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FEBRUARY 19, 1974

STATEMENT OF
DALE D. MYERS

ASSOCIATE ADMINISTRATOR FOR MANNED SPACE FLIGHT
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BEFORE THE

MANNED SPACE FLIGHT SUBCOMMITTEE

OF THE

COMMITTEE ON SCIENCE AND ASTRONAUTICS

HOUSE OF REPRESENTATIVES

FISCAL YEAR 1975

Thanked for support during 4 yrs. Intro. Pete as his replacement.

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE:

I APPEAR HERE TODAY AS A REPRESENTATIVE OF A VERY PROUD SKYLAB TEAM, HEADED BY MR. WILLIAM SCHNEIDER, (ML 73-6596) THAT HAS JUST COMPLETED THE FLIGHT PHASE OF ONE OF THE HISTORIC EVENTS OF OUR TIME. WHILE IT IS TRUE THAT SKYLAB DID NOT ENGENDER THE EMOTIONALISM OF THE FIRST LANDING ON THE MOON, IN ITS OWN WAY IT DID MORE. FOR YEARS, THE SKYLAB PROGRAM WAS ALL BUT HIDDEN BY THE EXCITEMENT OF APOLLO. THOSE WHO LABORED IN THE PROGRAM WERE DEDICATED TO THE THOUGHT THAT SPACE WAS THERE TO BE USED AS WELL AS EXPLORED AND THEY DEVELOPED A SET OF TASKS TO PROVE THEIR HYPOTHESES BY DEMONSTRATION. THAT THEY WERE RIGHT HAS NOW BEEN PROVEN CONCLUSIVELY, FOR THE RESULTS OF SKYLAB HAVE FAR EXCEEDED OUR EXPECTATIONS. LATER, DURING THESE HEARINGS YOU WILL HEAR TESTIMONY FROM SOME OF THE PEOPLE DIRECTLY INVOLVED AS WE DISCUSS THE PRELIMINARY FINDINGS RESULTING FROM OUR SOLAR OBSERVATIONS, OUR EARTH RESOURCES EXPERIMENT PACKAGE, OUR SPACE PROCESSING EXPERIMENTS, AND OUR STUDIES OF THE MEDICAL IMPLICATIONS OF MEN LIVING AND WORKING IN SPACE FOR EXTENDED PERIODS.

I THINK THE MOST EXCITING THING ABOUT SKYLAB IS THAT THE POTENTIAL FOR THE FUTURE HAS BEEN EFFECTIVELY DEMONSTRATED. TWO YEARS AGO, THIS COUNTRY COMMITTED ITSELF TO BUILD A

SPACE SHUTTLE ON THE PREMISE THAT INDEED WE COULD DO PRACTICAL THINGS IN SPACE. THIS PREMISE WAS BASED ON AN EXTRAPOLATION OF WHAT WE HAD LEARNED IN MERCURY, GEMINI AND APOLLO AND WHAT WE HAD LEARNED IN THE UNMANNED PROGRAMS, SUCH AS NIMBUS, TIROS, AND OSO. BUT IT REMAINED FOR SKYLAB TO PUT OUR EXPECTATIONS TO THE TEST. THIS IT DID ADMIRABLY AND IN SO DOING SKYLAB CONFIRMED THE WISDOM OF THE SHUTTLE DECISION AND THE WISDOM OF THIS COMMITTEE AND THE CONGRESS IN SUPPORTING THE SHUTTLE PROGRAM WHICH IS THE CORNERSTONE OF OUR NATIONAL SPACE EFFORTS IN THE 1980'S. USE OF SPACE IS PRACTICAL AND ITS POTENTIAL CAN NOW BE SEEN MUCH MORE CLEARLY, THANKS TO SKYLAB.

I SAID A MOMENT AGO THAT YOUR COMMITTEE WILL HEAR TESTIMONY FROM PEOPLE DIRECTLY INVOLVED IN SKYLAB SO I WILL NOT UNDERTAKE A LENGTHY DISCUSSION AT THIS TIME. I WOULD LIKE, HOWEVER, TO HIT SOME OF THE HIGHLIGHTS.

YOU ARE FAMILIAR WITH THE PROBLEMS WE ENCOUNTERED IN SKYLAB. PROBLEMS THAT WERE OVERCOME THROUGH THE INGENIOUS EFFORTS OF THE CREWS ON-ORBIT AND THE SUPPORT TEAMS ON THE GROUND. IF EVER A CASE FOR THE NEED FOR MAN IN SPACE WAS DEVELOPED, IT WAS IN SKYLAB. IT WAS NOT ONLY THAT HE PROVED TO BE A "MR. FIX-IT", IT ALSO PROVED THAT HE COULD ADAPT AND DO USEFUL

WORK AT A MUCH HIGHER RATE THAN WE HAD PREVIOUSLY ESTIMATED. HE WAS AMONG OTHER THINGS AN ASTRONOMER, AN OBSERVER, AND A SPACE MANUFACTURER. PROBABLY MORE IMPORTANT, HE PROVED THAT SPACE IS AN IMPORTANT ARENA TO DO THINGS IN. MANY OF THE SIGNIFICANT RESULTS OF THE SKYLAB EXPERIMENTS WON'T BE KNOWN FOR MONTHS OR EVEN YEARS, BUT WE CAN ALREADY SAY WITH CONVICTION THAT SKYLAB OPENED UP A NEW ERA, FOR INSTANCE, IN ASTRONOMY. THE SOLAR TELESCOPES, OPERATING IN SPACE, UNHAMPERED BY ATMOSPHERIC DISTORTIONS, PROVIDED A WHOLE NEW INSIGHT INTO THE SUN AND ITS RELATION TO US HERE ON EARTH. THE DATA OBTAINED, AND I MIGHT ADD, PARENTHETICALLY, THAT WE GOT SIGNIFICANTLY MORE THAN WE EVERY IMAGINED WE WOULD, PROMISES TO REVOLUTIONIZE MANY LONG STANDING THEORIES OF SOLAR PHYSICS AND COULD WELL LEAD TO THE MEANS TO CONTROL AND USE A PORTION OF THE ENORMOUS AMOUNTS OF SOLAR ENERGY THAT EXISTS.

BUT THE OBSERVATIONS ON SKYLAB DID NOT ONLY LOOK UP AND OUT, THEY ALSO LOOKED DOWN. THE EARTH RESOURCES EXPERIMENT PACKAGE PROVIDED US WITH A WEALTH OF DATA ABOUT THE EARTH - ITS LANDS, ITS WATERS, ITS RESOURCES AND ITS PROBLEMS OF POLLUTION, OF INFESTATIONS AND OF DROUGHT. WE EXPECT TO LEARN MUCH FROM THIS DATA EVEN THOUGH THE EARTH RESOURCES PACKAGE WAS PRIMARILY AN EXPERIMENT TO HELP DEFINE THE

BEST SENSOR DESIGNS FOR FUTURE USE IN EARTH ORBIT AND TO HELP DEFINE MAN'S ROLE IN THE SURVEYS. AND WHAT WE LEARN, IN MY VIEW, WILL SHOW THAT THE SHUTTLE ERA DOES HOLD GREAT PROMISE FOR ROUTINE EARTH OBSERVATIONS, USING BOTH SATELLITES AND MAN-TENDED SENSORS.

ONE OF THE MOST EXCITING THINGS TO COME OUT OF THE SKYLAB PROGRAM WAS THE RESULTS OF OUR MATERIAL PROCESSING EXPERIMENTS IN SPACE. THE EXPERIMENTS WERE DESIGNED TO EXPLORE THE EXPECTED FAVORABLE EFFECT OF ZERO GRAVITY ON THE MANUFACTURE OF METAL ALLOYS, COMPOSITES, AND CRYSTALS. ON THE BASIS OF PRELIMINARY RESULTS, ZERO "G" INDEED IS BENEFICIAL. INITIAL ANALYSES SHOW THAT THE SIZE AND HOMOGENEITY OF CRYSTALS GROWN ON SKYLAB GREATLY SURPASSED THOSE GROWN ON EARTH. SHOULD OUR PRELIMINARY CONCLUSIONS BE CONFIRMED, I CAN VISUALIZE THAT WE MIGHT WELL MANUFACTURE CRYSTALS ON A PROFITABLE BASIS ON REGULAR SHUTTLE FLIGHTS. THERE ARE ALSO INDICATIONS THAT ZERO GRAVITY CONDITIONS PERMIT FORMATION OF METAL ALLOYS WITH HIGHER STRENGTH AND BETTER PROPERTIES THAN THOSE NOW MADE ON EARTH.

ANOTHER SIGNIFICANT THING PROVEN BY SKYLAB WAS THAT PROLONGED EXPOSURE TO A SPACE ENVIRONMENT IS NOT AS HOSTILE TO MAN AS MANY BELIEVED. WITH SKYLAB, WE INCREASED BY SIXFOLD OUR LONGEST DURATION MEDICAL EXPERIENCE IN ORBIT, SINCE THE

FIRST TWO VISITS TO THE WORKSHOP PROVIDED US WITH ENOUGH INSIGHT TO LENGTHEN THE LAST MISSION TO EIGHTY-FIVE DAYS. THE U.S. TOTAL MAN-HOURS IN SPACE HAVE MORE THAN DOUBLED WITH THE ADDITION OF SKYLAB TO OUR PRIOR MERCURY, GEMINI AND APOLLO EXPERIENCES.

IN SUMMARY, I CONSIDER THE SKYLAB PROGRAM AN OUTSTANDING SUCCESS. ALL OUR MAJOR GOALS WERE NOT ONLY MET - THEY WERE BETTERED. IN SOLAR ASTRONOMY, FOR EXAMPLE, OUR VIEWING TIME WAS 30% ABOVE THAT ORIGINALLY PLANNED. MUCH THE SAME IS TRUE OF OUR EARTH SURVEY TIME AND COVERAGES. THAT MAN BELONGS IN SPACE AND THAT USEFUL WORK CAN BE DONE WAS DRAMATICALLY DEMONSTRATED.

I'D LIKE TO QUOTE DR. LEO GOLDBERG, WHO IS THE DIRECTOR OF THE KITT PEAK NATIONAL OBSERVATORY, TUCSON, ARIZONA, AND THE PRESIDENT OF THE INTERNATIONAL ASTRONOMICAL UNION: (QUOTE) I WANT TO EXPRESS MY APPRECIATION TO THE ENTIRE NASA ORGANIZATION FOR THE WONDERFUL HELP AND COOPERATION THAT MADE IT POSSIBLE FOR 'ASTRONOMERS TO GET TO HEAVEN WITHOUT THE USUAL UNPLEASANT PRELIMINARIES.' I PARTICULARLY WANT TO PAY TRIBUTE TO THE NINE ASTRONAUTS ON THE THREE SKYLAB MISSIONS--CONRAD, KERWIN, WEITZ, BEAN, LOUSMA, CARR, POGUE, AND MY FELLOW SOLAR PHYSICISTS GARRIOTT AND GIBSON. MANY OF US HAD SERIOUS DOUBTS ABOUT THE SCIENTIFIC USEFULNESS OF MEN-IN-SPACE, ESPECIALLY

IN A MISSION SUCH AS ATM, WHICH WAS NOT DESIGNED TO TAKE ADVANTAGE OF MAN'S CAPABILITY TO REPAIR AND MAINTAIN EQUIPMENT IN SPACE. BUT THESE MEN PERFORMED NEAR MIRACLES IN TRANSFORMING THE MISSION FROM NEAR RUIN TO TOTAL PERFECTION. BY THEIR RIGOROUS PREPARATION AND TRAINING AND ENTHUSIASTIC DEVOTION TO THE SCIENTIFIC GOALS OF THE MISSION THEY HAVE PROVEN THE VALUE OF MEN IN SPACE AS TRUE-SCIENTIFIC PARTNERS IN SPACE SCIENCE RESEARCH. (END OF QUOTE) THE SKYLAB TEAM IS NOW BEING REASSIGNED TO OTHER NASA PROGRAMS, SUCH AS THE SHUTTLE; AND AGAIN, THIS NATION HAS REACHED ANOTHER NEW PLATEAU OF KNOWLEDGE ABOUT THE PEACEFUL USE OF SPACE.

NOW WITH THE CHAIRMAN'S PERMISSION, I WOULD LIKE TO BRIEFLY REVIEW EACH OF THE MANNED SPACE FLIGHT PROGRAM ELEMENTS. FOR THE SPACE SHUTTLE (MH 74-5020) WE ARE REQUESTING EIGHT HUNDRED MILLION DOLLARS ($800 MILLION) FOR FISCAL YEAR 1975 TO CARRY ON WHERE THE SKYLAB PROGRAM HAS LEFT OFF.

SHUTTLE ORBITER VG. 1-7-74

WE HAVE MADE TREMENDOUS PROGRESS IN THE SHUTTLE PROGRAM SINCE WE LAST APPEARED BEFORE YOU. ONE YEAR AGO WE REPORTED THAT WE HAD TWO OF OUR FOUR PRIME CONTRACTORS ON BOARD - THE SPACE DIVISION OF ROCKWELL INTERNATIONAL FOR THE ORBITER AND THE ROCKETDYNE DIVISION OF ROCKWELL INTERNATIONAL FOR THE MAIN ENGINE AND FIVE OF OUR MAJOR SUBCONTRACTORS, TWO ON THE ENGINE AND THREE ON THE ORBITER. TODAY, ALL FOUR OF OUR PRIME CONTRACTORS HAVE BEEN SELECTED. LAST AUGUST THE MARTIN MARIETTA CORPORATION WAS SELECTED FOR THE EXTERNAL TANK, AND IN DECEMBER THE THIOKOL CHEMICAL CORPORATION WAS CHOSEN FOR

THE SOLID ROCKET MOTOR. THE MARTIN CORPORATION IS WELL ON ITS WAY INTO DESIGN OF THE EXTERNAL TANK. HOWEVER, AS YOU ARE AWARE, THE THIOKOL SELECTION HAS BEEN PROTESTED BY ONE OF THE UNSUCCESSFUL BIDDERS, AND THIS PROTEST WILL HAVE TO BE RESOLVED BEFORE WORK CAN BEGIN. WE HOPE THAT AN EARLY RESOLUTION IS FORTHCOMING. A TIMELY START OF THIS SOLID ROCKET MOTOR ACTIVITY IS VERY IMPORTANT TO ORDERLY PROGRESS IN THE SHUTTLE DEVELOPMENT SCHEDULE. WE ARE, OF COURSE, CONTINUING TO STUDY POSSIBLE IMPACTS AND WORKAROUNDS AND WILL KEEP THE COMMITTEE INFORMED AS THIS MATTER PROGRESSES.

IN THE PAST YEAR THERE HAS BEEN A DRAMATIC INCREASE IN SUBCONTRACTING ACTIVITY. AT THE PRESENT TIME FIRMS IN THIRTY-TWO STATES HAVE BEEN SELECTED AS SUBCONTRACTORS, VENDORS OR SUPPLIERS. OF THE MAJOR SUBCONTRACTORS, THIRTY (30) ARE ON BOARD AND A FEW MORE WILL BE SELECTED BY THE END OF JUNE 1974 BRINGING THE TOTAL MAJOR SUBCONTRACTOR TEAM VERY CLOSE TO ONE HUNDRED PERCENT BY THE END OF THIS FISCAL YEAR. AT THIS POINT, SHUTTLE EMPLOYMENT HAS REACHED 16,000

AND IS ESTIMATED TO BE AT 27,000 BY THE END OF THIS FISCAL YEAR AND AT 37,000 BY THE END OF FISCAL YEAR NINETEEN SEVENTY FIVE (FY 1975).

I AM NOT GOING TO GO INTO THE KEY MILESTONES WE HAVE COMPLETED TO DATE OR INTO OUR PROJECTED MILESTONES FOR OUR BUDGET YEAR. THE SHUTTLE PROGRAM DIRECTOR AND THE SHUTTLE PROGRAM MANAGER WILL BE DISCUSSING THESE IN DETAIL. HARDWARE IS BEING BUILT. BEFORE THE END OF THIS FISCAL YEAR (1974) WE WILL CONDUCT OUR FIRST MAJOR SUBSYSTEM TEST OF THE SHUTTLE MAIN ENGINE. ALSO BY THE END OF THIS YEAR WE WILL BEGIN ACTUAL FABRICATION OF ORBITER NO. 1, THE VEHICLE WHICH WILL BE USED FOR HORIZONTAL FLIGHT TESTING.

THE SHUTTLE FUNDING WE ARE REQUESTING IS LESS THAN THAT ANTICIPATED BASED ON THE FISCAL YEAR 1975 PROJECTION CONTAINED IN THE PRESIDENT'S BUDGET MESSAGE LAST YEAR. AS A RESULT, WE NOW EXPECT TO CONDUCT THE FIRST MANNED ORBITAL FLIGHT TEST IN THE SECOND QUARTER OF 1979 - A DELAY OF FOUR TO SIX MONTHS. UNLESS MAJOR PROBLEMS OCCUR, WE BELIEVE WE CAN HOLD THIS SCHEDULE, PRIMARILY BECAUSE THE OFFICE OF MANAGEMENT AND BUDGET HAS RECOGNIZED OUR NEED FOR FUNDING STABILITY OVER THE NEXT FEW YEARS AND HAS STATED AN INTENT TO SUPPORT THE REQUIRED FUNDING LEVELS.

ADD —: EXCEED 18 million MDW. PROBLEMS Horiz. flt. - 4-6 mos slip.

ASSOCIATED WITH THE REVISED DEVELOPMENT SCHEDULE IS AN INCREASE OF POSSIBLY FIFTY MILLION DOLLARS ($50 MILLION) IN OUR ORIGINAL COMMITMENT TO DEVELOP THE SHUTTLE FOR FIVE POINT ONE FIVE BILLION ($5.15 BILLION) IN 1971 DOLLARS. OUR NEW TOTAL OF ABOUT FIVE POINT TWO BILLION ($5.2 BILLION) (IN 1971 $) IS TENTATIVE SINCE WE HAVE NOT HAD AN OPPORTUNITY TO WORK OUT THE DETAILS OF THE NEW SCHEDULE WITH OUR CONTRACTORS. A MORE PRECISE VALUE SHOULD BE AVAILABLE IN FIVE OR SIX MONTHS.

OUR ABILITY TO HOLD CLOSE TO OUR ORIGINAL COST TARGET IN SPITE OF SCHEDULE ADJUSTMENTS IN THE LAST TWO YEARS IS, IN GREAT PART, DUE TO BRINGING ON OUR CONTRACTORS BELOW OUR COST ESTIMATES. FOR INSTANCE, THE COST PROPOSALS OF OUR NEWLY SELECTED CONTRACTORS FOR THE EXTERNAL TANK AND THE SOLID ROCKET MOTORS WERE BOTH WITHIN THE COST ESTIMATES WE HAD PROJECTED FOR THESE DEVELOPMENTS. THEY WERE ALSO WELL WITHIN OUR COST PER FLIGHT ENVELOP AND AS A RESULT I FEEL CONFIDENT THAT OUR AVERAGE COST PER FLIGHT COMMITMENT OF TEN AND ONE HALF MILLION ($10.5 MILLION) (IN 1971 $) WILL BE MAINTAINED.

ASIDE FROM OUR ABILITY TO BRING OUR CONTRACTORS ON-BOARD BELOW OUR TARGETS, ANOTHER GREAT CONTRIBUTOR TO OUR ABILITY TO STAY NEAR OUR ORIGINAL COMMITMENT HAS BEEN THE ABILITY OF OUR MANAGEMENT STRUCTURE TO REMAIN DYNAMIC AND REACT TO CHANGES. LAST YEAR WE EXPLAINED TO THE COMMITTEE OUR

LEAD CENTER CONCEPT FOR SHUTTLE MANAGEMENT. UNDER THIS CONCEPT WE ESTABLISHED A PROGRAM MANAGER AT THE JOHNSON SPACE CENTER TO BE RESPONSIBLE FOR THE DAY-TO-DAY MANAGEMENT OF THE OVERALL PROGRAM. THIS FREED THE PROGRAM DIRECTOR, HERE IN WASHINGTON, TO CONCENTRATE ON PROGRAM PLANNING, PERFORMANCE REQUIREMENTS AND RESOURCES ANALYSIS AND ALLOCATION.

IN THE PAST YEAR WE HAVE DEMONSTRATED THAT THE CONCEPT DOES WORK AND WORK WELL. PROGRAM DECISIONS HAVE BEEN QUICKLY IMPLEMENTED AND THE INTERACTIONS BETWEEN OUR CONTRACTORS AND OUR VARIOUS LEVELS OF MANAGEMENT HAVE BEEN EXPEDITED, PARTICULARLY AT THE MIDDLE MANAGEMENT LEVELS. THE DAY-TO-DAY CONTACT BETWEEN THE SYSTEM AND SUBSYSTEMS MANAGERS AT THE CONTRACTORS AND AT OUR CENTERS HAS GREATLY REDUCED THE POSSIBILITY OF "SURPRISE PROBLEMS" ARISING AT THE CONTRACTOR LEVEL. CONVERSELY, THIS DAY-TO-DAY CONTACT SPEEDS UP THE IMPLEMENTATION PROCESS ONCE A DECISION HAS BEEN MADE.

KEY DECISIONS, THOSE THAT AFFECT OVERALL COST OR SCHEDULE OR INVOLVE A MAJOR CONFIGURATION CHANGE ARE ALL REVIEWED BY THE PROGRAM DIRECTOR. WHEN JUDGED NECESSARY THEY ARE ALSO REVIEWED BY MYSELF, MY MANAGEMENT COUNCIL, AND AS NECESSARY, BY THE ADMINISTRATOR OF NASA.

ON THE BASIS OF OUR EXPERIENCE WE NOW HAVE SUFFICIENT CONFIDENCE TO EXTEND THIS MANAGEMENT CONCEPT TO OTHER NEW PROGRAM AREAS SUCH AS THE SPACELAB AND SPACE TUG, WHICH WE HAVE ASSIGNED TO THE MARSHALL SPACE FLIGHT CENTER AS LEAD CENTER.

KEEPING PACE WITH THE INCREASING TEMPO OF SHUTTLE DEVELOPMENT ARE OTHER ACTIVITIES THAT RELATE TO THE SHUTTLE ERA - THE 1980'S. THESE EFFORTS ARE INCLUDED IN THE BUDGET PROJECT WE CALL MISSION SYSTEMS AND INTEGRATION FOR WHICH WE PROPOSE FUNDING OF FIFTEEN MILLION, FIVE HUNDRED THOUSAND DOLLARS ($15.5 MILLION). OF THIS AMOUNT, FIVE MILLION, FIVE HUNDRED THOUSAND ($5.5 MILLION) IS RELATED TO PAYLOAD INTEGRATION AND MISSION ANALYSIS; TWO AND ONE-HALF MILLION ($2.5 MILLION) WILL BE USED FOR OUR COROLLARY WORK WITH THE EUROPEANS ON SPACELAB; ONE MILLION, FIVE HUNDRED THOUSAND ($1.5 MILLION) GOES FOR STUDY EFFORTS ON AN UPPER-STAGE FOR THE SHUTTLE; AND THE REMAINING SIX MILLION ($6 MILLION) WILL BE USED FOR ADVANCED DEVELOPMENT.

LAST YEAR WE REPORTED TO THE COMMITTEE THAT THE EUROPEANS HAD MADE A TENTATIVE COMMITMENT TO DEVELOP A SPACELAB (MF 73-6781) SUBJECT TO COMPLETION OF STUDIES THEN UNDERWAY. WE FELT CONFIDENT AT THAT TIME, ON THE BASIS OF CONCURRENT STUDIES WE WERE DOING AT MARSHALL, THAT THE STUDY RESULTS WOULD LEAD THE EUROPEANS TO A HARD COMMITMENT. THAT OPTIMISM WAS WELL FOUNDED AND LAST SEPTEMBER, HERE IN WASHINGTON, THE NECESSARY INTERNATIONAL AGREEMENTS WERE SIGNED. THE SPACELAB WILL BE DEVELOPED AND PRODUCED IN EUROPE, BASED ON TECHNICAL REQUIREMENTS ESTABLISHED BY NASA.

In addition to being Shuttle developer, we are also the central agent in discussions with the potential users of the Spacelab. To facilitate the dialogue between U.S. and European users and to insure that the proper requirements are incorporated into the Spacelab modules designs, we established a Joint User Requirements Group. This Group made up of both NASA and European representatives has been extremely active. The National Academy of Sciences has also made significant contributions as a result of a study conducted at Woods Hole, Massachusetts, last summer.

The Marshall Space Flight Center has been established as lead Center for U.S. Spacelab activities. As such, Marshall, in addition to providing technical monitoring, is responsible for all planning and studies related to the eventual use of the Spacelab including what we call Concept Verification Testing, an in-house effort for simulation and evaluation of design concepts for experiment and subsystem integration and operation.

Another development that has occurred during the last few months relates to what we referred to last year as the Space Tug. (MT 74-5226) The Space Tug is an unmanned reusable stage that will fit in the Shuttle payload bay and will provide the capability to place and retrieve payloads in orbits beyond

2-13-74

THE CAPABILITY OF THE SHUTTLE AND ACHIEVE EARTH ESCAPE VELOCITIES FOR TRANSPLANETARY SPACECRAFT. LAST YEAR WE TOLD YOU THAT NASA AND THE DEPARTMENT OF DEFENSE WERE JOINTLY STUDYING VARIOUS APPROACHES TO DEVELOP THIS CAPABILITY AND EXPECTED TO REACH A DECISION AS TO WHICH AGENCY WOULD DEVELOP THIS STAGE WHICH IS AN INTEGRAL PART OF THE SPACE TRANSPORTATION SYSTEM. A TENTATIVE AGREEMENT HAS NOW BEEN REACHED THAT THE DEPARTMENT OF DEFENSE WILL DEVELOP AN INITIAL UPPER STAGE CAPABILITY CALLED AN ORBIT-TO-ORBIT STAGE (OOS) USING A MODIFICATION OF AN EXISTING EXPENDABLE STAGE. THIS STAGE WILL NOT HAVE A PAYLOAD RETRIEVAL CAPABILITY BUT MAY BE REUSABLE. IT WILL MEET THE EARLY REQUIREMENTS OF NASA AND THE DOD UNTIL A FULL CAPABILITY STAGE - A SPACE TUG - BECOMES AVAILABLE. MARSHALL SPACE FLIGHT CENTER, AS LEAD CENTER, WILL CONTINUE THE STUDY OF AND PLANNING FOR THE SPACE TUG. OUR FUNDING REQUEST IS BASED ON THIS EFFORT PLUS STUDY EFFORTS BY NASA TO SUPPORT AIR FORCE EFFORT ON THE OOS.

UP TO THIS POINT WE HAVE BEEN DISCUSSING SPACE HARDWARE. AS THIS HARDWARE BECAME MORE AND MORE IN FOCUS, OUR EFFORTS TURNED INCREASINGLY TOWARD MISSION PLANNING AND PAYLOADS FOR THERE MUST BE COMPATIBILITY BETWEEN THE PAYLOADS TO BE FLOWN AND THE SPACE TRANSPORTATION SYSTEM. THIS IS A CONSTANTLY EVOLVING PROCESS AS NEW POTENTIAL PAYLOADS ARE IDENTIFIED AND OPERATIONAL CONCEPTS MATURE. THE MAJOR TASK FOR OUR

PAYLOAD INTEGRATION AND MISSION ANALYSIS OFFICE IS TO ESTABLISH THE BRIDGE BETWEEN THIS VERY BROAD SPECTRUM OF PAYLOADS AND THE SHUTTLE, TUG, AND SPACELAB TO ASSURE THAT THEY CAN MOST EFFECTIVELY SERVE THE NEEDS OF THE 1980'S.

ONE OF THE MOST IMPORTANT PLANNING FUNCTIONS WE HAVE IS MAINTAINING AND CONSTANTLY UPDATING THE SPACE TRANSPORTATION SYSTEM MISSION AND PAYLOAD MODELS SINCE THEY INCORPORATE THE BEST DOCUMENTATION WE HAVE AT ANY GIVEN TIME OF POTENTIAL USER REQUIREMENTS. I MIGHT ADD HERE, AND WE WILL BE DISCUSSING THIS FURTHER DURING THESE HEARINGS, THAT THE MISSION MODEL IS NOT AN AGENCY PLAN. RATHER, IT IS AN ESSENTIAL BASELINE, A COMPOSITE OF THE REQUIREMENTS OF ALL USERS, THAT WE USE TO UNDERSTAND HOW THESE NEEDS RELATE TO COST EFFECTIVE INTEGRATION AND SCHEDULING OF PAYLOAD DEPLOYMENT, MAINTENANCE AND RETRIEVAL. OUR CURRENT MODELS, PUBLISHED IN JANUARY AND SUPPLIED TO YOUR STAFF, IDENTIFY SOME NINE HUNDRED AND EIGHTY-SIX (986) PAYLOADS IN THE 1980 THROUGH 1991 TIME FRAME INVOLVING SEVEN HUNDRED AND TWENTY-FIVE FLIGHTS (725) OF THE SPACE SHUTTLE. THIS REPRESENTS AN AVERAGE RATE OF APPROXIMATELY 60 FLIGHTS PER YEAR. HOWEVER, OUR STUDIES INDICATE THAT AT A 10% RATE OF DISCOUNT, THE STS WOULD BREAK EVEN IN A COST COMPARISON WITH EXPENDABLE VEHICLES IF THE SHUTTLE WERE FLOWN ONLY ABOUT 25 TIMES A YEAR.

THE LAST ITEM INCLUDED IN MISSION SYSTEMS AND INTEGRATION IS ADVANCED DEVELOPMENT. IT PROVIDES FOR EARLY DEVELOPMENT, FABRICATION AND TEST OF ADVANCED STATE-OF-THE-ART SUBSYSTEMS AND COMPONENTS BEFORE THEY ARE COMMITTED TO FLIGHT PROGRAMS. TODAY, THE SHUTTLE IS BEING DESIGNED USING THE RESULTS OF

ADVANCED DEVELOPMENT WORK CONDUCTED OVER THE PAST SEVERAL YEARS. THE FUEL CELLS AND THE MATERIALS TO INSULATE THE SHUTTLE FROM THE EFFECTS OF ENTRY HEATING WERE HELPED TO READINESS WITH SUBSTANTIAL COST AVOIDANCE BY THE ADVANCED DEVELOPMENT PROGRAM. ONE MAJOR AREA OF WORK NOW IS TO SATISFY THE ADVANCED DEVELOPMENT NEEDS OF THE SPACE TUG, SO THAT WHEN FORMAL DEVELOPMENT IS BEGUN THE PROGRAM CAN BE CONDUCTED WITH A MINIMUM OF DEVELOPMENT PROBLEMS. OTHER TASKS RELATE TO THE MOST SIGNIFICANT TECHNICAL NEEDS OF PROJECTS BEYOND THE TUG.

LET ME NOW TALK TO THE APOLLO SOYUZ TEST PROJECT (ASTP). 9-18-73. (MAL 73-6312) AS YOU KNOW, THIS IS THE LAST MANNED MISSION NOW PLANNED WHICH WILL USE SATURN/APOLLO HARDWARE. APPROXIMATELY FOUR YEARS WILL PASS BEFORE ANOTHER AMERICAN WILL FLY IN SPACE. IT IS THE END OF AN ERA AND ALL OF US WHO WERE ASSOCIATED WITH THE DEVELOPMENT OF THESE SYSTEMS, INCLUDING, I AM SURE, THE MEMBERS OF THIS COMMITTEE, FEEL BOTH PRIDE AND A DEGREE OF REGRET AS THIS PHASE OF THE SPACE PROGRAM PASSES INTO HISTORY.

FOR ASTP IN FISCAL YEAR 1975, WE ARE REQUESTING ONE HUNDRED AND FOURTEEN MILLION, SIX HUNDRED THOUSAND DOLLARS ($114.6 MILLION). THIS IS THE FINAL INCREMENT OF THE TWO HUNDRED AND FIFTY MILLION DOLLARS ($250 MILLION) THAT HAD BEEN EARMARKED FOR THE PROJECT AND I AM HAPPY TO REPORT THAT

THERE IS EVERY INDICATION THAT WE WILL NOT EXCEED THIS AMOUNT WHICH WAS OUR ORIGINAL ESTIMATE. IN ADDITION TO COMPLETING AND DELIVERING TO KENNEDY THE MISSION FLIGHT HARDWARE AND EXPERIMENTS, THESE MONIES WILL ALSO PROVIDE FOR LAUNCH AND RECOVERY COSTS, CLOSEOUT OF THE PRIME CONTRACTORS AND PAYMENT OF EXPERIMENT PRINCIPAL INVESTIGATOR ACTIVITIES FOR A PERIOD OF ONE YEAR AFTER SPLASHDOWN. WHILE WE ARE TALKING ABOUT EXPERIMENTS, I WOULD LIKE TO INTERRUPT THE SEQUENCE OF MY PRESENTATION. I RECOGNIZE THIS COMMITTEE'S CONCERN ABOUT THE EXPERIMENT PAYLOAD FOR THE ASTP MISSION. WE HAVE ALLOCATED THIRTEEN MILLION DOLLARS ($13 MILLION) FOR EXPERIMENTS. BECAUSE IT WAS REALIZED THAT THE FLIGHT OFFERED A UNIQUE OPPORTUNITY TO CONDUCT SCIENTIFIC EXPERIMENTS NASA ISSUED AN ANNOUNCEMENT OF FLIGHT OPPORTUNITIES TO THE SCIENTIFIC COMMUNITY. OVER ONE HUNDRED AND FORTY (140) PROPOSALS WERE RECEIVED. THESE WERE REVIEWED, ASSESSED AND EVALUATED BY AD HOC COMMITTEES OF EMINENT SCIENTISTS AND MEDICAL DOCTORS FROM UNIVERSITIES, THE NATIONAL ACADEMY OF SCIENCES, PUBLIC AND PRIVATE RESEARCH CENTERS AS WELL AS NASA AND OTHER FEDERAL RESEARCH AGENCIES SUCH AS THE SMITHSONIAN INSTITUTION. THE FINAL SELECTION FROM THIS EVALUATION PROCESS RESULTED IN AN EXPERIMENT PACKAGE WHICH WAS GIVEN FINAL APPROVAL BY THE ADMINISTRATOR.

WE HAVE RECENTLY SELECTED ADDITIONAL EXPERIMENTS FROM A LIST RECOMMENDED BY MEMBERS OF THESE SAME GROUPS OF SCIENTISTS. THESE EXPERIMENTS WILL BE INCORPORATED IF FURTHER EVALUATION OF THE SPACE VEHICLE PERFORMANCE, MISSION PARAMETERS, AND VOLUME PERMIT ADDITIONAL EXPERIMENT PAYLOADS TO BE CARRIED. I AM COMPLETELY SATISFIED THAT WE HAVE A FIRST RATE SCIENCE AND APPLICATIONS PAYLOAD FOR THE ASTP.

LET ME RETURN NOW TO THE ASTP STATUS AND PROJECTED ACTIVITIES. JUST THIS LAST NOVEMBER WE COMPLETED A JOINT ASTP FINAL DESIGN ACCEPTANCE REVIEW OF THE DOCKING SYSTEM WITH THE USSR. WE ALSO SUCCESSFULLY COMPLETED JOINT DYNAMIC TESTING OF THE DEVELOPMENT DOCKING SYSTEMS LAST DECEMBER. THESE WERE VERY CRITICAL MILESTONES FOR BOTH NATIONS. THE RESULTS WERE POSITIVE AND ALLOWS US TO PROCEED WITH CONFIDENCE THAT THE ASTP MISSION WILL BE SAFELY AND SUCCESSFULLY COMPLETED ON SCHEDULE. I AM PLEASED WITH THE MUTUAL COOPERATION WE HAVE ACHIEVED WITH OUR RUSSIAN COUNTERPARTS. THEY HAVE BEEN FREER AND MORE OPEN THAN MANY OF US HAD EXPECTED. THIS, OF COURSE, WAS NOT INSTANTANEOUS, BUT HAS DEVELOPED AND INCREASED FROM MEETING TO MEETING. I THINK WE HAVE BROKEN THROUGH MANY OF THE BARRIERS OF SUSPICION THAT EXISTED PRIOR TO THIS UNDERTAKING AND THIS BODES WELL NOT ONLY FOR FUTURE EXCHANGES BETWEEN NASA AND THE RUSSIAN SPACE TEAM BUT FOR ACROSS THE BOARD RELATIONSHIPS BETWEEN THE TWO NATIONS.

DURING THE NEXT EIGHTEEN MONTHS WE WILL BE COMPLETING SEVERAL IMPORTANT STEPS LEADING TO THE FIRST VENTURE IN SPACE INVOLVING THE CREWS OF TWO NATIONS. INCLUDED ARE:

- THE DELIVERY OF THE ASTP SPACECRAFT TO THE KENNEDY SPACE CENTER THIS FALL;
- THE COMPLETION OF JOINT DOCKING SYSTEM SYSTEMS QUALIFICATION TESTING AND PREFLIGHT DOCKING SYSTEMS COMPATIBILITY TESTS THIS WINTER;
- THE QUALIFICATION OF EXPERIMENT HARDWARE FOR FLIGHT EARLY NEXT SPRING; AND
- THE COMPLETION OF FLIGHT READINESS ACTIVITIES THIS WINTER AND NEXT SPRING LEADING TO THE LAUNCH OF ASTP NEXT SUMMER.

AT THIS TIME, I WOULD LIKE TO UPDATE THE COMMITTEE ON OUR PLANS FOR THE REMAINING APOLLO AND SKYLAB HARDWARE. ON THE ASSUMPTION THAT THERE WILL BE NO NEED TO FLY A BACKUP MISSION FOR ASTP, THERE WILL REMAIN IN THE INVENTORY TWO SATURN V'S; TWO SATURN IB'S; ONE COMPLETE COMMAND AND SERVICE MODULE AND ONE THAT IS PARTIALLY COMPLETE; AND THE SKYLAB BACKUP WORKSHOP CLUSTER THAT WAS NOT NEEDED. ONE CHANGE FROM LAST YEAR IS THAT WE HAD TO USE PARTS OF A SECOND PARTIALLY COMPLETED CSM TO SUPPORT SKYLAB AND ASTP, AND THIS CSM IS NO

LONGER CONSIDERED PART OF THE INVENTORY. SOME OF THIS HARDWARE IS ALREADY IN STORAGE. WITH CONCLUSION OF THE FLIGHT PHASE OF SKYLAB THE BACKUP CLUSTER CAN NOW BE PLACED IN STORAGE AND AFTER ASTP THE REMAINDER OF THE HARDWARE WILL ALSO BE STORED.

TOTAL COST PER YEAR WILL BE LESS THAN ONE HUNDRED THOUSAND DOLLARS. WE WILL CONTINUE TO STORE IT THROUGH FISCAL YEAR 1975. AFTER THAT TIME, WE MUST CONSIDER DISPOSITION OF THE HARDWARE. AS TIME PASSES THE PROBABILITY OF ITS EVER BEING USED BECOMES EXTREMELY REMOTE BECAUSE RETRAINING THE CONTRACTOR TEAMS TO CONDUCT ANOTHER MISSION BECOMES VERY EXPENSIVE. ADDITIONALLY, THE SCHEDULE FOR SHUTTLE MODIFICATIONS AT LAUNCH COMPLEX 39 WILL BE INITIATED IN 1975.

FOR DEVELOPMENT, TEST AND MISSION OPERATIONS WE ARE REQUESTING ONE HUNDRED AND SEVENTY FIVE MILLION, TWO HUNDRED THOUSAND DOLLARS ($175.2 MILLION) TO ASSURE THE CONTINUITY OF OUR IN-HOUSE CAPABILITY TO CARRY OUT OUR APPROVED PROGRAMS. ALMOST HALF OF THIS EFFORT IS REQUIRED TO OPERATE AND MAINTAIN FACILITIES THAT DIRECTLY SUPPORT OUR LAUNCHES AND FLIGHT. LAUNCH COMPLEX 39 AT KENNEDY; THE MISSION CONTROL CENTER AND THE FLIGHT CREW TRAINING SIMULATORS AND AIRCRAFT AT JOHNSON ARE PRIME EXAMPLES. MOST OF THIS FUNDING IN FISCAL YEAR 1975 IS REQUIRED IN DIRECT SUPPORT OF PREPARATIONS FOR THE ASTP MISSION. HOWEVER, WE ARE ALREADY BEGINNING THE TRANSITION TO SHUTTLE OPERATIONS.

THE OTHER HALF OF THE FUNDING SUPPORTS THE LABORATORIES AT THE MARSHALL SPACE FLIGHT CENTER AND THE JOHNSON SPACE CENTER. THESE LABORATORIES ARE OPERATED BY CIVIL SERVICE PERSONNEL WHO DRAW UPON THE EXPERTISE OF SELECTED SUPPORT CONTRACTORS TO ROUND OUT OR ENHANCE THEIR CAPABILITIES. THE LABORATORIES PROVIDE THE PROGRAM MANAGER WITH A CAPABILITY TO INITIATE INDEPENDENT BACKUP DESIGNS AND PARALLEL DEVELOPMENT IN HIGH TECHNOLOGY AREAS OF DESIGN AND DEVELOPMENT AND CONDUCT SPECIAL IN-HOUSE INVESTIGATIONS OF PROBLEM AREAS. A RECENT EXAMPLE OF WHAT I AM TALKING ABOUT, IS THE WORK ACCOMPLISHED IN THE WATER IMMERSION TANK AT MARSHALL WHICH UNDOUBTEDLY SALVAGED THE SKYLAB PROGRAM. I DOUBT IF WE COULD HAVE MADE THE FIX ON THE JAMMED SOLAR ARRAY HAD IT NOT BEEN FOR THE SIMULATION EFFORTS CONDUCTED IN THAT TANK. THIS GAVE US THE OPPORTUNITY TO PRE-TEST THE PROCEDURES USED BY THE SKYLAB CREW TO FREE THE ARRAY AND DEPLOY IT.

THE DIRECT SUPPORT OF ON-GOING AND PROPOSED PROGRAMS SUPPORTED BY DEVELOPMENT, TEST AND MISSION OPERATIONS ENABLES US TO MAINTAIN THE VERY NECESSARY CORE OF CAPABILITY FOR ALL TYPES OF SPACE RESEARCH, AND FOR SUPPORT, IN DEPTH, OF OUR TECHNICAL MANAGEMENT OF OUR PRIME AND SUBCONTRACTORS.

FOR LIFE SCIENCES WORK, WE ARE REQUESTING EIGHTEEN MILLION DOLLARS ($18 MILLION). WITH SKYLAB 4, WE HAVE JUST COMPLETED THE MOST EXTENSIVE MEDICAL MISSION EVER FLOWN. FOR THE

FUTURE OF MANNED SPACE FLIGHT, IT MAY BE THE MOST SIGNIFICANT MEDICAL EVENT OF THE CENTURY. IN ALL THREE SKYLAB MISSIONS, WE LEARNED MANY NEW THINGS ABOUT MAN IN WEIGHTLESSNESS. LET ME CITE ONE EXAMPLE. OUR EXPERIENCE WITH THE FIRST CREW SHOWED AN INITIAL DROP IN BODY WEIGHT DUE TO BODY FLUID LOSS, FOLLOWED BY STEADY FURTHER DECLINE PROBABLY DUE TO THE LOSS OF MUSCLE MASS. WITH THE SECOND CREW, WE WERE ABLE TO STABILIZE THE WEIGHT DECLINE DUE TO THE APPARENT LOSS OF MUSCLE MASS AND IN SKYLAB 4, ALL THREE CREWMEN STABILIZED AND ONE EVEN GAINED WEIGHT AFTER THE INITIAL WEIGHT LOSS.

FROM A MEDICAL POINT OF VIEW, DR. BERRY HAS BEEN ABLE TO CONCLUDE THAT MAN CAN ADAPT TO LONG FLIGHT DURATIONS, BUT WITH SOME ADAPTIVE CHANGES. WE NOW KNOW WHAT CHANGES OCCUR WITH TIME. WHAT WE DON'T KNOW IN DETAIL ARE THE MECHANISMS OF THESE CHANGES. OUR SPACE LIFE SCIENCES PROGRAM IS DESIGNED TO PROVIDE THE IN DEPTH UNDERSTANDING OF THE MECHANISMS OF THESE ADAPTIVE CHANGES. THIS WORK WILL BE ACCOMPLISHED IN GROUND LABORATORIES AS A PRELUDE TO SCIENTIFIC EXPERIMENTS ON SHUTTLE, WHEN MEN AND WOMEN WILL BE GOING INTO SPACE WITH A MINIMUM OF TRAINING. WHILE THE ENVIRONMENT OF THE SHUTTLE WILL BE MUCH LESS RIGOROUS THAN THAT OF PREVIOUS SPACECRAFT, WE MUST NONETHELESS DETERMINE THE MINIMUM MEDICAL STANDARDS THAT SCIENTISTS AND OTHER PASSENGERS MUST MEET TO QUALIFY FOR FLIGHT. STUDIES ARE UNDERWAY AND WILL CONTINUE TO DETERMINE THESE CRITERIA.

WE ARE ALSO CONTINUING OUR EFFORTS TO DEVELOP A MEANS OF PROVIDING MEDICAL CARE TO ON-ORBIT PERSONNEL THROUGH A FORM OF TELEMEDICINE. DR. BERRY WILL DISCUSS THIS IN SOME DETAIL IN A LATER HEARING. I WOULD JUST LIKE TO SAY HERE THAT A GROUND-BASED DEMONSTRATION PROGRAM HAS BEEN WORKED OUT WITH HEW TO ESTABLISH A TELECOMMUNICATIONS LINK BETWEEN AN ARIZONA INDIAN RESERVATION AND A REMOTE LARGE HOSPITAL.

OTHER EFFORTS RELATED TO OUR NEW BREED OF SPACE TRAVELER INCLUDE PRELIMINARY STUDIES THAT WILL EVENTUALLY LEAD TO THE DEVELOPMENT OF NEW NON-CUSTOM-FITTED SPACE SUITS FOR EXTRAVEHICULAR ACTIVITY (EVA). SKYLAB HAS SHOWN THAT ROUTINE EVA IS PRACTICAL AND I AM SURE IT WILL BE USED ON MANY OF THE SHUTTLE MISSIONS. WE ARE ALSO CONTINUING STUDIES OF SIMPLE RESCUE AIDS.

THE LAST ITEM OF OUR RESEARCH AND DEVELOPMENT REQUEST IS ONE AND ONE-HALF MILLION DOLLARS ($1.5 MILLION) FOR ADVANCED MISSIONS STUDIES. IN THE PAST FEW YEARS THESE FUNDS HAVE BEEN USED ALMOST EXCLUSIVELY FOR STUDIES RELATED TO THE SPACE TRANSPORATION SYSTEM - THE SHUTTLE AND THE TUG. NOW, HOWEVER, OUR EMPHASIS IS SHIFTING AND WILL CONTINUE TO SHIFT IN FISCAL YEAR 1975 TO MISSION AND HARDWARE CONCEPTS DURING AND PERHAPS A LITTLE BEYOND THE SHUTTLE ERA USING WHAT WE HAVE LEARNED FROM APOLLO AND SKYLAB. IN COMPARISON TO THE REST OF OUR BUDGET REQUEST THIS ONE AND ONE-HALF MILLION ($1.5 MILLION) IS A MODEST REQUEST AND WE HAVE FOUND THAT THIS "SEED" MONEY PAYS BIG DIVIDENDS.

IT HAS BEEN OUR PRACTICE IN PAST YEARS TO INFORM THE COMMITTEE ON CHANGES IN THE MANNED SPACE FLIGHT ORGANIZATION AND BEFORE I GO INTO A DISCUSSION OF OUR FACILITY AND RESEARCH AND PROGRAM MANAGEMENT REQUEST, I WOULD LIKE TO TAKE THE OPPORTUNITY TO AGAIN UPDATE YOU. DURING THE PAST YEAR THE ORGANIZATION ITSELF HAS REMAINED VERY STABLE WITH NO MAJOR ORGANIZATIONAL REALIGNMENTS OTHER THAN UPGRADING OUR SORTIE LAB TASK FORCE TO PROGRAM STATUS. DOUGLAS LORD WHO HAD BEEN MANAGER OF THE TASK FORCE IS THE NEW DIRECTOR OF THE OFFICE WHICH HAS BEEN RETITLED SPACELAB PROGRAM TO BE CONSISTENT WITH THE EUROPEANS.

OTHER PERSONNEL CHANGES INCLUDE THE APPOINTMENT OF DR. MYRON MALKIN AS SPACE SHUTTLE PROGRAM DIRECTOR. HE REPLACES MR. CHARLES DONLAN, MY DEPUTY FOR TECHNICAL MATTERS, WHO WAS DOING DOUBLE DUTY AS ACTING DIRECTOR OF THE PROGRAM. MIKE MALKIN CAME TO US FROM THE DEPARTMENT OF DEFENSE WHERE HE SERVED AS DEPUTY ASSISTANT SECRETARY FOR TECHNICAL EVALUATION. HE HAS A VERY FINE AEROSPACE BACKGROUND AND IS A WELCOME ADDITION TO OUR TEAM. WE ALSO HAVE ANNOUNCED THAT DR. CHARLES BERRY, THE NASA DIRECTOR OF LIFE SCIENCES, WILL BE LEAVING US AT THE END OF MARCH. CHUCK HAS MADE OUTSTANDING CONTRIBUTIONS TO MANNED SPACE FLIGHT PROGRAMS. WE WISH HIM

WELL IN HIS NEW AND CHALLENGING POSITION AS PRESIDENT OF THE UNIVERSITY OF TEXAS' HEALTH SCIENCE CENTER IN HOUSTON. OUR MOST RECENT ANNOUNCEMENT WAS THAT OF THE APPOINTMENT OF MR. JOHN DISHER AS DIRECTOR OF ADVANCED PROGRAMS. JOHN HAS BEEN THE DEPUTY DIRECTOR OF SKYLAB AND PRIOR TO THAT DIRECTOR OF ENGINEERING FOR THE APOLLO PROGRAM. HE HAS TAKEN OVER FROM MR. PHIL CULBERTSON WHO HAS BEEN ACTING DIRECTOR OF ADVANCED PROGRAMS AS WELL AS MY DIRECTOR OF MISSION AND PAYLOAD INTEGRATION. THIS WILL PERMIT PHIL TO DEVOTE HIS TIME EXCLUSIVELY TO THE VERY IMPORTANT FUNCTION OF SHUTTLE PAYLOAD PLANNING, AND WILL BRING THE VITALLY IMPORTANT DATA BASE OF SKYLAB INTO OUR ADVANCED PROGRAMS STUDIES.

MY NEXT TOPIC IS OUR CONSTRUCTION OF FACILITIES REQUEST (MB 74-5121). WE ARE ASKING FOR A TOTAL OF EIGHTY-SIX MILLION NINE HUNDRED AND FIFTY-FIVE THOUSAND DOLLARS ($86.955 MILLION).

INCLUDED IS ONE INSTITUTIONAL CONSTRUCTION PROJECT COSTING NINE HUNDRED AND THIRTY-FIVE THOUSAND DOLLARS ($935 THOUSAND), TO PROVIDE TANKAGE, MAINS, CONNECTORS AND PUMPS TO PERMIT THE JOHNSON SPACE CENTER TO CONNECT TO THE HOUSTON WATER SYSTEM. AT THE PRESENT TIME THE CENTER GETS ITS WATER FROM ON-SITE WELLS; HOWEVER, THERE HAS BEEN A SERIOUS SUBSIDING OF LAND IN THE WHOLE AREA WHICH APPARENTLY HAS BEEN CAUSED BY EXTENSIVE USE OF WELL WATER AS THE AREA HAS BUILT UP. THE PROJECT IS PART OF A REGIONAL EFFORT TO CHANGE FROM GROUND WATER TO SURFACE WATER TO HALT THE SUBSIDING.

THE REMAINDER OF THE REQUEST, EIGHTY-SIX MILLION DOLLARS ($86.020 MILLION), PROVIDES FOR TEN SHUTTLE PROJECTS FOR WHICH TIMELY FUNDING IS ESSENTIAL. THEY SUPPORT KEY DEVELOPMENT MILESTONES. I WILL NOT GO INTO DETAIL ON THESE REQUIREMENTS BECAUSE AN IN DEPTH HEARING HAS BEEN SCHEDULED BY YOUR COMMITTEE. AT THIS POINT, HOWEVER, I WOULD LIKE TO POINT OUT THAT WE ARE CONTINUING TO MAKE MAXIMUM USE OF EXISTING FACILITIES BY MODIFYING THEM WHERE POSSIBLE. IN FACT, WELL OVER HALF THE MONEY IN THIS REQUEST IS FOR FACILITY MODIFICATIONS AS OPPOSED TO NEW CONSTRUCTION. I WOULD ALSO LIKE TO ASSURE THE COMMITTEE THAT WE INTEND TO FULFILL OUR COMMITMENT TO YOU THAT THE FACILITY COSTS ASSOCIATED WITH THE DEVELOPMENT OF THE SHUTTLE WILL NOT EXCEED THREE HUNDRED MILLION DOLLARS ($300 MILLION) IN 1971 DOLLARS. WITH THAT LET ME BRIEFLY HIGHLIGHT THE INDIVIDUAL PROJECTS. FOR LAUNCH AND LANDING FACILITIES WE ARE REQUESTING SEVENTY-ONE MILLION, NINE HUNDRED AND FIFTY THOUSAND DOLLARS ($71.950 MILLION) TO COMPLETE THE LANDING FACILITIES, THE INITIAL FUNDING OF WHICH WAS AUTHORIZED LAST YEAR; TO CONSTRUCT AN ORBITER PROCESSING FACILITY WEST OF THE VEHICLE ASSEMBLY BUILDING AT KENNEDY FOR ORBITER SAFING, MAINTENANCE (INCLUDING REFURBISHMENT) CHECKOUT, DOWN PAYLOAD REMOVAL AND NEW PAYLOAD INTEGRATION; AND TO INITIATE MODIFICATIONS OF LAUNCH COMPLEX 39 TO ADAPT IT FOR SHUTTLE USE.

AN ADDITIONAL SEVEN MILLION, FOUR HUNDRED AND EIGHTY THOUSAND DOLLARS ($7.480 MILLION) SHOWN ON THIS CHART IS REQUIRED FOR THE NEW CONSTRUCTION AND FACILITY MODIFICATIONS TO MAKE IT POSSIBLE TO CONDUCT ESSENTIAL GROUND TESTING AND HORIZONTAL FLIGHT TESTING PRIOR TO VERTICAL FLIGHT. THE FINAL INCREMENT OF THIS YEAR'S REQUEST IS RELATED TO SOLID ROCKET AND BOOSTER ACTIVITIES AND TOTAL SIX MILLION, FIVE HUNDRED AND NINETY THOUSAND DOLLARS ($6.590 MILLION). YOU WILL NOTE THAT WE HAVE NOT INDICATED A SITE FOR ROCKET MOTOR FACILITIES. THIS IS BECAUSE OF THE PROTEST RELATED TO THIOKOL SELECTION THAT I DISCUSSED PREVIOUSLY, HOWEVER, THE PROJECT PROPOSED HERE AT AN ESTIMATED COST OF FOUR MILLION DOLLARS ($4.0 MILLION) IS CONSISTENT WITH THIOKOL'S NEEDS.

MY LAST SUBJECT, BEFORE SUMMARIZING ALL THREE APPROPRIATIONS IS RESEARCH AND PROGRAM MANAGEMENT (MB 74-5164) FOR WHICH WE ARE ASKING THREE HUNDRED AND FORTY-SIX MILLION, ONE HUNDRED AND THIRTY-THREE THOUSAND DOLLARS ($346.133 MILLION) FOR FISCAL YEAR 1975. DESPITE INCREASING GOVERNMENT PAYROLL COSTS AND A GENERAL INCREASE IN EVERYTHING PAID FOR IN THIS ACCOUNT, WE ARE REQUESTING FIVE AND ONE-HALF MILLION ($5.5 MILLION) LESS COMPARED TO FISCAL YEAR 1974. THE REDUCTION IS POSSIBLE BECAUSE OF TWO THINGS. FIRST, A FULL YEAR'S REDUCTION IN SALARIES AND BENEFITS RELATED TO OUR

OVERALL REDUCTION OF 825 PERSONNEL SPACES IN FISCAL YEAR 1974 AND A FURTHER REDUCTION OF 354 SPACES IN FISCAL YEAR 1975 RELATING ONLY TO THE MARSHALL SPACE FLIGHT CENTER.

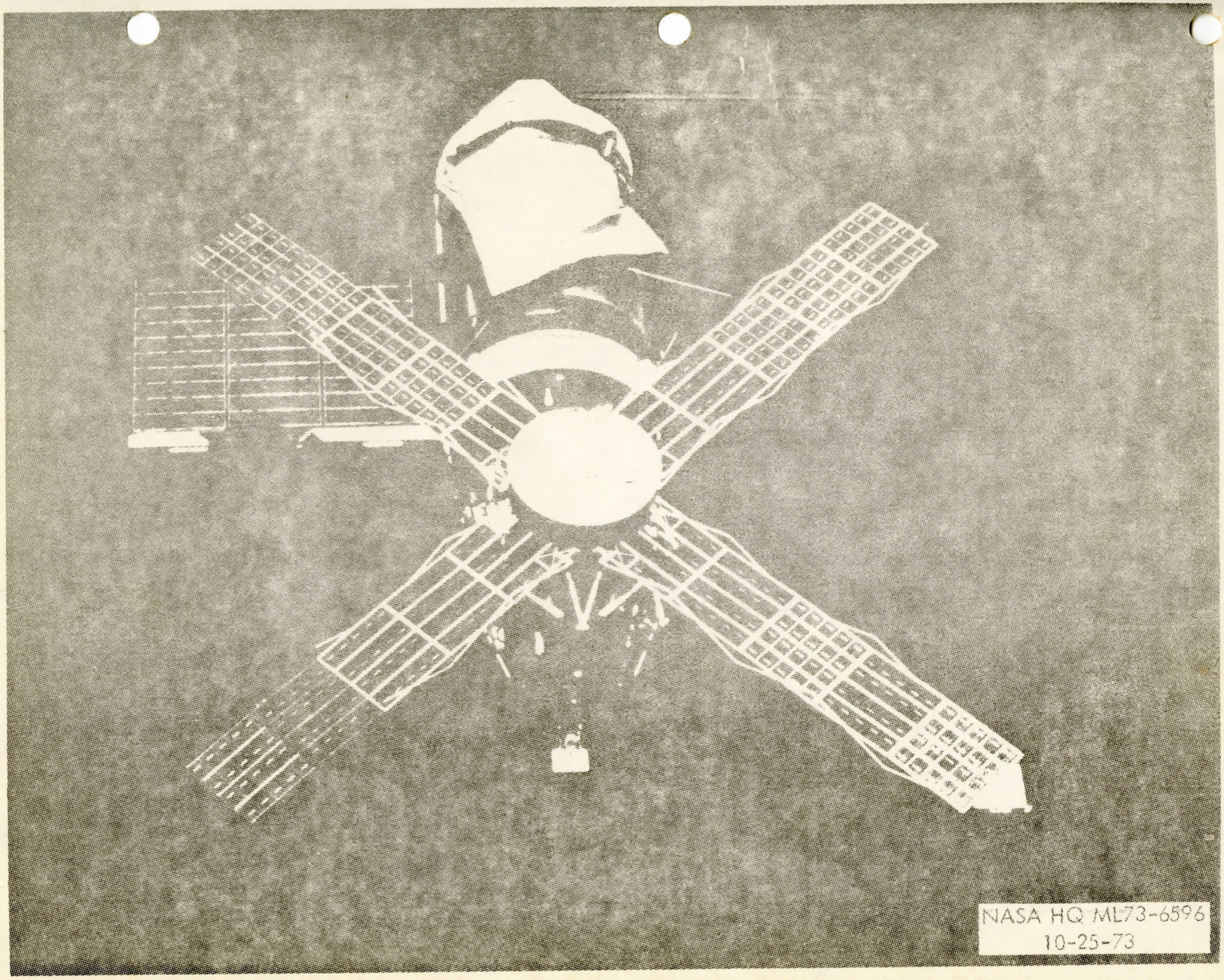
AS I REPORTED LAST YEAR, WE HAVE BEEN ABLE TO ACHIEVE SIGNIFICANT PERSONNEL ECONOMIES BECAUSE AS PROGRAMS ARE COMPLETED AND NOT REPLACED BY EFFORTS OF COMPARABLE MAGNITUDE, PEOPLE CAN COME OFF THE ROLLS. SKYLAB, OF COURSE, HAS JUST FINISHED ITS FLIGHT PHASE AND DEVELOPMENT ACTIVITIES RELATED TO ASTP WILL BE ESSENTIALLY COMPLETED IN FISCAL YEAR 1975 TO MEET A JULY 1975 LAUNCH DATE. IN ADDITION, WE HAVE GONE THROUGH VERY COMPREHENSIVE STUDIES OF MANPOWER REQUIREMENTS AT ALL THREE OF OUR CENTERS AND DID SIGNIFICANT BELT TIGHTENING. I, PERSONALLY, AM CONVINCED THAT APPROVAL OF THIS REQUEST FOR FISCAL YEAR 1975 WILL RESULT IN A MANNED SPACE FLIGHT ORGANIZATION THAT IS AS LEAN AND EFFICIENT AS I KNOW HOW TO MAKE AND STILL GET ON WITH THE BUSINESS OF LAUNCHING THE ASTP MISSION, DEVELOPING THE SHUTTLE AND PREPARING FOR THE NINETEEN EIGHTIES (1980'S).

MY NEXT CHART (MB 74-5204) SUMMARIZES THE REQUEST BEFORE YOU. FOR ALL THREE APPROPRIATIONS, WE ARE REQUESTING AUTHORIZATION OF ONE BILLION, FIVE HUNDRED AND FIFTY-SEVEN POINT NINE MILLION DOLLARS ($1,557.9 MILLION). OF THIS, ONE BILLION, ONE HUNDRED AND TWENTY-FOUR POINT EIGHT MILLION DOLLARS ($1,124.8 MILLION) IS FOR RESEARCH AND DEVELOPMENT; THE MAJOR PART, EIGHT HUNDRED

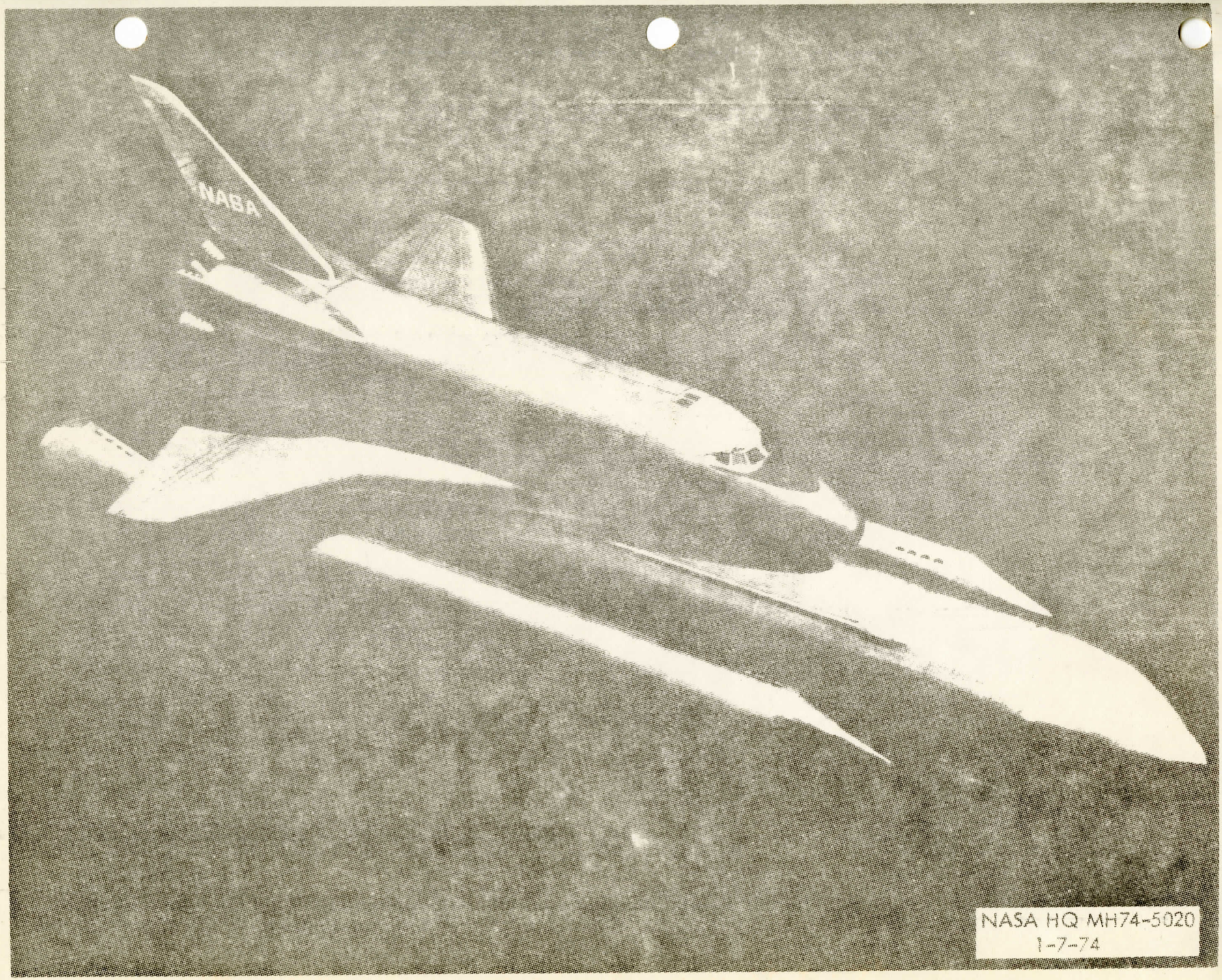
MILLION DOLLARS ($800 MILLION) IS FOR THE SHUTTLE. THE OTHER VALUES WHICH I HAVE JUST FINISHED DESCRIBING ARE, OF COURSE, CONSTRUCTION OF FACILITIES AT ABOUT EIGHTY-SEVEN MILLION ($87 MILLION) AND RESEARCH AND PROGRAM MANAGEMENT AT THREE HUNDRED AND FORTY-SIX POINT ONE MILLION ($346.1 MILLION). I WOULD LIKE TO MAKE ONE FURTHER POINT WITH THIS CHART. IN ABSOLUTE DOLLARS WHEN COMPARED TO FISCAL YEAR NINETEEN SEVENTY-FOUR (FY 1974) IT SAYS THAT WE ARE INCREASING SOME NINETY MILLION DOLLARS ($90 MILLION). HOWEVER, THAT NINETY MILLION DOLLARS JUST ABOUT EQUATES TO THE INFLATION THAT HAS OCCURRED IN THE AEROSPACE INDUSTRY IN THE PAST TWELVE MONTHS AND THE REAL RESULT IS ANOTHER LEVEL BUDGET WHEN COMPARED TO LAST YEAR. YET I DON'T WANT TO BE PESSIMISTIC BECAUSE I REALIZE WE HAVE TURNED THE CORNER. THE SKYLAB PROGRAM WAS MORE THAN WE COULD EVER HAVE DREAMED FOR. WE HAVE MADE SIGNIFICANT PROGRESS IN THE SHUTTLE PROGRAM IN THE LAST YEAR AND I SEE NO REASON WHY IT SHOULD NOT CONTINUE. I AM PLEASED WITH THE DECISION OF THE EUROPEAN COMMUNITY TO JOIN US IN OUR VISION OF SPACE IN THE NINETEEN EIGHTIES AND IN THE COOPERATION WE HAVE ACHIEVED WITH THE SOVIET UNION IN OUR JOINT ASTP MISSION. I AM CONFIDENT THAT THE PAST TRULY IS PROLOGUE AND THAT WITH THE CONTINUED SUPPORT OF THIS COMMITTEE AND THE CONGRESS THE FISCAL YEAR NINETEEN SEVENTY-FIVE AND SUBSEQUENT YEARS ARE GOING TO BE EQUALLY AS REWARDING AS THE PAST. LET ME CLOSE MY PREPARED

TESTIMONY WITH A VERY SHORT DISCUSSION OF OUR MANNED SPACE FLIGHT SCHEDULE (MB 73-5180-A). THE APOLLO SOYUZ FLIGHT WILL BE IN JULY 1975. THE SPACE SHUTTLE SCHEDULE, NOW SHOWS THE FIRST HORIZONTAL FLIGHT TEST IN THE SECOND QUARTER OF 1977 WITH THE FIRST MANNED ORBITAL FLIGHT TWO YEARS LATER IN THE SECOND QUARTER OF 1979 AND AN INITIAL OPERATIONAL SHUTTLE CAPABILITY IN 1980. WE EXPECT THE EUROPEANS TO BE READY WITH THEIR SPACELAB WHEN WE GO OPERATIONAL AND THE AIR FORCE TO COME ALONG WITH ITS ORBIT-TO-ORBIT STAGE A LITTLE LATER LEADING TO AN INITIAL SPACE TRANSPORTATION SYSTEM FOR USE IN THE EIGHTIES AND BEYOND.

THANK YOU MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE. THIS CONCLUDES MY SUMMARY OF THE MANNED SPACE FLIGHT REQUEST FOR 1975.



NASA HQ ML73-6596
10-25-73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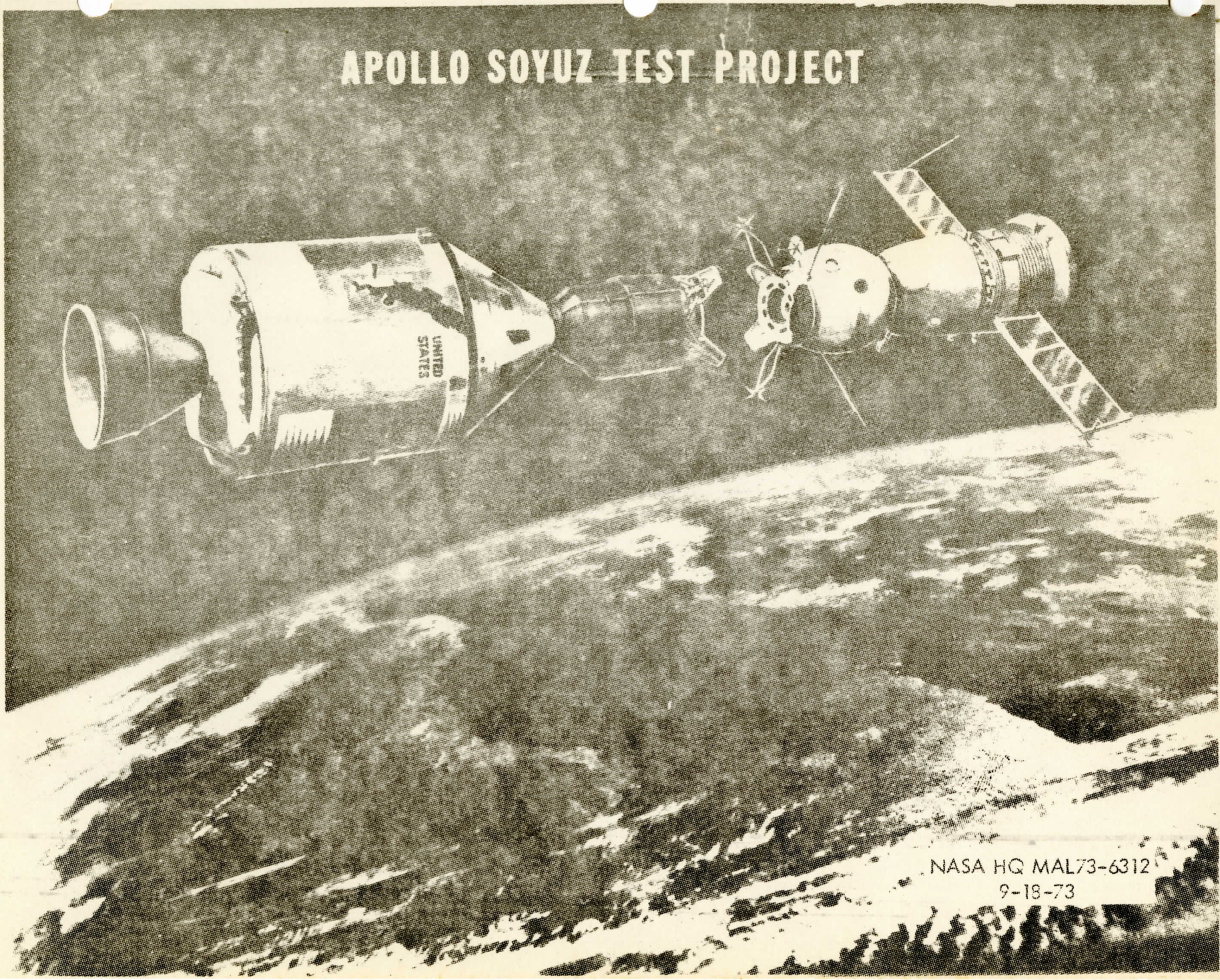
SPACELAB

APOLLO SOYUZ TEST PROJECT



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9-18-73

MANNED SPACE FLIGHT

FY 1975 CONSTRUCTION OF FACILITIES PROGRAM

SHUTTLE	COST ($ MILLIONS)
LAUNCH AND LANDING FACILITIES	$ 71.950
GROUND TEST FACILITIES	$ 7.480
SOLID ROCKET BOOSTER PRODUCTION AND TEST FACILITIES	$ 6.590
	$ 86.020

INSTITUTIONAL	
MODIFICATION OF WATER SUPPLY SYSTEM	$ .935
TOTAL	$86.955

NASA HQ MB74-5121
1-29-74

MANNED SPACE FLIGHT

RESEARCH AND PROGRAM MANAGEMENT
FY 1975 BUDGET ESTIMATES

DOLLARS IN THOUSANDS

	FY 1973	FY1974	FY 1975
TOTAL	338,902	351,580	346,133
KENNEDY SPACE CENTER	91,117	94,471	96,739
JOHNSON SPACE CENTER	110,600	116,860	118,179
MARSHALL SPACE FLIGHT CENTER	137,185	140,249	131,215

NASA HQ MB74-5164
2-5-74

MANNED SPACE FLIGHT

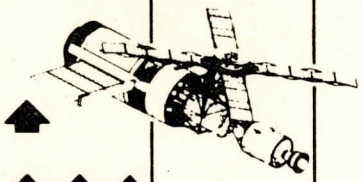
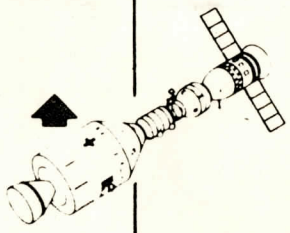
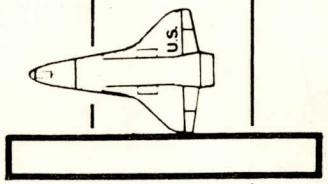
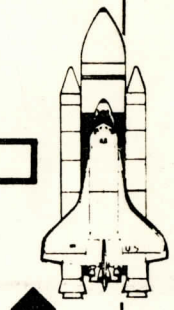
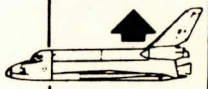
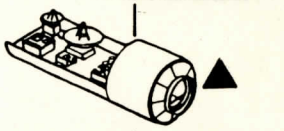
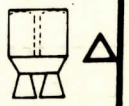
TOTAL PROGRAM
FY 1975 BUDGET ESTIMATES

DOLLARS IN MILLIONS

	FY 1973	FY 1974	FY 1975
TOTAL	1,504.6	1,465.5	1,557.9
1 RESEARCH AND DEVELOPMENT	1,135.8	1,056.5	1,124.8
SPACE FLIGHT OPERATIONS	(879.0)	(580.0)	(323.3)
SPACE SHUTTLE	(198.6)	(475.0)	(800.0)
ADVANCED MISSIONS	(1.5)	(1.5)	(1.5)
APOLLO	(56.7)	(—)	(—)
2 CONSTRUCTION OF FACILITIES	29.9	57.4	87.0
3 RESEARCH AND PROGRAM MANAGEMENT	338.9	351.6	346.1

NASA HQ MB74-5204
2-6-74

MANNED SPACE FLIGHT
FLIGHT ACTIVITY

PROGRAMS	1973	1974	1975	1976	1977	1978	1979	1980
SKYLAB								
WORKSHOP	▲							
MANNED	▲ ▲ ▲ (28) (59) (84) (DAYS)							
ASTP			▲ 					
SHUTTLE								
HORIZONTAL TEST FLIGHTS							▲	
FIRST MANNED ORBITAL FLIGHT								
OPERATIONAL							 ▲	
SPACELAB (EUROPE)								
ORBIT TO ORBIT STAGE (USAF)*								 △

*TENTATIVE AGREEMENT

NASA HQ MB73-5180-A
REV. 1-17-74

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PRESENTED BY WITNESS

DRAFT
2/5/74

Statement of

Charles A. Berry, M.D.
NASA Director for Life Sciences

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Committee on Science and Astronautics

Subcommittee on Manned Space Flight

House of Representatives

Mr. Chairman and Members of the Committee:

It is my privilege to discuss with you today the Space Life Sciences Program, ~~that part of the total Life Sciences program which is in OMSF.~~ It is a research program which provides the understanding and technology necessary to determine man's capabilities and limitations in the space environment. It also develops the technology base for future environmental systems which will permit man to live and work effectively for long periods of time. Many of these research and technology efforts also relate very directly to clinical health care on earth.

With Skylab 4, we have just completed the most extensive medical mission ever flown. For the future of manned space flight, it may be the most significant medical event of the century. Dr. Kerwin has related his subjective experience in the first Skylab mission. In all three missions we learned many new things about man in weightlessness.

*
There have been changes and some are visible. Here you see (MOVIE)
the second Skylab crew emerging from their Command Module on
the recovery ship after 59 days of flight. They are in
pretty good shape but notice they accept support from the
crew surgeons. This is because of the rapid transition from
weightlessness to 1-G. Their cardiovascular system and its
control are so adapted to the long period of weightlessness,
that they do not respond quickly or sufficiently to the
new 1g environment of earth. The adjustment to weightless-
ness is easier - downhill physiologically - while that to
1g after being weightless is more difficult - uphill physio-
logically. To follow the changes in the adaptive process
during flight, we used a suction device as an analogue of
gravity; to challenge the astronaut's cardiovascular system,
that is, we applied suction to the abdomen and legs. This
tended to pool the blood in the legs and we were able to
follow the body's response by measuring the heart rate, the
blood pressure, and the swelling of the legs. This suction (MOVIE)
machine is called the Lower Body Negative Pressure Device
which you see here. From these periodic tests, we found
that the body's responses to this analogue of gravity, have
proven to be a good indicator of what is happening in flight,
and furthermore, a predictor of what we might see post-flight.
We do know, however, that the procedure appears to be even
more stressful in flight than it was in the ground-based
situation. In-flight we have seen some evidence of mild
types of cardiac arrhythmia - irregular heart beats - but

none of these are of clinical concern to us. Post flight, we have seen a reduced stroke volume, i.e., the amount of blood pumped by each beat of the heart and there has been a shift in the circulating blood volume with changes in the electrolytes, important mineral ions, in the blood. These changes ~~too~~ also appear to be the result of physiological adaptation to 0g and readaptation to 1g. But the significant question is whether they will compromise the performance reserve of the crewman or scientist and whether protection by countermeasures ~~are~~ is needed.

We also studied the body's response to exercise tolerance using the bicycle ergometer as Astronaut ~~Weitz was~~ Bean is doing in the film. MOVIE All crewmembers maintained their capacity for work of this nature inflight, but showed performance decrements back in 1g. Yet in spite of ~~all of this~~ a large amount of exercise, their leg muscles became smaller. We call this "loss of muscle mass" and it was demonstrated by reduced leg girth and by measurements of increased muscle nitrogen excretion in the urine. Now, this does not say that exercise is bad or that this exercise is doing no good. What it does say to us is that, this particular kind of exercise was not doing much for specific sets of muscles in the legs. These are the anti-gravity muscles. They support us here on earth, when we stand or walk. They work hard. In space they do very little work, even on ~~this~~ the bicycle ergometer.

The questions we must answer in our research starting in FY'75 are what are the mechanisms causing all these

adaptive changes. With the heart, is it all hormonal and nervous regulatory change, or is there some sort of intrinsic cardiac muscle change or effect? The answers to these questions are going to be important for the future. The answers will also undoubtedly assist in the understanding of heart disease and hypertension (high BP) here on earth.

Another change we noted in the Skylab astronauts was that, following the 28 day mission, all three (MOVIE) crewmen had a reduction in their red blood cell mass. For the first time ever, we were able to get inflight blood samples in Skylab. Here is Dr. Kerwin drawing blood inflight from Pete Conrad. The blood was then prepared for storage by freezing and was returned to earth for analysis. The reduction of red cell mass has been about 15%, a significant reduction but not life endangering. Associated with this red cell reduction was a lack of response by the blood forming elements of the body causing a marked delay in the return of the red blood cell mass to the preflight values, until about the sixth week postflight.

Although a similar reduction in red blood cell mass was observed on the 59 day mission, there was a faster compensating response of the blood forming elements which resulted in a return to almost the preflight red cell mass level by two weeks postflight. These blood changes are at the cellular level of human response and point up the need for studies using the Shuttle of the response of the bone marrow, the blood forming element.

~~in the Shuttle-Spacelab flights.~~ These studies should assist in our better understanding of the body's physiological processes here on earth - is there a physiological governor of red cell mass levels?

The response of the body's system of balance, the vestibular system, seems to be another adaptive process which occurs within three to five days. This film shows the vestibular experiment. We found that the vestibular system and/or the gravity sensors in the inner ear became so adapted to weightlessness that the astronauts could do many head movements while rotating rapidly without any symptoms even if motion sickness was suffered in the first few days of flight. We are studying the mechanisms of adaptation in detail. We need to be able to select Shuttle passengers who are not prone to motion sickness. We also need better motion sickness preventive measures. Then, we will be ready to conduct the necessary scientific experiments testing vestibular functions in Shuttle. (MOVIE)

We also measured the amount and depth of sleep on one astronaut of each Skylab crew periodically, using this specially designed cap. The data were analyzed automatically for level of sleep by this device. The sleep was essentially normal and the amount adequate.

In Skylab 3, one of the experiments examined the growth and division of human lung cells (fibroblast) as you see in the movie. More is known of the biology of this human cell strain than any other in the world. You are witnessing the first time in the history of space

flight, timelapse photography showing the growth and division of human cells in culture, in zero g. These data are being examined to determine if there are changes in cell structure and/or function including cycle duration, rate of migration and associated intra-cellular activities ~~associated with~~ related to the nucleus and its role in cell division. The results of this experiment are still under investigation and some of the cells returned alive from the flight have been regrown and "banked" for future investigation. This is the type of investigation which will help us determine how certain physiological changes occur by observing effect at the cell level, the basic biological building block.

As Dr. Kerwin noted, in Skylab we found that man could perform very efficiently in space and improve the reliability of the spacecraft systems through maintenance and repair activities. Man's usefulness in space operations was well demonstrated. He has increased the return from space flight experiments by providing flexibility and using his ability to maintain recalcitrant equipment as well as making on the spot decisions. In addition, man learned to use weightlessness to an advantage. He became more efficient as he acclimated to weightlessness and was able to do tasks * (MOVIE) more quickly than he could at first. Here we see Astronaut Kerwin entering the Lower Body Negative Pressure device on Mission Day 5. Note it takes him some time. (Pause) Now watch how quickly Joe enters the device on Mission Day 20, his fifth trial. This is quite a difference. (Pause)

The Space Shuttle and Spacelab will open to us great opportunities to follow up on the problems identified and somewhat scoped by our Skylab experience. Here for the first time, scientists/passengers will be transported into the space environment with minimal preflight indoctrination and training. Medical selection and qualifications of these scientist/passengers will, however, pose a unique problem. Applying a single set of relatively restrictive medical standards similar to those now established for astronauts seems to be neither required nor desireable.

SLIDE ON (MM73-5063)

Medical data previously gathered during manned space flight and medical criteria already established for air transportation are being coupled with such factors as those anticipated in the Shuttle environment, known passenger characteristics and anticipated work performance requirements for inflight tasks as depicted in this chart in order to determine where there are gaps in our knowledge. We are using ground-based, space flight analog, studies to develop the understanding necessary to validate the medical selection criteria which can reasonably be expected to protect the health of passenger/scientists selected for space flight without needlessly restricting the scientific programs to be carried out.

SLIDE OFF

We are continuing our effort to develop a capability to provide clinical medical care and support to future space crews. It is a form of telemedicine. Considering the similarities which exist between providing health care to men in space and providing health care to a remote

SLIDE ON (MM73-667

population on earth, a plan was developed to verify the requirements for a space health care delivery system by building and testing a ground-based analog of the system.

NASA is designing and assembling, and will operationally test such a ground-based health care system in collaboration with the Department of Health, Education and Welfare (DHEW).

In April 1973, the HEW selected the Papago Indian Reservation near Tucson, Arizona, as the site for the field test to begin early in 1975. This chart illustrates the similiarities of space and remote ground medical support; In both circumstances a ground medical data base and the expertise at a large hospital are available to assist by telecommunications in the diagnosis and care of remote patients. The system makes optimum use of advanced medical instrumentation, television, voice, data communications, and modern data processing techniques. With these aids, a specially trained paramedical crewman may examine a patient, transmit medical information from the remote site to a physician in a control center miles away, and consult with a physician who may diagnose the problem and prescribe treatment.

Since currently planned Shuttle flights will not exceed 30 days in duration, and many of the space adaptive physiological mechanisms require longer durations in weightlessness for changes of sufficient

magnitude to occur to permit detailed study, we are considering the feasibility of a Shuttle launched and recovered free-flyer satellite.* It could be a general purpose space flight experiment carrier system capable of accomplishing long duration orbiting space research for all elements of the Space Life Sciences program. This chart depicts how such a system might be deployed and recovered by an attached arm of the orbiting Shuttle. As I have indicated before, our research requires a range of experiments including cells, tissues and small animals.

SLIDE ON (MM73-6847)

SLIDE OFF

In the Space Life Sciences program we have considerable effort under way in an area best described as "Advanced Research and Technology". These efforts are very exciting and often times lead to the cutting edge of technology.

In the important area of life support technology and crew equipment systems, we have made great strides in improving performance, logistics, and cost effectiveness. Here* is a recently completed prototype orbital extravehicular suit. Our goal ~~here~~ was a design which could be produced for less money and provide a "universal" or non custom-fitted spacesuit ~~which would~~ and still have the same fit and comfort characteristics as an individually tailored suit. This is accomplished with tucked fabric joint designs using rotary bearings which improved mobility, and allow for various sized arms and legs.

SLIDE ON (MM73-6721 or exhibit)

In addition, the new materials used in this prototype suit holds promise of increased service and shelf life, so that an individual suit can be used for as much as 4 or 5 years, a significant improvement over current suits. SLIDE OFF (After the hearing you may wish to examine this suit in greater detail.)

In our advanced research and technology program of life support we consult and work with various agencies of the government with similar needs. This enhances the research effort and at the same time makes it more cost effective. An important area of such an endeavor is the treatment of water for human consumption. For this ozone has considerable potential. It is capable of higher reductions of residual organic contaminants than carbon adsorption, and is fully cost competitive. In a joint program with the Environmental Protection Agency, we are studying methods of ozone application. One method being investigated, shown on this chart, is a diffusion technique which controls the size of the ozone bubble, thereby reducing the ozone consumption and shortening the required contact time to a mere 30-60 seconds. On the question of sterilization, ozone, if properly applied will destroy all pathogenic bacteria and improve the acceptability of water by eliminating an undesirable flavor, odor or color. The success of this technology development could contribute much to the handling of water for human consumption here on earth.

SLIDE ON (MM73-6803

SLIDE OFF

Another of our efforts in advancing technology will augment man's capabilities in space operations as well as here on the ground. It is called "teleoperator systems technology." Our space goal is to provide remote/on-orbit satellite servicing technology. A free-flying remotely controlled spacecraft would extend man's sensory, manipulative and cognitive capabilities in performing replacement and repair tasks on satellites. Illustrated in this chart is a manipulator system accomplishing the replacement of a terminal board under the remote control of an operator viewing the worksite through a visual system. The operator could be in the Shuttle or in a ground station.

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SLIDE OFF

SLIDE ON (MM73-665

This same manipulator technology can be used to improve prosthetic devices for handicapped persons, such as that used by the young lady who appeared before the Committee last year as shown here. She testified to the usefulness of a motorized brace to assist the movement of her arms. ~~The new technology provides joint designs which have quieter, smoother movements capable of use with a closed loop control.~~ add insert

SLIDE OFF

Our efforts with the Soviets to publish the volumes on "Foundations of Space Biology and Medicine" are concluding. Publication will begin this year.

The Joint US/USSR Working Group on Space Biology and Medicine continued its data exchange with two meetings in 1973, one in Moscow in March and the second in Houston in December. The exchange has been marked

by a bilateral broadening of the scope and detail of information discussed. The participants have been able to visit institutes and laboratories where mutually important medical research is being conducted.* This photo shows the members of the U.S. delegation being briefed by Dr. Yeromin, physician to the cosmonauts, in the pre- and post-flight medical examination facility at Star City. Also shown is the special "exercise" suit and the exercise treadmill as was used on-board the Salyut space station. ~~On the table~~ On the left are other pieces of flight-type equipment such as bioinstrumentation and blood collection and stowage devices also used on-board Salyut. Major progress has been achieved in defining common laboratory and pre-and post-flight procedures for examining flight crews.

SLIDE ON (MM74-5130 on the table

SLIDE OFF

Several years ago, the life sciences activities within the National Aeronautics and Space Administration were consolidated to insure the ~~effective and~~ coordinated management, and effective accomplishment* of the total life sciences program, under the direction of the NASA Director for Life Sciences. Efforts in biomedical research, bioengineering, bioenvironmental systems, and flight project support are now coordinated with work in the areas of exobiology, planetary quarantine, ecology, aeronautical life sciences, occupational medicine, and life sciences applications.

SUMMARY

Now, at the close of the Skylab program, men in the US and USSR have lived in space a total of over 25,000 man hours. Skylab 4 increased the record approximately four times that of the pre-Skylab mark set by the USSR. Further, the 84 continuous days of weightlessness proved to be uniquely productive.

I feel that from a medical point of view, I can conclude that man can adapt to long flight durations, but with some adaptive changes. We have observed how these changes have occurred with time. What we don't know in detail are the mechanisms of these changes. Our Space Life Sciences program is designed to provide the in-depth understanding of the mechanisms of these adaptive changes. These studies using the new tool of space will undoubtedly assist our understanding of basic body physiology of man here on earth. Specifically we have quantitated the effects of bed rest such as orthostatic hypotension (a drop in blood-pressure and increase in heart rate on standing), calcium loss from bones and loss of muscle mass. We are also determining countermeasures to these effects which can ~~also~~ help patients ~~treated at bed rest for prolonged periods~~.

Also the cardiovascular studies inflight have allowed us to study the heart and blood vessel response to some pressure and volume changes precipitated by the unique environment of weightlessness. These results will assist our ground studies of heart disease and failure and

hypotension. Our in and postflight stressor of the cardiovascular system - LBNP - has also shown NIH researchers a way to determine specific heart function capability by combining it with the use of echocardiography as we did on Skylab 4 crew.

The opportunity to study the balance mechanism of the body - the vestibular system - in a gravity free environment is producing new theories of normal and abnormal function of this system. This will undoubtedly lead to new concepts of treatment and management of the vexing + oftentimes disabling maladies of the vestibular system here on earth.

New physiology is also being pioneered in the loss of red blood cells where it appears there is some physiological governor.

Thus our pre-in-and-postflight studies of ~~environmental~~ environmental adaptational physiology is indeed helping man on earth. Work will be accomplished in ground laboratories to further investigate and understand these changes as a prelude to scientific experiments on Shuttle for we have learned that even superb ground based studies are not true analogs of weightlessness and therefore flight data must be obtained.

In developing technology to make this possible, we also gain, for there is considerable spin-off of technology applications to our earth-bound problems. One of these is the collaborative study with HEW to apply telemedicine techniques to health care in space and here on earth.

LIST OF CHARTS

1.	MM73-5063	Medical Selection Criteria for Space Shuttle Passengers
2.	MM73-6836	IMBLMS Integrated Medical and Behavioral Laboratory Measurement System
3.	MM73-6847	Biomedical Experiments Scientific Satellite (BESS
4.	MM73-6721	Shuttle/Spacelab Orbital Extravehicular Suit
5.	MM73-6806	Ozone Application for Waste Water Treatment
6.	MM73-6676	Remote On/Orbit Satellite Servicing Technology
7.	MM73-6655	Improved Prosthetic Device
8.	MM74-5130	U.S. Medical Delegation Visit to Star City, USSR

MEDICAL SELECTION CRITERIA FOR SPACE SHUTTLE PASSENGERS

AVIATION MEDICAL STANDARDS

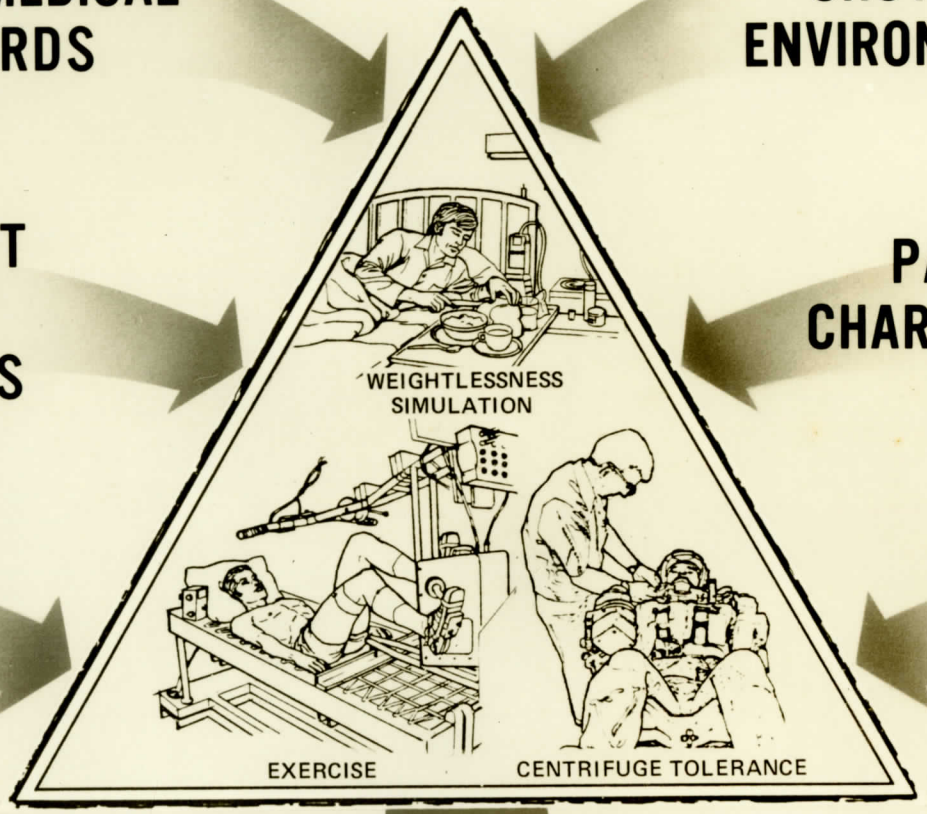
SHUTTLE ENVIRONMENT

ASTRONAUT MEDICAL STANDARDS

PASSENGER CHARACTERISTICS

BIOMEDICAL PROBLEMS OBSERVED

SIMULATION STUDIES



MEDICAL SELECTION STANDARDS AND CRITERIA

NASA HQ MM73-5063
12-31-73

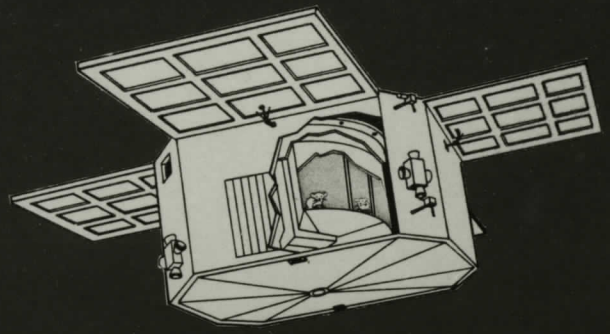
IMBLMS WILL PROVIDE FOR:

- SPACEFLIGHT CLINICAL MEDICINE CAPABILITY
- GROUND BASED TELEMEDICINE TECHNOLOGY

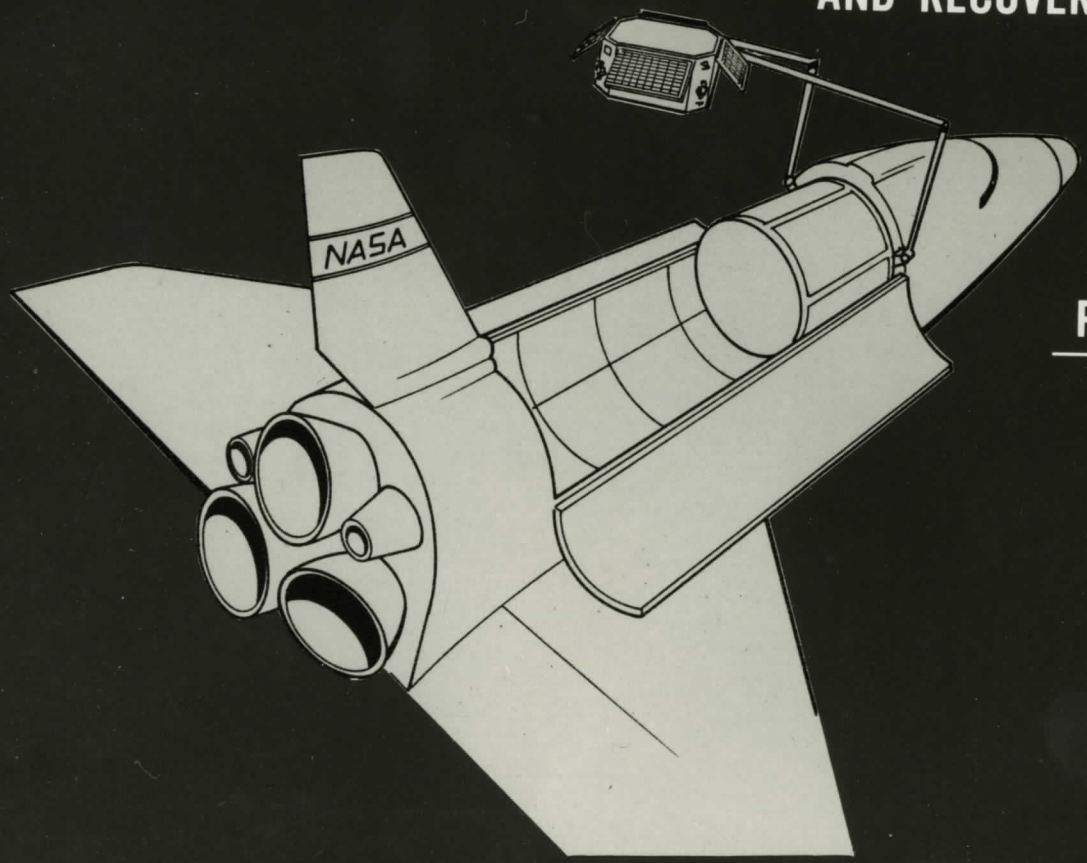
GROUND CONTROL CENTER

NASA HQ MM73-6836
12-31-73

BIOMEDICAL EXPERIMENTS SCIENTIFIC SATELLITE (BESS)



SHUTTLE DEPLOYED AND RECOVERED



PAYLOADS

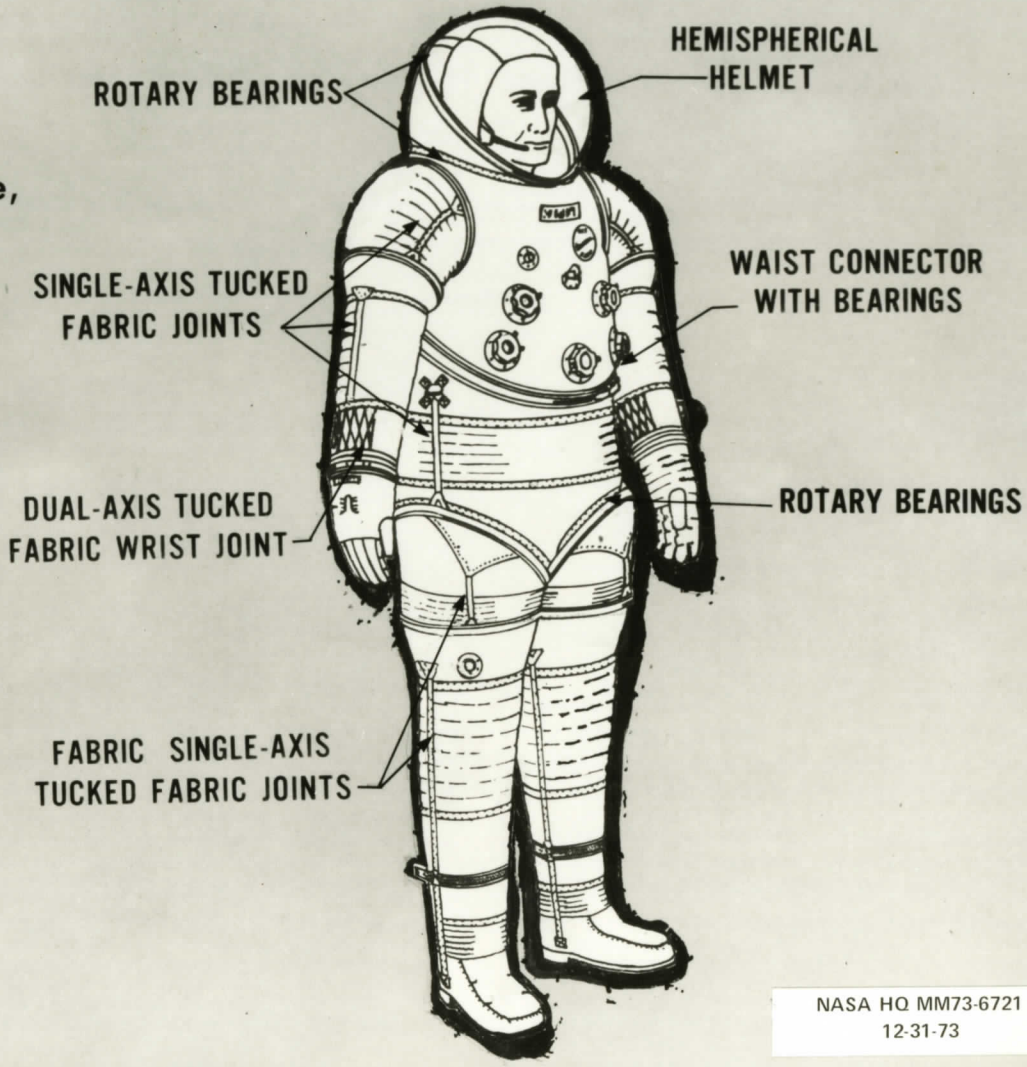
- ANIMALS
- ANIMAL SUBSYTEMS
- TISSUES
- CELLS

NASA HQ MM73-6847
12-31-73

SHUTTLE/SPACELAB ORBITAL EXTRAVEHICULAR SUIT

FEATURES

- REDUCED COST
  (Lower production cost, longer life, reduced inventory)
- IMPROVED MAINTENANCE
- INCREASED MOBILITY
  (Improved range of motion, reduced torques)



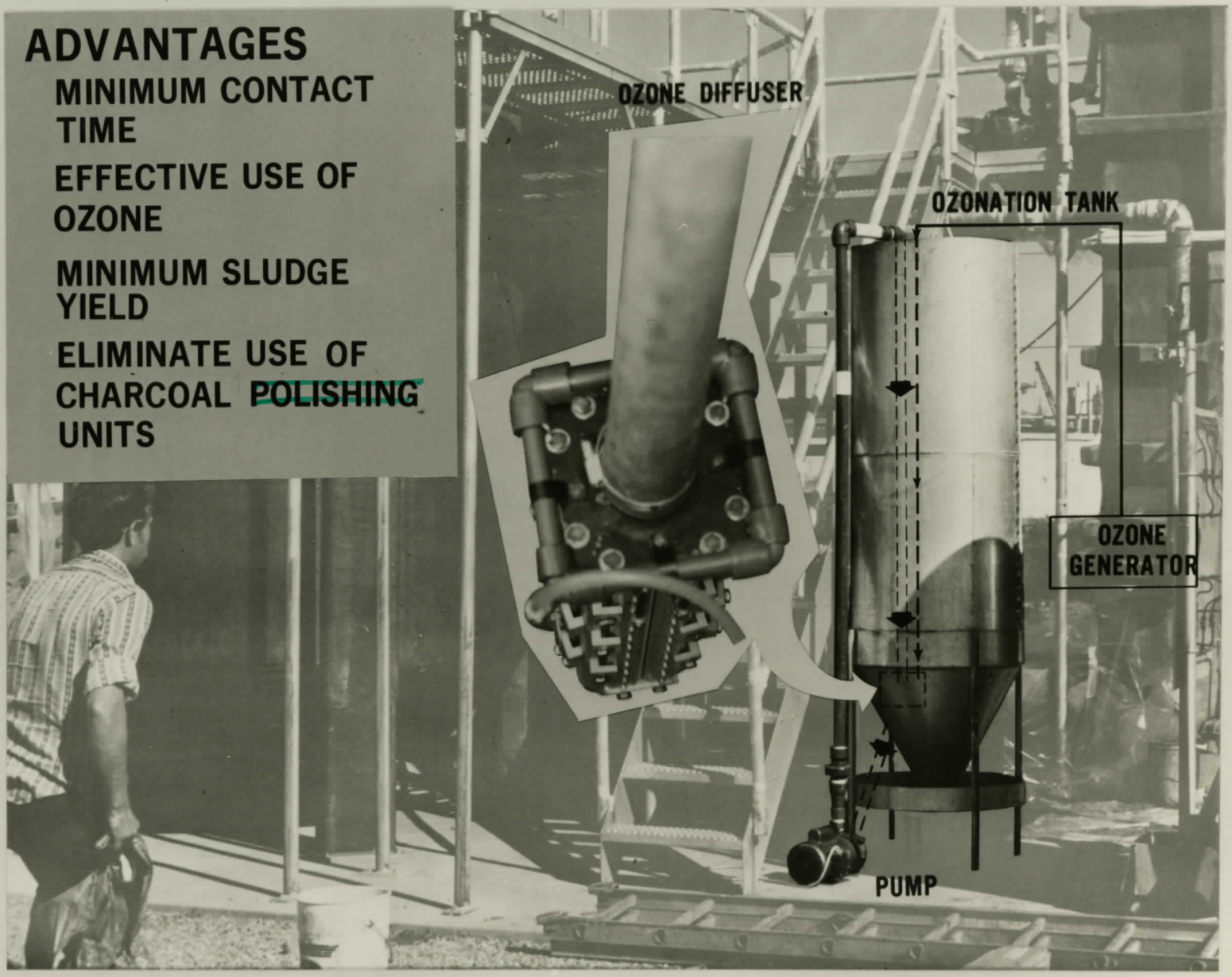
NASA HQ MM73-6721
12-31-73

JOINT NASA, E[illegible]

OZONE APPLICATION FOR WASTE WATER TREATMENT

ADVANTAGES

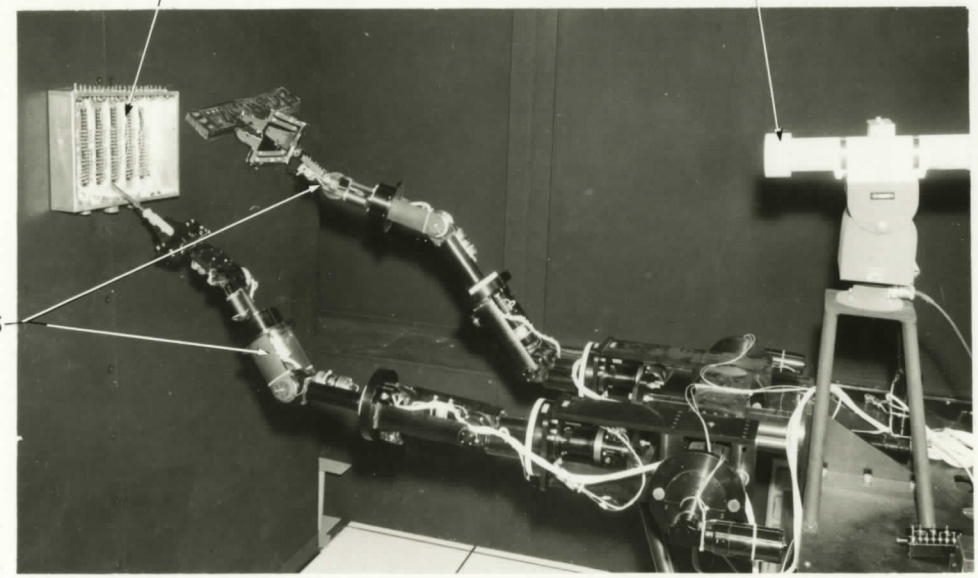
- MINIMUM CONTACT TIME
- EFFECTIVE USE OF OZONE
- MINIMUM SLUDGE YIELD
- ELIMINATE USE OF CHARCOAL POLISHING UNITS



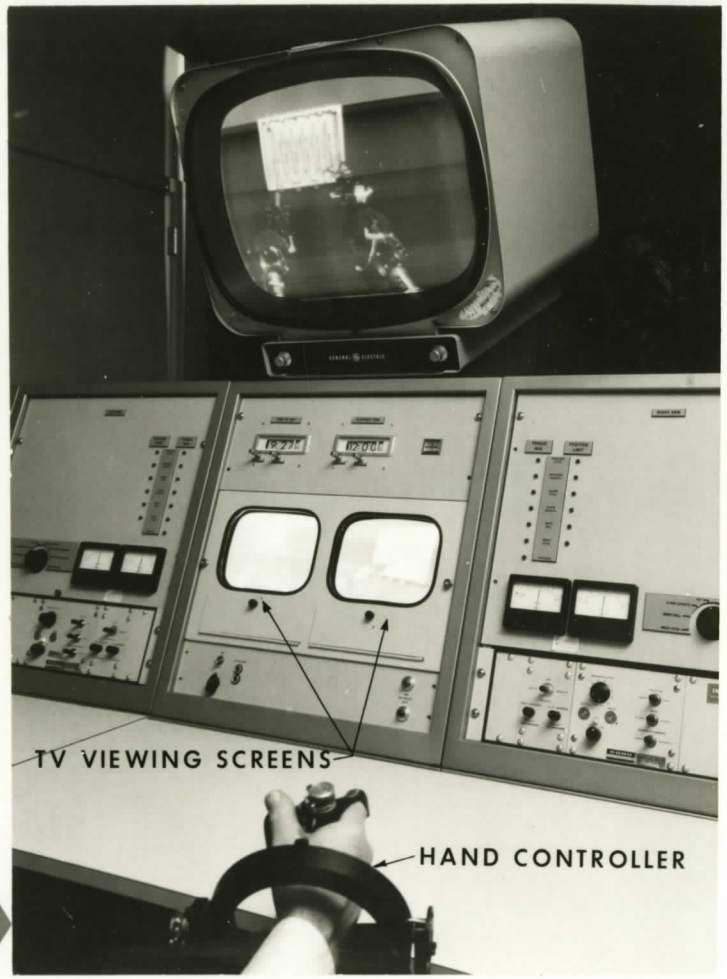
NASA HQ MM73-6806
12-31-73

REMOTE ON/ORBIT SATELLITE SERVICING TECHNOLOGY

MANIPULATOR SYSTEM



REMOTE CONTROL STATION

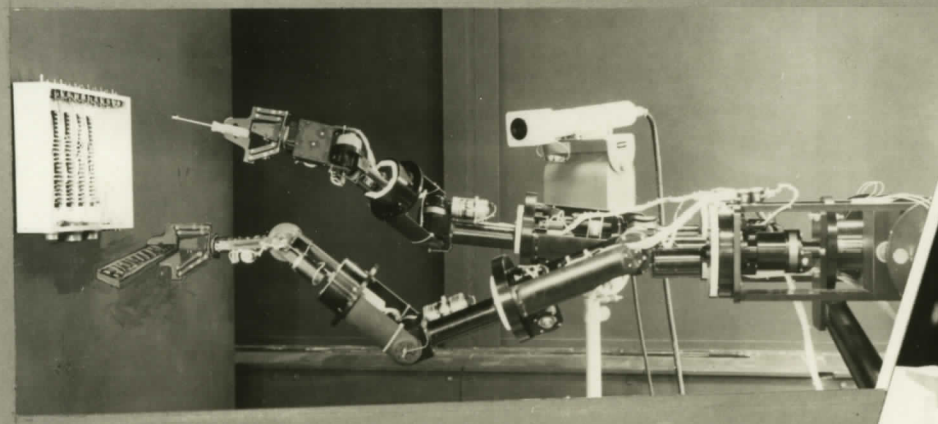


NASA HQ MM73-6676
12-3-73

TELEOPERATOR TECHNOLOGY SPIN-OFF

IMPROVED PROSTHETIC DEVICE

- **IMPROVED FEATURES**
  - JOINT DESIGNS
    - QUIETER OPERATION
  - CONTROL
    - REDUCED WORKLOAD

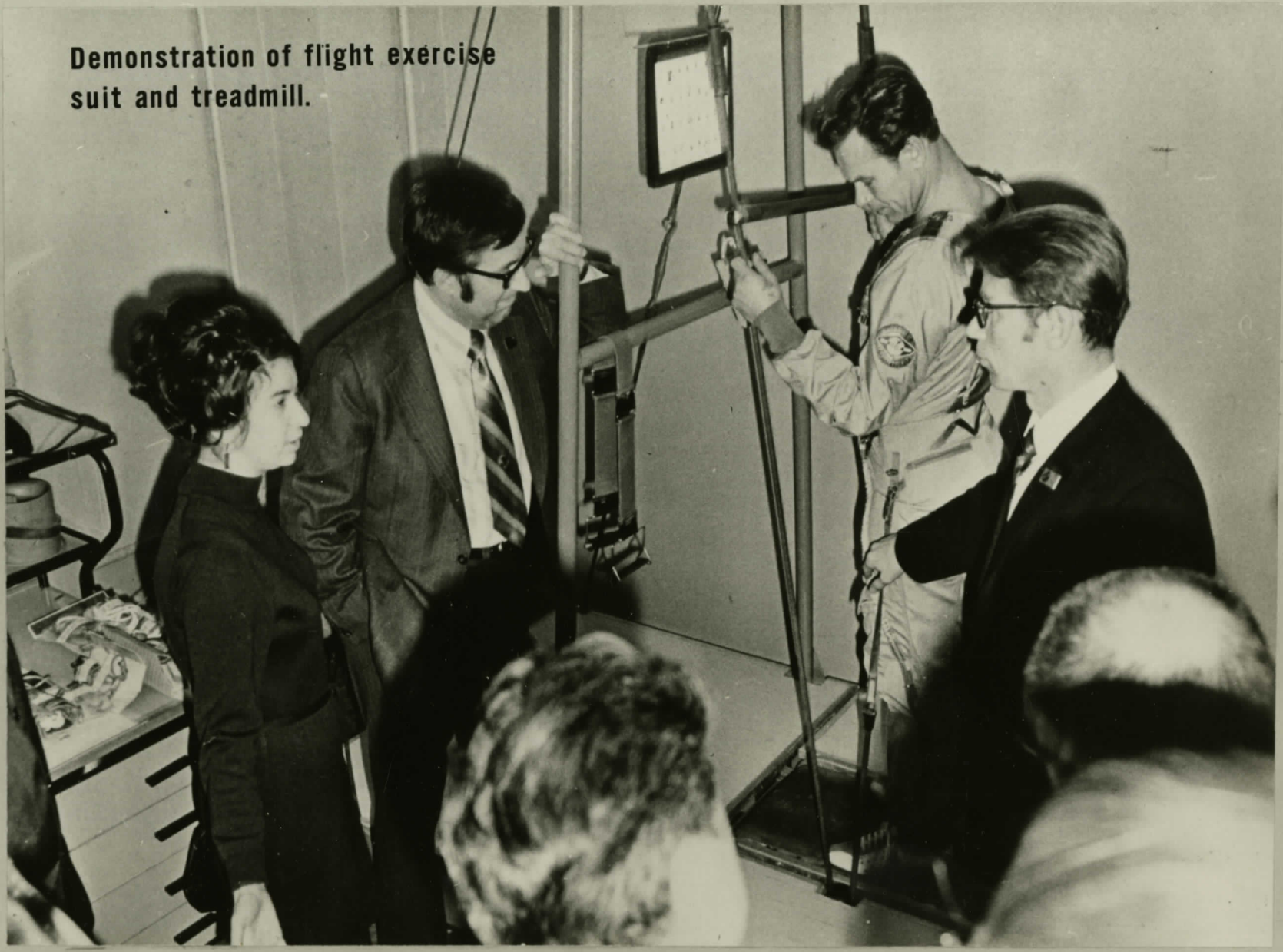


- **PRESENT DESIGN**

- **ADVANCED TECHNOLOGY CAPABILITY**

NASA HQ MM73-6655
12-3-73

U.S. MEDICAL DELEGATION VISIT TO STAR CITY,USSR



Demonstration of flight exercise suit and treadmill.

NASA HQ MM74-5130
1-30-74

DR. Berry

DR. KERWIN'S PRESENTATION

About three years ago - nearly two years before my flight on Skylab I - I had the privilege of writing about some of the things I anticipated as a crewman - a physician-scientist - onboard Skylab.

I recall that I began by stating that in the history of expanding man's frontier, the explorer has been followed by the homesteader and the generalist by the specialist. Skylab has truly followed that pattern. I guess as true homesteaders, the crewmen of Skylab would have to be considered only temporary settlers; however, when we began, we planned to inhabit Skylab for 140 days and, in fact, we exceeded that duration by more than a month or more than 20% longer than we expected. I believe that our Skylab I mission of 28 days was a significant advance over the previously completed U.S. flight of 14 days. However, as events have marched forward, I must admit that it was merely a first step to the subsequent Skylab II and III flights of 59 and 84 days respectively. Even with these important attainments, I still believe that Skylab was, in fact, only the beginning of a transition - a transition to that time when the scientist would enter his space transport vehicle, coast up to his orbiting space station, and go to work in his laboratory. We approached that idea in Skylab, but we still have a way to go to its ultimate consummation.

Many of the ideas which I shared with my fellow crewmen back in 1971 have been proven valid. The many attainments of Skylab, some

of which you have already heard and some of which will follow my statement, were made possible only because each crewman shared responsibilities, either as a subject or as an observer, in the variety of tasks required by the various disciplines onboard. While each crewman was designated primary responsibilities, we all worked at examining the Earth and its resources, at observing the Sun, at conducting what we called corollary experiments, and most important for me, at participating in the medical observations.

I believe that Skylab has been an historic program. We have proven that man can repair and maintain a complex space system. There is no question in my mind that man and his unique flexibility, versatility and ability made the sick Workshop well. The first significant event of the Skylab manned mission, after we tested for toxic gases, was the deployment of the parasol which was done under thermal stress conditions. As you recall, we worked in 130 degrees ambient temperature while we deployed the parasol. This was my first major medical activity in space; using basic thermal physiology criteria to regulate the length of time we worked before returning to the MDA to cool off.

Vugraph #1

In the medical area, I believe that the ideas we expressed in 1971 were well-founded. As a physician, I had the opportunity to work with the procedures and checklists both prior to launch and inflight, and to make them more efficient for our mission and for the subsequent flights.

We were fortunate that no significant illness developed among crew members during the flight of Skylab, however, I had the opportunity of activating and documenting the use of the Inflight Medical Support System - our onboard medical diagnostic and treatment capability - and of testing its potential application in the event of illness. I'm pleased to report that its design and make-up proved most adequate and some of its contents were used for the treatment of minor illnesses, for medical experiments and for microbiological sampling.

The obtaining of blood samples by venipuncture was a first in the history of manned space flight and proved to be an invaluable adjunct to the biochemical determinations postflight and then, I performed a blood count in space. Vugraph 2 Vugraph 3

There is no question in my mind that the physical examinations I performed established beyond any doubt that medicine can be practiced in the space environment and the diagnostic equipment adequately supports the physician's requirements. Vugraph 4

While we found little need to alter the planned medical procedures during my Skylab I mission, I feel that one of the most important contributions to the total Skylab Program was the series of recommendations which arose from the flight and ground-based medical personnel from the preliminary evaluation of our inflight findings and which resulted in the innovative use of the onboard equipment to make important new and unique medical observations.

I would like to talk to you about the clinical and the subjective data as we developed it onboard the first Skylab mission. In order to do so, I have pretended that the three of us on Skylab were one man, and have put together a composite medical history and physical examination.

On the 13th of June, 1973 which was the 20th day of the Skylab mission, I was called from my busy practice to examine a patient who had the following story to tell. His chief complaint was an unexplained weight loss of about six-and-a-half pounds. His story of his present illness was as follows.

Three weeks ago, he was minding his own business on launch pad 39 at Cape Kennedy, when he was suddenly launched into a circular orbit around the Earth whose parameters have been previously described. The resulting state of free fall has continued until the present, that is day 20.

There was an initial period of somewhat decreased appetite which lasted three or four days, with a corresponding slight decrease of thirst, but no subjective diuresis. On weighing himself on the fifth day, he had lost three-and-a-half pounds. Since that time, his appetite has returned to essentially normal levels, and he feels well. But, an additional three pounds have been lost at the end of three weeks.

On the review of BODY systems, I got the following answers. He describes a feeling of well-being. He says that his appetite and

thirst are normal, and that he could eat more food if it were necessary. He says that he especially craves meat and ice cream. He has noted the following abnormal, for him, sensations.

Number one, a feeling of fullness in the head, as though he had a cold, which he does not. This has been continuous since the very first minutes of his arrival in weightlessness. And, it decreases subjectively only during the time that he is subjected to lower body negative pressure.

Number two, he has noticed a peculiar posture. When he is relaxed, his neck extends and moves backward, his shoulders and elbows flex 20 or 30 degrees, the same is true of the hips and the knees in that the shoulders tend to rise up towards his ears. This is uncomfortable at first, and it is a little annoying when he attempts, for instance, to read a book in the normal fashion by putting it down on his lap. But, he has gradually become accustomed to it and has stopped attempting to pull his shoulders down manually, because it is no good, they just go right back up again as soon as he relaxes. He has noted a tendency to become sleepy, and even to take cat naps at such times when he is motionless and relaxed. For instance, during the resting phase of the various medical experiments, this happened. Frequent exercise is desired to restore feeling of vigor and alertness.

As far as the various body systems go, no abnormal eye symptoms except that he reports that when his eyes are closed and dark

Vugraph 5

adapted as it is when he is preparing for sleep, he occasionally sees light flashes described either as pinpoint stars or occasionally as streaks going across the visual field. This is not a constant finding, it only occurs every once in a while. As far as the ears are concerned, one ear has a feeling of fullness all the time, the other ear is normal. Although, he reported that during the first several days of the mission, he had frequent crackling noises in his ears, and a requirement to valsalva in order to refill the middle ears several times a day. This has by now, gone away.

He also reports that distant sounds appear to be more difficult to hear than they are on the ground. In the nose and throat area, he said that he and his fellow crewmates were quite hoarse during the first week or ten days of the flight. He attributes this to the fact that they had to shout in order to be heard across the distances involved in the workshop. They gradually gave up on shouting, and began using the intercom system instead, and the hoarseness has gone away.

He also has noticed in himself and in his crewmates a peculiar nasal quality to the voice. This was immediate, and has been continuous.

In the gastrointestinal system, the only abnormal finding is that is is very difficult to belch, to pass gas out through the mouth. One does swallow a great deal of gas, and one finds that the GI system processes it posigrade, very effectively, and with great volume and frequency.

When asked about the vestibular system this particular individual reported that there were no symptoms of motion sickness as he had been taught to experience them and describe them during preflight testing. That is, there was no malaise, no nausea, no pallor, no sweating, and so forth. There was, as reported previously, the slight decrease in appetite. Along about the eighth or ninth day of the mission, the patient decided at that time that he felt better than he had during the first two or three days. But, it was strictly hindsight. If you had asked him how he felt on the third day, he would have said that he felt fine.

Since that time, he has been essentially immune to motion sickness. He has discovered that his method of orienting himself and of moving about is quite different from the ground. He finds that his orientation is completely visual, completely internal, and extremely rapid. By completely internal, he means, that whatever his body attitude is at a particular time, he describes not only intellectually, but subjectively, "up" as being above his head, "forward" as being straight in front of him. He is carrying his own frame of reference around with him. If he rotates his body to a new attitude, his frame of reference follows it very quickly. By completely visual, he means that if he closes his eyes, he loses immediately all track of the location of exterior objects relative to his body frame of reference. He is completely lost.

In the cardiovascular area, he has no complaints. He has Vugraph 6 noticed that his pulse rate seems to be lower. The only difficulty that he has had subjectively inflight, has been during the lower body negative pressure exercise which is a great deal more difficult to complete in weightlessness than it was on the ground before the flight. The pulse rate is higher, the blood pressure is somewhat lower, and there is an increased tendency towards syncope on some of the runs. This is the one medical experiment that is subjectively stressful inflight. However, he is not able to say that as the days go on, the tests become more stressful. The distribution seems to be random. One day will be better, one day will be worse, but there is no clear cut trend.

As far as sleep, he says that the quality of sleep has been good. Although, it seems to have taken him a little longer to get to sleep, at least, at first. He feels this is strictly a subjective comfort thing that he is not able to arrange his limbs in the same way that he does on the ground.

My colleagues and I did not appear to be under any chronic stress, and we did not feel as though we were under any chronic stress. These, as I say, are clinical impressions only. We felt that our general health was good. We felt that our skin problems were probably due to the dryness of the low humidity of the atmosphere.

The immunity to motion sickness was very dramatic to us inflight, and crudely appeared to be due in some way to the removal of the

stimulus to and the output from the otolith organ. I cannot give any more detail than that.

The chief complaint was weight loss. That, to me, remains an enigma. We have the paradox of weight loss in the face of a normal appetite, and a normal caloric intake, and with less than normal exercise, and apparently, a somewhat lower than normal basal metabolic rate, and apparently, with no fat storage.

Without the laboratory and the chemical data, a clinician can go no further.

I do not intend to attempt to discuss the medical findings of Skylab since Dr. Berry, the NASA Director for Life Sciences, will do that in his presentation to you. I would like to say, however, that the opportunity of participating in an historic space mission as a crewman and a physician has been a uniquely rewarding experience. I know first hand what man can do in space. There are physiological responses and penalties to the space environment. We now know much more what these reactions are and we need to understand the physiological mechanisms which mediate these changes. Personally, I am convinced that man can do in space anything that he can do reasonably well here on Earth. We need some new protective measures which must be developed and tested; however, we must recognize the vast improvements which we have already made since the days of Mercury and Gemini in a time span that has been less than 15 years.

Hopefully, space stations will be a reality at some time during the next human generation. Five days before our crew was launched, we went outside in the evening to watch Skylab pass overhead. It moved pretty rapidly, but it shone as bright and steady as a star, and we knew it was going to be up there for a long time. To me, it was as though we were going up to homestead a new state--as though that vehicle were the fifty-first star on the flag. The territory is still open and there's a lot to be done up there. We'll be ready when you are.