

Appendix 9

**The Development of SM-80 Minuteman
R. F. Piper, April 1962
Documents 7, 8, 9
Digital National Security Archive
NH00024**

21 February 1956

MEMORANDUM FOR: Colonel Charles H. Terhune, Jr.

SUBJECT: Research and Development in Rocket Motors

1. With regard to our coordination of activity with WADC and AFOSR, this office is operating exactly along the lines suggested by General Demler in the inclosed communication. With regard to AFAC, however, no lines of coordination have been established. Although the work of AFAC in the general field of propellant and rocket basic development has been limited, it is felt that a review of the program sponsored by AFAC and those contemplated would be in order.

2. It is recommended, therefore, that WDTP be permitted to contact AFAC and arrange for a general discussion of the program sponsored by the two organizations so as to avoid unnecessary duplication and overlap.

E. N. HALL
Lt. Colonel, USAF

1 Incl:
Cy ltr 30 Jan 56
fm RDTDAG

E. N. HALL
Lt Colonel, USAF
Chief, Propulsion Group

*Approved, but with
315A and other duties
of WDTP in mind. J
22 Feb*

WDG

25 February 1956

MEMORANDUM FOR: Colonel Sheppard

SUBJECT: System Mobility

Do we have studies underway concerning a completely mobile ICBM Operational System. Also, what are we doing with respect to studies concerning mobility of the missile stockpile.

Bos.
B. A. SCHRIEVER
Major General, USAF
Commander

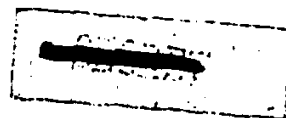
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DOD DIR 5200.10

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FROM: (Originator)

COMDR WESTERN DEV DIV INGLEWOOD CALIF

DATE-TIME GROUP

23 2200 Feb 56 Z

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PRECEDENCE FOR:

ACTION

INFORMATION

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TO:

COMDR HQS ARDC BALTIMORE MD
ATTN: LT COLONEL L. F. AYRES RMDTDP

BOOK MESSAGE

ORIGINAL MESSAGE

MULTIPLE ADDRESS

CRYPTOPRECAUTION

YES

NO

REFERS TO MESSAGE:

IDENTIFICATION

CLASSIFICATION

INFO: cy: LT COLONEL P. G. ATKINSON RMDTDP

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FROM: WDTLP-2-6-E

I THE FOLLOWING DEVELOPMENT PLAN IS SUBMITTED AS PER REQUEST 24 FEBRUARY 1956.
PROPELLANT

SOLID/ROCKET DEVELOPMENT PLAN. A. OBJECTIVES 1. THE OBJECTIVES OF THE SOLID PROPELLANT ROCKET PROGRAM ARE TO OBTAIN THE BASIC INFORMATION NECESSARY TO DETERMINE THE FEASIBILITY OF DEVELOPING SOLID PROPELLANT ROCKETS SUITABLE FOR USE AS PRIME POWER PLANTS FOR MISSILES OF THE IRBM TYPE AND AS BOOSTERS FOR NUCLEAR POWERED ROCKETS AND RAMJETS. AND ESTABLISH DESIGN CRITERIA FOR ^{development of these ~~solid~~ rockets} ~~INITIATING/~~ ^{ENGINE} ~~DEVELOPMENT.~~ THE IMMEDIATE OBJECTIVES ARE TO DEVELOP PRACTICAL TECHNIQUES FOR MANUFACTURING HIGH PERFORMANCE SOLID PROPELLANT ROCKETS OF MAXIMUM RELIABILITY WITH OVERALL IMPULSES BETWEEN FIVE (5) MILLION AND TWENTY (20) MILLION POUND-SECONDS AND BURNING TIMES BETWEEN FIFTY (50) AND ONE HUNDRED AND FIFTY (150) SECONDS. B. DEVELOPMENT PROGRAM.

1. IT IS PLANNED TO CARRY OUT THE TWO-YEAR ^{General} DEVELOPMENT PROGRAM IN TWO PHASES: AN EXPLORATORY PERIOD, DESIGNED TO LAST FOR ONE YEAR WHICH WILL INCLUDE STUDIES,

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PAGE OF PAGES

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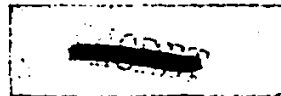
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TO:

COMDR HQS ARDC BALTIMORE MD
ATTN: LT COLONEL L. F. AYRES RDTDPP

INFO: CY: LT COLONEL P. G. ATKINSON RDTDPP

ANALYSES, EXPERIMENTAL WORK IN THE AREAS OF PROPELLANTS, INTERIOR BALLISTICS, HARDWARE, CONTROLS, AND IGNITION, AND AN ADVANCED DEVELOPMENT PHASE WHICH WILL BE DEVOTED TO THE DEVELOPMENT AND TESTING OF ONE OR MORE SPECIFIC UNITS. 2. NO WORK IS PLANNED ON THE DEVELOPMENT OF NEW PROPELLANT FORMULATIONS, NEW METALS (ALLOYS), PLASTICS, OR CASES. EFFORT WILL BE CONCENTRATED ON THE DEVELOPMENT OF TECHNIQUES FOR USING THE BEST AVAILABLE PROPELLANTS AND MATERIALS OF CONSTRUCTION IN ROCKETS OF THE SIZES REQUIRED FOR IREM APPLICATION. 3. SPECIFIC ITEMS TO RECEIVE ATTENTION CONCURRENT WITH COMMENCEMENT OF EXPERIMENTAL WORK BY CONTRACTOR ARE BEING PLANNED FOR UNDERTAKING ANALYSES OF THE POTENTIAL MISSILE SYSTEMS FOR WHICH THE POWER PLANTS ARE INTENDED. THIS ANALYSIS WILL PROVIDE THE INFORMATION WHICH FOLLOWS: (A) AN EXACT DETERMINATION OF THE FEASIBILITY AND DESIRABILITY FROM A PRACTICAL STANDPOINT OF DEVELOPING AN IREM POWERED WITH SOLID PROPELLANT ROCKETS. (B) DESIGN OBJECTIVES FOR THE MISSILE POWER PLANTS: (1) NUMBER OF STAGES REQUIRED. (2) THRUST TIME RELATIONSHIPS REQUIRED. (3) OPTIMUM CONFIGURATION FROM STANDPOINT OF AERODYNAMICS. (4) GUIDANCE REQUIREMENTS. (5) STRUCTURAL REQUIREMENTS. (6) BALLISTIC CONTROL

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PAGE 2	OF 6 PAGES

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CC:DR WESTERN DEV DIV INGLEWOOD CALIF

TO:

 BOOK MESSAGE ORIGINAL MESSAGECC:DR HQS ARDC BALTIMORE MD
ATTN: LT COLONEL :L. F. AYRES RDTDPP MULTIPLE ADDRESS

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 YES NO

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INFO: cy: LT COLONEL P. G. ATKINSON RDTDPP

REQUIREMENTS. 4. EFFORT DURING THE SECOND YEAR WILL CONSIST OF REFINEMENT OF BASIC DESIGNS DEVELOPED DURING THE FIRST YEAR AND THE COMMENCEMENT OF RELIABILITY TESTING OF ROCKETS BASED ON THESE DESIGNS. THE RELIABILITY TESTING PROGRAM WILL CONSIST OF FIRING OF APPROXIMATELY 40 FULL SCALE ROCKETS LEADING TO THE SELECTION OF A DESIGN FOR FLIGHT TESTING. 5. ~~THE~~ ^A ~~THE~~ THIRD YEAR PROGRAM ~~WILL~~ ^{WILL} CONSIST OF FURTHER TESTING BASED ON SECOND YEAR FINDINGS AND THE FLIGHT TESTING OF THESE DESIGNS. IT IS EXPECTED THAT APPROXIMATELY ONE HUNDRED (100) UNITS ~~WILL~~ ^{WILL} BE FLIGHT TESTED IN THIS PROGRAM WITH COMPLETION OF DEVELOPMENT EXPECTED BY MARCH 1960. 6. IN ADDITION TO THE PREVIOUS TASKS ASSIGNED TO WESTERN DEVELOPMENT DIVISION THE OFFICE OF SCIENTIFIC RESEARCH HAS BEEN DELEGATED THE TASKS OF DEVELOPING HIGH TEMPERATURE CEMENTS, THERMAL BARRIERS, COATING MATERIAL, AND CONDUCTING CHEMICAL KINETIC STUDIES OF SOLID PROPELLANTS TO ESTABLISH LAWS OF EROSIIVE BURNING AND OTHER APPROACHES TO HIGH LOADING DENSITY. C. ANTICIPATED PROBLEM AREAS 1. HARDWARE - NO SYSTEMATIC STUDY HAS BEEN MADE TO OBTAIN MAXIMUM STRENGTH-TO-WEIGHT RATIO ROCKET MOTORS FOR SOLID PROPELLANTS; IN PARTICULAR, THE DESIGN OF NOZZLES HAS BEEN ACCOMPLISHED ON A PURELY EMPIRICAL BASIS WITH LITTLE ATTENTION TO MINIMIZING WEIGHT. INVESTIGATIONS WILL BE PERFORMED ON THE USE OF HIGH-STRENGTH WOUND CASES (OF THIN STEEL STRIP), PLASTIC CASES, ADHESIVES, AND INSULATING MATERIALS. STUDIES ARE ALSO NEEDED ON MINIMUM WEIGHT NOZZLES CAPABLE OF OPERATION FOR REQUISITE PERIODS. 2. CONTROLS - MAJOR PROBLEMS EXIST IN THRUST

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COMDR WESTERN DEV DIV INGLEWOOD CALIF

TO:

COMDR HQS ARDC BALTIMORE MD
ATTN: LT COLONEL L. F. AYRES RDTDPP

INFO: cy: LT COLONEL P. G. ATKINSON RDTDPP

VECTOR CONTROL AND THRUST TERMINATION. JET VANES, GIMBALED NOZZLES, AND DEVIATION OF THE EXHAUST GASES BY BOUNDARY LAYER SEUCK WILL BE INVESTIGATED AS POSSIBLE SOLUTIONS FOR THE THRUST VECTOR CONTROL PROBLEM, AND BOTH CHEMICAL AND MECHANICAL MEANS FOR THRUST TERMINATION WILL BE EXPLORED. 3. PROPELLANTS - TWO CLASSES OF PROPELLANTS ARE COMPOSITES BASED UPON POLYURETHANES, OR BUTYL AND MODIFIED GRS SYNTHETIC RUBBER. THICKOL PROPELLANTS HAVE THE MAJOR DISADVANTAGES OF HAVING A POLYMER WHICH IS DIFFICULT TO CONTROL WITHIN NARROW LIMITS, AND WHOSE THERMAL STABILITY IS UNDESIRABLY POOR. POLYURETHANE, WITH AN APPRECIABLE PERCENTAGE OF BOUND OXYGEN, REQUIRES A LOWER PERCENTAGE OF OXIDIZER FOR STOICHIOMETRIC LOADING WITH CONSEQUENT GOOD PHYSICAL PROPERTIES. SPECIFIC IMPULSES OF THESE PROPELLANTS ARE SOMEWHAT LOWER THAN THAT OF THE RUBBER BASED FORMULATIONS, AND EXTRACTION OF MANDRELS FROM VERY LARGE GRAINS MAY BE DIFFICULT. THESE PROPELLANTS ARE CASTABLE WHICH MAY PRESENT A SIGNIFICANT ADVANTAGE OVER THE RUBBER BASE MATERIALS. SPECIFIC IMPULSES OF THE MATERIALS WHICH SEEM WORTHY OF FURTHER STUDY RANGE BETWEEN 220 and 240 SEC. 4. INTERIOR BALLISTICS IN ORDER TO OBTAIN LOADING DENSITIES (14), OF THE ORDER OF 0.95, IT WILL BE NECESSARY

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PAGE 4 OF 6 PAGES

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CC:DR WESTERN DEV DIV INGLEWOOD CALIF

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TO:

CC:DR HQS ARDC BALTIMORE MD
ATTN: LT COLONEL L. F. AYRES RDTDPP

INFO: cy: LT COLONEL P. G. ATKINSON RDTDPP

TO STUDY METHODS OF ACHIEVING CONTROLLED EROSION BURNING, AND OPERATE AT VERY LOW PORT TO THROAT RATIOS. CHARGE CONFIGURATIONS CONTAINING A ^{OR CONICAL} CYLINDRICAL/PERFORATION APPEAR TO OFFER MAXIMUM PROMISE BECAUSE SUCH CONFIGURATIONS EVIDENCE MINIMUM DISTORTION WITH TEMPERATURE CHANGE. IT PROBABLY WILL BE NECESSARY TO VARY THE COMPOSITION OF THE PROPELLANT THROUGH THE WEB IN ORDER TO COMPENSATE FOR THE PROGRESSIVE PRESSURE TIME CURVE WHICH IS NORMALLY OBTAINED WITH A CYLINDRICAL PERFORATION.

5. IGNITION AND SUPPORT - IGNITION OF CHARGES OF THE ORDER OF 40 FEET IN LENGTH IS EXPECTED TO PRESENT SOME UNIQUE PROBLEMS, PARTICULARLY BECAUSE IT WILL BE NECESSARY TO IGNITE FROM THE NOZZLE END IN ORDER TO PRESERVE THE STRUCTURAL INTEGRITY OF THE CASE. IT IS EXPECTED THAT IGNITERS OF THE "SHOT GUN SHELL" TYPE, USING METAL-OXIDANT-PYROTECHNIC MIXTURES WILL PROVE SATISFACTORY. THE MECHANICAL PROBLEMS INVOLVED IN MOUNTING THE IGNITER WILL REQUIRE ATTENTION. IN ADDITION, IT WILL BE DESIRABLE, IF NOT MANDATORY, TO HAVE A PROGRAM LEADING TO THE DEFINITION OF THE FUNDAMENTAL PARAMETERS OF IGNITION OF COMPOSITE SOLID PROPELLANTS. A BASIC PROGRAM IN OTHER SUPPORT AREAS SUCH AS THE DEVELOPMENT OF SUPERIOR PLASTICS AND ADHESIVES WILL BE PURSUED.

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COMDR WESTERN DEV DIV INGLEWOOD CALIF

TO:
COMDR HQS ARDC BALTIMORE MD
ATTN: LT COLONEL L. F. AYRES RD2DPP

INFO: cy: LT COLONEL P. G. ATKINSON RD2DPP

II. ESTIMATED COST BREAKDOWN THROUGH FY 1958. FY 1956: P-600 FUNDS - \$3,000,000 -
 AND EXPERIMENTAL INVESTIGATION,
 PROPULSION DEVELOPMENT AND MISSILE STUDIES/ FY 1957: P-600 FUNDS - \$5,000,000 -
 AND GENERAL DEVELOPMENT.
 PROPULSION DEVELOPMENT AND MISSILE STUDIES/ P-150 FUNDS - \$15,000,000 - PROPULSION
 FABRICATION AND LEAD TIME ITEMS, INSTALLATION OF SPECIAL TEST EQUIPMENT, INITIAL
 MISSILE DEVELOPMENT. *(not possible to estimate amount required until priority of program is known)*
 FY 1958: P-150 FUNDS - \$100,000,000 - PROPULSION FABRICATION AND

LEAD TIME ITEMS, ~~COMPLETE~~ RELIABILITY TESTING, MISSILE DEVELOPMENT AND FABRICATION,
 INCLUDING LEAD TIME ITEMS. ^{Possible} III. SOLID PROPELLANT ROCKET DEVELOPMENT SCHEDULE.

- A. INITIAL PROCUREMENT WORK TO SELECT CONTRACTORS AND AWARD CONTRACTS - JAN-MAR 1956.
- B. PROPULSION CONTRACTORS PERFORMANCE AND DESIGN STUDIES - APRIL-JUNE 1956.
- C. PROPULSION DEVELOPMENT TEST PROGRAM (DETERMINATION OF FEASIBILITY & OPERABILITY) - JULY 1956-APRIL 1957.
- D. PROPULSION RELIABILITY TEST PROGRAM (PREPARATION FOR FLIGHT TEST) - MAY 1957-APRIL 1958.
- E. WDD AND R-W SPONSORED MISSILE OPTIMIZATION STUDIES (DEFINES MISSILE SYSTEM TO BE DEVELOPED) - JULY 1956-DECEMBER 1957.
- F. MISSILE SYSTEM CONTRACTOR DEVELOPMENT PROGRAM - APRIL 1957-MARCH 1960.
- G. MISSILE AND PROPULSION FLIGHT TEST PROGRAM - AUGUST 1958-MARCH 1960.

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DRAFTER'S NAME (and signature, when required) <i>Edward H. Hall</i> EDWARD H. HALL, Lt Col., USAF prs		RELEASING OFFICER'S SIGNATURE SIGNED CHARLES H. BERHUNE, JR., Col., USAF
SYMBOL WDPLP	TELEPHONE 1050	OFFICIAL TITLE DEP COMDR, TECH. OPERATIONS