WEAPON SYSTEM 117L

PRELIMINARY DEVELOPMENT PLAN

(Initial Test Phase)

3 0 OCT 1989

[redacted]

WESTERN DEVELOPMENT DIVISION
HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND

~~CONFIDENTIAL~~

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WESTERN DEVELOPMENT DIVISION (ARDC) DEVELOPMENT PLAN

WEAPON SYSTEM 117L
PRELIMINARY DEVELOPMENT PLAN
(Initial Test Phase)

ADVANCED RECONNAISSANCE SYSTEM

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FOREWORD

1. This volume presents the planning for that portion of the overall Advanced Reconnaissance System necessary to demonstrate an orbital capability within the International Geophysical Year and shortly thereafter. (CONFIDENTIAL)

2. It appears perfectly feasible to provide an orbiting vehicle of considerable payload capacity within the IGY period, provided implementing action is taken at an early date. This vehicle development can be carried out as a coherent part of the overall Advanced Reconnaissance System Program without significant compromise to the latter. Further, if current schedules can be maintained, no hardware interference with the ICBM program is foreseen. Some interference from a personnel dilution standpoint will necessarily exist. This can be minimized by advanced planning if a consistent program is pursued. (SECRET)

3. This tentative plan is presented in response to an urgent request from Headquarters, ARDC for an early plan covering only the IGY period. A complete plan for the development of the overall Advanced Reconnaissance System will be submitted to Headquarters, ARDC on or about 1 April 1956. (CONFIDENTIAL)

B. A. SCHRIEVER
Major General, USAF
Commander

CONFIDENTIAL WD-56-00088

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I - BACKGROUND AND DESCRIPTI[redacted]

A. Background

This document answers a request from Hq USAF to present a possible development program for the initial test phase of the Advanced Reconnaissance System which would permit the launching of an orbiting vehicle during the IGY (International Geophysical Year) or shortly thereafter. ~~(SECRET)~~

This initial test phase of the ARS Program includes the research, design, development and/or provision of all components and subsystems for both an orbiting vehicle system, and its attendant facilities for launching, acquisition, tracking, communications and ground test. This initial portion of the ARS Program will culminate in a series of 10 orbiting vehicle tests, representing an integral and essential part of the overall development of the Advanced Reconnaissance System. The Plan limits the system vehicle to the Convair Series "C" missile (XSM-65, Series "C"). The first planned orbiting test follows a minimum of seven Series "C" ICBM flights. The first orbiting flight could be launched in August 1958 and successive flights launched at the rate of one per month thereafter for a total of ten vehicles; six of these vehicles could reasonably be expected to reach orbiting conditions. ~~(SECRET)~~

Although the request for this initial test phase (to provide orbital vehicles within the International Geophysical Year) was not made until late December 1955, previous studies made within the ARS Program have provided reliable material to permit the preparation of this Plan. These previous studies represent considerable planning and detailing of the various aspects of orbiting systems utilizing the Convair "C" missile, and their incorporation into this particular program at this time adds validity and confidence to the potential success of the initial test phase during the International Geophysical Year. (SECRET)

Notably among the studies integrated into this preparation are the ARS Test Programs which were prepared by Lockheed Aircraft Corporation (MSD), The Glenn L. Martin Co., and Radio Corporation of America (Princeton) in their Design Studies for the Advanced Reconnaissance System. These documents provide a basis for the vehicle, scheduling, and cost analysis for the Program. From the overall ARS Design Studies has been drawn the information to support feasibility of integrating various components into an orbiting vehicle. A Program of various technical tasks has been under way within the ARS Program. These tasks were devised to advance the "state of the art" for the various components required for an orbiting vehicle and for techniques required to provide reconnaissance utility to such a vehicle. ~~(SECRET)~~

A proposed System Development Plan for the Advanced Reconnaissance System will be submitted for approval in April 1956. This Development Plan will provide more detailed information on the aspects of orbiting vehicles than is presently available and will amplify as well as incorporate the Initial Test Phase Plan outlined in this document. ~~(SECRET)~~

Within the limitation of time available, every effort has been made to evaluate all past information available in preparing this Plan.

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A. Background (Contd)

It is planned that development of this initial test vehicle will form an integral part of the ARS Program. As such, the characteristics of the initial vehicle will be governed not only by the requirement for its availability during the IGY time period, but also for consonance with the requirements and specifications of the Advanced Reconnaissance System itself. (~~SECRET~~)

The attainment of a fully operational Satellite Reconnaissance vehicle involves a long and thorough test program: first, to identify the operating environment; second, to establish a suitable and reliable vehicle combination; third, to test the actual reconnaissance components, subsystems, and finally the complete system. Thus, the requirement for an IGY orbiting capability does not in any sense require reorientation or redirection of the ARS Program; - rather, it indicates a need for acceleration. (~~SECRET~~)

Since it is only a part of the overall ARS Program, the resource requirements for the initial test vehicle represent only a proportionate part of the whole requirement. Statements in this document outlining the need for funds, facilities, etc., refer only to the development of the initial test vehicle itself. The total estimated concurrent resource requirements for the Advanced Reconnaissance System will be outlined in the ARS Development Plan to be presented in April 1956. (~~SECRET~~)

B. General Description

The Advanced Reconnaissance System Development Program is broken down into logical phases. The Initial Test Phase is the first of these logical phases. The objective of the Initial Test Phase is primarily concerned with providing the orbital test vehicle. As herein set forth, a series of flights during the IGY, and shortly thereafter, is scheduled. (~~SECRET~~)

This initial phase, as well as all other phases, consists of the four (4) major subsystems having a degree of complexity reflected by the objectives of the specific phase. These four major subsystems, as delineated for the Initial Test Phase, are briefly described as follows: (~~SECRET~~)

1. The satellite will have a total weight of approximately 3500 pounds and will be of suitable configuration for replacing the nose cone of the ICBM-Convair Series "C" vehicle. Adaptibility to the Series "C" vehicle is important to insure maximum utilization of ICBM engineering, test data and facilities and to minimize interference with the ICBM Program. It is to be handled, when assembled with the ICBM, on the available launching stands. (~~SECRET~~)

The satellite vehicle will be designed to provide a test bed for the instrumentation and equipment tests and will include a propulsion system, guidance and control equipments, beacons and other items being developed for the ARS and essential for these tests. Operational subsystems will be tested at the earliest possible date. (~~SECRET~~)

2. The booster for this phase of the test program will be an ICBM missile (Convair's XSM-65, Series "C"), minus the nose cone. This includes all equipments

B. <u>General Description</u> (Contd)

and facilities necessary to boost and guide the satellite to the separation point on the trajectory. These equipments are being developed for the ICBM Program. (~~SECRET~~)

3. The Ground-Air Communication, acquisition and tracking and Control Subsystem consists of the facilities and equipment essential to locate the vehicle in its orbit, determining its path and associated data, and maintaining communications between the ground and the vehicle for the purpose of receiving information relating to the flight and for transmitting instruction to the vehicle. A number of ground facilities are required for this subsystem. Utilization of the ground stations and communication system planned for the support of the Scientific Satellite (IGY) will be considered. (~~SECRET~~)

4. The Data Handling Subsystem for this phase will not have the capacity required for operational tests. It will have the elements and designed capability for handling environmental and subsystem data generated in the early flights. At the earliest possible date, the operational Data Handling System will be installed and tested. This will include the basic ground recording equipment for visual and ferret data and initial read-out, indexing, coding, and storage equipment. (~~SECRET~~)

C. <u>General Design Specifications</u>

The general specifications which follow apply only to the satellite vehicle itself; it is assumed that this vehicle will be boosted by the XSM-65C missile, and that no or at best very minor modifications to the XSM-65C missile will be required to "marry" the vehicle combination. Overall performance of the XSM-65C will be unchanged. (~~SECRET~~)

The general level of "sophistication" indicated by the specifications for the Initial Test Vehicle is that considered feasible for attainment by the 1958-59 time period. However, it is proposed to retain maximum flexibility within the development program so as not to compromise an IGY orbiting capability; in every instance where possible, new developments will be backed up with existing components of lesser capability but greater reliability. Such an approach will permit maximum development progress by the required availability date. As an example, the radioisotope auxiliary power unit appears feasible by the IGY time period; however, batteries capable of satisfying power needs for a shorter period are available and will provide insurance against unforeseen development delays. A further back-up can be provided through use of current chemical techniques to provide power supply. (~~SECRET~~)

It is again emphasized that the general design specifications listed below should be considered as "suggested" specifications which can probably be met for the Initial ARS Test Vehicle. However, bearing in mind the importance of having a reasonably sophisticated orbiting capability during the IGY time period, the specifications will be adjusted downward from the "desired" level where necessary to insure a timely capability for orbiting flight. (~~SECRET~~)

C. General Design Specifications (Contd)

SPECIFICATION AREA	INITIAL ARS TEST VEHICLE
OVERALL PERFORMANCE:	
Orbiting Altitude	230-300 N. Mi. Elliptical orbits due to elementary vernier thrust control
Orbiting duration	15 days +
Accuracy	Elliptic - Eccentricity 30-100 miles
Payload	1500 pounds
Mission	Gathering environmental & scientific data and testing elementary ARS subsystems
COMPONENT CHARACTERISTICS:	
Power plant	15,000 pound thrust engines to circularize elliptical orbit (probably Hustler XCR-81-BA-1, weighing 1600 pounds approximately, including propellants)
GUIDANCE & CONTROL:	
Transition after separation	Stable platform and computer to control vernier boost for attaining orbit
Orbital Control	Fully stable configuration with reaction wheel control based on rate gyro sensing
POWER SUPPLY:	Battery pack; alternatively radioisotopes with thermo-couple conversion
AIRFRAME:	Probably Semi Monocoque (Sheet Stringer) Design Integral Tanks, Cylindrical with conical blunt, or ogival, nose. End frame to mate with ICBM booster warhead attachment bulkhead

C. General Design Specificat[redacted]

SPECIFICATION AREA	INITIAL ARS TEST VEHICLE
OTHER SUBSYSTEMS:	Sensing devices for gathering environmental and scientific data. Equipment operation monitors. Rudimentary TV, photo, and ferret equipments. Advanced technique system test devices. Antennae. Beacon transponder or transmitter for acquisition and tracking. Telemetering system. Self-destruct system
GENERAL WEIGHTS AND PERFORMANCE:	
Separation Weight	Approximately 3500 pounds
Total ARS Vehicle Length	Approximately 14 feet
Accelerations	Same as those applicable to ICBM

(SECRET)

[redacted]

II. APPROACH TO PROVIDING AN ORBITING FLIGHT DEMONSTRATION IN 1958 AS A PART OF THE ADVANCED RECONNAISSANCE SYSTEM (ARS) PROGRAM.

A. <u>Introduction</u> - The ARS Program, with proper reemphasis and acceleration, can provide a Flight Demonstration of an orbiting vehicle in CY 1958. This first became evident in September 1955 and has subsequently been substantiated with the progress of the Design Study Phase of the ARS Program. The ARS Program requires an early test vehicle to provide essential data for the future logical development of many equipments in the system. ~~(SECRET)~~

Due to the nature of any orbiting flight having utility, it is necessary to consider a great complex of individual technical problems as they relate to a complex system. Each portion of the system is so interlaced with others that none can be considered separately. Neither does it appear desirable to develop a test vehicle separately, or outside the ARS Program, since the elements of a separate test vehicle program are essentially the same as would be required in a test vehicle integrated with and required for the ARS development. ~~(SECRET)~~

The Initial Test Phase of the ARS Program will have as its primary objective the establishment of the feasibility of operation of vehicle in orbit and the collections of basic environmental data relating to the orbiting operation. Contingent upon the success of the earliest flights will be imposed the additional objective of early component testing. ~~(SECRET)~~

The overall ARS Test Program may be presumed to require some 80 orbiting flights. Captive tests and other flights will preclude the orbital flights and continue until the Advanced Reconnaissance System is fully operational. A limited operational capability is anticipated with orbiting vehicles during Initial Test Phase of the test program. However, the achievement of any operational capability is of secondary importance and will not be allowed to jeopardize the attainment of a flight demonstration in 1958. ~~(SECRET)~~

An example of the operational utility that might be possible with the Initial Test Program is the use of simple camera (with read-out components) to photograph selected portions of the earth under the orbital path. A payload of 1500 pounds allows adequate space and weight capacity for this type of equipment, which is expected to be available within this time period. ~~(SECRET)~~

B. <u>Elements of Initial Test Vehicle System</u>

The development and test schedule of the ARS contains the required elements for a sound and logical progress of the combined systems to yield ultimately a successful reconnaissance system and to meet the immediate requirement for the earliest successful orbital flight. Of the subsystems which have been selected for inclusion into the early part of the program, there are relatively few which are not already in the development phase. No subsystems have been considered unless basic research has already indicated that these subsystem concepts are compatible with an early flight. ~~(CONFIDENTIAL)~~

1. <u>Booster or First Stage</u>

The ICBM Convair Series C vehicle will be utilized as the initial stage and is considered to [redacted] suitable as a first stage even under conditions of modest degradation in design [redacted] eptable degradation is indicated in Figure 1. In the event of degradation in performance in the Series C vehicle, it will be noted that an utilitarian payload can be placed on orbit. General performance characteristics for the Series C are assumed to be: Nose Cone weight - 3500 pounds and Burnout velocity - 23,000 fps for a 300 mile apogee trajectory. (~~SECRET~~)

Design of subsequent staging will be on the basis of minimizing modification to the Series C vehicle. (UNCLASSIFIED)

2. Subsequent Staging

AIRFRAME:

The vehicle will be approximately 5 feet in diameter with a faired fitting at the aft section to mate with the Atlas C booster diameter. The length of the vehicle will be limited to approximately 14 feet in order that stands presently used for the Atlas vehicles may be utilized. The vehicle will have an ogival, blunt, or conical nose which houses the payload compartment containing the subsystems described in the design specifications. Provisions will be made to employ environmental control techinques for the payload section as required. Aft of the payload section will be the fuel tank section, the lower bulkhead of which will mount the engine thrust frame. (~~SECRET~~)

PROPULSION:

A conservative estimate on the increment of velocity to be given the vehicle in order to place it in an orbit is of the order of 3000 fps on a 300 mile apogee ascent to orbit trajectory. A third stage propulsion system will be necessary to provide this velocity increment. Due to the short development time allowed to meet the Phase I ARS time schedule, it was decided to investigate the AF inventory for a developed item, to see if a feasible system is available. The "Hustler" engine (XCR-81-BA-1) (presently under development) will begin flight test in the fall of 1956 and seems suitable. The total weight of a modified Hustler system (decrease in tankage and fuel weight for this usage) is 1575 pounds, which will supply a thrust of about 15,000 pounds for a duration of 20 seconds. It is expected that this system will be developed for Initial Test Vehicle use by January 1958 and will allow a payload of about 1500 pounds. With this propulsion system, it should be possible to control the final velocity to within ±25 fps. A deviation of ± 20 miles from circular orbit at 300 mile altitude is thereby obtained with correct thrust orientation. This is a designed air start engine and the time period between the initiation of an Initial Test Phase and first flights will be utilized in a research program to improve reliability and further investigate the use of hydrazine as a fuel. (~~SECRET~~)

AUXILIARY POWER UNIT (APU):

The following APU performance requirements for the Initial Test Vehicle have been assumed:

a. Total payload on orbit: Approximately 1500 pounds.

b. Duration of APU Operati[redacted]ys to 2 months.

c. Peak electrical power required: 300 watts.

d. Electrical energy required per day on orbit: 600 watt hours / day ~~(SECRET)~~

Various Auxiliary Power Units have been under study in the ARS Program and it appears that a wide range of power source can be made available. Listed here, in order of increasing development time, are those appearing to be feasible in this Phase:

a. Chemical batteries
b. ~~Chemically~~ fueled turbine-generator
c. Radioisotope heat source coupled to

    (1) A reciprocating engine-generator;
    (2) a turbine-generator;
    (3) Thermocouples.

d. Nuclear reactor coupled to a turbine-generator
e. Solar batteries.

Further study will indicate an optimum unit to be used. ~~(SECRET)~~

GUIDANCE:

It is assumed that the XSM-65 C missile will have main and second stage guidance of the radio inertial type. Accuracy from this system would provide guidance necessary to achieve a degree of orbital accuracy adequate for ARS initial test requirements. ~~(SECRET)~~

With guidance during the boost phase provided by the XSM-65 C missile, there remains the problem of guiding the satellite vehicle itself to an orbit. A stabilized platform will be required for this phase with a pre-determination of time and orientation of the vehicle required for the third stage initiation. ~~(SECRET)~~

Guidance on orbit will consist of sensing and feeding proper signals to an adequate control system which will maintain a reference orientation in the orbiting vehicle. Of the many possibilities for accomplishing this, the best appears to be the "dumb bell mass distribution" method which will take advantage of the gravity restoring torque to provide inherent stability of the vehicle in the downward direction and to provide sensing reference. Another method under consideration for obtaining a vertical reference indication for the orbiting vehicle will utilize an infra red horizon scanner. This horizon scanner is currently in the early testing stages utilizing balloon flights. ~~(SECRET)~~

CONTROL:

Control during the boost will be furnished by the XSM-65 Series "C" control system and will be by means of gimballed engines and control of verniers. ~~(SECRET)~~

During the coast period from booster cut-off, control will be required to torque the vehicle into the preferred orientation required for vernier thrust initiation. This will be done with reaction wheels (or possibly by jet thrust). The same reaction wheels will be used to orient the vehicle and to damp out oscillations of the vehicle in orbit. Control of either a gravity stabilized vehicle or a closed loop control system (sensing a reference direction) require that disturbing torques arising from other vehicle subsystems be kept to a minimum, such as by counter-rotating any rotating machinery with either usable rotation or dummy flywheels. ~~(SECRET)~~

ACQUISITION AND TRACKING, AND COMMUNICATIONS:

Acquisition and Tracking:

The AN/FPS-16, instrumentation radar, presently being fabricated, appears to be the best approach to the acquisition and tracking problem for the initial orbital flights. However, to meet these requirements, the antenna system, transmitter power and several other items must be modified. The two major problems that must be investigated throughout the test problem are propagation reliability and transponder reliability. ~~(SECRET)~~

Theoretical studies have indicated that the acquisition problem is contingent upon providing adequate power in the air-to-ground link. Thepresent "state of the art" indicates that a receiver with adequate sensitivity and an airborne transmitter with adequate output power can be constructed to meet the ARS requirement and within the desired time schedule. ~~(SECRET)~~

Communications:

It appears that advantages can be obtained by maximum utilization of the radar-tracking beam for some of the ground-air functions. The ground-to-air command link and air-to-ground telemetering link can be so implemented in accordance with presently available techniques. To be given further consideration will be a scheme whereby commands will be transmitted from the ground station to the vehicle via the tracker-transponder link by pulse position modulation or similar techniques; low content information will be transmitted via the transponder-tracker link by the same techniques. ~~(SECRET)~~

The Ground Communications techniques necessary to support the flight of the first orbiting vehicle are in existence today and can be made available as operating equipment within the desired time schedule. The problems associated with the Orbital Computer, Programmer-Timer, and the Command of the vehicle will be attacked by presently known techniques and by the modification of existing equipment. ~~(SECRET)~~

INSTRUMENTATION AND COMPONENT TESTING:

Both the ground facilities and the spaceborne vehicles will be instrumented to collect, transmit and record information relative to the vehicle's performance in orbit. Presently [redacted]echniques will be utilized to obtain this information. Each test vehicle will serve a multiplicity of purposes, providing essential data for the future logical development of each of many equipments in the system. The complexity of the tests on any vehicle will depend upon the success of preceding tests. As an example, a particular vehicle will be used to test the performance of tracking equipment, to gather environmental data, to test communications, and to conduct experiments to determine the optimum chassis configuration. Instrument tests will be planned to make optimum use of the relative large payload and space available aboard each vehicle. ~~(SECRET)~~

GEOPHYSICAL-ENVIRONMENTAL DATA COLLECTION

From its inception the Advanced Reconnaissance System documentation has included the provision that the ARS Test Program should be so oriented as to maximize the usefulness of the test vehicles to the scientific community in general as well as to satisfy environmental and engineering requirements of system. ARDC System Requirement No. 5 requires that the System Development Plan contain provisions for the fabrication and launching of "research laboratory models" of the Satellite Test Vehicle, capable of obtaining and transmitting to the earth valuable scientific data on the space environment and astronomical bodies. ~~(SECRET)~~

The geophysical environmental program to be performed as part of the Initial Test Phase will have two objectives. First, it will provide for the measurement of such environmental data as has been determined to be necessary if not critical for the succesful design of the system. Secondly, it will provide for the measurement of other geophysical environmental data which may be of limited importance to the design of the ARS but of great scientific importance. ~~(SECRET)~~

Based on current studies, the environmental factors which appear to be of primary importance to the Advanced Reconnaissance System are (a) density at orbital altitude, (b) rate of influx and mass of micrometeoric material (c) thermal flux of the earth and sun as they affect equilibrium temperatures at altitude (d) Solar radiation in the ultraviolet and X-ray regions and (e) the effects of the ionosphere and troposphere on communication and tracking of the vehicle. Though not listed in any order of priority all these will be thoroughly investigated in this phase. ~~(SECRET)~~

In addition to the above areas of direct importance to ARS Design, certain other geophysical areas also of primary importance to the scientific community are expected to be studied by use of the orbiting vehicle. These include, but will not be limited to, (a) measurements of the direction of influx and intensity of cosmic radiation, (b) measurement of the direction and intensity of the earth's magnetic field and (c) measurements of cosmic and solar high frequency radio noise. Also, for scientific purposes, more sophisticated scientific experiments in the areas of direct interest to ARS Design may be conducted. ~~(SECRET)~~

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ARS GEOPHYSICAL-ENVIRONMENTAL DATA COLLECTION PROGRAM.

1. **Meteor Measurements**

The measurement of the influx of meteoric material has a two-fold significance. It is necessary in order to determine the hazard to a very high altitude vehicle from bombardment by cosmic dust impinging at velocities of the order of 100,000 miles per hour. Also this information may be of geophysical importance since the extent that radio communications are affected by such cosmic dust is presently unknown. (~~CONFIDENTIAL~~)

The presence of micrometeoric dust will be measured from acoustical vibrations resulting from their collision with an elastic diaphragm incorporated as part of the skin of the satellite. This acoustic technique has been successfully used in rockets and can be readily modified for satellite use to determine the rate of influx of meteoric matter, as well as the mass, and, orbit permitting, latitude variations of influx. (~~SECRET~~)

2. **Thermal Radiation Measurement**

Thermal radiation flux incident and absorbed on the skin of the ARS vehicle, with the sun and the earth acting as sources of energy, can produce extremely large variations in the skin temperature with a possible severe degradation of structural integrity. The skin conductivity and internal reradiation can be expected to produce a heating or cooling effect on the equilibrium temperature of the interior, depending on the radiation absorption and emission characteristics of the system and its insulation features. Also, thermal radiation information relative to the flux of the earth in the infra red may be required to determine or control the attitude of the system while in orbit. (~~SECRET~~)

In order to provide the needed information, instrumentation to be satellite-borne will be developed for the measurement of the absolute radiation flux from the sun in the ultraviolet, visible and infra red, by means of filter radiometry. Similar equipment will be developed and measurements made to determine the flux from the earth due to daytime albedo and emission and nocturnal emission. Existing equipment will be modified to measure satellite skin temperatures and interior temperature. (~~SECRET~~)

3. **Density Measurements**

The measurement of density at orbital altitudes is of primary importance since successful operation is dependent on the ability of the ARS vehicle to remain in orbit for long periods of time and the choice of orbiting altitude for any desired life time is dependent, among other things, on a knowledge of the density. (~~SECRET~~)

There are several methods by which density might be determined from or by means of an orbiting body. (UNCLASSIFIED)

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[redacted]

The most obvious metho[redacted] track the vehicle itself and, assuming known aerodynamic[redacted] atmospheric density can be determined by variations of the orbit as compared with a vacuum orbit. A similar method suggested by Whipple involves the rearward ejection from the satellite of two or three spheres of equal size but different mass. These spheres must be ejected rearward with sufficient velocity so that they will spiral towards the earth's surface. By optical or radar tracking, the trajectory can be determined and this versus the time data will determine density at various altitudes. Kellogg and Kallmann have suggested a method involving the ejection of a balloon of some kind from the satellite and dragging it by means of a line in which the tension would be a measure of the relative drag force between the two bodies. This drag force together with information of mass and size of the two bodies plus orbital velocity and drag on coefficients will yield density. ~~(SECRET)~~

It is expected that the ambient pressure at 500 KM will be of the order of 10^{-9} mm of Hg which is within the range of the Alpert guage. Assuming a non-aspect controlled spherical body or any known shape with aspect control, Alpert guages can be used to determine import pressure. Impact pressure plus a knowledge of the velocity of the body relative to the air mass will permit determination of density. ~~(SECRET)~~

4. <u>Solar Radiation Measurements in the Ultraviolet and X-Ray Region</u>:

With regard to solar radiation, there are two principal areas of research which should be investigated as being of possible critical importance to the design of the ARS. These are the effect of radiation (solar x-ray and short wave length ultraviolet) and the effect of molecules, atoms and ions existing at 500 km. ~~(SECRET)~~

Since a vehicle traveling at 500 km is essentially receiving unfiltered solar radiation of low wave length, one must consider a possible "charging-up" of the metal due to the loss of photoelectrons from the surface. This charging-up can theoretically rise to thousands of volts, depending on the wave length and intensity distribution of the incident radiation. Such a charging-up could influence the telemetering and other electronic functions of the equipment in the vehicle. ~~(SECRET)~~

Also, the effect of the atmospheric composition at 500 km is difficult to assess since the pressure at that altitude is not accurately known. The best estimates range from 10^{-7} to 10^{-10} mm of Hg. If the real pressure lies in this range there might be heating of the vehicle due to recombination of atoms on the surface as well as impacts with other atoms and molecules. ~~(SECRET)~~

A photo counter-type instrument will be developed to be satellite-borne to measure solar radiation in the x-ray and ultraviolet region. Also an ultrasensitive light weight mass spectrometer will be developed and flown during the test program to determine atmospheric composition at orbital altitudes. ~~(SECRET)~~

[redacted]

5. <u>Ionospheric and Tropo</u>[redacted]<u>ts</u>:

Techniques based on the use of electromagnetic radiation will be used as a method for guidance into orbit and tracking in orbit of the ARS vehicles. Depending on the frequencies used, the ionosphere (at low frequencies) and the troposphere (at high frequencies) will cause the electromagnetic waves to be deviated from their normal straight line path, as well as delayed, thus giving a false position for the vehicles. If the index of refraction is determined for the ionsphere and troposphere, correction can be made to give the true position of an object being tracked. (~~SECRET~~)

In order to determine the fine structures of the ionosphere, a pulse transmitter with a frequency of about 30 mc/s will be carried in the ARS Test Vehicle. The pulses are synchronized with the interrogation pulse of ground stations. The time delay between the 30 mc/s pulse and the interrogation pulse, the amplitude fluctuation and possibly also the phase fluctuations and changes of polarization will be recorded at the ground stations (5 stations several miles apart). (~~SECRET~~)

This information enables one to determine the integrated refractive effect through the whole ionosphere up to the height of the satellite. Studies will be instituted to determine the feasibility of developing suitable equipment to study tropospheric effects. (~~SECRET~~)