

M00-NX000-001

THE VARIOUS MAJOR MARKS OF THE IKARA
MISSILES 1959-1989



IKARA

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A E R O S P A C E T E C H N O L O G I E S

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I K A R A

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SUMMARY

As the Ikara missile enters its 31st year a listing of its various major marks is provided.

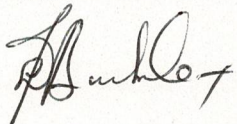
No attempt has been made to list all the minor marks such as Action/Practice Non Recoverable/Test/Handling Missiles etc.

This report is a compilation of the information provided in the references listed and various project files held by the PDS GW section

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IKARA

The late 1950s saw rapid advances in submarine technology with considerable improvements in propulsion, endurance, noise reduction and sonar performance. To redress the balance and counter the potential threat to shipping and land targets, intense activity in the development of improved anti-submarine systems followed.

A major task of the Royal Australian Navy (RAN) in time of emergency (then and now), related to the defence of our communications with the rest of the world, is the protection of shipping and military task forces against attack by hostile submarines. Ships to carry out such tasks are generally of a specialized nature. In the mid-1950s approval was given for the construction of the first of four such ships in Australia. These were known as Type 12 Destroyer Escorts and were of British design.

The equipment fitted to these ships for detecting submarines was a hull-mounted detection system formerly known as ASDIC, and now known as sonar. The ships were initially equipped with a short range anti-submarine system which had been in service for a number of years, known as Mortar MK10 or Limbo. However, a much longer ranging sonar, Type 177, had been developed in Britain and was to be fitted to these ships.

In 1952 the operational research group of the Central Office of the R&D Division of the Department of Supply had made a feasibility study of providing RAN destroyer escorts with a means of attacking submerged submarines at ranges exceeding the ranges of existing anti-submarine systems, i.e. Mortar MK10 (Limbo).

The concept was to develop a small controllable vehicle, possibly wire-guided to carry the mortar bomb at high speed to the target area and then to plunge it into the sea at the expected location of the submarine.

The study showed that although it was quite practicable to deliver the mortar bomb to a predetermined point on the surface several kilometres from the ship the kill probability would be low, because the shipborne sonar could not track the submarine reliably at the desired ranges. Consequently, the project was shelved.

Because of the close naval, scientific and technical co-operation between the UK and Australia, it was known that the Royal Navy had developed an anti-submarine homing torpedo by adding a homing device to a standard torpedo.

A technical presentation of the characteristics of this torpedo (MK 23) was made at the Offices of Naval Inspection at Maribyrnong, Melbourne by Lt Cdr Dean Murray in 1958. The Chief Scientist's Naval Liaison Officer at the time, Cdr H Jarrett, and the Scientific Adviser to the RAN, Mr P Ward recently seconded from the Royal Navy Scientific Service also attended the presentation.

Cdr Jarrett reported the substance of the presentation to the Chief Scientist and stated that, in his view, the torpedo was too large and its search speed too slow to be of much interest to the RAN. However, Dr. Butement was interested and recalled the earlier study of the Flying Depth Charge (Limbo Carrier). After discussions with Cdr Jarrett he agreed that to be effective, such a torpedo would have to be flown through the air to the target area.

Fortunately at this time, a report from the United States Navy's Research Station at China Lake arrived in Cdr Jarrett's office. This report described tests carried out on the USN MK 43 anti-submarine homing torpedo. The US MK 43 torpedo was smaller, faster and much lighter than the British MK 23 torpedo and was the first of a family of lightweight air-dropped torpedoes.

After a later discussion between Dr. Butement, Cdr Jarrett and Mr Ward, it was suggested that a guided weapon system in which the US MK 43 torpedo would be carried by a flight vehicle based on Malkara technology might be feasible.

Mr Ward was enthusiastic about the idea because he had been Development Engineer in the UK on the Medium Range Sonar for the Type 12 Frigates and was well aware that there was no existing weapon system which could complement the design goals and initially achieve trial characteristics of the new Type 177 sonar.

Mr Ward and Cdr Jarrett went to the Navy Office in Canberra to outline the proposal to the Deputy Chief of Naval Staff (Admiral Becher). They suggested that a draft requirement should be prepared by Navy Office and forwarded to the Chief Scientist in the Department of Supply with a request that a feasibility study be undertaken. This was done early in 1959.

At that time, the Malkara team at ARL was fully engaged with the completion of the production version of Malkara. New approvals for variations of Malkara features, such as short range and lighter anti-tank weapons, were also being sought.

Though the task was given to ARL, the Chief Defence Scientist requested that a new group carry out the feasibility study.

Those appointed were Mr J H Strachan, a member of the ARL Operational Research group, and Mr J Aitken, who as Chief Experimental Officer on the Chief Defence Scientist's staff had been responsible for the development and procurement of the wire used in Malkara in the early 1950s.

After discussions with Dr Butement and a review of the earlier studies the team proposed a weapon system in May 1959, comprising:

- (a) UK Sonar Type 177 (as fitted to the new Type 12 Frigates) for target detection.
- (b) a radio/radar system for determining the optimum position for placing the terminal weapon and for guiding the missile to that point.
- (c) An unmanned miniature aircraft powered by conventional solid propellant rocket motors.
- (d) Locally-designed ship magazine, handling and launch arrangements.
- (e) A US MK44 acoustic homing torpedo as the terminal weapon.

Two components listed above were already in existence, the Type 177 sonar and the MK 44 torpedo.

Prior to the completion of the feasibility study, Dr. Butement was in close contact not only with the then Chief of Naval Staff and his Deputy, but also with the then Minister of the Navy (Senator Gorton). Their support ensured that the Ikara concept was finally approved.

The two main weapons systems being developed overseas which may have met the RAN's Draft ASW Requirement were examined. The first of these was an anti-submarine rocket (ASROC) for the United States Navy. Work had commenced in 1956 on a tandem solid propellant-boosted unguided missile carrying a homing torpedo. It was almost 4.5 metres long, 750mm wing span and weighed 450kg. At a predetermined point the torpedo separated from the rocket motor and was lowered into the water by a parachute. Though fired at the computed optimal position for water entry to reach the expected position of the submarine, its flight was ballistic. Since the flight was unguided, its accuracy was not good.

The RAN rejected it because it was unguided and its terminal accuracy was low. In addition, it could not be fitted into the Type 12 Frigates because the excessive weight would make the ship top heavy, if a sufficiently large complement of missiles for operational purposes were fitted. The ASROC system was finally developed in 1960 and became operational in the US Navy in 1961.

It is interesting to observe that a UK team which considered desirable features for a long range anti-submarine system also rejected ASROC for the same reasons.

At that time the only other overseas system known to Australia was the UK system of manned helicopter carrying a homing torpedo. This system was called MATCH, which is an acronym for Medium ASDIC Torpedo Carrying Helicopter. The helicopter carried a dunking sonar and two torpedoes. However it was rejected because of its slow speed from ship to target, when not on station and its lack of all weather capability. A UK working party concurred with this decision three years later.

The initial feasibility study for Ikara was completed in a few weeks. The design was heavily influenced by the experience gained on Malkara but had some serious drawbacks that were overcome during the Project Study Phase.

The Department of Supply presented a submission with the support of the Department of Navy to the relevant defence committee on the 12th August 1959. The submission also contained reference to developments then proceeding on towed-sonar systems overseas. These developments have not yet achieved their full potential.

On the 2nd November 1959, the Minister of Defence approved the project, and late in 1959 the Project Study or Design Phase for Ikara, (an aboriginal word meaning throwing stick) was commenced in earnest.. At the same defence committee meeting, which endorsed the Anti-Submarine weapon proposal, Malkara's further development was not approved. Thus staff engaged in the Malkara program progressively became available.

ARL was given the task of being the System Co-ordinating Authority. Mr Evans, then Superintendent of the Systems Division, was appointed OISC and Mr. Alan Sharpe was made Project Co-ordinator. Mr. Stan Schaetzel was brought in from GAF with a team of engineers, draftsmen and technical officers, totalling approximately 20 to form a Missile Design Group. Mr Don Hatton, in charge of the Systems Dynamics Group, was responsible for the simulation, control system and autopilot design.

ARL was responsible for overall system design and in particular missile development.

WRE's Weapons Projects Division under Mr. Elgar Treharne was deeply involved with all of its three groups virtually full time on Ikara. These were Circuits Group under Mr Mike Rososinski, Guidance Group under Mr Jim Adams and Propulsion Group under Mr Alan Shalders.

The customer, the RAN, was represented by Cdr Angus Bennett, who had the title NRDO (Navy R & D Officer) and considerable power in this project. He participated in the design discussions and accepted proposals on behalf of the RAN. This arrangement was one of the reasons for the success of the project. Cdr Bennett also supervised directly the Commonwealth Aircraft Corporation (CAC) (now Hawker de Havilland) contract for the development of launcher and handling equipment.

Before moving to ARL, the GAF Design Department had a quick look at the results of the ARL Feasibility Study and proposed a completely different layout, namely the torpedo underslung under the main body of the vehicle. This resulted in a much smaller and lighter vehicle, barely 1.5ft longer than the payload. The above configuration was adopted as the basis for further development.

IKARA variants M1, M2 and M3.

The basic requirement of the Ikara missile was to carry the MK 44 Acoustic Homing Torpedo for several thousand yards to a predicted submarine position whilst receiving updates for the predicted aiming point right up to the release of the torpedo.

The main objective was to develop a small light low drag vehicle. This was achieved by using as few aerodynamic surfaces as possible. The motor structure formed the backbone of the missile. Propulsion was by means of a two stage solid fuel motor. The boost stage produced a launch acceleration sufficient to achieve cruising speed quickly and the sustainer motor maintained the cruising speed over the required range.

There were several problems that required resolution:

(a) After jettison of the torpedo, loss of half of its AUW and alteration to its aerodynamic configuration, the vehicle had to continue flying in a stable manner for a short time, so as not to attract the homing torpedo once the vehicle entered the water.

(b) Due to its significant drag, the rear portion of the torpedo had to be enclosed by a fairing, which had to be released in flight prior to deployment of the torpedo.

(c) The torpedo was aerodynamically unstable at release, yet the snatch upon deployment of the parachute attached to the torpedo propeller shaft had to be within 10 degrees of the centre line of the torpedo.

(d) The vehicle had to fly with virtually zero static margin, so as to have negligible steady state control deflections.

(e) The missile had to be launched at a high elevation (a QE of 55 deg), to ensure clearance of the ship's main-mast during over the bow firings.

(f) The high QE created the need to minimize boost dispersion and led to the concept of a closed-loop system in pitch during the boost phase by using a jet deflection vane that entered the boost efflux.

It was decided to follow a simultaneous two-pronged approach to the development for the following reasons:

- (a) To minimize the delay before guidance trials hardware would become available.
- (b) To optimize the use of suitably proven Malkara hardware.
- (c) To flight-test components of the full-scale missile control system.

This approach led to the use of:

- (a) A 0.6 dynamic scale flight vehicle model, using the wire control link of Malkara, in lieu of the radio link, and other Malkara components to address missile dynamic problems. This was identified as variant M1.
- (b) The full sized R&D vehicle. This was identified as variant M2.

Initially the main development trials took place at Woomera, enabling failed missiles to be recovered and investigated. This proved invaluable because the causes of several flight failures were able to be identified immediately. In some instances, modifications were introduced by the trials team at Woomera with no more than a few days delay to the firing program.

A controlled 0.6 scale model (M1) with a boost-only rocket motor was fired in February 1961, some 13 months from the start of development work. The first uncontrolled, boost-only full sized M2 vehicle was fired in December 1962, 23 months from start.

The M1 trials at Woomera helped considerably in proving missile components, particularly the height lock. However since the controlled M1 flight missiles appeared to have their own problems and the full scale vehicles were progressing so successfully, it was decided to terminate further scale model flights in July 1962.

In August 1963 the first sea trials using launcher proving missiles were conducted from HMAS Stuart off Sydney. All subsequent Ikara M3 variant missiles were fired at sea off the Queensland coast. The R&D program of the M3 variant was effectively completed with the final sea trials missiles in July 1965. The aim of all the trials was to use as few missiles as possible. This was achieved by using extensive pre- and post-trial simulation in conjunction with the assessment of missile in-flight performance data, recorded via a telemetric sender fitted in the missile. In this way, the trials proved the actual hardware and validated the computer simulation models. Throughout the design and development process of Ikara, simulation was used extensively. The importance of the missile flight simulation work cannot be over-emphasised since it was vital to the success of the whole project.

For earlier Ikara variants, analogue simulation was employed. The main contributions at Aeronautical Research Laboratory were made by Mr Hatton, Mr John Marsh and Mr Alan Ross.

With the advent of digital computers of appropriate speed and capacity, digital simulation techniques were then employed for most of the mathematical modelling with the main contribution being made by Dr W Mather Mason.

In 1961 some additions to the organisation were made and Trials Group was formed at the Aeronautical Research Laboratory under the supervision of Mr Graham Quigg.

Another significant aspect of the Ikara R&D program was the work undertaken by the Mechanical Engineering Division of Aeronautical Research Laboratory in developing of three parachutes. One was to enable trial missiles to be recovered, either at Woomera or at sea. Another was to lower the MK44 torpedo into the water whilst the third was undertaken as part of the M5 program in order to lower the MK46 torpedo into the water. Mr A A Keeler was responsible for this work.

Many flight trials were carried out with a partial missile airframe fitted beneath an aircraft. Dummy torpedoes were released in the same manner as they were to be from the missile. Various aircraft were used. They included a RAN Firefly, a RAN Sea Venom and RAAF Canberra. For the M4 variant, flight trials were conducted in the UK using payloads fitted with the British parachute.

M3 production version drawings were initiated in February 1963 and the first production missile was fired at sea 21 months later.

The first production version of the Ikara system entered service, fitted to HMAS DERWENT, upon the completion of successful acceptance firing trials in January 1966.

IKARA variants M4 and M5

In 1961, the UK was looking for an anti-submarine missile and finally narrowed the choice to three options, viz. the US ASROC, the French Malafon and the Australian Ikara.

In 1963, the UK selected the Ikara system and contracted Australia to develop a version which could carry either the US MK44 torpedo or other UK stores. One of these weighed 700lb and was considerably heavier than the MK44 torpedo. An unusual aspect of this proposal was that the missiles had to be capable of having their payloads interchanged at sea within thirty minutes. The UK version of Ikara was identified as M4.

At the same time work on another Ikara variant for the RAN was initiated. It had to be capable of carrying the US MK46 torpedo as well as the US MK44 torpedo. This version was identified as M5 Ikara.

Thus the project progressed as a joint program with costs shared between the UK and Australian Governments. Financial approval to proceed was given by the UK Treasury in March 1965. Australian Defence approval was given in June 1965.

In 1966 the UK reviewed the program and decided that they only needed the missile to carry a UK MK31 torpedo which was the UK adaption of the US MK44 torpedo. The physical parameters of the two torpedoes were essentially the same. However they also wished the torpedo to be fitted with a parachute developed in the UK.

In 1967 the Chief Superintendent of Aeronautical Research Laboratory, Mr T F C Lawrence, suggested that since the research element of the program had virtually ceased and the project was effectively in the development and production phases, it was inappropriate for the Missile Design Group (MDG) to remain at Aeronautical Research Laboratory.

At the same time it was decided to transfer the Design Authority responsibility for the missile to Government Aircraft Factory. Thus the MDG team return to Government Aircraft Factory and Government Aircraft Factory became the Design Authority for the missile.

The first R&D firing trials took place at Woomera in March 1968. Flight trials were conducted with both M4 and M5 missile variants.

Delivery of production M5 missiles to the RAN commenced in September 1968, while delivery of production M4 missiles to the Royal Navy (RN) did not commence until 1972. Missile manufacture was delayed to coincide with the installation of the system into the RN ships, which was behind schedule, and the introduction of the MK46 to replace the MK31 Torpedo in RN service. The UK Ministry of Defence conducted operational evaluation trials in late 1973 at the Atlantic Underwater Test and Evaluation Centre (AUTEC) in the Bahamas. Of the twenty missiles fired, nineteen were completely successful. The UK Ministry of Defence later undertook further successful trials under icing conditions in the Arctic.

The M4 Ikara system, which was fitted to nine RN ships, remained in service until March 1989 when the last Ikara fitted ship was withdrawn from service. The Missile Handling and Launcher system was designed by Vickers to suit the configuration of RN ships in which the Ikara Launcher replaced the forward gun mount. One of the RN Leander class ships (HMS DIDO) fitted with Ikara was subsequently sold to the Royal New Zealand Navy (RNZN) and thus Ikara is currently in service with the RNZN on HMNZS SOUTHLAND.

IKARA for Brazil (BRANIK)

In 1972 Vosper Thornycroft of the UK obtained a contract from the Brazilian Navy to supply six frigates, four of which were to be fitted with the Ikara system. This requirement was achieved with the supply of missiles that were essentially the same as the RAN M5 variant. In addition a new handling and magazine system developed by the Commonwealth Aircraft Corporation was installed. Thus in 1978, the Ikara system entered service with the Brazilian Navy.

Extended Range IKARA (ERIK) and M6 IKARA

In 1974 the UK Ministry of Defence commissioned the preparation of a Development Cost Plan by the DSTO for the provision of an extended range version of Ikara capable of carrying the UK Stingray torpedo. This requirement grew largely from operational research studies carried out at ARL, which demonstrated a significant increase in operational performance derived from extended range.

The proposal progressed through the Ministry of Defence Defence Committees. However, the severe monetary constraints that prevailed in the UK at the time caused the UK Treasury to cancel any further work on the program.

In 1979 the Ministry of Defence sought a review of the work that had been done on the ERIK study. A submission for a further revised version was prepared and this was identified as M6 Ikara. However, history repeated itself. Once again, as the submission was proceeding through the Defence Committee stage, the proposal was cancelled. This time, it was due to the impending reduction to the RN surface fleet, necessary to enable the introduction into the RN of the nuclear-powered Trident submarines. The reduction in surface ships would result in all the Ikara-fitted ships being withdrawn progressively from service.

IKARA variant M7

This variant introduced the folding wing which enabled the design of a much smaller box launcher than would be required for the fixed wing variants.

This development programme was funded by the Australian Government and involved the development and proving of the wing folding mechanism and efflux management of the box launcher. Successful Launcher exit trials were carried out at Woomera in 1987.

Concept studies on various guidance/tracking system and payloads options were carried out as part of this programme.

Features of IKARA M7 were:-

- (a) the lightweight box launchers which enable the missile to be fitted in ships as small as 1000 tonnes
- (b) a magazine/trainable launcher version for installation in larger vessels (e.g. frigates) or for permanent shore batteries;

(c) integration with any suitable ship-fitted or shore-based tracking and guidance such as Otomat Teleguidance;

(d) normally fitted with the US MK 44 or MK 46 torpedo, but IKARA is capable of being modified to carry

- Italian WMF A 290 S
- Swedish FFV Tp 42
- UK Stingray

SURFACE UNDERWATER GUIDED WEAPON (SUGW)

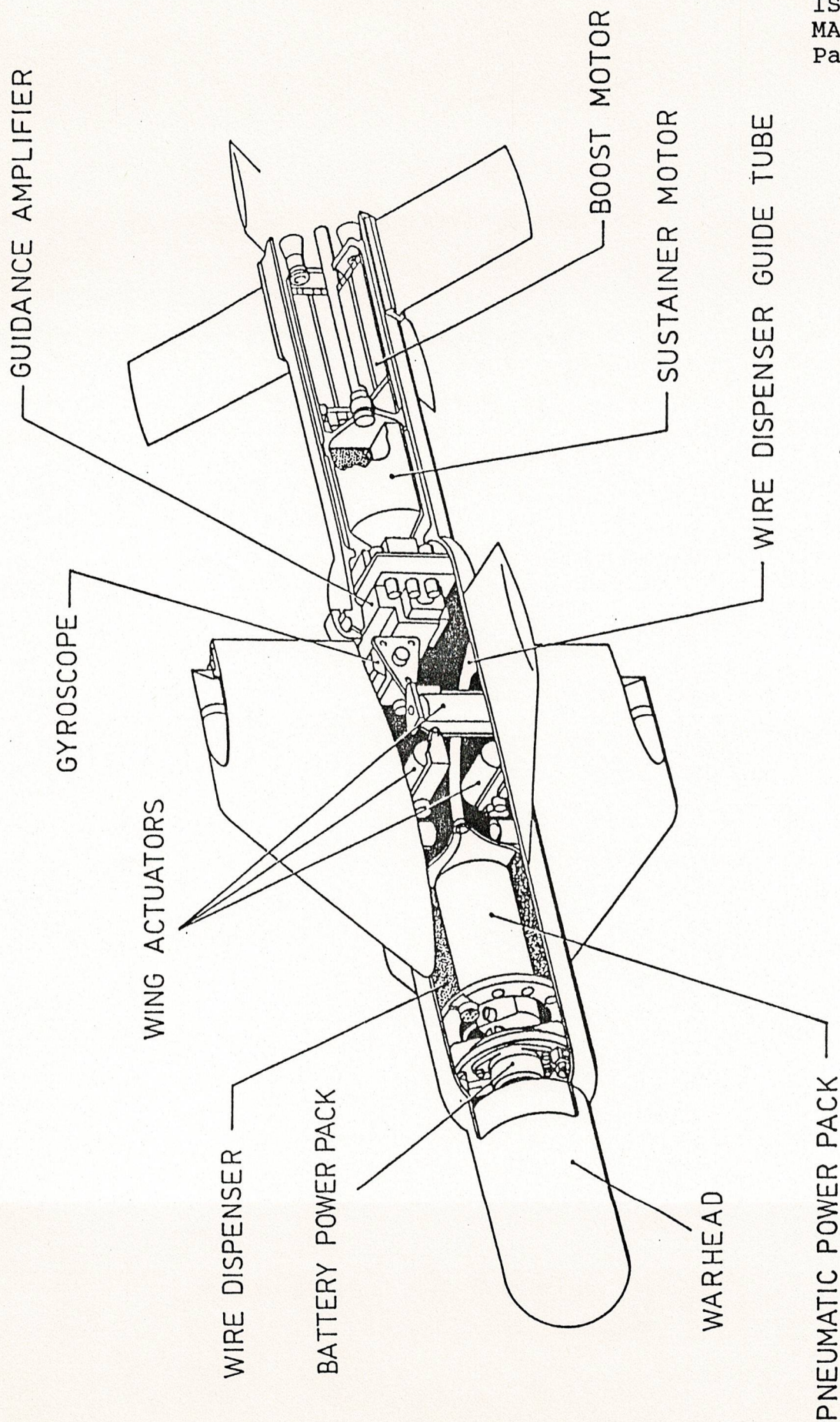
The SUGW or Super Ikara is boxed launch with folding wings. It will use a jettisonable solid fuel rocket motor for the initial firing from the box, after that the jet engine will take over.

The inertial navigation system which enables it to fly direct to the target without in flight guidance.

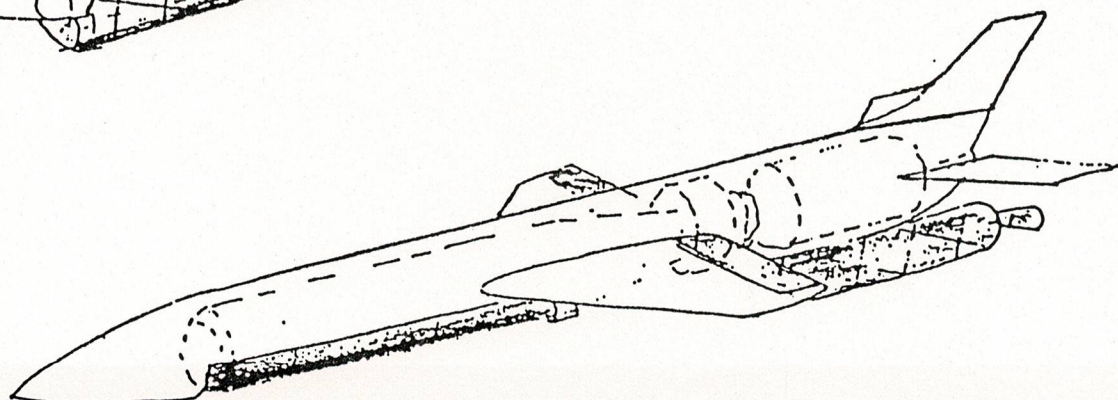
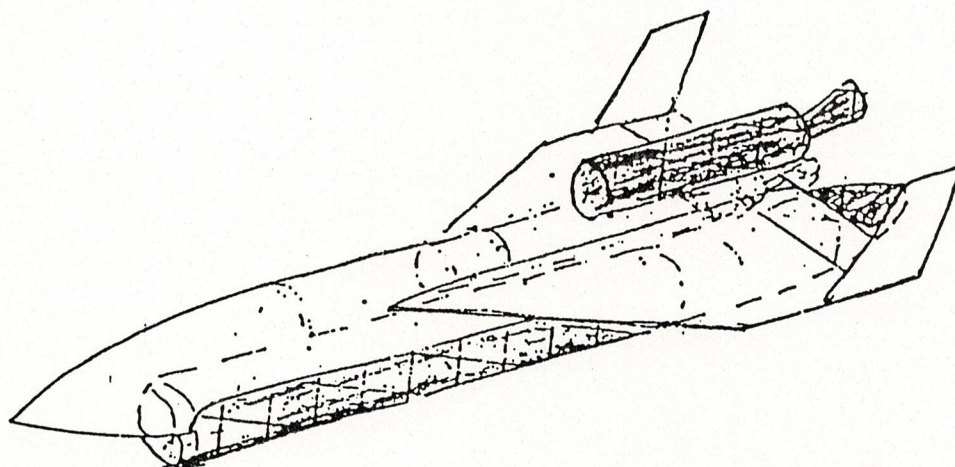
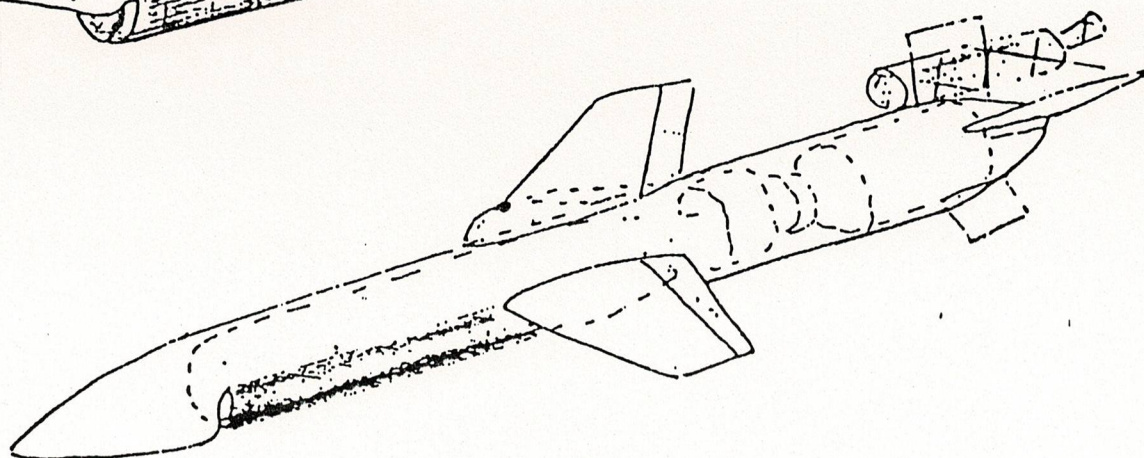
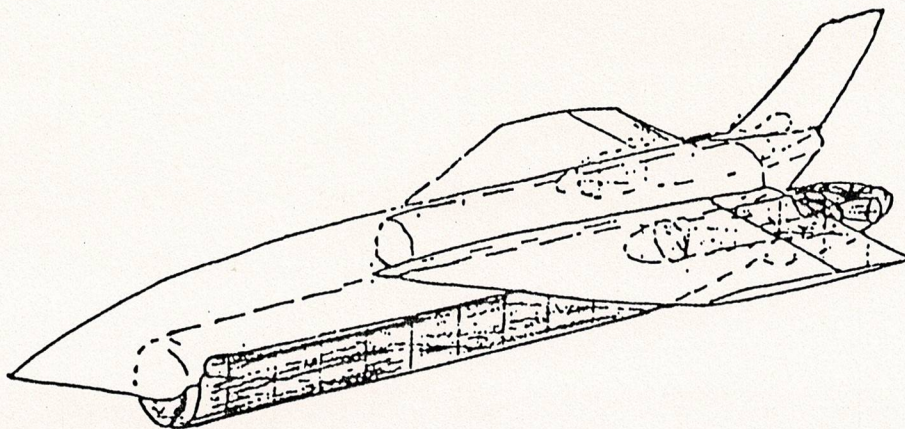
Its range is 100 kilometres compared with about 20 for the present IKARA.

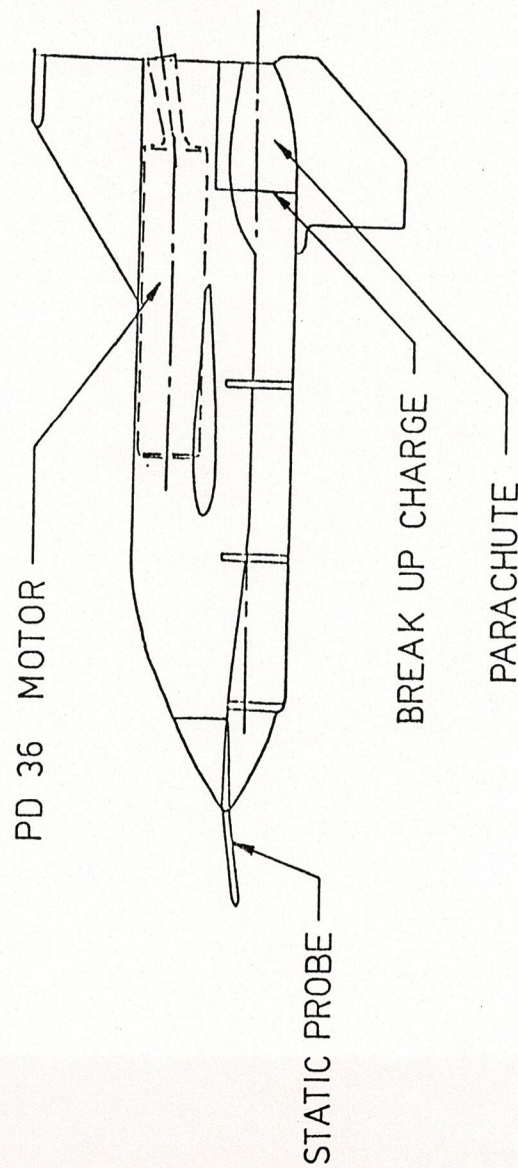
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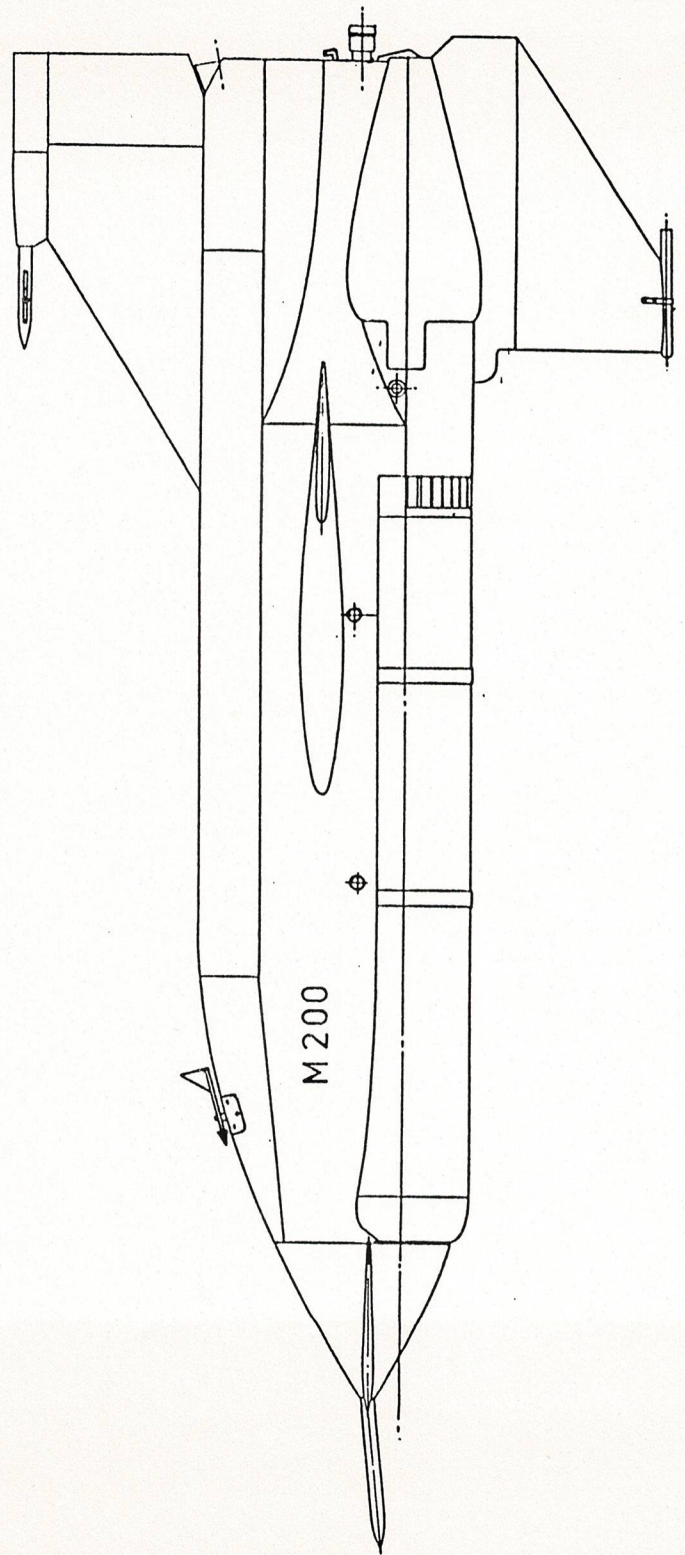
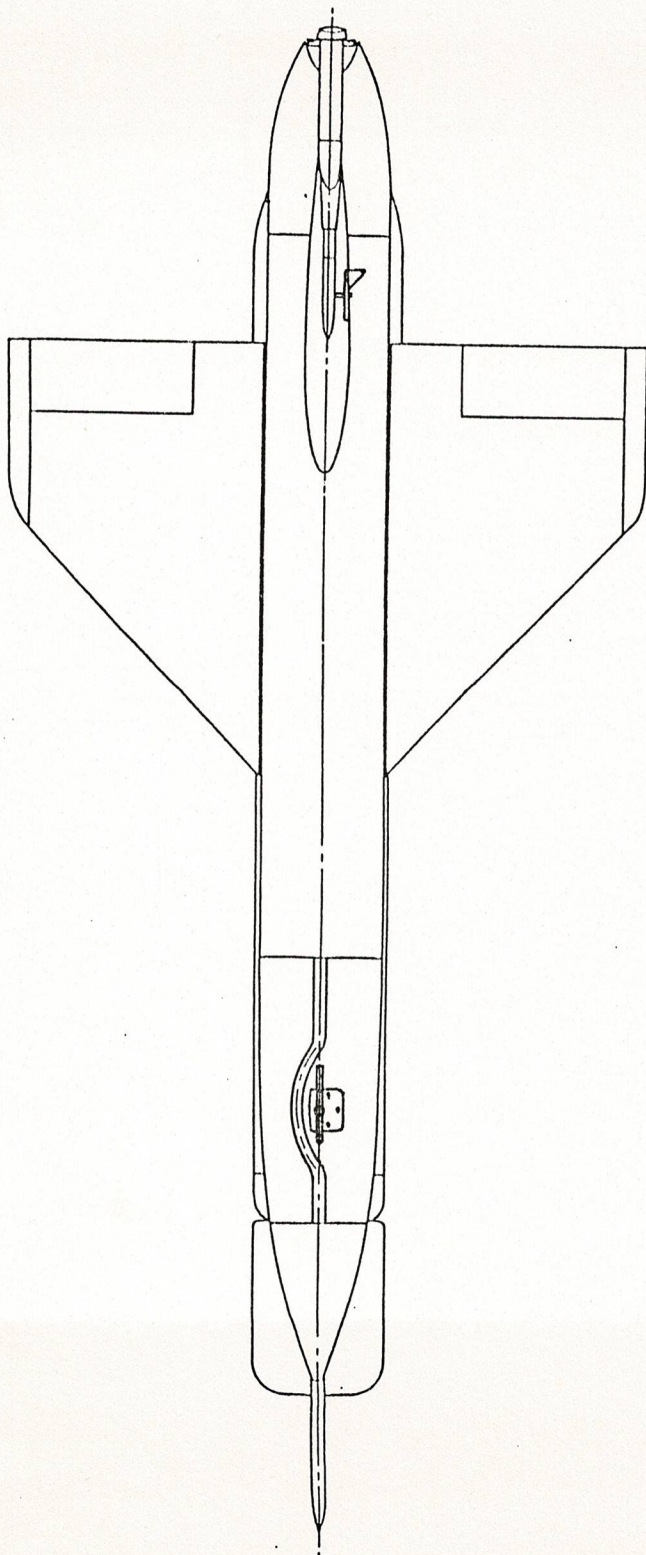


MALKARA MK.1A MISSILE

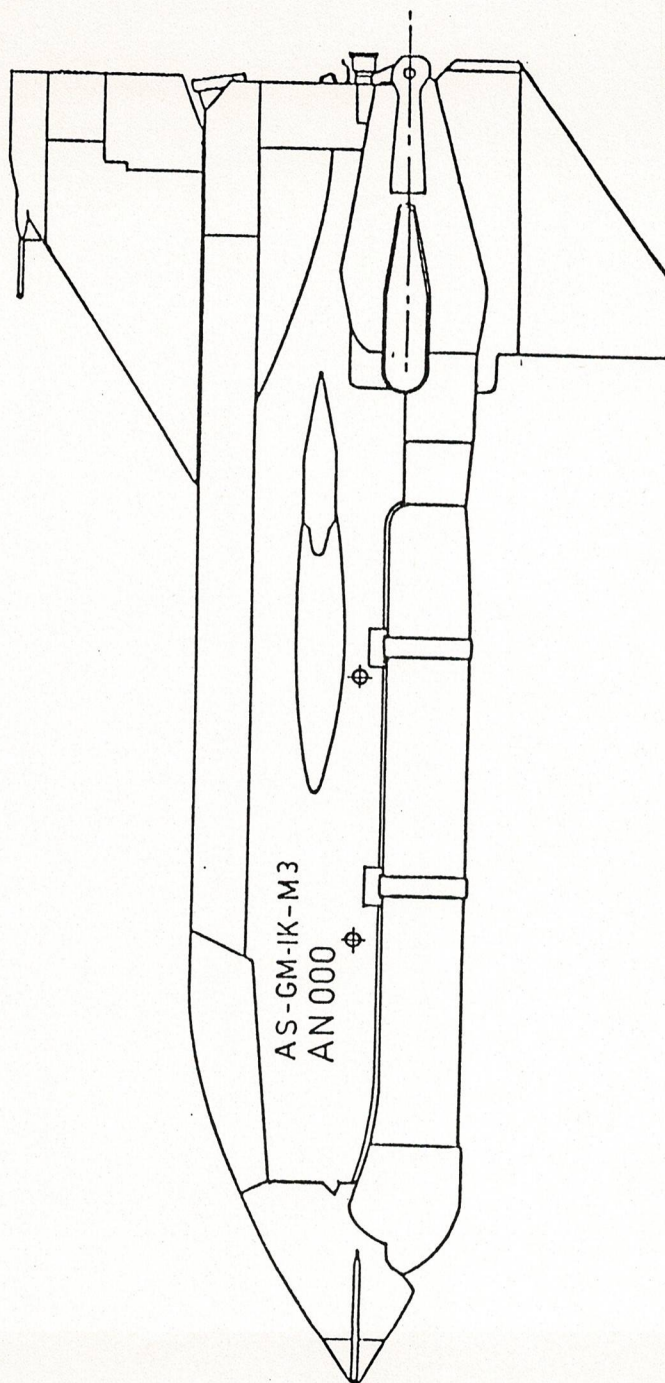
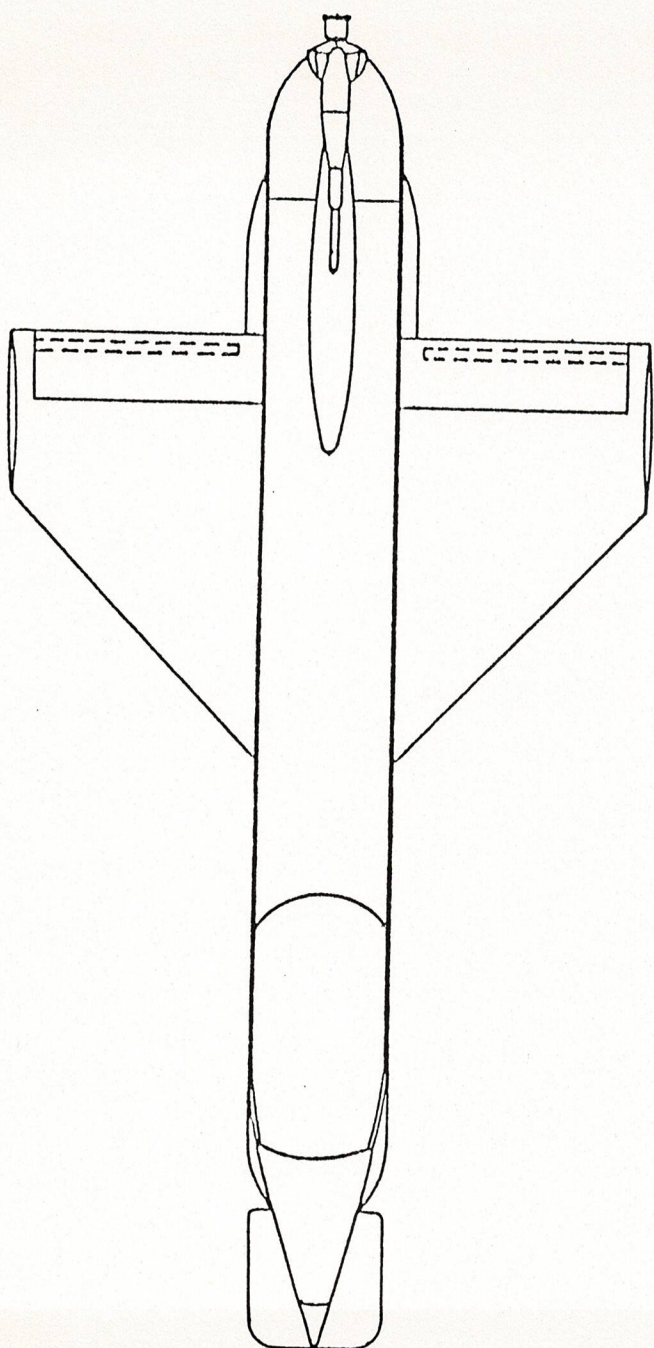


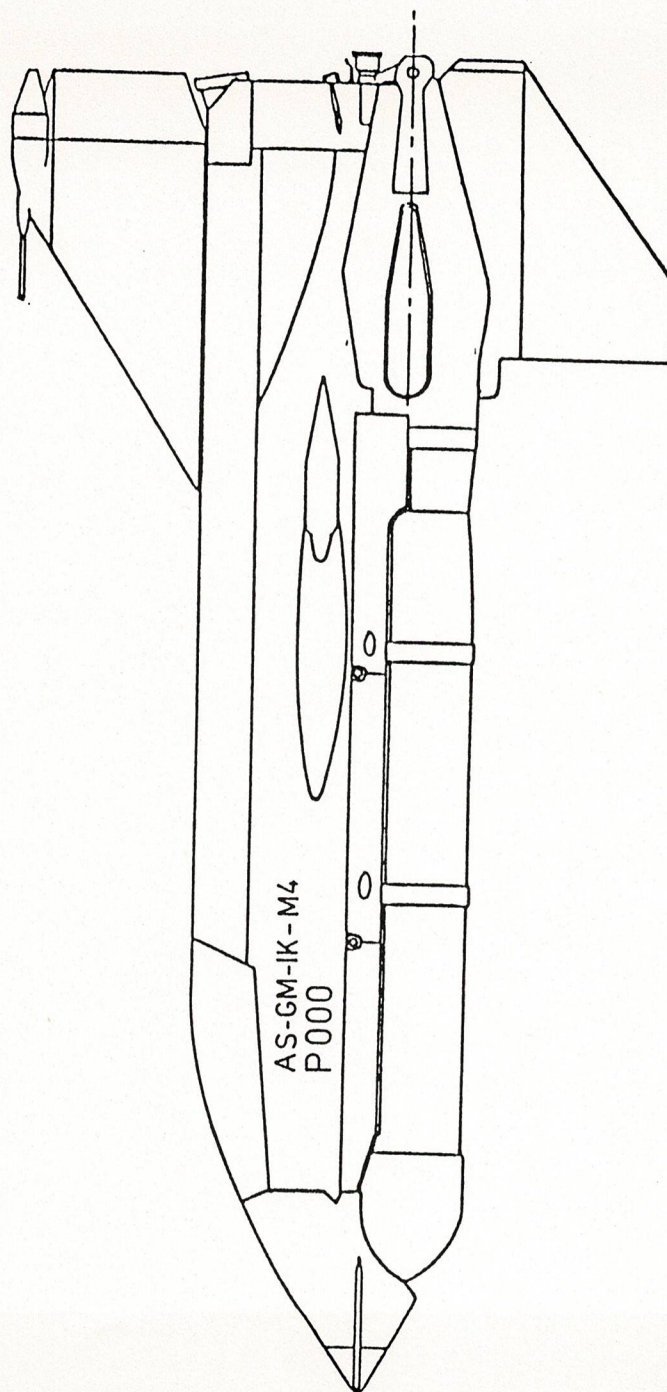
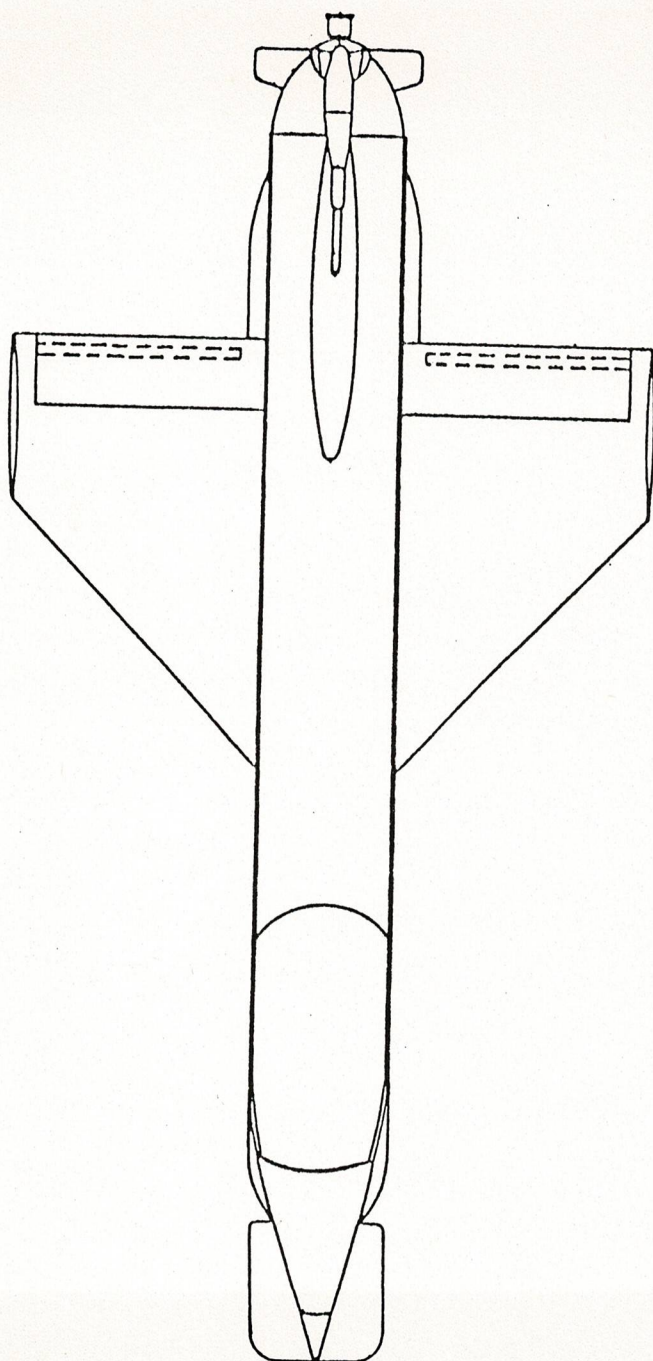


0.6 SCALE MISSILE

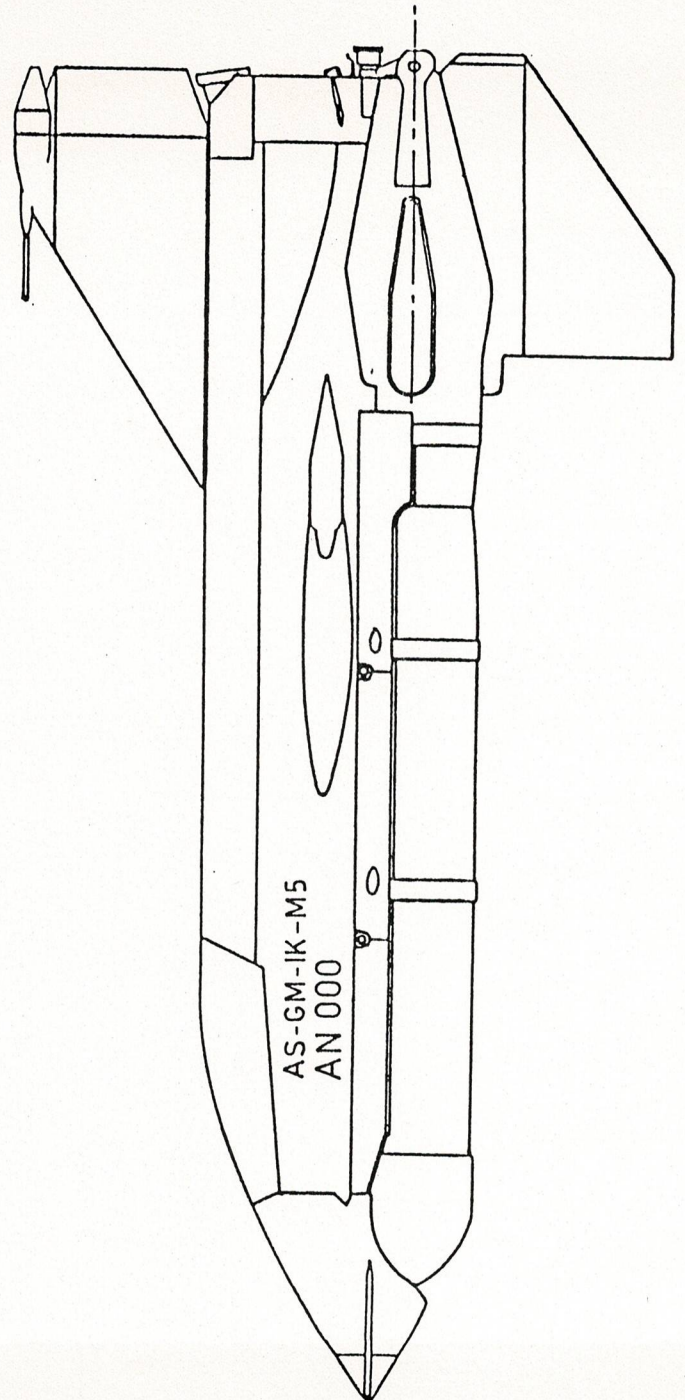
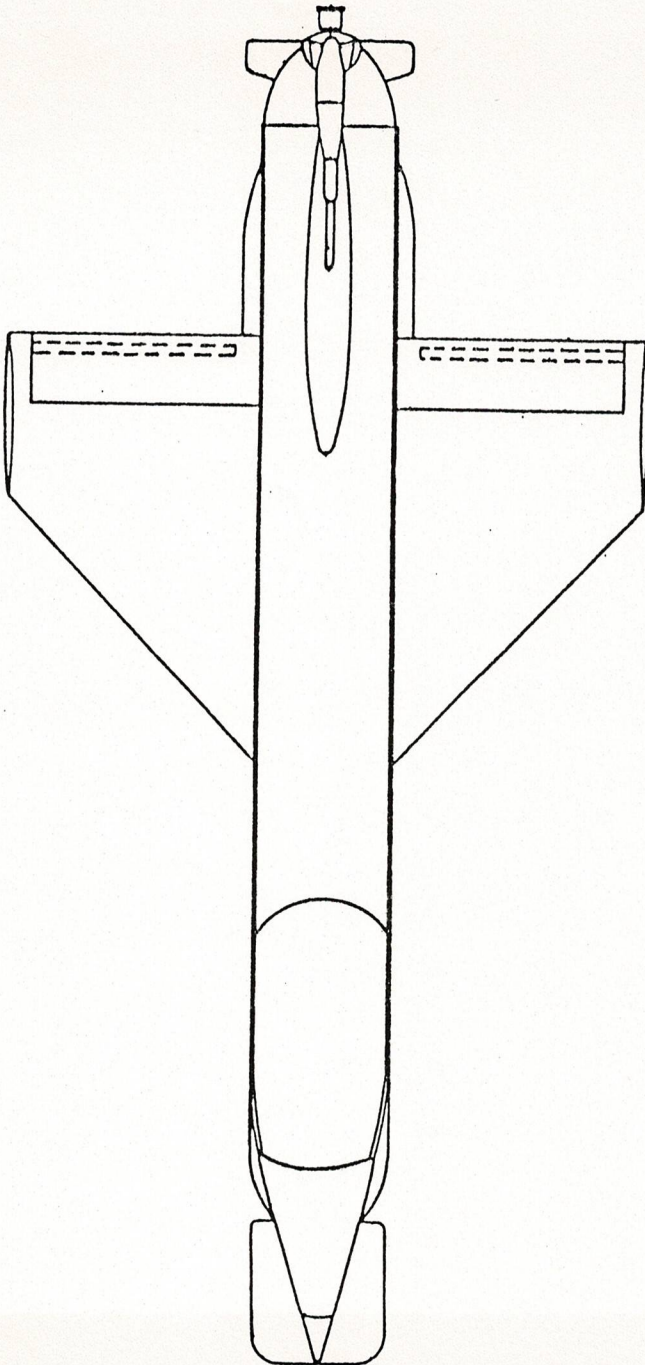


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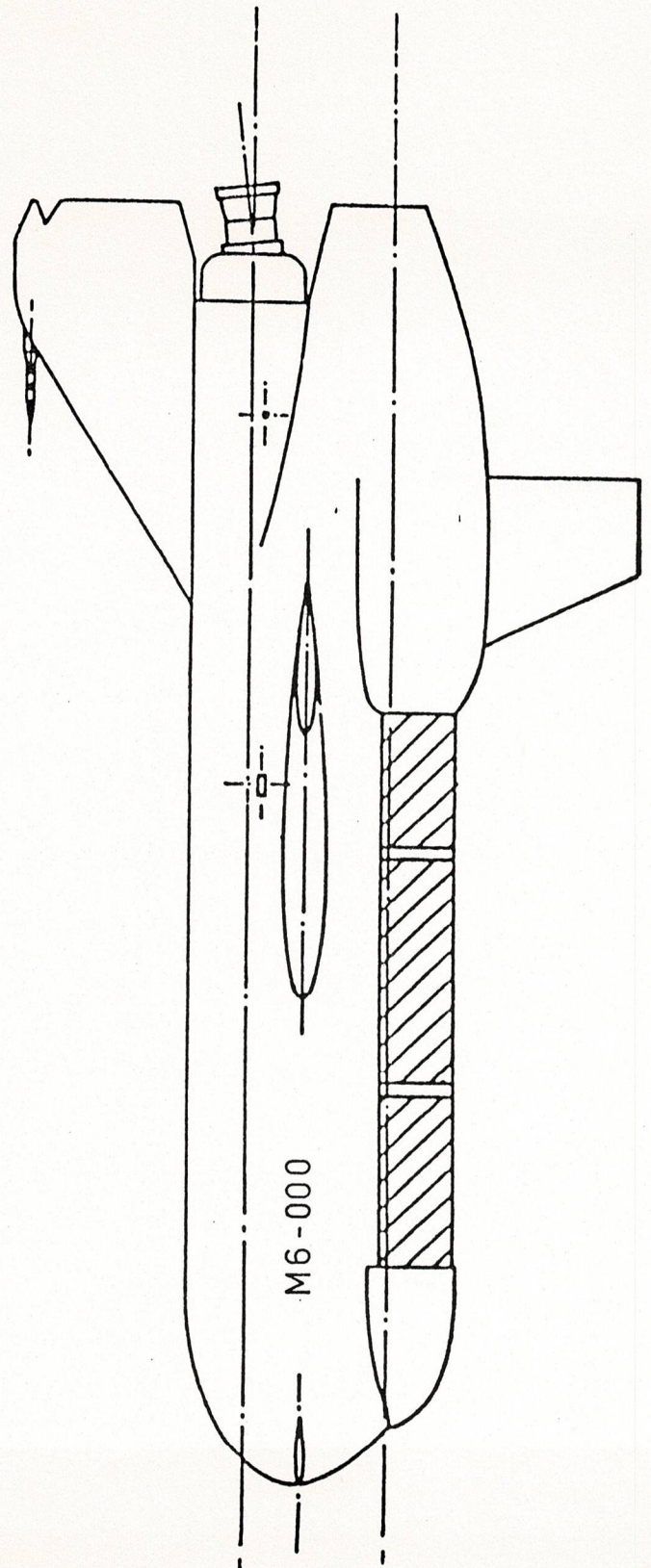
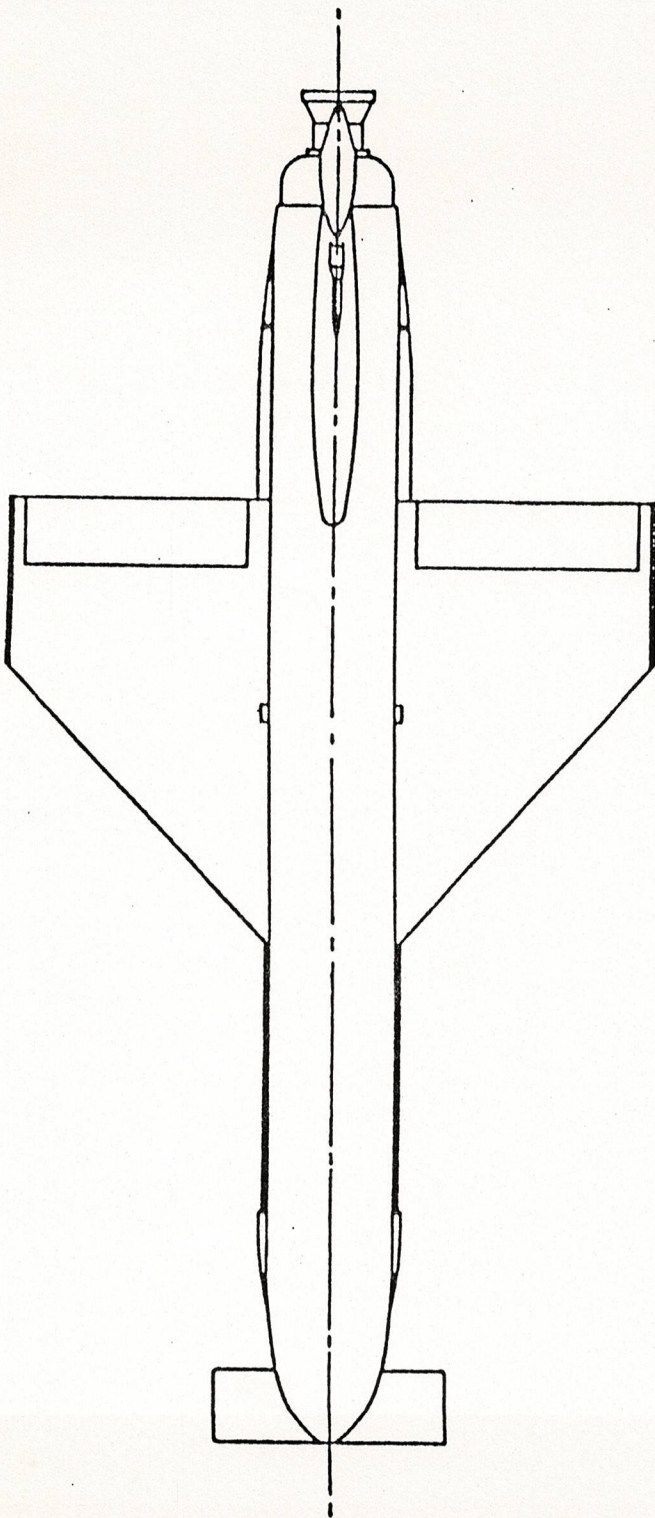




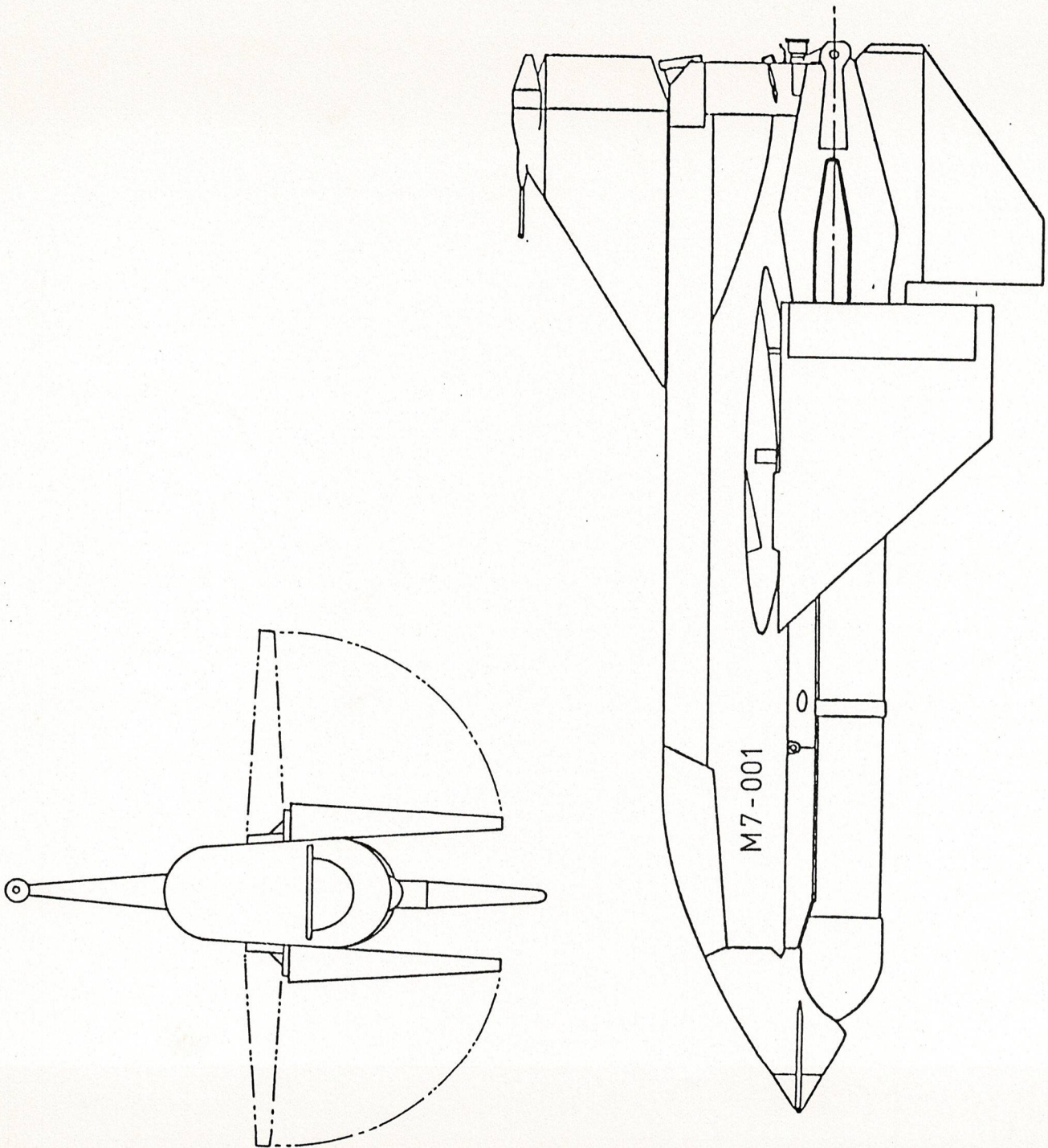
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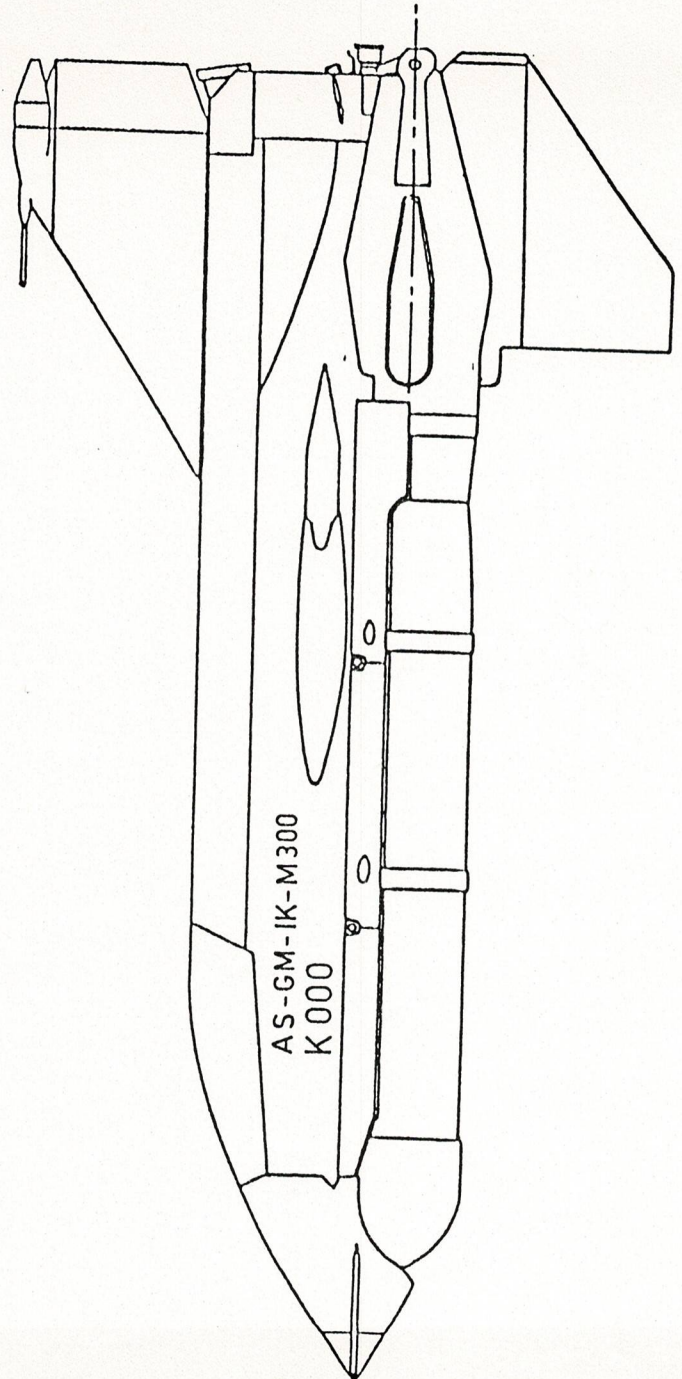
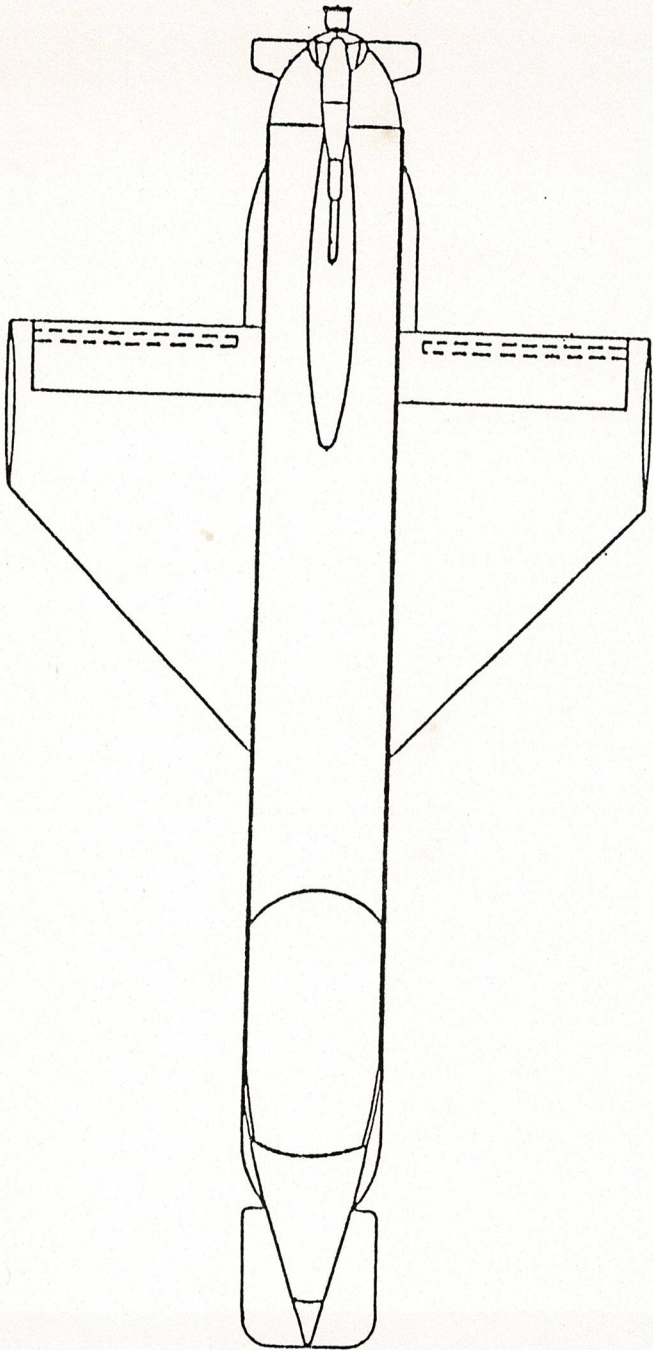
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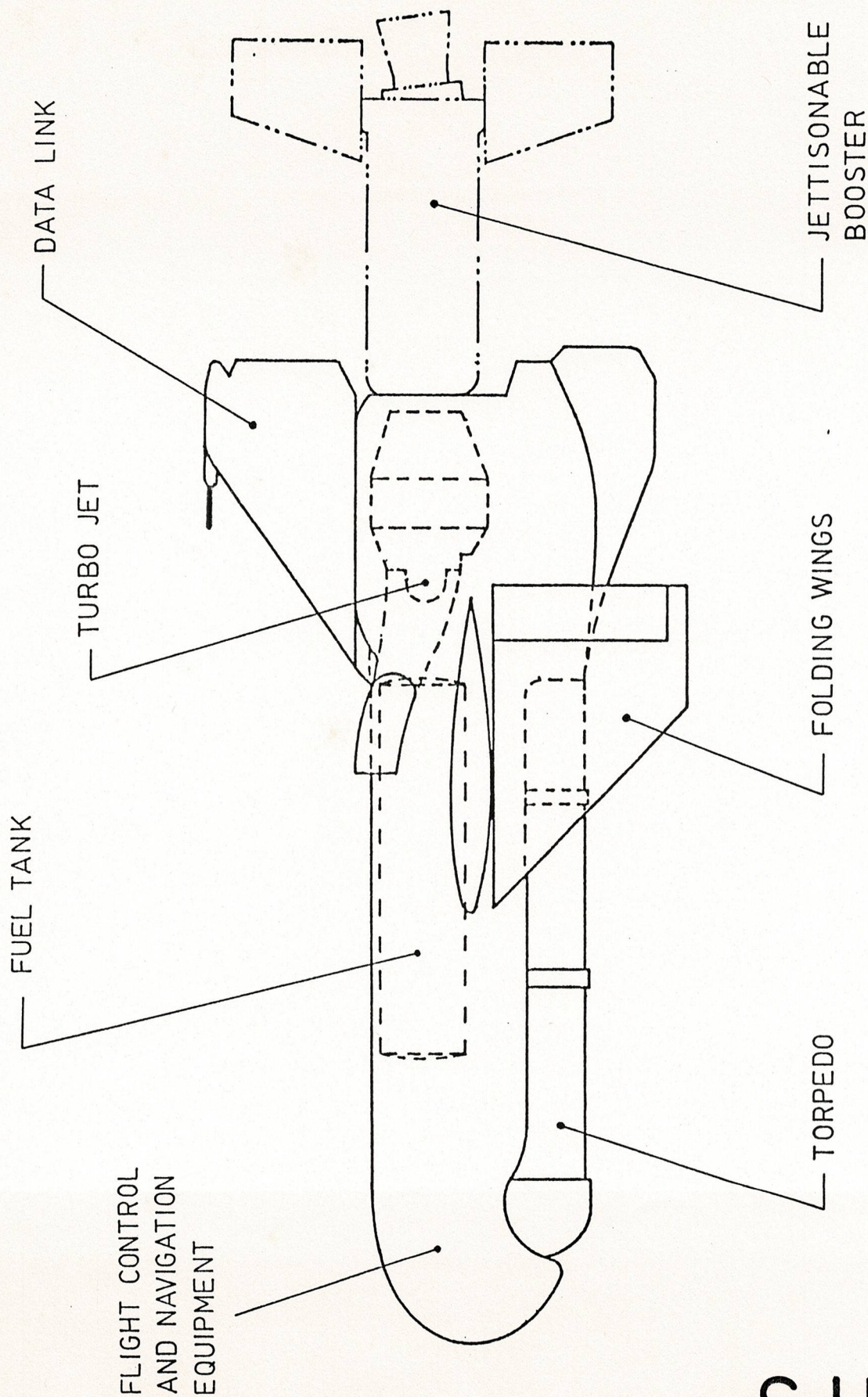
M6



M 7



M 300



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