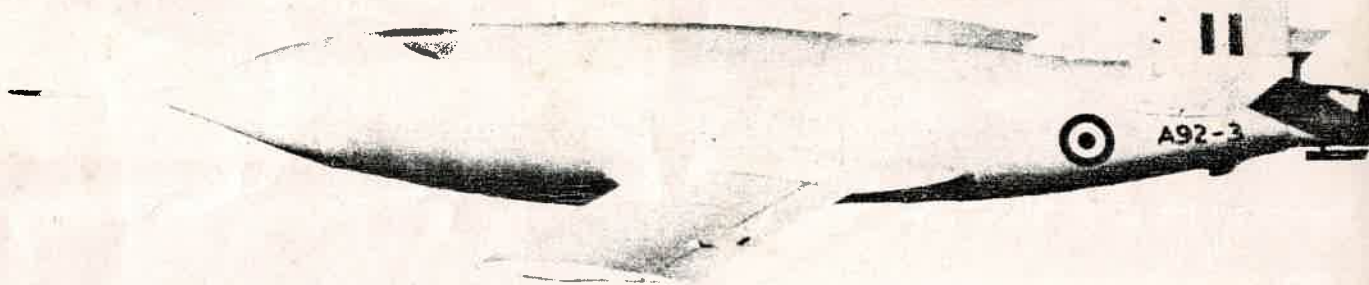


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EXCLUSIVE

① MR JBR
② Jindivik File.

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THE HUNTED ONE



By TONY SELF

The Government Aircraft Factories Jindivik is perhaps the most successful target drone ever produced, and is Australia's only mass-produced locally-designed jet aircraft. The concept of a remotely controlled jet target evolved in 1948 when Australian and British Government officials discussed and formulated specification E7/48 for a "high speed pilotless target aircraft". Two piloted prototypes were designed and manufactured by the Government Aircraft Factories (GAF) under the designation "Project C — Pika". The first Pika made its maiden flight in October, 1950. (The GAF Pika was described in December 1980 AADR). The two single-seat Pikas were powered by the Armstrong Siddeley ASA1 Adder turbojet especially designed for the target project. A tentative order for twelve Project B Jindivik Mk 1 pilotless aircraft was initially placed with GAF. Since this first order, the Jindivik has been re-engined and greatly modified, and has appeared as Mk 2, 2A, 2B, 3, 3A before the current 3B version. Close to 500 Jindiviks have taken to the air since the first Mk 1 flew in August, 1952, and have served in the United Kingdom, United States, and Sweden, in addition to Australian service with the Weapons Research Establishment and the Royal Australian Navy.

Operation

The Jindivik target drone operates from a normal airstrip. For take-off the aircraft is mounted on a tricycle trolley with a gyro-steered nosewheel. The aircraft takes off under its own power and is automatically electromechanically released from the trolley at 120 knots. As the aircraft accelerates to 130 kts, the flaps retract and the aircraft adopts a climbing attitude. The trolley is braked to a stop 3000 feet (910 m) from its starting point.

Although Jindivik may be directed from a shepherd aircraft, it is normally controlled from a ground station. The ground station team is led by a skipper who "pilots" the aircraft once it is airborne, and assisted by a navigator who tracks the flight pattern. A pilot beside the strip has control for take-off and landing, and is assisted for landing by a batsman positioned at the end of the strip to maintain the correct heading.

The remote control and its auto-pilot system, designed by the Royal Aircraft Establishment at Farnborough, is effective at ranges greater than 100 nautical miles from the ground station. Push-button selection allows the auto pilot to provide aileron,

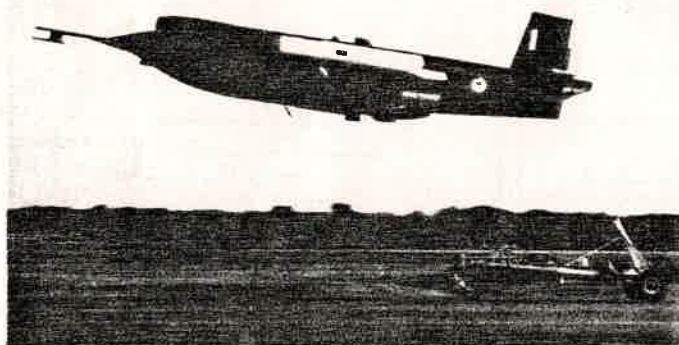
elevator, and engine rpm conditions for any of the flight conditions — fixed climb, level flight, turning, and descending attitudes. Any intermediate attitudes or engine conditions can be adjusted by "beep" control, allowing the Jindivik to operate any flight pattern desired. A telemetry system transmits airspeed, altitude, rate of climb, engine and other information to the ground controller.

Jindivik carries a variety of special equipment to enable it to simulate the radio echoing properties and infra-red radiation characteristics of very large aircraft. To provide realistic weapons engagement conditions, electronic counter-measure (ECM) equipment may be fitted, and the target can be made to execute intricate evasive manoeuvres. Cameras fitted on the wings film the missile's approach and accurately assess the miss distance of the missile. By fitting a radio altimeter, the Jindivik can be made to simulate a very low flying aircraft at altitudes as low as fifty feet. Optional luneberg lenses are often fitted to the Jindivik to boost the radar image of the small drone to simulate that of a larger aircraft.

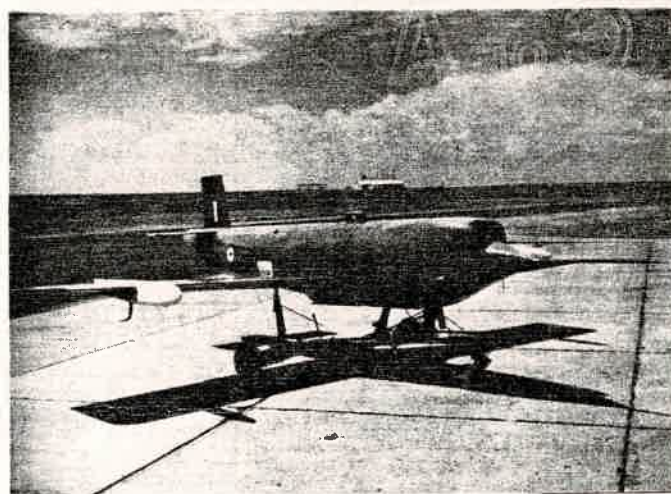
Because of the cost of the Jindivik itself, it is often desirable for the weapon being tested to home on an auxiliary towed target rather than the Jindivik itself. In fact, the Jindivik's present task is primarily to calculate distances by which the trials missile misses the very small towed targets. Sophisticated high speed wide angle cameras are used to record the missile's path past the target, and are mounted in special pods on the wings. The main type of towed target is the "Tonic", an active radar/infra-red augmented device designed to simulate a much larger target such as a bomber. Two Tonics can be carried under the inboard wings, and are streamed out behind the Jindivik and recovered by a special winch. Other expendable targets are available, including the WREDUSAIR, an infra-red augmented tow designed to present a discrimination problem for the missile being tested.

After the trials are complete the Jindivik is directed back to the airstrip for a normal approach and landing, but with Jindivik landing on a single retractable skid fitted with a pneumatic shock absorber strut. When "approach" is selected by push button, the flaps and skid automatically lower, and the aircraft is then controlled to a conventional approach. On touch-down the fuel supply to the engine is cut and flaps automatically retracted. The target's landing slide is uncontrolled and usually maintains a true path, normally coming to rest 1500 feet (460 m) after touch-down.

HEADING: the first Jindivik to fly was A93-3, seen here in flight over the WRE facility at Woomera from where it was operated. (GAF).



The RAN have operated the Jindivik during weapons testing since 1967, and still have a number of aircraft on order. Here a RAN Jindivik is seen after lift-off from its take-off trolley. Royal Air Force Jindiviks operate from Wales, and have been used for air-to-air missile testing from RAF Lightnings and Hunters (Defence PR.)



A Mk2B prototype photographed at Woomera. This aircraft is fitted with 40-inch wingtip extensions and Mk5 pods. The "big wing" Jindivik can operate at altitudes as great as 67,000 ft, its Viper turbojet providing excellent thrust control at this Foxbat simulating altitude. (Government Aircraft Factories.)

Construction

The GAF Jindivik is constructed essentially from lower alloy grades of aluminium. The use of forgings and extrusions have been minimised, while fabricated sheet items are used extensively. Araldite bonding methods are used for many major assemblies.

The fuselage is built in four main sections; front fuselage, equipment bay canopy, centre fuselage, and rear fuselage. The canopy section, constructed of fibreglass, is held in position over the equipment bay by a single collar nut over the pitot tube assembly. After removing the canopy, all aircraft control systems are readily accessible.

The Jindivik's power plant is mounted in the rear fuselage on trunnions located on either side of the forward frame. Fuel is stored in a 64 gallon (290 l) flexible crash-proof bag surrounding the intake duct, and in two 16 gallon (70 l) integral wing tanks.

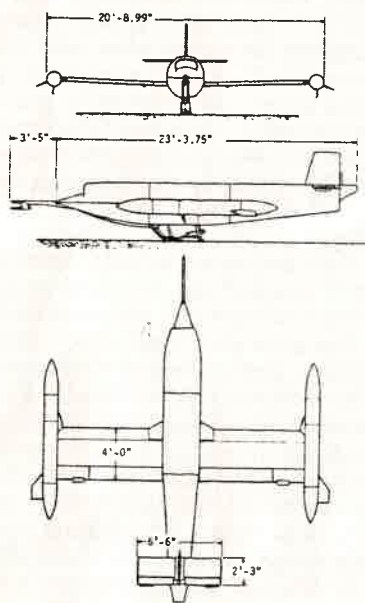
History

The first Jindivik Mk 1 to Specification E7/48 was delivered to the RAAF Air Trials Unit in October, 1951. The Armstrong Siddeley Viper ASV1 was originally intended as the Mk1's engine, but delays in production meant that the first twelve Jindiviks were to be powered by the Adder. The first Jindivik to fly was A92-5 which lifted off from Woomera in Central Australia on August 28, 1952. The final Mk 1 was delivered in May, 1953, and the last flight of the Jindivik Mk 1 was completed on October 6, 1954.

Before the Jindivik Mk 1 had even flown, the British Ministry of Supply issued a new specification U22 49 for a high-speed pilotless target for use by the three British services, the performance requirements of which were somewhat more demanding than E7/48, and some additional operational features were required. At this time, the Viper engine design was progressing satisfactorily, but with mass flow and thrust increased over initial expectations for the ASV1 by 50 per cent, which would affect the interchangeability with the Adder. It was decided, therefore, to redesign the Jindivik around the new Viper ASV3, but using the same proven general layout of the Mk 1, but with larger intakes and jetpipe to cope with the additional thrust of the new engine. The new Jindivik, given the Mk 2 designation, had no provision for rudder control, as Pika tests had shown that specification turns could be achieved on ailerons alone. An order for a number of Mk 2 prototypes was placed in late 1951, this being followed quickly by production orders. The first Mk 2, A92-21, was delivered to the RAAF in November, 1953, and made its maiden flight at Woomera in December. 88 Jindivik Mk 2s were produced for the Woomera Weapons Research Establishment which was then undertaking most weapons trials for both Australia and Great Britain. A further sixteen were exported to the British Ministry of Supply, and ten to the Swedish Government, making a total of 144. The last Mk 2 was delivered (to Britain) in 1959.

JINDIVIK OPERATORS						
VERSION	No Produced	Operated by:	First Flight	TOTAL	Figures in Brackets are firm orders	
Mk 1	12	W. R. E., Woomera	Aug 28, 1952	12		
Mk 2	88	W. R. E., Woomera	Dec 11, 1953			
	16	RAF Llanbedr				
	10	Swedish Air Board		114		
Mk 2A	3 Converted	W. R. E., Woomera	Sep 18, 1958	3 Converted		
Mk 2B	12	W. R. E., Woomera	Oct 8, 1959			
	64	RAF Llanbedr		76		
Mk 3	9	W. R. E., Woomera	May 12, 1961	9		
Mk 3A	64	RAF Llanbedr	Nov 10, 1961			
	42	USN, Pt Mugu				
	10	RAN, Jervis Bay				
	31	W. R. E., Woomera		147		
Mk 3B	9	W. R. E., Woomera	July 4, 1968			
	90(+20)	RAF Llanbedr		126(+40)		
	27(+20)	RAN, Jervis Bay		484(+40)		

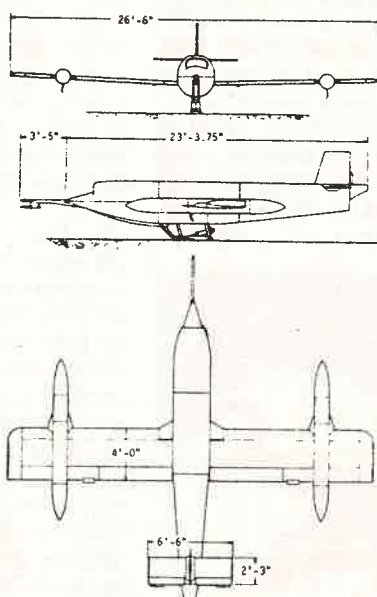
CONFIGURATION: MK 8 POD WITH FIN



JINDIVIK
LOW ALTITUDE HIGH SPEED ROLE

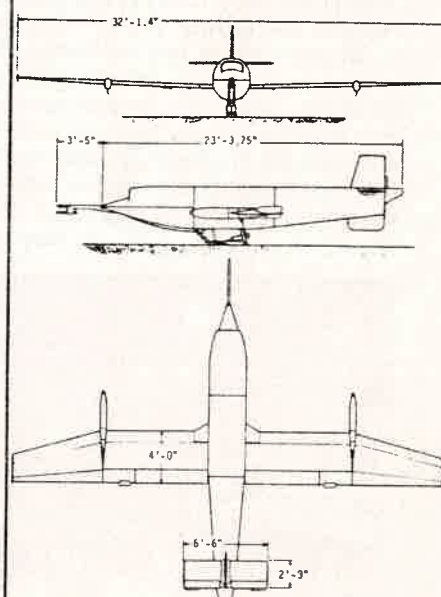
**JINDIVIK AIRCRAFT
CONFIGURATION**

CONFIGURATION: MK 8 POD
40in WING EXTENSION



JINDIVIK
HIGH ALTITUDE EXTENDED ENDURANCE ROLE

CONFIGURATION: MK 5 POD
80in WING EXTENSION VENTRAL FIN



JINDIVIK
EXTRA HIGH ALTITUDE ROLE

UPDATE — JINDIVIK Mk. 4

In March, 1977, the British Ministry of Defence began making enquiries regarding an eventual replacement for the highly successful Jindivik Mk3B, in service with the Royal Aeronautical Establishment at Llanbedr, North Wales. Because the Jindivik was beginning to become relatively expensive, the Beechcraft company was approached by the MoD with regard to their MQM-107 drone. The MQM-107 is a jet-powered, zero-launch parachute recovered system. The Government Aircraft Factories offered to investigate methods of reducing the cost of the Jindivik.

As a result, the Jindivik Mk4 emerged. Meanwhile, the British Marconi company had designed a Universal Drone Pack (UDP) for the MoD. The UDP was designed to enable most service aircraft to be converted to drones by fitting the UDP in the space normally occupied by the ejector seat. The system is to be used specifically for drone conversion of Royal Navy Sea Vixens. It was decided to design the Jindivik Mk4's electronics so that it could utilise the UDP, but because of the technical differences between the Sea Vixen and Jindivik, and because the Universal Drone Pack was not

entirely "Universal", the system was modified for the Jindivik to become known as the Flight Control Computer.

At the same time it was decided to use new, cheaper manufacturing techniques which both lowered the cost and strengthened the structure to extend the Mk4's acceleration limit from +3.5 g to +6.0 g. The electronics were updated to reduce the number of "black boxes" from 30 or so to 12. The extra space achieved was used for fuel storage; an extra 19 to 20 gallons bringing the total capacity to 156 gallons. A new wing tip pod, the Mk9, was also introduced, using welded stainless steel instead of the earlier Mk8's alloy construction. Other changes included a fully machined wing replacing the folded metal type, foam filled leading edge structure replacing the earlier ribbed structure, a new method of fibreglass canopy construction, and a generator replacing the earlier alternator. Although a new engine version was looked at, the Viper 201 engine of the 3B was to remain the power plant.

A jointly funded Anglo-Australian Jindivik Mk4 Development Project was established to finance the re-design and the construction of two prototypes. The first prototype was to use a basic

Mk3B airframe with re-designed electronics, with the second prototype using both the new construction techniques and the new electronics. In early 1980 the British Ministry of Defence placed an order for forty production Mk4 aircraft. In early 1981 the first prototype, cyphered N11-800, was completed and delivered to the Royal Australian Navy's Jervis Bay Jindivik facility for testing. The flight tests, which consisted of about sixteen sorties, were completed in early July, 1981. The new Jindivik has all the previously "optional" electronics packages as standard equipment, and is, therefore, common to both the RAN and the UK RAE, unlike the RAN Mk3B (203B) which differed from the British Mk3B (103B). The second prototype is expected to be completed in early 1982. Both types are to be designated Mk4 and numbered N11-800 and -801, whilst the forty production aircraft, numbered A92-802 to -841, will be designated Mk4A. The first of the batch is expected to be delivered in early 1983, and with a production rate of only about one per month planned, the first Mk4A order will be completed in mid-1986. The final cost-saving achieved was in the vicinity of 15 per cent — and the price of Jindivik? Well, it's roughly \$½m.

After the success of the Mk 2, it was decided to produce a new Jindivik variant Mk 2B which was to be fitted with a new version of the Viper, the ASV8, and to assist in the development program, three Mk 2 aircraft were re-built with a new fibreglass canopy with a pitot type intake replacing the metal submerged entry intake of the standard Mk 2. These three aircraft, which retained their original ASV3 engines, were designated Mk 2A and serialled A92-87, -90, and -111 by the RAAF. Flight evaluation trials were conducted between September, 1958, and May, 1959. In addition to the layout change with the new canopy, slightly drooping flaps were incorporated to improve high altitude performance, and optional wing extensions and Mk 4 camera pods became available. The wing extensions boosted the maximum operating altitude from 47,000 to 52,000 feet. The first Mk 2A flew in September, 1958.

The first Mk 2B, fitted with the new 1750 lb thrust ASV8, flew in October, 1959, and was very similar in layout to the 2A, but had a re-designed rear fuselage to accept the increased diameter ASV8 jetpipe. The Mk 2Bs were always flown with the Mk 4 camera pods fitted to the wing tips, and bolt-on wing tip extensions could increase the wing area by 35 per cent. 76 Mk 2Bs were produced for WRE and the UK Ministry of Supply.

In late 1960, the first of nine Mk 3 Jindiviks was delivered to the RAAF at Woomera to assist in the development of a Mk 3A version. The Mk 3s were basically Mk 2B airframes fitted with a 2500 lb st ASV11 Viper. The Mk 3A was called for after a new requirement arose for the Jindivik to fly at an altitude of 60,000 ft. The 3A, which first flew on November 10, 1961, actually achieved a ceiling of 67,000 feet with an exceptional rate of climb of 16,000 ft/min. At this stage in Jindivik development, Mach numbers of 0.86 were being achieved at 40,000 ft. 40 and 80 inch wing tip extensions were available for the Mk 3A.

147 Mk 3A Jindiviks were produced during the 1960s, 64 of which were exported to the UK (as Mk 103A), 42 to the US Navy (as Mk 303A), and the remainder were delivered to the RAN (10 Mk 203s) and WRE (31 Mk 3As). The US Navy operated the 3As from 1962 to 1964 and from 1966 to 1967. Some US missile trials with Jindivik involved air-to-air test firing from Phantoms. A high malfunction loss rate was experienced by the Americans, and after trials were complete in 1967, only one US Jindivik remained in air-worthy condition.

When the need arose for the Jindivik to operate at low level at speeds close to 500 kts EAS, the GAF design team revised the 3A version to produce the current Mk 3B version. The Mk 3B is virtually identical to the 3A externally, but incorporates a number of internal modifications designed to increase the control effectivity at low level. The changes include more powerful servo motors for elevator and aileron activation, and some aerodynamic changes. The engine became known as the Rolls Royce Viper Mk 201. Radio and telemetry equipment was also improved.

The resulting aircraft is an outstanding performer, with a maximum limiting Mach No of 0.86 from 6000 to 50,000 feet and $M=0.72$ at 65,000 feet. Its ceiling is 67,000 feet, and at altitudes up to 60,000 ft the 3B can perform 60° bank turns. In low level operation the 3B can fly at 500 kts EAS at 50 feet! Small Mk 5 camera pods or the huge 12 ft long Mk 8 camera/fuel luneberg lens pods can be fitted to the wings for miss distance calibration. It is believed that 127 Mk 3Bs have been delivered to the RAN and UK, and a further forty are still on order.

The RAN has been operating Jindiviks from the Jervis Bay Missile Range since 1967.

The loss rate due to malfunction of the Jindivik is surprisingly low, although initially this was not the case. Over the period 1952 to 1960, about one Jindivik in 10 was lost due to malfunction. Today, this figure stands at one in 85. One Jindivik at Woomera survived for ten years to complete 285 missions before being shot down. WRE Jindiviks have been given the cypher A92 by the RAAF, and all aircraft operated from Woomera before the test facility closed down in 197 were

numbered A92-11. All RAF Jindiviks delivered to the UK were also given RAAF A92 numbers. RAN aircraft were serialled with the N11 prefix.

The Jindivik has not always been used purely as a target or target tug. In 1972 it was announced that WRE would work in collaboration with the United States Air Force to produce a Bell Aerospace Air Cushion Landing System (ACLS) for the Jindivik. Two prototype Jindiviks were tested at Woomera, and although they contributed to ACLS know-how, the system was never incorporated in production line aircraft.

The Jindivik is not yet approaching its twilight days, and is still a snappy performer. A further updated Mk 4 Jindivik is now being finalised at GAF. The basic soundness of the design is evident by the better and wider performance ranges which have been achieved again and again over almost thirty years of operation. The Jindivik is truly the best.



JINDIVIK PERFORMANCE

MK 3B VERSION

WING SPANS —

- A. Basic with Mk 8 Pods: 20 ft 9 in (6.33 m)
- B. 40" Ext with Mk 8 Pods: 26 ft 6 in (8.16 m)
- C. 80" Ext with Mk 5 Pods: 32 ft 1 in (9.79 m)

LENGTH

26 ft 9 in (8.16 m)

MAX SPEED — TAS:

- A 540 Kts at 3000 ft
- B 490 Kts at altitude
- C 470 Kts at altitude

Mach No:

- A $M=0.86$
- B $M=0.86$
- C $M=0.82$

CEILING —

- A 54,000 ft
- B 61,000 ft
- C 67,000 ft

ENDURANCE —

Max time on station:

- A 98 mins
- B 112 mins
- C 63 mins

RANGE —

- A 670 nm
- B 900 nm
- C 700 nm

MAX ALL-UP WEIGHT —

- A 3650 lbs
- B 3650 lbs
- C 3300 lbs

PAYLOAD —

- A 550 lbs
- B 400 lbs
- C 400 lbs

MAX BANK ANGLE — 60°

MAX DIVE ANGLE — 40°

MAX "g" PULL-UP AT 50 ft — A 4.5 g

TAKE-OFF DISTANCE — Trolley 3000 ft

LANDING DISTANCE — Skid 2500 ft

TOW CABLE LENGTH — 50 to 500 ft.

POWER PLANT

Rolls Royce (Bristol Siddeley) Mk 201 of 2750 lb st with
relight facility.

FUEL — Normal: JP1, JP4, Alternative: JP5

OPERATING THE JINDIVIK

A normal airstrip is used for take-off. The aircraft is mounted on trolley having a gyro steered nose-wheel and is automatically released at a speed of 120 knots. As the aircraft accelerates to 130 knots, the flaps retract and the aircraft sets itself in a steady climbing attitude. The trolley is braked to a stop 3000ft from its starting point.

Although Jindivik may be directed from a shepherd aircraft, it is normally controlled from a ground station. It is operated by a skipper who "pilots" the aircraft once it is airborne and a navigator to track the flight pattern. A pilot beside the strip has control for take-off, and for landing is assisted by a batsman stationed at the end of the strip who maintains the correct heading.

Jindivik carries a variety of special equipment to enable it to simulate the radar echoing properties and infra-red radiation characteristics of very large aircraft. To provide realistic weapon engagement conditions, electronic counter-measuring equipment may be fitted and the target made to execute intricate evasive manoeuvres. Cameras fitted at the wing tips film the missile approach and accurately calibrate and assess the behaviour of the missile.

Jindivik is powered by a Bristol Siddeley Viper ASV11 engine of 2500lb thrust. The basic version has a take-off weight of 3200lb and a wing span of 19ft. Two sizes of wing extension panels are available which increase this span to 32ft and enable it to operate at altitudes up to 68,000ft.

Jindivik flies at Mach numbers of up to almost 0.90 and a fuel capacity of 130 imperial gallons allows flights of up to 140 minutes duration.

The remote control system is effective at ranges beyond 100 nautical miles from the ground station. Push button selection allows the automatic pilot to provide aileron, elevator and engine rpm conditions for fixed climb, level flight, turning and descending conditions. Intermediate altitudes or engine conditions, adjusted by "beep" control,

allow the aircraft to operate any flight pattern desired. The Telemetry system provides the ground controller with continuous indications of altitude, speed, climb, engine rpm and other information.

By fitting a radio altimeter, Jindivik can be made to simulate the threat of very low flying aircraft and fly at high speeds at altitudes as low as 50ft. Equipment and techniques have been developed to enable two Jindiviks to fly as a closely formed pair, station keeping accuracy being maintained to within a few feet.

In weapon trials it is often desirable for the weapon to home not on Jindivik itself, but on an auxiliary target towed from Jindivik. A variety of such tows, augmented to enhance radar or infra-red characteristics have been developed in Australia. In particular "Tonic" has been designed to stream below Jindivik either as a single tow or as dual tows. These tows are winched back to Jindivik and recovered after the weapon exercise is complete.

Jindivik returns and lands at its base airstrip. When "land glide" is selected, the flaps and shock absorbing skid undercarriage are lowered and the aircraft is controlled to a conventional approach. On touch down the fuel supply to the engine is cut and the flaps are automatically retracted to keep the aircraft on the runway. The aircraft maintains a steady course and normally comes to a halt 1500ft after touch down.

It is important in weapon trials for the target to be available as readily as instrumentation and other range facilities. Although Jindivik is a low cost expendable aeroplane it can be maintained at a peak of serviceability with minimum effort. A single lock nut fitted over the pitot tube releases the nose canopy to provide ready access to all control equipments, and a panel on the fuselage side permits all necessary adjustment of the engine controls. Release of three bolts separates the rear fuselage to expose all systems in the centre fuselage and the accessories mounted on the engine.

