25 MAY 1959

WDG

MEMORANDUM FOR GENERAL SCHRIEVER

SUBJECT: Letter of Appreciation for Support on Recent DISCOVERER Capsule Search to Commander-in-Chief, Royal Norwegian Air Force

1. The attached letter of appreciation to the Commander-in-Chief of the Royal Norwegian Air Force is forwarded for your approval and further transmission to General White for signature.

2. The letter is both timely and appropriate in expressing our sincere appreciation for their effort in support of the DISCOVERER II capsule search at Spitsbergen, Norway.

Original Signed
O. J. RITLAND

1 Incl
Ltr to RNAF,
Oslo, Norway

O. J. RITLAND
Brig General, USAF
Commander

Ltr [illegible] signed by Gen Schriever

Lt. General Birger F. Motzfeldt
Commander in Chief
Royal Norwegian Air Force
Myntgaten 1, Oslo, Norway

Dear General Motzfeldt:

I would like to express my appreciation and gratitude, to you and your staff, for your excellent effort in support of the United States Air Force in the recent search mission for Discoverer II.

It is regrettable that we were unable to give you more advanced notice of our arrival. Those personnel under your command, who were already carrying a heavy work load by regular assignment, were suddenly burdened with the additional support of our activities. I am told, however, that each individual undertook these additional duties with a spirit of enthusiasm and worked unceasingly for the accomplishment of a mutual and common end. This important provision of prompt, effective, and enthusiastic local assistance, rendered by Bodø Air Base personnel, was most gratifying and of inestimable value to the United States Air Force.

The high confidence level in the thoroughness of the search, [illegible], is a direct reflection of your [illegible] response and support under less than ideal conditions. Our project personnel have expressed great pride in their association with your people and feel that the fellowship engendered mitigates in large measure the [illegible] disappointment in not locating the capsule.

My Project Officer informs me that certain individuals made contributions of such outstanding value as to warrant personal mention. They are:

[illegible]-Johnsen, Air Commander, North Norway

Colonel J. [illegible], Wing Commander, Bodø Air Base, Norway

It is with great personal satisfaction and appreciation that I tender this letter to you indicating my observations and acknowledgement of your dedicated energy, your warm friendship, and your traditional Norwegian hospitality.

Sincerely,

WDZWF IZ 11 May

Capt. Fruge 3045

25 MAY 1959

Brigadier General Thomas J. Dubose
Commander, Air Rescue Service
Orlando Air Force Base, Florida

Dear General Dubose:

I have long been aware of your excellent performance in the [illegible] of rescue service in all parts of the world. It is, therefore, very gratifying for me to forward this letter as evidence of my appreciation for your contributions in our recent search mission for DISCOVERER II, at Spitsbergen, Norway.

Your high state of operational readiness, your efficient administrative activities, and your immediate response to our call, guaranteed rapid participation by selected elements of your command. I understand that simultaneous to receipt of the affirmative message by the Norwegian Government for our entry to Norway, your rescue service aircraft started landing procedures at Bodo Air Base, Norway. Further, within a few hours thereafter, your personnel had completely manned and staffed a search control center and had orderly dispatched aircraft for the search mission.

Lt Colonel [illegible], my senior representative at Bodo, Norway, informed me that certain individuals made contributions of such outstanding value as to warrant personal mention. They are:

[illegible], T. F., Colonel, Deputy Commander, Air Rescue Service, Europe

[illegible], Ernest O., Lt Colonel, 67th Air Rescue Service, Prestwick, Scotland

Etheredge, Arthur L., Lt Colonel, 53rd Air Rescue Service, Keflavik, Iceland

Krafka, E., Major, Operations Officer, 3rd Detachment, Ramstein, Germany

Voite, A. K., Major, Asst Ops Officer, 67 ARS, Prestwick, Scotland.

My sincere thanks to you and those members of your command who participated in the Search Program.

Original Signed
O. J. RITLAND

O. J. RITLAND
Brig. Gen., USAF
Commander

2 5 MAY 1959

Major General E. Tufte-Johnsen
Area Commander, Northern Norway
Bodo Air Base, Norway

Dear General Tufte-Johnsen:

I would like to express my appreciation and gratitude for your excellent efforts in support of our recent search mission for Discoverer II.

During the planning, operational, and terminal phases of this program, your people were most helpful in assisting with support problems peculiar to this mission. While many unusual tasks were imposed on your Bodo Air Base Center Agencies, our request for support was always courteously received and the resulting actions were prompt and effective.

The performance of the truly outstanding officer is manifested by incidents illustrating consistently good judgment, cooperation, and leadership in the execution of his assigned duties. Comparative appraisal of over-all performance will indicate that individual merits justification of the recognition "truly outstanding." I was informed by Lt Col Mathison, who was my senior representative at Bodo Air Base, that he observed the following named Norwegian Air Force Officers, during the period April 17 to April 27, 1959, and I wish to apprise you of his acute awareness of their prominent contribution to the handsome and orderly dispatch of the Search Program. Lt Col Mathison stated categorically that each of the following is a "truly outstanding officer."

[illegible], J. Chr., Colonel, Wing Commander, Bodo Air Base

[illegible], K., Major Deputy Wing Commander, Bodo Air Base

Pettersen, A., 1st Lt., Air Transport Officer, Bodo Air Base

The United States Air Force tenure at Bodo Air Base and Spitsbergen is memorable and interesting, and, justifies in full measure my original high estimate of the Norwegian courtesy, friendship, and hospitality. It is with great personal satisfaction that I tender this letter, indicating my observations of a job well done.

Original Signed
O. J. RITLAND

O. J. RITLAND
Brig. Gen, USAF
Commander

WDZWF IZ 11 May
Capt. Fruge 3045

AIR FORCE BALLISTIC MISSILE DIVISION
HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
Air Force Unit Post Office
Los Angeles 45, California

In reply address both communication and envelope to:
WDZ

18 May 1959

MEMORANDUM FOR GENERAL RITLAND

SUBJECT: Letters of Appreciation for Support on Recent Discoverer Capsule Search to Commander-in-Chief, Royal Norwegian Air Force, Area Commander, Northern Norway and the Commander, Air Rescue Service

1. The subject and attached letters of appreciation are forwarded for your review and approval.

2. The letter to Commander-in-Chief, Royal Norwegian Air Force is to be forwarded to General White, after your approval, for transcription to USAF stationery and appropriate signature.

3. The latter two of the subject letters of appreciation can be forwarded directly from AFBMD upon your approval and signature.

4. The text of each letter expresses the sincere feeling of appreciation which this office holds for the respective support and services accorded the Discoverer Program.

RICHARD D. CURTIN
Colonel, USAF
Deputy Commander
Military Space Systems

3 Incls
1. Ltr to RNAF, Oslo, Norway
2. Ltr to Area Comdr, N. Norway
3. Ltr to Comdr ARS

[redacted]

[illegible]

[redacted]

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DOWNGRADED AT 12 YEAR
INTERVALS; NOT AUTOMATICALLY
DECLASSIFIED. DOD DIR 5200.10

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[redacted]

Deputy Commar… , Installations
Air Force Ballis… Missile Division

Date 10 June 59

To Gen. Ritland

At siting conference last Fri, PMR pushed for splitting SENTRY and MIDAS operations by proposing MIDAS site in new area of Arguello. (PLAN 1)

1st. M.D. & BMD representatives recommended expansion of present SENTRY site (PLAN 2)

A large scale map is attached.

Recommend your approval and signature on TWX.

W. E. Leonard
Colonel, USAF

[redacted]

[illegible]

3

1959

DOWNGRADED AT 12 YEAR
INTERVALS; NOT AUTOMATICALLY
DECLASSIFIED. DOD DIR 5200.10

SIGNED

O. J. RITLAND
Brig. Gen., USAF
Commanding

[redacted]

[redacted]

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[redacted]

JOINT MESSAGEFORM

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	BOOK	MULTI	SINGLE			
ACTION PRIORITY INFO ROUTINE		X		AF	AFCGC 51270 4/28 May 59	[redacted]

FROM:

COMDR AFBMD (ARDC) LOS ANGELES CALIF

SPECIAL INSTRUCTIONS

TO:

COMDR PMR NAMTC PT MUGU CALIF

1 MISSILE DIV VANDENBERG AFB CALIF

INFO: AFBMD FIELD OFFICE VANDENBERG AFB CALIF

DOWNGRADED AT 12 YEAR INTERVALS; NOT AUTOMATICALLY DECLASSIFIED. DOD DIR 5200.10

[illegible] FROM WDZE-6-2-E

SUBJECT IS SENTRY/MIDAS LAUNCH COMPLEXES AT POINT ARGUELLO. THIS MESSAGE IN THREE PARTS. PART ONE. AS A RESULT OF CONFERENCES WITH THE DEPARTMENT OF DEFENSE AND DEPARTMENT OF THE NAVY, IT HAS BEEN DETERMINED THAT THE AIR FORCE BALLISTIC MISSILE DIVISION SHOULD TAKE IMMEDIATE ACTIONS REQUIRED WITH THE COMMANDER, PACIFIC MISSILE RANGE, TO LOCATE THREE ADDITIONAL SENTRY/MIDAS LAUNCH STANDS ON POINT ARGUELLO. IN DETERMINING THE PROPER LOCATION OF THESE LAUNCHERS, THE DEPARTMENT OF DEFENSE HAS STRESSED THAT EVERY CONSIDERATION

DATE	TIME
3	
MONTH	YEAR
June	1959

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WDZE/WDE

WRITER

TYPED NAME AND TITLE (Signature, if required)

Maj Bailey/Col Leonhard

PHONE 2891 | PAGE NR. 1 | NR. OF PAGES 2

SECURITY CLASSIFICAT[redacted]

RELEASER

SIGNATURE SIGNED

TYPED (or stamped) NA[redacted]

O. J. RITLAND
Brig. Gen., USAF
Commander

WDZE-59-10 Cy 2 of 10 Cys

DD FORM 1 MAY 55 173 REPLACES DD FORM 173, 1 OCT 49, WHICH WILL BE USED UNTIL EXHAUSTED

JOINT MESSAGEFORM - CONTINUATION SHEET

SECURITY CLASSIFICATION [redacted]

FROM: COMDR AFBMD (ARDC) LOS ANGELES CALIF [redacted] cont'd)

WILL BE GIVEN TO PROVIDING THE ULTIMATE WEAPON SYSTEM OPERATOR WITH MAXIMUM FREEDOM OF ACTION IN AN AREA APART FROM OTHER RESEARCH AND DEVELOPMENT EFFORTS.

PART TWO. IN VIEW OF THE DISCUSSION OUTLINED IN PART ONE, IT IS RECOMMENDED THAT A CONFERENCE BE CONVENED WITH WORKING GROUPS FROM THE AIR FORCE BALLISTIC MISSILE DIVISION, 1ST MISSILE DIVISION AND THE PT MUGU NAVAL AIR MISSILE TEST CENTER FOR ON-THE-SPOT INVESTIGATION AT POINT ARGUELLO ON 5 JUNE. AS TARGET OBJECTIVE, CONCURRENCE OF COMMANDERS CONCERNED IN RECOMMENDED SITE SHOULD BE SECURED NOT LATER THAN 10 JUNE TO PERMIT TIMELY AND ORDERLY PROSECUTION OF DESIGN.

PART THREE. PROJECT OFFICER TO REPRESENT AIR FORCE BALLISTIC MISSILE DIVISION WILL BE MAJOR WARREN BAILEY, WDSE, TELEPHONE EXTENSION 2891.

Copies to:
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

[redacted]

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☆ U.S. Government Printing Office

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[redacted]

ROUTINE
ROUTINE X AF

COMDR AFBMD (ARDC) LOS ANGELES CALIF

COMDR PMR PT MUGU CALIF

INFO: 1MISSLEDIV VANDENBERG AFB CALIF

DOWNGRADED AT 12 YEAR INTERVALS; NOT AUTOMATICALLY DECLASSIFIED. DOD DIR 5200.10

~~SECRET~~ FROM WDI-6-2-E

PURSUANT TO OUR WDIZ-6-2-E DATED 4 JUNE 1959 REPRESENTATIVES OF PMR, 1ST MISSILE DIVISION AND AFBMD INVESTIGATED POTENTIAL SITES FOR THREE MIDAS LAUNCH STANDS AT PT. ARGUELLO ON 5 JUNE. TWO AREAS, IDENTIFIED AS FOLLOWS, WERE PROPOSED FOR USE: PLAN 1 CONTEMPLATES DEVELOPMENT OF NEW AREA IN SOUTHWEST PORTION OF PT ARGUELLO IN VICINITY OF LA HONDA CANYON. PLAN 2 CONTEMPLATES EXPANSION OF SENTRY COMPLEX AREA FOR WHICH THERE IS ADEQUATE USABLE LAND AVAILABLE.

PAR. FOR FOLLOWING SIGNIFICANT REASONS, THIS HEADQUARTERS RECOMMENDS SITING OF MIDAS COMPLEX

11 June 1959

WDI 11 JUN 1959

Col W. E. Leonhard 9 Jun. 59 [redacted]
2374 1 3

[redacted]

SIGNED
CHARLES H. TERHUNE, JR.
Colonel, USAF
Vice Commander

WDI-59-36 Cy 3 of 8 Cys

UNDER PLAN 2 WITH STANDS LOCATED IMMEDIATELY WEST OF SENTRY COMPLEX ALONG EXISTING ACCESS ROAD:

1. PLACEMENT OF MIDAS STANDS IN THIS AREA WILL STERILIZE LEAST ADDITIONAL LAND AND RESERVE LAND PROPOSED UNDER PLAN 1 FOR FUTURE PROGRAM NEEDS.

2. OUR DESIGN AND CONSTRUCTION SCHEDULES CONTEMPLATED SITE ADAPTATION OF SENTRY STANDS NOW UNDER CONSTRUCTION. THIS CAN BE ACCOMPLISHED UNDER PLAN 2, BUT TOPOGRAPHY IN VICINITY OF LA HONDA CANYON WILL NECESSITATE FACILITY REDESIGN AND ADDITIONAL SITE DEVELOPMENT WORK. SCHEDULED NEED DATES FOR COMPLETED STANDS WILL NOT PERMIT THIS DELAY.

3. PLACEMENT OF MIDAS STANDS IN VICINITY OF SENTRY COMPLEX WILL PERMIT PLANNED UTILIZATION OF EMERGENCY POWER AND WATER SUPPLIES TO BE PROVIDED UNDER SENTRY PROGRAM.

4. IN CONSIDERATION OF 2 AND 3 ABOVE, IT IS APPARENT THAT AF FUNDS PROGRAMMED IN FY 60 WILL NOT BE ADEQUATE TO CONSTRUCT A COMPLEX OF THREE MIDAS STANDS IN THE NEW AREA PROPOSED UNDER PLAN 1.

5. FROM STANDPOINT OF UTILIZING EXISTING BI GROUND GUIDANCE STATIONS AT VANDENBERG AFB, PLAN 2 IS SUPERIOR TO PLAN 1.

[redacted]

[redacted] [redacted]

6. PRIORITY AND IMMINENCY OF MIDAS PROGRAM WOULD APPEAR TO WARRANT FAVORED POSITION VIS-A-VIS VAGUE NEEDS OF LOWER PRIORITY TERRIER, HAWK AND AEROBEE PROGRAMS FOR AVAILABLE LAND BETWEEN SENTRY STANDS AND SURF.

7. FROM STANDPOINT OF INITIAL COST INVESTMENT, EXPANSION OF PRESENT SENTRY AREA WILL PERMIT COMMON USAGE OF EXISTING COMMUNICATION AND INSTRUMENTATION INSTALLATIONS.

8. ON CONTINUING BASIS, SIGNIFICANT SAVINGS IN MANPOWER AND COSTS CAN BE REALIZED BY CONSOLIDATING ACTIVITIES OF COMMON WEAPON SYSTEM CONTRACTORS ENGAGED IN SENTRY/MIDAS OPERATIONS. EXAMPLES INCLUDE NUMBER OF REQUIRED LAUNCH AND SERVICE CREWS; GUARD SERVICE; PAD MAINTENANCE, REHABILITATION AND REPAIR; FIRE PROTECTION; MEDICAL; AND TRANSPORTATION.

PAR. THE COMDR 1ST MISSILE DIVISION CONCURS IN THE RECOMMENDATION TO SITE THE MIDAS LAUNCH COMPLEX IN THE AREA IMMEDIATELY WEST OF THE SENTRY STANDS.

PAR. YOUR EARLY CONCURRENCE WITH THE ABOVE RECOMMENDATION IS REQUESTED IN ORDER THAT DESIGN AND CONSTRUCTION OF THE ADDITIONAL FACILITIES MAY PROCEED ON SCHEDULE.

[redacted]

WDI [redacted] 3

WDI-59-36 WEL

[redacted]

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FM HQUSAF
TO RJWZBK/AFBMD INGLEWOOD CALIF
INFO RJEZFF/ARDC ANDREWS AFB MD
BT

~~/S E C R E T~~//FROM AFCGM 52523

REFERENCE (1) FINAL ITEM IN YOUR AGENDA FOR SUBSYSTEM (D) BRIEFING TO ARPA 0900 JUNE 23 AND TO DOD-NASA SPACE FLIGHT FACILITIES BOARD ON THE AFTERNOON OF 23 JUNE 1959. (2) TELECON BETWEEN B/GEN GREER AND M/GEN RITLAND ON 18 JUNE 1959. (3) AFDAT MESSAGE 52303 DATED JUNE 1959.

1. THE FOLLOWING IS ADDITIONAL GUIDANCE AND INFORMATION IN REGARD TO THE REFERENCED BRIEFING:

A. IT IS REQUESTED THE BRIEFING BE A STRONG PITCH OUTLINING THE AF-DOD CAPABILITIES TO SATISFY NASA

PAGE TWO RJEZHQ 368

REQUIREMENTS, SPECIFICALLY POINTING OUT THE PRESENT TECHNICAL AND ORGANIZATIONAL CAPABILITY THAT EXISTS WITH THE SENTRY, MIDAS AND DISCOVERER TRACKING AND ACQUISITION STATIONS. FURTHER, EMPHASIZING MILITARY FACILITY REQUIREMENTS OF DYNA SOAR, COMMUNICATIONS SATELLITE, ETC., AND HOW THESE GROUND ENVIRONMENTAL FACILITIES CAN BE DESIGNED, EXPANDED, AND LOCATED TO BE COMPATIBLE WITH THE MERCURY PROGRAM REQUIREMENTS.

B. IT SHOULD BE REALIZED THAT THE IMPRESSIONS GENERATED BY THESE BRIEFINGS MAY WELL SERVE AS A DETERMINING FACTOR IN THE EVENTUAL RESOLUTION OF TOP-LEVEL MANAGEMENT ASSIGNMENT RELATIVE TO DIRECTION AND CONTROL OF THE GROUND ENVIRONMENT FOR SPACE SYSTEMS. HENCE, IT IS REQUESTED YOUR BRIEFING BE GIVEN BY A HIGHLY POLISHED SPEAKER WHO IS THOROUGHLY FAMILIAR WITH THE SUBJECT MATTER.

C. AN AIR STAFF REVIEW OF THIS BRIEFING IS BEING SCHEDULED FOR 1530 JUNE 22.

BT
M/1944Z JUN RJEZHQ

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COMDR AFBMD (ARDC) LOS ANGELES CALIF

COFS HQ USAF WASH DC

OSAF WASH DC

INFO: ARDC ANDREWS AFB MD

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DECLASSIFIED AFTER 12 YEARS.
DOD DIR 5200.10

SECRET FROM WDL-8-4-E

HQ USAF FOR AFCGM AND AFOCE. PERSONAL FROM RITLAND TO MINTON AND GREER. OSAF FOR SAFFM ATTN MR. TURNER. ARDC FOR SCHRIEVER. SUBJECT IS RETENTION OF 23.4 MILLION DOLLARS IN AIR FORCE FY 60 MCP FOR SENTRY AND MIDAS FACILITIES. IT IS UNDERSTOOD THAT THE HAC HAS RECOMMENDED TRANSFER OF REQUESTED AMOUNT TO ARPA IN FY 60 BUDGET. IT IS URGED THAT RECLAMA WITH SENATE COMMITTEE BE MADE TO RETAIN FUNDS IN AIR FORCE FOR FOLLOWING REASONS: (1) IT IS A FACT THAT THE SERVICE OR AGENCY HAVING CONTROL OF EXISTING TEST, DEVELOPMENT AND OPERATIONAL FACILITIES HAS ADVANTAGEOUS

20 0100Z
Aug 59

WDL

Col W. E. [illegible], Dep Comdr/[illegible]
2576 1 2

CHARLES H. TERHUNE, JR.
BRIGADIER GENERAL, USAF
VICE COMMANDER

[redacted]

[redacted]

WDL-59-53

WDL Reading File Copy

COMPETITIVE POSITION FOR ASSIGNMENT OF FUTURE PROGRAMS INVOLVING USE OF THESE FACILITIES. (2) "ULTIMATE OWNERSHIP" OF FACILITIES FINANCED FROM ARPA FUNDS IS VESTED IN THAT AGENCY. ACCORDINGLY THIS AIR FORCE ADVANTAGE IS LOST IF FACILITY PROJECTS ARE FINANCED THROUGH ARPA. (3) SIGNIFICANT PART OF FY 60 MCP FOR SENTRY AND MIDAS PROVIDES FOR PHYSICAL ADDITIONS TO EXISTING AIR FORCE FINANCED FACILITIES. DUAL OWNERSHIP AND CONFUSED MANAGEMENT CONTROL WILL RESULT FROM THIS SITUATION. (4) MAJOR PORTION OF FY 60 SPACE FACILITY PACKAGE IS IN SUPPORT OF OPERATIONAL PHASE OF SENTRY AND MIDAS PROGRAMS. ARPA OWNERSHIP, WITH POSSIBLY LATER DIVERSION OF SUPPORT TO OTHER PROGRAMS, WOULD BE DAMAGING TO SYSTEMS OPERATION.

PARA. PROTECTION OF AIR FORCE INTERESTS IN FUTURE SPACE WORK AND ASSURANCE OF NEEDED CONTROL OF TEST AND OPERATIONAL FACILITIES IN SUPPORT OF CURRENT SPACE PROGRAMS REQUIRES THAT PROGRAMMED FUNDS REMAIN IN THE AIR FORCE FY 60 BUDGET. THE PLAN TO APPROPRIATE FACILITY FUNDS THROUGH ARPA WILL HAVE FAR REACHING IMPLICATIONS ON FUTURE AIR FORCE MISSIONS IN THE SPACE FIELD. YOUR PROMPT AND CAREFUL CONSIDERATION OF THIS REQUEST IS RECOMMENDED.

CHARLES H. TERHUNE, JR.
[redacted] AL, USAF

Copies to: WDEO, WDIL, WDX

[redacted]

JOINT MESSAGEFORM

SECURITY CLASSIFICATION [redacted]

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ACTION	PRIORITY	BOOK	MULTI	SINGLE			
INFO	PRIORITY						

FROM:

COMDR AFBMD (ARDC) LOS ANGELES, CALIFORNIA

TO:

COMDR, PACIFIC MSL RANGE, PT MUGU, CALIF

INFO: ARPA, WASH DC
CNO, WASH DC
BUAER, WASH DC
NAVAL MSL CTR, PT ARGUELLO, CALIF
COMDR 1 MSL DIV, VAFB, CALIF
HQ ARDC, ANDREWS AFB, MD
HQ USAF, WASH DC

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SPECIAL INSTRUCTIONS

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DECLASSIFIED AFTER 12 YEARS
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CONFIDENTIAL-FROM WDTT-8-11-E

PERSONAL FROM GENERAL TERHUNE TO ADMIRAL MONROE IN THE ABSENCE OF GENERAL RITLAND. REFERENCE YOUR WIRE DATED 14 AUGUST 1959 AND PHONE CALL OF 19 AUGUST 1959. THIS MESSAGE IN TWO PARTS. PART I. I SHARE YOUR CONCERN REGARDING CONSTRUCTION WORK DELAYS AT PT. ARGUELLO AND AM FULLY AWARE OF THE NEED FOR RESOLUTION OF THE PROBLEM. IT IS IMPRACTICAL TO OPERATE ON A LAUNCH SCHEDULE RESTRICTED TO FRIDAYS AND SUNDAYS AS YOU SUGGEST. UNDERSTAND THAT NATIONAL POLICY PRECLUDES SCHEDUL-

DATE		TIME
21	MONTH AUG	YEAR 59

SYMBOL WDTT

TYPED NAME AND TITLE (Signature, if required)

PHONE | PAGE NR. | NR. OF PAGES 2

SECURITY [redacted]

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SIGNATURE

TYPED (or stamped) NAME AND TITLE

CHARLES H. TERHUNE, JR.
BRIGADIER GENERAL, USAF
VICE COMMANDER

Date 16 Oct 58 1C 1024T

[redacted]

recd WD1

7 OCT 1959 08

INFO WDC/WDP
WDGE, WDG

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...ZZIAL
...ED
...N/SEC AIR FORCE WASH DC
... ACDC ANDREWS AFB
... LOSA

ARPA Msg

...ONFIDENTIAL//DEF 966463 FROM ARPA SIGNED JOHNSON
... ASST SEC FOR R&D. REFERENCE AFBMD TWX WDIZ-9-2-E DATED
... SEPT 59. FUNDS FOR SUNNYVALE DEVELOPMENT CONTROL CENTER IN
...NT OF 1.25 MILLION DOLLARS WILL BE REQUESTED FOR
...PORTIONMENT BY THE BUREAU OF BUDGET. APPROVAL IS CONTINGENT
...ON RECEIPT OF PRELIMINARY CONSTRUCTION PROPOSAL OUTLINING
...CESSARY INFORMATION REQUIRED FOR APPORTIONMENT OF CONSTRUCTION
...NDS. INFORMATION REQUIRED IS OUTLINED IN STANDARD ARPA
...NSTRUCTIONS DATED 20 OCT 58 COPIES OF WHICH ARE AVAILABLE AT AFBMD.
...ON RECEIPT OF REQUIRED INFORMATION IT IS ANTICIPATED THAT
...NDS CAN BE RELEASED EXPEDITIOUSLY.

...IS IS A CAT "AC" MESSAGE.
...0IAIZ OCT RJWZNF

"...PARAPHRASING NOT [illegible]
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to ch WDZF & WDZI WDTI WDG

Extra copy supply to ... if ... ma...

22/1920Z

ROM CHIEF AFBMD FLD OFC VANDENBERG AFB CALIF/COL CODY/
TO COMDR AFBMD HEDARDC , INGLEWOOD CALIF
ATTN-WDZ, WDTI, WDG

"A—PARAPHRASE NOT REQUIRED EXCEPT PRIOR TO CATEGORY B ENCRYPTION—PHYSICALLY REMOVE ALL INTERNAL REFERENCES BY DATE-TIME GROUP PRIOR TO DECLASSIFICATION."

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~~S E C R E T~~/ FROM WDGEV-10-54-C. PERSONAL TO COL EVANS WDZ AND LTCOL GREENE WDTI FROM COL CODY. INFO TO GEN TERHUNE WDG. THIS MESSAGE IN FIVE PARTS. PART 1. DUE TO A NUMBER OF REQUESTS FOR DATA CONCERNING THE THOR LAUNCH COMPLEXES AT VANDENBERG, FOR VARIOUS FUTURE PROGRAM STAND LOAD PLANNING IT IS FELT EXPEDIENT TO DISCUSS THE TOTAL SITUATION AND IN THIS MANNER ANSWER THE SPECIFIC REQUESTS. CURRENT STATUS FOLLOWS- A. COMPLEX 75-1, BLOCKHOUSE, PADS 1 AND 2 FOR IWST AND CTL. B. COMPLEX 75-2, BLOCKHOUSE, PADS 6, 7, AND 8 FOR IWST AND CTL. C. COMPLEX 75-3, BLOCKHOUSE, PADS 4 AND 5 FOR DISCOVERER. D. RIM BUILDING FOR IWST AND CTL/EXTENSION-DISCOVERER/. THERE IS NO FIRM INFORMATION AVAILABLE TO 1MD ON CTL PROGRAM FOR THE 5TH SQUADRON. BASED ON INFORMATION FROM GREENE, INGLEWOOD, THESE DISCUSSIONS ARE PREDICATED ON THE ASSUMPTION THAT THERE WILL BE NO 5TH SQUADRON AND THAT THE CTL LAUNCH RATE WILL BE FOUR/4/ PER YEAR. IF THIS ASSUMPTION INVALID, DATES WILL VARY AS THE

PAGE TWO [redacted]

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OCT 23 1959 WDZF

PROGRAM VARIES. IF ASSUMPTION IS VALID COMPLEX 75-1 WILL COMPLETE IWST/CTL COMMITMENTS BY END OF JAN 60. COMPLEX 75-2 WILL BE IN SUPPORT OF CTL AT FOUR PER YEAR. PART 11. FUTURE USE INFORMATION FOLLOWS- A. A PAD FOR IN-SERVICE ENGINEERING BY SBAMA IS A REQUIREMENT. DETAILS REQUIRE SPECIFICATION. B. EFFORTS ARE BEING MADE FOR USE OF A PAD IN THE THOR DELTA PROGRAM. C. LOCAL DOUGLAS INFORMS ME THAT LMSD HAS CONTACTED THEM RELATIVE TO A THOR BOOSTED SAMOS PROGRAM. NO INFORMATION EXISTS IN THE FIELD OFFICE CONCERNING THIS PROGRAM. D. RUMORS HAVE ALSO BEEN HEARD CONCERNING A SIZABLE EXTENSION TO THE DISCOVERER PROGRAM. IT IS PRESUMED THIS FOLLOWS PRESENT PROGRAM AND DOES NOT INVOLVE ADDITIONAL STANDS. E. SOME DISCUSSION OF STORIC HAS BEEN NOTED. WHETHER THERE ARE ANY AFB IMPLICATIONS ARE UNKNOWN TO THIS OFFICE. INFORMAL AGREEMENT MADE WITH COMMANDER 1MD THAT STANDS SHOULD REVERT TO BMD FOLLOWING OPERATIONAL USE. THIS OFFICE HAS REQUESTED BMD INGLEWOOD TO FORMALLY AGREE WITH SAC THAT ALL STANDS RETURN TO BMD FOLLOWING COMPLETION OF SAC OPERATIONAL USE. THIS DEVICE WOULD ENABLE STAND LOADING FACTOR FOR PLANNING OPERATIONS TO REMAIN CENTRALIZED. IT WOULD FURTHER PRECLUDE INDIVIDUAL NEGOTIATIONS ENDING IN OVER OR UNDER COMMITMENT, AND ENGINEERING DIFFICULTIES IN MAKING EFFORTS TECHNICALLY COMPATIBLE. PART 111. IN VIEW OF FOREGOING THE FOLLOWING LOADING CONCEPTS SEEM REASONABLE. MODIFICATION SHOULD BE MADE AS NECESSARY AT INGLEWOOD BASED ON BETTER DATA. A. COMPLEX 75-1. PAD 1 /THOR DELTA/ AND PAD 2 ...

WDZF SUBJECT FILE
LI DESIGNATION

TWO PROGRAMS CAN BE ACCOMODATED DEPENDING ON RATE OF LAUNCH AND SECOND STAGE CONFIGURATION. BLOCKHOUSE- MOD TO ACCOMODATE CONTROL EQUIPMENT OF SECOND STAGES. LEFT PORTION OF CURRENT CONTROL ROOM FOR THOR DELTA, 2D STAGE, MID SECTION FOR THOR BOOSTER, AND RIGHT ADDITION FOR SAMOS CONTROL EQUIPMENT. THIS APPROACH WOULD REQUIRE ENGINEERING AND SMALL AMOUNT OF CONSTRUCTION. AT FIRST GLANCE APPEARS TECHNICALLY FEASIBLF. B. COMPLEX 75-2, PAD 6 AND BLOCK-HOUSE- DEVOTED TO SBAMA EFFORT. BLOCKHOUSE INCLUDED BECAUSE OF INSTRUMENTATION REQUIREMENTS. PADS 7 AND 8 AND OPERATIONAL CONTROL VANS- FOR CTL PROGRAM. ONE PAD SHOULD EASILY ACCOMODATE PROPOSED LAUNCH RATE. HOWEVER, FEAR OF PAD LOSS MAKES TRAINING PEOPLE WARY OF COMMITTING TO SINGLE PAD OPERATION. USE OF VANS ENCOURAGED. FOLLOWS EMILY CONFIGURATION. INSTRUCTOR CAPACITY, SYSTEM MONITOR CONSOLES, ETC, PERTINENT TO TRAINING COULD BE ACCOMODATED IN ANOTHER"CCUPLED ON " VAN. ALSO FEASIBLE TO VAN CONTROL SBAMA OPERATION AVAILABILITY OF VANS AND ENGINEERING FEASIBILTY SHOULD BE DETERMINANTS. THIS APPROACH BASED PRIMARILY NOT ON STAND LIMITATIONS BUT ON BLOCKHOUSE LIMITATIONS. ENGINEERING INVOLVED SEEMS FEASIBLE AND MINIMAL. FURTHER THE PROXIMITY WITHIN THE SAME COMPLEX OF SBAMA AND TRAINING EXERCISE SHOULD EXPEDITE IN-SERVICE ENGINEERING TYPE FIXES. DISCUSSION WITH PLANS, TRAINING AND MATERIEL PEOPLE OF 1MD ON THEIR REQUIRE-MENTS AND PROBABLE STAND RELEASE TIMES HAS BEEN ACCOMPLISHED, AND THEIR GENERAL AGREEMENT INDICATED. PART IV. IN VIEW OF FORE-GOING RECOMMEND- A. FORMAL AGREEMENTS WITH SAC ON STAND USE AS FOLLOWS- /1/ COMPLEX 75-1, RETURN TO AFBMD O/A 30 JAN 60.

MISSING A PAGE

/2/ COMPLES 75-2, PAD 6 TO SBAMA. BMD TO MONITOR TECHNICAL INSTALLATION PARAMETERS WITH SBAMA. PAD 7-8, REMAIN SAC FOR CTL. BMD/SAC TO POSTURE TWO PADS TO VAN LAUNCH CONTROL WITH ADDITIONAL VAN CONFIGURED TO TRAINING REQUIREMENTS. OR 1PAD TO VAN CONTROL FOR SBAMA AND TRAINING CONDUCTED FROM BLOCKHOUSE. /3/ RIM BLDG, ALL SPACE LESS THAT NECESSARY TO SUPPORT CTL AND SBAMA OPERATION TO BMD. THIS SPACE SUBJECT TO SPECIFIC AGREEMENT WITH AGENCIES INVOLVED. B. UPON COMPLETION OF AGREEMENT PER A ABOVE BMD COMMIT PADS 1 AND 2 AS NECESSARY, AND START ENGINEERING NOW IF TWO DIFFERENT PROGRAMS ARE INDEED TO BE ACCOMODATED. PART V. MISCELLANEOUS APPLICABLE DISCUSSION- A. IT IS UNDERSTOOD THAT THOR DELTA AND THOR SAMOS WOULD USE EXTERNAL GUIDANCE/BTL-MOD 11/. SEPARATE INVESTIGATION OF THE TECHNICAL PARAMETERS INVOLVED ARE NECESSARY PRIOR TO AGREEMENTS IN THIS DIRECTION. NO LOCAL DISCUSSION HAS BEEN HELD THIS SUBJECT. B. IT IS UNDERSTOOD THAT REDUCTION OF 392D MISSILE TRAINING SQUADRON WILL OCCUR AS IWST PHASES OUT. BMD SHOULD CONSIDER POSSIBLE NEGOTIATION WITH SAC CONCERNING THESE TRAINED PERSONNEL IF THOR MILITARY LAUNCH CAPABILITY IS A POINT.

[redacted]

[redacted]

[redacted]

PRIORITY
PRIORITY X AF

COMDR AFBMD (ARDC) LOS ANGELES CALIF

COMDR [illegible] SAN DIEGO CALIF

INFO: COMDR PMR PT MUGU CALIF

[illegible] VANDENBERG AFB CALIF

[illegible] PT MUGU CALIF

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SECRET [illegible] 11-7-E

FOR [illegible] REFERENCE YOUR MESSAGE [illegible]. CITATION OF GREAT FACTORS SUCH AS CHANGE ORDERS [illegible] WORK INTERRUPTIONS HAVE ACCOUNTED FOR SLIPPAGE IN COMPLETION OF SAMOS LAUNCH COMPLEX AT PT. ARGUELLO FROM INITIAL CONTRACT DATES TO 1 JANUARY 1960. [illegible] PLEASED TO HAVE YOUR COMMITMENT THAT THIS DATE WILL NOT BE FURTHER DELAYED. OUR CONCERN EXPRESSED IN [illegible] DI-11-3-E WAS BASED UPON KNOWN CONTRACTUAL PROBLEMS EXISTING WITH [illegible]

NOV [illegible]

WDI

[illegible] Col. [illegible] [redacted]

[illegible] 1 2

Colonel, USAF
Executive Officer

[redacted]

[redacted] [redacted]

COMDR [illegible] (ARDC) LOS ANGELES CALIF WDL-[illegible]-E (Cont'd)

[illegible] AND [illegible] LACK OF [illegible] WORK NEEDED TO VALIDATE PLANNED COMPLETION. YOUR AFFIRMATION THAT THESE CONDITIONS WILL BE CORRECTED IS REASSURING.

Copies to:
WDZ
WDIZ

[redacted]

[redacted]

WDZ

20 NOV 1959

Transfer of Launch Complex 75-1 at Vandenberg AFB, Calif

SAC
Offutt AFB, Nebr

1. With the advent of additional space programs and the acceleration of programs now underway the Air Force finds itself in the position of an inadequate number of launch complexes to support the entire space effort.

2. During a recent meeting between members of my staff and representatives of the 1st Missile Division of Vandenberg AFB, Calif., it was informally agreed that Thor Launch Complex 75-1 should revert to the AFBMD on completion of the SAC Integrated Weapons System Training (IWST) program now taking place on the subject complex.

3. I understand that the IWST requirement for 75-1 phases out 30 Jan 1960 and no further SAC requirement exists for the complex in that Combat Training Launch (CTL) can be supported by Thor launch complex 75-2 which is now being utilized for IWST. Thus 75-1 would be available for transfer to the AFBMD on or about 1 Feb 1960.

4. The AFBMD requests that the Thor launch complex 75-1 be turned over to the AFBMD upon completion of the 1st Missile Division IWST effort.

5. I have instructed members of my staff to fully work with the SAC representatives and affect the transfer if you agree.

Original Signed
O. J. RITLAND

O. J. RITLAND
MAJOR GENERAL, USAF
COMMANDER

Inclosures are withdrawn (or not attached) the classification of this correspondence will be Uncl

[redacted]

WDZF SUBJECT FILE:
FILE DESIGNATION
FANFOLD NO.

WDZFR/Capt /ams/2292/12 Nov 59

MEMORANDUM FOR THE RECORD: Subj: Transfer of Launch Complex 75-1 at Vandenberg AFB, Calif

This letter has been prepared at the request of Colonel Cody as contained in message WDGEV 10-54-C, dated 22 October 1959, in which he requests the AFBMD to formally agree with the SAC in the transfer of launch complexes to the AFBMD.

[redacted]

[redacted]

FEB 23 1960

[illegible]

[illegible] Application of Direction Finding System - WS 117L

Major General [illegible]
USAF
Main Navy Building
Washington 25, D. C.

Dear [illegible]

1. On 27 February 1959, Air Force Ballistic Missile Center requested that the Lockheed Missile and Space Division establish a source selection board to evaluate and recommend awards on major subcontracts for the Samos recovery program. On 1 April 1959, LMSD notified BMD that a source selection board had been selected and forwarded the subcontract list with suggested sources. The request for proposal for the Samos radio beacon system was released on 29 September 1959 to fifteen selected bidders based on a work statement summarized as follows:

a. The transmission system, located in the recovery capsule, shall not exceed 2.5 pounds less batteries. It shall maintain a frequency stability of better than .01%. The carrier must contain some form of identification coding. The antenna shall be designed to minimize the effects of salt water such as would occur if waves were occasionally passing over the capsule.

b. The direction finder system on the aircraft and ships of the recovery force shall be capable of detecting, identifying, and homing on the capsule beacon. Bearing accuracies shall be better than plus or minus one degree azimuth and plus or minus five degrees elevation. Essentially spherical search is desired to a range of 250 nautical miles. Range information is also desired.

2. Several contractors responded to the request for proposals. Among the bidders submitting a proposal was Hallamore Electronic Company. The contractor proposals were submitted to the source selection board at LMSD on 19 January 1960. After review and discussion of the data submitted, the board unanimously agreed to the selection of Cook Research and Development Company as the most qualified source for contract award of the radio beacon system. The source selection board submitted their findings with a list of the bidders, summary of requirements, system evaluation criteria, system description and rating analysis for further approval by the AFBMD technical staff. The results of the AFBMD study concurred with the LMSD source selection.

[redacted]

[illegible]

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DOD DIR 5200.10

[redacted]

[redacted]

[redacted]

3. It is [illegible] consideration [illegible] reason. It is [illegible] system can [illegible] in your letter. I have directed [illegible] with your representatives [illegible] capability of the [illegible] system to satisfy your requirements.

Sincerely

SIGNED

CHARLES H. TERHUNE, JR.
BRIGADIER GENERAL, USAF
VICE COMMANDER

2

[redacted]

WDZNR (Capt Fruge)
Ext 1802

[redacted]

22 January 1960

Brigadier General Charles H. Terhune, Jr.
Vice Commander
Air Force Ballistic Missile Division
AF Unit Post Office
Los Angeles 45, California

Dear Terry:

Further to our telephone conversation of yesterday, the background goes something like this.

As you probably are aware, the Air Force has any number of different type transmitters designed to assist in the location of aircraft and/or personnel in the event of a crash. Unfortunately, we do not seem to have one that meets the field requirements. Recent SAC losses emphasize the necessity for such a piece of equipment.

As a result, I have had a series of meetings with some of the engineers from Baltimore Electronics on a new recovery procedure and equipment for locating downed aircrew members. I happen to know these people fairly well. From the conversations, it looks like we could spin-off this type of equipment from another system they are proposing that is definitely within your purview. If it would be possible to capitalize on the research money already spent in both your recovery area and ours, I think the savings that would accrue in man and material would be extremely worthwhile.

This was the reason for my call. I am not trying to inject myself into your business - God forbid! I am anxious to give [illegible] downed crew members a better chance of being picked up. Since there is a possibility of mutual help, I took the liberty of calling it to your personal attention, rather than risk the possibility of a routine action at the action level.

Whatever you do on this will be greatly appreciated.

Sincerely,

JOSEPH D. CALDARA
Major General, USAF
Deputy Inspector General for Safety, USAF

Mgr 1 SSZA

HEADQUARTERS
SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Air Force Unit Post Office, Los Angeles 45, California

REPLY TO ATTN OF: SSZ

15 September 1961

SUBJECT: 6594th Test Wing Operating Concepts (Satellite Control Facilities)

TO: (See Distribution)

1. The purpose of this letter is to describe the mission and functions of the Satellite Control Office and the 6594th Test Wing (Satellite) in developing and operating the SSD Satellite Control Facilities. It will assist program offices and potential users in planning development tests to make the best use of existing functions, equipment and personnel for support of testing.

2. Prior to 1 April 1961 the Satellite Control Facilities were operated by the Lockheed Missiles and Space Company (LMSC), Sunnyvale, California and the 6594th Test Wing (Satellite), Sunnyvale, California (6594th) monitored LMSC's operation. On 1 April 1961, these positions were changed so that the 6594th was assigned the responsibility for direct supervision of the technical and logistic support furnished by LMSC. The mission of the 6594th Test Wing is to:

a. Support the existing MIDAS, SAMOS, and DISCOVERER programs.

b. Support new programs as assigned.

c. Plan, integrate, and effect simultaneous orbit operations of several different types of satellites.

d. Operate the Satellite Control Facilities as an R&D facility for tracking, data acquisition, and control for those satellite systems assigned by SSD. Peculiar requirements associated with new satellite systems to be tested will be integrated by modification of or addition to existing facilities by the Satellite Control Office, SSZC.

e. Provide trained personnel and proven techniques to specified satellite programs, thus insuring a maximum utilization of personnel and facilities.

3. The following are the functional satellite control responsibilities of the 6594th:

a. Test Control. Direct over-all system test operations, including tracking and payload data processing, and tracking station operations and direction.

b. On-line Data Processing. Receive and process tracking, communications and control, and telemetry data; perform command synthesis and generation, and generate data required for test control purposes.

c. Analysis and Evaluation. Accomplish on-line analysis of test data necessary for optimum control of the satellite, payload, and recovery systems.

d. Payload Data Processing. Process pertinent payload data necessary to generate commands for satellite control.

4. The system contractor will provide the test direction compatible with his responsibilities. He will be provided all available data consistent with and required in the support of the test function. The program office concerned will submit to SSZC the planning requirements and will receive in return a detailed Support Plan. (Formats and procedures for these documents are being prepared by SSZC and the 6594th Test Wing.)

5. Multiple satellite operations require compatibility of each satellite computer program with the computer program of all other satellites being tested in the SSD Satellite Control Facilities. Development of these computer programs must be accomplished in close conjunction with the SSD Program Office, SSZC, and the 6594th.

6. The 6594th will prepare and issue the necessary Test Directives and other operational directives and procedures which involve the participation of equipment and personnel assigned to the SSD Satellite Control Facilities.

7. The 6594th will determine the operational readiness of the Satellite Control Facilities for each operation.

8. Those offices responsible for satellite systems should insure that requirements documents, test plans, test objectives, and other program planning documents take cognizance of these concepts.

O. J. Ritland
Major General, USAF
Commander

1 Atch
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HEADQUARTERS
SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Air Force Unit Post Office, Los Angeles 45, California

REPLY TO ATTN OF: SSH

25 MAY 1962

SUBJECT: Management of Development Test Facilities, Lockheed Missiles and Space Company, Sunnyvale, California

TO: Chiefs of Major Subordinate Staff Offices

1. The Santa Cruz Test Base (SCTB) and the newly established Development Test Laboratory (DTL) comprise a pair of key vehicle and component development test facilities within the Lockheed Missiles and Space Company. The SCTB has served every military space program and NASA program utilizing the AGENA satellite vehicle. The DTL established under the AGENA D development contract, will serve all AGENA launched programs in a similar manner. Our dollar investment interest and scope of operations have reached the point where it is desirable to establish an Executive Manager for over-all AF-SSD operations at the SCTB and in the DTL.

2. The System Program Director for AGENA, SSH, is designated AF-SSD Executive Manager of these development test facilities. The SPD for AGENA will have responsibility for integrating and scheduling all SSD test requirements, analyzing and evaluating contractor manpower and funds requirements and projections and approving contractor operating schedules and requests for facilities. In the discharge of this responsibility, the SPD for AGENA will give objective consideration to all AF-SSD requirements and coordinate all operating and managerial policies and actions relative to these facilities.

3. Within the organization of the System Program Director for AGENA respective executive agents are as follows:

SCTB - Chief, Astro-Vehicle Division - SSHAA

DTL - Chief, Electronics Division - SSHAE.

Robert E. Greer

ROBERT E. GREER
Major General, USAF
Vice Commander

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3-3

HEADQUARTERS
SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Air Force Unit Post Office, Los Angeles 45, California

REPLY TO
ATTN OF: SSH

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DTL - Chief, Electronics Division - SSHAE.

Robert E. Greer

ROBERT E. GREER
Major General, USAF
Vice Commander

DISTRIBUTION: A-2

[illegible] ANGELES CALIF

U N C L A S S I F I E D /FROM [illegible] [illegible] COLONEL [illegible] SMGLN [illegible], COLONEL [illegible] [illegible], COLONEL [illegible] SMGLN [illegible] MAJOR SANDERS REFERENCE OUR MESSAGE [illegible] DATED [illegible] SEPTEMBER 1959, AND TELEPHONE CONVERSATION BETWEEN MAJOR SANDERS, [illegible] AND LT COLONEL [illegible], RDZGV, ON 11 SEPTEMBER 1959. REQUIREMENT [illegible] REPLY TO REFERENCED MESSAGE IS CHANGED TO 1 OCTOBER 1959.

[illegible]19Z SEP RJEZFF

ACTION WDZ
WDP
11 SEP 1959 18 36
INFO WDT
WD
[illegible]

[illegible] PLS ACK
[illegible] MSGS END

HWA039YFDW037
PP RJWZBK
DE-RJEZFF 40C
P 021357Z

[redacted]

RECEIVED AFBMD

ACTION WDT/WDZ WDGE

-8 SEP 1959 22 45

FM COMDR ARDC ANDREWS AFB MD
TO OMDR AFBMD LOS ANGELES CALIF
BT

~~S E C R E T~~/ RDZCV/S-9-7E, ATTN: WDZ, COLONEL CURTIN; WDT, COL O'NEILL; WDGE, COL HAMILTON. QUOTED IS A MESSAGE FROM USAF, SEKE AFORQ-RN 41059 DATED 4 SEP 1959. REQUEST YOU PROVIDE INFO ON WHICH TO BASE AN ANSWER TO THE QUOTED WIRE. YOUR REPLY SHOULD REACH ARDC IN TIME TO MEET 15 SEP 1959 DEADLINE. delete (E) ?

"SECRET FROM AFORQ-RN
SUBJ: PAD REQUIREMENTS FOR SPACE PROGRAMS. THIS HQS IS CONTINUING TO ATTEMPT TO RESOLVE THE PROBLEM OF THE NUMBER OF LAUNCH PADS REQUIRED TO SUPPORT THE VARIOUS SPACE PROGRAMS. THE DIFFICULTY IN FINDING AN ANSWER TO THE PROBLEM HAS BEEN INCREASED

PAGE TWO RJEZFF [redacted]

[redacted] BRIEFINGS AT THIS HQS HAVE NOT
[redacted] OF THE NUMBER OF WEEKS EACH
[redacted] IT IS THEREFORE REQUESTED THAT
[redacted] ~~TIMATE OF THE PAD-WEEKS REQUIRED FOR EACH~~
[redacted] OLLOWING PROGRAMS: (A) SAMOS (B) MIDAS (C)
[redacted] TIONS SATTELITE. REPLY SHOULD INCLUDE ESTIMATES OF PAD
... FOR INITIAL R&D LAUNCHES AND FOR LATER SHOTS AFTER EXPER-
IENCE IS GAINED. REQUEST REPLY NLT 15 SEP 59."
BT
08/2140Z SEP RJEZFF

NNNN

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WORKING PAPER

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FEASIBILITY STUDY OF AGENA-B LAUNCH FROM AMR

by

J. T. Kopecek
and
H. P. Roberts

1122

September 2, 1960

DECLASSIFIED IAW E.O. 12958
REVIEWED
BY
DATE

Approved: H. P. Roberts
H. P. Roberts, Manager
Test Support Department

UNCLASSIFIED

[redacted]

Space Technology Laboratories, Inc.
P. O. Box 95001
Los Angeles 45, California

TABLE OF CONTENTS

TABLES

FIGURES

[redacted]

FEASIBILITY STUDY OF AGENA-B LAUNCH FROM AMR

I. INTRODUCTION

Of the several types of payloads now planned for the Atlas Agena-B system, the E-5 payload is of particular interest since it is to be one of the first to be placed in orbit. The primary purpose of the E-5 payload will be to photograph selected areas of the Soviet Union and to recover the data via a recoverable capsule. The mission objectives dictate a near polar orbit with a preselected altitude and eccentricity. As presently planned, polar orbits at an altitude of 200 n. miles above the surface of the earth are sufficient but not necessary; lower orbital altitudes will, as the program progresses, probably be required.

The urgency of the Atlas Agena-B program necessitated an investigation of the possibility of conducting the launch from the Atlantic Missile Range. At the request of AFBMD, the Test Support Department of the Space Technology Laboratories, Inc. conducted a feasibility study of placing a payload into polar orbit with the Atlas Agena-B vehicle. This report is a summary of the feasibility study and presents all available data utilized in the study.

II. GROUND RULES

The Agena-B launch from AMR is predicated upon the criterion of conforming to range safety practices as closely as possible while achieving the two objectives of attaining a polar orbit and placing maximum payload into orbit. In meeting the range safety criterion, two basic ground rules were established: (1) the booster and sustainer impact zones were to be

[redacted]

in ocean areas and (2) overflight of land masses was to be avoided during early booster phase. Trajectory studies revealed that, fortunately, the trajectory which minimized range safety risk was also the one that achieved a near polar orbit. The problem remaining was to place maximum payload into the orbit.

III. VEHICLE CONFIGURATION

The over-all vehicle configuration comprises a Series-D type Atlas missile as the booster or stage I vehicle and an Agena-B as the second stage containing the payload. The Atlas would be modified to incorporate a yaw programmer and an interface fairing which could accept the Agena-B vehicle. Standard range safety equipment, including the two complete receivers and the destruct system, a Mark II Azusa transponder, and a standard GE Mod III transponder would be on board the Atlas. The Agena-B vehicle would be self-guided (i.e. no radio guidance equipment on board). No range safety receivers would be incorporated into the Agena-B vehicle.

IV. ASCENT TRAJECTORY

Studies were made to determine the trajectory which would minimize range safety risk by carrying the IIP trace from Cape Canaveral over the Atlantic Ocean and which would achieve a polar orbit with maximum payload. These conditions were most satisfactorily met by the following trajectory program: After liftoff, the missile is rolled to an exit azimuth of 150°. Shortly after roll completion, a 90% booster tilt program is initiated and the missile flies this trajectory until a time 100 seconds after liftoff. At this point, a 2° per second right yaw turn is initiated which persists for a period of 20 seconds and then returns to a zero yaw program. This right yaw turns the velocity vector from a heading of 150° to a southerly heading. The missile continues to fly from 120 seconds to booster staging with a fairly large yaw attitude angle. Staging is initiated at 148.5 seconds with booster impact at latitude 18.68°N, longitude 80.14°W. The sustainer, after the initiation of radio guidance, is programmed to turn in yaw to the right until the IIP passes over the northernmost portion of Panama. Sustainer shutdown occurs at 239.2 seconds, placing the instantaneous sustainer impact at latitude 4.02°N and longitude 85.06°W. The vernier phase continues until a time 258.1 seconds, placing the vernier impact point at 3.87°N latitude and 85.11°W longitude. A plot of the IPP trajectory during early booster phase is shown in Figure 1. The major portion of the sustainer trajectory is shown in Figure 2. It will be noted from these two figures that two right yaw turns are programmed in the trajectory. The IIP overflies Cuba and Panama. Shortly after vernier cutoff, the sustainer separates from Agena-B vehicle and the Agena-B coasts on a transfer ellipse to a point 60 seconds prior to reaching apogee, at which time the Agena-B vehicle engine is started. This corresponds to a time of 394.4 seconds. At apogee, the velocity is 14,408 ft/sec. The Agena-B vehicle is oriented parallel to the local surface of the earth and continues in this orientation until burnout which occurs at 567.8 seconds. At this time, orbital velocity will have been reached at an orbital altitude of 200 n. mi.

This trajectory was calculated on the basis of assuming a total take-off weight of 276,500 pounds. This figure assumed a total Agena-B weight of 16,034 pounds. At Agena burnout the total in-orbit weight was calculated to be 4,742 pounds. A comparison trajectory was run in which the exit azimuth was assumed to be 190°. No doglegging was incorporated but the same burnout parameters were assumed for the Atlas, i.e., apogee velocity of 14,500 feet per second and a net orbital altitude of 200 n. mi. In this case, the total take-off weight was assumed to be 277,500 pounds and the ignition weight of the Agena-B to be 19,497 pounds. As a result of this trajectory, the total in-orbit weight was calculated to be 5,859 pounds.

TABLE I

TRAJECTORY PARAMETERS

time (sec)	Total Weight	Velocity (Air) ft/sec.	Range from Pad n. mi.	Altitude ft
0	Atlas 260,466 Agena-B 16,034 276,500	0	0	0
148.5 BECO	Atlas 55,145 Agena-B 16,034	10,471	68.1	240,487
258.1 VECO	Atlas 23,833 Agena-B 16,034	15,178	296	657,292
263.1 Separation	Agena-B 16,034	15,140	308	676,422
294.5 Start Agena	16,034	14,485	623	1,000,129
567.8 Agena Cutoff	4,742	25,372	1,132	

[redacted]

V. ORBIT

At an altitude of 200 n. mi., the orbital period is found by simply equating the gravitational force to the centrifugal force. Then

$$T = \frac{2\pi}{\sqrt{\frac{G}{r^3}}} = 92 \text{ minutes}$$

r = distance from center of the earth to orbital altitude
G = gravitational constant (1)

The inclination of this orbit with respect to the polar axis is about 11°. This inclination is acceptable because it covers all of the continental region of the Soviet Union except for part of the northernmost areas of the Soviet Islands, Franz Josef Land and Severnaya Zemelya. Inclinations smaller than 11° would be difficult to achieve if the criterion of impacting the sustainer in open ocean areas is to be met. As noted from Figure 2, the sustainer impact is at a point midway between Panama Canal, the Galapogos Islands, and Equador. The sustainer impact zone then restricts the inclination of the orbit to about 10 to 12°.

VI. RECOVERY

The ultimate purpose of the Agena-B system will be to recover from orbit a photographic capsule. The recovery area must be located within the United States continental limits or in the ocean areas controlled by the United States. This location will depend upon the time of launch, the ephemeris, the number of orbits desired, and the accuracy of the deorbit system. The time of launch is critical since it will determine what portions of the Soviet Union will be covered by the satellite and at what time of day. Calculation of the ephemeris is important since this will determine when to transmit the deorbit commands.

[redacted]

II. RANGE SAFETY PROBLEM

A. Hazard Areas

There are three potential hazard areas in the ascent phase of the Atlas-Agena-B trajectory which present range safety problems. The first occurs during the early portion of booster flight when the coast of Florida, Grand Bahama Island, Andros Island, and the Biminis are hazarded due to the proximity of the IIP trace. The second hazard area is Cuba during the latter phase of booster flight. And, finally, the overflight of Panama during the latter phase of sustainer flight presents the third hazard area. Since the impact of the booster and sustainer stages occurs a considerable distance from land areas, no range safety problem is incurred. It is only the fly-by of inhabited areas during the early booster phase and the overflight of Cuba and Panama that must be investigated to assess the individual risk to each area and to determine the total risk involved in the launch operation.

B. Impact Probability

If the hazarded area is defined as a rectangle with one side, $\Delta\bar{x}$, parallel to the nominal trajectory and the other side, $\Delta\bar{y}$, normal to the nominal trajectory, then the probability of impact within this area is resolved into a function of the downrange impact probability, $P(\bar{x})$, and the corresponding crossrange impact probability, $P(\bar{y})$.

Consider the downrange direction, x. If a missile failure occurs t seconds after launch, the missile will impact at a downrange point $\bar{x}$. The probability of a failure occurring in a time interval Δt

is postulated to be equally likely anywhere within the powered flight regime of each stage, as is expressed as

$$P_{f_n} = \frac{\Delta t}{T_{B_n}} \qquad (2)$$

where T_{B_n} is the powered flight time of the Nth stage.
By deduction, the probability of a missile failure occurring during the time interval $(t_b - t_a)$ during the Nth stage of operation is

$$P_{f_n} = \frac{t_b - t_a}{T_{B_n}} \qquad (3)$$

A distribution function or a line probability density $P(\bar{x})$ is determined such that the probability of impact in an interval $\Delta\bar{x}$ is equal to $P(\bar{x})\cdot\Delta\bar{x}$. The probability that $\bar{x}$ impacts in the downrange interval $\Delta\bar{x}$ is equal to the probability that the failure occurs in the corresponding interval of time Δt. Then

$$P(\bar{x})\cdot\Delta\bar{x} = \frac{\Delta t}{T_B} \qquad (4)$$

or

$$P(\bar{x}) = \frac{\Delta t}{\Delta\bar{x}} \cdot \frac{1}{T_B} \qquad (5)$$

As $\Delta\bar{x}$ and $\Delta t \rightarrow 0$

$$P(\bar{x}) = \frac{dt}{dx} \cdot \frac{1}{T_B} \qquad (6)$$

Under normal missile operating circumstances, the crossrange deviation of the IIP will follow a Gaussian distribution and hence be negligible. On the other hand, a failure in guidance or engine control can grossly deviate the IIP within a short time after initiation of failure. The crossrange distribution function will be determined by the type of failure and the severity of its influence on the missile acquiring a sidewise velocity. A cursory examination of the types and modes of guidance and engine control failures which can carry the IIP outside the normal 3σ limits of operation reveals a great number of possibilities, some, of course, more probable than others. To say that a crossrange distribution can be derived based upon the highly probable failures alone would not be accurate. Generally speaking, however, it can be stated with a high degree of confidence that most failures will place the IIP relatively close to the nominal trajectory and other less likely failures could carry the IIP farther crossrange. In the category of small crossrange deviations are such failures as those caused by hard-over engine deflections resulting in an immediate tumble of the missile and small subsequent IIP deviations. In case of open loop guidance, large gyro drifts can carry the IIP somewhat more in the crossrange direction. Failures resulting in no engine control signals or inoperative guidance can cause the engine to stay in a nulled condition with only its small bias or misalignment producing a thrust vector slightly different from the missile axis. This condition, if sustained for a considerable length of time, can cause large IIP deviations.

It is reasonable to assume that the crossrange failure distribution should be based on some function which indicates large probabilities for small sidewise deviations and smaller probabilities for large sidewise deviations. A line probability density $P(\bar{y})$ equal to $\frac{1}{2y}$ describes a linear crossrange distribution function meeting the above criteria. The factor 2 assumes that failure can carry the IIP to either side of the nominal trajectory with equal probability.

The area probability density is expressed as a product of the downrange and crossrange line probability densities.

$$P(\bar{x}) \cdot P(\bar{y}) = \frac{dt}{dx} \cdot \frac{1}{T_B} \cdot \frac{1}{2y} \qquad (7)$$

For a normally operating missile, the above probability density is zero for any area other than the intended impact area. To have meaning, the impact probability density at some point (x, y) other than the intended impact area must be qualified by stating its probability of deviating from normal. The downrange failure probability P_x and the crossrange failure probability P_y when multiplied by $(P\bar{x})(P\bar{y})$ then describes the impact probability density at (x, y). Or

$$\rho\ (x, y) = \frac{dt}{dx} \quad \frac{P_x\ P_y}{T_B\ 2y} \qquad (8)$$

The quantity $\frac{dt}{dx}$ is the inverse of the instantaneous impact point velocity $\dot{D}_i$; equation (7) then reduces to the following expression.

$$\rho\ (x, y) = \frac{P_x\ P_y}{2T_B\ \dot{D}_i y} \qquad (9)$$

Consider the trajectory of Figure 1. The risk to the Florida coastline, Grand Bahama Island, Andros and Bimini Island can be determined by applying equation (9) to each hazarded area. In order to show a pessimistic situation, let $P_y = 0.2$ which is the probability

[redacted]

that the missile will veer in yaw. Then, let $P_x = 0.2$, which is the thrust failure probability when $P(y)$ occurs. Utilizing the above figures and obtaining distances to inhabited areas from the trajectory of Figure 1, the risk to each significant populated area is determined by the relation

$$P_k = \rho(x, y) \cdot N \cdot A_L \tag{10}$$

where A_L = lethal area of missile fragments (3000 sq. ft)
These results are tabulated in Table II.

In the overflight of Cuba, the land impact probability is given by the relation

$$P_c = \frac{P_x (t_b - t_a)}{T_B} \tag{11}$$

where $t_b - t_a$ is the dwell time of the IIP on Cuba and $T_B = 148.5$ seconds. From the trajectory simulation, $t_b = 139.5$ seconds, $t_a = 134.2$ seconds. Then $P_L = 7.15 \times 10^{-3}$. The collective kill probability on Cuba is calculated for areas lying 3σ and 10σ to either side of the trajectory. Results of these calculations are tabulated in Table III.

The impact probability for Panama and Costa Rica is found, from relation (11), to be

$$P_p = \frac{0.2\ (224.5 - 217.5)}{90.8} = 0.0155$$

Based on a nominal Atlas closed loop trajectory, 3σ deviations to either side of the IIP plot across Panama (Fig. 3) are included in the range safety calculation. Included in the deviation are tumble dispersions past 3σ limit. These results are tabulated in Table IV.

A summary of the land impact probability and risk calculations for each of the potentially hazarded areas are tabulated in Table V.

VIII. RANGE SAFETY INSTRUMENTATION

The primary range safety instrumentation that will be used to support this flight will be a Mark II Azusa system. Both present position and instantaneous impact point information will be displayed to the range safety officer. A secondary range safety system consisting of the FPS-16/IBM-709 will be utilized to provide the same information. In all likelihood a C-band beacon transponder will be required to extend the range capability of the FPS-16 radar tracker. Other standard range safety instrumentation utilized during launch of any ballistic missile from the AMR will complement the above mentioned instrumentation.

IX. SUPPORT INSTRUMENTATION

Preliminary consideration of range capability indicates that there should be no difficulty in meeting the instrumentation requirements associated with the proposed flights on the AMR. Booster and Agena-B telemetry requirements should easily be met up to about +525 seconds and trajectory data requirements to VECO should pose no difficult problem for the range. No consideration has been given to the range instrumentation problems associated with the coast phase, Agena-B powered phase, and orbital phase of flight since the data requirements associated with the payload are unknown at this time, and because for the purpose of this study it has been assumed that the worldwide instrumentation and tracking network being utilized to support Discoverer, Samos, and Midas flights from PMR can meet the requirements associated with these proposed flights.

X. GROUND FACILITIES

Preliminary consideration of the capability of the range to meet the facility requirements associated with the proposed AMR flights indicates that there should be no serious problems. Checkout and launch facilities exist at AMR for receiving, checking out, and launching Atlas/Agena vehicles and presumably could be used for these purposes in this program, subject to further determination of the effect of the proposed operation on the over-all utilization and scheduled usage of these facilities. It is possible that the contractor who will be responsible for the development of the payload will require separate checkout facilities with unique environmental conditions which perhaps cannot be met by the allocation of space within existing facilities. This situation cannot be determined until a payload contractor is selected and the payload checkout requirements are determined.

XI. PROBLEM AREAS

It is the purpose of this section to identify, in as much detail as possible, problem areas that the feasibility study revealed. These problem areas are:

A. Yaw Programmer

In order to provide the booster yaw program called for in the ascent trajectory, a yaw programmer will be required in the Atlas missile. The necessary development and hardware implementation lead times will have to be seriously considered in view of the early launch dates that are anticipated for the Atlas Agena-B. The weight, physical size and power requirements of the yaw programmer are currently estimated to be relatively small. The major problem lies in expediting the development effort required to produce this programmer.

B. Missile Dynamics

A plot of the yaw attitude angle versus time of powered flight (Fig. 4) indicates that after the booster yaw program is initiated, fairly large yaw attitude angles are built up. At t = 120 seconds, the yaw attitude angle rises to 28° and starts dropping sharply thereafter. The aerodynamic load imposed by such a large yaw angle is currently thought to be within design limits of the Atlas missile. However, this problem should be given more detailed study to ascertain whether such large yaw angles could be detrimental to the missile structure. The lofted trajectory as incorporated in this study was designed to carry the missile as rapidly as possible out of the large aerodynamic loading regime such that the yaw program could be initiated at as high an altitude as possible. If future studies indicate that the qa product reaches undesirable values during any portion of the booster yaw program,

[redacted]

it will be necessary to initiate a different program to keep the $q\alpha$ product within allowable limits. This can be done by starting with a very small right yaw program and building it up successively as the missile continues to fly out of the denser atmosphere. The net result in the trajectory shaping will be a decreased right yaw turn which will have to be compensated in the sustainer phase of flight.

During booster staging, the yaw attitude is about 11°. In this region of powered flight, a preliminary examination of the staging sequence at this yaw attitude angle indicates that a problem may exist but probably not a major one. However, this assumption should be confirmed by more study.

C. Look-Angles

In Figures 5 and 6, the GE Mod III guidance look-angles are indicated for this trajectory. Look-angle 1 is defined as the angle between the missile roll axis and the line-of-sight to the tracking radar (sometimes referred to as LA1). Look-angle 2 (LA2) is defined as the angle formed by the projection of the line-of-sight between the tracking radar and the missile into the plane formed by the pitch and yaw axis. LA2 is measured clockwise from the yaw axis extending from the bottom of the missile. A minor physical relocation of the missile antennas is required to support these look-angles.

The elevation and azimuth angles as seen by the GE Mod III Guidance sight radars are plotted in Figures 7 and 8 and, from the ground radar look-angle standpoint, no problem is anticipated in tracking capability all the way to VECO.

D. Range Safety Problem

The proximity to the Florida coastline of the early phase of the flight will impose strict limits on the missile during the ascent trajectory. The time reaction margin, missile instrumentation error, and wind drifts that are built into the impact limit lines by the range will probably leave almost no margin for the missile to deviate from the nominal. The probability of destroying a good missile during this phase of the powered flight should be assessed in view of the range safety limitations.

E. Range Safety Instrumentation

During the early phase of the ascent trajectory the slew rates of the Azusa Mark II will be considerable. However, if a tie-in is provided from the FPS-16 radar, the slew rate problem can be minimized. A preliminary investigation indicates that perhaps a slight modification of the Azusa Mark II equipment can accommodate these slew rates.

F. Downrange Instrumentation

For data on sustainer separation, the ascent ellipse, and the firing of the Agena-B vehicle, additional downrange sites will be required to provide either a passive or an active track on the missile. The problem of the location of these sites, the instrumentation required, and its tie-in with the AMR at Cape Canaveral is recognized but is yet unresolved.

XII. INITIAL STUDY EFFORTS

To support the problem-area analysis and recommendations made in the previous section, it is strongly urged that the following studies be initiated immediately in view of the length of time such studies will require.

(1) Guidance Equations

As soon as range safety problems have been resolved and the final trajectory determined, new guidance equations will be required for the trajectory. About six months will be needed to determine and implement these equations.

(2) Yaw Programmer

The long development and hardware implementation time required for the yaw programmer dictates that effort in this area be initiated immediately.

(3) Aerodynamic Studies

The study of aerodynamic problems associated with the ascent trajectory should be started.

(4) Range Instrumentation

A study of the range instrumentation requirements to support an Agena-B vehicle launch should commence as soon as possible.

[redacted]

[illegible]I. CONCLUSIONS

Launching an Atlas Agena-B vehicle into a polar orbit from the Atlantic Missile Range is feasible from a technical point of view; however, several attendant problems exist. Studies must be initiated as soon as possible to find solutions to the problems if the planned launch dates are to be met.

TABLE II

FLORIDA

City	Pop.	y (n.mi.)	ρ(x,y)	P_K
Cocoa Beach	1,000	7	$.3376^{-6}$	2.737^{-8}
Melbourne	7,000	15	$.8718^{-7}$	4.948^{-8}
Vero Beach	8,500	19	$.2836^{-7}$	1.954^{-8}
Fort Pierce	21,000	20	$.2245^{-7}$	3.822^{-8}
Stuart	3,700	25	$.1497^{-7}$	4.492^{-9}
West Palm Beach	160,000	30	$.9760^{-8}$	1.266^{-7}
Palm Beach	5,100	32	$.8770^{-8}$	3.627^{-9}
Lake Worth	15,300	34	$.8085^{-8}$	1.003^{-8}
Delray Beach	8,300	35	$.7697^{-8}$	5.180^{-9}
Deerfield Beach	3,400	39	$.6579^{-8}$	1.814^{-9}
Pompano Beach	12,500	40	$.6354^{-8}$	6.440^{-9}
Oakland Park	1,700	42	$.5831^{-8}$	8.038^{-10}
Fort Lauderdale	95,000	45	$.5298^{-8}$	4.081^{-8}
Dania	6,500	46	$.5049^{-8}$	2.661^{-9}
Hollywood	34,000	49	$.4740^{-8}$	1.307^{-8}
Miami Beach	55,000	47	$.4698^{-8}$	2.095^{-8}
Miami	1,150,000	54	$.4089^{-8}$	3.812^{-7}
Coral Gable	34,000	58	$.3686^{-8}$	1.016^{-8}
Perrine	3,000	60	$.3508^{-8}$	8.532^{-10}
Homestead	11,000	66	$.3116^{-8}$	2.779^{-9}
				7.661×10^{-7}

ANDROS ISLAND

City	Pop.	y (n.mi.)	ρ(x,y)	P_K
Nicolls' Town	435	50	$.2830^{-8}$	9.979^{-11}
Staniard Creek	346	77	$.2430^{-8}$	6.816^{-11}
				1.680^{-10}

GRAND BAHAMA ISLAND

City	Pop.	y (n.mi.)	ρ(x,y)	P_K
West End	1,000	27	$.9594^{-8}$	7.779^{-10}

BIMINI ISLAND 200

$$P_I = \frac{0.2(t_b - t_a)}{T_B} = \frac{0.2(1)}{148.5} = \underline{1.347 \times 10^{-3}}$$

$$P_K = P_I \cdot \frac{A_L}{\text{Area}} \cdot N = P_I \cdot \frac{.8108 \times 10^{-4}}{25} \cdot 200 = \underline{8.736 \times 10^{-7}}$$

Note: For Florida, GBI and Andros Island calcculations, a confidence level of 0.1 was introduced in Px Py to account for RSO not being able to contain IIP within prescribed limits. Then $PxPy = 4 \times 10^{-5}$.

TABLE III

Cuba

City	N Pop.	y (n.mi.)	$\rho(x,y)$	P_K
Caibarien	21,382	9	$.1085^{-5}$	1.881^{-6}
Yaguajay	5,867	21	$.4651^{-6}$	1.835^{-7}
Sancti Spiritus	28,262	13	$.7513^{-6}$	1.722^{-6}
Trinidad	15,453	15	$.6511^{-6}$	8.158^{-7}
Santa Clara	53,981	17	$.5745^{-6}$	2.514^{-6}
*Punta San Juan	100	48	$.2035^{-6}$	1.650^{-9}
*Adelaide	100	48	$.2035^{-6}$	1.650^{-9}
Moron	13,954	58	$.1684^{-6}$	1.905^{-7}
Ciego de Avila	23,802	53	$.1843^{-6}$	3.556^{-7}
Jucaro	868	49	$.1993^{-6}$	1.403^{-8}
Cienfuegos	52,910	43	$.2271^{-6}$	9.741^{-7}
*San Blas	100	70	$.1395^{-6}$	1.131^{-9}
*Calimete	100	71	$.1376^{-6}$	1.116^{-9}
Colon	11,534	72	$.1357^{-6}$	1.269^{-7}
Corralillo	1,073	57	$.1714^{-6}$	1.491^{-8}
Sagua La Grande	24,044	27	$.3617^{-6}$	7.052^{-7}
*Zulueta	100	2	$.4884^{-5}$	3.960^{-8}
Placetas	19,693	5	$.1953^{-5}$	3.117^{-7}
Fometo	6,038	7	$.1395^{-5}$	6.829^{-8}
Remedios	10,485	4	$.2442^{-5}$	2.076^{-7}
Zuemado de Guines	3,276	39	$.2504^{-6}$	6.650^{-8}
Palmira	5,865	40	$.2442^{-6}$	1.161^{-7}
Cruces	9,043	32	$.3052^{-6}$	2.238^{-7}
Casilda	1,986	15	$.6511^{-6}$	1.048^{-7}
Tunas de Zaza	475	10	$.9767^{-6}$	3.761^{-8}
Jatibonico	3,486	40	$.2442^{-6}$	6.902^{-8}

$$\Sigma = 10.7^{-6}$$

*Estimate

Note: All exponents refer to $\times 10^{-\text{exponent}}$

[redacted]

TABLE IV

Costa Rica and Panama

COSTA RICA

City	Pop.	y (n.mi.)	ρ(x,y)	P_K
Siquirres	326	45	$.3498^{-6}$	6.165^{-9}
Limon	11,310	18	$.8744^{-6}$	5.345^{-7}
*Vesta	100	9	$.1749^{-5}$	9.453^{-9}
*Puerto Viejo	100	2	$.7870^{-5}$	4.254^{-8}
*Suretka	100	4	$.3935^{-5}$	2.127^{-8}
Buenos Aires	750	22	$.7155^{-6}$	2.900^{-8}
Boruca	300	22	$.7155^{-6}$	1.160^{-8}
*Dominica	100	45	$.3498^{-6}$	1.891^{-9}
			Σ	6.564×10^{-7}

PANAMA

City	Pop.	y (n.mi.)	ρ(x,y)	P_K
Bocas del Toro	1,768	37	$.4254^{-6}$	4.065^{-8}
Almirante	2,351	30	$.5247^{-6}$	6.667^{-8}
Chiriqui Grande	60	54	$.2915^{-6}$	9.456^{-10}
Boquete	1,967	37	$.4254^{-6}$	4.522^{-8}
Dolega	732	45	$.3498^{-6}$	1.384^{-8}
Concepcion	3,455	34	$.4629^{-6}$	8.644^{-8}
*David	100	46	$.3522^{-6}$	1.850^{-9}
Pedregal	309	48	$.3279^{-6}$	5.475^{-9}
Puerto Armuelles	5,808	25	$.6296^{-6}$	1.976^{-7}
			Σ	4.587×10^{-7}

*Estimate

Note: All exponents refer to $\times 10^{-\text{exponent}}$

TABLE V

Summary of Risk

Area	Situation	Impact Probability	Kill Probability
Florida Coast	Flyby	-	7.6×10^{-7}
Andros Island	Flyby	-	1.6×10^{-10}
Grand Bahama Island	Flyby	-	7.7×10^{-10}
Bimini Island	Overflight	1.3×10^{-3}	8.7×10^{-7}
Cuba	Overflight	7.1×10^{-3}	10.7×10^{-6}
Costa Rica	Overflight	1.5×10^{-2}	6.5×10^{-7}
Panama	Overflight	1.5×10^{-2}	4.5×10^{-7}

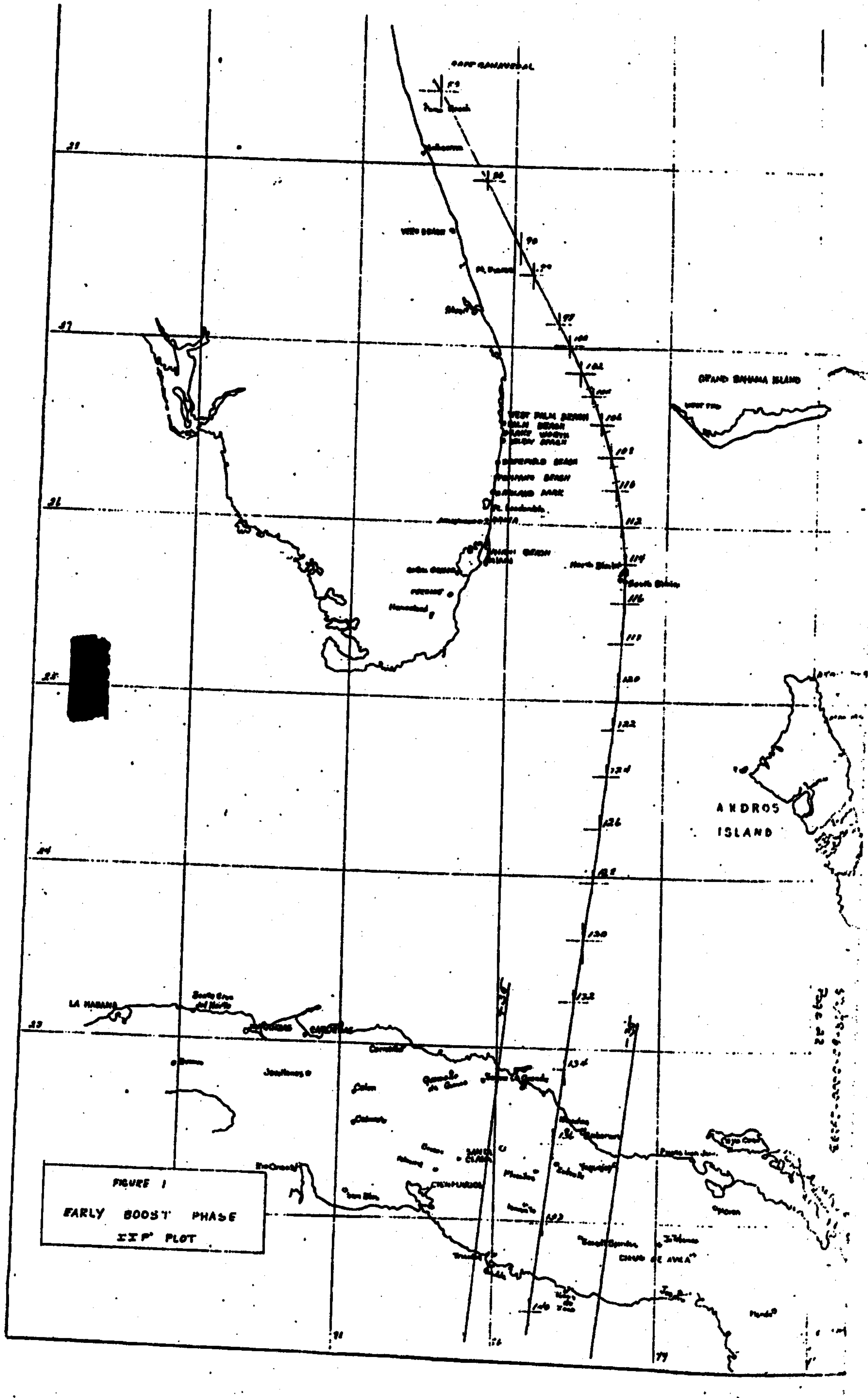

FIGURE 1
EARLY BOOST PHASE
IIP PLOT

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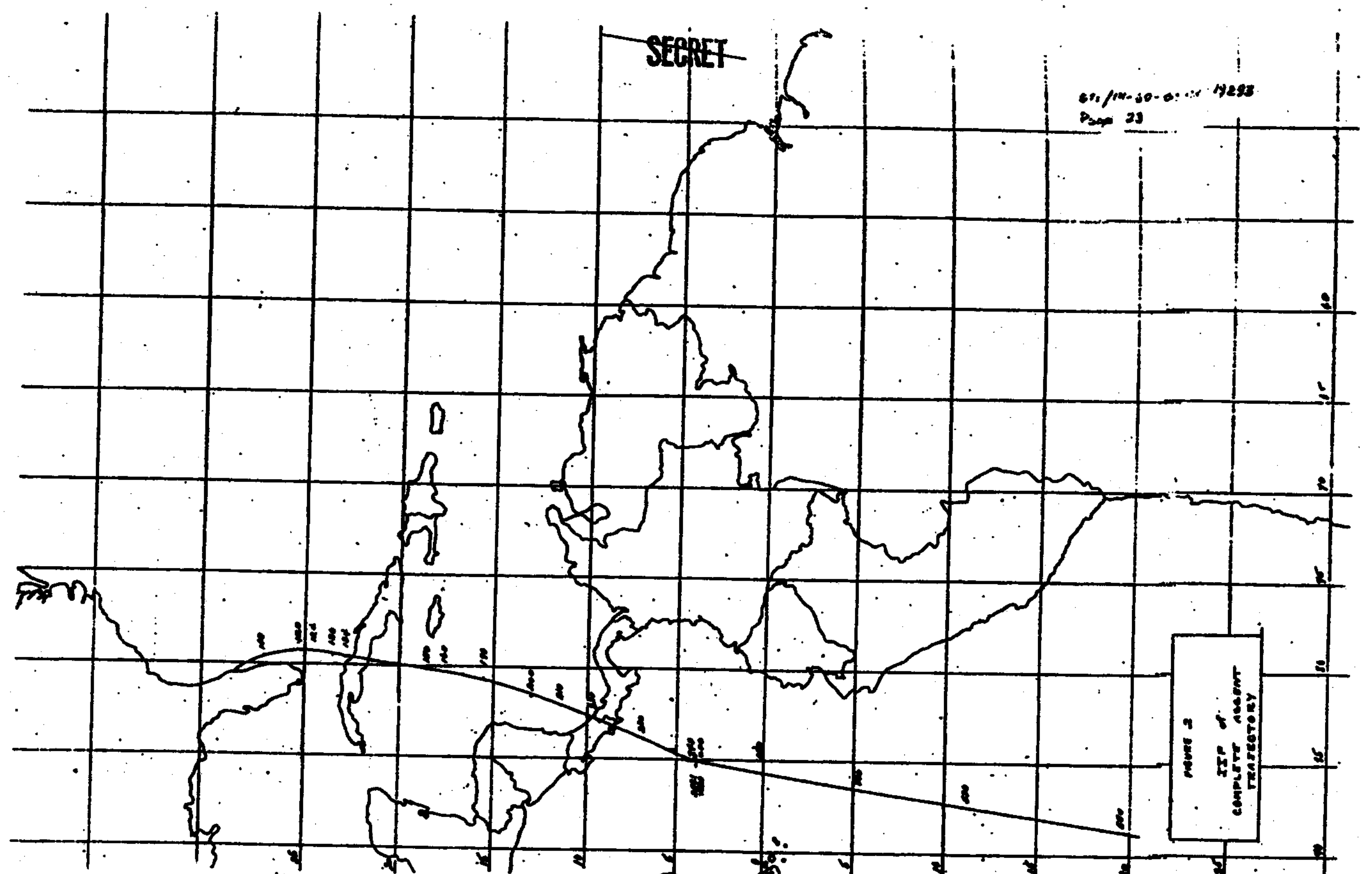

FIGURE 2
COMPLETE ASCENT TRAJECTORY

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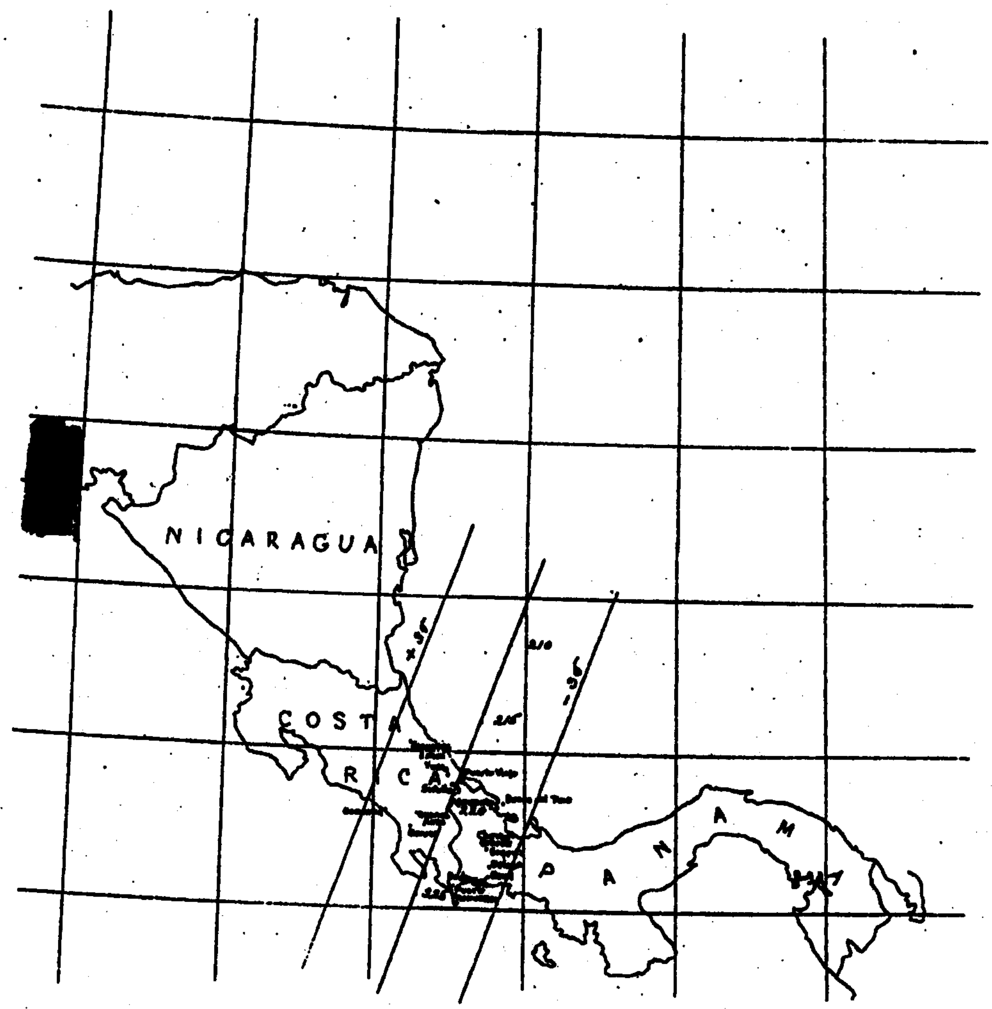

FIGURE 3
COSTA RICA AND PANAMA
IIP PLOT

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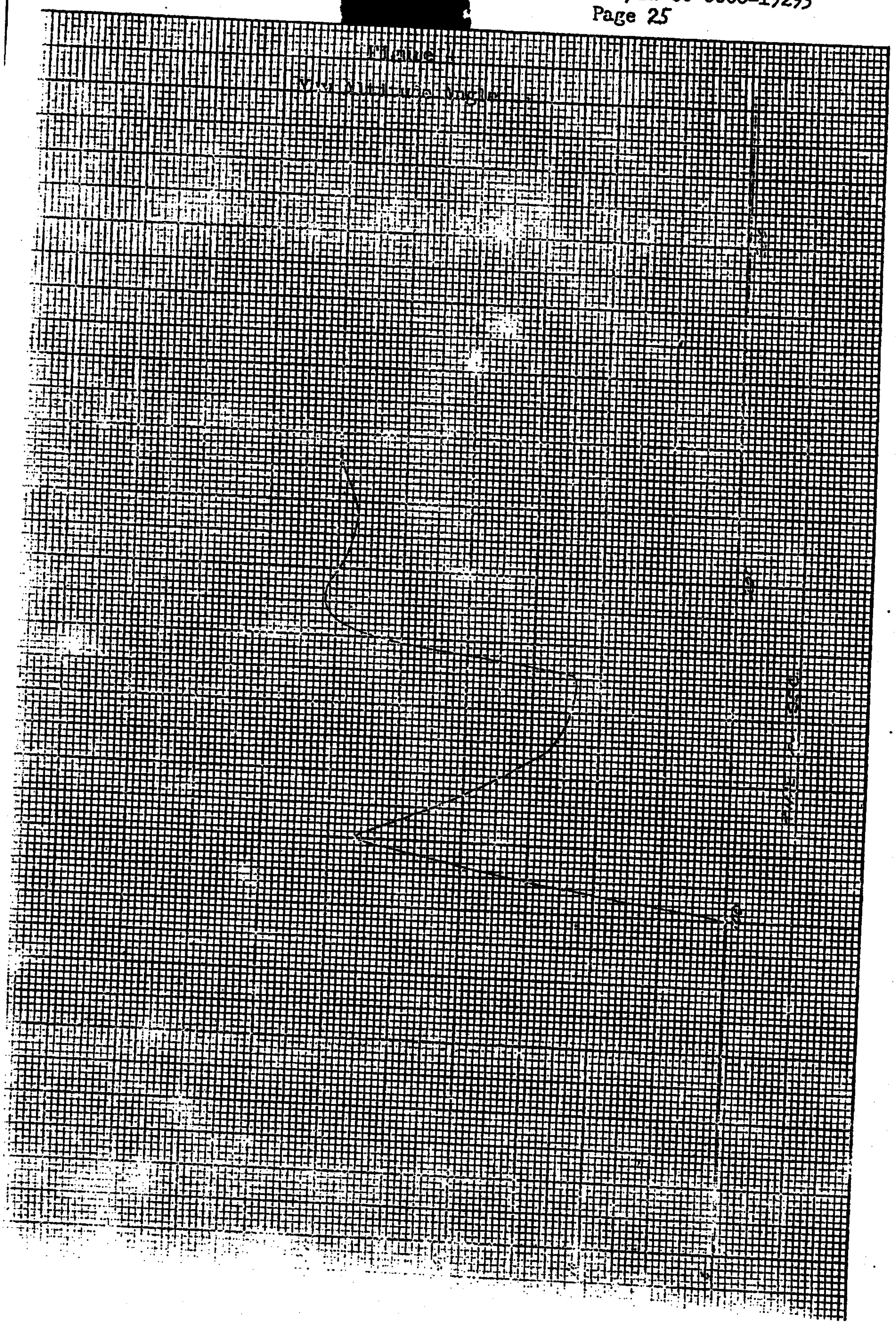

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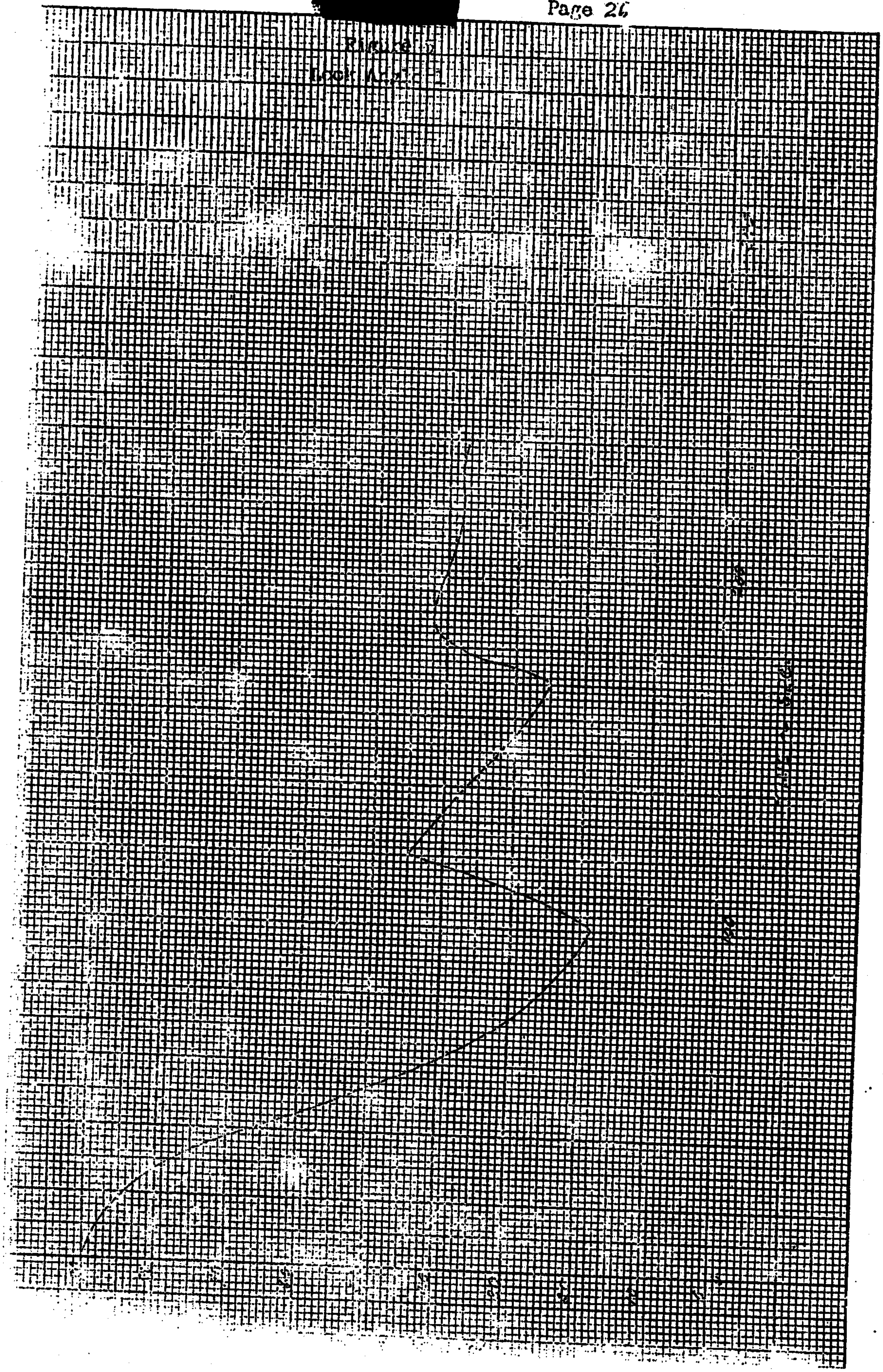

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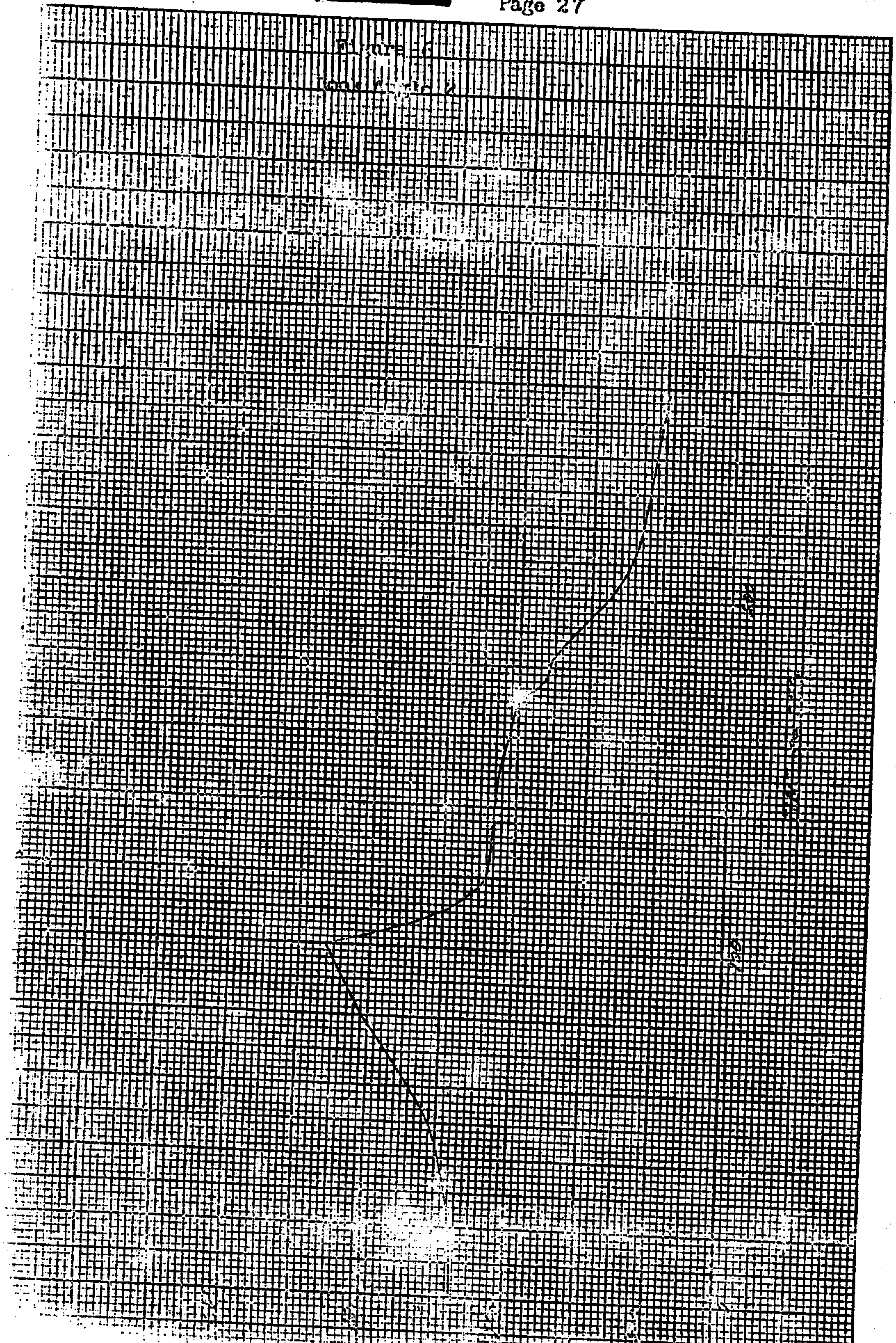

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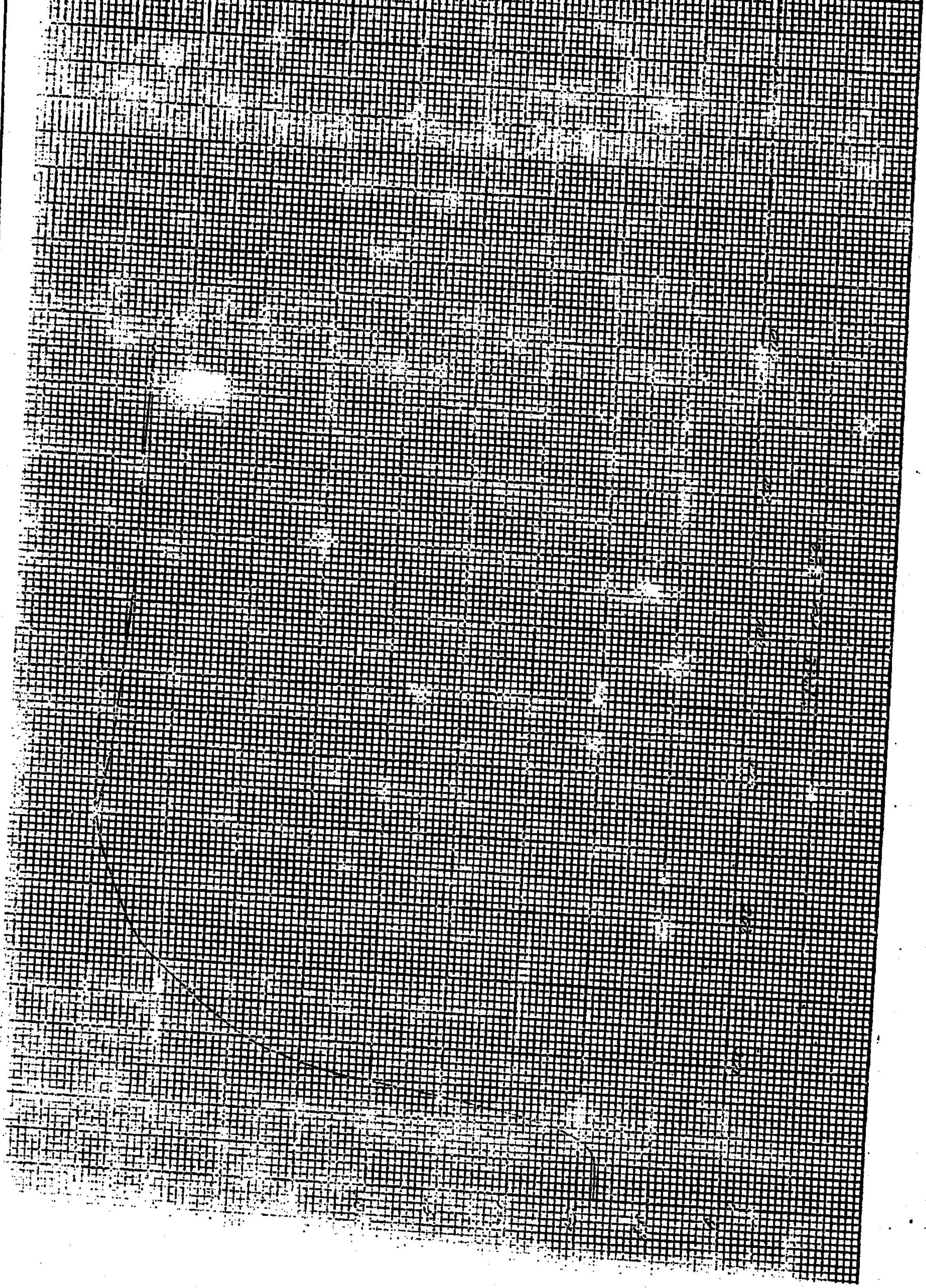
Figure 7



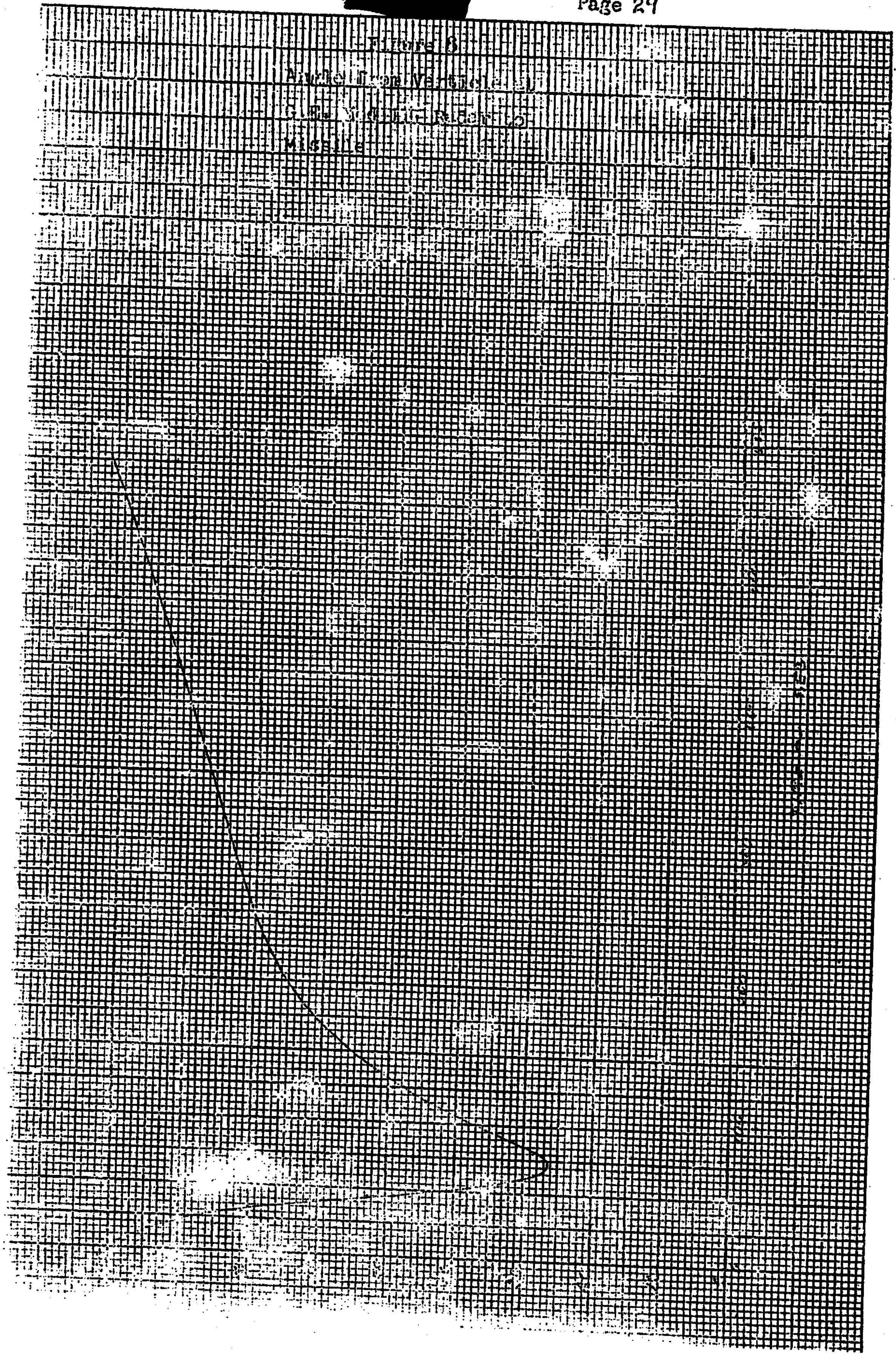


Figure 8
Missile