SECRET

A REVIEW OF PROMISING FUTURE AVRO PROJECTS

DEVELOPMENT PROGRAM REPORT No. 9

NOVEMBER 1958

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SALES ENGINEERING DEPARTMENT

AVRO AIRCRAFT LIMITED

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This is copy number..... 1 .....

Issued to..... Mr. M. O. Wells .....

Date..... 8th December 1958 .....

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SUMMARY

The results of the Sales Engineering Department's investigations into the prospects of future business for Avro Aircraft Limited shows an excellent potential exists. The prospects in both the Military and Commercial field appear to be very good.

No fewer than thirteen different vehicles show promise of a good potential market and some of these represent only one of a family of possible vehicles which should also be marketable. In addition there are seven other projects which are currently being investigated to assess their market potential.

It is significant that the ultimate success of a high percentage of the most promising projects described in this report is heavily dependent upon the successful flight of the Avrocar. Satisfactory demonstration and reduction to practice of the basic principles by the Avrocar will confirm the good prospects claimed for a large number of subsonic and supersonic vehicles based on that design concept.

It is also significant that no single program of this group can by itself support the Company at a level of business equivalent to that afforded by the Arrow project. It is apparent that several projects must be carried on simultaneously and that new programs must be properly introduced to replace those programs which are phasing out.

Some of the projects recommended will require a germination period during which company money will be needed to finance preliminary investigations, design studies, market analysis, proposals and in one case (P-15) the costs through development of the prototypes.

Others may reasonably be expected to be financed under contract with the U.S. and Canadian Governments. It is expected that with proper phasing of schedules and reasonable technical success the majority, if not all of these projects can be carried out at Avro and result in a high level of continuity in production effort for many years to come.

PROJECT SUMMARY AND MARKETING PROSPECTS

IDENTITY	COMMERCIAL	MILITARY
I SPECIAL PROJECTS		
A. AVROMOBILE FAMILY		
Note: Avrocar #1 & #2 under contract	* Worldwide	*** US Army, Cdn Army. UK Army ** US, Canada, NATO
1. Avroangel	* Dept. Lands & Forest (Canada US primarily)	* US, Canada, NATO
2. Avrotruck & Avrocoach	** Worldwide	*** (Army & Air Force ** US, Canada, NATO
3. Avrodrone		*** US Signal Corps Canadian Army
B. AVRODYNE FAMILY		
1. VTOL Fighter Bomber Weapon System		*** USAF, RCAF, NATO ** Worldwide
2. VTOL Mach 3 Interceptor		** RCAF, USAF, NATO
C. AVROSKIMMER FAMILY		
1. Avrofliver & Avrowagon	** Worldwide	** US, Canada, NATO
2. Avrocruiser	** Worldwide	** US, Canada, NATO
D. AVRO ANTI SUB WEAPON SYSTEM (AVROPELICAN)		** RCN, USN, NATO
II JUMP START GYRODYNE (7 passenger)	** Worldwide	* USAF, RCAF, NATO US Army, Cdn Army, & Pos. Worldwide
III AVRO SPACE PROGRAM (ANTI BOOST-GLIDE WEAPON SYSTEM)		** USAF, RCAF, RAF

PROJECT SUMMARY AND MARKETING PROSPECTS (Cont'd)

IDENTITY	COMMERCIAL	MILITARY
IV AW 660	* North America	*** RCAF
V OTHER PROGRAMS UNDER CONSIDERATION		
A. AVRO 748	* North America	
B. T.C.A. VISCOUNT REPLACEMENT	*** Worldwide	Unknown
C. AVRO MONORAIL	* Worldwide	* USAF, SAC
D. CF-100 + GENIE		* Canada, NATO
E. A.W. SEASLUG		* R.C. Navy
F. NORTHROP N-156		* RCAF
G. BOMARC		* RCAF

LEGEND:

* Limited Market Only
** Good Prospective Market
*** Positive Evidence of Market

A REVIEW OF PROMISING FUTURE AVRO PROJECTS

November 5, 1958.

INTRODUCTION

Since its establishment in July 1957, the Sales Engineering Department has conducted a series of investigations into and promotions of new products to be designed, developed, manufactured and serviced by the Company. A wide range of requirements for aeronautical vehicles including commercial, VTOL and space projects has been covered.

The prospects for various types of commercial transport aircraft were examined and the results reported for Management review by Development Program Report (D. P. R.) No. 3. This phase of the investigation was then narrowed to concentrate on the cargo transport aircraft and the results of an extensive market analysis and survey were recorded in D. P. R. No. 7. The Engineering Division, in conjunction with Orenda, is seeking a solution to the problem defined by this study.

Also on the commercial side, the prospects for conversion of the DC-6B to a turboprop configuration and the possibility of license arrangements for manufacture of the Doman and Alouette helicopters were explored. (D. P. R. Nos. 1 and 2). These three programs were rejected by the Management Committee.

RCAF requirements for a primary jet trainer were reviewed in D.P.R. No. 5 and the results of a survey of Anti-ICBM missiles were given by D. P. R. No. 6.

The U. S. Army requirement for a new family of air vehicles and the ability of the Avromobile to meet it were discussed in D. P. R. No. 4 and the prospects for commercial applications of VTOL aircraft were assessed by an economic analysis and market survey as reported in D. P. R. No. 8.

As a consequence of these investigations, surveys, exploratory studies and discussions of their requirements with military and civil operators, a number of programs for the development of new products have been defined. These products accommodate a wide range of commercial, Army, Navy and Air Force requirements to offer a diversified, multi-project situation not previously enjoyed by Avro.

This Report presents for Management consideration the promising projects which might be undertaken by Avro Aircraft Limited in preparation for future business. It does not include an analysis of the Arrow or its possible variants, a number of which have been suggested and reviewed by

the Engineering Division. It does include manpower charts which show the effect of various prospective programs on the Company manpower picture with and without the Arrow program.

Some of the programs discussed are long range in scope and will demand considerable lead time prior to the introduction of hardware into the military and commercial inventories. Other proposed projects promise to provide marketable products quickly.

While the length of program development schedules will be seen to vary considerably, certain of the programs should be initiated simultaneously to establish proper phasing and continuity.

Of greatest significance, however, is the fact that Avro is by no means devoid of promising future business. On the contrary, this investigation indicated that in several areas of endeavour Avro is uniquely suited to the task and appears to be in an excellent position to successfully compete in both commercial and military markets.

I SPECIAL PROJECTS

From the investigations of the Special Projects Group into VTOL concepts there have evolved three distinct families of vehicles:

(a) Subsonic VTOL vehicles with capability of operating in the ground cushion or as aircraft in free flight. This class has been designated the Avromobile family.

(b) Supersonic VTOL aircraft which could be called Avrodyne.

(c) Subsonic vehicles operating wholly within the ground cushion and not as aircraft. This class has been given the name Avroskimmer for identification purposes.

A number of the more promising members of these families are identified and discussed below:

A. AVROMOBILE FAMILY

The first member of the Avromobile family, the Avrocar, is in prototype manufacture under contract to the U. S. Government and is considered very favourably in comparison with its U. S. competitors. The Armies of the U. S., Canada and the U. K. have evidenced interest in the vehicle and following a successful short development phase the Avrocar will have a wide range of military and civil applications.

Evolving from the Avrocar are a number of related vehicles which also have promising futures.

1. AVROANGEL: The U. S. and Canadian Air Forces have a requirement for a firefighting and crash vehicle to operate from air bases to combat fires and save crews of aircraft which crash within 15 miles of the base. This requirement would be applicable to SAC, TAC, ADC and MATS bases in particular.

   Recognizing the shortcomings of conventional ground crash and firefighting equipment both Air Forces want a vehicle which can perform a rescue mission if an aircraft crashes "on the other side of the fence" where ground fire trucks cannot be effectively utilized.

   A recent USAF competition for such a vehicle was won by the Kaman Helicopter Corporation in the U. S. which is now developing the H-43 to meet this requirement. It has a design gross weight of 5, 800 lbs. and carries 1, 000 lbs. of firefighting equipment. The H-43 B has room for eight (8) passengers, but the crash vehicle version will normally carry a crew of four (4).

   The mode of operation is to dash to the scene of the crash and drop a three (3) man crew on the site, with foamite extinguisher equipment. The Pilot then hovers over the burning wreckage directing the downwash of the rotors so as to blow the flames away from the ground crew. While two men employ the hose, one in protective clothing enters the wreckage to rescue the crew.

   With its superior performance and load carrying capacity the Avrocar should be capable of hovering over the scene and direct foamite on the flames from equipment mounted on the underside of the vehicle, while depositing a ground crew to accomplish flight crew rescue. (Figure 5).

   The USAF has committed 1959 funds for the purchase of a number of these Kaman vehicles, however, a suitable effort on the part of Avro could divert 1960 funds away from this program and capture the initiative from Kaman resulting in a contract for the Avroangel as an Air Force follow-on program.

2. AVROTRUCK: The U. S. Army requirement for a combat cargo vehicle having a four ton payload capacity has been discussed with Transportation Corps personnel on several occasions and preliminary design work on the Avrotruck has been accomplished.

   It has been recently learned that the U. S. Army plans to conduct an

STOL cargo transport competition to meet this requirement, originally scheduled for late fall or early winter, has been postponed indefinitely.

The Management Committee had given approval for preparation of a proposal for our entry into this anticipated competition. This recent change in Army plans opens the way for submission of an unsolicited proposal for development and production of the Avrotruck. Discussions with the Special Projects Group indicate that the similarity of the Avrotruck to the Avrocar would permit immediate initiation of the Engineering design and that the vehicle could be put into production within a very short period of time. The Avrocar and Avrotruck appear to be the most promising programs available to quickly occupy our facilities in the event of an adverse decision on the Arrow program (Figures 6, 7).

3. AVRODRONE: The U. S. Army Signal Corps has a requirement for a family of surveillance drones for use in combat theatres. Their general requirement seems to be very acute, but they have had a great deal of difficulty in establishing specific requirements. Several discussions have been held with U. S. Army Signal Corps personnel who evidenced considerable interest in the Avro VTOL design concept as it may be applied to meet their requirement for this drone family. Rather than initiate a separate program, the Signal Corps people decided to monitor the Avrocar development since it would demonstrate the design concept applicable also to their vehicle. Prospects are quite good for the initiation of a drone development program pending successful demonstration of the Avrocar in its flight test program.

B. AVRODYNE FAMILY

1. VTOL FIGHTER/BOMBER WEAPON SYSTEM: The initial efforts of the Special Projects Group were directed towards the development of a supersonic aircraft incorporating VTOL capability. USAF Project 1794, System 606A and the Company's P. V. 704 programs were all directed towards the supersonic vehicle and a great deal of analytical and test work has been done towards this objective.

The Avrocar will demonstrate the basic design principles and the functioning of sub-systems also applicable to supersonic versions.

Both the USAF and the RCAF are formalizing requirements for a supersonic VTOL Fighter/Bomber and the two services have been coordinating to agree upon a common requirement. They have also

discussed in considerable detail the advisability and ways and means of joint sponsorship of an Avro developed weapon system to meet this mutual requirement. The recent visit of A/C Bean and General Ferguson and the expressed interest of Requirements and R & D personnel suggest that the probability of receiving contractual coverage for a weapon system of this type is quite high. The Management Committee has authorized the preparation of a weapon system proposal for presentation to the two services immediately after successful flight of the Avrocar.

2. VTOL MACH 3+ INTERCEPTOR: The recent declaration by the USAF that the best defence against the manned bomber threat is a defence in depth in which both manned interceptors and missiles are utilized has earned a reprieve for the manned interceptor.

The manned bomber threat from 1963 to about 1970 will be the Russian equivalent of the Mach 3, 75,000 ft. B-70, known to be under development. The American F-108 is being developed to cope with this threat. There is no Canadian counterpart. During recent discussions with RCAF Headquarter's personnel, (G/C P.F. Peter, Deputy for Arm. Engineering), it was indicated that this defence in depth philosophy was in the process of being adopted by the RCAF and would in all likelihood be reflected in future requirements for manned interceptors.

Because of its VTOL capability and the unique integration of its airframe and propulsion system a Mach 3+ interceptor of Special Projects design would offer a high rate of climb and an altitude bordering on the upper limits of controlled flight within the atmosphere. It is planned to determine if the RCAF would be receptive to a proposal for such a weapon system after the flight of the Avrocar demonstrates the basic VTOL principles. It is also possible that the Avro interceptor would be accepted as an F-108 backup by the USAF.

C. AVROSKIMMER FAMILY

Considerable effort has been expended at Avro on the Avromobile and supersonic aircraft, but no direct work has been done on the ground cushion vehicles. Thus the potential of ground transportation utilizing the peripheral ducting principle has not been explored.

Ground vehicles operating on a cushion of air are receiving much attention in the United States with the U.S. Army as one very interested customer. The commercial prospects of air cushion

vehicles are also recognized by the Detroit automobile manufacturers who are vigorously experimenting in this area.

Results of the Avrocar program have clearly indicated that peripheral ducting is superior to the "flow-through ducted fan" approach as a means of producing a ground cushion. If work is initiated now, Avro may well become the leading competitor in this field since the superiority of the technical approach will have been clearly demonstrated by the Avrocar.

1. AVROFLIVER AND AVROWAGON: The Avrowagon is a small version of the Avroskimmer which would employ a conventional internal combustion engine to drive the rotor. (Illus. 1). It should be designed for 4 to 6 passengers and have a body offering the features and carrying capacity of a conventional station wagon.

This vehicle should be of a size compatible with operation on roads and highways attaining a height of from 2 to 4 ft. which will allow operation over rough terrain for cross-country travel. If possible, it should have enough power to allow operation in the ground cushion over terrain 15,000 feet above sea level. At lower altitudes this reserve power could be employed when needed to clear obstacles of a height greater than the vehicle attains in normal operation. Peripheral burners might also serve this function.

It should be manufactured as light as possible using aircraft type structure and a body of aluminum or fibreglass.

As a preliminary to this effort, a much less sophisticated version (Avrofliver) possibly carrying only two persons and a limited amount of baggage or cargo could be developed as a "Model T" version.

Detroit Automobile Manufacturers are actively engaged in research leading to vehicles which ride on an air cushion. So far as is known their efforts thus far have been confined to designs using the "flow-through" ducted fan principle. The "Avrowagon" or "Avrofliver" could head off this effort and capture the market early if introduced soon enough to the public.

This is one Project which should be initiated immediately to see if such a vehicle can be produced economically and profitably marketed. If a practicable vehicle could be developed it might reasonably be marketed on a world-wide basis. Military Versions of these vehicles would include staff cars and utility vehicles for all three Services.

2. AVROCRUISER: This vehicle would be one of the larger versions of the Avroskimmer family, again operating at heights of from 2 to 4 ft. in the ground cushion and not as an aircraft. These versions, however, may employ either a conventional or turbojet powerplant to drive the rotor depending upon the requirements dictated by the mission which the vehicle is designed to accomplish. (Figure 2).

Light weight construction is also a prime design requirement for these vehicles.

The size restrictions dictated for the Avrowagon would not apply here although it would be desirable if these vehicles too could be made reasonably compatible with operation on roads and highways.

This class of vehicle would be designed to accomplish the classic commercial and military ground transportation mission, the object here being to provide the user with a light weight, high speed, maneuverable vehicle, which operates essentially independent of ground conditions and to some degree independent of terrain.

One unique feature of the Avroskimmer family is that a basic "Air platform" can be provided with a large variety of body styles to suit the desired missions of the different Services and commercial applications.

For example, one basic platform using an internal combustion engine to drive the rotor could be fitted with bodies allowing the vehicle to serve the Army and Marines as a scout car, staff car, reconnaissance vehicle, tank destroyer, ambulance, carryall and many others.

Another basic platform possibly using one turbojet to drive the rotor could be fitted with bodies to fit missions as a combat cruiser, weapon carrier, troop carrier, cargo carrier, missile launcher and many other missions requiring large payload capacity. Similar possibilities exist to provide the Navy and Air Force with useful vehicles.

This class of vehicle would be essentially free of the problems encountered by the armored units of World War II and the Korean War which became immobilized when faced with obstacles such as mud, swamps, swollen rivers, hedge rows, snow, ice and other natural barriers to wheel and track vehicles. Also there are the man-made barriers such as road-blocks, mine fields, blown-up bridges, tank traps, etc.

The Avroskimmer class of vehicles would give the military a new dimension in ground warfare and a mobility never before available to them in strictly ground operations. It should be economical to operate and require no more special tallent than that required of the modern army tank operator, as it can be designed to be stable on the ground cushion. The Avroskimmer as proposed performs a different mission than the Avrocar family, so that they are complementary not competitive in the overall picture.

Artists' conceptions of other Avroskimmer vehicles are shown in Figures 3 and 4.

When Brig/General R. D. Meyer, Deputy Chief of Transportation for Aviation, Office of the Chief of Transportation of the U. S. Army, visited Avro on September 17th, 1958, he was briefed on the Avrocar program. The Avroskimmer class of vehicle was described to him at that time and he expressed extreme interest in the idea on his own behalf and that of the U. S. Army. To use his own words, "The Army is mad at people on the ground and on or near the ground is where it wants to do battle". He agreed that a mobile strike force made up of versions of the Avroskimmer and Avrocar operating in close cooperation was just the kind of military machine the Army has been looking for.

The Navy should be interested in the Avroskimmer and Avrocar families for beach-head assault to replace the current amphibious assault concept with its inherent serious shortcomings.

The USAF Strategic Air Command should be interested in both the Avroskimmer and Avrocar families for their dispersed site logistics operations. SAC is currently investigating the use of monorails to provide a logistic support to their dispersed weapon systems on a given site for manned bombers, ICBM and IRBM bases.

Transportation of men and materials by Avroskimmer and Avrocar would be more suitable for their requirements than a monorail which is a fixed installation and would paint an identifying radar pattern on the ground.

D. AVRO ANTI-SUB WEAPON SYSTEM

Perhaps the greatest immediate threat to the Nations of the Free World is from Russian submarine launched missiles. Russia is known to have the largest fleet of this type of submarine in the world. Recent reports of extensive Russian submarine activity off both coasts of North America have been attributed to an attempt to

accurately locate sites for under-sea missile launchings.

The fact that the Russians are building and perhaps have already attained under-sea missile launching capability from submarines is undeniable. If indeed this capability exists and they have managed to accurately locate launch sites in the Atlantic and Pacific they are in a position to do mortal damage to this Continent without firing a single ICBM - the weapon most feared today.

An Anti-Sub Weapon System which would have the capability of locating and destroying these submarines represents another very worthwhile area for investigation. It is not clear at this time whether a supersonic VTOL Avrodyne class or an Avromobile class vehicle would be the most suitable airframe. Perhpas both types could be employed effectively depending on specific weapon system requirements.

Another possibility lies in utilizing ship based anti-sub vehicles in convoy escort work against the conventional submarine threat.

The combination of VTOL, speed, range and load carrying capabilities of the Avro vehicles suits them extremely well for this anti-submarine role (See illustration).

II JUMP START GYRODYNE

Development Program Report #8 presented a plan for entering the commercial VTOL field in three logical steps as follows:

1. Licensed agreement with an outside firm, for the manufacture and/or sale of a VTOL or related type vehicle to establish Avro immediately in this field in Canada.

2. Design, manufacture and market a VTOL class vehicle of original Avro design to establish Avro as the leader in this field in Canada.

3. Design, manufacture and market commercial versions of the Avromobile family.

To date, two commercial vehicles of Step 1 recommended by Sales Engineering have been disapproved by the Management Committee, however, the search for an appropriate licensed product is still under way.

A design proposal designated the P-15 has been prepared by the

Engineering Division which appears to be a very suitable vehicle for implementing Step 2. (Figure 8).

Except for the ability to hover (seldom used in practice anyway), the P-15 combines the advantages of rotary wing characteristics with those of conventional utility aircraft. The P-15 thus provides a vehicle which is a great improvement over the helicopter in terms of performance and economics.

A presentation to the Management Committee of the seven-place Jump Start Gyrodyne vehicle was delivered jointly by the Engineering Division and the Sales Engineering Department on October 22nd, 1958. Approval of the recommendations made at that time is pending submission of supplementary financial information to Management.

III AVRO SPACE PROGRAM (ANTI-BOOST-GLIDE WEAPON SYSTEM)

The U.S. industry has acknowledged the space age and has organized and planned for it. A determined effort is required now if Avro is to avoid being left hopelessly behind in this new area of aviation endeavour. Granted, there is a large amount of space fever and hysteria among the nations of the free world today, with the U.S. as probably the worst offender. To date, the U.S. has been totally unable to establish an integrated program for space exploration and its military applications. Far too many of the space proposals being given serious consideration are nothing more than stunts. In spite of the present confusion in defining programs, however, the fact must be faced that efforts to explore space and develop military weapon systems operating in the upper fringes of the earth's atmosphere and beyond will continue and be continuously accelerated. Certain sound programs which are currently competing for approval with the stunts will survive this period of hysteria and rise to the head of the list of programs to be heavily funded by the U.S. in the near future.

One of these sound programs is USAF's project DYNA SOAR. Briefly, the DYNA SOAR project consists of a development program for a family of hypersonic boost-glide vehicles in a fashion similar to the Avromobile family approach. The soundness of this program lies in the fact that the development will progress in logical, engineering steps from an initial "Conceptual Test Vehicle", to explore the upper atmosphere (altitudes of about 100 miles and speeds to and including satellite speed) to a family of weapon systems utilizing this concept within these speed and altitude limits and beyond, as the state of the art advances. Perhpas the most significant factor concerning Boost-Glide is that the current state of the art will support the development and flight of this

Conceptual Test Vehicle and that the USSR is known to be somewhat advanced in the development of a similar system.

There is considerable evidence that the Russians have already recognized boost-glide as an excellent approach to attain space supremacy. Their "Skip-Glide" vehicle program appears to be very similar to the DYNA SOAR program approach and in fact may turn out to be identical. There can be no doubt that the Russian "Skip-Glide" program is directed toward development of a military weapon system or family of systems. The current state of the art will support one of the powerful nations of the world placing such a weapon system into operation within the next eight years. Whichever side is the first to successfully accomplish this task will have their opponent at a serious disadvantage, if not be in virtual military control of the earth, if its flight is unopposed. In any case a capability to knock such a system down is of paramount importance to the free world.

It is suggested that Avro can not only build a capability in space technology but at the same time embark on a militarily desirable development program. This program should be within the capability of Avro technically and productionwise and within the capability of the Canadian Government, or perhaps in conjunction with the U.K., to support financially.

Much work is underway in the U.S. on Anti-ICBM Systems and work has begun on Anti-Satellites, but there is no evidence that any work has been initiated to date on an Anti-Boost-Glide system. What little thought has been given by the USAF to this problem has resulted in the offhand statement that an Anti-ICBM Weapon System could be used equally effectively against either an ICMB or a boost-glide system. Even a cursory examination of the nature of the trajectories of these two systems gives rise to serious doubts as to the validity of this contention. With respect to Anti-Satellite systems being effective against Boost-Glide systems the disparity in operating altitudes (100 MI vs 1000 MI +) casts doubt on this possibility also.

Although certain aspects of the Anti-Boost-Glide problem such as detection, tracking and reaction time are more difficult than that of defence against the ICBM, it should not be inferred that the ICBM defence is a simple matter. Defence against either will be difficult. It is the differences in modes of operation of each that makes it appear that two different weapon systems will be required to properly defend against the threat of each.

The cost of the development of an Anti-Boost-Glide vehicle should prove to be considerably lower than the development costs of a boost-glide

system and within the realm of reason as a project for joint sponsorship of the Canadian and U.K. Governments. If Avro could take the lead in this type of defensive weapon the U.S. might well be happy to help support the venture. Such an immediate approach could provide several important advantages.

(a) Allow early entry by Avro into the field of space technology requiring no immediate increase in engineering personnel with the special skills which would be required if a more ambitious undertaking in space technology were embarked upon.

(b) Open the security doors in the U.S. for access to the latest classified information, thus allowing the company to build a capability in space techology.

(c) Put Avro ahead of the industry as a whole in the field of Boost-Glide defensive systems.

(d) Allow time for Avro to prepare for more extensive participation in future space programs during the time it is building a capability.

Time is of the essence here for our U.S. competitors will not for long ignore this area and will be submitting Anti-Boost-Glide proposals of their own.

IV CARGO TRANSPORT (AW 650 or 660)

As a consequence of the market survey for a cargo transport aircraft, covered by Development Report No. 7, it was concluded that the commercial prospects for the Armstrong Whitworth Model 650 were not good in North and South America. However, discussions with RCAF Requirements personnel indicated that the military version, the AW 660, comes very close to meeting RCAF needs as expressed in an Operational Characteristics under preparation, but, not yet issued. A requirement for approximately 25 aircraft by 1963 is indicated although there is a possibility that this requirement may be changed to an aircraft of the Lockheed VC-130B type. Latest information, brochures, etc., on the Armstrong Whitworth cargo aircraft have just been received and a proposal in conjunction with Armstrong Whitworth is being prepared for discussion with the RCAF in December. A formal proposal will be ready for submission to the RCAF in February 1959.

V. OTHER PROGRAMS UNDER CONSIDERATION

A. AVRO 748

The Sales Engineering Department prepared a brief market analysis of the Avro 748 which was reviewed by Messrs: Floyd and Marshall with Mr. Galtizine during their visit to the U.K.

It was concluded that this project is not attractive to Avro for the following reasons:

1. It will be several years before the Avro 748 will be in service. By that time competitive aircraft with equal or better performance will be well established in service.

2. The quantities of aircraft likely to be required, even on the basis of an initial price which is comparatively low, are insufficient to warrant manufacturing in Canada.

3. The short take-off and landing features of the aircraft are such that a substantial penalty is paid in cruising speed. Field lengths in Canada are such that this feature is not justified.

B. T.C.A. VISCOUNT REPLACEMENT

This requirement was revealed during recent discussions with T.C.A. relative to the Avro 748. It has also been confirmed by the Minister of Transport.

A meeting has been arranged with T.C.A. for late November at which representatives of Engineering and Sales and Service will be present. A Questionnaire, to record the technical details of the impending discussion is being prepared.

C. AVRO MONORAIL

This program has been under investigation for some time at Avro. The USAF Strategic Air Command has recently expressed an interest in utilizing a monorail system to connect its dispersed fighter and bomber vehicles on their bases. This does not mean connecting dispersed site bases but rather connecting equipment which has been dispersed on a given base. The Sales Engineering Office will pursue the possibilities here to determine if in fact a requirement does exist and if so, a proposal may be submitted to the U.S. Government.

It is believed, however, that the basic SAC requirement can better be

met by a fleet of Avroskimmers and Avromobiles rather than a monorail. A monorail system since it is a permanent installation, has three very important disadvantages, for a SAC type operation:

1. A monorail network will layout a pattern on the ground which will be impossible to camouflage and make every base where it is installed a readily identifiable radar target.

2. Monorail installations will be vulnerable to Nuclear attack and rendered useless for post bombing operations.

3. The SAC operation is based on mobility from which a Monorail would definitely detract.

If after approaching SAC with such an argument and proposal they still want a monorail system it would then be in order to present Avro's Monorail proposal.

D. CF-100 - GENIE

In an effort to extend the useful life of the CF-100 aircraft, Sales Engineering is investigating the merits of a CF-100 - Genie "Marriage". It is not recommended that the Company proceed in contacts with the RCAF on this subject until it is clearly not going to prejudice the Arrow program.

E. A. W. SEASLUG

Avro's Sales Engineering Representative in the U. K. has been instructed to obtain information and data on the Seaslug surface-to-air missile. The Sales Engineering Department will utilize this material in its investigation of the market potential of this missile for the Royal Canadian Navy.

F. NORTHROP N-156

The Royal Canadian Air Force has shown interest in the N-156 as a replacement for their Sabre Squadrons. A meeting between Avro and Northrop is being scheduled for the near future to discuss the possibility of a license agreement for the production of the N-156 at Avro in the event that the RCAF decides to procure this vehicle.

G. BOMARC

Representatives of the Boeing Aircraft Company visited Avro on 12 November 1958 to discuss the possibilities of Avro manufacturing the Bomarc Missile under license for the Canadian Government.

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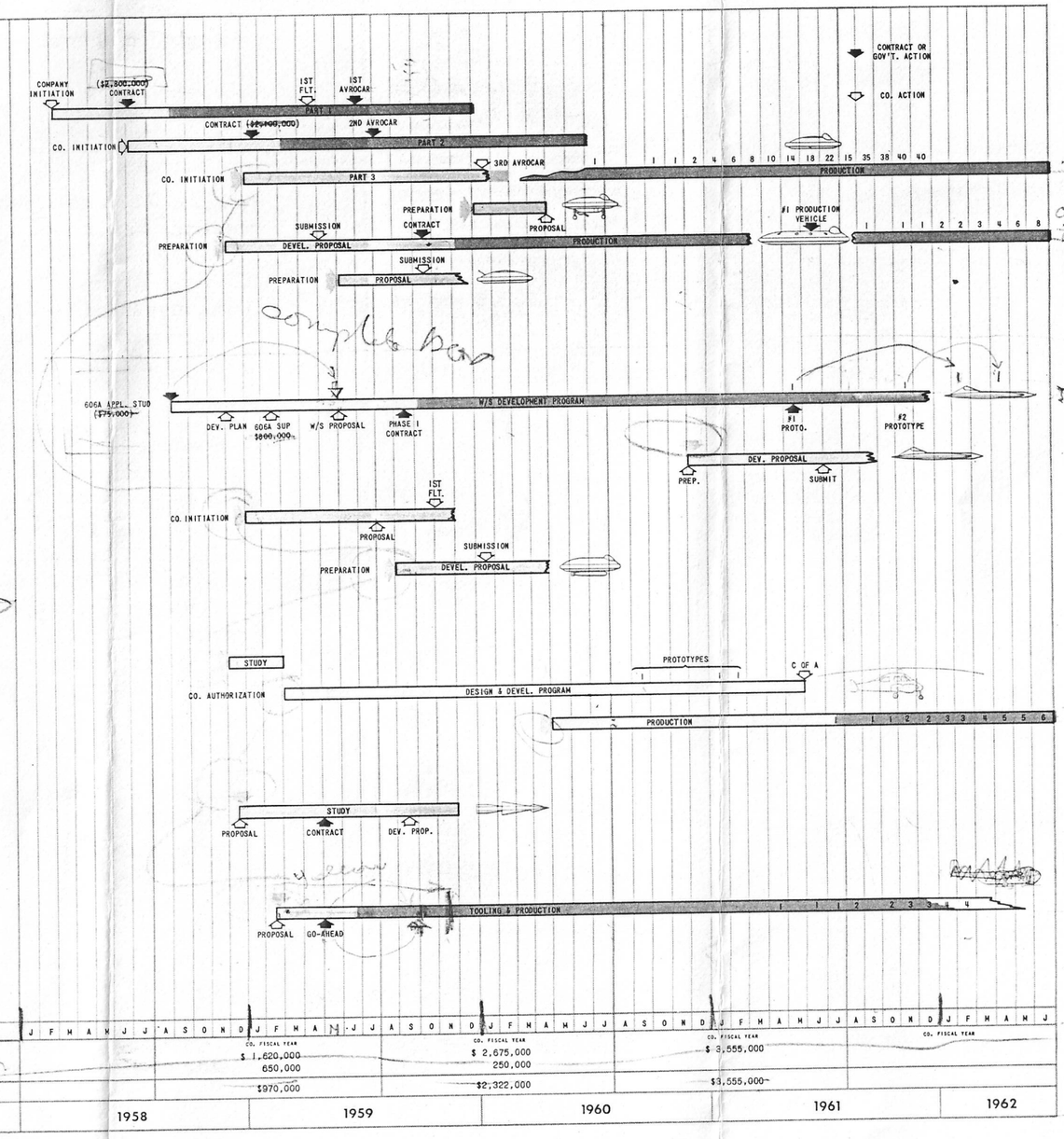
AVRO AIRCRAFT LIMITED

SECRE

~~MASTER~~ PHASING CHART

	CO. FUNDS REQ'D.
I SPECIAL PROJECTS	
A. AVROMOBILE FAMILY	
AVROCAR PART-1	
PART-2	
PART-3	$280.000
1. AVROANGEL	$25.000
2. AVROTRUCK AND AVROCOACH	$100.000
3. AVRODRONE	$50.000
B. AVRODYNE FAMILY	
1. VTOL FIGHTER BOMBER WEAPON SYSTEM	$400.000
2. VTOL MACH 3 INTERCEPTOR	$50.000
C. AVROSKIMMER FAMILY	$110.000
D. AVRO ANTI-SUB WEAPON SYSTEM	$100.000
II JUMP START GYROPLANE 7 PASSENGER	
PHASE-1	$120.000
PHASE-2	$3,131.000
PHASE-3	$3,069.000
III AVRO SPACE PROGRAM ANTI BOOST-GLIDE WEAPON SYSTEM	$400.000
~~IV AW 660 MILITARY TRANSPORT~~ COMMERCIAL	$110.000
~~V OTHER PROGRAMS~~	
TCA VISCOUNT REPLACEMENT	
AVRO 748 / AVRO HONORAIRE	
CF-100 + GENIE / A.W. SEASLUG	
~~ACFTHROF R-4566~~ / BOMARC	



	MONTH	J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
INITIAL COST TO AVRO	7,845,000	CO. FISCAL YEAR $ 1,620,000 / $ 2,675,000 / $ 3,555,000 / CO. FISCAL YEAR
RECOVERABLE UNDER ANTICIPATED CONTRACTS	900,000	650,000 / 250,000
INITIAL NET. COST	6,945,000	$970,000 / $2,322,000 / $3,555,000
	YEAR	1958 / 1959 / 1960 / 1961 / 1962

MASTER PHASING CHART

1

The prospects of this materializing are good, in view of the interest expressed by the Canadian Government in obtaining American Defence work for Canada and the inclusion of the Bomarc in the Canadian Defense Arsenal.

MASTER PHASING CHART

The Master Phasing Chart presents development schedules and Company funding requirements for each of the programs discussed in Sections I through IV. Section V projects are not so covered because of their preliminary status.

It should be noted that only the development schedules for the Avrocar, Avrotruck, VTOL Fighter/Bomber, the P-15 and the AW 660 are shown in detail. The remaining programs are of a study nature and the milestones shown are "initiation" and "proposal submission" dates.

The chart presents the recommended programs in a phasing sequence designed to provide continuity of development programs in future years.

Estimates of Company funds required to promote each program as well as a fiscal year breakdown are indicated on the chart.

Funding provisions are of three types: (1) All contract dollars; no Company funds required (2) Company funding required to initiate a program for which contractual coverage is virtually assured (3) Company funding required to accomplish preliminary work on a speculative basis towards future contracts.

CONCLUSIONS

There are no programs in view to immediately fill the void which would be created by cancellation of the Arrow program.

The slightly longer range picture looks much better and Avro Aircraft Limited has every reason to expect a bright future in the design and manufacture of aerial vehicles for both military and commercial applications in the years ahead.

In a few months the Special Projects Group VTOL concept will be put to the test with the flight of the Avrocar. Many potential customers are awaiting the first successful flight of the Avrocar before committing themselves to procurement of members of the three families of vehicles incorporating these design concepts.

It is reasonable to predict a good commercial market potential for these vehicles once the military versions are in production and have been proved in service.

In addition to the Special Projects Group program there are three other promising projects which might be undertaken in the near future. These are the Jump Start Gyrodyne (P-15), the Anti-Boost-Glide Weapon System study program, and the production at Avro of the Armstrong Whitworth 660 cargo and troop transport.

At the moment seven additional projects are under investigation which may result in enlarging the list of promising development projects which might be initiated.

RECOMMENDATIONS

The following recommendations are offered for Management consideration:

1. In so far as future projects are concerned (in this sense the Arrow is a current program), prime emphasis should be placed on exploitation of the Special Projects Group's VTOL vehicles. Number one priority is the Avrocar, for all other prospective programs depend upon demonstration of the design concept by flight of this vehicle. Every effort should be made to insure a high probability of success.

2. Of next immediate promise is the Avrotruck. Its promotion to fill the U.S. Army requirement for a cargo vehicle should be continued.

3. In the supersonic field, efforts to obtain joint sponsorship by the USAF and RCAF of the VTOL fighter/bomber weapon system should be pressed.

4. Every means should be investigated to reduce the development time and the cost of the P-15 Jump Start Gyrodyne to make it competitive with conventional aircraft and afford the Company an early entry into the commercial market.

5. An RCAF order for a quantity of AW 660 cargo transports would provide a manufacturing program at an early date. The sales campaign already in progress should be continued.

6. Avro should keep abreast of the advance of technology into the space age through the anti-boost-glide weapon system.

7. Investigations into new programs to provide continuity on a diversified, multi-project basis should be encouraged by Management.

APPENDIX I

DIRECT HOURLY MANPOWER

Figures 3, 4 and 5 show the effect of the five most promising projects on the Direct Hourly manpower situation at Avro under three assumed situations:

1. Figure 3 - assumes that the Arrow program is terminated in March 1958.

2. Figure 4 - assumes that the present program for 37 Arrow aircraft is terminated at the end of the manufacture of the 37th aircraft.

3. Figure 5 - assumes a continuing production order of 158 Arrow aircraft.

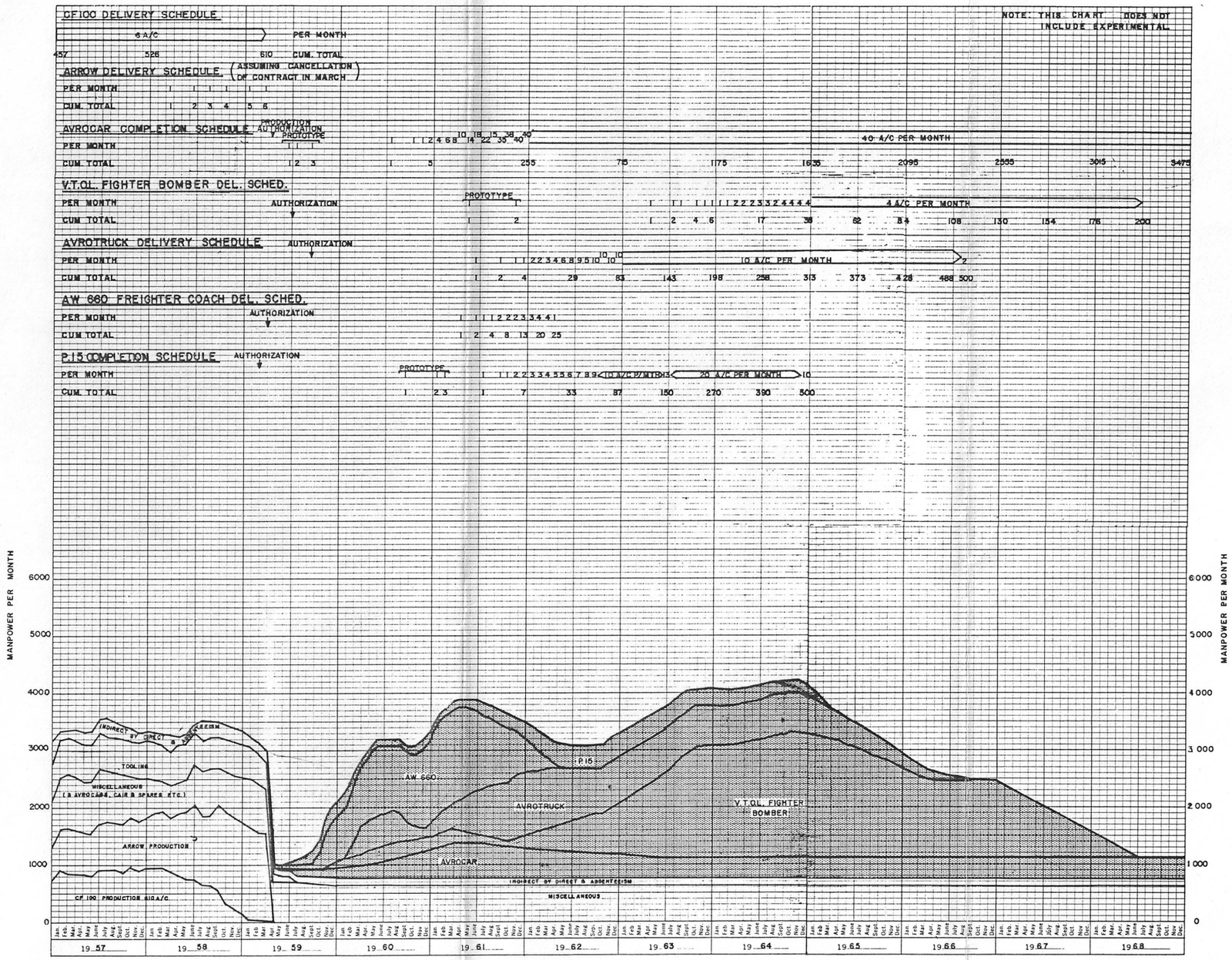


FIG. 1 SUMMARY OF DIRECT HOURLY MANPOWER (Assuming Arrow cancelled in March)

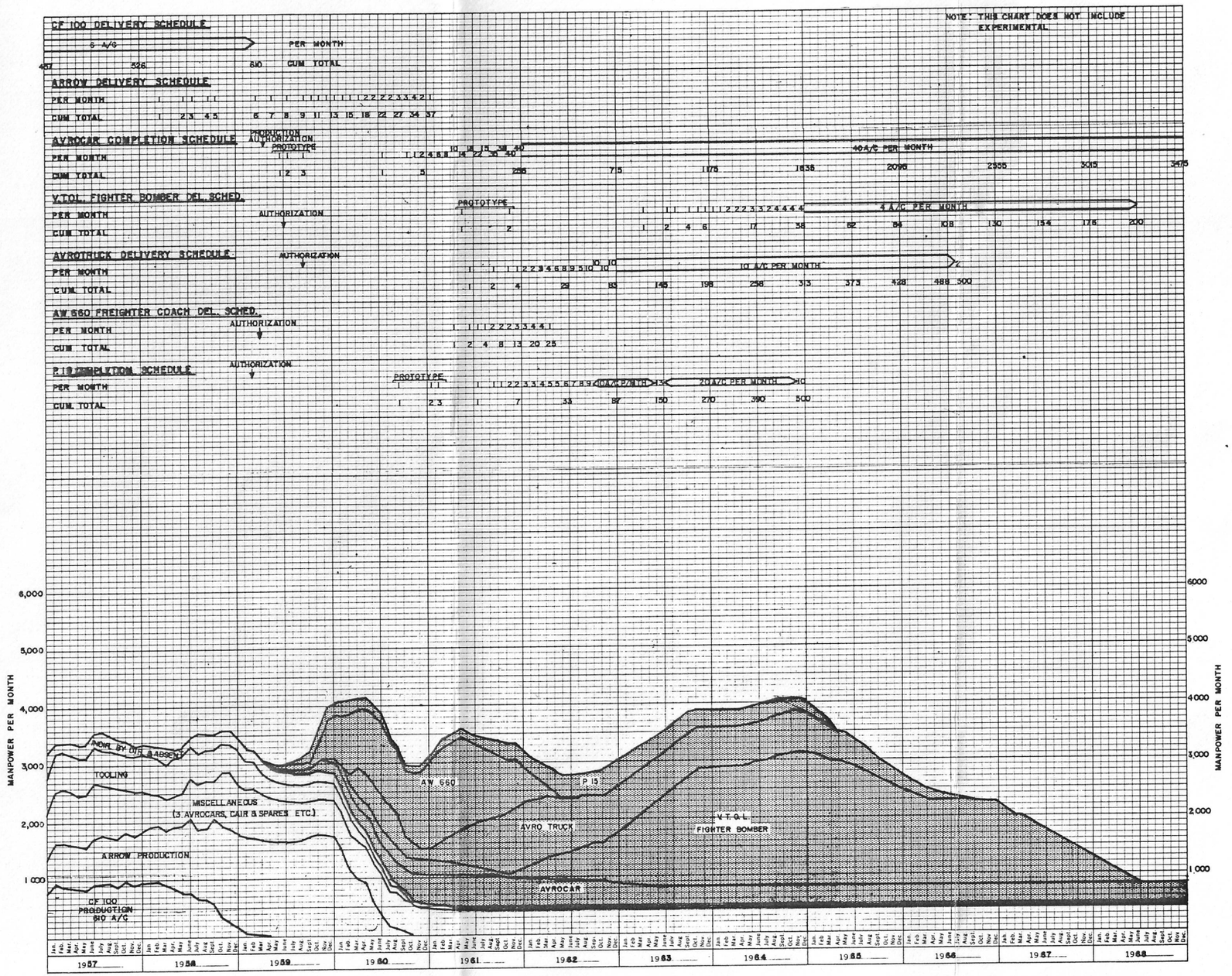


FIG. 2 SUMMARY OF DIRECT HOURLY MANPOWER (Assuming 37 A/C Program continued)

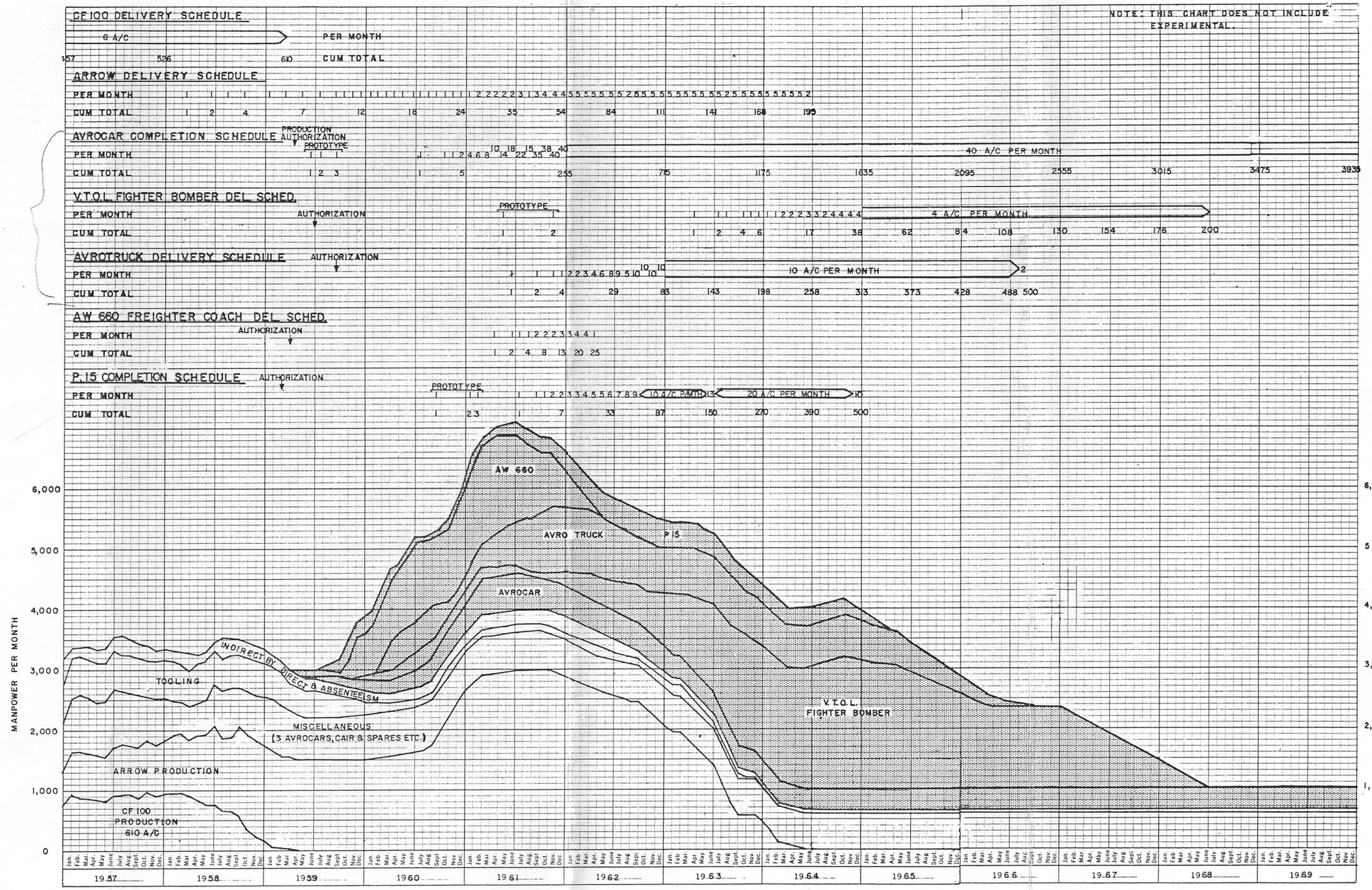


FIG. 3 SUMMARY OF DIRECT HOURLY MANPOWER (Assuming stretched out prod. cont.)

APPENDIX II

ARTISTS CONCEPTIONS

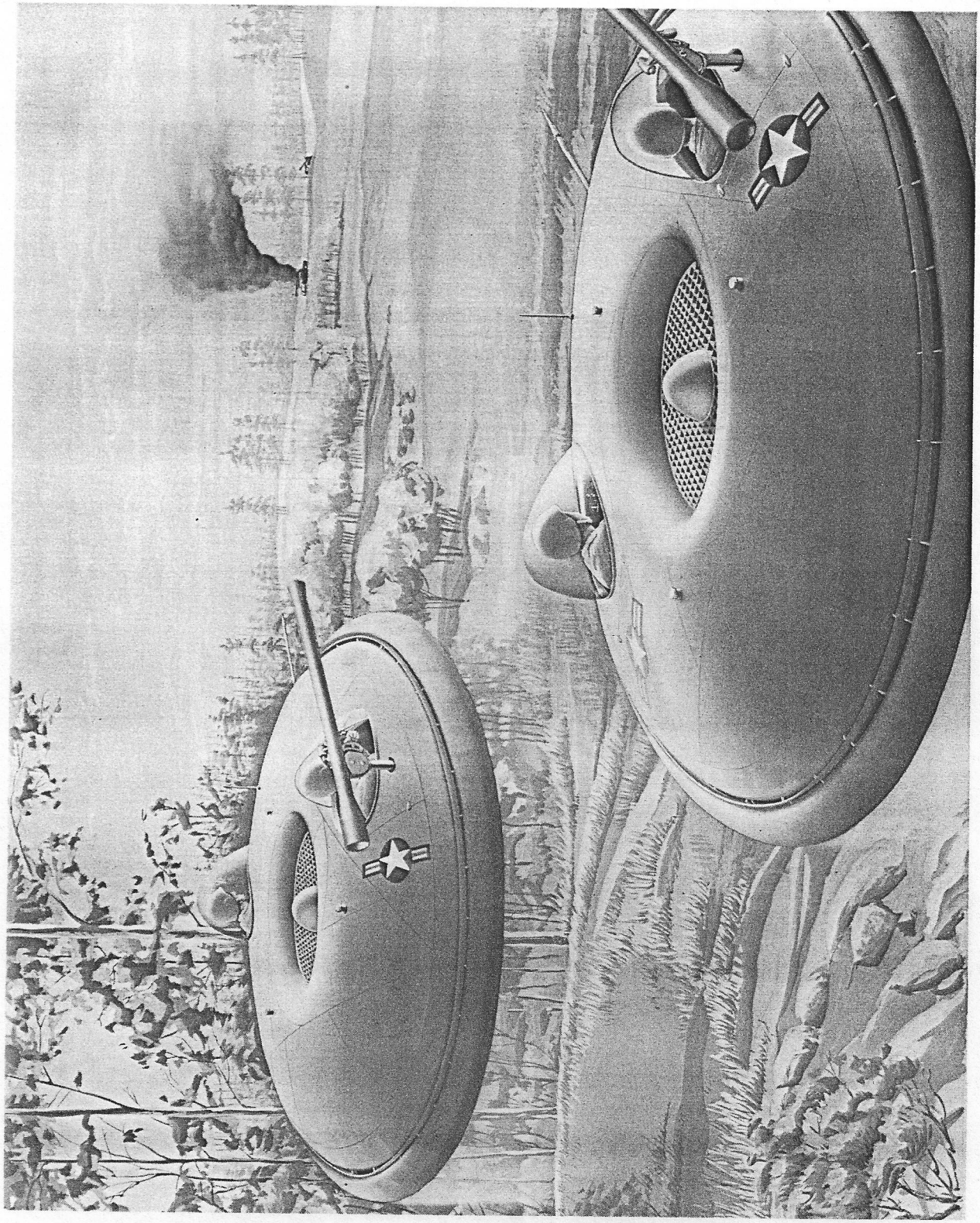


FIG. 1 AVROCAR

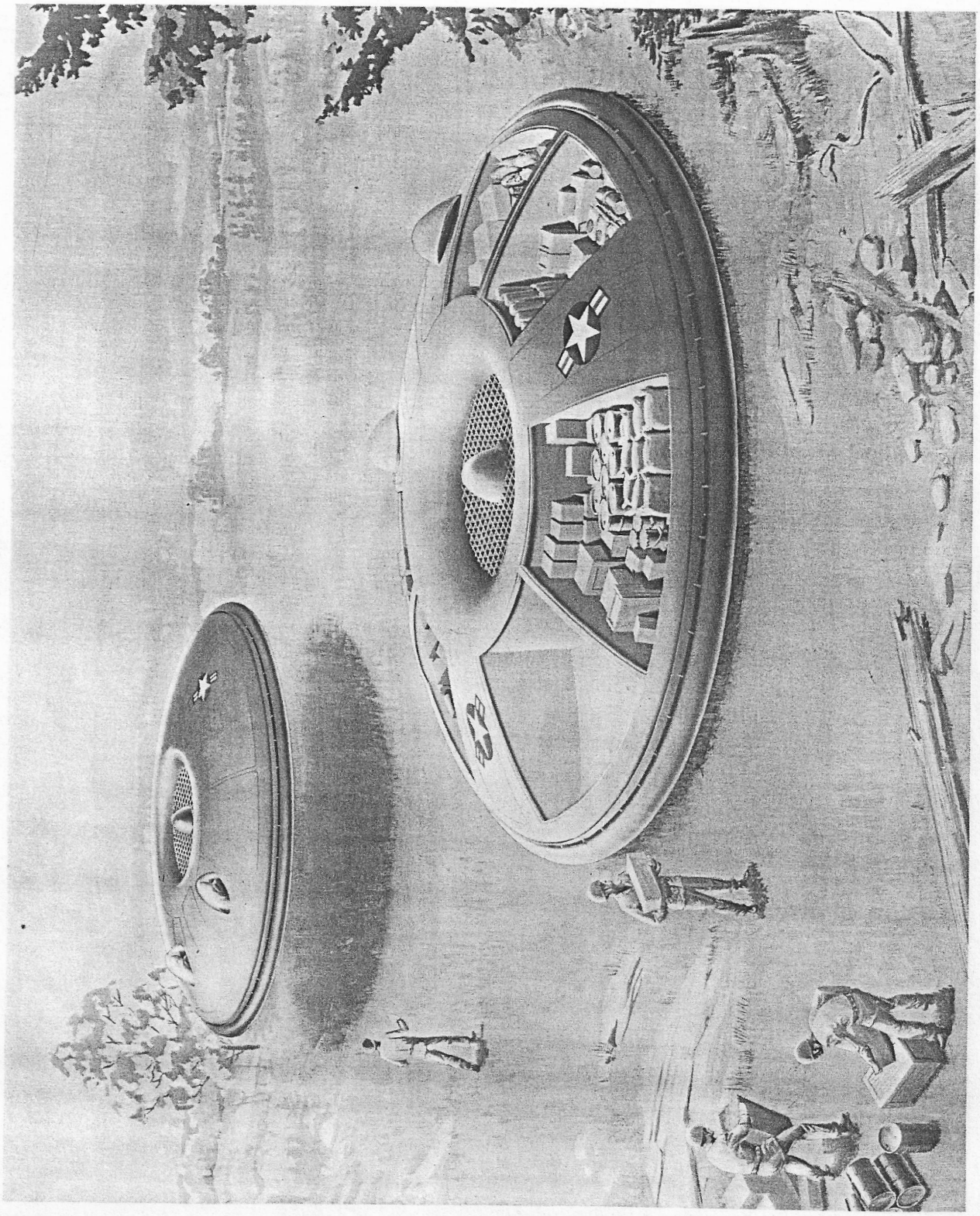


FIG. 2 AVROTRUCK

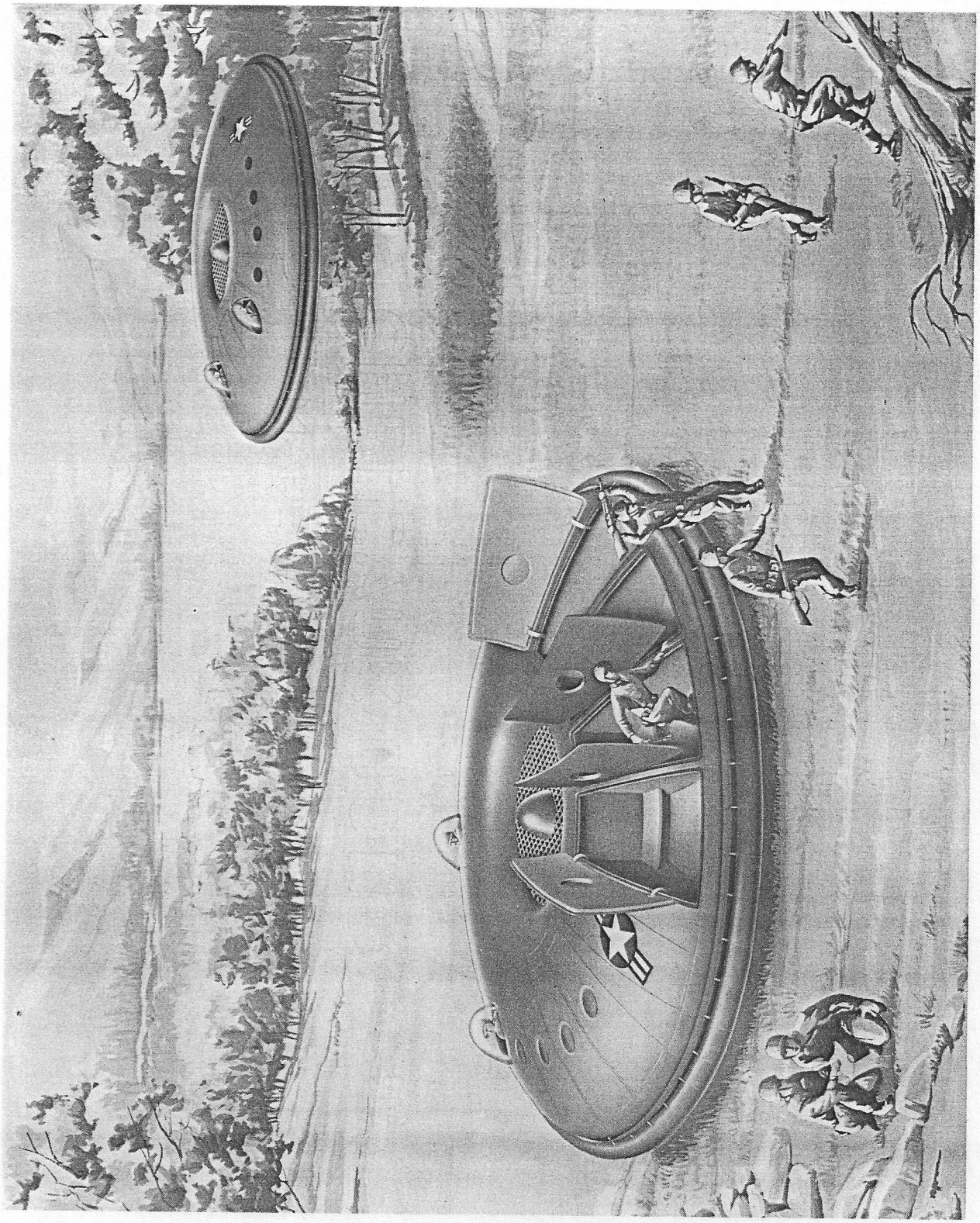


FIG. 3 AVROCOACH

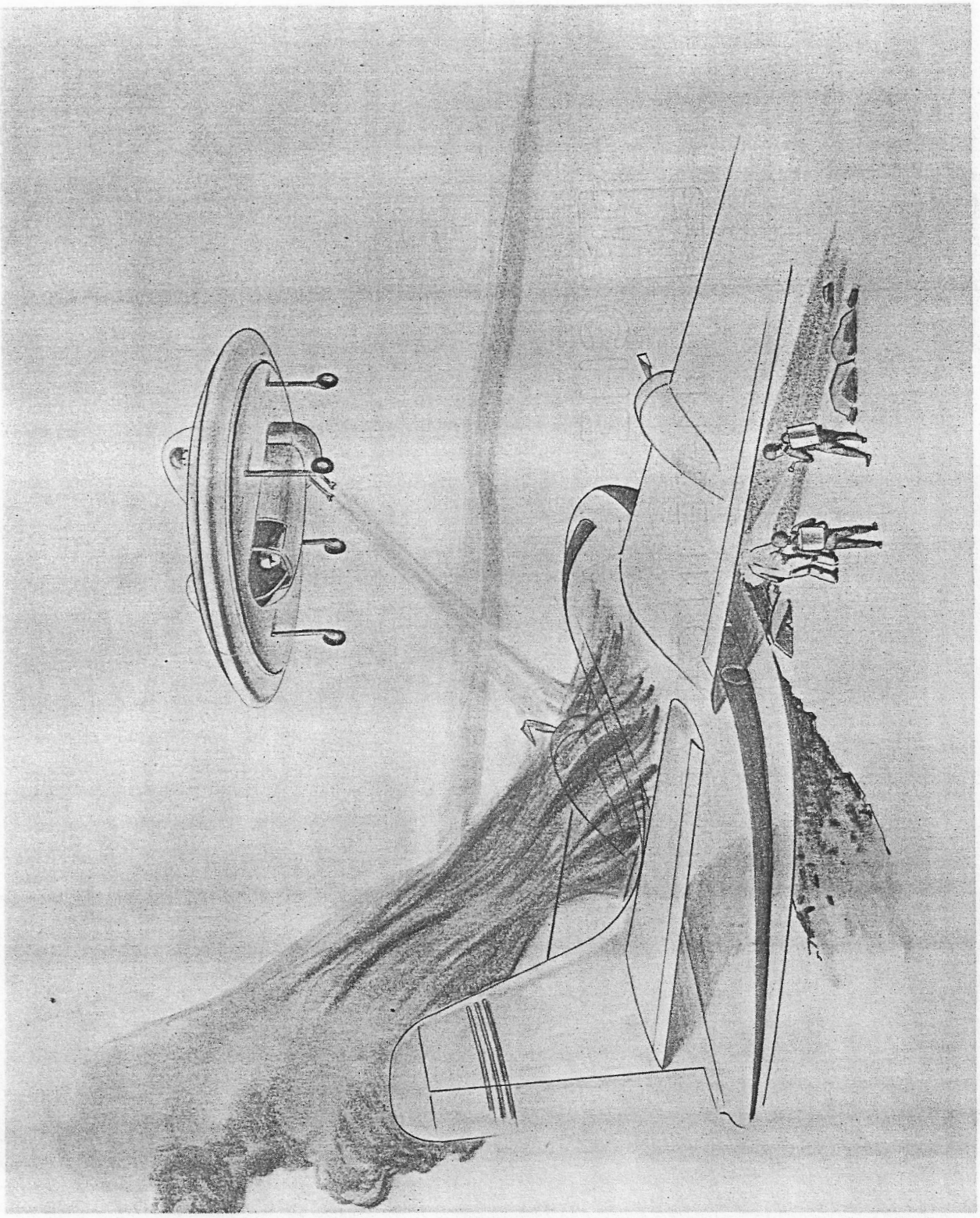


FIG. 4 AVROANGEL

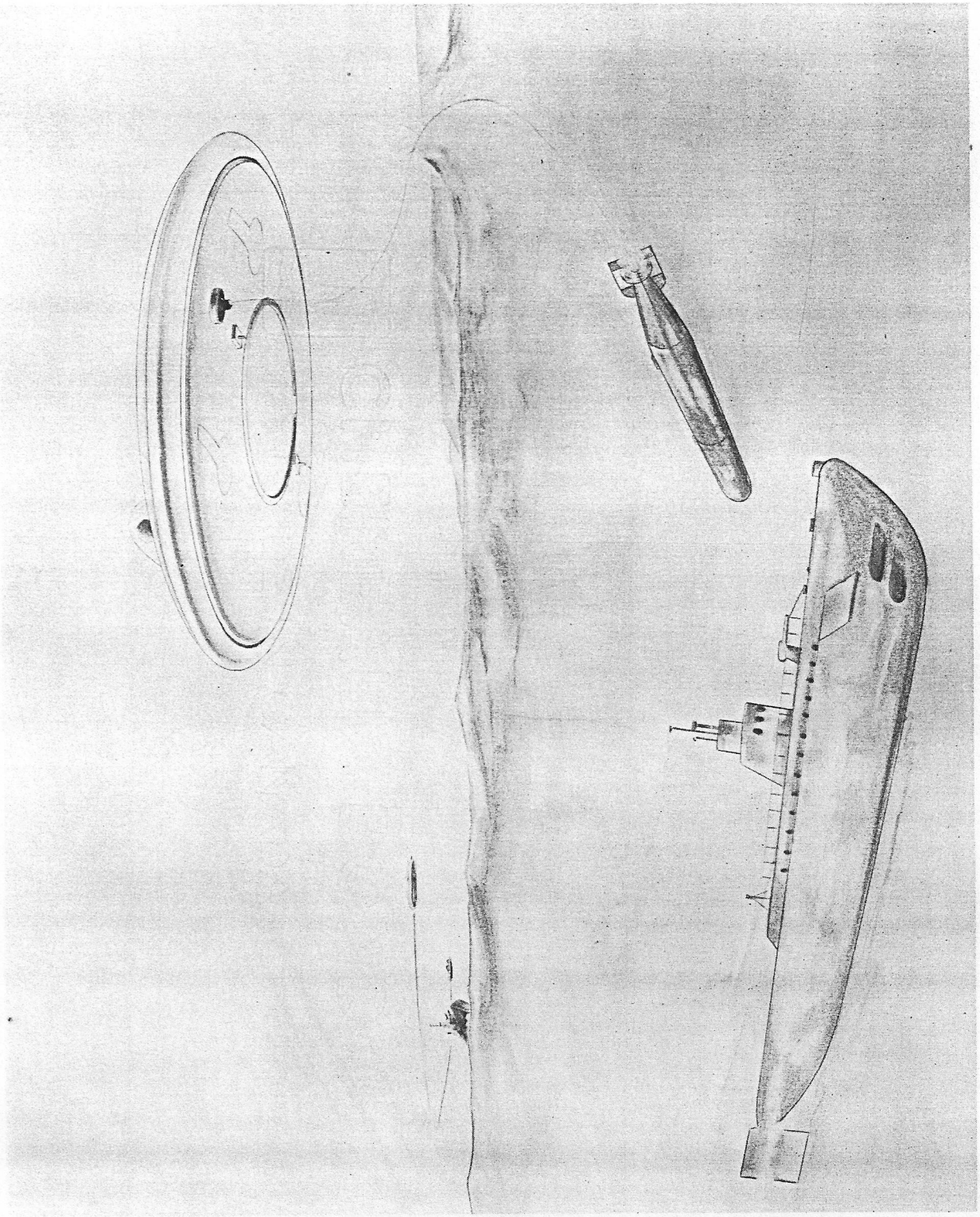


FIG. 5 AVROPELICAN

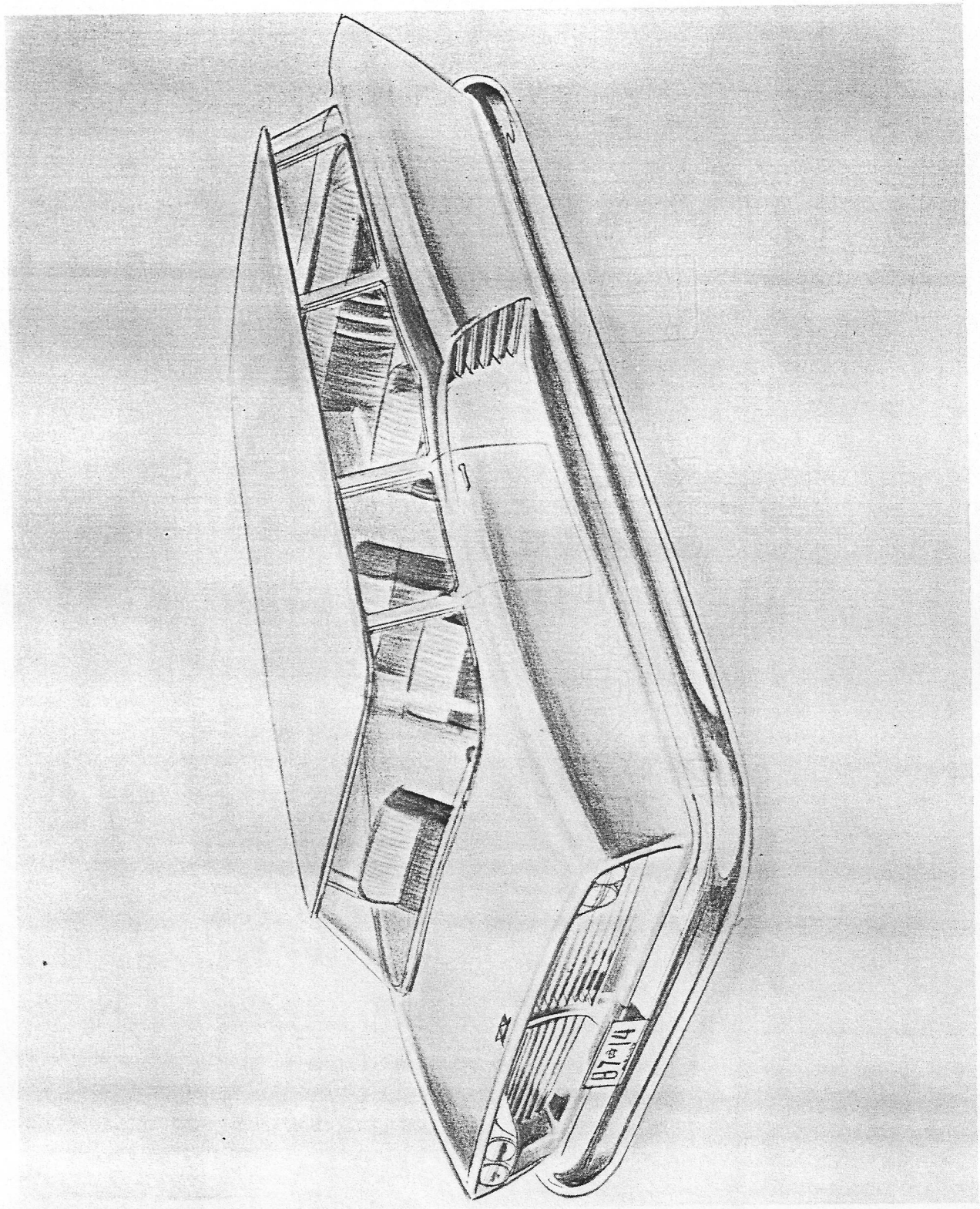


FIG. 6 AVROWAGON

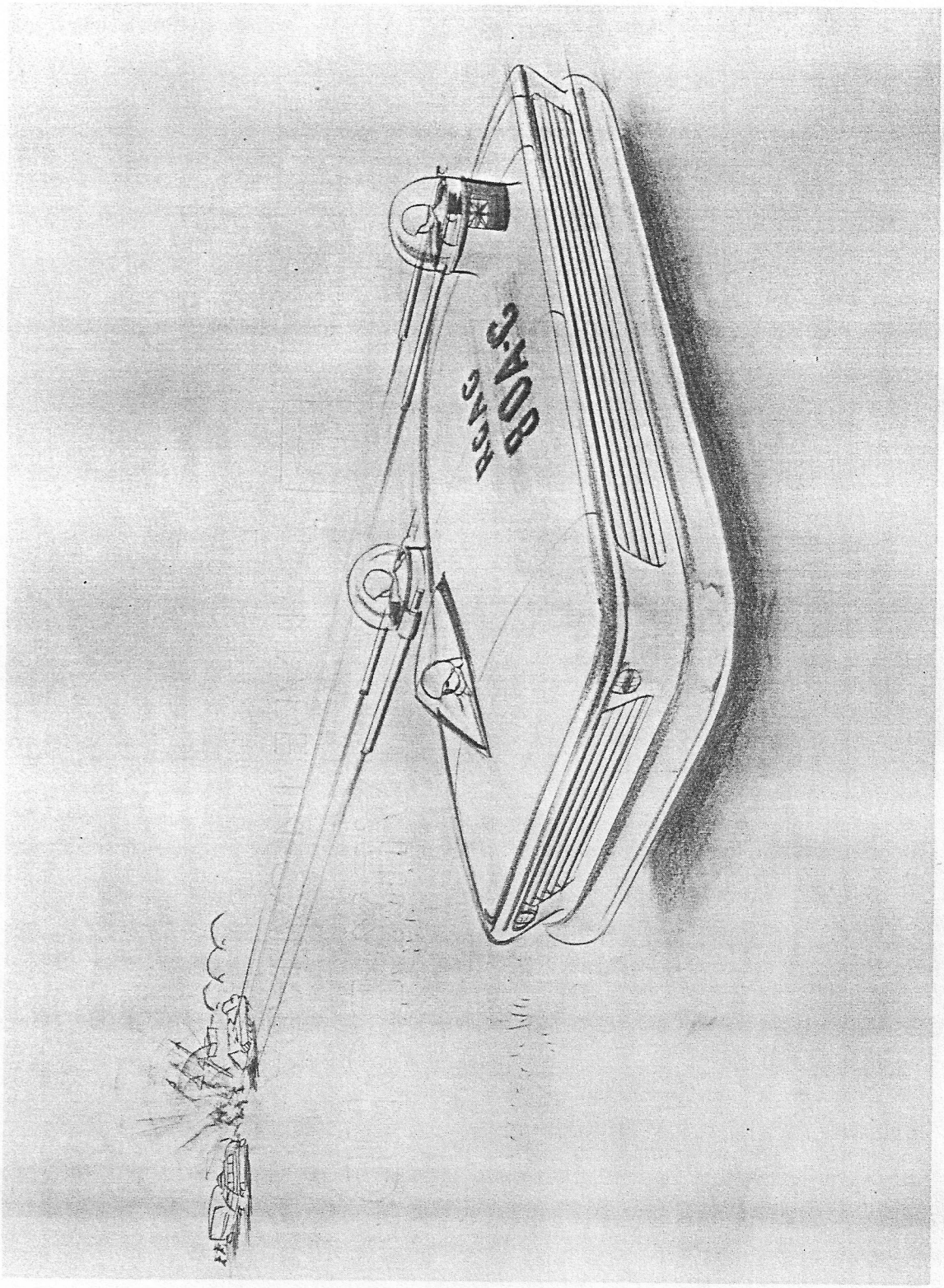


FIG. 7 AVROCRUISER

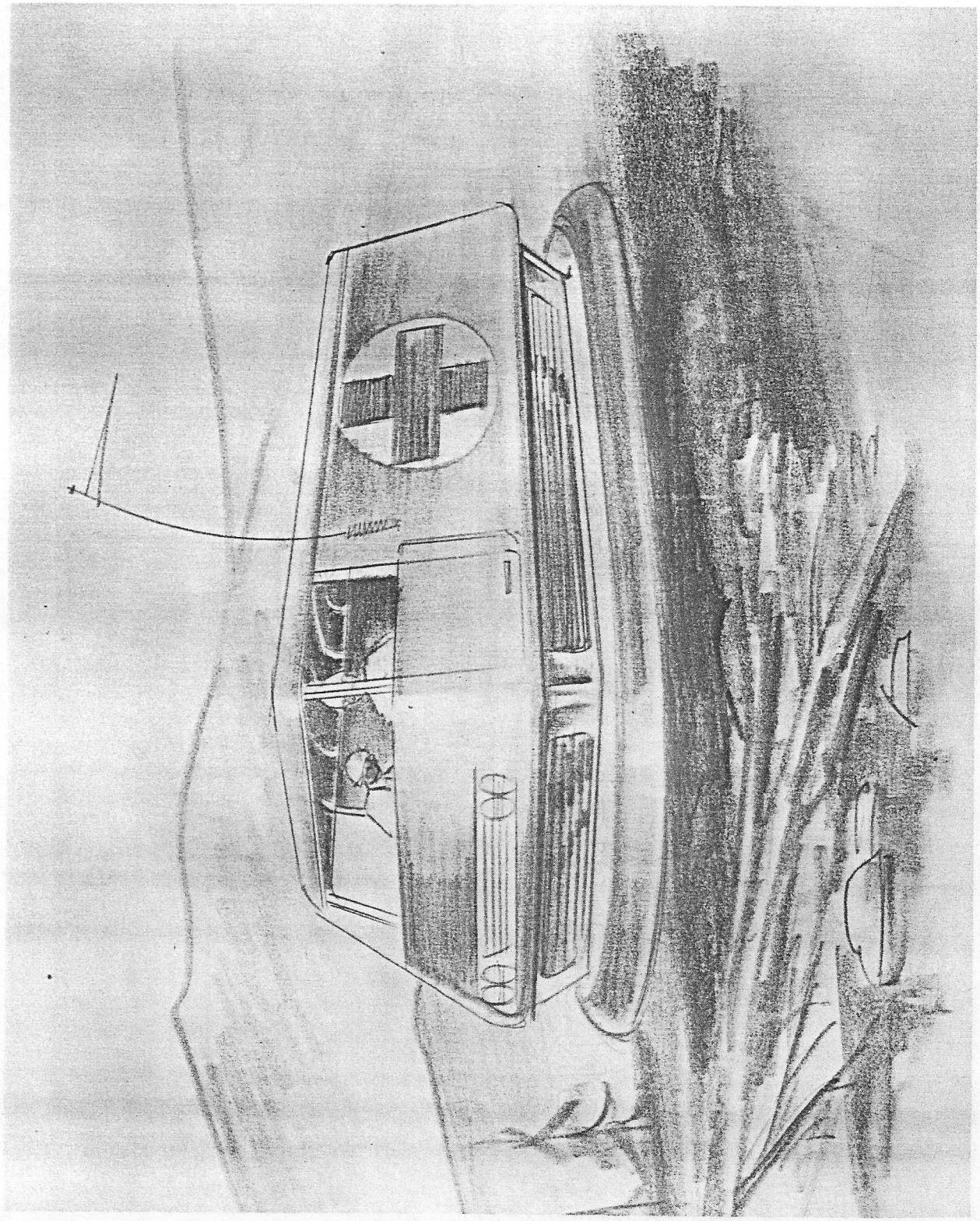


FIG. 8 AVROAID

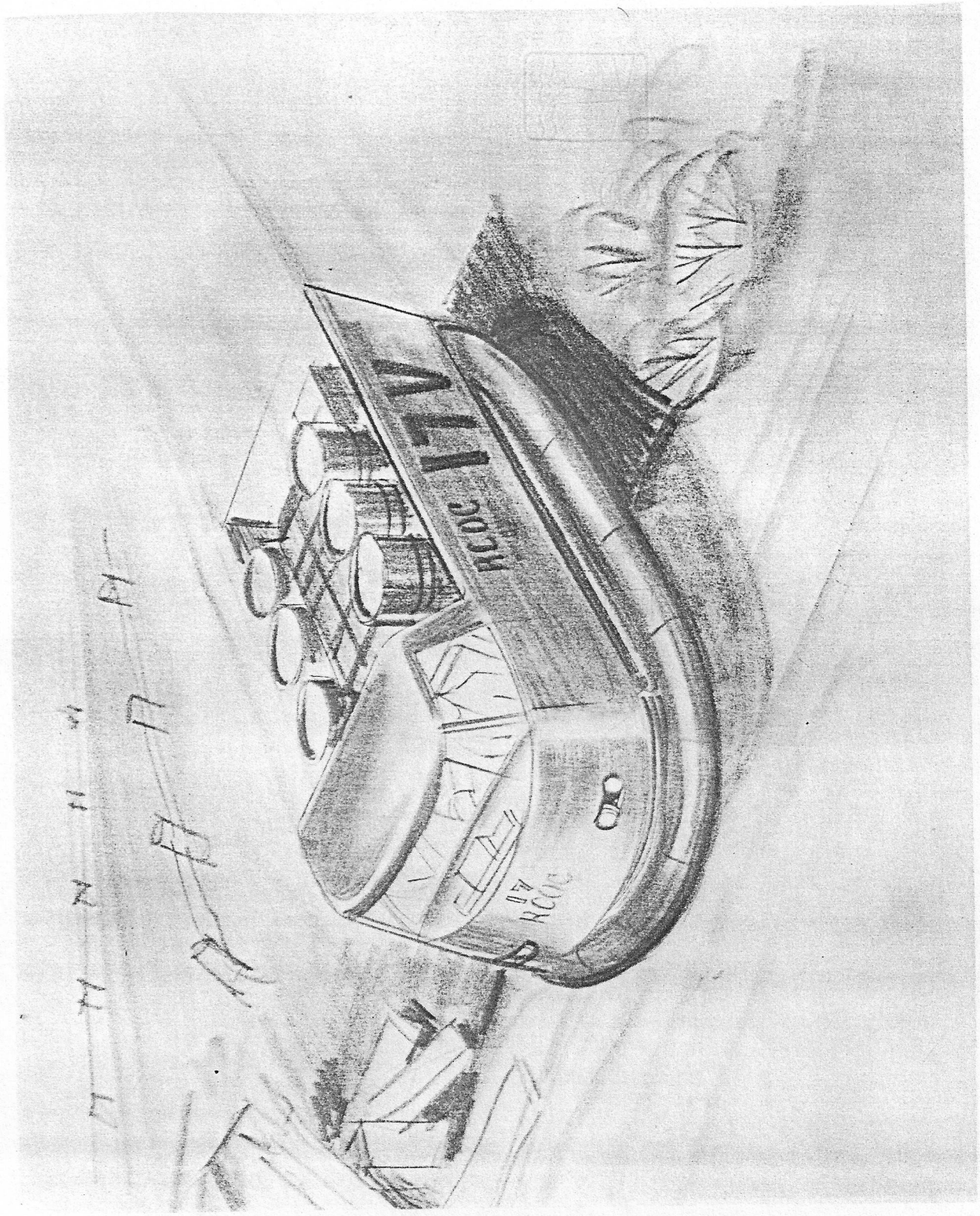


FIG. 9 AVROUNIVERSAL

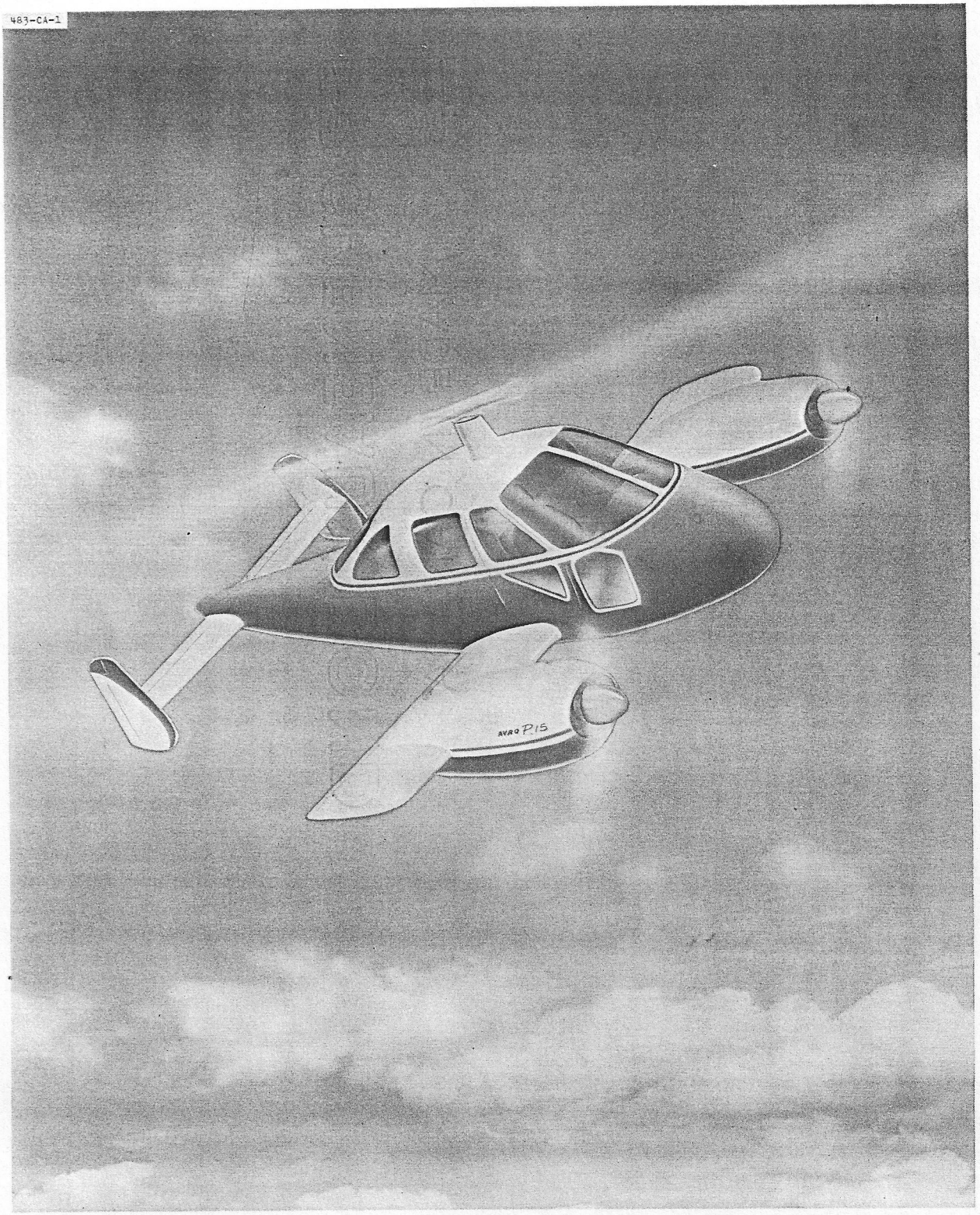


FIG. 10 AVRO P-15

APPENDIX III

PRELIMINARY OPERATIONAL REQUIREMENTS

The following preliminary operational requirements are presented concerning those projects for which a requirement can be reasonably well defined at this time.

AVROSKIMMER FAMILY

Operating height:

Normal:	2-4 ft
Emergency:	4-8 ft (over obstacles)
Maximum Speed:	100 MPH
Combat Range:	100 Stat. Miles
Carrying Capacity:	Note: Dependent upon mission for which vehicle is designed
AVROWAGON:	1,000 lbs. (Passenger & Baggage)
AVROCRUISER:	1,500 lbs. (Crew of 3 plus Armament)

AVROMOBILE FAMILY

AVROCAR

Basic Role:	2-Seater version of the Avromobile family. Suitable for carrying crew and supplies or for reconnaissance use. Aerial Combat capability. Payload capacity of 3,000 lb.
Max. Speed:	320 MPH at 10,000 ft alt.
Max. Range with	1,700 lb. payload: 100-miles, 10,000 ft cruise (VTOL operation)
Max. Range with	3,000 lb. payload: 143-miles, 10,000 ft cruise (STOL operation)

PRELIMINARY OPERATIONAL REQUIREMENTS (Cont'd)

Accommodation:	1 Pilot + 1 Observer
Normal Ceiling:	10,000 ft
Diameter:	18 ft
Max. Gross Wt for VTOL	5,650 lb.
Power Plants:	(3) Continental J-69 - T-9

AVROTRUCK:

Basic Role:	Aerial Supply Vehicle
Accommodation:	1 Pilot + 1 Observer. Cargo capacity up to 20,000 lb.
Power Plants:	(3) Orenda P.S. 16 (3) Westinghouse J.34
Diameter:	30 ft
Payload:	VTOL: 8,200 lb. STOL: 20,000 lb.
Max. Gross Wt:	21,700 lb. (VTOL)
Ceiling:	(1,000'/min): 21,000 ft.
Range: (VTOL) with	8,200 lb. @ 20,000' cruise: 210 St. Miles
(STOL) with	20,000 lb. @ S.L. cruise: 175 St. Miles
Max. Speed:	425 MPH @ S.L.

AVROCOACH:

Basic Role:	Aerial Troop Transport
Accommodation:	1 Pilot + 1 Observer + 12 fully-equipped troopers.
Power Plants:	(3) Orenda P.S. 16 (3) Westinghouse J-34
Diameter:	30 ft
Payload:	VTOL: 8,200 lb. STOL: 20,000 lb.

PRELIMINARY OPERATIONAL REQUIREMENTS (Cont'd)

Max. Gross Wt:			21,700 lb. (VTOL)
Ceiling:			(1,000'/min): 21,000 ft.
Range:	(VTOL)	with	8,200 lb. @ 20,000 ' cruise: 210 St. Miles
	(STOL)	with	20,000 lb. @ S.L. cruise: 175 St. Miles
Max. Speed:			425 MPH @ S.L.

AVROANGEL:

Ceiling	10,000 ft
Max. Speed:	320 MPH at 10,000 ft alt.
Radius:	15 miles

This vehicle should be capable of delivering a ground crew of three men fully equipped with portable foamite fire fighting equipment to the scene of an aircraft crash within a radius of 15 miles of the base. It should carry a flight crew of 2 men - one pilot and one crewman to operate the foamite extinguisher turret mounted on the underside of the vehicle.

VTOL FIGHTER/BOMBER

Combat alt:	90,000 - 100,000 feet desired, 70,000 feet minimum
Max. Speed:	Mach = 3.0 to 3.5
Combat radius:	900 to 1,000 nautical miles at optimum speed and altitude. Disposable tanks are permissible. A ferry range of 2,500 nautical miles is desired, but this is not mandatory if it compromises other performance.

A low altitude mission below 500 feet at a Mach number of 0.9 is also required.

It should be capable of carrying both nuclear and conventional weapons.

PRELIMINARY OPERATIONAL REQUIREMENTS (Cont'd)

1. Tactical "A" bomb having the following characteristics:

   Weight: 1,000 lbs.
   Length: 160 - 170 inches.
   Diameter: 18 - 20 inches.

2. Conventional 500 - 750 lb. bombs.

3. An air-to-air missile such as "Sidewinder".

4. A follow-on to the "Bull-pup" air-to-surface missile known as the "White Lance" should be accommodated.

It should be capable of bombing large fixed targets from any altitude, the lower or the higher this altitude the better. LAB, dive and level bombing techniques will be used.

P-15

Basic Role: "Jump Start" Autogyro with VTOL capability. Stored energy in the form of compressed air is used to actuate the blades at take-off and landing.

Accommodation: Pilot + (a) Six passengers & baggage
(b) Payloads up to 1,600 lbs.

Power Plants: 2 Lycoming 250 H.P. engines

Rotor Diameter: 50 ft.

Gross Weight: 5,645 lbs.

Max. Range with Pilot + 6 passengers: 500 Miles

Cruising Speed: 157 MPH

Take-off & Landing Distance: 0 feet.

AW 660

Basic Role: Military Transport Aircraft - capable of para-dropping men, combat equipment, supplies or weapons.

PRELIMINARY OPERATIONAL REQUIREMENTS (Cont'd)

Accommodation:	Crew of 4 + (a) 44 paratroops with kits (b) 72 fighting troops with kits (c) 64 stretcher cases (d) Payloads up to 23,000 lb.
Power Plants:	(4) R.R. R.Da/7 Dart Prop-jet engines.
Max. Gross Wt:	90,000 lb.
Ceiling:	@ 70,000 lb. (200'/min): 25,000 ft.
Max. Cruise Speed	@ 80,000 lb. @ 20,000': 275 MPH
Max. Range with 20,000 lb:	1,380 St. Miles
Take-off Distance over 50':	3,100 feet.

PRELIMINARY OPERATIONAL REQUIREMENTS (Cont'd)

Accommodation: Crew of 4 + (a) 44 paratroops with kits
(b) 72 fighting troops with kits
(c) 64 stretcher cases
(d) Payloads up to 23,000 lb.

Power Plants: (4) R.R. R.Da/7 Dart Prop-jet engines.

Max. Gross Wt: 90,000 lb.

Ceiling: @ 70,000 lb. (200'/min): 25,000 ft.

Max. Cruise Speed @ 80,000 lb. @ 20,000': 275 MPH

Max. Range with 20,000 lb: 1,380 St. Miles

Take-off Distance over 50': 3,100 feet.