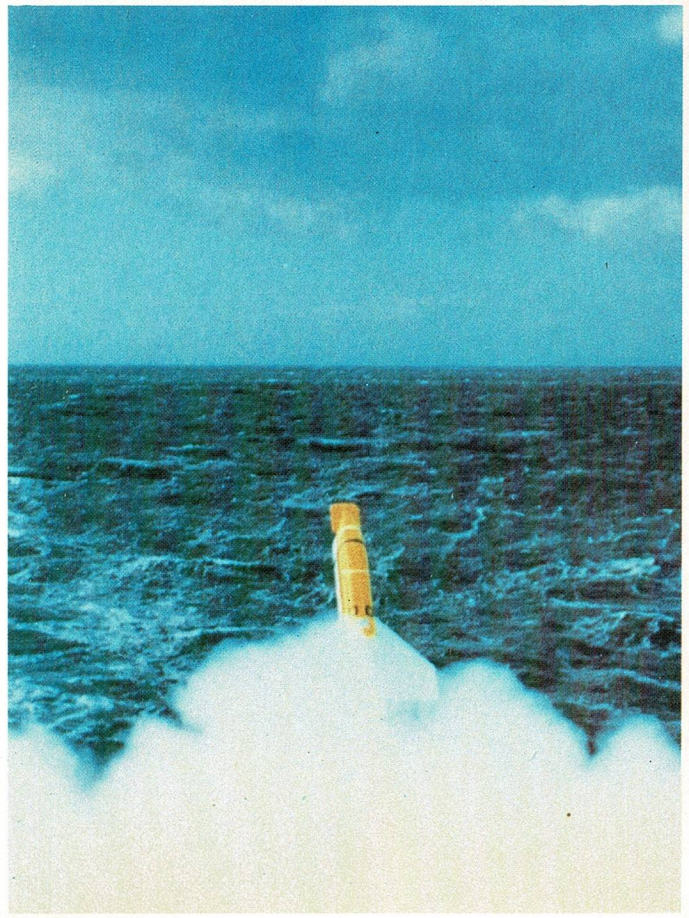
BRITISH AEROSPACE DYNAMICS GROUP

IKARA

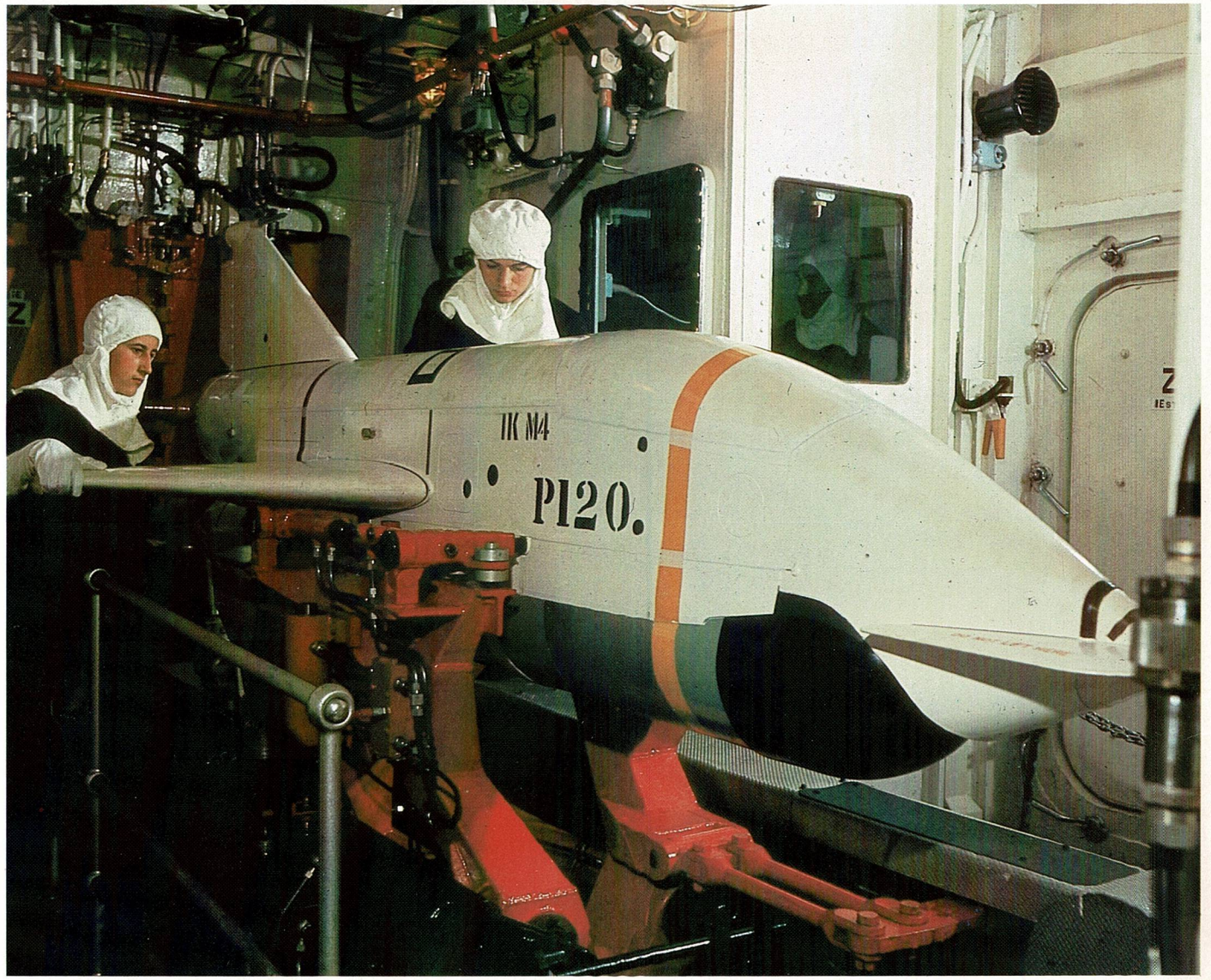
IKARA



Ikara is a long-range anti-submarine weapon system designed by the Australian Government and commercial weapon specialists. British Aerospace is the Australian Government's representative for promotion and sale of Ikara. The Ikara System installed in surface ships comprises an airborne guided vehicle carrying a homing torpedo, a magazine incorporating missile handling and launching equipment, a firing system, and the means of electronic tracking and guidance for missile in-flight control.

Optimum drop-point for the torpedo is computed and continuously updated from first acquisition of the target by sonar. The guidance sub-system directs the flight of the missile, making automatic course adjustments as necessary to correct for any evasive action by the target, and orders the release of the torpedo when it is reached. The torpedo parachutes into the sea, seeks out and homes on the target and completes the attack.

Ikara first entered service with the Royal Australian Navy and has since been adopted by the Royal Navy and the Brazilian Navy.



THE ADVANTAGES OF IKARA

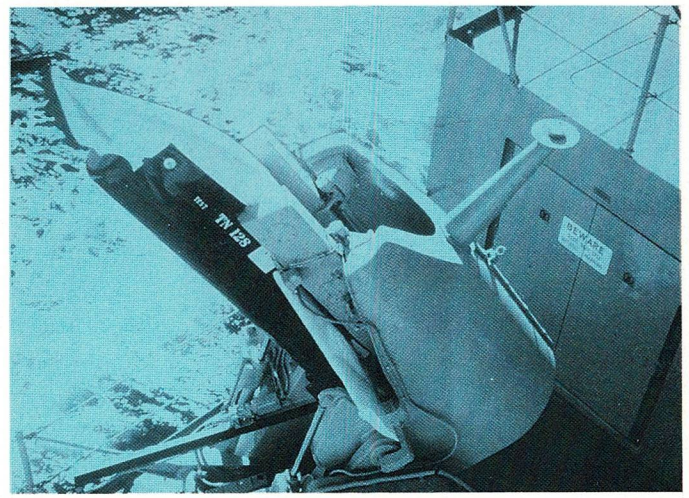
Ikara is a long-range ship-borne anti-submarine weapon system. Ikara's great merit is that it can be used, by day and night, in the most adverse operational environments and in sea states in which it is difficult or impossible for an anti-submarine helicopter to operate.

There are other long-range ship-borne anti-submarine weapons but, in the comparison between conflicting values, Ikara fares best.

A torpedo carried by and launched from a ballistic missile is one such long-range anti-submarine weapon. It has the major disadvantage that it cannot be as accurate as a torpedo carried by a missile which is steered throughout its flight with the aid of information received after the firing button has been pushed. The accuracy of a ballistic device is limited and the greater the range the less it becomes. Ikara, on the other hand, maintains undegraded accuracy even at extreme range.

Another form of long-range anti-submarine weapon system involves the dropping of a torpedo from a helicopter - either a drone helicopter or a manned one - but helicopters are not always able to operate in all weather conditions. In situations where a navy chooses a weapon-carrying helicopter in preference to Ikara as an anti-submarine weapon system in a surface vessel, this choice is made on the grounds of the multi-role capability of the helicopter and not on the grounds of most-effective submarine killing. The helicopter does, indeed, enable other tasks to be tackled - but it provides a greatly reduced anti-submarine capability.

Ikara's ability to attack a submarine at long range contrasts with the use of depth-charge throwing mortars or over-the-side torpedoes which have a relatively short range.



As a torpedo-delivery system Ikara has the following operational merits.

1. **It has a better operational availability than a helicopter.**
2. **It can operate in all weathers.**
3. **It does not require the ship to make special manoeuvres which put the ship at risk, e.g. during helicopter landing and take-off.**
4. **It is faster to the target area.**
5. **It is guided and re-directed in flight using continuous target data.**
6. **It allows a search helicopter to concentrate on its role and remain on station for longer periods without the endurance restrictions of a payload of torpedoes, or it permits the use of a smaller, cheaper search helicopter.**

Ikara as an installation also has the following advantages over a torpedo-carrying helicopter -

1. **Ikara uses expertise which is normally available in a ship. A helicopter, however, requires a specialist crew (e.g. for maintenance, as aircrew and as relief aircrew), all requiring accommodation and facilities.**
2. **On a system weight, topweight and space requirement basis Ikara compares favourably with a helicopter when the hanger, pad, crew and accommodation, fuel and maintenance facilities are considered.**
3. **The layout of the Ikara system within the ship is flexible and can be tailored to meet most ship configuration circumstances. This is not possible with a helicopter installation since, for operational reasons, the helipad must be situated aft.**

Economically, Ikara again has advantages.

1. **The cost of supplying and supporting Ikara compares very favourably with the cost of supplying one or two helicopters (in the submarine-killer role) for each ship, plus training and back-up aircraft ashore, and all personnel requirements.**
2. **Ikara missiles can be stored on board for long periods at minimal costs.**

THE IKARA CONCEPT

The Ikara long-range anti-submarine weapon system comprises the following.

- **A guided missile carrying a torpedo,**
- **a ship-borne missile tracking and guidance system,**
- **a target predictor and fire control system which may use target information derived from shipboard and/or external sources, and**
- **ship-borne handling, launching and storage arrangements.**

In the Ikara concept, a submarine is detected by ship's sonar or helicopter-borne dunking sonar and information is fed into a computer to generate a fire control solution. Using information from this solution, a missile carrying a homing torpedo (typically the U.S. MK46) can be fired from the ship and guided out to a desired splash point. At this location the missile is commanded to release its payload. The torpedo deploys a parachute which it releases as it enters the water and then, using its own active sonar, independently identifies the target, homes on to it and runs in to achieve its kill. While the torpedo is descending to the water, the missile flies on for some distance before diving into the sea, so ensuring that the missile is well clear of the searching torpedo and cannot seduce it from its submarine target.

During its flight the missile is tracked by the Ikara tracking radar and its position is fed into the computer. Corrections are transmitted to the missile to remove flight aberrations and to ensure that the missile is flying to the latest computed torpedo release position. Throughout the attack the computer is being up-dated by the sonar and a continuous fire control solution is being generated. It is this closed loop guidance system which gives Ikara its fundamental advantage over a ballistic system by significantly increasing the probability of completing a successful attack.

The Ikara missile is fired from a launcher at a fixed elevation of 55° with minimum restrictions on arcs of fire. The launcher is designed to fire missiles under all weather conditions. It is trained onto the firing bearing by the computer and, once the firing button has been pressed, the complete sequence of attack is automatically controlled by the computer.

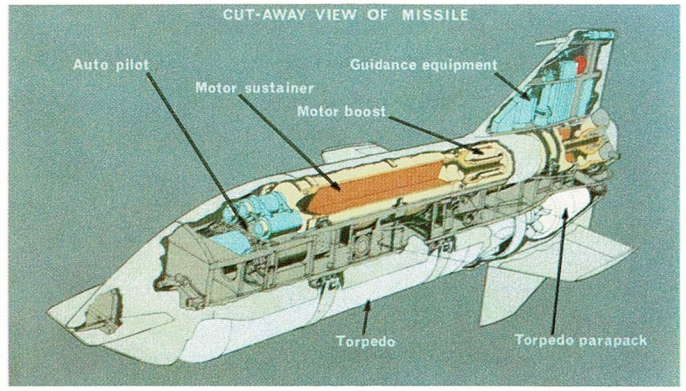
Ikara can attack enemy submarines out to the maximum range of a ship's sonar, regardless of weather conditions. In addition to using its own sonar, as has already been discussed, a ship can carry out an attack on information received from another ship or from a helicopter equipped with dunking sonar via a suitable data link. In this case, target information is passed to the firing ship's computer and an attack is carried out in the normal manner even though the Ikara ship is not itself in contact with the target. This mode of operation has been successfully proved in trials, and considerably enhances the potential of Ikara to provide a long range anti-submarine capability.

The computer programme which generates the fire-control solution and the torpedo dropping position takes into account such factors as the ship's course and speed, the changes in wind speed and direction, and target movement during the time of flight.

In the Australian Navy version of Ikara the computer is a specific-to-purpose digital system whereas the Royal Navy utilises the ship's integrated weapons computer - a further example of the flexibility of Ikara.

The missile handling system (which can be supplied in varying degrees of automation) ensures re-loading of the launcher from the magazine where the missiles are stowed with their torpedoes attached. The layout of the magazine and handling area can vary considerably to suit the differences in classes of ships, and many designs are available.

THE IKARA MISSILE



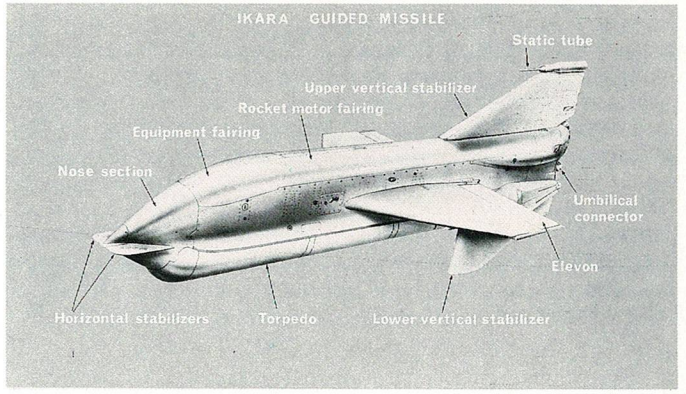
The Ikara missile is 3.42 metres in overall length, has a wingspan of 1.52 metres and an overall height of 1.57 metres. Launch weight is less than 600 kg. In the ship it is stowed in the magazine without wings or fins, to achieve a greater density of missile storage. The wings and fins are manually fitted before launch and are completely interchangeable between missiles. In flight, the missile's method of control is by twist and steer - elevons at the trailing edge of each wing are the only moving control surfaces.

The main strength member of the missile is provided by the 2-stage 'Murawa' motor, a combined boost and sustainer rocket motor specially developed for Ikara. The boost motor accelerates the missile to its subsonic flight speed which is maintained by the sustainer motor to a range in excess of 20,000 metres. Forward of the motor are the autopilot and the thermal batteries.

The torpedo is faired-in under the body of the missile and its parachute is stowed under the top of the lower fin. So that the topedo can be ejected cleanly from the missile, the fairing and lower fin are blown clear before the torpedo is ejected. This is achieved by explosive charges. The payload is ejected by similar means. For safety reasons, the current which activates these explosive sequences is provide by an inertia generator, run-up at missile launch.

In order to preserve the aerodynamic stability of the missile after release of the torpedo, two small fins at the rear descend and are locked in position. A spoiler flap under the rocket motor also locks down. The overall result is that the missile remains stable during its remaining flight, so flying clear of the release point.

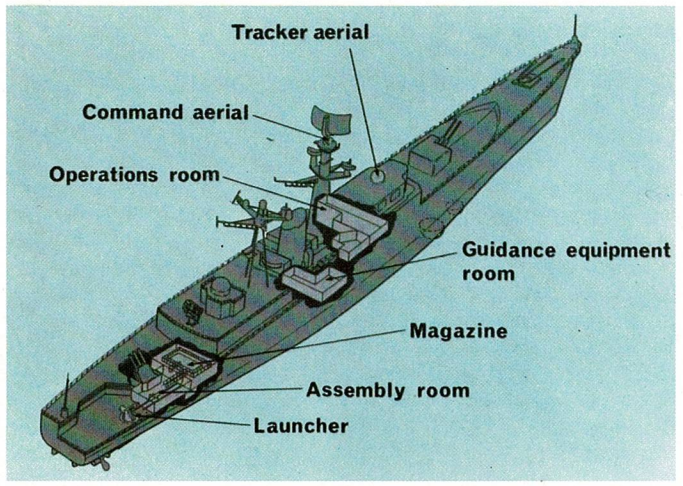
Electronic equipment in the upper fin receives and decodes guidance signals from the launch ship to obtain the missile commands which are passed to the autopilot in the missile body. The missile is maintained at a steady height of about 300 metres by height lock control data which includes input from a barometric capsule housed in the upper fin. Within the autopilot, the command signals are processed and the outputs move the elevons through servo amplifiers and actuators, thus maintaining the missile on course. Also in the upper fin is the microwave transponder which is activated by the incoming tracking signal and sends out its pulse to the ship's tracking aerial, so completing the guidance loop. Power supplies for all the electrical services (except those for the explosive activation already described) are derived from thermal batteries in the missile body.



THE IKARA LAUNCHER, MAGAZINE AND HANDLING ARRANGEMENTS

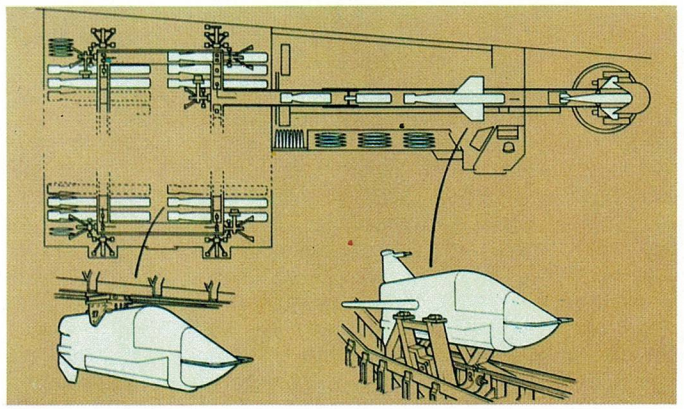
In the launcher, magazine and handling arrangements there is flexibility to suit the individual layout of different classes of ship.

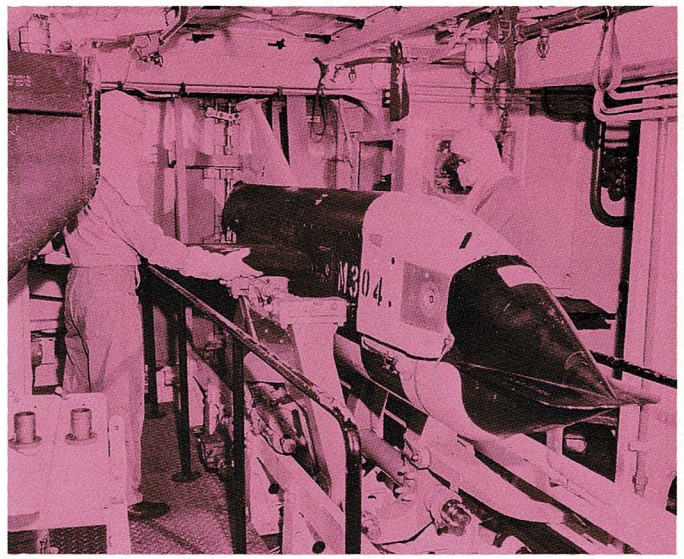
There is a magazine where the missiles, complete with their payload but without wings or fins, can be stowed. From the magazine the missiles are transferred to an assembly room where the fins and wings are fitted and thence to the launcher ready for firing.



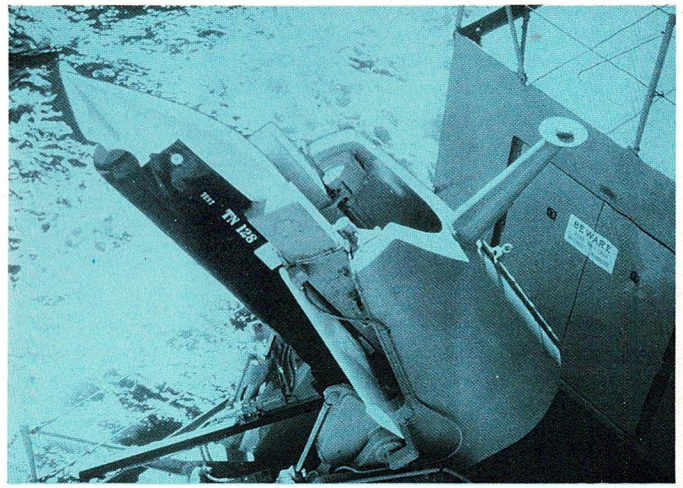
In the Australian River Class Destroyers (the first class of ship to be fitted with Ikara), the magazine assembly room and the launcher are sited right aft on the same deck level.

The missiles are suspended in overhead saddles on two athwart-ship beams. Two more fore-and-aft beams complete the square, and there is an extraction point where missiles are transferred from an overhead carriage to a missile trolley. Missiles are cycled hydraulically around the 'race-track' and the complete operation is automatically controlled, including transfer from overhead carriage to the trolley in the assembly room. In operational use, this magazine is not manned.



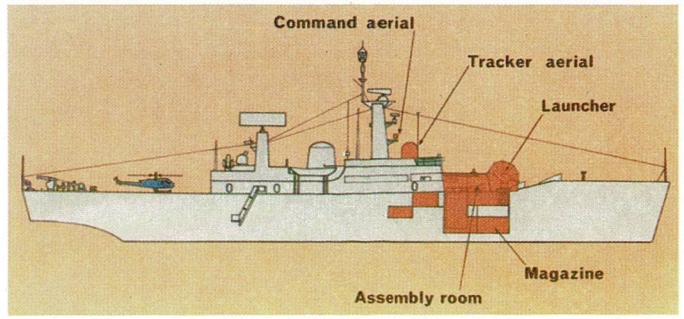


The wings and fins are fitted in the assembly room and the trolley then carries the completed missile to the launcher and loads it stern first into the beams of the depressed and locked launcher.

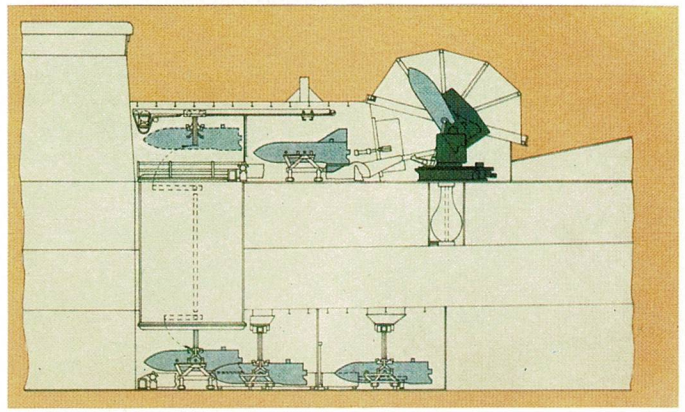


The trolley is withdrawn and the launcher elevates to its fixed firing angle of 55° and trains onto the firing bearing. The complete operation within the magazine area is controlled from a console sited in the 'missile quarters' position. Pump and power rooms in this River Class layout are sited in compartments adjacent to and under the magazine.

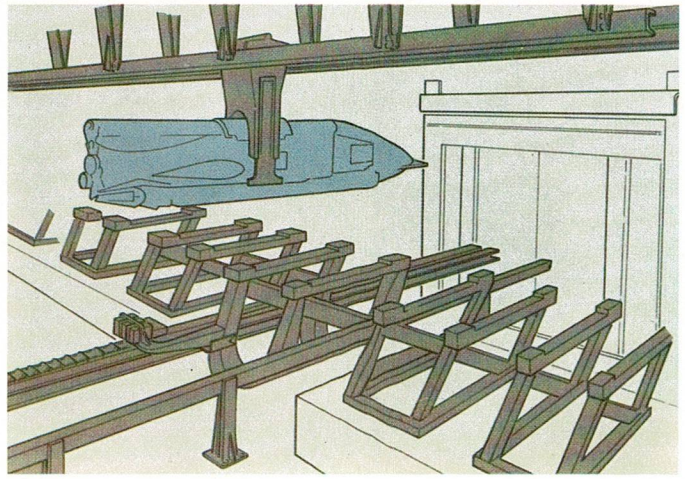
For safety reasons, the magazine is separated from the missile assembly room and the missile assembly room from the launcher by flash doors which are interlocked to prevent both being opened together. To contain any ignition of the motors by accident or by enemy action, a water spraying system is fitted in the magazine and in the assembly room, together with venting slots to release pressure and gases.



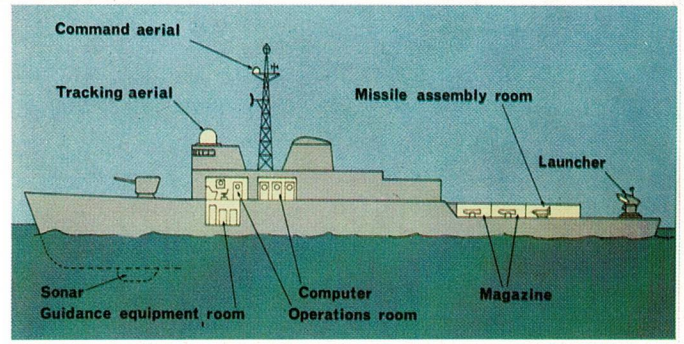
A completely different approach to the magazine installation has been taken by the Royal Navy in its Leander frigate conversions. In this case the 4.5'' main armament, originally located in the forepart of the ship, has been replaced by the Ikara installation.



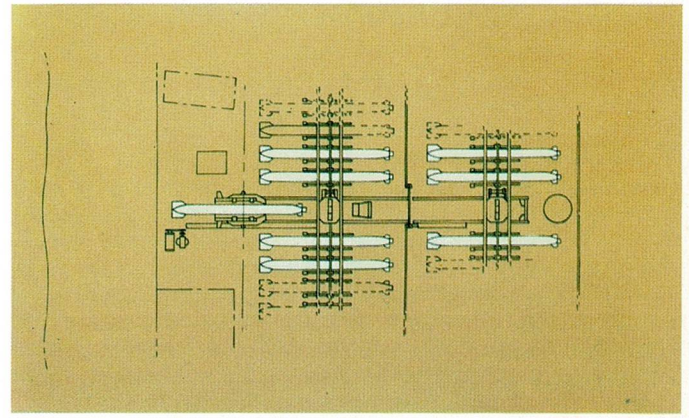
The launcher and assembly room are on the upper deck and the magazine is sited below the waterline. This necessitates a vertical transfer of missiles. Because the launcher is sited forward, it is located in a well and protected by a folding canopy.



In the magazine there is a marked difference - instead of missiles being suspended and moved automatically around the magazine, some manually-controlled handling takes place. Each missile is located on a shock mounted deck stool. An overhead grab, manually operated, lifts the missile and places it on a trolley running on a central railway along the length of the magazine. There are 2 rows of missiles, each with an overhead grab rail, and the trolley runs between them. Once under the hatch, the missile is lifted by another grab to the assembly room. From this point on, the sequence of events is exactly as it is in the Australian system.



A third arrangement is used by the Brazilian Navy, combining the advantages of the Royal Navy system with the simplicity of a one deck horizontal layout.
In this arrangement, missiles are again stowed on stools with an overhead beam to carry them to the trolley which can run the full length from the magazine through the assembly room to the launcher.



The major attraction of such a layout is that the number of missiles carried can be varied with little difficulty to meet individual ship dimensions. Further rows of missiles can be added or the number of stools per row varied in order to take account of the space available.

There is no operational disadvantage in a semi-automatic system. The time taken to fire the second and subsequent missiles is not critically dependent on the time to load the launcher, but rather on the flight-time of each preceding missile. Although the semi-automatic magazine has to be manned, unskilled personnel can be employed.

The reduction in maintenance (which makes use of skilled personnel) compared with that necessary in a fully automatic magazine, coupled with initial cost and weight savings, makes the semi-automatic version a viable alternative.

IKARA'S ENVIRONMENTAL CAPABILITY

Ikara can be used in the most adverse operational environments.

For example, Ikara can be successfully launched in a 70 knot cross-wind and an air temperature of −18°C, with the ship rolling +25°, pitching ±9°, heaving ±4.5 metres, heeling 15° and with the launcher training at the rate of 10°/sec.

It should be noted that in such sea conditions it would be very difficult for a helicopter to take off for an attack on a submarine.

'Normal' Ikara performance can be expected with a 70 knot cross-wind, with the ship rolling ±6° (period of 9 secs) pitching ±6° (period of 6 secs), heaving ±2 metres (period of 6 secs), heeling 5°, and with the launcher training at 5°/sec. As the actual instant of firing of a launcher is within 10° of the vertical and moving towards the vertical, the rougher the sea the greater the possibility of a brief delay in the moment of fire; this delay is only up to about 4 seconds and is operationally unimportant.

The missile itself has been designed on the assumption that it will spend a minimum of time exposed on a launcher, awaiting firing: no more than an hour under normal conditions, for example. There are thus no de-icing arrangements for the missile. It is advisable, therefore, for the missile to spend no longer than is necessary on the launcher in freezing conditions. Normally, when a firing is withheld, the missile can be returned to the assembly room in about three minutes.

The missile tracking radar, in common with most radars, has an aerial radome which is affected by ice accretion, but only under the most extreme conditions. The temperature range within which the external equipment can be expected to perform satisfactorily is from −18°C to 50°C, with solar radiation of up to 10 Cals/inch²/hour.

The protected below-decks Ikara equipment normally requires either a ventilated compartment (between 15°C and 37°C and with 70% maximum humidity) or an air-conditioned compartment (15°C to 30°C, 50% maximum humidity), being maintained above the dew point in both cases. In the least favourable environment in these ranges the equipment is capable of operating for at least 12 hours with no degradation in performance.

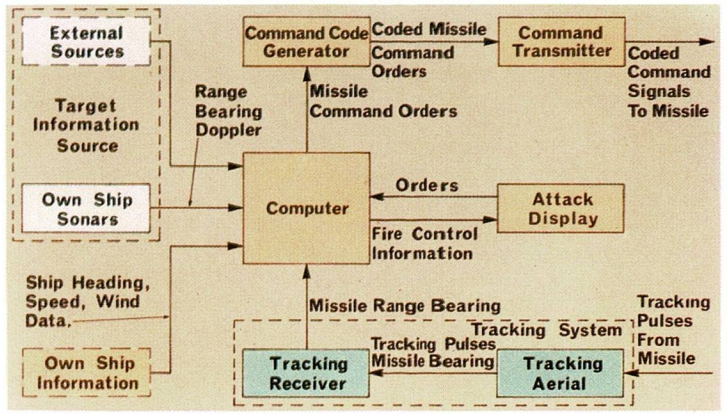
Specially designed mountings ensure that the effects of shock and vibration are minimised. Exposed equipment is proofed against wind, blast, boost efflux, salt and funnel gases etc.

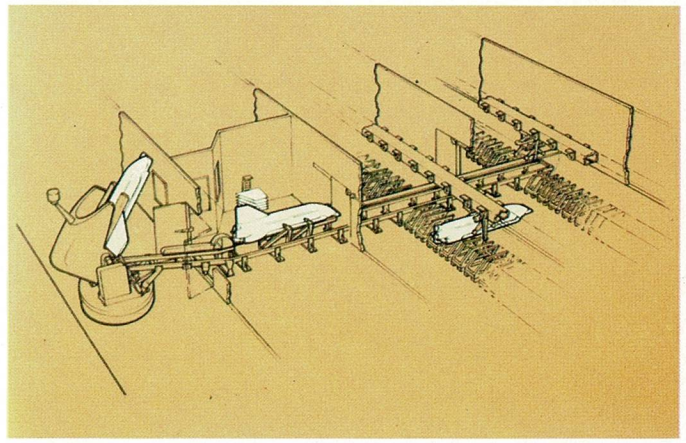
USING IKARA OPERATIONALLY

Commands to an Ikara missile in flight are transmitted by UHF from an omnidirectional aerial on the launch ship. To permit other friendly ships to fire their own Ikara missiles without UHF interference, several combinations of frequencies and codes are available.

The Anti-Submarine Warfare Officer in each ship is presented with displayed information including the Ikara ship's position and track; the predicted position of the target; the position of the missile in flight; and the blind sector in which firings cannot take place because radar tracking is inhibited by the ship's structure. The display is used to ensure safe operation with ships in company. A danger line is indicated, marking the centre of a corridor between the ship and the splash-point, along which there is some danger to shipping and low flying aircraft. There is also an indication of the area around the splash-point in which the presence of a surface ship is likely to seduce the torpedo. The ditch arc is also indicated, (that is, the sector beyond the splash-point in which the missile will probably ditch itself after it has released its payload).

The Ikara data system includes a variety of facilities to inform and aid the Anti-Submarine Warfare Officer in his overall control of an attack situation. These facilities enable him to assess the current position and decide the best course for the missile, the time for which a firing can be held if required, changes to the splash-point, and selection of operating depth and search pattern of the torpedo. The officer can also terminate the missile flight, making it dive into the sea with its payload inert, should the need arise.

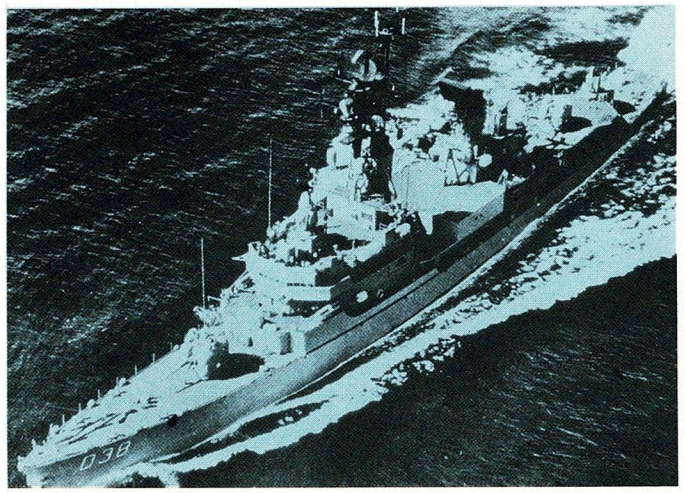




The Ikara weapon system has four states of readiness. The fourth and lowest is a maintenance state, in which the system will spend most of its time, with the crew in cruising watches or fallen out. In this state, about 1 hour per day of maintenance is usually sufficient, and the system can be ready in ten minutes. The third state - 'defence stations' - brings the equipment to a stand-by condition. The radar, sonar and computer start operating; the first missile is brought to the assembly room and the wings and fins are fitted; and the launcher is locked in the 'load' position.

At 'action stations', the second state is initiated. The missile is loaded on to the launcher, the hydraulic pumps are started and the next missile is prepared. This second "action" state can normally be maintained for up to an hour. In the final state the missile on the launcher is warmed up, the guidance is locked on and the launcher moves in accordance with the instructions from the computer. The rate of fire is determined principally by the time taken for the missile flight.

SERVICE EXPERIENCE WITH IKARA



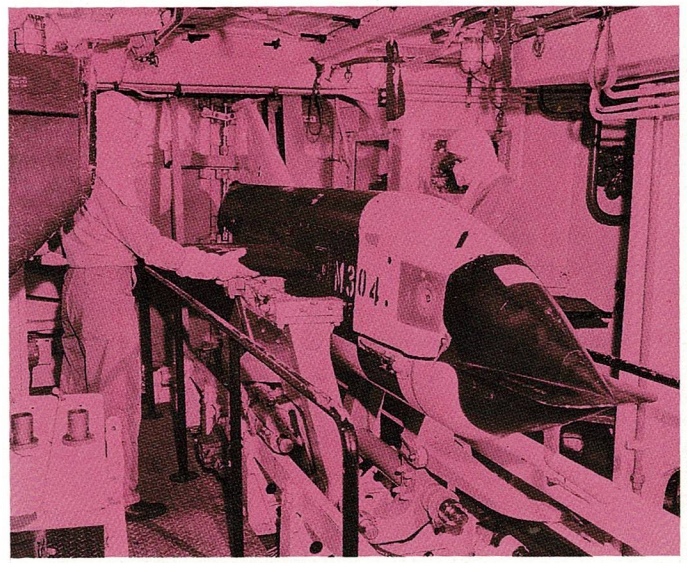
Ikara first entered service with the Royal Australian Navy, and it has since been adopted by the Royal Navy and the Brazilian Navy.

Nine ships in the Australian fleet are equipped with Ikara, comprising three American built ships of the Charles F. Adams Class design and six Type 12 frigates. A twin-launcher Ikara sytem is fitted in place of the ballistic ASROC anti-submarine system used by the USN in its Charles F. Adams Class ships. In these nine ships, the reliability of the missile in service has been so good that the ship-borne test equipment originally fitted has been progressively removed as the ships came in for refitting.

No major system changes have been necesary and the results of firings both under controlled conditions and in simulated tactical exercises - especially in those using an external data link which enables one ship to fire Ikara using helo or another ship's sonar data - were highly successful. The performance of RN Ikara has been equally impressive.

The Royal Navy has Ikara in HMS Bristol, a Type 82 destroyer, and in eight Leander frigates. In the latter ships, Ikara is fitted in place of the twin 4.5 inch main armament (including the magazine and power room space). In the Brazilian Navy, Ikara is fitted to four Vosper Mk. 10 frigates as the ships' primary anti-submarine weapon system.

In all three navies using Ikara the ships are different, and the magazine layout in each case has been designed to fit the configuration of the class of ship and national requirements. Types of sonars used in the ships also differ. This demonstrates the flexibliity of the design and layout of the Ikara system equipment, and its ability to meet the varying requirements of different users.



Regarding availability and reliability, the design aims for ship-borne equipment have been achieved - 95% availability and a 99% probability that ship equipment operates without failure for the required time. As for the missile, the very high designed in-flight reliability has been significantly bettered, and the desired aim-point accuracy has been achieved in the scores of operational firings which have been made.

BRITISH AEROSPACE AND IKARA

The British Aerospace Corporation is a powerful aerospace enterprise which in width of experience and total capability matches any other single organisation in the world aerospace industry.

The output of British Aerospace demonstrates a wealth of pioneering technological expertise over the whole spectrum of aerospace engineering. Activities range from supersonic and subsonic civil and military aircraft to major guided weapon systems, space vehicles, high technology equipment and extremely sophisticated support contracts. British Aerospace has at its disposal experience in international collaboration which is second to none.

British Aerospace Dynamics Group (BAeDG) is the guided weapon system and space vehicle part of British Aerospace. By agreement between the British and Australian Governments, BAeDG is the representative for the promotion of the sale of Ikara by the Commonwealth of Australia. In the early stages with potential customers, BAeDG discusses, informs, advises and prepares Ikara system proposals to suit customers' requirements.

As a customer's interest becomes more firm, the Commonwealth assisted by BAeDG will prepare system designs - the documents comprising the information necessary for the integration of the various elements of Ikara into a system to meet the specific requirements of the customer. The system design also covers, in technical detail, the methods of integrating the Ikara system with other systems in the ship, providing the information necessary for the ship to be prepared to receive the system elements. It also provides the necessary installation details.

BAeDG is the prime contractor for UK support of the missile for the R.N.

At all stages leading to a contract with the Commonwealth, the potential customer can be assured of continuity and coherence. BAeDG's pre- and post-sales experience with its own designed and manufactured weapon systems and Ikara, will guarantee that a customer can look forward to having all of the services which a modern navy will expect with the supply of a major weapon system.

BRITISH AEROSPACE DYNAMICS GROUP

For further information contact:
Sales Manager,
Surface Launched Missiles,
British Aerospace Dynamics Group,
Filton House,
Bristol BS99 7AR
England.
Telex 449452
Telephone: (0272) 693831

BRITISH AEROSPACE DYNAMICS GROUP

IKARA