GENERAL ELECTRIC

GROUND SUPPORT EQUIPMENT FOR PROJECT APOLLO

APOLLO SYSTEMS DEPARTMENT

The Apollo Systems Department of General Electric Company was organized in 1962 to provide equipment and engineering services to NASA's Apollo project. ASD is the fifth largest contractor in the program, having supplied most of its Ground Support Equipment.

This ground support equipment may be divided broadly into three functional areas:

- Checkout of Spacecraft (ACE-S/C)
- Checkout and control of launch vehicle (ESE)
- Checkout and control of launch facilities (LCCE)

The Apollo Systems Department is headquartered at Daytona Beach, Florida, and has large Center operations at Cape Canaveral, Florida; Houston, Texas; Huntsville, Alabama; and maintains, in addition, a Washington Office. ASD personnel are also located at Apollo contractors' facilities in Downey, California, and Bethpage, New York.

SPACECRAFT CHECKOUT EQUIPMENT (ACE S/C)

Before lift-off, thousands of test points on the Apollo spacecraft **must** be checked out. This testing is accomplished utilizing checkout equipment built by the Apollo Systems Department of General Electric. This equipment, called "ACE" for Acceptance Checkout Equipment, checks out the three Apollo modules, but not the launch vehicles.

An ACE checkout station consists of two main rooms of equipment--a control room, and a computer room. The computer room contains two high-speed computers. Advanced system design permits centralized, preprogrammed operation.

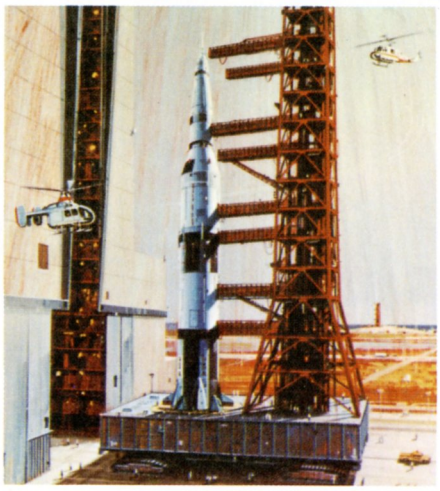
ACE can make tests in three different operating modes - manual, semiautomatic, or fully automatic. ACE checks all spacecraft systems including instrumentation, communications, environmental control, power, stabilization, and control. ACE can test one tiny component buried deep within the spacecraft or the entire, integrated spacecraft.

The 14 ACE stations, manufactured by General Electric, are used from factory to launch pad.

LAUNCH VEHICLE CHECKOUT EQUIPMENT (ESE)

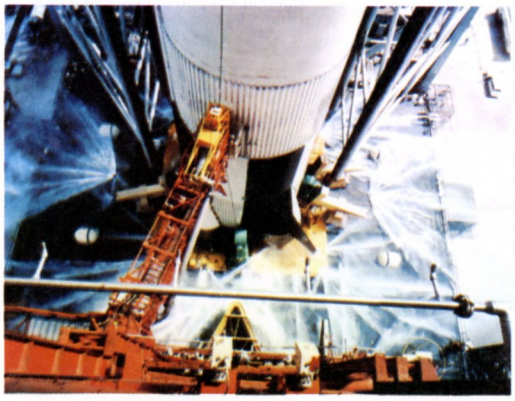
While ACE checks out the Apollo spacecraft, other GE-built equipment checks out the Saturn launch vehicle. Known as ESE, for Electrical Support Equipment, this system contains about 10,000 racks, panels, and control consoles.

ESE is the type of equipment seen in the launch control centers at KSC. It tests all the thousands of checkpoints on Saturn V's three stages manually and automatically. ESE also conducts all switching operations in the final three minutes of countdown.



General Electric also provides equipment to check out and control the launch facilities themselves.

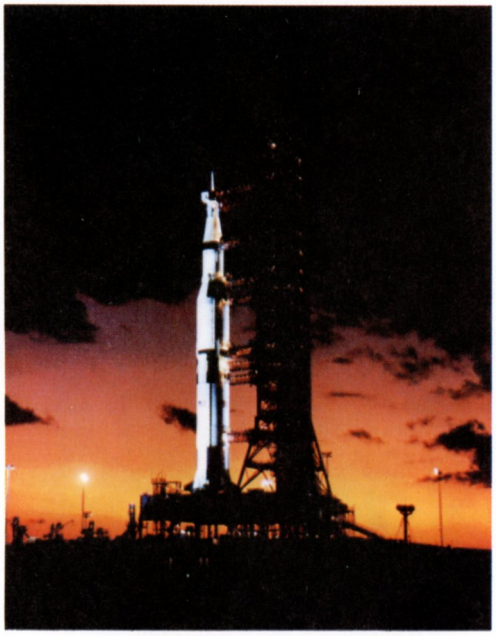
LAUNCH FACILITIES CHECKOUT EQUIPMENT (LCCE)



Water Control Systems Provide Fire Protection, Pad Cooling and Quenching

The launch facilities are controlled and tested by Launch Control and Checkout Equipment (LCCE). This equipment is located throughout the entire launch complex and includes systems used to check and control fueling of the various stages, as well as equipment concerned with communications, telemetry, water control, and other launch complex operations.

General Electric's Ground Support Equipment never leaves the ground..... but without it, neither does anything else.



GENERAL ELECTRIC
MISSILE AND SPACE DIVISION
APOLLO SYSTEMS DEPARTMENT

ASD

DAYTONA BEACH, FLA.

GENERAL ELECTRIC CONTRIBUTIONS TO APOLLO

FOR FURTHER
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Space Division
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GENERAL ELECTRIC

GE/APOLLO STORY

The capability to land a man on the Moon is made possible through the efforts of the National Aeronautics and Space Administration and an estimated 20,000 different companies, each contributing a vital product or service to Project Apollo. General Electric has been a major Apollo contributor, calling on more than 6000 men and women in 37 different GE organizations at some 26 locations to provide materials and support for Apollo ranging from checkout of the spacecraft, booster and launch facilities to providing live color television coverage of the Astronauts' return from the Moon.

The principal General Electric contributions to Apollo include: General Electric's Apollo Systems Organization, fifth largest contractor for Apollo, located in Daytona Beach and Cape Kennedy, Fla., Huntsville, Ala., and Houston, Tex., which provided intricate checkout equipment and a broad variety of engineering services to NASA.

Acceptance Checkout Equipment Spacecraft, or ACE-S/C, is used to test the pulse of the spacecraft. General Electric has built 14 of these stations so that the spacecraft can be checked all the way from manufacture to launch. ACE-S/C permits centralized, programmed control of spacecraft test and checkout operations. It can test the nearly 3000 system checkpoints manually, semiautomatically, or fully automatically.

Electrical Support Equipment (ESE) has the task of checking out the launch vehicle, of providing support to other ground systems, and of conducting switching operations during the final three minutes of countdown. It is the largest known such system in the world. ESE sends commands to exercise or control each of the critical components of the various launch stages. It then receives and displays the status conditions of the thousands of test points so that the test conductors at all times know in detail if the launch stages are operating properly.

Launch Control and Checkout Equipment (LCCE) is primarily associated with the electrical con-

trol of propellants and gases, and the mobile launcher equipment, but includes systems which spread over the entire Cape Kennedy complex to control and checkout thousands of test points and subsystems.

The 25-square-mile Mississippi Test Facility, a component of NASA's Marshall Space Flight Center, is operated and maintained by the GE Mississippi Test Support Department, Bay St. Louis, Mississippi. GE is responsible for the full range of services at this proving ground for the booster and second stages of the Apollo/Saturn V space vehicles. Services include utilities, communications, logistics, buildings, roads and grounds, security, reproduction and mail, pest control and fire protection.

After the Moon trip, the world will be able to see the entire recovery spectacular through a color television transmission system developed by GE's Space Systems Organization, Valley Forge, Pa., for Western Union International.

On the second trip to the Moon, now scheduled to be this fall's Apollo 12 mission, the astronauts will leave the Apollo Lunar Surface Experiment Package to gather data to be relayed to Earth for at least one year. SNAP-27, developed by GE's Space Systems Organization, is a radioisotope, thermo-electric system that will supply power for the experiments.

Large-scale General Electric 635 multi-programming and processing computers, made by GE's Information Systems Equipment Division at Phoenix, Arizona, conduct pre-launch checkout of the Saturn V launch vehicles on all Apollo missions, and are key components in the post-flight reduction of data received from Saturn during the flight. During the final hours of countdown the computers continuously monitor some 3,000 different valves and gauges on Saturn, checking them 12 times each second, and flashing selective bits of data to any one or all of 30 display terminals — all in real time.

PRESS INFORMATION HANDBOOK

GROUND SUPPORT EQUIPMENT FOR PROJECT APOLLO

"THIS EQUIPMENT NEVER LEAVES THE GROUND—
WITHOUT IT, NEITHER DOES ANYTHING ELSE."

ASD

APOLLO SYSTEMS DEPARTMENT

GENERAL ELECTRIC

INTRODUCTION

This handbook is distributed by General Electric for the convenience of the press and broadcast media. It describes—in handy, readily usable form—the major systems and subsystems comprising most of the Apollo/Saturn ground support equipment; equipment produced by General Electric's Apollo Systems Department.

This ground support equipment may be divided broadly into three functional areas:

- Checkout of Spacecraft (ACE-S/C)
- Checkout and control of launch vehicle (ESE)
- Checkout and control of launch facilities (LCCE)

Each major subject is listed alphabetically and tabbed for easy reference. An index is included listing the nearly two dozen major subsystems treated under the main headings.

General Electric is the fifth largest contractor on the Apollo project and provides, in addition to ground support equipment, broad engineering services to NASA.

ACE-S/C—The Acceptance Checkout Equipment—Spacecraft is used to test the operational readiness of the Apollo spacecraft from factory to launch pad. Fourteen of these three-room checkout stations have been manufactured by General Electric's Apollo Systems Department.

ACE is an advanced, integrated checkout system that permits centralized, programmed control of spacecraft test and checkout operations. ACE can be used to test all of the spacecraft's nearly 3,000 system checkpoints manually, semi-automatically, or fully automatically.

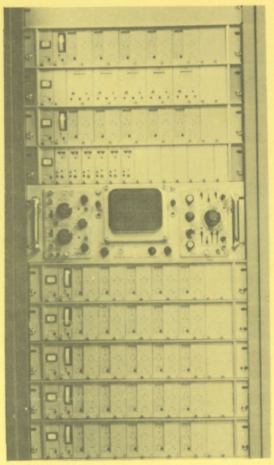
Shown above is an ACE computer room. The control room of a typical ACE station is illustrated on the front cover of this handbook.

BACKGROUND ON ACE

The need for automated checkout equipment was brought about by the increasing complexity of our nation's space vehicles. The Mercury capsule which first took American astronauts into space had only 88 checkpoints and was tested manually. NASA designed the ACE equipment to automatically perform the thousands of tests required on the Apollo spacecraft which will take American astronauts to the moon.

ACE uses a computer to monitor operational characteristics of all the spacecrafts' systems. If a test shows a system or component is not up to par, a TV-like screen in front of the test engineer blinks to call his attention to the discrepancy. Several lines of systems information are displayed on this screen as the various tests are conducted. Additional data is displayed on lights, meters, and recorders.

If all the data from a continuous 8-hour test was printed out and stacked beside the Saturn V, it would stand 65 feet taller than the space vehicle itself.



DDAS—One of the largest subsystems of the Electrical Support Equipment (ESE) is the Digital Data Acquisition System (DDAS). This major ESE subsystem collects launch vehicle and ESE responses to test commands and places them in the proper format (decommutates them) for transmission to the control room monitors and display panels. The decommutated test data is provided to computers for processing and display and for computer control of automatic vehicle checkout subroutines.

The DDAS interfaces with other equipment to aid in checkout and launch, such as propellant tanking computer, tail service masts, Q-ball system, service arms, and measuring station.

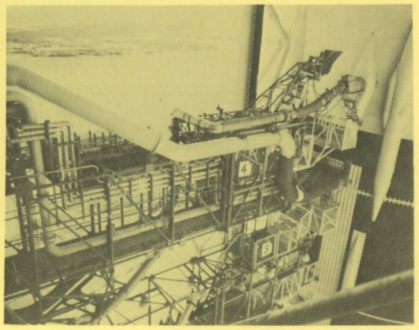
ANOTHER WAY TO LOOK AT APOLLO'S GSE . . . .

Should you want to give your readers, listeners, or viewers some idea of the vast size of the GSE used on Apollo, here are some examples related to familiar comparisons:

- A total of 25,000 cables were built for all ESE sites. If these cables were placed end to end, they would reach from Washington, D. C. to New York City. The wire in these cables alone is equivalent to running a wire from Washington, D. C. to Paris, France to Karachi, Pakistan to Bangkok, Thailand to Tokyo, Japan.

- Also included in this work at the Cape was the design and fabrication of 20 different power systems. These systems generate enough power for 16,000 homes. Another way to say this is that these power systems could supply a city of 80,000 people. For example — Las Vegas.

(Other comparisons on GSE will be found on the back of tabs 4, 5, and 6.)



THE ELECTRICAL LAUNCH SUPPORT EQUIPMENT (ELSE) is primarily associated with the electrical control of propellants and gases, and the mobile launcher equipment, but includes systems which spread over the entire Cape Kennedy complex to control and check out thousands of test points and subsystems. ELSE consists of approximately 800 racks of electrical equipment in 24 different systems, including the following:

Environmental Control System—Provides controlled atmosphere in the vehicle stages and in the spacecraft.

(Continued on reverse side)

ELSE (Continued)

Service and Access Arms Control System—Tests, controls, and monitors operation of the service and access arms for the Saturn V launch vehicle stages and Apollo spacecraft on the mobile launcher at the launch pad.

Hold Down Arm and Lift Off Control System—Controls, monitors, and tests the operation of the four hold-down arms and the two pairs of service arm control switches for the Saturn V launch vehicle.

Other ELSE systems monitor and control pneumatic valves for fuel and oxygen; tail service mast operations; Q-ball cover retract mechanisms; and purge pressurization, area warning, and traffic lights. Two additional major ELSE systems, water control and PTCS, are described in detail elsewhere in this handbook.

ELECTRICAL SUPPORT EQUIPMENT (ESE)—The checkout of the Saturn launch vehicle is performed by the Electrical Support Equipment (ESE). This equipment also provides operational support to other ground systems and conducts all switching operations required during the final three minutes of countdown.

ESE sends commands to exercise or control each of the critical components in the various launch stages. It then receives and displays the status conditions of the thousands of test points so that the conductors at all times know in detail if the launch stages are operating properly.

ESE is the largest known checkout system in the world.

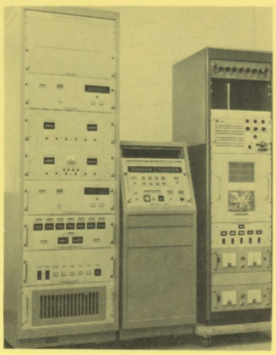
MORE ON ESE

ESE provides the following capabilities:

- Rapid checkout
- Independent launch vehicle subsystem testing
- Testing across system interfaces
- Compatibility with spacecraft checkout system
- Test documentation
- Safe and arm capability
- Automatic capability
- Manual, semi-automatic, and automatic modes
- Fault isolation and troubleshooting

Over 2,000 so-called "equivalent" racks (4 chassis per rack) were built for the ESE Program. Stacked end to end, these racks would form a column 3 miles high, a height equivalent to a stack of 42 Saturn V vehicles. In order to launch one Saturn V vehicle, a column of ESE racks 7 times the vehicle height is required. The volume of equivalent racks that was shipped on ESE would fill 13 railroad boxcars.

(For more comparisons on ESE, see tabs 2, 5, and 6.)



PROPELLANT TANKING COMPUTER SYSTEM (PTCS)—Before the launch vehicle can start its engines, more than 100 tank cars of fuel must be loaded into the Saturn boosters' storage tanks. The responsibility for this task lies with the Propellant Tanking Computer System (PTCS), a major subsystem of ELSE.

This system solves the problems of checking and controlling the loading of propellants and liquid oxygen to assure that the tanks are properly filled prior to lift-off.

For Launch Complex 39, six systems are required, two for each stage (S-IC, S-II, and S-IVB). For Launch Complexes 34 and 37, four systems are required, two for each stage (S-IB and S-IVB).

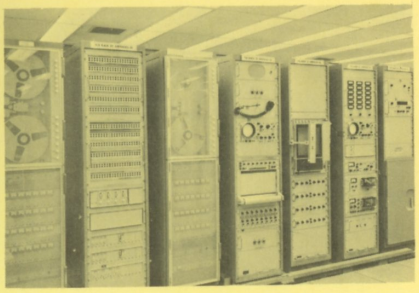
The systems may be operated in either a manual or an automatic mode. Normal operation, however, is automatic.

MORE GSE COMPARISONS

- The Water Control System for Launch Pad A can pump 1,400,000 gallons of water at 65,000 gallons per minute. This is enough water to supply 300 homes for one month.

- The total power utilized when all ESE stations are operating simultaneously is 2.1 million watts. There are enough backup batteries for emergency power to operate 1,000 automobiles.

(For more comparisons on GSE, see the back of tabs 2, 4, and 6.)



RADIO FREQUENCY AND TELEMETRY CHECKOUT EQUIPMENT—Two vital functions that help assure a safe launch are the Radio Frequency and Telemetry Checkout systems.

THE RADIO FREQUENCY CHECKOUT SYSTEM validates the readiness of on-board radio frequency systems during pre-launch activities. This system can monitor two vehicles at one time.

THE TELEMETRY CHECKOUT EQUIPMENT monitors three telemetry systems on the Saturn launch vehicles. It also functions as a checkout of the pulse code modulation (PCM) signals routed within the space complex. This system tells NASA that the on-board telemetry systems are ready to go.

MORE GSE COMPARISONS

- The ESE equipment contains over 2.2 million individual patchable connections.
- To date, 280 miles of wire have been utilized in patchboards, along with 1.5 million goldplated patch pins.
- The gold plating on these pins is worth $75,000.

(For more comparisons on GSE see the back of tabs 2, 4, and 5.)

THE VEHICLE MEASUREMENTS CHECKOUT EQUIPMENT is made up of the Launch Control Center Measuring System (LCCMS) and the Vehicle Measurement Ground Support Equipment (VMGSE).

The LCCMS is used for real-time recording of selected signals from the Digital Data Acquisition System and hard wire distribution systems during the checkout operations in the VAB and prelaunch operations at the pad. These signals are recorded to provide a continuous display of critical measurements for post-launch evaluation. Special VAB and pad tests are also recorded using this system.

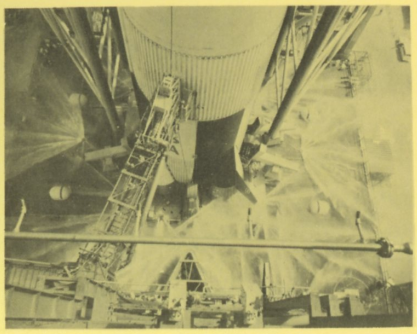
(See reverse side for VMGSE.)

THE VEHICLE MEASUREMENT GROUND SUPPORT EQUIPMENT (VMGSE) is used to verify and check the calibration and operation of the Saturn V launch vehicle measurements. To accomplish this, the VMGSE provides data conversion, display monitoring, and control functions.

Each calibration test station within VMGSE is capable of providing the following functions:

- Verifying calibration and serving as a reference for the adjustment of a launch vehicle measurement system.
- Facilitating test and checkout of a launch vehicle stage.
- Supporting other launch vehicle requirements by providing real-time launch vehicle measurement display and permanent recordings for post-test evaluation.

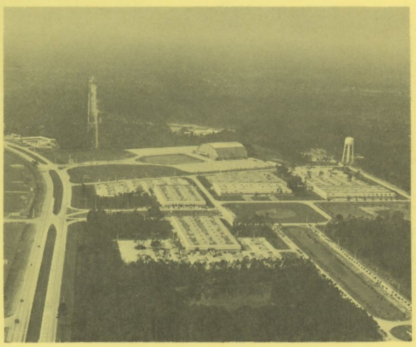
Although the two systems comprising the Vehicle Measurements Checkout Equipment (LCCMS and VMGSE) are not directly related to the launch, they play a vital role as support systems that back up the primary equipment.



WATER CONTROL SYSTEMS provide water for fire protection (the Firex System) and for cooling and quenching the launch site and storage areas prior to, during, and following launches (the Industrial System). This is a major subsystem of ELSE.

During launch, automatic sequence control is exercised of the flame deflector cooling and quench, the mobile launcher deck quench, and the swing arm cooling valves. The remainder of the water system remains under the control of switches in the LCC. All valves are operated pneumatically through a solenoid pilot valve.

INDEX



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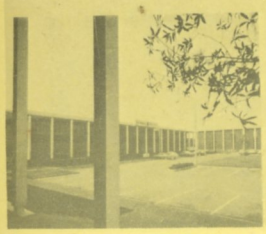
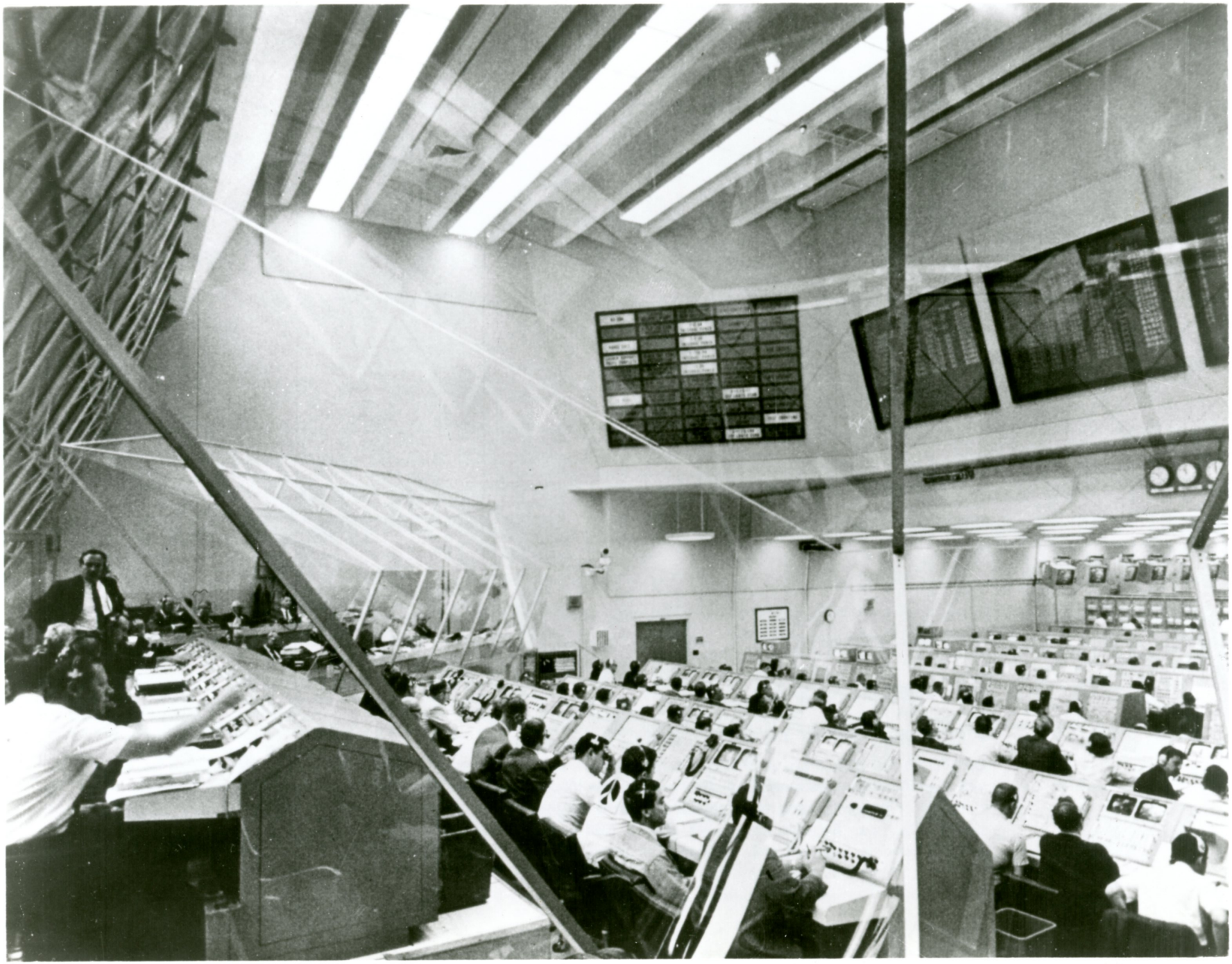


PRODUCT INFORMATION-MARKETING

Progress Is Our Most Important Product

GENERAL ELECTRIC

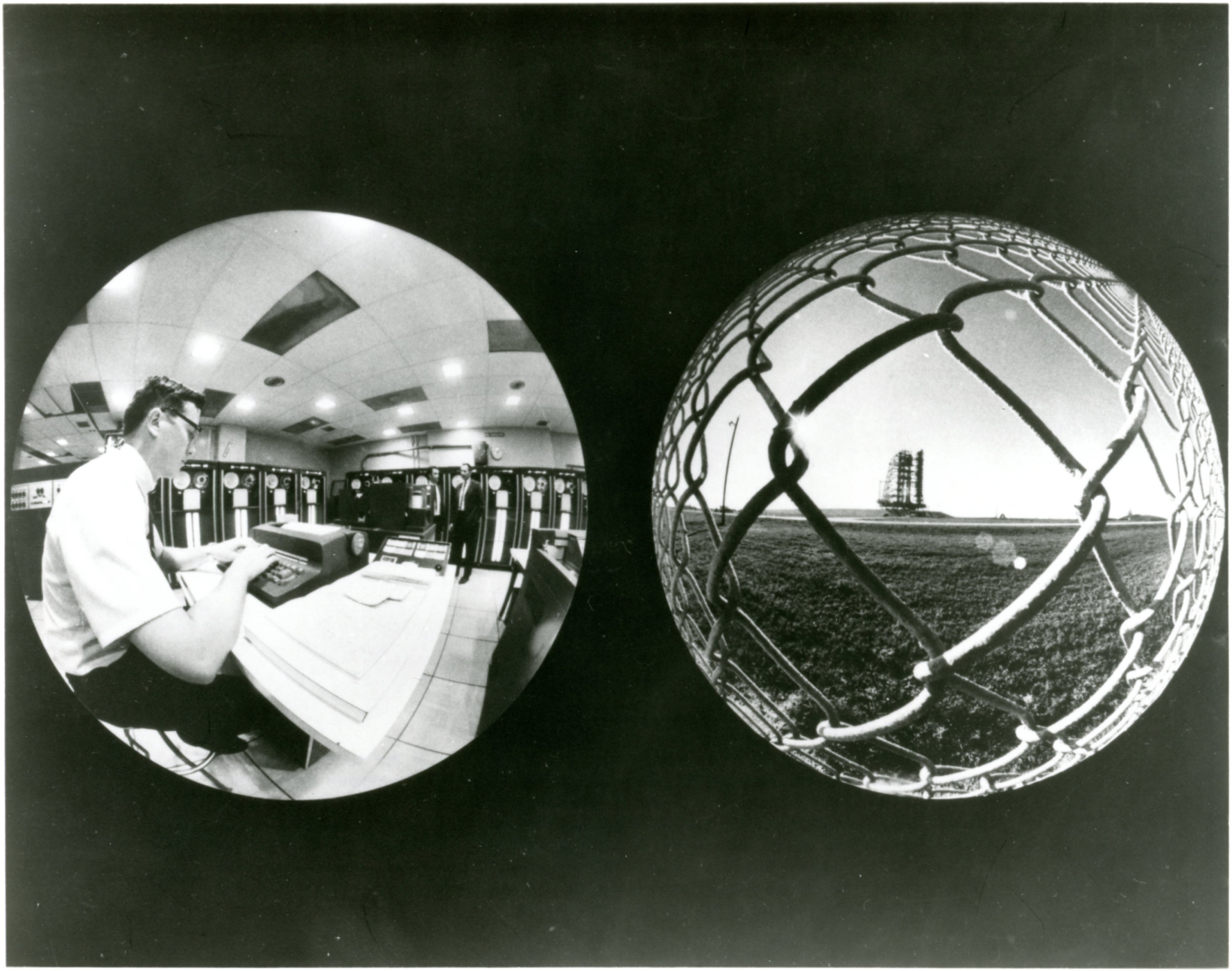
APOLLO SYSTEMS DEPARTMENT
MISSILE AND SPACE DIVISION
DAYTONA BEACH, FLORIDA



FOR IMMEDIATE RELEASE

ELECTRICAL SUPPORT EQUIPMENT (ESE)

DAYTONA BEACH, FLA. — During the countdown and launch of the Saturn V Rocket which will start American Astronauts on their way to the Moon, the giant space vehicle will be checked out and controlled during the pre-launch phase by the largest checkout system in the world, called Electrical Support Equipment (ESE). ESE also provides operational support to other ground systems and conducts all switching operations in the final three minutes of countdown. ESE was designed and manufactured by General Electric's Apollo Systems Organization at their Center Operation in Huntsville, Alabama.



FOR IMMEDIATE RELEASE

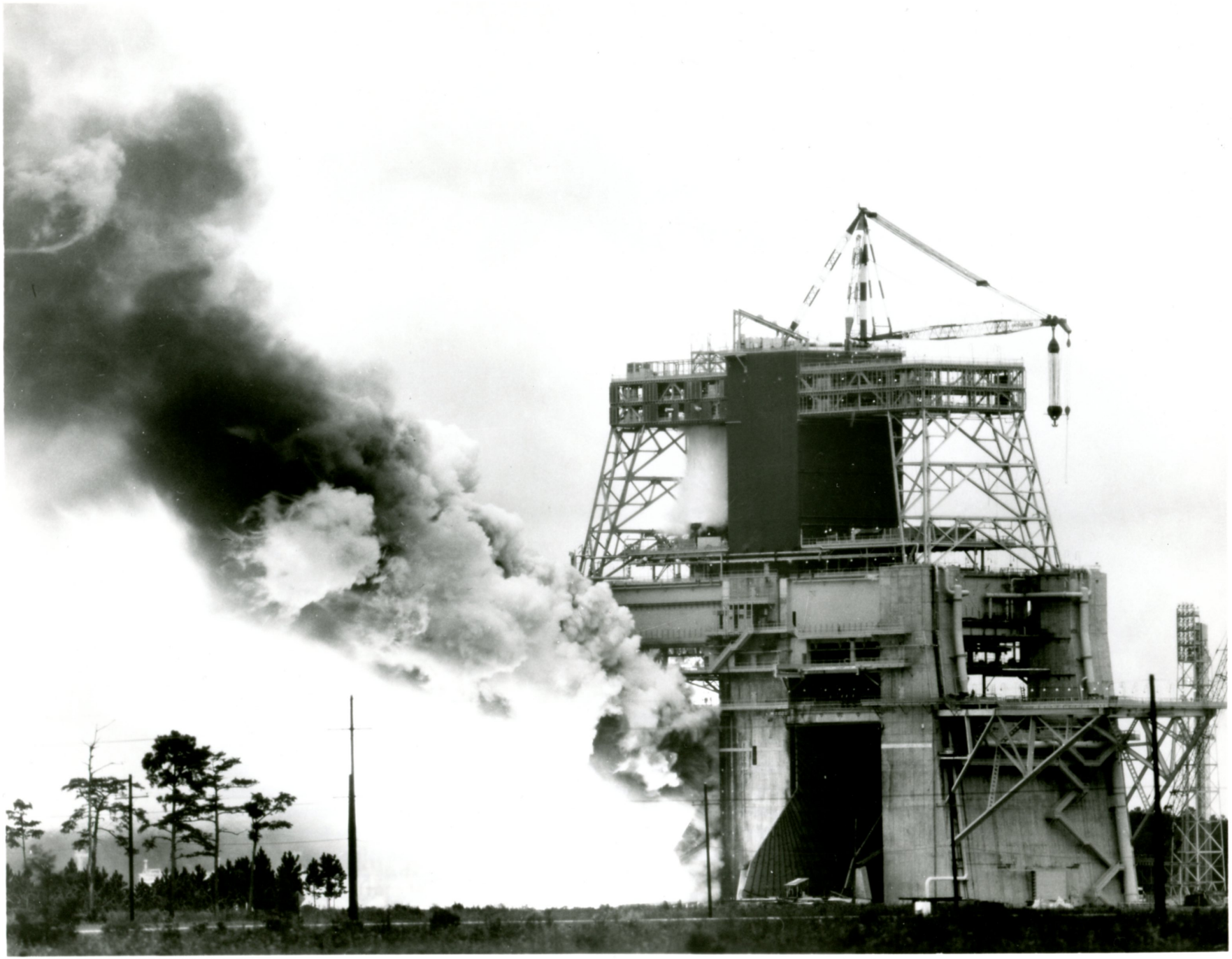
SPACE AGE VISION

KENNEDY SPACE CENTER, FLA. — Computers and space ships at the NASA launch site here presented this unusual view to a fish eye camera during final countdown of an Apollo Moon mission. During final hours of the countdown, a high-speed General Electric multi-programming computer five miles from the launch pad was continuously checking and re-checking some 3,000 critical valves and gauges 12 times a second on the Saturn V launch vehicle, "looking" for any signs of failure or malfunction. The binocular effect shown above is a composite of two photos taken during a countdown; one of the Apollo 8, the other of the GE-635 computer used in pre-launch checkout of the Saturn launch vehicle.

FOR IMMEDIATE RELEASE

LAUNCH CONTROL AND CHECKOUT EQUIPMENT (LCCE)

DAYTONA BEACH, FLA. — General Electric's Apollo Systems Organization has provided a broad range of equipment used to control and check out the facilities used in launching America's Apollo astronauts. This hardware is known as Launch Control and Checkout Equipment (LCCE), and includes systems which spread over the entire Cape Kennedy Complex. Shown here is a test of the Water Control System used for cooling and quenching the launch site and storage areas before, during, and after a launch.



FOR IMMEDIATE RELEASE

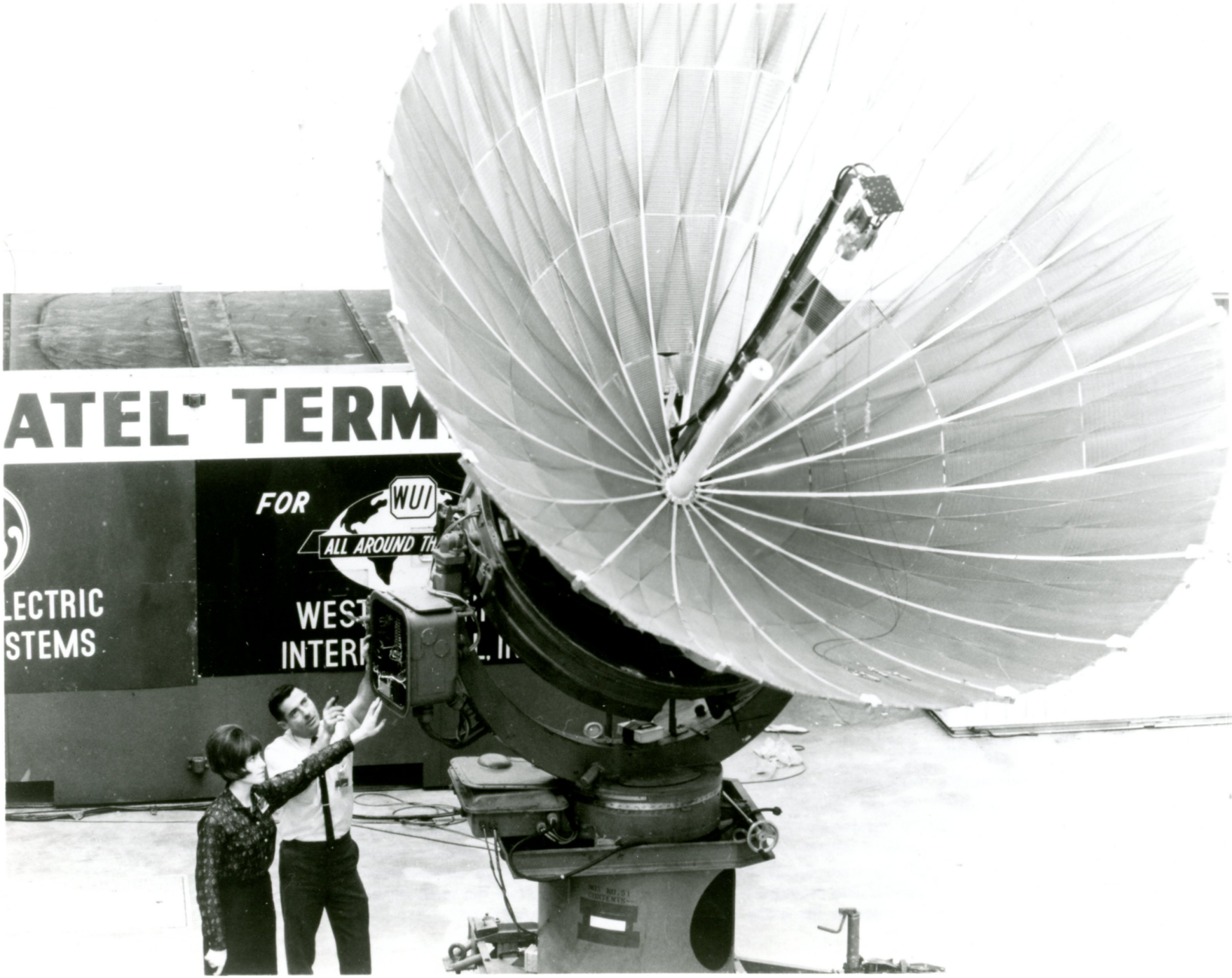
MISSISSIPPI TEST — TORRENTS OF FLAME

BAY ST. LOUIS, MISS. — Torrents of flame and smoke pour from deflector of 407-foot high test stand at NASA/Mississippi Test Facility as America's largest rocket undergoes static test firing. The S-IC-9 shown here, first stage for an Apollo/Saturn V launch vehicle, is 138 feet high and produces 7.5 million pounds of thrust, equal to 160 million horsepower. Flightworthiness tests are conducted on the first two stages of Apollo/Saturn V which will boost the first American astronauts to the Moon and beyond. General Electric Company's, Mississippi Test Support Department under prime contract with NASA, operates and maintains the space-age proving ground in Hancock County, Miss., and provides technical and test services to users.

FOR IMMEDIATE RELEASE

ACCEPTANCE CHECKOUT EQUIPMENT — SPACECRAFT (ACE-S/C)

DAYTONA BEACH, FLA. — Thousands of system test points on the Apollo spacecraft must be thoroughly checked out before it can be launched. These tests are made using checkout equipment designed by NASA and developed and manufactured by General Electric's Apollo Systems Organization. Called ACE-S/C, for Acceptance Checkout Equipment — Spacecraft, this system is capable of testing all the checkpoints on the Apollo modules manually, semi-automatically, or fully automatically. Shown above is the control room of one of the 14 ACE stations manufactured by Apollo Systems for NASA. Each station also contains a computer room and terminal/switching facility. These ACE stations are in use at locations throughout the nation for checkout of the Apollo modules from factory to launch pad.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FOR IMMEDIATE RELEASE

TRANSATEL

VALLEY FORGE, PA. — IT'S NOT AN UMBRELLA AT ALL — that's what General Electric secretary Barbara Torvend learns as she examines a 15-foot diameter antenna that helps provide live color TV coverage of Apollo splashdowns. Pointing out some key components of the antenna is GE technician Joseph McCarthy. The antenna is part of a portable television transmission system built by GE's Space Systems Organization for Western Union International, Inc. The system transmits live pictures of the recovery operations from the deck of the recovery carrier to TV viewers across the globe via satellite high above the Pacific.

NEWS BUREAU

GENERAL ELECTRIC

SD-69-1g

1010 Barclay Bldg., Bala Cynwyd, Pa. 19004

Area Code 215 TE 9-3093

P. H. Scott

HIGHLIGHTS OF GENERAL ELECTRIC'S PARTICIPATION

IN THE U.S. MISSILE AND SPACE PROGRAM

FOR IMMEDIATE RELEASE

The General Electric Company was given the first industrial contract for liquid-fuel rocket engine work in the history of the United States. The Army Ordinance contract called for research and development in all phases of guided missiles. The project was named Hermes.

A year later General Electric also was asked to focus its technical talent on the work that had been done by the Germans, and sent four members of the team to Europe to gather what they could of German missile technology and equipment.

Hermes highlights included:

First missile operations at White Sands Proving Grounds and the area that is now Cape Kennedy.

First launch of a missile from shipboard at sea.

Project Bumper, the first launch of a two-stage rocket.

Construction and flight test of first inertially-guided missile.

An altitude record of 252 miles, set by Bumper Five, stood for 7 years.

A total of 103 missiles were built, or rebuilt, and fired during the 10 years of the Hermes program.

-more-

Subsequent General Electric Space Highlights:

1955 The Company is selected by the Air Force to develop the reentry vehicle for the Atlas intercontinental ballistic missile.

1958 General Electric rocket engine launches Vanguard space satellite as part of International Geophysical Year.

1959 The Department of Defense awards General Electric the development contract for a complete unmanned spacecraft.

1960 The Company secures contract for construction of the space vehicle and integration of the subsystems for Project Nimbus, first weather study satellite.

Recovery of the Discoverer space capsule whose reentry and recovery system was designed and built by General Electric marks the first successful recovery of an object that had been orbited around the Earth.

1961 The Company's Atlas radio-command guidance system is used to guide the Mercury spacecraft carrying the chimpanzee Enos into a predetermined orbit in preparation for manned orbital flight. The system is also being applied to the guidance of Atlas boosters for the Advent communication satellite launching and the Ranger Moon probe vehicles.

1962 General Electric's radio-command guidance system is part of all three of the US's manned orbital launches, as well as on the Mariner II spacecraft on its journey to observe the planet Venus. The system has been chosen to provide the precise control required to put the two-man Gemini spacecraft into orbit, a new step in space scheduled for 1964.

General Electric is awarded a major supporting role in Project Apollo. General Electric will provide supplies and services to assist NASA in the performance of checkout, reliability assessment and integration support for the program.

1963 General Electric is awarded an additional responsibility in the lunar program: operation of NASA's Mississippi Test Facility, a static test area for Saturn boosters.

Major new contracts include one for the development of the Mark 12 reentry system for the Air Force's advanced Minuteman missile, as well as one for the development of NASA's Biosatellite - a recoverable space vehicle which will study the combined effects of radiation and weightlessness on biological specimens during extended orbital flight.

1964 GE assembles and tests NASA's Nimbus weather satellite.

General Electric delivers the first of a series of complex electronic checkout systems as part of the reliability and checkout support being supplied to NASA.

1965 The first GE-635 computer is installed at Kennedy Space Center. Primary function: monitor some 3,000 different parts on the early Saturn.

NASA's Geodetic Earth Orbiting Satellite (GEOS) is launched. General Electric's gravity gradient test system is the satellite's stabilizer.

1966 The highly successful Gemini manned flights, which used General Electric's radio guidance system and fuel cells, are completed.

1967 The Nimbus II weather satellite, originally slated for a six-month orbit, continues its outstanding performance after functioning in orbit for 20 months as of the end of this year.

The second GE-635 computer -- with such applications as pre-launch checkout, post-test reduction and multi-programming requirements -- is installed at Cape Kennedy.

Successful launch and recovery of Biosatellite II, developed and manufactured for NASA by GE.

1968 NASA's Orbiting Astronomical Observatory II, for which General Electric designed and built a stabilization and control subsystem, is successfully launched. OAO's objective is to provide for the first time a detailed survey of the stars.

General Electric's TRANSATEL (Transportable Satellite Telecommunications) provides live color TV coverage of the Apollo 7 splashdown and recovery.

1969 General Electric's portable nuclear generator, SNAP-27, is readied for the Apollo 12 Moon Landing, when it will be left to provide power for the equipment package which will monitor and transmit data on the Moon's environment for a year after the astronauts return to Earth.

Nimbus III, most sophisticated of the experimental meteorological observatories built for NASA by General Electric, is launched successfully.

GE is prime contractor for TEKTITE I, a program sponsored by NASA, the Navy and the Department of the Interior to determine man's capability to perform a scientific research mission while living on the ocean floor. TEKTITE will also access the correlation between long duration missions under the sea and in outer space. General Electric is furnishing the undersea habitat and assisting in the program planning and scientific coordination.

NEWS BUREAU

GENERAL ELECTRIC

SD-69-1

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P. H. Scott

FOR IMMEDIATE RELEASE

The Space Age represents "the greatest technological era of mankind without the utter waste and devastation of a world war."

The observation, by Daniel J. Fink, General Manager of General Electric's Space Division, refers to the wealth of new technological knowledge man is acquiring as he goes about the orderly exploration of his universe and as he applies what he has learned in space to a variety of terrestrial problems.

Shepherding this nation's space efforts is the National Aeronautics and Space Administration, created 11 years ago. NASA oversees both manned and unmanned space programs, the latter including scientific projects, such as the Mariner

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deep-space probes, and applications programs, represented, for example, by the NIMBUS weather satellite.

In its brief lifetime NASA and its thousands of industrial contractors have accumulated a vast body of knowledge and an amazing array of new technologies. This government/industrial team has developed new materials, new tools, new techniques, products and processes, which are being applied in increasing number to everyday aspects of our lives.

COMMUNICATIONS

Communications is perhaps the oldest application we have made of our space technology. Since President Eisenhower's Christmas message from space in 1958, satellites have been used increasingly for broadcasting and international telecommunications.

Use of satellites has reduced the cost per channel from $25,000 for one circuit on new submarine trans-oceanic cables to as little as $4,200 for one satellite channel.

Satellites also have allowed, for the first time, live, world-wide TV broadcasting of events such as the Olympic Games. And a General Electric portable color TV transmission system now permits live color TV coverage of such remote events as the re-entry and recovery of the Apollo spacecraft in the South Pacific.

Space broadcasting, points out Mr. Fink, has many advantages for underdeveloped nations, since nations can achieve a direct television broadcasting capability this way without the delays and expense of building terrestrial broadcast stations, microwave

links, and receiving stations. India and Brazil are well into the planning stages for space broadcast systems, Mr. Fink says.

METEOROLOGY

Advance satellite warning of the approach of Hurricane Carla allowed orderly evacuation of the communities in its path. The early notice of the destructive storm allowed villages and towns to prepare themselves and sharply curtailed losses of live and property.

It has been estimated that the ability to predict weather five days in advance with satellites like the GE-built NIMBUS will result in an annual savings to the United States of $2.5 billion for agriculture, $45 million to the lumber industry, $100 million to the transportation industry, $75 million in retail marketing and millions more in recreational activities.

Furthermore, the cost of maintaining a global weather satellite system could save at least $150 million annually contrasted to the cost of maintaining a conventional global observation system.

Satellites such as NIMBUS also have demonstrated their ability to monitor thermal characteristics of the oceans and have discovered a close correlation between the location of fish and temperatures of the ocean -- knowledge which could dramatically increase the world's supply of high-protein general-purpose food. Lately, Nimbus III has been demonstrating new meteorological measurement techniques which atmospheric scientists believe may lead to reliable, long range weather predictions.

EARTH RESOURCES

NASA's Earth Resources program deals with the application of satellite information to transportation, agriculture, forestry, shipping, geology, and health.

"In agriculture and forestry," Mr. Fink says, "Earth Resources satellites could result in higher crop yields, rapid detection of plant and tree diseases, more accurate definition of irrigation requirements and quicker location of forest fires. There are similar benefits for the other resource areas."

The advantages of using an orbiting spacecraft to acquire earth resources data over use of conventional methods are reduced costs, reduced data acquistion times, more rapid and continuous observation, greater freedom from weather disturbances, better quality of data, and synoptic views of larger regions.

One of the Gemini flights demonstrated the value of this program. In less than three minutes a crew photographed 80 percent of Peru, producing a better mosaic of the region than any available map.

MEDICAL TECHNOLOGY

New high-speed dental drills, sensors which permit continuous monitoring of the heartbeats of patients in hospitals and use of computers to sharpen fuzzy X-Ray pictures -- all of these are by-products of space technology.

General Electric is developing means of drawing electrical power from the body. The use of bioelectric power, already accomplished

in the laboratory, is expected eventually to permit development of a human-radar mechanism for the blind, powered by the wearer's own body!

ELECTRONICS

It is estimated by the Stanford Research Institute that about 40 percent of the space technology which is making an impact on civilian life in the United States is in the electrical and electronics fields.

Micromin_aturization and solid state devices, for example, have contributed directly to the size, efficiency and reliability of many consumer products, such as radios and television sets.

Microsystems electronics also are found in computers that are now commercially-available.

There are other benefits coming from the space program, too. General Electric's Apollo Systems Organization applied their expertise in simulation work to the development of a simulated nuclear power plant control room. The simulated control room is used to train operators at GE's Boiling Water Reactor training center at Morris, Illinois.

General Electric, at its Mississippi Test Support Department, is working on socio-economic studies in five states. As a result of one study in Tennessee, which checked the economic feasiblity of opening manufacturing plants in areas of high unemployment, a zipper factory will soon open.

And a GE computed display system developed to simulate a Lunar landing or two spacecraft docking in space also has been programmed to teach people how to drive an automobile, or how to fly light aircraft. The device, which uses no models or drawings or pictures, creates three-dimensional images in color using only numbers which have been stored in a computer. Using the computed display it would be possible for an architect to design an urban renewal project and "walk through" it before the first foundation had been dug.

It is far too early to determine in terms of dollars and cents how much value the space program will have in our lives tomorrow, for there is a lag between the development of a new technology and its application to everyday problems. Sales of automobiles didn't top one million until 20 years after the car was developed, for example.

Nor is it possible to estimate just how far space technology will eventually take us.

Mr. Fink suggests we've just crossed the threshhold as far as space technology is concerned.

"Technological progress over the next ten years may make the past ten years look like the model T days of space history," he said.

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FOR IMMEDIATE RELEASE

CAPE KENNEDY, FLA. -- As many as 20,000 separate contractors have been involved in the Apollo program. One of the largest and most diverse of these contractors is the General Electric Company.

Over 6,000 General Electric employees in 26 locations provide support ranging from checkout of the spacecraft, booster and launch facilities to illumination of the instrument panels in the command and lunar modules and color TV transmission of the splashdown of Apollo.

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Pre-launch checkout systems, built by GE's Apollo Systems Organization in Daytona Beach, Fla., have already conducted thousands of tests on the Apollo 11 spacecraft, its Saturn launch vehicle and on the launch facilities themselves.

"Fourteen Apollo Systems ACE (Acceptance checkout Equipment) stations have tested the Apollo 11 spacecraft from factory to launch," G. T. Smiley, General Manager of Apollo Systems, said. "Each three-room ACE station comprises racks of equipment which conduct critical tests, acquire data, analyze findings and report on those findings. They are capable of checking all of the spacecraft's more than 3,000 test points automatically, receiving data at the rate of 200,000 bits per second."

Similar GE Apollo Systems equipment inspects all of the thousands of checkpoints on Saturn V's three stages; conducts all switching operations in the final three minutes of countdown; checks fueling of the Saturn stages; and controls communications, telemetry, water control and launch complex operations.

Another General Electric component, the Mississippi Test Support Department, operates and maintains the 25 square-mile NASA Mississippi Test Facility (MTF) near Bay St. Louis. According to J. R. Picard, General Manager of this GE Department, services provided NASA at MTF, proving ground for the first and second stages of the Apollo/Saturn V space vehicles, include range maintenance, systems modifications, central control and the transport, storage and transfer of cryogenic propellants and high-pressure gases.

The department also operates high-pressure water systems on the test stands, performs test and range data acquisition and processing, and operates the laboratories which provide electronics, instrumentation, materials, calibration, photographic, acoustic, and video services.

The Company's Information Systems Equipment Division in Phoenix, Arizona, provided two high-speed GE-635 multi-programming and multi-processing computers to conduct pre-launch checkout of the Saturn V launch vehicles on all Apollo missions and are key components in the post-flight reduction of data. During the final hours of countdown, the GE computers continuously monitor some 3,000 different valves and gauges on Saturn, checking them 12 times each second and flashing selective bits of data to any one or all of 30 display terminals--all in real time.

The Valley Forge, Pa., based GE Space Systems Organization has made two principal contributions to the Apollo program. Lee Farnham, General Manager of Space Systems said that a color TV transmission system, built and operated by GE for Western Union International, Inc., provides live color television coverage of all Apollo recoveries via satellite from the recovery carrier. And an isotope thermoelectric power system called SNAP-27 will provide electricity to power a package of experiments to be left on the surface of the Moon on the Apollo 12 mission this fall.

Neutrography service, a non-destructive testing technique similar to X-Ray but which reveals details which can not be seen

in X-Rays, is being used by contractors who supply components to the Apollo Project and is provided by the General Electric Irradiation Processing Operation in Pleasanton, Calif. Neutrography is used principally to inspect pyrotechnic devices such as the tension tie cutters which must separate the command module from the command service module prior to re-entry. The service is especially useful for inspecting explosive devices which contain high quantities of hydrogen but which appear transparent when X-Rayed.

Instrument panels aboard NASA's Apollo 11 command module and its piggyback Moon-exploring Lunar Module will glow with "moonlight" lamps manufactured by the General Electric Miniature Lamp Department in Cleveland, Ohio. The low-brightness electro-luminescent (EL) light sources are wafer thin and produce a brightness approximating moonglow. They were chosen for the job because they provide more visual comfort for the astronauts and because of their extreme ruggedness.

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CONTRIBUTIONS OF OTHER GE COMPONENTS

Other General Electric components, their locations and contributions were:

Component	Location	Contribution
Aerospace Electrical Equipment Department	Syracuse, N.Y.	Electrical control assemblies for LM
	Erie, Pa.	Hydraulic pump motor on Saturn II first stage
Aircraft Engine Group	Lynn, Mass.	Engines for Apollo recovery helicopters; and engines for Lunar Landing Training Vehicles.
	Evendale, Ohio	Ullage rocket motor cases for second stage of Saturn
Apparatus Service Shops Department	Chamblee, Ga.	Instrumentation repair
Capacitor Department	Irmo, S.C.	Capacitors used in Lunar and Command modules
Distribution Assemblies Department	Plainville, Conn.	Switchboards and panelboards used in ground support equipment

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Component	Location	Contribution
Distribution Protective Equipment Dept.	Pittsfield, Mass.	Emergency substation at Cape Kennedy
Distribution Transformer Department	Oakland, Calif.	Transformers aboard Essex provided power for TV coverage of Apollo 8 recovery.
Electronics Laboratory	Syracuse, N.Y.	Computed Display developed for NASA simulates space docking.
Industry Control Dept.	Salem, Va.	Controls for hoist systems at Redstone Arsenal, KSC Complex 39 and MTF.
Industry Sales and Engineering Operation	Schenectady, N.Y.	Engineered hoist systems at Redstone, KSC and MTF.
Insulating Materials Department	Schenectady, N.Y.	Insulating materials used in variety of applications at Kennedy Space Center.
Lamp Glass Dept.	Cleveland, Ohio	Meteor shield built for first Apollo mission.
Lamp Metals and Components	Cleveland, Ohio	Raw tungsten supplied for Apollo control jets.
Large DC Motor Business Section	Schenectady, N.Y.	Traction drives in crawler transporters at Cape Kennedy.
Lighting Systems Dept.	Hendersonville, N.C.	Interior lighting of Vertical Assembly Building (VAB) at Cape Kennedy.
Magnetic Materials Business Section	Edmore, Mich.	Thermistors for use in automatic exposure controls.

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Component	Location	Contribution
Marine Turbine and Gear Dept.	West Lynn, Mass.	Marine steam turbines and gears for Apollo 7 recovery ship, USS Essex.
Mechanical Drive Turbine Dept.	Fitchburg, Mass.	Generators for power on all Apollo instrumentation ships.
Medium AC Motor Dept.	Schenectady, N.Y.	Motor used in derrick at Redstone.
Mobile Radio Dept.	Lynchburg, Va.	Radios used by security and maintenance personnel at Kennedy Space Center.
Plastics Dept.	Pittsfield, Mass.	Lexan polycarbonate used in helmets worn by Apollo astronauts.
Power Transformer Dept.	Pittsfield, Mass.	Lightning protection studies at Cape Kennedy.
Semiconductor Products Dept.	Syracuse, N.Y.	Semiconductors used in Apollo spacecraft.
Small AC Motor Dept.	Schenectady, N.Y.	Motors in use at Redstone, Cape Kennedy and Miss. Test.
Speciality Control Dept.	Waynesboro, Va.	About 500 relays for use in Apollo spacecraft.
Speed Variator Dept.	Erie, Pa.	56 Max speed drive systems for derricks and cranes at Redstone, KSC and Miss. Test.

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Component	Location	Contribution
Tempo	Santa Barbara, Calif.	Twelve Apollo related studies. Former Tempo manager, Dr. Thomas O. Paine, now NASA Administrator.
Tube Department	Owensboro, Ky.	Video display devices in use at Houston Manned Space Flight Center Bethpage, N.Y. and Downey, Calif.
Visual Communication Products Dept.	Syracuse, N.Y.	Color TV cameras used by network crews on Apollo 8.
Wire and Cable Dept.	Bridgeport, Conn.	Electronic and power cable in three launch towers and VAB at Cape Kennedy

GENERAL ELECTRIC/APOLLO COMMUNICATORS

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ESE -- Checkout of Saturn Vehicle
LCCE -- Checkout of Launch Facilities

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SNAP-27 thermonuclear power system.
Color TV transmission system aboard
recovery aircraft carrier.

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Computer evaluation and checkout
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Computed display

MINATURE LAMP DEPARTMENT

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Lamps used in instrument panels aboard the command and lunar modules

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