.

IN MAJOR check-ups, Wichita technicians remove as many as 125 black boxes and/or electronic assemblies from each craft, for inspection, test, adjustment and repair. The assemblies range in size from cigar-box to file-cabinet dimensions.

Many of the black boxes were

unknown in the earlier B-52s. One example is the heading and vertical reference system, a delicately balanced series of gyros that refines navigation and bombing accuracy. Another is a dual-purpose radar system which provides a presentation for navigators and gives terrain height indications.

A celestial tracker has been added to the late-model B-52s for accurate determination of the airplane's direction. Penetration devices of a new order have been installed, to improve the bomber's ability to deal with enemy defenses.

Other new devices are identified with low-level flight. The SAC tactic of flying as low as possible in order to penetrate enemy radar defense makes unusual demands on the structure as well as the control of the bomber. It is one of the major areas in which the B-52 shows its ability to change and grow, electronically and otherwise.

The B-52 originally used approximately 2,140 electron tubes (not counting transistors), a number about equivalent to the tubes in 144 home TV sets. Some were 18 inches long with a 10-inch diameter. Now the bomber's electronic system uses many transistors and diodes. They improve reliability, reduce weight, require less power, and help solve heat problems.

Test-and-repair techniques in the electronic shops at Wichita are highly modern. For example, the equipment used to check out the B-52H gunnery system is a tape-controlled unit.

One of the B-52 navigation instruments is so sensitive that electronics technicians must place it, for test and adjustment, on an individual concrete column base topped with a slab of granite. An atomic-gas device is required for calibration of the check-out equipment used on the celestial tracker. A four-wheeled cart in the electronic laboratories contains a set of circuits that respond to the activation of the Hound Dog missile control systems. When those systems are removed from an airplane, linked to the test cart and activated in the lab, technicians can determine exactly whether they would get the desired result from the system.

Electronic equipment from each airplane is scheduled in and out of the laboratories on a time schedule designed to get the bomber back in service with SAC quickly.

THE ELECTRONIC center at Wichita is a three-story building in the flight-line area, with temperatures and humidity controlled for the perfect comfort of sensitive instruments. Specially constructed walls and floors are laced with electrical lines and cables, supplying seven different types of power. It is one of the largest concentrations of electronic equipment in the Midwest. Included is a stock of components and repair parts on the ground floor.

On a typical day technicians may be checking out B-52 wave guides (involving frequencies of billions of cycles per second) in one of the laboratories, while others are testing new antenna designs on the roof. Others may be working with man-made starlight, noting the pinpoint accuracy of an ultra-sensitive tracker. Others may be doing more routine jobs in the fire-control areas, radar shops, or environmental chamber. They are all trained in theory as well as practice. Technicians have an average experience of more than 10 years. They are B-52 heart specialists.

For a B-52 directional instrument, the technicians measure increments as small as 30 seconds of arc. In checking out the heading reference system, test increments as small as 15 seconds of arc are measured. Basic timing within the bombing system is checked to .001 per cent of error.

When the electronic assemblies have completed inspection, test, adjustment and repair, they go back to the bombers. They get a final live check-out.

When the B-52s have received their electronic and other modernization touch-ups at Wichita, they are ready to resume front-line action for SAC. They can successfully carry out any peace-keeping assignment required.

After modification the B-52 is a new airplane in many ways.

ADVENTURES IN MANAGEMENT

WHAT-NEXT MAN

ON A WALL in the office of George S. Schairer, Boeing vice-president—research and development, is a picture of some shiftless and motley characters, hung there by mischievous members of his staff. The caption reads: "Our highly skilled and intelligent personnel are eagerly waiting to serve you."

They wondered what the boss' reaction would be. They knew when they heard a loud explosion — of laughter.

As a matter of fact, the research leadership group headed by Schairer is one whose daring technological pioneering has helped keep Boeing among the front-runners of the aerospace industry. The company's interest in such projects as the fantastically successful Minuteman ICBM originated in the product research group.

"There was a time when the ballistic missile was a minority idea, when most people thought it couldn't be done," Schairer said. "You've got to get aboard while something is still a minority idea to stay ahead in the race, which means you have to get aboard when most people think it is not going to pay."

Schairer has had a direct role in the aerodynamic design and development of all Boeing aircraft since he joined the company in 1939 as head of the aerodynamics unit. In 1949 Schairer was awarded the Sylvanus Albert Reed Award of the Institute of the Aeronautical Sciences for his work in development of large swept-wing craft.

A fellow and technical director of the American Institute of Aeronautics and Astronautics, he was honored this year for outstanding work by being selected to give the Wright Brothers Lecture.

In 1958 Swarthmore College acknowledged the distinction he had brought to his alma mater by conferring on him an honorary doctor of engineering degree.

Schairer encourages his staff to show initiative. "I want them to pick up the ball and run with it," he says.

Recently Schairer helped his 18-year-old son, John, repair a broken axle on daughter Sally's sports car. Putting John in charge of the job was his father's way of encouraging him to "pick up the ball and run with it."

MOSTLY ON TIME

TO STRETCH a point, Howard Neffner is to Boeing what Arnold Palmer is to golf. Neffner is a professional contract negotiator whose favorite pastime is golf, and Palmer is a professional golfer whose favorite pastime is contracts.

The last contact between the two was in mid-June when Neffner, braving 90-degree heat, oppressive humidity and a jammed gallery, trod the 18-hole Congressional Country Club course in Washington, D.C., to watch Palmer and company in the National Open.

To Neffner, golf is a diversion, definitely a notch down the ladder from his first love of sitting down at a conference table and becoming immersed in the give-and-take of contract negotiating. He has been doing this for more than 20 years at Boeing. Two months ago he was elected company vice president — director of government contracts. He also is director of contracts for the Aero-Space Division. His office is in Seattle.

Associates describe him as self-effacing, a person with only one modest eccentricity—he never arrives at an airport until the last possible minute before takeoff.

Neffner can recall contract figures negotiated 20 years ago. A co-worker says Neffner is the "most talented person I've seen in mentally putting together a complex set of facts and reaching a logical conclusion."

Neffner is a small-town product who was born and raised in New Vienna, Ohio, population 600. He took four years of high school in three, entered college at 16, and obtained his law degree from Ohio State University at age 24.

After four years of trial law in private practice, Neffner found his notch in business with a small airplane company, later helped the firm move to Wichita, Kansas. He joined Boeing in 1941 and soon was negotiating military airplane contracts as the company's assistant representative at Dayton, Ohio. Since transferring to Seattle in 1950, he has helped launch Boeing in the missile and space field.

Recently the word got out that Neffner finally had timed his arrival at an airport a little too close and had missed an airplane departure for the first time in 20 years. It proves again that you can't win 'em all.

Probe at lower right is major comparator improvement.

New device floats on air.

FASTER INSPECTOR

By ALLEN HOBBS

BOEING technicians have made a major improvement in a widely used quality-control machine, the optical comparator. The basic process remains the same—surfaces such as bores and contours are traced by a probe, and an image formed by the probe is projected on a circular glass screen where it is compared with a template.

Inspectors found that the old-style probe and tracking mechanism were not always accurate. The probe rode on ball bearings and even a speck of dust could cause an error. A slight pressure would bend the probe minutely and destroy accuracy. In some cases the weight of the probe fixture would cause trouble.

The Turbine Division manufacturing development department solved the problem by a redesign of the probe fixture. Passageways were installed instead of ball bearings. Feeding air into the passages, technicians floated a lightweight probe on a cushion of air. Five pounds of air pressure is enough.

The resulting featherlight tracer tracks across a part almost of its own accord. This air-cushioned probe enables inspectors to check tolerances of complex parts such as turbine stator vanes and compressors with a rapidity and accuracy never before possible.

As 100 per cent inspection of critical turbine engine parts is made, the floating probe is a significant addition to the division's production effort.

"...the 727 has exceeded by appreciable margins the Boeing performance guarantees."

"Customer reaction has been most enthusiastic."

That's how a top U.S. airline executive describes the new Boeing 727's performance in commercial service.

The 727 is exceeding even the highest expectations.

Cruising speed is higher than predicted, field-length requirements are less, and distance flown per pound of fuel consumed is greater than specified. Performance is as much as 12% above Boeing's original guarantees.

Just as important, passengers are reacting with enthusiasm to the 727's exhilarating performance and its incredibly quiet cabin. The Boeing 727 is attracting load factors well above industry averages.

The Boeing 727 offers airlines the uniquely profitable combination of big-jet passenger appeal and small-jet economics. It also offers the reliability and performance benefits of more than 1½ billion miles of Boeing 707 and 720 flight experience.

The 727 is now in service with All Nippon, American, Eastern, Lufthansa, TWA and United airlines. It goes into service later with Ansett-ANA, BWIA, JAL, National, Northwest, Pacific Southwest, South African, and TAA (Australia). These leading world airlines have already ordered 222 Boeing 727s.

BOEING 727