It is a rare privilege to be able to accept an invitation in one's own home area — I've been all over the country and this is my first, & I hope not my last opportunity to talk in Phila.

III.6

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July 4th - Independence Day
Phila - a city of many great heritages - signing of Declaration of Independence - what a wonderful opportunity I have in discussing the exploration of Space - independence - etc

MANNED LAUNCH VEHICLE DEVELOPMENT

MAN HAS BARELY CROSSED OVER THE THRESHHOLD INTO SPACE, THE NEWEST AND LARGEST FRONTIER HE HAS EVER FACED. AS YET WE KNOW VERY LITTLE ABOUT MANNED TRAVEL IN THIS VAST ENVIRONMENT. EVEN OUR KNOWLEDGE ABOUT THE MOON IS MEAGER. SCIENTISTS HAVE ADVANCED MANY NOVEL AND CONFLICTING THEORIES RECENTLY ABOUT THE LUNAR SURFACE. DIFFERENT OBSERVERS HAVE SPECULATED THAT THE MOON'S SURFACE HAS A TEXTURE OF SOLID ROCK, ROCK FOAM, DUSTY COBWEBS, AND FUZZ AN INCH THICK. SOME SAY A SPACECRAFT WILL BOG DOWN AS IN SAND, OR POSSIBLE EVEN SINK OUT OF SIGHT. THE TRUTH OF THE MATTER IS THAT WE JUST DON'T REALLY KNOW.

THE STRUCTURE OF THE LUNAR SURFACE IS PROBABLY THE GREATEST UNKNOWN IN PROJECT APOLLO, AMERICA'S MANNED LUNAR LANDING PROGRAM. THE THEORIES I MENTIONED ARE BASED ON GROUND OBSERVATIONS AND FROM 240,000 MILES AWAY, AND CONJECTURE. WE PLAN TO OBTAIN DECISIVE INFORMATION BY SOFT LANDING INSTRUMENTS ON THE MOON BEFORE THE FIRST ASTRONAUTS BRING THEIR APOLLO SPACECRAFT TO REST ON ITS SURFACE.

OTHER PROBLEMS PILE UP OUR SURPLUS. THERE ARE PROBLEMS OF DESIGN, ENGINEERING, TESTING, QUALITY ASSURANCE, RELIABILITY, CHECKOUT AND LAUNCHING OF LAUNCH VEHICLE AND SPACECRAFT. THERE ARE PROBLEMS OF ACCURACY AND

SENSITIVITY OF GUIDANCE EQUIPMENT, CELESTIAL MECHANICS, AND TRAJECTORY OPTIMIZATION.

AND ONE OF THE MOST VITAL PROBLEMS IS TO KEEP THREE MEN IN HEALTHY AND ACTIVE CONDITION WHILE THEY ARE TRAVELING THROUGH AN ENVIRONMENT FOR WHICH THEY HAVE SIMPLY NOT BEEN CREATED. RADIATION, METEOROIDS, AND SOLAR FLARES CONSTITUTE HAZARDS TO THEIR WELL-BEING.

THE PROBLEMS SEEM SO NUMEROUS AND OVERRIDING TO SOME FOLKS THAT THEY THROW UP THEIR HANDS, AND SAY, "IT CAN'T BE DONE."

THERE WERE PEOPLE WHO SAID THAT ROBERT FULTON WOULD NEVER PROPEL A SHIP BY HITCHING A PADDLEWHEEL TO A STEAM BOILER. OTHERS SAID THAT HENRY FORD WAS FOOLISH FOR TRYING TO PUT A GASOLINE ENGINE ON WHEELS, AND THAT THE WRIGHT BROTHERS WERE CRAZY FOR PUTTING WINGS ON ONE.

FOLKS IN OUR OWN TIME HAVE SAID THAT PLANES WOULD NEVER BREAK THE SOUND BARRIER. AND THAT AN OBJECT PLACED IN SPACE WOULD NEVER SURVIVE THE "HEAT BARRIER" ENCOUNTERED ON RE-ENTRY INTO THE ATMOSPHERE. TODAY THEY ARE SAYING THAT AN ASTRONAUT CAN'T PASS THROUGH THE RADIATION BELTS SURROUNDING THE EARTH AND LIVE. OR THAT HIS SPACECRAFT WILL BE PUNCTURED BY TINY METEOROIDS SPEEDING THROUGH SPACE AT FANTASTIC SPEEDS. AND EVEN IF HE DOES ADJUST TO A WEIGHTLESS STATE FOR PROLONGED PERIODS, A SOLAR FLARE WILL GET HIM.

WELL, YOU KNOW THE ANSWER. MAN WILL SURMOUNT THESE OBSTACLES TO SPACE TRAVEL JUST AS HE HAS OVERCOME COUNTLESS OTHER PROBLEMS DURING HIS SLOW AND DIFFICULT PROGRESS UPWARD FROM CAVEMAN TO SPACEMAN. SPACE TRAVEL HAS LONG BEEN AN IMAGINATIVE DREAM OF MANKIND. NOW, FOR THE FIRST TIME, OUR SCIENCE, OUR TECHNOLOGY, AND OUR ECONOMY CAN SUPPORT THE

IMAGINATION OF THE PAST. BECAUSE WE CAN EXPLORE SPACE, WE MUST.

WE HAVE LEARNED A GREAT DEAL ABOUT THE EARTH AND OUR SOLAR SYSTEM DURING THE FIRST FIVE YEARS OF THE SPACE AGE, AND WE ARE LEARNING MORE EVERY DAY. THE UNITED STATES HAS LAUNCHED A VARIETY OF EARTH SATELLITES AND DEEP SPACE PROBES, AND HAS SHARED WITH THE WORLD THE INFORMATION GAINED ABOUT SPACE AND MAN'S ABILITY TO FUNCTION IN THIS NEW ENVIRONMENT.

THE RUSSIANS HAVE BEEN ABLE TO LAUNCH FAR LARGER PAYLOADS THAN THE UNITED STATES, BECAUSE THEIR LAUNCH VEHICLES WERE LARGER THAN OURS. WE HAVE MADE IMPRESSIVE PROGRESS IN LAUNCHING MANNED AND INSTRUMENTED PAYLOADS INTO SPACE. BUT WE HAD TO MAKE FOUR TIMES AS MANY LAUNCHES AS THE RUSSIANS TO GET THEM THERE. FOR A LONG TIME NASA HAS NEEDED MORE POWERFUL ROCKETS FOR HEAVIER EARTH SATELLITES, INSTRUMENTED DEEP SPACE PROBES, AND MANNED SPACE TRAVEL.

THIS NEED WILL BE MET BY THE SATURN FAMILY OF ROCKETS NOW UNDER DEVELOPMENT BY THE GEORGE C. MARSHALL SPACE FLIGHT CENTER AT HUNTSVILLE AND MANY ASSOCIATED INDUSTRIES. THE MARSHALL CENTER HAS A THREE-FOLD MISSION: DEVELOPMENT OF LAUNCH VEHICLES, CONDUCTING RELATED RESEARCH AND PERFORMING ADVANCE SYSTEM STUDIES FOR SPACE TRANSPORTATION CONCEPTS OF THE FUTURE. ALTHOUGH OUR CIVIL SERVICE PEOPLE AT MARSHALL HAVE YEARS OF EXPERIENCE IN ROCKETRY, WE RELY MOST HEAVILY UPON INDUSTRY FOR ASSISTANCE. IN FACT, DURING THE COMING FISCAL YEAR, 92 PER CENT OF THE DOLLARS WE RECEIVE WILL BE PASSED ON TO CONTRACTORS.

OUR PRIMARY MISSION AT THE MARSHALL CENTER FOR THE NEXT FEW YEARS IS PROVIDING SATURN VEHICLES FOR PROJECT APOLLO. THIS PROGRAM IS DIRECTLY SUPPORTED BY THREE NASA FIELD CENTERS: WE PROVIDE THE LAUNCH VEHICLES; THE MANNED SPACECRAFT CENTER AT HOUSTON TRAINS THE ASTRONAUTS AND PROVIDES THE SPACECRAFT; AND THE LAUNCH OPERATIONS CENTER AT CAPE CANAVERAL PROVIDES THE LAUNCH FACILITIES AND OPERATES NASA'S "MOONPORT."

INCIDENTALLY, BOB GILRUTH, DIRECTOR - NASA - MSC WAS ONCE ASKED IF HE PLANS ON USING WOMEN ASTRONAUTS IN THE MAN-IN-SPACE PROGRAM. WITH A STRAIGHT FACE, BOB REPLIED: "WELL WE ARE RESERVING 110 POUNDS FOR RECREATIONAL EQUIPMENT."

NOW, WITH THE AID OF SOME SLIDES, I WOULD LIKE TO DESCRIBE IN MORE DETAIL MARSHALL'S ROLE IN PROJECT APOLLO, AND THEN OUTLINE THE STEPS TO BE TAKEN IN THE LUNAR ORBITAL RENDEZVOUS METHOD OF LANDING ASTRONAUTS ON THE MOON AND RETURNING THEM SAFELY TO EARTH WITHIN THIS DECADE.

SLIDE 1 -- SATURN VEHICLES (IXaj)

THE THREE MEMBERS OF THE SATURN FAMILY ARE SATURN I, SATURN IB, AND SATURN V. THESE SATURNS WILL BE THE HEAVY-DUTY WORKHORSES FOR NASA'S PROGRAM OF SPACE EXPLORATION FOR THE NEXT DECADE. TO ILLUSTRATE THEIR WEIGHT-LIFTING CAPABILITIES, LET ME COMPARE THEM WITH CURRENT LAUNCH VEHICLES. THE MOST POWERFUL ROCKET NOW IN USE IS THE ATLAS-AGENA B, WHICH CAN LIFT 5,000 POUNDS INTO EARTH ORBIT.

JOHN GLENN'S MERCURY SPACECRAFT, WHICH WEIGHED ABOUT 3,000 POUNDS, WAS LAUNCHED BY A MODIFIED ATLAS D VEHICLE.

THE SATURN I WILL BE ABLE TO PLACE THE EQUIVALENT WEIGHT OF SEVEN JOHN GLENN CAPSULES INTO EARTH ORBIT; THE SATURN IB WILL LIFT THE EQUAL OF 11 GLEN CAPSULES, WHILE THE SATURN V, LARGEST LAUNCH VEHICLE NOW UNDER ACTUAL DEVELOPMENT BY NASA, WILL BE ABLE TO LIFT A PAYLOAD EQUAL IN WEIGHT

TO 80 MERCURY SPACECRAFT.

AS A COMPARISON TO EARTH REALITIES, THE SATURN V VEHICLE WILL BE POWERFUL ENOUGH TO TOSS THE EQUIVALENT OF ONE JET AIRLINER INTO A 300 NAUTICAL MILE ORBIT ABOVE THE EARTH, DRIVE A 40 TON LOAD TO THE VICINITY OF THE MOON AND SEND A _____ AIRLINE DC-3 AIRPLANE ALL THE WAY AROUND THE SUN. IT WILL BOOST A CHEVROLET OUT OF THE SOLAR SYSTEM AND IF DONE WOULD PROBABLY BE APPLAUDED BY THE FORD AND PLYMOUTH DISTRIBUTORS. I CAN'T PREDICT HOW FAR THE SATURN V CAN SEND A VOLKSWAGON.

SLIDE 2 -- SATURN I LAUNCH (M-PIO IA6c)

FURTHEST ALONG IN DEVELOPMENT OF THE THREE SATURNS IS THE SATURN I. THE FIRST FOUR RESEARCH AND DEVELOPMENT FIRINGS, SUCH AS THE ONE SHOWN HERE, HAVE BEEN HELD AT THE CAPE. EACH SUCCESS FURTHER DEMONSTRATED THE SOUNDNESS OF ENGINEERING DESIGN, AND PAID SPECTACULAR TRIBUTE TO THE PAINSTAKING EFFORTS OF THE SATURN TEAM TO OBTAIN THE MAXIMUM IN QUALITY ASSURANCE AND RELIABILITY IN MANUFACTURE, INSPECTION, TESTING, AND LAUNCHING.

SLIDE 3 -- H-1 ENGINE (M-PIO IXAk)

THE FIRST STAGE OF SATURN I IS POWERED BY A CLUSTER OF EIGHT H-1 ENGINES, BURNING LIQUID OXYGEN AND KEROSENE. THE H-1 EVOLVED FROM AN EARLIER 150,000-POUND THRUST ROCKETDYNE ENGINE USED SUCCESSFULLY IN THE JUPITER, THOR, AND ATLAS MISSILES. WITH IMPROVED PERFORMANCE, ALL EIGHT ENGINES PROVIDE A TOTAL OF 1.5 MILLION POUNDS OF THRUST FOR THE BOOSTER.

SLIDE 4 -- S-I STAGES UNDER FABRICATION (M-PIO IA2)

THE MARSHALL CENTER IS BUILDING EIGHT SATURN I BOOSTERS AT HUNTSVILLE FOR TEST FLIGHTS. THE CHRYSLER CORPORATION IS PRESENTLY UNDER CONTRACT TO BUILD 8 - 20 MORE OF THESE BOOSTER AT OUR MICHOUD PLANT IN NEW ORLEANS.

SLIDE 5 -- S-I STAGE ON WHEELED TRANSPORTER

HERE WE SEE A COMPLETED FIRST STAGE BEING TOWED A SHORT DISTANCE ON A SPECIALLY CONSTRUCTED WHEELED TRANSPORTER TO A STATIC TEST STAND AT THE MARSHALL CENTER. THE SIZE OF THIS BOOSTER, WHICH IS 21.5 FEET IN DIAMETER AND 82 FEET IN LENGTH, DEMANDS SPECIAL HANDLING.

SLIDE 6 -- STATIC FIRING OF S-I STAGE (M-PIO)

EACH BOOSTER UNDERGOES TWO OR THREE HOT PERFORMANCE TESTS AT THE MARSHALL CENTER. TO PREVENT THE FLAMING EXHAUSTS FROM MELTING THE METAL DEFLECTOR PLATES AT THE BASE OF THE TOWER, 40,000 GALLONS OF WATER PER MINUTE MUST BE PUMPED THROUGH TINY HOLES IN THE PLATES. THE FLAMES LITERALLY RIDE ON A CUSHION OF STEAM. DURING EACH STATIC TEST WE RECORD SOME 1,000 CHANNELS OF INFORMATION TO KEEP OUR FINGERS ON THE PULSE OF THIS INTRICATE MACHINE.

SLIDE 7 -- SATURN BARGE

BARGES TAKE THE STAGES BUILT AT HUNTSVILLE TO CAPE CANAVERAL FOR FLIGHT TESTING. THE BARGE GOES DOWN THE TENNESSEE, OHIO, AND MISSISSIPPI RIVERS TO THE GULF OF MEXICO, CIRCLES THE TIP OF THE FLORIDA PENINSULA, THEN GOES UP TO FLORIDA'S EAST COAST TO THE CAPE.

SLIDE 8 -- BOOSTER BEING ERECTED

HERE WE SEE A SATURN I IN THE SERVICE STRUCTURE AT THE CAPE. ONLY THE FIRST STAGES WERE LIVE DURING THE FIRST FOUR FLIGHT TESTS OF THE SATURN I. INERT UPPER STAGES WERE ADDED TO COMPLETE THE EXTERNAL CONFIGURATION, AND ABOUT 100 TONS OF WATER WAS CARRIED AS BALLAST TO SIMULATE FULL PROPELLANT LOADING.

SLIDE 9 -- SATURN I SECOND STAGE

THE SECOND STAGE OF THE SATURN I IS UNDER DEVELOPMENT BY THE DOUGLAS AIRCRAFT COMPANY AT SANTA MONICA, CALIFORNIA WITH TEST FIRINGS AT SACRAMENTO. THE SECOND STAGE WILL BE FLIGHT TESTED FOR THE FIRST TIME DURING THE FIFTH LAUNCH OF SATURN I, TO BE HELD LATER THIS YEAR AT THE CAPE. WE ARE LOOKING FORWARD EAGERLY TO THIS LAUNCH, FOR IT WILL BE A SIGNIFICANT MILESTONE IN THE SATURN I PROGRAM. SEVERAL FIRSTS WILL BE ACHIEVED.

IT WILL BE THE FIRST LAUNCH FROM NEW FACILITIES THAT MAKE UP LAUNCH COMPLEX 37, OUR SECOND SATURN LAUNCH AREA AT THE CAPE.

ENGINES IN THE BOOSTERS GENERATED 165,000 POUNDS OF THRUST EACH DURING THE FIRST FOUR FLIGHTS. NEXT TIME THEY WILL BE FLIGHT TESTED AT THEIR FULL-RATED CAPACITY OF 188,000 POUNDS EACH. THE BOOSTER WILL CARRY A FULL PROPELLANT LOAD OF 850,000 POUNDS, AND WILL BE PROGRAMED TO BURN FOR ABOUT 2-1/2 MINUTES.

THE SECOND STAGE WILL CARRY A FULL PROPELLANT LOAD OF ABOUT 100,000 POUNDS, AND WILL BURN FOR MORE THAN SEVEN MINUTES. THE SECOND STAGE WILL INJECT ITSELF, A GUIDANCE AND INSTRUMENTATION MODULE, AND A DUMMY PAYLOAD INTO AN ELLIPTICAL EARTH ORBIT. THE ENTIRE WEIGHT IN ORBIT WILL BE ABOUT 35,000 POUNDS. NO OBJECT THIS HEAVY HAS YET BEEN INJECTED INTO ORBIT FROM THE EARTH IN A SINGLE LAUNCH.

SLIDE 10 -- RL10 ENGINE

THE SECOND STAGE OF SATURN I HAS SIX 15,000-POUND THRUST RL10 ENGINES, DEVELOPED BY PRATT AND WHITNEY. THESE ENGINES USE THE NEW FUEL COMBINATION OF LIQUID OXYGEN AND LIQUID HYDROGEN, WHICH GIVES US ABOUT 40 PER CENT MORE THRUST PER POUND OF PROPELLANT THAN THE LIQUID OXYGEN/KEROSENE COMBINATION. MANY SEVERE MECHANICAL AND ENGINEERING

PROBLEMS HAD TO BE OVERCOME IN HANDLING THESE CRYOGENIC FUELS. AS YOU WILL REMEMBER, LIQUID OXYGEN BOILS AT -297 DEGREES FAHRENHEIT, AND LIQUID HYDROGEN AT -423 DEGREES.

SLIDE 11 -- SACRAMENTO TEST FACILITY, S-IV STAGE TEST

DOUGLAS HAS SUCCESSFULLY CONDUCTED NUMEROUS STATIC TESTS OF THE SIX ENGINES IN THE SECOND STAGE OF SATURN I AT THE SACRAMENTO TEST FACILITY YOU SEE HERE. SEVERAL TESTS HAVE BEEN MADE AT FULL THRUST FOR FULL FLIGHT DURATION--MORE THAN SEVEN MINUTES. AND PRATT & WHITNEY AIRCRAFT RECENTLY FIRED A SINGLE RL10 ENGINE CONTINUOUSLY FOR 28 MINUTES IN AN ENDURANCE TEST. WE BELIEVE WE ARE READY FOR FLIGHT TESTING, ALTHOUGH WE DO NOT HAVE TOO MUCH INFORMATION ON THE BEHAVIOR OF LIQUID HYDROGEN UNDER ZERO GRAVITY CONDITIONS, AND IN THE UPPER ATMOSPHERE, WHERE THE RL10 ENGINES WILL BE IGNITED. THE TEST FACILITY HERE ATTEMPTS TO SIMULATE THE NEAR-VACUUM CONDITIONS UNDER WHICH THE ENGINES WILL OPERATE. SIMULATION OF ALTITUDES OF ABOUT 13 MILES IS POSSIBLE DURING TESTS.

SLIDE 12 -- INSTRUMENT UNIT

THE SATURN I IS GUIDED ON ITS FLIGHT BY THE INSTRUMENTATION IN THESE PRESSURIZED CONTAINERS, WHICH SEND GUIDANCE AND SEQUENCING SIGNALS TO THE APPROPRIATE STAGES DURING POWERED FLIGHT. ON THE FIRST STAGE, THE FOUR INNER ENGINES ARE RIGIDLY MOUNTED, WHILE THE FOUR OUTER ONES ARE GIMBALLED FOR CONTROL. THE SECOND STAGE IS CONTROLLED BY GIMBALLING ALL SIX ENGINES.

THE GUIDANCE SYSTEM IS BASED ON SENSITIVE GYROS AND FAST COMPUTERS, SIMILAR TO THAT USED IN THE JUPITER MISSILE. THESE INSTRUMENTS CAN TELL IF THE VEHICLE IS MOVING OFF ITS PRE-PROGRAMMED COURSE, AND SEND ELECTRICAL SIGNALS TO HYDRAULIC PISTONS TO GIMBALL THE ENGINES.

THE VEHICLE STRUCTURE IS FLEXIBLE. IT BENDS, SWAYS, SWINGS, AND VIBRATES AS IT ACCELERATES. AND MOST OF THE WEIGHT OF THE ENTIRE VEHICLE--ABOUT 85 PER CENT--IS LIQUID. HAVE YOU EVER TRIED TO RUN WITH A WASH TUB HALF FULL OF WATER? THEN YOU KNOW HOW THE FUEL SLOSHES ABOUT. THE INSTRUMENT UNIT MUST KNOW IF THE VEHICLE IS REALLY OFF COURSE, OR WHETHER IT IS ONLY DOING A GIANT VERSION OF THE TWIST.

SLIDE 13 -- APOLLO SPACECRAFT (M-MS-G)

PAYLOADS FOR THE SATURN VEHICLES WILL BE APOLLO SPACECRAFT, PROVIDED BY THE MANNED SPACECRAFT CENTER. [THERE IS AN UNCONFIRMED STORY ABOUT ONE OF OUR ASTRONAUTS BEING ASKED BY A NEWSPAPER MAN HOW IT FELT TO BE IN ORBIT. HE REPLIED: "WELL, HOW DOES IT FEEL WHEN YOU KNOW YOUR LIFE DEPENDS ON 150,000 PARTS, ALL BOUGHT FROM THE LOWEST BIDDER?"]

THIS SPACECRAFT WILL BE COMPOSED OF THREE SEPARATE MODULES, EACH ONE OF WHICH WILL HAVE ITS OWN TASKS TO PERFORM. THE COMMAND MODULE, WHICH CARRIES THE THREE-MAN CREW, WILL SERVE AS A CONTROL CENTER FOR SPACECRAFT OPERATIONS. IT IS THE ONLY PART OF THE SPACECRAFT THAT RETURNS TO EARTH, AND IS DESIGNED TO RE-ENTER THE ATMOSPHERE AT A VELOCITY OF 25,000 MILES PER HOUR UPON RETURN FROM THE MOON. THE SERVICE MODULE WILL CONTAIN MANY OF THE SPACECRAFT'S LIFE SUPPORT SYSTEMS, AND A MAJOR PROPULSION SYSTEM FOR MISSION ABORT, MID-COURSE CORRECTIONS AND INJECTION INTO AND OUT OF LUNAR ORBIT. THE LUNAR EXCURSION MODULE, OR BUG, IS A SHUTTLE BUS FOR THE TWO MEN WHO WILL MAKE THE LUNAR LANDING.

SLIDE 14 -- APOLLO SPACECRAFT - MERCURY ATLAS (NASA M63-441)

THE THREE MODULES OF THE APOLLO SPACECRAFT, TOGETHER WITH A LAUNCH ESCAPE SYSTEM SIMILAR TO THAT USED IN PROJECT MERCURY, WILL STAND 80 FEET TALL. WHEN WE COMPARE THE SPACECRAFT WITH THE PROJECT MERCURY HARDWARE

AT THE RIGHT, WE SEE THAT THE APOLLO SPACECRAFT IS ALMOST AS TALL AS THE ATLAS LAUNCH VEHICLE, MERCURY SPACECRAFT, AND ESCAPE TOWER COMBINED.

SLIDE 15 -- APOLLO COMMAND MODULE (NASA M63-452)

THE COMMAND MODULE, WHICH HAS BEEN CONTRACTED BY HOUSTON TO NORTH AMERICAN AVIATION, INC., IS 13 FEET IN DIAMETER AND WEIGHS ABOUT FIVE TONS. IT WILL BE PROTECTED FROM THE HEAT OF RE-ENTRY BY A SPECIAL MATERIAL ON ITS BLUNT SIDE THAT ABLATES--OR BOILS TO A GAS--AT EXTREMELY HIGH TEMPERATURES.

SLIDE 16 -- INTERIOR OF APOLLO COMMAND MODULE (NASA M63-578)

HERE WE SEE THE INTERIOR OF THE COMMAND MODULE. THIS MODULE ALSO CONTAINS THE GUIDANCE AND NAVIGATION SYSTEM AND INSTRUMENTATION DISPLAYS FOR EQUIPMENT IN THE OTHER MODULES.

SLIDE 17 -- APOLLO SERVICE MODULE (NASA M63-483)

THE PROPULSION SYSTEM IN THE SERVICE MODULE WILL PROVIDE 22,000 POUNDS OF THRUST, ALMOST ONE-THIRD THAT OF THE REDSTONE MISSILE. THE SERVICE MODULE ALSO HAS AN ORIENTATION CONTROL SYSTEM, HYDROGEN-OXYGEN FUEL CELLS FOR ELECTRICAL POWER SUPPLY, RADIATORS FOR SPACECRAFT COOLING, AND SUPPLIES OF OXYGEN FOR THE LIFE-SUPPORT SYSTEM.

SLIDE 18 -- APOLLO LUNAR EXCURSION MODULE (NASA M63-457)

HOUSTON HAS CONTRACTED DEVELOPMENT OF THE LUNAR EXCURSION MODULE TO THE GRUMMAN AIRCRAFT ENGINEERING CORPORATION IN NEW YORK. THE BUG, AS IT IS OFTEN CALLED BECAUSE OF ITS ODD SHAPE AND EXTENDED LEGS, WEIGHS ABOUT 12 TONS. IT CONTAINS ITS OWN ELECTRICAL POWER, GUIDANCE AND CONTROL, COMMUNICATIONS, PROPULSION, AND SUPPORT SYSTEMS FOR A TWO-MAN CREW.

SLIDE 19 -- APOLLO SPACECRAFT TESTING (NASA M63-539)

WORK ON THE COMMAND SERVICE MODULES IS WELL ADVANCED, AND THE FIRST BOILERPLATE COMMAND MODULES HAVE BEEN MANUFACTURED AND TESTS ARE BEING MADE OF THEIR WATER-HANDLING QUALITIES, EARTH AND WATER IMPACTS, AND LANDINGS BY PARACHUTE. THIS PYRAMID SHOWS THE INTENSIVE TEST PROGRAM DESIGNED TO ASSURE THE UTMOST RELIABILITY OF COMPONENTS, SUBSYSTEMS, MODULES, AND THE COMPLETE SPACECRAFT. YOU WILL NOTICE THAT PROPULSION DEVELOPMENT AND TESTING WILL BE CARRIED OUT AT WHITE SANDS. HIGHLY TOXIC PROPELLANTS ARE BEING USED IN ALL THREE MODULES OF THE SPACECRAFT. NEW FACILITIES DESIGNED ESPECIALLY FOR HANDLING AND TESTING THEM ARE UNDER CONSTRUCTION AT THE WHITE SANDS MISSILE RANGE.

SLIDE 20 -- LAUNCH ESCAPE SYSTEM DEVELOPMENT (NASA M63-573)

THE LAUNCH ESCAPE SYSTEM WILL ALSO BE TESTED AT WHITE SANDS, BOTH IN PAD-ABORT TESTS, AND AT HIGHER ALTITUDES ON FLIGHTS POWERED BY LITTLE JOE II, A SPECIAL SOLID-PROPELLANT LAUNCH VEHICLE.

SLIDE 21 -- APOLLO SPACECRAFT

FIRST FLIGHT TESTS OF APOLLO BOILERPLATE SPACECRAFT WILL BE MADE IN 1964 FROM CAPE CANAVERAL, USING THE SATURN I VEHICLE. THE FIRST MANNED EARTH ORBITAL FLIGHTS, ALSO POWERED BY THE SATURN I, ARE SCHEDULED FOR 1965. ON THE FIRST MANNED FLIGHTS, THE SATURN I WILL ALLOW US TO FLY THE COMMAND AND SERVICE MODULES, AND THE SERVICE MODULE WILL CARRY A SMALL AMOUNT OF FUEL FOR EXERCISES IN MANEUVER. RE-ENTRY OF THE COMMAND MODULE FROM A LOW EARTH ORBIT WILL ALSO BE TESTED.

SLIDE 22 -- SATURN IB AND APOLLO SPACECRAFT

THE ENTIRE APOLLO SPACECRAFT, INCLUDING THE LUNAR EXCURSION MODULE, WILL BE TESTED IN EARTH ORBIT BY AN INTERIM LAUNCH VEHICLE DESIGNED ESPECIALLY FOR THIS PURPOSE -- THE SATURN IB. THE SATURN IB IS FORMED BY PLACING THE THIRD STAGE OF THE SATURN V ATOP THE FIRST STAGE OF THE SATURN I. THIS STAGE HAS ONE J-2 ENGINE THAT BURNS LIQUID HYDROGEN AND LIQUID OXYGEN TO PRODUCE 200,000 POUNDS OF THRUST. THIS WILL GIVE US A VEHICLE THAT WILL PLACE ABOUT 16 TONS INTO ORBIT, COMPARED WITH TEN TONS FOR THE SATURN I. ON THE SATURN IB FLIGHTS, WHICH ARE SCHEDULED TO BEGIN IN 1966, A PARTIAL FUEL SUPPLY WILL BE CARRIED IN BOTH THE SERVICE MODULE AND THE LUNAR EXCURSION MODULE. ON A LUNAR MISSION, THE THREE MODULES OF THE APOLLO SPACECRAFT ARE LAUNCHED IN THE POSITIONS SHOWN ON THIS SLIDE, WITH ALL THREE MEN IN THE COMMAND MODULE. ON THE WAY TO THE MOON, HOWEVER, THE COMMAND AND SERVICE MODULES SEPARATE FROM THE LUNAR EXCURSION MODULE, AND ARE RE-ORIENTED WITH ATTITUDE CONTROLS, TURNING 180 DEGREES, TO MATE NOSE-TO-NOSE WITH THE LUNAR EXCURSION MODULE. THIS PLACES THE EXHAUST NOZZLE OF THE PROPULSION SYSTEM IN THE SERVICE MODULE FORWARD, WHERE IT CAN BE FIRED FOR BRAKING THE SPACECRAFT INTO A LUNAR ORBIT. THIS SEPARATION AND DOCKING MANEUVER WILL BE PRACTICED IN EARTH ORBIT BEFORE A MANNED LUNAR LANDING IS ATTEMPTED.

SLIDE 23 -- ENGINES FOR MANNED FLIGHT (NASA M63-435)

SO FAR, I HAVE BEEN TALKING ABOUT LAUNCH VEHICLES FOR PLACING PAYLOADS INTO EARTH ORBIT AT SPEEDS OF ABOUT 18,000 MILES PER HOUR. FOR A TRIP TO THE MOON, THE APOLLO SPACECRAFT WILL HAVE TO REACH A SPEED OF 25,000 MILES TO OVERCOME THE GRAVITATIONAL FORCE OF THE EARTH. BACK IN 1958 THE JUNO II, WITH A FIRST STAGE BOOSTER THRUST OF 160,000 POUNDS, SENT A PAYLOAD PAST THE MOON. BUT OUR PIONEER IV WEIGHED ONLY 13.5 POUNDS, WHILE THE APOLLO SPACECRAFT WILL WEIGH 90,000 POUNDS. IT'S EASY TO SEE WHY LARGER ROCKETS WITH TREMENDOUSLY POWERFUL ENGINES ARE NEEDED. SATURN V, THE LAUNCH VEHICLE BEING DEVELOPED FOR THE LUNAR LANDING MISSION, WILL BE POWERED BY F-1 AND J-2 ENGINES.

SLIDE 24 -- SATURN V AND STATUE OF LIBERTY

MEASURING MORE THAN 350 FEET, THE THREE-STAGE SATURN V/APOLLO MOON ROCKET WILL STAND TALLER THAN THE STATUE OF LIBERTY. IT CAN HURL 45 TONS TO THE VICINITY OF THE MOON. THIS IS EQUAL TO THE WEIGHT OF ABOUT 25 STANDARD-SIZE FAMILY AUTOMOBILES.

SLIDE 25 -- SATURN V BOOSTER

THE FIRST STAGE OF THE SATURN V IS BEING DEVELOPED JOINTLY BY THE MARSHALL CENTER AND THE BOEING COMPANY. BOEING WILL MANUFACTURE BOOSTERS AT THE NASA-OWNED MICHOUD PLANT IN NEW ORLEANS. THE FIVE F-1 ENGINES IN THIS STAGE WILL PROVIDE A TOTAL STAGE THRUST OF 7 1/2 MILLION POUNDS. THIS IS ROUGHLY EQUIVALENT TO THE HORSEPOWER OF A STRING OF AUTOMOBILES STRETCHING BUMPER-TO-BUMPER FROM NEW YORK TO SEATTLE.

WHEN YOU SAY "FILL 'ER UP" YOU ARE ASKING FOR 4,400,000 POUNDS OF LIQUID OXYGEN AND KEROSENE TO BE PUMPED INTO THIS STAGE.

SLIDE 26 -- F-1 ENGINE (NASA M63-498)

THE F-1 IS THE LARGEST KEROSENE-FUELED ENGINE UNDER DEVELOPMENT IN THE FREE WORLD. HERE YOU SEE AN ENGINE, WHICH STANDS 18 FEET HIGH, IN THE ASSEMBLY AREA OF THE ROCKETDYNE PLANT AT CANOGA PARK, CALIFORNIA.

SLIDE 27 -- F-1 ENGINE FIRING (NASA M63-501)

ROCKETDYNE HAS STATIC FIRED THE F-1 ENGINE MORE THAN 250 TIMES. IN MORE THAN HALF A DOZEN OF THESE RECENT TESTS IT HAS DEMONSTRATED ITS FULL THRUST OF 1.5 MILLION POUNDS FOR OVER THE FULL 2 1/2 MINUTES OF OPERATION. IN DOING SO, IT CONSUMES THREE TONS OF FUEL PER SECOND.

SLIDE 28 -- S-II STAGE CUTAWAY

THE SECOND STAGE OF THE POWERFUL SATURN V IS BEING PRODUCED BY NORTH AMERICAN AVIATION AT DOWNEY AND SEAL BEACH, CALIFORNIA. STAGES FABRICATED IN CALIFORNIA WILL BE BROUGHT BY WATER THROUGH THE PANAMA CANAL TO A TEST SITE NOW UNDER CONSTRUCTION IN SOUTHERN MISSISSIPPI.

SLIDE 29 -- J-2 ENGINE

THE SECOND STAGE OF SATURN V WILL CLUSTER FIVE J-2 ENGINES, PRODUCING A TOTAL OF ONE MILLION POUNDS OF THRUST. ROCKETDYNE HAS CONDUCTED MORE THAN 140 STATIC FIRINGS OF THE J-2, PRIMARILY FOR INVESTIGATION AND DEVELOPMENT OF THE IGNITION SYSTEM AND FOR CHECKOUT OF THE PUMPS AND OTHER SUBCOMPONENTS.

SLIDE 30 -- S-IVB STAGE

A SINGLE J-2 ENGINE WILL BE USED IN THE THIRD STAGE OF SATURN V. THIS STAGE IS BEING DESIGNED AND DEVELOPED BY DOUGLAS AIRCRAFT COMPANY THE INSTRUMENT UNIT WILL BE CARRIED DIRECTLY ABOVE THE THIRD STAGE.

WE HOPE TO LAUNCH THE FIRST SATURN V WITHIN FIVE YEARS FROM THE TIME WE RECEIVED DEVELOPMENT APPROVAL. THE FIRST FLIGHT WILL CONSIST OF A LIVE FIRST STAGE, TWO INERT UPPER STAGES, AND AN UNMANNED DEVELOPMENTAL SPACECRAFT.

THE SECOND FLIGHT WILL USE LIVE FIRST AND SECOND STAGES AND WILL INCLUDE STAGE SEPARATION. ALL THREE STAGES WILL BE LIVE BEGINNING WITH THE THIRD VEHICLE LAUNCHED. THIS IS AN EXTREMELY ACCELERATED FLIGHT TEST PROGRAM, BUT THE COST OF VEHICLES OF THIS SIZE SEVERELY LIMITS THE NUMBER THAT MAY BE SCHEDULED IN A RESEARCH AND DEVELOPMENT PROGRAM.

SPACECRAFT EXPERIMENTS, SUCH AS HIGH-SPEED RE-ENTRY, WILL BEGIN WITH THE FOURTH LAUNCH. THE FIRST MANNED FLIGHT WITH THE SATURN V MAY OCCUR AS EARLY AS THE SEVENTH LAUNCH, NOW SCHEDULED DURING 1967.

SLIDE 31 -- VERTICAL ASSEMBLY BUILDING AT COMPLEX 39

AN ENTIRELY NEW CONCEPT IN LAUNCHING FACILITIES WILL BE USED IN THE SATURN V PROGRAM. HERETOFORE, THE DIFFERENT STAGES OF THE VEHICLE HAVE BEEN ASSEMBLED AT THE PAD, AND THE ENTIRE VEHICLE UNDERGOES A NECESSARY BUT LENGTHY CHECKOUT PROCESS. THIS LIMITS THE NUMBER OF FIRINGS THAT CAN BE MADE FROM ONE LAUNCH PAD, AND THE WORK OF MAKING THE CHANGES AND ADJUSTMENTS FREQUENTLY REQUIRED AS THE CHECKOUT PROCEEDS IS ACCOMPLISHED UNDER VERY DIFFICULT CONDITIONS.

IN THE SATURN V PROGRAM, THE DIFFERENT STAGES OF THE ROCKET AND THE SPACECRAFT ARE ASSEMBLED IN A LARGE BUILDING MORE THAN TWO MILES FROM THE LAUNCH PAD. THE VERTICAL ASSEMBLY BUILDING SHOWN HERE WILL BE ONE OF THE LARGEST BUILDINGS ON EARTH. THE HIGH BAY AREA WILL BE 524 FEET TALL, ABOUT AS HIGH AS THE WASHINGTON MONUMENT. THE BUILDING WILL CONTAIN ABOUT 128 MILLION CUBIC FEET. THIS IS ALMOST 1 1/2 TIMES THE CUBIC VOLUME OF THE PENTAGON, THE WORLD'S LARGEST OFFICE BUILDING.

SLIDE 32 -- CRAWLER VEHICLE

THE LAUNCH VEHICLE STAGES WILL ARRIVE BY BARGE, AND WILL BE ASSEMBLED ON A MOBILE LAUNCHER, ON WHICH A TOWER FOR UMBILICAL CONNECTIONS WILL BE MOUNTED. THE TOWER WILL BE 425 FEET TALL. THE PLATFORM WILL BE CONSIDERABLY LARGER THAN A STANDARD BASEBALL DIAMOND. WHEN ASSEMBLY IS COMPLETED, A CRAWLER-TYPE VEHICLE WILL MOVE TO THE BUILDING ON EIGHT TANK-TYPE TREADS. IT WILL BE DRIVEN BY ELECTRIC MOTORS POWERED BY DIESEL-DRIVEN GENERATORS. THE CRAWLER WILL PICK UP THE RACK WITH THE SATURN V, SPACECRAFT, AND THE UMBILICAL TOWER AND CARRY THEM OVER SPECIAL ROADWAYS TO THE LAUNCH PAD, WITH A STOP AT THE ARMING TOWER. THE LAUNCH VEHICLE AND SPACECRAFT SYSTEM INCLUDE SMALL AND MEDIUM-SIZED SOLID-PROPELLANT ROCKETS AND PYROTECHNIC DEVICES IN THE LAUNCH ESCAPE SYSTEM, FOR RETROGRADE PROPULSION ON RETURN FROM EARTH ORBIT, AND FOR STAGE SEPARATION. FOR REASONS OF SAFETY, THESE DEVICES MUST BE INSTALLED OUT OF DOORS. AT THE PAD, THE CRAWLER WILL LOWER THE RACK AND VEHICLE ONTO SUPPORT BLOCKS ON THE LAUNCH PLATFORM. THE FINAL STEP IN READYING FOR LAUNCH IS TO PUMP LIQUID FUELS INTO THE TANKS, FIRST THE STORABLE FUELS, AND THEN LIQUID OXYGEN AND LIQUID HYDROGEN.

SLIDE 33 -- SATURN V LAUNCH

AN ELEVATOR WILL CARRY THE THREE ASTRONAUTS, DRESSED IN THEIR SPACESUITS, TO THE LEVEL OF THE COMMAND MODULE, ABOUT 320 FEET ABOVE THE BASE OF THE SATURN V LAUNCH VEHICLE. THEY WILL CLIMB INTO THEIR POSITIONS, AND THE FINAL MINUTES AND SECONDS OF THE COUNTDOWN WILL TICK AWAY. AT IGNITION THE FIVE F-1 ENGINES OF THE FIRST STAGE WILL FLAME TO LIFE, GENERATING 7 1/2 MILLION POUNDS OF THRUST. THE HOLD-DOWN ARM WILL RELEASE THE SIX-MILLION POUND VEHICLE, AND IT WILL LIFT OFF FOR THE MOON.

SLIDE 34 -- LAUNCH TO INJECTION SEQUENCE

THE VEHICLE RISES ON AN ARCHING PATH OVER THE OCEAN. STEADILY INCREASING ACCELERATION WILL PLACE GREATER FORCE ON THE ASTRONAUTS, AND THEY WILL BE PUSHED BACK INTO THEIR COUCHES, FEELING APPARENT GRAVITY THAT RISES TO ABOUT 4 1/2 TIMES WHAT THEY EXPERIENCE ON EARTH. THE FIRST AND SECOND STAGES DROP AWAY AFTER CUTOFF, AND THE THIRD STAGE AND ATTACHED SPACECRAFT WILL GO INTO AN INCLINED EARTH ORBIT.

SLIDE 35 -- INJECTION INTO LUNAR TRAJECTORY

THE VEHICLE WILL CIRCLE THE EARTH ABOUT 1 1/2 TIMES IN A PARKING ORBIT, WHILE THE SPACECRAFT AND THE THIRD STAGE ARE CHECKED OUT, BY THE ASTRONAUTS THEMSELVES, AND FROM THE GROUND THROUGH TELEMETRY. IF ALL SYSTEMS ARE FUNCTIONING PROPERLY, THE THIRD STAGE WILL BE IGNITED AGAIN AT A MOMENT DETERMINED PRECISELY BY THE GUIDANCE SYSTEM. IT BURNS FOR ABOUT FIVE MINUTES TO REACH ESCAPE VELOCITY.

SLIDE 36 -- DOCKING AND THIRD STAGE SEPARATION (NASA M63-567)

THE ASTRONAUTS ARE NOW EXPERIENCING ZERO GRAVITY. NOW THE ADAPTER SURROUNDING THE LUNAR EXCURSION MODULE, OR BUG, IS SEPARATED. NEXT, THE COMMAND AND SERVICE MODULES WILL SEPARATE, LEAVING THE BUG ATTACHED TO THE THIRD STAGE. USING THE SERVICE MODULE PROPULSION SYSTEM, THE ASTRONAUTS WILL TURN THE COMMAND AND SERVICE MODULES AROUND AND DOCK, NOSE-TO-NOSE, WITH THE BUG. FINALLY, WHEN THE STRUCTURAL CONNECTION HAS BEEN ACCOMPLISHED, THE THIRD STAGE WILL BE SEPARATED.

YOU CAN IMAGINE HOW TRICKY THIS MANEUVER WILL BE IS YOU HAVE EVER TRIED TO GIVE A STALLED CAR A PUSH WITH THE FRONT BUMPER OF YOUR CAR. IF YOU ONCE GET THE CAR MOVING AND LOSE BUMPER CONTACT, YOU PRACTICALLY HAVE TO STOP TO BEGIN PUSHING AGAIN WITHOUT SOME NECK-JARRING BUMPING AND JOLTING.

SLIDE 37 -- ENTERING LUNAR ORBIT

DURING THE EARLY PHASES OF THE FLIGHT, THE ASTRONAUTS WILL TAKE STAR SIGHTS AND THE ON-BOARD GUIDANCE SYSTEM AND THE GROUND TRACKING SYSTEM WILL MEASURE ANY DEVIATION FROM THE DESIRED FLIGHT PATH. A NUMBER OF MID-COURSE MANEUVERS MAY BE REQUIRED TO PLACE THE SPACECRAFT INTO POSITION FOR BRAKING INTO A PRECISE CIRCULAR LUNAR ORBIT. AT THE PRECISE MOMENT, ABOUT 72 HOURS AFTER LEAVING THE EARTH, THE 22,000-POUND THRUST ENGINE IN THE SERVICE MODULE WILL BE IGNITED. BURNING FOR ABOUT SIX MINUTES, IT SLOWS THE SPACECRAFT ENOUGH TO PLACE IT IN AN ORBIT ABOUT 60 MILES ABOVE THE MOON'S SURFACE.

SLIDE 38 -- TRANSFER TO LEM (NASA M63-466)

IF ALL ELEMENTS OF THE SPACECRAFT ARE FOUND TO BE FUNCTIONING CORRECTLY AFTER ANOTHER CHECKOUT, TWO OF THE ASTRONAUTS WILL CLIMB THROUGH THE HATCH FROM THE COMMAND MODULE INTO THE LUNAR EXCURSION MODULE, AND IT WILL DETACH FROM THE COMMAND AND SERVICE MODULES.

SLIDE 39 -- LEM APPROACH ORBIT (NASA M63-976)

THE ENGINE OF THE BUG'S LANDING STAGE WILL BE IGNITED, BURNING FOR ABOUT HALF A MINUTE TO PLACE THE BUG IN AN ORBIT THAT WILL BRING IT WITHIN TEN MILES OF THE PRE-SELECTED LANDING SITE AT THE LOWEST POINT OF ORBIT. FROM THIS LOWER ALTITUDE, THE EXPLORERS CAN TAKE A LOOK AT THE LANDING SITE. IF FOR ANY REASON THEY DECIDE NOT TO ATTEMPT THE LANDING, THEIR ORBIT ASSURES THEM OF A RENDEZVOUS WITH THE MOTHER SPACECRAFT EVERY TWO HOURS.

SLIDE 40 -- LUNAR DESCENT AND LANDING

WHEN THE BUG REACHES THE TEN-MILE MINIMUM ALTITUDE OF ITS APPROACH ORBIT, IT WILL BE TRAVELING ABOUT 4,000 MILES PER HOUR IN RELATION TO THE MOON'S SURFACE. IF EVERTHING LOOKS OKAY FOR A LANDING, THE ENGINE IS IGNITED AGAIN TO SLOW THE LUNAR EXCURSION MODULE AND ALLOW IT TO DESCEND TOWARD THE SURFACE. THE ROCKET ENGINE CAN BE THROTTLED DOWN FROM ABOUT 8,800 POUNDS OF THRUST TO PERHAPS 1,100 POUNDS OF THRUST TO PERMIT THE CRAFT TO HOVER ABOVE THE LANDING SITE FOR A SHORT TIME. IT CAN MANEUVER HORIZONTALLY AS MUCH AS 1,000 FEET UNTIL IT IS DIRECTLY ABOVE THE DESIRED LANDING POINT.

SLIDE 41 -- LUNAR TOUCHDOWN (NASA M63-576)

THE CRAFT WILL THEN DESCEND SLOWLY TO THE SURFACE AND TOUCH DOWN AT A SPEED OF LESS THAN SEVEN MILES AN HOUR. DURING THE TOUCHDOWN MANEUVER, THE COMMAND MODULE, ORBITING THE MOON WITH THE THIRD ASTRONAUT AT THE CONTROLS, WILL ALWAYS BE WITHIN LINE OF SIGHT OF THE BUG.

WHEN THE FIRST ASTRONAUT STEPS FROM THE LUNAR EXCURSION MODULE AND SETS FOOT ON THE MOON, IT WILL TRANSCEND IN SIGNIFICANCE THE DISCOVERY OF ANY OCEAN OR CONTINENT HERE ON EARTH.

SLIDE 42 -- LUNAR EXPLORATION

MANNED EXPLORATION OF THE MOON IS A LOGICAL EXTENSION OF UNMANNED LUNAR EXPLORATION. MAN'S JUDGMENT AND ABILITY TO MAKE UNSCHEDULED OBSERVATIONS MAKE HIM A VALUABLE MEANS OF GATHERING SCIENTIFIC INFORMATION. AFTER THE LANDING, THE TWO EXPLORERS WILL FIRST CHECK OUT THE LUNAR EXCURSION MODULE FOR THE RETURN FLIGHT. ONE OF THE TWO ASTRONAUTS WILL THEN LEAVE THE BUG AND EXPLORE THE LUNAR SURFACE IN THE IMMEDIATE VICINITY OF THE LANDING SITE. HE WILL COLLECT AND PREPARE SAMPLES FOR RETURN TO EARTH, AND PHOTOGRAPH THE SURROUNDING AREA. HE MAY EMPLACE EXPERIEMENTS THAT CAN CONTINUE TO FUNCTION AFTER THE CREW HAS LEFT THE MOON. AFTER FOUR HOURS, THE TWO EXPLORERS WILL CHANGE POSITIONS AND THE OTHER ASTRONAUT WILL CONTINUE THE EXPLORATION. ON THE FIRST MISSION, THE TOTAL LENGTH OF STAY WILL PROBABLY BE ABOUT 24 HOURS.

SLIDE 43 -- LUNAR LIFTOFF

AFTER COMPLETING THEIR EXPLORATION AND GETTING A NIGHT'S SLEEP, THE TWO EXPLORERS WILL BEGIN THE COUNTDOWN FOR LAUNCH FROM THE MOON, WHICH WILL TAKE PLACE WHEN THE COMMAND MODULE IS IN LINE OF SIGHT OVER THE HORIZON. THE RETURN STAGE OF THE LUNAR EXCURSION MODULE WILL SEPARATE AND LIFT OFF FROM THE LANDING STAGE, LEAVING IT ON THE MOON, A SORT OF LUNAR CAPE CANAVERAL. ITS 3,000-POUND THRUST ENGINE WILL BURN FOR ABOUT SIX MINUTES, BOOSTING THE CRAFT TO A SPEED OF ABOUT 4,000 MILES AN HOUR, AT AN ALTITUDE OF 10 MILES. RADARS ABOARD BOTH THE COMMAND MODULE AND THE BUG TRACK EACH OTHER.

THE BUG'S ENGINE WILL MAKE ANY MAJOR COURSE CORRECTIONS NEEDED TO ASSURE THE RENDEZVOUS.

SLIDE 44 -- LIFTOFF, RENDEZVOUS, AND RETURN TO EARTH

ABOUT AN HOUR AFTER LIFTOFF, AFTER BOTH SPACECRAFT HAVE COASTED HALFWAY AROUND THE MOON, THEY WILL BE QUITE CLOSE TOGETHER, AND THE RELATIVE DIFFERENCE IN THEIR SPEEDS WILL BE ABOUT 70 MILES AN HOUR. WHEN THEY ARE ABOUT FIVE MILES APART, THE BUG'S GUIDANCE SYSTEM WILL COMMAND ITS ENGINE TO BRING IT CLOSER TO THE MOTHER CRAFT. WHEN THE DISTANCE HAS BEEN REDUCED TO A FEW HUNDRED FEET, THE TWO ASTRONAUTS IN THE BUG WILL TAKE OVER THE CONTROLS, AND COMPLETE THE DOCKING MANEUVER. ONCE THE EXPLORERS HAVE CLIMBED BACK ABOARD THE COMMAND MODULE, THE BUG IS DETACHED AND LEFT IN LUNAR ORBIT. NEXT, THE SERVICE MODULE ENGINE WILL BE IGNITED. IT WILL BURN FOR ABOUT 2 1/2 MINUTES TO GAIN AN ADDITIONAL VELOCITY OF 2,000 MILES AN HOUR THAT WILL BREAK THE SPACECRAFT OUT OF LUNAR ORBIT AND SPEED IT ON THE HOMEWARD JOURNEY.

SLIDE 45 -- RE-ENTRY CORRIDOR

ON THE RETURN TO EARTH, A VERY PRECISE TRAJECTORY MUST BE FLOWN TO BRING THE SPACECRAFT INTO POSITION FOR A 25,000 MILE-PER-HOUR RE-ENTRY. TOO SHALLOW AN APPROACH, AND THE EARTH WILL BE MISSED ENTIRELY. TOO STEEP AN APPROACH, AND THE SPACECRAFT WILL PLUNGE DIRECTLY INTO THE ATMOSPHERE. WHEN MID-COURSE CORRECTIONS AND FINAL FLIGHT PATH ADJUSTMENTS HAVE BEEN COMPLETED TO ASSURE HITTING THE 40-MILE RE-ENTRY CORRIDOR, THE SERVICE MODULE WILL BE DISCARDED, AND THE COMMAND MODULE WILL BE ORIENTED FOR RE-ENTRY. THIS MANEUVER CAN BE LIKENED TO A MAN RUNNING BETWEEN THE POSTS OF THE GOAL AT ONE END OF A FOOTBALL FIELD FIRING A .22 CALIBER RIFLE AT A MOVING NICKLE AT THE OTHER END OF THE FIELD. ITS A MIGHTY TOUGH TARGET TO HIT.

SLIDE 46 -- RE-ENTRY

THE ANGLE OF ATTACK AT RE-ENTRY WILL BE ABOUT 30 DEGREES. HEATING RATES SEVERAL TIMES THOSE EXPERIENCED DURING PROJECT MERCURY MAY BE ENCOUNTERED. BY THE TIME THE FIRST APOLLO FLIGHT IS MADE, WE HOPE TO BE ABLE TO OVERCOME THE IONIZATION PROBLEM THAT BLACKED OUT COMMUNICATIONS DURING PROJECT MERCURY RE-ENTRIES.

SLIDE 47 -- DESCENT

ONCE THE MAIN AERODYNAMIC DECELERATION HAS TAKEN PLACE, AND THE COMMAND MODULE HAS BEEN SLOWED TO BELOW THE SPEED OF SOUND, THREE 85-FOOT PARACHUTES WILL BE DEPLOYED, FLOATING THE COMMAND MODULE TO REST ON THE EARTH'S SURFACE. SEVERAL WESTERN PLAIN STATES ARE BEING CONSIDERED BY THE MANNED SPACECRAFT CENTER FOR THE LANDING SITE. A FLAT AREA WITH GOOD VISIBILITY IS NEEDED, FREE OF THE RESTRICTIONS POSED BY A DENSE POPULATION.

SLIDE 48 -- RECOVERY

RADAR AND OPTICAL INSTRUMENTS TRACK THE CAPSULE TO THE PREDESIGNATED LANDING AREA. THE ASTRONAUTS WILL AIM FOR AN AREA THE SIZE OF A LARGE AIRPORT. DURING RE-ENTRY, THE OFFSET CENTER OF GRAVITY OF THE COMMAND MODULE WILL PROVIDE A LIFT-TO-DRAG RATIO OF ABOUT 0.5. THIS WILL PERMIT MANEUVERING THE COMMAND MODULE THROUGH PART OF ITS DESCENT THROUGH THE ATMOSPHERE.

RECOVERY TEAMS ARE SOON ON HAND TO PICK UP THE THREE EPIC EXPLORERS. AND NOW COMES ONE OF THE MOST FORMIDABLE HAZARDS OF THE TRIP--THE PRESS CONFERENCE.

LIGHTS ON

THE JOURNEY WHICH I HAVE JUST DESCRIBED WILL TAKE PLACE BEFORE THE END OF THIS DECADE. UNTIL JUST A FEW YEARS AGO, IT WAS CONSIDERED IMPOSSIBLE. THE MOON WAS REGARDED AS THE EXCLUSIVE PROPERTY OF ASTRONOMERS, POETS, DREAMERS, AND YOUNG LOVERS. NOW TWO STRONG NATIONS ARE TRYING TO SET FOOT ON THIS DISTANT FRONTIER, AND TO EXPLORE THE SPACE ABOUT US.

MAN HAS AN INSATIABLE CURIOSITY TO LEARN EVERYTHING POSSIBLE ABOUT HIMSELF AND THE UNIVERSE, TO EXPLORE NEW REGIONS, TO IMPROVE THE PAST. HIS CURIOSITY HAS OFTEN BEEN THE MEASURE OF HIS PROGRESS. THE RESULTS OF SCIENTIFIC INQUIRY CAN SELDOM BE FORETOLD WITH ACCURACY. BUT HISTORY TEACHES THAT IT ALWAYS PAYS, OFTEN IN THE MOST UNEXPECTED MANNER, TO PROVE THE MYSTERIES OF THE UNIVERSE ABOUT US.

SOME PEOPLE HAVE BEEN SLOW TO ACCEPT THE ADVENT OF THE SPACE AGE. I AM REMINDED OF THE TWO CATERPILLARS WHO WERE CRAWLING ALONG THE GROUND ONE DAY, WHEN THEY SAW A BUTTERFLY FLUTTERING ALONG OVERHEAD. ONE OF THE CATERPILLARS LOOKED UP AND SAID, "THEY'LL NEVER GET ME UP IN ONE OF THOSE THINGS."

WHILE SOME OF OUR ADULTS HAVE BEEN DRAGGED SCREAMING INTO THE SPACE AGE, I HAVE FOUND THAT MOST YOUNG PEOPLE ACCEPT IT EAGERLY. STUDENTS, MORE THAN ANY OTHER AGE GROUP, SEEM TO RECOGNIZE THE SWIFTNESS AND DEPTH OF THE REVOLUTIONARY CHANGES THAT ARE SWEEPING THE WORLD.

THEY ARE STIMULATED BY THESE CHANGES, THAT ARE BROUGHT ABOUT BY THE EXPANSION OF KNOWLEDGE ON EVERY FRONTIER.

STUDENTS HAVE THEIR EYES ON THE FUTURE. WHAT GREAT WONDERS DOES IT HOLD IN STORE FOR US? NO ONE CAN ACCURATELY FORETELL, BUT ONE THING IS CERTAIN: TODAY'S PREDICTIONS WILL BECOME TOMORROW'S ACCOMPLISHMENTS.

AS JULES VERNE, WHO WROTE A FICTIONAL STORY OF A TRIP TO THE MOON A CENTURY AGO, SAID: "ANYTHING ONE MAN CAN IMAGINE, OTHER MEN CAN MAKE REAL."

(SEE NOTES AS TO "QUESTION & ANSWER" PERIOD AND SATURN V PROGRESS FILMS)

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Buzz 2 films for 16mm Saturn Recap film.
Turn over question period to Sue Ivemann Lee.