Appendix 10C

SAAF main equipment

Platforms

Fighters

Saab JAS[1]39C & D Gripen[2]	
Type:	Multi/swing-role fighter & two-seat conversion trainer. Single seat: C; two-seater: D-model.
Country of origin:	Sweden.
First flight:	December 9, 1988 for first Swedish variant, November 11, 2005 for the first SAAF JAS39D.
Delivered to the SAAF:	From 2008.
Associated project name(s):	Ukhozi (eagle).
Numbers:	26; 19 single-seat fighters, seven fighter-trainers. Four delivered to SAAF by August 2008.
Cost:	R15 billion for 28[3]. R20 billion for 26[4].
Crew:	1 pilot (C-model), pilot, navigator (D-model).
Major dimensions & weights	
• Wingspan:	8.4m.
• Length:	14.1m (C), 14.8m (D).
• Height:	4.5m.
• Wing area:	25.54m2.
• Wheel track:	2.4m
• Wheel base:	5.2m (C), 5.9m (D).
• Basic empty weight:	6.620mt.
• Operational empty weight:	7.4mt (C), 7.7mt (D).
• Max stores weight:	5.3mt.
• Max take-off weight, clean:	8.720mt.
• Max take-off weight, with stores:	14mt.
• Max internal fuel:	2.27mt.
• Max external fuel:	3300 litres in three 1100 litre tanks (one under each wing and centreline.
Performance	
• Take-off to clear 15m:	nn, 400m in fighter configuration.
• Landing from 15m:	nn, requires 500m strip.
• Rate of climb:	Two minutes to 10,060m (33,000ft), three minutes to 14,000m (46,000ft).
• Service ceiling:	15,000m (50,000ft).
• Max operating speed:	Mach 1.9 approx.
• Max low-level speed:	Mach 1.15.
• Max cruise speed:	nn.

[1] JAS: Jakt, Attack & Spaning. Swedish for fighter, attack and reconnaissance, the type's main functions.
[2] Griffin in English: a legendary creature with the head of an eagle and the body of a lion.
[3] According to Beeld newspaper, July 22, 2006.
[4] 2007 Treasury figure.

• Max range at cruise speed:	nn.
• Acceleration:	From Mach 0.5 to Mach 1.1: 30 seconds.
• Combat range:	800km (500 miles) at max load.
• Ferry range:	3000km (with external tanks).
• Stall speed:	nn.
• G-loads:	+9, -3.
• Wing loading:	nn.
• Thrust:	54kN dry, 80kN with afterburner.
• Thrust/weight ratio:	6.2N/kg.
Engine Specifications	
• Make:	Volvo (General Electric).
• Model:	RM12 (a modified F404J).
• Type:	Turbofan (Twin-spool augmented low bypass-ratio) .
• Number:	1.
• Compression ratio:	27.5:1.
• Engine diameter:	0.884m (27.9in) maximum.
• Engine length:	4.04m (159in).
• Dry weight:	1.055mt (2325lbs).
• Bypass ratio:	0.31:1
• Power turbine rotor speed:	nn.
• Shaft horsepower:	nn.
Hard points:	Eight (Centreline, one on starboard wing root, two per wing, one on each wingtip).
Armament:	
Bombs:	120kg HE and 250kg HE ballistic, laser- or global positioning system guided bombs.
Missiles:	MBDA IRIS-T short-range air-to-air missile as interim missile until the production and service acceptance of the Denel Dynamics A-Darter. SAAF still to select a beyond visual range air-to-air missile. (Denel Dynamics is proposing the T-Darter).
Rockets:	FZ70 70mm unguided.
Cannon:	1 x Mauser BK27 27mm cannon.
Other attachments:	
Reconnaissance pod:	Thales Vicon 70.
Laser designator:	Rafael Litening
External fuel tanks:	Three, one under each wing, one on the centreline.
Comment:	Some factoids – Each Gripen contains 30km of wire, about 60,000 parts, 84,000 rivets and 16,000 other fasteners, 40 computers and 450 boxes, valves, etc. Major South African components included are the audio management system and part of the airframe. Swedish components include the remainder of the airframe (with the British), the radar, radome, electronic display system and servos. British parts include the control stick and throttle lever, the escape system (ejection seat), environmental control system, hydraulic system, the telescopic air-to-air refuelling probe, landing gear, wheel brakes and brake control system. The Germans manufacture the cannon and the Americans the air data computer, part of the secondary power system (with the British) and part of the flight control system (with the Swedes. Although Volvo makes the engine, it is to a US design. The fuel system is French.

The turbofan RM12 is equipped with a full authority digital engine control system that optimises the engine cycle and controls the engine condition monitoring system as well as its built-in test system. The control system also includes a number safety functions and a separate hydro-mechanical back-up fuel system to provide high-level single-engine safety. 60% of the engine is built in the US and shipped to Sweden as components. The RM12 differs from the F404J fitted to the F18 in having a Swedish afterburner and a larger fan – generating a larger air inflow and greater power. It is also more resistant to bird strikes.

The radar is the Ericsson Microwave Systems PS-05A.

Some critics have slated the Gripen for a perceived lack of range. Design parameters called for excellent performance and high agility – not long range (the Swedish Flygvapnet has a defensive posture and up to recently did not practice power projection or out-of-area deployments.[5] But a comparison with other single-engine fighters does not particularly embarrass the Gripen. The Dassault Mirage F1 and III could reach 700km. The Lockheed Martin F16C can reach 925km, the Dassault Mirage 2000, with a 1mt load can apparently fly 1480km and the Dassault Rafale will reach 1093km with 12 250kg bombs and four MBDA Mica air-to-air missiles.

Some hay has also been made of the four crashes the type has had since 1989. The first crash was on February 2, 1989 when the first prototype crashed on its sixth landing attempt, apparently after a software glitch in the Lockheed Martin fly-by-wire system. The second crash, involving the same pilot took place on August 8, 1993 during an air show, apparently again after the failure of the fly-by-wire system. In September 1999 a F7 Wing (Såtenäs) Gripen fell into Lake Vänern[6] during an exercise. The pilot ejected safely. In June 2005, a F17 Wing aircraft reportedly ceased to obey the pilot's commands, forcing him to eject. To date over 200 of the type have been built and the fleet has flown over 46,000 hours.

Saab has always been cagey about the cost of the aircraft (the figure above is a wikipedia entry). No corroborating evidence is provided. Saab says the "exact price will depend on the details of the requirement, and in any case is commercially sensitive information. Our price is extremely competitive…" A fact sheet on the aircraft's economy put the development

[5] The design also had to be simpler and cheaper to maintain than the Viggen and easy to turn around to ensure a high combat sortie rate – a factor important to South Africa due to the small size of its fleet. LTG Roelf Beukes, a the most recent retired CAF, during his tenure indicated that the "Gripen's adaptability and active service capability are of great importance to the SAAF. It can operate from military bases or standard roads, serviced by a handful of technicians and auxiliary personnel." The Swedes use a scale of one specialist and five minimally trained conscripts per aircraft. This team can refuel and rearm a Gripen in 10 minutes.

[6] A large lake in south-eastern Sweden, called the "Frog Atlantic by pilots. The Såtenäs base is on its southern shore.

and manufacture cost of the first 200 Gripens at 100 billion Swedish crowns over 25 years, or SEK4 billion a year – or SEK50 million per aircraft. The Swedish Crown has traded at two to the dollar, perhaps corroborating the price of US25 million. Saab says the Swedish National Audit Office, in a 1996 report, found the cost "no more significant or exceptional" compared to any other project of the same size. On the issue of economy, the company says the modern design of the fighter gives lower maintenance and upgrade costs. Its low weight and efficient engine has decreased fuel costs by 50% in comparison to the Saab 37 Viggen. "One reason for these low operational costs is the number of easily replaced modules equipped with built-in sensors, installed on the aircraft, that continuously monitor and indicate when it is time to replace a component. In this way, no component is replaced unnecessarily, which contributes to keeping costs down. Maintenance costs are already 40% lower than those of the (1970-era) Viggen-system." The aircraft's credentials as a light-eight fighter is emphasised by it weighing just 78% of a F16 (empty) and half of a Viggen, Rafale or Boeing F/A18E/F Super Hornet.

In common with the US Boeing F22 Raptor and the Lockheed Martin F35 Joint Strike Fighter, the Gripen was designed to be inherently aerodynamically unstable – a factor that boosts agility and performance. To compensate, the aircraft is fitted with a triple redundant fly-by-wire system with analog back-up. Its large canards improve short-field performance and two small strakes on the nose generate vortices useful to improved flight control at high angles of attack. On landing the canards can almost be tilted 90 degrees to act as landing breaks. The composite materials and small size of the aircraft greatly reduces its radar signature, giving it a fair degree of stealth.

The cockpit is fitted for hands-on-throttle-and-stick flying and features a wide angle head-up display and three full colour LCD screens, served by a sophisticated internal databus system (five MILSTD 1553B data busses) and external datalink. The link, the Tactical Information Datalink System provides the fighter four high-bandwidth two-way datalinks with a range of about 500km and a high resistance to jamming. The link works equally well on the ground as in the air, meaning a pilot on standby can attain a high degree of "situational awareness" before take off. It also allows a Gripen to receive or transmit targeting data to another, to an airborne or ground-based command centre or to other aircraft types fitted with the TILDS. The system also allows aircraft to use their radars to triangulate a target track, or one aircraft to jam a target while others track, engage or sneak up on it. They can also pool their radars to "burn" through enemy jamming… In reconnaissance mode, Gripens can transmit gathered data real-time for interpretation and use.

Much as is the case with the A400M, government has perhaps been less concerned over the choice of aircraft than the

economic value of the choice. Speaking at the roll-out ceremony in Linköping, Sweden, in October 2005, Minister for Public Enterprises Alec Erwin again highlighted the programme's role as a catalyst for broad industrial, trade and economic development in South Africa. Underlining this sentiment, Saab CEO, Åke Svensson, described the significance of the Gripen programme in establishing South Africa as Saab's second home-market. Underpinning its commitment to South Africa, Saab has invested in several businesses, including its major investment in Grintek, the South African advanced technology group. "Saab is now a proudly South African company employing around 1300 of the best technical and marketing brains within Saab Grintek, in which we own a 70% stake" he explained at the time.

A brief note on the Gripen's "fourth generation fighter aircraft" and multi/swing role status: A Saab Q&A fact sheet describes a fourth generation fighter aircraft as an airplane with supersonic performance "that has a digitally designed infrastructure with a fully integrated, computerised system, which utilises a common database with standardised interface. This means that sensors, weapons, control surfaces, displays and so forth, can be used to supply and store data; theoretically, in almost infinite combinations. Using all this, the desired system functions can be created. It is only us humans, and physical laws that are the limitation. Gripen is not only a multi-role aircraft, but also a swing-role aircraft, which means that the Gripen can change roles in flight."

After its November 11, 2005 maiden flight, the SAAF's first Gripen, SA01, flew another 25 hours in the skies around Linköping, Sweden, before being shipped to South Africa where it arrived by sea on July 16, 2006 for a 14-month test programme at the TFDC near Bredasdorp. The programme was completed at the Gripen Flight Test Centre South Africa (GFTC SA) at the TFDC in January 2008. SA01 is a fully instrumented test aircraft and will remain at the TFDC for most of its career. SA02 to SA26 are allocated to 2 Squadron at AFB Makhado.

The Gripen bested the Dassault Mirage 2000/5, the Moscow Aircraft Production Organisation MiG29 and the theoretical DaimlerChrysler Aerospace AT2000 Mako in the race to be the SAAF ALFA. It emerged in July 2005 that the US had offered South Africa a number of "previously owned" F16's in the early1990s. The aircraft on offer was a number of F16A and B's ordered and paid for by Pakistan but embargoed subsequently by the Clinton administration. Defence minister Mosiuoa Lekota said in July 2005 that the deal was not possible at the time because of the US embargo against Armscor and other South African concerns resulting from sanctions busting in the 1980s. Lekota in a written answer to a question posed in the National Assembly by the Freedom Front Plus claimed the aircraft would require upgrades put at US300 million "before they could be put to effective use."

Table 10C.1: The Saab Gripen.

Atlas Cheetah C, D

Type:	Multi-role fighter & two-seat conversion trainer.
Country of origin:	France, South African modifications; Mirage III built under license in SA.
First flight:	May 1985.
Delivered to the SAAF:	From 1986.
Associated project name(s):	Bark, Brahman, Carver, Cushion, Kiemvry, Recipient, Tunny[7]
Numbers:	38 C-models, 16 D-models and 16 E-variants remanufactured from 1983. In 2003 28 C-models and 10 D's remained. In 2005 the total for both types was 29.
Cost:	nn
Crew:	1 pilot (C-model), pilot, navigator (D-model).
Major dimensions & weights (C-model)	
• Wingspan:	8.22m (34.78ft).
• Length:	16.3m.
• Height:	4.5 (13.94ft).
• Wing area:	34.85m2 (380ft2).
• Basic empty weight:	7.26mt.
• Max take-off weight, utility:	13.545mt.
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	1494m/min (3 minutes to 10.975 metres).
• Service ceiling:	17,000m.
• Max operating speed:	Mach 2.2 (2350km/h) @ 10,975m, Mach 1.115 (1368km/h) @ sea level.
• Max cruise speed:	nn.
• Max range at cruise speed:	nn.
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	250kg/m2 (52lb/ft2).
• Thrust:	70.6kN (15,873lbs) with afterburner.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	SNECMA.
• Model:	9K50.
• Type:	Turbojet.
• Number:	1.
• Compression ratio:	6.5.
• Engine diameter:	1m.
• Engine length:	5.9m.
• Dry weight:	1.582mt.
• Power turbine rotor speed:	nn.

[7] Dave Becker, Cheetah Farewell, SA Flyer, May 2008, p40.

• Shaft horsepower:	nn.
Hard points:	7 (Centreline, one per wing root, two per wing).
Armament:	
Bombs:	120kg HE and 250kg HE ballistic, laser- or global positioning system guided bombs.
Missiles:	V4 (Denel R-Darter) electromagnetic-guided beyond visual range air-to-air missile, V3D (Denel U-Darter) Infrared-guided short-range air-to-air missile.
Rockets:	FZ70 70mm unguided.
Cannon:	2 x 30mm DEFA.
Other attachments:	
Reconnaissance pod:	Vinton Vicon 600E
External fuel tanks:	1 x centre line tank (800 litres), 2 x 600 litre tanks, 2 x 1300 litre tanks or 2 x 1700 litre tanks.
Comment:	The Cheetah is essentially a remanufactured and upgraded Dassault Mirage III. South African airframes were used for the D and E range and Israeli airframes for the C-model. The first aircraft to be converted was a Mirage III D2Z (airframe number 845) from April 1983. It is not known publicly when its conversion was completed, but when the type was officially unveiled to the public on July 16, 1986, the type was already in service with 89 Combat Flying School, although it was only declared operational the next year. In order to bring the airframes back to "zero hours" flown, some 50% of components were replaced. Non-moving canards were added just aft of the air intake, as were more hard points, a aerial refueling probe, a new ejection chair and the 9K50 engine. Also fitted was a new main wingspar, a "drooping" leading edge and a dog-tooth incision on each main wing. Improvements were also made to the avionics, radar, electronic warfare and self-protection systems, including a modern pulse doppler radar. This is used in conjunction with a digital navigation attack system and HOTAS (hands on throttle and stick). Ten aircraft have since been upgraded to fire beyond visual range missiles and two to drop laser-guided bombs. Tactical reconnaissance is limited to day operations only. The type was phased out in April 2008, well ahead of the planned date of 2012, because of cost cuts.

Table 10C.2: The Atlas Cheetah.

BAE Systems Hawk Mk120

Type:	Lead-in fighter trainer and light fighter, fighter-attack and reconnaissance aircraft.
Country of origin:	United Kingdom.

First flight:	August 21, 1974.
Delivered to the SAAF:	First two (numbers 251[8] and 252) delivered on May 24, 2006. Two delivered per week thereafter until 10 handed over to the SAAF. The remainder to be delivered by end August 2008, a delay on the mid-2007 figure previously given.
Associated project name(s):	Winchester.
Numbers:	24 (23 assembled in SA, one in UK).
Cost:	R4.7 billion[9] (R15.772 billion in real 1999 Rand: 24 Hawk and 28 Gripen, no separate costing published by government). Jane's International Defence Review in 2006 put the cost at US620 million. R7.2 billion[10].
Crew:	1 pilot with/without navigator or 1 pilot-instructor with 1 pupil.
Major dimensions & weights	
• Wingspan:	9.94m (32ft 7in).
• Length:	12.43m (40ft 9in).
• Height:	3.98m (13ft 1in).
• Wing area:	16.7m2 (179.64ft).
• Basic empty weight:	4.4mt (9700 lbs).
• Max take-off weight:	9.1mt (20,062lbs).
• Max internal fuel:	1.304mt (2875lbs).
• Max external fuel (2x591 litre tanks):	932kg (2055lbs).
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	3597m/min.
• Service ceiling:	12,240m (50,000ft).
• Max operating speed:	575 knots (Mach 1.2, 1063km/h).
• Max cruise speed:	nn.
• Max range at cruise speed:	3094km (1923 miles).
• Combat radius:	998km with a 2.268mt war load.
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	6500lbs
• Bypass ratio:	0.8
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Rolls Royce/Turbomeca
• Model:	Adour Mk951
• Type:	Turbofan.
• Number:	1.
• Compression ratio:	12.2.
• Engine diameter:	22.7inches.
• Engine length:	77 inches.
• Dry weight:	1345lbs.
• Power turbine rotor speed:	nn.

[8] Number 250 is the test platform. See below.
[9] According to the German Flug Revue magazine, November 1998 (British Aerospace Hawk LIFT, www.flug-revue.rotor.com/FRTypen/FRHawkLi/htm, accessed on December 29, 2005 last updated November 24, 1998.
[10] 2007 Treasury figure.

• Shaft horsepower:	nn.
Hard points:	7 (Centreline, two under each wing, wingtip), maximum load 3.085mt.
Armament:	
• Bombs:	120kg HE and 250kg HE ballistic bombs
• Missiles:	V3D (Denel U-Darter) Infrared-guided short-range air-to-air missile likely.
• Rockets:	FZ70 70mm unguided.
• Cannon:	Pod on centreline.
Other attachments:	
Reconnaissance pod:	Can be fitted.
External fuel tanks:	2 x 591 litre tanks.
Manufacturers:	
• Fuselage:	BAE Systems
• Wings:	BAE Systems
• Engine:	Rolls Royce
• Tailplane:	Denel
• Air brake:	Denel
• Flaps:	Denel
• Avionics & navigation suite:	Advanced Technologies & Engineering
• Radios:	Reutech Defence Industries
• Electronic warfare:	Saab (formerly Grintek) Avitronics
• Identification Friend or Foe:	Tellumat
• Health & Usage Management Systems:	Aerospace Monitoring Systems
• Flight data recorders:	Aerospace Monitoring Systems
• Cockpit voice recorders:	Aerospace Monitoring Systems
• Flight Test Support:	Denel Overberg Test Range
Comment:	Part of the Strategic Defence Package, the Hawk Mk120 LIFT was selected over the Czech Aero Vodochody L39/59/139, the German/US Dasa/Boeing Ranger 2000, the Italian Aermacchi MB339 and the Russian MAPO MiG-AT and Russo-Italian Aermacchi/Yakovlev YAK130. The basic design dates to 1968 when the then-Hawker-Siddeley aircraft company was asked to propose a successor to the Folland Gnat. The design, innovative for its time, was named the Hawk in 1973 and flew in 1974. It entered RAF service in 1976. The Hawk Mk120 LIFT and other "second generation" Hawks (Mks 127 and 128) only have 10% commonality with the original and feature new wings, forward and centre fuselage, fin and tailplane. The new variants are also said to have four times the fatigue life of the original aircraft. The South African purchase includes ground based training systems, mission planning and ground support systems, logistical support equipment and in-country support. All 24 LIFTs are dual seat aircraft. They will be optimised for fast-jet training as well as weapon-delivery instruction. The normal operating speed in SAAF service will probably be 400 knots in a typical training configuration. The Hawk enjoys an exceptionally low maintenance requirement (in 1995 the lowest per flight hour of any jet aircraft in the world) as well as a remarkably low accident rate and outstanding fuel.

Besides modernising the SAAF's jet trainer capability, the Hawk has also been portrayed as a catalyst for "the reorientation and significant rejuvenation of South Africa's aerospace and defence industry"[11], with several local partners participating as sub-contractors and suppliers to the programme under the Defence Industrial Participation programme emanating from South Africa's Hawk, Gripen and other defence system acquisitions.

"BAE Systems is thrilled that the Hawk should be the first jet aircraft to be built in the democratic South Africa. These aircraft represent the labours, capacity and expertise of a new generation of South Africans across industry and government with whom we have enjoyed several years of close collaboration. With Hawk, the training of South Africa's future fighter pilots is in safe hands and we look forward to supporting the SA Air Force as it operates the aircraft," said Mike Rennardson, the Project Director, Hawk South Africa at BAE Systems at the handover ceremony of the first two aircraft on May 24, 2006.

"With the exception of South Africa's initial Hawk (SA 250) flight test and development aircraft[12], which was built in the United Kingdom, all of its other Hawks were assembled at Denel's aircraft factory at Johannesburg International Airport in Kempton Park near Johannesburg," the PR added.[13] "Under a reciprocal industrial participation agreement, Denel has become the exclusive manufacturer of tailplanes, airbrakes and flaps for the Hawk programme, with these components already being incorporated onto aircraft operated by or being built for South Africa, India, Bahrain and the UK's Royal Air Force."

"South African systems integrator, Advanced Technologies & Engineering (ATE), has been responsible for the design, development and integration of the Hawk's combat avionics and navigation suite [aka a navigation and weapons system, NWS], ensuring that the cockpits and systems on South Africa's Hawks closely resemble those which student fighter pilots will work with when they operate the Gripen fighter. This ability to customise the cockpits and systems to match those of various front-line fighters is a feature unique to Hawk and a major factor in its selection as the trainer of choice by 19 customers worldwide," the PR expanded. The NWS was developed under a R500 million (USD73 million) prime avionics subcontract from BAE Systems, the first time that the latter has placed such a contract with a foreign company. Rennardson said the order, when placed in April 2000, was the

[11] BAE Systems News Release, BAE Systems Delivers First Hawk Mk120 Lead-In Fighter Trainers To South Africa, Ref SA 1/05/06, May 24, 2005.
[12] A fully instrumented test aircraft that will spend its life at the SAAF's Test Flight and Development Centre in the southern Cape, near Bredasdorp.
[13] Ditto.

"biggest ever contract placed on a South African private sector aerospace firm." ATE has some previous experience in this field, having developed the avionics for the Rooivalk attack helicopter, the Pilatus Astra primary trainer and the NWS and mission computer for the Spanish Air Force's Mirage F-1 upgrade. The company also modernised a number of Algerian Air Force Mi-24 attack helicopters. ATE's NWS is a fully configurable "glass cockpit" integrated with an advanced navigation and mission computer system and an `intelligent' stores management and weapons-delivery system.

The delivery of the aircraft was scheduled for April but was apparently delayed, according to two independent and authoritative sources, due to software problems. An eight-strong team from BAE Systems was deployed to solve the problem. As a result, the release of ATE's NWS Operational Clearance Software Standard 2 (OC2) only took place in September. The release made the Hawk fully operational for fighter-pilot training. Final operational clearance is planned for mid-2007 ad will allow the aircraft to drop ordnance. OC1 was released in June 2006 and allowed the commencement of flight operations on the 5th of that month. An earlier programme delay was the result of the Adour engine failing its first encounter with a bird *circa* October 2005.

The September 2006 International Defence Review (IDR) noted that the NWS Stores Management Unit was to be certified to RTCA 178B Level A and the overall operational flight programme and individual hardware items such as the mission computers, displays and audio-management unit to Level B[14]. "A particular feature of the Hawk Mk 120 NWS is its radar-simulation function," the IDR said. "This approach was selected as the most cost-effective way to provide in-flight radar training, which is vastly cheaper than installing and maintaining a suitable radar in the LIFT or conducting that training on the Gripen itself. The radar simulation will be used to give future Gripen pilots their initial training in the use of radar in air-to-air combat, and has been designed to give the trainees a close approximation of the capabilities and data that will be provided in that role by the Gripen's actual Ericsson PS-05/A radar," the IDR added.

ATE explains that the radar simulation air-to-air target generation has two modes: Virtual formations can be generated within the system itself and simulated as radar targets. This function allows for single-aircraft radar simulation exercises. Secondly, up to eight co-operating aircraft can acquire each other as radar targets through Link ZA, a digital network protocol that uses one of the Hawk's three Reutech Defence Industries ACR500 U/VHF radios. Link ZA ensures that every aircraft continuously transfers

[14] Helmoed-Römer Heitman, Jane's International Defence Review, Hawk software release will open flight path for South African Air Force's Gripen training, September 2006, p24, as reprinted at www.saairforce.co.za

positional data to every other. This data is then processed by the mission computer on the co-operating aircraft in the network to render a real-time radar page. Displayable on any of the six multi-function displays (MFDs) in the LIFT's tandem glass cockpit, the radar page provides the pilot with radar target information, as if the aircraft were fitted with a real fire control radar system.

Link ZA was developed by Thales Advanced Engineering[15], a South African company that should not be confused with Thales, the notorious French multinational. The IDR notes data transmission is by way of one of three RDI V/UHF ACR 500 radios installed in each Hawk and is managed by an ATE-developed audio-management system.

The British publication further adds that the *ersatz*[16] radar uses a range-while-scan format as primary mode and a single target track of the highest priority target as a secondary mode. "The pilot can also select up to five priority targets," the IDR said. "The display will provide action volumes for both an intercept missile and a self-defence missile. Radar targets may also be acquired by searching the HUD [head-up display] field of view, with four radar combat modes available: HUD Search, HUD Slewable Box, HUD Boresight and HUD Vertical Scan."

The Radar Simulation System was tested at the SAAF's Test Flight Development Centre, located near Bredasdorp in the Western Cape in early 2006. Initial results indicated that the system was extremely stable up to ranges well outside the required specification. "The test pilot stated that the tracked radar targets were displayed with acceptable accuracy in the HUD," ATE said in a report on the February flight tests. "The RF data-link was tested down to ranges of 200 meters and performed extremely well at close range. All parties involved in the flight-testing were extremely impressed with the performance of the radar simulation, in particular BAE Systems the prime contractor, who stated that the LIFT Radar Simulation System surpassed all existing radar simulations systems in performance and function in existence on their aircraft."

The primary objective of the February flight tests was to check the stability and robustness of the RF datalink between two networked aircraft. Flight-testing included monitoring the RF datalink stability for non-manoeuvring aircraft and for manoeuvring aircraft.

"The navigation element of the NWS combines a laser-gyro inertial navigation system with a GPS unit to achieve an optimal mix of accuracy (GPS) and continuity (INS)," the IDR

[15] The company has since changed its name to Protoclea and sold the division that developed Link ZA to Saab Grintek.
[16] *Ersatz* – German, meaning "replacement", not "instant" as often stated.

added. “It provides the pilot with steering, time and fuel guidance. That can be in relation to a pre-planned mission downloaded by means of a portable data store, in relation to routes planned in flight or in relation to points selected by the pilot. The portable data store can also be used for post-mission avionic data downloading for debriefing and analysis purposes. The NWS includes an integral photo-reconnaissance function.

The ATE stores-management system has been fully certified as safety-critical to international standards, the IDR added. “It provides armament management and control for both air-to-air and air-to-ground operations.” The IDR notes it has been developed to RTCA Level A standard and will be certified as such.

The Hawk features a Saab Avitronics electronic-warfare system, comprising a radar-warning receiver (RWR) and a countermeasures dispenser subsystem. “It has been developed on the basis of the multisensor system developed for the SAAF's fighters, and can later be expanded or upgraded if that is required,” the IDR added. The communications system is fully redundant with three ACR 500 radios, as previously noted, and can be used for voice and data communications and relay, “telebriefing” and as hardware host for Link ZA. “The audio-management system also provides an intercom function, the ground-crew interface and various caution and warning functions, and manages aspects of the radio navigation function (TACAN, VOR, ILS),” the IDR said.

Other system elements include:
• a Selex Sensor and Airborne Systems forward-looking infrared (FLIR) system, incorporating a camera developed jointly with Denel;|
• a laser rangefinder;
• a Tellumat PT-2000 IFF (identification friend-or-foe)/Mode S transponder and crypto unit;
• crew actions, flight parameters, events and configuration logging;
• time-stamped HUD video and cockpit audio and voice recording;
• system status monitoring providing real-time recording of system failures and of avionics and aircraft system events, which can be displayed on an MFD and recorded for later retrieval. Both this health and usage monitoring system (HUMS) and the cockpit voice recorders were developed by Aerospace Monitoring Systems (AMS), now part of Saab Grintek.
“The integrated avionics are managed by dual-redundant mission computers developed by ATE, and the system runs on a dual-redundant MIL-STD-1553 databus,” the IDR explained.

The AMS-designed cockpit voice recorders, flight data recorders and HUMS are offered as standard on all new

	Hawks. They are already fitted to the Australian Hawk fleet and those operated by the NATO Flight Training Centre in Canada. Gripen and Hawk pilots will be trained at a Centralised Training Centre (CTC) at AFB Makhado also established under Project Winchester and handed over to the SAAF in late 2005.[17] "As the *'Fighter Centre of Excellence'* of the SA Air Force, it is appropriate that Makhado Air Force Base provides the teaching and learning environment to match the intricacies of the aircraft systems," the SA Soldier enthused in its November 2005 edition. In keeping with the latest pedagogic principles, the CTC provides a comprehensive computer based instruction system (CBIS) and a Virtual Aircraft Training System (VATS) for ground and aircrews at 85 Combat Flying School. "While the CBIS provides basic and advanced knowledge of aircraft systems for aircrew using instructor lead and self-paced learning strategies, an Integrated Training Management System (ITMS) manages student activities and provides access to student records," SA Soldier added. "…VATS provides students with the capability to practice the operation, maintenance and diagnosis of faults in complex aircraft systems," SA Soldier continued. "The training device responds in exactly the same manner as the real aircraft in normal and fault modes, allowing for the free-flow execution of maintenance procedures and fault diagnostic training. VATS is designed to reinforce and consolidate the knowledge gained through the CBIS courses by facilitating the 'practical' experience of interacting with the aircraft and its systems in a benign, glass screen environment. The VATS courseware is accessed through the same high-resolution twin-screen units of the CBIS classrooms, the student interacting via mouse and stick and throttle units.[18]" The Operational Flight Trainer soft- and hardware was developed by BAE Systems Australia and installed by Thoroughtec. Pilots have to fly the Hawk about 430 hours and pass a number of courses before graduating to the Saab Gripen, the advanced fighter the SAAF will receive from 2008.

Table 10C.3: The BAE Systems Hawk.

Air Transport & Maritime

Boeing B707-320C

Type:	Strategic transport, in-flight refueller, electronic warfare platform.

[17] Flight Sgt H. Denkewitz, New facilities for the Hawk and Gripen, SA Soldier, November 2005.
[18] Ditto

Country of origin:	United States.
First flight:	1954.
Delivered to the SAAF:	1987.
Numbers:	5 delivered, three still on strength, one flying in early 2006. At year end all were believed grounded.
Associated project name(s):	nn.
Cost:	nn.
Crew:	3 cockpit crew.
Major dimensions & weights	
• Wingspan:	44.42m (145ft 9in).
• Length:	46.61m (152ft 11in).
• Height:	12.93m.
• Wing area:	nn.
• Basic empty weight:	66.406mt (146,400lbs).
• Max take-off weight:	151.320mt (333,600lbs).
• Max landing weight:	112.040mt (247,000lbs).
• Max internal fuel:	90,300 litres.
• Max external fuel:	nn.
• Main deck useable volume:	162m3
• Bulk volume:	50.5m3
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	nn.
• Service ceiling:	15,240m (50,000ft).
• Max operating speed:	nn.
• Max cruise speed:	550 mph (886 km/h).
• Max range at cruise speed:	5,755 miles (9 265 km).
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	84.4kN (19,000lbs) per engine.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Pratt & Whitney.
• Model:	JT3D-7.
• Type:	Turbofan.
• Number:	4.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	nn.
Hard points:	none.
Armament:	none.
Other attachments:	Refuelling pods: one under each wing and rear fuselage.
Comment:	

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Acquired in the late 1980s to give the Mirage strike fighter fleet strategic range through air-to-air

	refuelling. No longer used as an EW platform due to the obsolescence of the EW equipment. Currently mostly used as a transport. Likely to be phased out after 2010 in favour of the Airbus Military A400M. In the period April 2004 to March 2005 the B707 flew 891 hours.

Description:

The aquisition of three Boeing 707's in March 1982 was the result of a ten year project undertaken to provide the SAAF with a dedicated air-to-air refuelling capability and it fell upon 60 Squadron to undertake this responsibility when the unit was reformed at AFB Waterkloof on 16 July 1986. The fleet grew to five aircraft with the acquisition of two more Boeings in 1990 and 1992 respectively. An electronic warfare and early warning capability was added to the unit's primary responsibility.

The squadron provided a highly effective force multiplier to the Buccaneers of 24 Squadron, 1 Squadron's Mirage F1AZ's, Cheetah E's of 5 squadron and continued to do so for 2 Squadron's Cheetah C and D variants.

With the reduction of a potential threat against South Africa, 60 Squadrons duties were expanded to include both a transport and a humanitarian role. In recent times the Boeing 707's of 60 Squadron have become well known to South African troops on peace support missions in Africa. The boeing's range has also made it effective in patrolling South Africa's maritime resources with flights as far south as Marion Island and Antartica. The squadron's contribution was rewarded with the awarding of it's Colours during a parade at AFB Waterkloof on 7 October 1994.

The Squadron were active ambassadors flying the South African flag across the world. During 1995 the unit displayed a Boeing 707 at the IAT RAF Fairford in the United Kingdom with huge success. Other visits abroad included the mission in July 1994 to fetch the crew of Shackleton 1716 that went down in North West Africa, visits to Moscow in 1995, Rio de Janeiro in 1996, Haiti in 2004 and the United Kingdom in 1996 and 1999. In 2001 and 2002 the squadron provided support to the German Tornado deployments to TFDC Overberg from Ongolstadt, Manching in Germany. During 2006 the squadron was involved in the Gripen development programme with a 707 flying to Sweden to conduct in-flight refuelling trials.

Operations wound down with the last operational Boeing 707 flight flown on 10 july 2007 to Bujumbura, Kinshasa and Kindu. Aircraft 1415 was flown to AFB Makhado on 3 October 2007 and 1419 was flown to the SAAF Museum, Swartkop, on 2 November 2007.

Source: SAAF Museum

Table 10C.4: The Boeing 707.

B737-7ED (BBJ)

Type:	VIP transport.
Country of origin:	United States.
First flight:	Late 1998.
Delivered to the SAAF:	June 26, 2001.
Associated project name(s):	nn.
Numbers:	1.
Cost:	US37.5 million for the aircraft, US13.5 million for the fittings, translating to about R500 million, plus R82 million value added tax. Estimated operating cost for first three years: R12 million R98 million budgeted for pilot training, spares and support equipment.[19]
Crew:	2 cockpit crew.
Major dimensions & weights	
• Wingspan:	34.3m.
• Length:	33.6m.
• Height:	12.6m.
• Wing area:	.
• Basic empty weight:	43.082mt (94,980lbs).
• Max take-off weight:	77.565mt (171,000lbs).
• Max landing weight:	.
• Max internal fuel:	.
• Max external fuel:	.
• Main deck useable volume:	
• Bulk volume:	
• Passengers:	Up to 18.
Performance	
• Take-off to clear 15m:	.
• Landing from 15m:	.
• Rate of climb:	
• Service ceiling:	.
• Cruising altitude:	41,000ft.
• Max operating speed:	.
• Max cruise speed:	Mach 0.8 (870km/h).
• Max range at cruise speed:	11,480km with fitted auxiliary tanks.
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	27,000lbs.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	CFM (Jointly owned by General Electric of the US and SNECMA of France.
• Model:	CFM56-7B3.

[19] INet-Bridge, Presidential Jet costs detailed, October 18, 2002.

• Type:	Turbofan.
• Number:	4.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	nn.
Hard points:	none.
Armament:	none.
Other attachments:	none.
Comment:	Based on the Boeing 737-700, the SAAF's BBJ is named the Inkwazi (Fish Eagle) and is registered as ZS-RSA. It is primarily used to transport President Thabo Mbeki and his entourage. The government has maintained that Mbeki cannot fly long distance commercial flights for safety reasons, which have never been further articulated. Reports at the time of its delivery contrasted these concerns with the travel arrangements of several other heads of state, who did use public transport. The government also said the existing VIP fleet were too short in endurance to carry Mbeki in a single bound to Europe, Asia or the Americas, a technical deficiency that had protocol implications when they landed somewhere to refuel.

Table 10C.5: The Boeing BBJ.

Casa C212 Aviocar

Type:	Light/tactical transport.
Country of origin:	Spain.
First flight:	March 26, 1971.
Delivered to the SAAF:	April 1994.
Associated project name(s):	nn.
Numbers:	4.
Cost:	nn.
Crew:	Pilot, co-pilot, Flight engineer/loadmaster.
Major dimensions & weights	
• Wingspan:	20.28m (66ft 7in).
• Length:	16.15m (53ft).
• Height:	6.6m (21ft 8in) at tail.
• Wing area:	41m2 (441.33ft2).
• Cabin length:	5m (16ft 5in).
• Cabin width:	2m (6ft 6.5in).
• Cabin height:	1.7m (5ft 7in).
• Basic empty weight:	3.780mt (8333lbs).
• Max take-off weight:	7.700mt (16,975lbs).
• Max landing weight:	nn.
• Max internal fuel:	nn.
• Max external fuel:	nn.
• Max cargo weight:	2mt

• Main deck useable volume:	nn.
• Bulk volume:	nn.
• Passengers:	18 passengers with luggage, 16 parachutists with kit, 12 stretchers.
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	497m/min (1630ft/min) initial.
• Service ceiling:	7925m (26,000ft).
• Max operating speed:	191kts (354km/h, 220mph) at 3050m (10,000ft).
• Max cruise speed:	275km/h.
• Max range at cruise speed:	835km (519miles) with max payload or 2680km (1665 miles) with max fuel and 1.192mt (2628lbs) load.
• Endurance:	5hrs 40mins.
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Garrett
• Model:	TPE331-10R-513C
• Type:	Turboprop.
• Number:	2.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	900 (671kW) each.
• Propeller:	nn.
Hard points:	none.
Armament:	none.
Other attachments:	none.
Comment:	The Aviocar fleet as inherited in 1994 from the air wings of the former Bophuthatswana (1, 1985), Transkei (2, 1986) and Venda (2, 1988). It is a short-take-off and landing aircraft with a rough field capability, high wings and a fixed landing gear. The C212 was designed as a C47 replacement and has been called a scaled-down C130. The C212 can take off from fields as short as 400m. In the late 1980s the Aviocar was apparently the cheapest certified aircraft in its class.

Table 10C.6: The Casa C212.

Casa/IPTN Airtech CN235

Type:	Medium/tactical transport.
Countries of origin:	Spain & Indonesia

First flight:	November 11, 1983 (Spain).
Delivered to the SAAF:	April 1994.
Numbers:	1.
Associated project name(s):	nn.
Cost:	nn.
Crew:	Pilot, co-pilot, Flight engineer/loadmaster.
Major dimensions & weights	
• Wingspan:	25.81m (70ft 2in).
• Length:	21.40m (84ft 8in).
• Height:	8.18m (26ft 10in) at tail.
• Wing area:	59.10m2 (636.17ft2).
• Cabin length:	21.4m (31ft 8in).
• Cabin height:	1.9m (6ft 3in).
• Cabin width:	2.7m (8ft 11in).
• Basic empty weight:	8.8mt (19,400lbs).
• Max take-off weight:	16.5mt (36,376lbs).
• Max landing weight:	16.5mt (36.376lbs).
• Max internal fuel:	5220 litres (1378 US Gallons).
• Max external fuel:	nn.
• Max cargo weight:	6mt (13,227lbs).
• Main deck useable volume:	nn.
• Bulk volume:	Four 88x108in pallets.
• Passengers:	44 passengers with luggage, 46 parachutists with kit, 24 stretchers.
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	579m/min (1900ft/min).
• Service ceiling:	8110m (26,600ft).
• Max operating speed:	240kts (445km/h, 276mph) at sea level.
• Max cruise speed:	248kts (460km/h, 286mph) at 4570m (15,000ft).
• Max range at cruise speed:	5000km empty, 4355km (2706 miles) with a 3.6mt load, 1500km (932 miles) with max payload.
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Garrett
• Model:	TPE331-10R-513C
• Type:	Turboprop.
• Number:	2.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	1750 (1305kW).
• Propeller:	nn

Hard points:	none.
Armament:	none.
Other attachments:	none.
Comment:	The SAAF inherited its CN235 in 1994 from the Bophuthatswana Defence Force Air Wing, who acquired theirs in 1991. The type originated as a joint venture between Casa of Spain and IPTN of Indonesia, at the time manufacturing Casa 212s under license. The CN235 sports high wings, an unswept rear fuselage with ramp and a retractable tricycle landing gear, with the rear wheels retracting into external fairings to ensure an unrestricted cabin. A maritime patrol version exists that can carry missiles and torpedoes on up to six under-wing hard points. Like the C212, the C235 is a short-take-off and landing aircraft with a rough field capability. It is also said to have excellent low-level flying characteristics for tactical penetration missions. The aircraft is seen as an ideal complement to the C130.

Table 10C.7: The Casa 235.

Cessna 185A, D & E Skywagon (RETIRED NOV 2006)

Type:	Light transport/reconnaissance/liaison.
Country of origin:	United States.
First flight:	nn.
Delivered to the SAAF:	1962.
Associated project name(s):	nn.
Numbers:	13.
Cost:	nn.
Crew:	Pilot.
Major dimensions & weights	
• Wingspan:	11.92m (36ft 2in).
• Length:	7.77m (25 ft 6in).
• Height:	2.29m.
• Wing area:	nn.
• Basic empty weight:	0.769mt (1696 lbs).
• Max take-off weight:	1.451mt (3200lbs).
• Max landing weight:	nn.
• Max internal fuel:	nn.
• Max external fuel:	nn.
• Max cargo weight:	nn.
• Passengers:	5 passengers.
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	nn.
• Service ceiling:	nn.
• Max operating speed:	283km/h.
• Max cruise speed:	274 km/h (170mph) at sea level.
• Max range at cruise speed:	1987km (1235 miles) at sea level.
• Stall speed:	nn.

• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Continental.
• Model:	IO-470-F.
• Type:	Piston, six cylinder.
• Number:	2.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	260.
• Propeller:	nn
Hard points:	none.
Armament:	none.
Other attachments:	none.
Comment:	The SA Army acquired the type between 1962 and 1967 for its air reconnaissance squadrons. The type migrated to the SAAF in 1971.

Table 10C.8: The Cessna Skywagon.

Cessna C208 Caravan

Type:	Light transport
Country of origin:	United States
First flight:	nn.
Delivered to the SAAF:	1988.
Associated project name(s):	nn.
Numbers:	13.
Cost:	nn.
Crew:	Pilot.
Major dimensions & weights	
• Wingspan:	15.9m (52ft 1in)
• Length:	11.46m (37ft 7in)
• Height:	4.5m.
• Wing area:	nn.
• Basic empty weight:	1752kg (3862lbs).
Max take-off weight:	3629kg (8000 lbs).
• Max landing weight:	nn.
• Max internal fuel:	nn.
• Max external fuel:	nn.
• Max cargo weight:	nn.
• Passengers:	13 passengers.
Performance	
• Take-off to clear 15m:	nn.

• Landing from 15m:	nn.
• Rate of climb:	nn.
• Service ceiling:	nn.
• Max operating speed:	350km/h (217mph).
• Max cruise speed:	nn.
• Max range at cruise speed:	1870km (1162 miles) at sea level.
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Pratt & Whitney
• Model:	PT6
• Type:	Turboprop.
• Number:	1.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	600.
• Propeller:	nn
Hard points:	none.
Armament:	none.
Other attachments:	none.
Comment:	The SAAF acquired the type in 1988.

Table 10C.9: The Cessna Caravan.

Cessna C550/1 Citation II

Type:	VIP transport.
Country of origin:	United States.
First flight:	nn.
Delivered to the SAAF:	1983.
Associated project name(s):	nn.
Numbers:	2.
Cost:	nn.
Crew:	Pilot, co-pilot.
Major dimensions & weights	
• Wingspan:	15.89m (52ft 2in).
• Length:	14.38m (47ft 2in).
• Height:	nn.
• Wing area:	nn.
• Basic empty weight:	3.351mt (7388lbs).
• Max take-off weight:	6.395mt (14,000lbs).
• Max landing weight:	nn.
• Max internal fuel:	nn.

• Max external fuel:	nn.
• Max cargo weight:	nn.
• Passengers:	?.
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	nn.
• Service ceiling:	nn.
• Max operating speed:	nn.
• Max cruise speed:	693km/h (431 mph).
• Max range at cruise speed:	2618km (1627 miles).
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	2500lbs.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Pratt & Whitney.
• Model:	JT15D.
• Type:	Turbofan.
• Number:	2.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	nn.
• Propeller:	nn
Hard points:	none.
Armament:	none.
Other attachments:	none.
Comment:	none.

Table 10C.10: The Cessna Citation

Dassault Falcon 50

Type:	VIP transport.
Country of origin:	France.
First flight:	nn.
Delivered to the SAAF:	1982.
Associated project name(s):	nn.
Numbers:	2.
Cost:	nn.
Crew:	Pilot.
Major dimensions & weights	
• Wingspan:	18.86m (61ft 10in)
• Length:	18.52m (60ft 9in)
• Height:	nn.

• Wing area:	nn.
• Basic empty weight:	9.163mt (20,200lbs)
• Max take-off weight:	17.6mt (38,800lbs)
• Max landing weight:	nn.
• Max internal fuel:	nn.
• Max external fuel:	nn.
• Max cargo weight:	nn.
• Passengers:	8.
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	nn.
• Service ceiling:	nn.
• Max operating speed:	nn.
• Max cruise speed:	870 km/h (541mph)
• Max range at cruise speed:	6500km (4039 miles)
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	lbs.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Garrett.
• Model:	TFE 731.
• Type:	Turbofan.
• Number:	3.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	nn.
• Propeller:	nn
Hard points:	none.
Armament:	none.
Other attachments:	none.
Comment:	The SAAF has spent a fair amount of money in recent years upgrading these aircraft. The unofficial SAAF website at www.saairforce.co.za reported in March 2006 that over R62.2 million had been spent with Duncan Aviation Inc of the USA on three contracts to upgrade the two aircraft. The Chief of the Air Force in March 2007[20] described the aircraft "as good as new."

Table 10C.11: The Dassault Falcon 50.

Dassault Falcon 900

[20] CAF briefing, AFB Makhado, March 9, 2007.

Type:	VIP transport.
Country of origin:	France.
First flight:	nn.
Delivered to the SAAF:	1992.
Associated project name(s):	nn.
Numbers:	1.
Cost:	nn.
Crew:	Pilot, co-pilot.
Major dimensions & weights	
Wingspan:	19.33m (63ft 5in).
• Length:	20.21m (66ft 4in).
• Height:	nn.
• Wing area:	nn.
• Basic empty weight:	11.186mt (24,660lbs).
• Max take-off weight:	20.638mt (45,500lbs).
• Max landing weight:	nn.
• Max internal fuel:	nn.
• Max external fuel:	nn.
• Max cargo weight:	nn.
• Passengers:	19.
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	nn.
• Service ceiling:	nn.
• Max operating speed:	nn.
• Max cruise speed:	864 km/h (537mph).
• Max range at cruise speed:	7432km (4618 miles).
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	lbs.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	AlliedSignal.
• Model:	TFE 731-5.
• Type:	Turbofan.
• Number:	3.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	nn.
• Propeller:	nn
Hard points:	none.
Armament:	none.
Other attachments:	none.
Comment:	.

Table 10C.12: The Dassault Falcon 900.

Douglas C47TP

Type:	Medium transport.
Country of origin:	United States.
First flight:	DC3: December 17, 1935, C47: 1940.
Delivered to the SAAF:	DC3: from June 21, 1943; “Turbodak” 1991.
Associated project name(s):	nn.
Numbers:	11.
Cost:	nn.
Crew:	Pilot, co-pilot.
Major dimensions & weights	
• Wingspan:	28.96m (95ft).
• Length:	20.68m (67ft 9in).
• Height:	5.18m (17ft).
• Wing area:	nn.
• Basic empty weight:	7.144mt (15,750lbs).
• Max take-off weight:	13.041mt (28,750lbs).
• Max landing weight:	nn.
• Max internal fuel:	nn.
• Max external fuel:	nn.
• Max cargo weight:	nn.
• Passengers:	34.
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	nn.
• Service ceiling:	7300m (24,000ft).
• Max operating speed:	nn.
• Max cruise speed:	368km/h (229mph).
• Max range at cruise speed:	2810km (1746 miles).
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Pratt & Whitney.
• Model:	PT6A AR.
• Type:	Turboprop.
• Number:	2.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	nn.
• Propeller:	nn
Hard points:	none.

Armament:	none.
Other attachments:	none.
Sensors (AMI Maritime)	Elta M2022 search radar, forward-looking infra-red (FLIR), Sysdel electronic support measures, sonobuoy acoustic processor.
Comment:	The most widely used transport aircraft of World War Two, the DC3/C47 has been in SAAF service since 1943. In the early 1990s several were modernised with, *inter alia* turboprops replacing the piston engines. The conversion has not exactly been a success and only 11 of the aircraft remain in service. At one stage it was joked that pilots were issued raincoats for the leaks and black cats for good luck. In the period April 2004 to March 2005 the C47 fleet flew 1761 hours. The Chief of the Air Force in March 2007[21] said that those assigned to maritime tasks would be given a sensor upgrade.

Table 10C.13: The Douglas C47.

Lockheed Martin C130BZ Hercules

Type:	Medium tactical transport.
Country of origin:	United States.
First flight:	August 23, 1954.
Delivered to the SAAF:	January 1963 (#401-407).
Associated project name(s):	Ebb (21st Century upgrade).
Numbers:	9.
Cost:	US11.9 million (1998 constant dollars) for similar C130E.
Crew:	Pilot, co-pilot, navigator, flight engineer & loadmaster.
Major dimensions & weights	
• Wingspan:	39.7m (132ft 7in).
• Length:	29.78m (about 97ft).
• Height:	11.9m (38ft 10in).
• Wing area:	nn.
• Cabin length:	12.31m (40ft).
• Cabin width:	3.12m (119in).
• Cabin height:	2.74m (9ft)
• Basic empty weight:	35.5mt.
• Max take-off weight:	77.5mt.
• Max landing weight:	nn.
• Max internal fuel:	nn.
• Max external fuel:	nn.
• Max cargo weight:	22.5mt.
• Cargo capacity:	6 pallets
• Passengers:	90 troops, 64 paratroops, 74 stretchers.
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	nn.
• Service ceiling:	9150m.

[21] CAF briefing, AFB Makhado, March 9, 2007.

• Max operating speed:	nn.
• Max cruise speed:	618km/h.
• Max range at cruise speed:	3539km with max payload, 7803km (4850 miles) with max fuel.
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Allison.
• Model:	T56-A-7A.
• Type:	Turboprop.
• Number:	4.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	4200.
• Propeller:	nn
Hard points:	none.
Armament:	none.
Other attachments:	none.
Comment:	The SAAF C130 fleet consists of seven platforms purchased in 1963 before a US arms embargo was imposed on South Africa's apartheid government and five received in 1997/8 from the US (three C130B's ex-USAF; two C130F's ex-US Navy) as part of their Excess Defence Articles programme. Two of the US platforms, a C130B and a C130F were subsequently put in service. The nine-strong fleet underwent a major refit from December 1996, when Marshall Aerospace of Cambridge in the UK and Denel was contracted to upgrade the aircraft as part of Project Ebb, fitting *inter alia* digital avionics in the place of the electromechanical. The upgrade was not without delay and infighting between Marshalls and Denel and ran at least three years over its expected date of completion, set for June 2002. The last aircraft, two former US platforms, were scheduled to rejoin the SAAF in June 2007 and March 2008 respectively. The fate of one of the aircraft is still in dispute. Its brakes caught fire during a landing after a test flight in early 2005 at the then-Johannesburg International Airport. Damage estimated in the millions of rand was inflicted on the aircraft and an equally damaging dispute then erupted between Denel and Marshalls as to whom had to carry the cost of the repairs. The other aircraft was also damaged while undergoing testing after upgrading – its fuel tanks were over-pressurised. In the period April 2004 to March 2005 the Hercules fleet flew 1207 hours. Seven of the nine were grounded in 2005 on the recommendation of the manufacturer after metal fatigue was discovered on the main spars and outer wing structures of

	several US C130Bs. Lockheed Martin subsequently allowed three to resume flying, but in May 2006 the remaining four had to undergo a further battery of tests. The SAAF plans to use the aircraft until 2015. The average SAAF C130 now has 10,000 hours on log (after 40 years of flying); while in the US it is 60,000[22]. The Chief of the Air Force in March 2007[23] said Lockheed Martin had assured him this target would be reached.

Table 10C.14: The Lockheed Martin Hercules.

Pilatus PC12

Type:	Light transport.
Country of origin:	Switzerland.
First flight:	nn.
Delivered to the SAAF:	1997.
Associated project name(s):	nn.
Numbers:	1.
Cost:	nn.
Crew:	Pilot, co-pilot.
Major dimensions & weights	
• Wingspan:	16.08m (52ft 9in).
• Length:	14.38m (47ft 2in).
• Height:	nn.
• Wing area:	nn.
• Basic empty weight:	2.386mt (5260lbs).
Max take-off weight:	4mt (8818lbs).
• Max landing weight:	nn.
• Max internal fuel:	nn.
• Max external fuel:	nn.
• Max cargo weight:	mt.
• Cargo capacity:	nn.
• Passengers:	10.
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	nn.
• Service ceiling:	nn.
• Max operating speed:	nn.
• Max cruise speed:	498km/h (310mph).
• Max range at cruise speed:	3796km (2360 miles).
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.

[22] By simple calculus South Africa's C130BZ fleet needs to fly another 200 years before encountering the same problem. The calculus, of course, is not really that simple… The formula to determine wing wear includes variables such as hours flown, the weight loading of the aircraft, the type of surface landed or taken off from, etc.

[23] CAF briefing, AFB Makhado, March 9, 2007.

• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Pratt &Whitney Canada.
• Model:	PT6A-67B.
• Type:	Turboprop.
• Number:	1.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	700.
• Propeller:	nn
Hard points:	none.
Armament:	none.
Other attachments:	none.
Comment:	Rarely seen.

Table 10C.15: The Pilatus PC12.

Raytheon Beechcraft King Air 200

Type:	VIP transport.
Country of origin:	United States.
First flight:	nn.
Delivered to the SAAF:	1983.
Associated project name(s):	nn.
Numbers:	2.
Cost:	nn.
Crew:	Pilot.
Major dimensions & weights	
• Wingspan:	16.61m (54ft 6in).
• Length:	13.34m (43ft 9in).
• Height:	nn.
• Wing area:	nn.
• Basic empty weight:	3.79mt (8358lbs).
• Max take-off weight:	5.670mt (12,500lbs).
• Max landing weight:	nn.
• Max internal fuel:	nn.
• Max external fuel:	nn.
• Max cargo weight:	mt.
• Cargo capacity:	nn.
• Passengers:	7/8.
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	nn.
• Service ceiling:	nn.

• Max operating speed:	nn.
• Max cruise speed:	535km/h (333mph).
• Max range at cruise speed:	3746km (2329 miles).
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Pratt &Whitney Canada.
• Model:	PT6A-42.
• Type:	Turboprop.
• Number:	2.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	850.
• Propeller:	nn
Hard points:	none.
Armament:	none.
Other attachments:	none.
Comment:	nn.

Table 10C.16: The Raytheon Beechcraft King Air 200.

Raytheon Beechcraft King Air 300

Type:	VIP transport.
Country of origin:	United States.
First flight:	nn.
Delivered to the SAAF:	1983.
Associated project name(s):	nn.
Numbers:	1.
Cost:	nn.
Crew:	Pilot.
Major dimensions & weights	
• Wingspan:	16.61m (54ft 6in).
• Length:	13.34m (43ft 9in).
• Height:	nn.
• Wing area:	nn.
• Basic empty weight:	3.79mt (8358lbs).
• Max take-off weight:	5.670mt (12,500lbs).
• Max landing weight:	nn.
• Max internal fuel:	nn.
• Max external fuel:	nn.
• Max cargo weight:	mt.
• Cargo capacity:	nn.

• Passengers:	7/8.
Performance	
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	nn.
• Service ceiling:	nn.
• Max operating speed:	nn.
• Max cruise speed:	535km/h (333mph).
• Max range at cruise speed:	3746km (2329 miles).
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Pratt &Whitney Canada.
• Model:	PT6A-42.
• Type:	Turboprop.
• Number:	2.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	850.
• Propeller:	nn
Hard points:	none.
Armament:	none.
Other attachments:	none.
Comment:	nn.

Table 10C.17: The Raytheon Beechcraft King Air 300.

Helicopters

Agusta A109

Type:	Light utility helicopter.
Country of origin:	Italy, 25 locally assembled.
First flight:	nn.
Delivered to the SAAF:	From October 19, 2005.
Associated project name(s):	Flange.
Numbers:	30.
Cost:	R1949 million (1999 constant Rand). R2.39 billion[24].
Crew:	Pilot, co-pilot.
Major dimensions & weights	
• Wingspan (rotor diameter):	10.83m (35.53ft).

[24] 2007 Treasury figure.

• Number of rotors:	4.
• Wingspan (tail rotor diameter):	1.94m (6.36ft).
• Number of tail rotors:	2.
• Length (fuselage):	11.45m (37.59ft).
• Length (rotor running):	12.94m (42.45ft).
• Height:	3.4m (11.15ft).
• Max cabin width:	1.61m (5.28ft).
• Basic empty weight:	1.67mt (3602lbs).
• Max take-off weight:	3/3.2mt (6614/7055lbs or 3.175mt (7000lbs).
• Max landing weight:	nn.
• Max internal fuel:	881 litres (5 cells).
• Max external fuel:	nn.
• Max cargo weight:	mt.
• Cockpit & cabin volume:	5.10m3 (180.17ft3).
• Baggage compartment:	0.95m3 (33.55ft3).
• Passengers:	6 normal, 8 max.
Performance (MGW ISA-5L clean configuration)	
• Operating conditions:	-40deg C to +50deg C.
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	MCP: 9m/s (1780ft/min) OEI[25]: 4.8m/s (950ft/min).
• Service ceiling:	6096m (20,000ft).
• Max operating speed:	168kts (311km/h).
• Max cruise speed:	153kts (283km/h).
• Max range at cruise speed:	935km (505nm).
• Max endurance with 881litres of fuel (no reserve) at 6000ft:	4hrs 54min.
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Turbomeca.
• Model:	Arius 2K2.
• Type:	Turbine.
• Number:	2.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower (max continuous):	609 (454kW) each.
• SHP (max contingency):	791 (590kW) each.
• Transmission rating:	900 SHP (671 kW).
Hard points:	Provision for two pylons (can carry 300kg each).
Armament:	Various options, including: pintle mounted 7.62mm or 12.7mm door machine guns. The pylons can each accommodate a 7-, 12 or 19-round 70 or 81mm unguided

[25] OEI: One engine inoperative.

	rocket pod, twin 7.62mm GPMG, 12.7mm HMG or 20mm cannon pods, combined cannon/rocket pods, four-round ZT3/Ingwe or similar anti-tank missiles or two Mistral air-to-air missiles.
Other attachments:	Optional auxiliary equipment includes an external loudspeaker system, windshield wipers, a wire strike protection system, bleed air heater, environmental control unit, one or two longitudal stretchers, 500kg internal cargo platform, single or dual external cargo hooks, taking 500kg or 1mt respectively, rear view mirror, 270kg rescue hoist, snow skids, slump protection pads, emergency floats, engine particle separator, engine fire extinguisher, closed circuit refueling system, SX16 high-intensity search light, FLIR/TV sensors and a gyro stabilised sight. Survivability equipment includes armoured seats for the pilots, chaff and flare dispensers, a crashworthy fuel system and self-sealing fuel tanks, radar and laser illumination warning systems and an infrared jammer. Comment: The rotorcraft is part of the Strategic Defence Package and was selected in competition with the Bell 427 (Canada), Eurocopter Cougar and the Eurocopter EC635 (both Franco/German). Thirty were acquired under Project Flange and an option for ten more exists. South African companies involved in the project that slipped two years because of problems caused by local modifications, included Saab Grintek, Denel Optronics, Tellumat and Waymark. The CAF, LTG Carlo Gagiano has said the SAAF requires the type to take pressure off the Oryx fleet. The service has long had the need for a platform more capable than the Alouette III but less expensive and more efficient than the Oryx for the bulk of taskings. The A109 is expected to fill that niche. The helicopter is well suited to tasks such as light passenger and cargo transport, patrolling and reconnaissance, liaison and command, medical evacuation, light attack and antitank, escort and area suppression. The cockpit is ergonomically designed and its three 6x8 inch flat screen digital displays are compatible with night vision goggles and fully capable of IFR[26]/IMC. The helicopter boasts a four-bladed, fully articulated rotor for low flicker/low acoustic detectability as well as low vibration. The blades are ballistic tolerant. All critical systems are duplicated and seperated for low vulnerability. The helicopter's fuel tanks are self-sealing and protected against 12.7mm Armour-Piercing Incendiary hits. Four 87 Helicopter Flying School pilots completed the inaugural conversion course in early October 2005. Three instructor pilots and a pilot followed later than same month. The first A109 operational conversion course presented by SAAF instructors was scheduled for February 2006 and was to see eight pilots converting from the Alouette III. Two of the eight were scheduled to be black and two more female. The first technical course was completed in September 2005, the second in November and the third in January 2006. By

[26] IFR: Instrument flight rules.

	midyear it was planned that 60 personnel, 34 of them black, would have completed their training.
The Chief of the Air Force in March 2007[27]	said the rotorcraft was cleared for command-and-control, Casevac, trooping and cargo-slinging duties.

Table 10C.18: The Agusta A109.

Denel CSH2/AH2A Rooivalk

Type:	Combat support helicopter.
Countries of origin:	South Africa, France.
First flight:	February 11, 1990; Engineering Development Model: February 17, 1997.
Roll-out dates:	First model: January 15, 1990, Advanced Development Model: 1992, Engineer Development Model: November 17, 1996. Still considered a project and not an operational system in early 2007.
Delivered to the SAAF:	From May 7, 1998.
Associated project name(s):	Impose.
Numbers:	12 production aircraft built, 11 survive; one or two prototypes exist in addition.
Cost:	Estimated R2 billion to date, original purchase price said to be R876 million. In 2005 R600 million more was required to operationalise the helicopter. In late 2006, informed aviation industry sources put the price of the Denel-manufactured "Mark 1" at US25 million and that of a mooted "Mark II" at

[27] CAF briefing, AFB Makhado, March 9, 2007.

	US15 million. By comparison, a Mil 24/5 Hind retails at US10 million. (The Mark II would have updated cockpit avionics and simpler weapons). Denel also had plans in 2006 to sell about 90 of the rotorcraft to Turkey for US2 billion (R14 billion), a price that has been described as a "garage sale".
Crew:	Pilot, weapons systems operator (interchangeable cockpits).
Major dimensions & weights	
• Wingspan (rotor diameter):	15.58m.
• Number of rotors:	4.
• Main rotor disc area:	191.13m2 (2057.43ft2).
• Wingspan (tail rotor diameter):	3.051m.
• Number of tail rotors:	5.
• Length (fuselage):	16.39m.
• Length (rotor running):	18.74m.
• Landing-gear wheel base:	11.77m.
• Height:	5.187m.
• Width (stub wingtip to wingtip):	6.355m.
• Width (wheelbase):	3.005m.
• Width (fuselage, including sponsons:	1.77m. .
• Basic empty weight:	5.910mt.
• Max take-off weight:	8.75mt.
• Max landing weight:	nn.
• Max internal fuel:	1.469mt.
• Max external fuel:	nn.
• Max cargo weight:	mt.
Performance	
• Operating conditions:	-35degC to +50degC; +32degC seen as norm.
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Rate of climb:	2620ft/min.
• Service ceiling:	Greater than 20,000ft.
• Max operating speed:	167kts.
• Max sideway speed:	+- 50kts.
• Max cruise speed:	240km/h.
• Max range at cruise speed:	700km.
• Ferry range:	700km, 1260km with external tanks).
• Max endurance with 881litres of fuel (no reserve) at 6000ft:	.
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Turbomeca.
• Model:	Makila 1K2.
• Type:	Turboshafts.
• Number:	2.
• Compression ratio:	nn.
• Engine length:	2.103m.
• Engine height:	0.68m

• Engine width:	0.528m
• Dry weight:	0.243mt.
• Power turbine rotor speed:	nn.
• Twin engine take-off rating:	1492kW.
• Single engine super contingency rating:	1716kW.
• Transmission rating (max continuous):	1817kW.
• Transmission rating (max take off):	2243kW. .
Hard points:	Provision for three pylons on each stub wing (670kg on the inner pylon, 285 on the outer and 260kg on the wingtip pylon.
Armament:	
• Cannon:	F2 20mm, 750 rounds.
• Rockets:	38 or 76 FZ70 70mm or FZ90 90mm unguided rockets.
• Missiles:	4 x Mistral ATAM or 4 x V3D short-range infra-red air-to-air missiles or 8 or 16 Mokopa or Ingwe ATGM. Also cleared for Euromissile HOT.
Other attachments:	2 x 750 litre ferry tanks.
Comment:	There is no nice way of saying it: The Rooivalk is a dinosaur that survived its mass extinction. It was conceived in the 1980s as tankbuster operating in a high-threat, high-intensity environment. That world has disappeared since the end of the Cold War and South Africa's transition to nonracial democracy. It was also meant to be "a cost effective, off-the-shelf, reliable weapon system…"[28] By 2006 it was none of these, nor operational. According to a candid assessment, the requirement for four Rooivalk would only be met at the end of 2006 and the best estimate for a deployable capability is for sometime in 2007[29]. The reliability of the system could also be challenged after the August 3, 2005 smash that has resulted in one of the helicopters being scrapped. At thee time the incident was described as a "possible technical malfunction" that led to a chain of events that led to an uncontrolled landing. According to reports, the incident took place during the testing of a new automatic hovering system. Both crew members were afterwards given a clean bill of health. It was the second accident involving the type. In 2002 a Rooivalk crashed next to a main road near Pretoria after an apparent engine failure. The claims of cost effectiveness and the off-the-shelf credentials of the system has also been somewhat dented by information made public in the last ten years. While the true cost of the Rooivalk may never be known[30], some estimates go up to R2 billion since the project started in March 1984. In August 2005 the DoD asked Parliament's help in

[28] Rooivalk Client Programme, Department of the Rooivalk Programme Office, Rooivalk attack helicopter, a complete operational and technical description, Atlas Aviation, 1995, p1-1.
[29] In April 2005 LTG Gagiano pegged the date as July of that year. In March 2007 he said the date had slipped to early 2008. He also said the UN had no immediate need for the helicopter in the DRC, Burundi or Sudan, and as a result operationalising the helicopter was no longer a priority.
[30] And may be irrelevant considering the programme's strategic industrial intent up to 1999 of keeping going a viable aviation industry and after 2004 of expanding the same in line with a scheme to manufacture and export motor vehicles. Whether this is either feasible or wise falls outside the scope of this work, but if reports of inflated car prices and violations of world trade rules in connection with the state-subsidised vehicle scheme are anything to go by, it could be an interesting debating point.

securing a further R600 million for the project from the Treasury. The department told the Parliamentary defence committee R200 million was needed a year for the next three years. A further R40 million a year was needed to operate the aircraft of which R10 million would be needed to buy missiles.

At least one current programme insider considers the rotorcraft unsuitable as a combat support platform, saying it is too large and too expensive to operate in that role. The insider, who requested anonymity, said the type compared poorly in that regard to Agusta's A129 Mangusta (its competition in the Turkish bid) or the Eurocopter Tiger – or even the Bell AH1Z Cobra.

Other myths also surround the programme; principally that it is an indigenous design. It is not. As should be clear from a cursory examination, the type is essentially a gunship version of the Oryx, itself a customised Eurocopter Cougar. Although South Africa may not be keen to admit this for reasons of pride and the French may be equally reluctant – as their involvement up to 1994 was in violation of a UN arms embargo, it is known that Eurocopter and Turbomeca engineers did extensive development work on the design. Another myth, propagated as recently as December 2005, is the so-called cost advantage of the platform relative to its peers. A defence journal that ought to know better wrote: "It seems likely that, benefiting from low labour rates in South Africa, the Rooivalk can be sold for less than its US and European competitors."[31] But this contrasts with repeated complaints from Denel over the fickleness of its technical staff who have to be paid international rates to keep them at Denel and in South Africa. Since the delivery of the last Rooivalk to the SAAF in 2004 the production line has largely been gathering dust and the highly skilled production force dispersed to other projects. Many have also left the company – and the country.[32] Should Denel succeed in selling any more of the platforms, a major staffing and re-education process would have to proceed production to replace lost skills, and more importantly, lost institutional memory and knowledge. The system is by no means cheap. As Australian officials said when Rooivalk lost the AIR87 competition there in 2001, "Nice people, but too expensive."[33] Eurocopter won the bid instead, delivering its first Hellfire-armed AussieTiger (of 22)

[31] Roy Braybrook, Whirly Stingers: Not cheap, but nasty, armada INTERNATIONAL, 6/2005, December 2005/January 2006, p32.

[32] The issue was discussed in the South African Parliament in August 2005, where MPs noted that the helicopter's development was being delayed by the restructuring of its primary contractor, Denel, and the recruiting of and retaining of skilled personnel staff at Denel and the SA Air Force. See Leon Engelbrecht, Rooivalk Crash Illustrates Programme Difficulties, Defence Systems Daily, August 5, 2005, www.defence-data.com, accessed August 6, 2005.

[33] Related to the author by an Australian colleague. Of interest is that the Eurocopter Tiger won that competition. The first "AussieTigers" were delivered in 2005 and are already fully operational. By contrast the Rooivalk is still under development, as recounted above.

on budget and on time on December 15, 2004.

There is also the myth of Rooivalk superiority when compared with peer systems. SAAF director of projects Bob King put it this way in 1993: "Rooivalk is the best in the world – better than the US built (Boeing AH64) Apache, which is more expensive."[34] In size the two are certainly peers, as is the Russian Mil24/25/35 Hind (and its successor, the Mil Mi28 Havoc). Whether the one is better than the other is not for this writer to say. The Rooivalk is still not operational and neither is it's the majority of its weapons. While one assumes King was referring to the AH64A version of the Apache, not the current AH64D Longbow variant, and while one knows the AH64 programme has had a manifold of problems – including a too-high cockpit workload and a difficulty flying at night as recently as the Kosovo war in 1999 (when two were flown into the ground during manoeuvres), King's claims are difficult to take seriously in the absence of corroborating evidence. To this writer's knowledge, none has ever been provided. Propaganda claims of this sort are in any case best avoided. It may make the patriotic heart beat faster, but at the cost of credibility in informed circles.

Turkey shortlisted the Rooivalk in late June 2006, in what Denel said was an US2 billion contract for up to 91 helicopters but which the country's defence minister, Vecdi Gonul said was an initial purchase of 30 followed by an option for 20 more. The Rooivalk was shortlisted alongside AgustaWestland's A129 Mangusta International. Gonul told The Associated Press[35] that American bidders withdrew over concerns about technology transfer. By comparison, Denel's bid included full transfer of equipment and technology, leading some to compare the deal to a fire sale. "The goal is to co-produce the helicopters, not buy them off-the-shelf." The report noted the bidding rules included full access to the aircraft's specific software codes – "which the US considers a security risk – and a written guarantee from the provider's government that there will be no political obstacles to the export of the arms[36]." By late 2006 unconfirmed reports said that Turkey had told the two bidders it was buying the Apache in any case. This may allow ATE to upgrade the Rooivalk to Rooivalk II standard, discarding the Mokopa and using the Ingwe instead, replacing the chin 20mm cannon and upgrading the cockpit avionics that was state-of-the-art 20 years ago.

In the meantime, its 16 Squadron crews in 2006 began working up on the helicopter to achieve day and night operational capability with cannon and rockets[37]. The helicopter was, however, not entirely up to the regimen, one

[34] Roger Makings, SAAF to fly the Rooivalk, Business Times, October 30, 1993.
[35] Khulu Phasiwe, Rooivalk is Turkish delight for Denel, Business Day, July 4, 2006, p1,2.
[36] This raises an interesting question about South Africa's ability to produce such a letter, considering the strictures placed on arms exports by the National Conventional Arms Control Act.
[37] Note the absence of missiles in the mix.

making a hard landing in September 2006 after apparently after the loss of power to an engine. As a result, the fleet was grounded and only one Rooivalk flew at AAD2006 at AFB Ysterplaat that month. It afterwards emerged that the type suffers of a gearbox not suitable to its flight profile. The problem has reportedly been long in running and as long concealed.

In March 2007 the Chief of the Air Force said the Turkish bid had been re-opened with the end of that month being the closing date. But in the waning days of that same month, Turkey selected the A129.

In May 2007, Business Day newspaper[38] quoted Denel as deciding that the Rooivalk was not commercially viable and that it would not spend any new money on the helicopters. "Armscor and the defence department will now have to decide whether to subsidise the maintenance of Denel's Rooivalk capability so that it can continue servicing the 12 helicopters bought by the South African Air Force over their 25-year lifespan," the paper said. "The other option would be for the air force to mothball the helicopters and for the costs to be written off entirely."

In the report Denel group CEO Shaun Liebenberg added his company would not be able to afford to look after the air force's Rooivalk aircraft in the future. "There are some big strategic decisions which the air force and the shareholder must make on this product. The government could decide to subsidise it because of the defence force's operational requirements," said Liebenberg.

"Liebenberg said that after Denel's failure to win the $2bn Turkey tender for 50 helicopters after giving it its best shot, the company realised that it would not be able to sell the Rooivalk anywhere else and that it could not sustain the project commercially," Business Day reported.

"Liebenberg has always maintained that Denel cannot be a global prime contractor competing on price with the major defence manufacturers as it does not have the necessary critical mass and economies scale."

"I am satisfied that our marketing approach was superb and very satisfied that we had government support. Technically we were successful," Liebenberg said.

"Denel lost the Turkey bid as its pricing structure could not compete with that of the other shortlisted bidder, the Italian Agusta. It had had to revise its price upwards when it learnt that it would be prohibited from selling the industrialised product from Turkey into other markets in the region."

"Erwin said in an interview that the departments of defence and public enterprises would have to decide later in the year what to do about the Rooivalk." No decision has been announced to date.

Table 10C.19: The Denel CSH2A Rooivalk.

What went wrong with the Rooivalk?

Date: 8 June 2007

By: Keith Campbell

Eagle or turkey? Should it be saved or slaughtered? These are the questions exercising

[38] Linda Ensor, Denel gets R8bn shot in the arm, ditches Rooivalk, May 18, 2007, http://www.businessday.co.za/Articles/TarkArticle.aspx?ID=2779055.

the minds of the South African government, parliamentarians, journalists, interested taxpayers (and they should all be interested, given the amount of money it has consumed), and, not least, the nation's aerospace industry, concerning the Denel Rooivalk attack helicopter.

Reportedly, from the inception of the Rooivalk (Afrikaans for ‘Kestrel') project in 1984 to the first flight of the first prototype in 1990, R1-billion was invested in the programme. From the start to the present, the programme is believed to have cost just over $1-billion (roughly R7-billion). For the sake of comparison, the cost of South Africa's acquisition of 28 Gripen fighters and 24 Hawk fighter-trainers is $2,2-billion.

The Rooivalk was hailed in South Africa as a world-beater, the best such helicopter anywhere. Yet, 17 years after the Rooivalk first flew, not one export order has been won, and only 12 production standard aircraft have been manufactured, all for the South African Air Force (SAAF).

Even more incredibly, these production Rooivalks are still not fully operational and could not be deployed elsewhere in Africa if an emergency arose and United Nations (UN) forces needed their support. (The UN has employed Russian-built Mi-24 and Mi-35 attack helicopters on combat missions in the Democratic Republic of the Congo in recent years.)

No one could reasonably claim that this represents a success story. So what went wrong?

The idea of South Africa developing an attack helicopter was not, in and of itself, erroneous. The then South African Defence Force saw a real need for an attack helicopter, in order to escort and support heliborne raiding forces, destroy anti-aircraft positions, and meet the potential threat of growing tank forces in other African countries, particularly Angola. Equipped with anti-tank missiles, such a helicopter could neutralise numerically superior hostile tank forces.

But - and this is a very important point - South Africa could not design and build a complete helicopter from scratch. The design, development and manufacture of the necessary powerplant and dynamics system (rotor head, main and tail rotors, and main and tail gearboxes) were beyond this country's capabilities. Acquiring such capabilities would have been extremely time consuming and incredibly expensive, rendering the project totally impractical. So the new machine had to be based on an existing design, as far as its power plants and dynamics were concerned.

At the time, the SAAF operated two main helicopter types - the Aerospatiale (formerly Sud Aviation, now Eurocopter) Alouette III and the Aerospatiale Puma. The Alouette III could not possibly form the basis of a credible attack helicopter - it was not just that it was small, but its powerplant and dynamics system were 1960s technology, clearly outdated, and lacking in power. (An Alouette III powerplant and dynamics system were used as the basis for an engineering and development capability demonstrator for Atlas - now Denel - as a precursor to the Rooivalk programme; designated the Alpha XH-1, it first flew in 1984 and is today preserved at the SAAF Museum at Air Force Base Swartkops, Pretoria.)

Athough the Puma was larger and more powerful than the Alouette III, it had already been displaced on the French production line by its bigger and more powerful offspring, the Super Puma, which first flew in late 1978. This led to South Africa's developing and successfully executing a project to produce a new helicopter that was a hybrid of the Puma and the Super Puma - the Denel Oryx. The Oryx has a fuselage that is longer than

that of the Puma but shorter than that of the Super Puma, and was fitted with the powerplants, dynamics systems, and tail boom of the Super Puma (later, military versions of the Super Puma were redesignated Cougar).
The result was and is a helicopter with a greater payload and range capability than the Puma and a greater power-to-weight ratio than the Super Puma/Cougar. In consequence, the Oryx is an ideal transport helicopter for the hot temperatures and high altitudes frequently found in Southern Africa.
The Oryx was developed in parallel with the Rooivalk prototypes. Being simpler and cheaper than the Rooivalk, the Oryx programme was completed much more rapidly, the helicopter being unveiled in 1991, and has been the SAAF's transport helicopter ever since. Thus it was proposed that the Super Puma powerplants and dynamics systems, being made in South Africa for the Oryx programme, be used as the basis for the planned attack helicopter.
At least one engineer is known to have proposed that the attack helicopter be based on the engines and dynamics system of the Aerospatiale Dauphin, an intermediate-(light/medium) size helicopter with good manoeuvreability and power, which would have resulted in a smaller, more rapidly developed, and more economical (to develop, buy and operate) system. As the French were
allowing South Africa to use the powerplants and dynamics of the Super Puma, they would surely have agreed to the South Africans using the same elements from the Dauphin. However, the SAAF felt that using the same engines and dynamics as the Oryx would simplify logistics and reduce maintenance costs, so the decision was made to use the Super Puma systems as the basis for the Rooivalk.
The consequence of this decision was that the attack helicopter would have to have a big airframe, which it needed in order to accommodate the fuel required for it to achieve the desired range. But it also meant that it would be able to carry many sensors, advanced avionics, and a heavy and diversified weapons load. In short, it would have the capacity to be outfitted as a top-of-the-line, world-beating attack helicopter. And this, possibly, plus the lavish defence budgets of the 1980s, seduced the SAAF and Armscor/Atlas/Denel into seeking to make the Rooivalk a world-beating system, forgetting the saying that "the best is the enemy of the good enough".
This was the fundamental conceptual flaw in the programme - it was an oversophisticated project for a country like South Africa. Trying to be the best drove up the costs, and extended the development timeframe, very significantly indeed. (The cost increase, relative to a simpler design, was not unforeseen, with the result that an appropriate budget was assigned and, contrary to some reports, the Rooivalk programme never exceeded its budget during the period 1984 to 1990.)
Whereas a simpler, cheaper, basic "good enough" Rooivalk system would almost certainly have completed its development in the late 1980s and entered production in parallel with the Oryx, the actual Rooi-valk was far from finishing its development when the war in Angola ended in 1988 and the then South African government began to cut the defence budget. The first Rooivalk proto- type made its maiden flight only in 1990. Budget cuts inflicted further delays on the programme, and the planned acquisition was cut from 36 to only 12. This deprived the programme of the benefits of economies of scale.
"Some key people in the SAAF felt that the Rooivalk was a threat to what was most

important to them - their fighter programme - so they sought to kill it; for a period, the Rooivalk was kept going with army funding because the army felt that it was essential for them: without the Rooivalk, they would have needed a lot more armour," reports defence analyst and Jane's Information Group correspondent Helmoed-R?mer Heitman. "But the money was always very tight."

Make no mistake - the Rooivalk was a triumph for South African industry and technology. The programme created a significant and powerful pool of experience and expertise in the country, which played an essential role in the creation of highly successful South African private- sector aviation companies such as Advanced Technologies & Engineering (ATE) and Aerosud. But

the delays that were caused by the budget cuts meant that what had been a cutting-edge aircraft in 1990 was an obsolete aircraft when it finally began to be delivered to the SAAF in 1998.

As a flying machine (as distinct from a fighting machine) the Rooivalk is first class, reportedly hailed by all who have flown it. It is also ideal for operations in Africa.

But its avionics system, a magnificent achievement for local industry when it was developed and integrated in the late 1980s, is today as obsolete as a dinosaur's brain. This is a key reason in Denel's failure to export the aircraft. No one will buy a warplane whose avionics system is based on 20-year-old computers. Then there is the cost of the aircraft - the direct result of both attempting to make it a world beater and depriving it of eco-nomies of scale by cutting the order to only 12. "The unit cost of the Rooivalk is about $40- million,"

says Heitman. This makes it as expensive as the Boeing Apache and the Eurocopter Tiger, the latest models of which have state-of-the-art avionics, and much more expensive than the smaller AgustaWestland Mangusta/Mongoose, and the Russian Mi-24/35 family.

Export possibilities have been further reduced by foreign worries about the long-term viability of Denel: will the company still be around in 20 years to continue to support the Rooivalk, if they should buy it? And then there is the fact that the Rooivalk is very heavily dependent on French technology, now the property of Eurocopter, yet Denel tried to export the Rooivalk not only without Eurocopter's prior agreement and support, but actually in open competition (for example, in Australia) with Eurocopter's

own Tiger. Foreign diplomatic sources have indicated that the European company has warned countries interested in buying the Rooivalk that they could not be guaranteed the support they would need for the engines and dynamics. This effectively killed off any remaining interest in the Rooivalk.

Oversophisticated, overdelayed, overexpensive, outdated, and lacking economies of scale - what next for the Rooivalk?

The programme could simply be cancelled, the costs written off, the aircraft scrapped or sent to museums, like so many other South African aerospace projects launched in the 1980s. But the South African National Defence Force would still need an attack helicopter, to support UN missions elsewhere in Africa.

Attack helicopters - this term, by the way, is technical North Atlantic Treaty Organisation jargon indicating an armed helicopter intended to undertake missions in direct support of troops, "attack" originally being the US term directly equivalent to the British term "ground attack" - are the only vertical take-off and landing combat aircraft available to a

country like South Africa. Unlike the SAAF's fighters, they do not need good-quality surfaces to operate from, nor large spaces, and they will also be able to operate from the flight decks of the Navy's planned amphibious ships. Cancelling the Rooivalk will leave a gap which will, sooner or later, have to be filled by buying someone else's attack helicopter.
Further, the Defence Force needs more than 12 of these machines - an absolute minimum deployment would need three attack helicopters, to ensure two were always available for operations; with just 12, the SAAF could not have more than just two such deployments at any time. But the Defence Force is already involved in three major missions - in Burundi, the Democratic
Republic of the Congo, and Darfur, in Sudan. "South Africa needs 24 attack helicopters, which would give 16 operational," argues Heitman.
So, an alternative is to reinvest in the Rooivalk programme, order another 12, but to a new, more modern, yet simpler and cheaper, standard, and subsquently refurbish the existing aircraft to the same standard. This 'Rooivalk Mk 2' would also produce a much cheaper aircraft, with a unit cost of less than $20-million. That would be financially and technically much more appealing to many developing countries.
It would also cease to be a competitor to the Tiger, but become a complement to it.
This would open the door to cooperative marketing of the Rooivalk with Eurocopter, and, if this could be negotiated, the Eurocopter name and support would assure possible customers so that the new Rooivalk would indeed enjoy long-term through-life support.
Heitman thinks that developing the Rooivalk Lite, or Rooivalk Mk 2, will cost South Africa another R1,5-billion. "This is a lot less than the cost of scrapping it and bringing another type into service," he argues.
Denel does not have this money. Only the government does. The future of the Rooivalk thus lies in the hands of the Cabinet. They are the ones who are going to have to make the final decision. Ultimately, it is President Thabo Mbeki who will decide whether the aircraft will soar like an eagle or be slaughtered as a turkey.
(This story was also based on interviews conducted, on the basis of anonymity, with an engineer and an SAAF officer, who were involved in different aspects of the Rooivalk project.)
Engineering News

Denel Gets R8bn Shot in The Arm, Ditches Rooivalk

Business Day
Linda Ensor
Political Correspondent
18 May 2007
http://www.businessday.co.za/Articles/TarkArticle.aspx?ID=2779055

Arms maker to provide defence force with 264 combat vehicles

Cape Town Struggling arms maker Denel has been given an R8bn vehicle contract lifeline by Armscor. This comes hard on the heels of its failure to win a bid to supply Turkey with Rooivalk helicopters.

Denel has now decided that the Rooivalk, on whose development the government spent R8bn, is not commercially viable and it will not spend any new money on the helicopters.

Armscor and the defence department will now have to decide whether to subsidise the maintenance of Denel's Rooivalk capability so that it can continue servicing the 12 helicopters bought by the South African Air Force over their 25-year lifespan.

The other option would be for the air force to mothball the helicopters and for the costs to be written off entirely.

Denel group CEO Shaun Liebenberg announced Denel's decision on the Rooivalk and details of the Armscor contract the biggest in the company's history ahead of Public Enterprises Minister Alec Erwin's budget vote speech in Parliament yesterday.

He said Denel would not be able to afford to look after the air force's Rooivalk aircraft in the future.

"There are some big strategic decisions which the air force and the shareholder must make on this product. The government could decide to subsidise it because of the defence force's operational requirements," said Liebenberg.

Erwin said in an interview that the departments of defence and public enterprises would have to decide later in the year what to do about the Rooivalk.

The R8bn Armscor contract, known as Project Hoefyster, would see Denel Land Systems supply the South African National Defence Force with 264 infantry combat vehicles in five variants over 10 years.

The new-generation combat vehicle would replace the Ratel and would be based on a Finnish Patria platform with a Denel- designed turret. It would be an 8x8-wheeled vehicle in the 25-ton class to transport and protect infantry troops.

"The contract signifies a tremendous boost to local industry and the economy," Liebenberg said. "This contract puts Denel Land Systems on the road to sustainability" as well as commercial viability. South African companies would deliver more than 70% of the total value of the contract, 18% of which would be for the development of the turret systems.

Denel as main contractor would involve numerous local defence companies and subcontractors such as BAE Systems' subsidiary Land Systems OMC in delivering the product.

The vehicle itself would be built locally under a Patria licence.

Liebenberg said that after Denel's failure to win the $2bn Turkey tender for 50 helicopters after giving it its best shot, the company realised that it would not be able to sell the Rooivalk anywhere else and that it could not sustain the project commercially.

Liebenberg has always maintained that Denel cannot be a global prime contractor competing on price with the major defence manufacturers as it does not have the necessary critical mass and economies scale.

Denel lost the Turkey bid as its pricing structure could not compete with that of the other shortlisted bidder, the Italian Agusta. It had had to revise its price upwards when it learnt that it would be prohibited from selling the industrialised product from Turkey into other markets in the region.

"I am satisfied that our marketing approach was superb and very satisfied that we had government support. Technically we were successful," Liebenberg said.

Liebenberg said Denel had obtained a cash injection of about R600m-R800m from the disposal of large properties and R400m from noncore asset sales.

Erwin said in his speech that government and representatives of the local defence-related industry were working closely to develop the very fragmented industry, estimated to consist of 49-70 companies.

An estimated 85% of total industry revenue of R9,5bn was produced by the top 15 companies.

"Fragmentation makes it unlikely that all capabilities will be sustainable and we believe that consolidation is desirable and inevitable," Erwin said.

Government departments would focus on interventions to develop the industry over the next couple of years.

"It is imperative that consolidation and upgrading of capabilities, plant and equipment is achieved for our industry to serve South African, regional and international defence requirements," Erwin said.

Already the consolidation of test and evaluation facilities was under way and a Defence Evaluation and Research Institute would be established.

Denel to fire on all cylinders with smart SANDF deal
May 18, 2007

By Michael Hamlyn (BUSINESS REPORT)

Cape Town - Troubled state-owned arms maker Denel has won an R8 billion contract from the SA National Defence Force (SANDF) to supply a new generation of light armoured vehicles to replace the outdated Ratel and Rooikat.

Public enterprises minister Alec Erwin made the announcement in parliament yesterday, during debate on his budget in the national assembly.

Shaun Liebenberg, Denel's chief executive, was excited and believed that this success justified his dramatic turnaround strategy, which involved splitting the company into 10 separate divisions and selling off non-core units.

"Importantly for Denel, a new chapter has been written. This contract puts Denel Land Systems on the road to sustainability," said Liebenberg.

He said that the new infantry combat vehicle, known as Project Hoefyster (Horseshoe), would provide Denel with the biggest contract in its 16-year history.

As the lead contractor, Denel will be responsible for the design and manufacture of the turret.

The 25-ton vehicle will be based on the Patria, a Finnish design. It will be manufactured under licence in South Africa by Oliphant Manufacturing, a subsidiary of British Aerospace.

The new vehicle will be developed over the next three years and the first of 264 vehicles is expected to roll off the production line in six or seven years.

South African companies would deliver more than 70 percent of the contract.

The contract gives a much needed boost to the state arms maker at a time when it is still licking its wounds after losing the deal to supply the Rooivalk helicopter to Turkey, and failing to get nothing but crumbs from the multibillion-rand arms procurement that is under way.

Liebenberg said the loss of the Turkey contract had in a way vindicated Denel's new posture and strategy of giving up the role of a prime contractor in global markets.

Instead, the company wanted to concentrate on securing privileged access to the local industry and get a share of the expenditure of the department of defence, he said.

Political pressure was brought on Denel to bid for the Turkish contract, but inability to use the deal as a springboard for further overseas sales and employment of expensive foreign technicians made the company price itself out of the market.

The vehicle will be manufactured in five variants each of which will need intricate turret design with several Denel business units, along with a number of other specialist suppliers, providing systems for the turrets.

Denel M1 Oryx

Type:	Medium utility helicopter.
Country of origin:	France, assembled in South Africa.
First flight:	AS332 Super Puma (later AS532 Cougar): September 13, 1978; SA Oryx: September 18, 1987.
Delivered to the SAAF:	From May 1989.
Associated project name(s):	Drummer (2006/7 mid-life upgrade).
Numbers:	51 assembled, 39 survive.
Cost:	nn.
Crew:	Pilot, co-pilot, flight engineer.
Major dimensions & weights	
• Wingspan (rotor diameter):	15.6m (51.18ft).
• Number of rotors:	4.
• Main rotor disc area:	191.13m2 (2057.43ft2).
• Wingspan (tail rotor diameter):	3.051m 10ft).
• Number of tail rotors:	5.
• Length (fuselage):	15.45m (53.44ft).
• Length (rotor running):	18.74m 61.35ft).
• Wheelbase:	4.055m.
• Height (tail rotor running):	5.14m.
• Height (to main rotor hub):	4.63m (15.09ft).
• Width (wheelbase):	3m (9.84ft).
• Width (fuselage, including sponsons:	2m (6.56ft). .
• Basic empty weight:	4.460mt (9832lbs).
• Max take-off weight:	9mt (19,841lbs) with an internal load or 9.35mt with a slung load.
• Max landing weight:	nn.
• Max internal fuel:	1.469mt.
• Max external fuel:	nn.

- Max cargo weight (internal): 3mt. .
- Max weight, cargo hook: 4.5mt.
- Max weight, rescue hoist: 272kg.
- Passengers: 16 on canvas seats, 20 on floor, six stretchers with four medics.

Performance

- Operating conditions: -35degC to +50degC.
- Take-off to clear 15m: nn.
- Landing from 15m: nn.
- Rate of climb: 915m/min (3000ft/min).
- Service ceiling: 23,500ft (6mt), 19,000ft (7mt), 15,000ft (8mt).
- Max operating speed: 165kts (6mt), 164kts (7mt) & 161kts (8mt).
- Fast cruise speed: 152kts (6mt), 151kts (7mt), 149kts (8mt).
- Fuel consumption, fast cruise speed: 500kg/h (6mt), 505kg/h (7mt), 510kg/h (
- Max range at econ cruise speed: 303nm (6mt), 297nm (7mt), 288nm (8mt), with standard tanks, without reserve; 448nm (6mt), 441nm (7mt), 427nm (8mt).
- Ferry range: 2000km with four auxiliary ferry tanks.
- Stall speed: nn.
- G-loads: nn.
- Wing loading: nn.
- Thrust: nn.
- Bypass ratio: nn.
- Thrust/weight ratio: nn.

Engine Specifications

- Make: Turbomeca.
- Model: Makila 1K2.
- Type: Turboshafts.
- Number: 2.
- Compression ratio: nn.
- Engine length: 2.103m.
- Engine height: 0.68m.
- Engine width: 0.528m.
- Dry weight: 0.243mt.
- Power turbine rotor speed: nn.
- Engine rating: 1400kW each.
- Twin engine take-off rating: 1492kW.
- Single engine super contingency rating: 1716kW.
- Transmission rating (max continuous): 1817kW.
- Transmission rating (max take off): 2243kW. .

Hard points: Normally none.

Armament: None normally fitted, but the type can carry pintle-mounted door machine guns or machine guns, cannon, unguided rockets or various missiles in pods under stub wings.

Other attachments: Ferry tanks can be carried internally. For search-and rescue, a hoist, loudhailer, searchlight and flotation gear is fitted. A tactical EW kit can be fitted.

Comment: Another platform of dubious parentage. Despite the hype of the type's local origin, the Oryx is best described as a locally assembled Eurocopter Cougar, using kits smuggled to South Africa via Romania and Portugal and in violation of a UN arms embargo. The pilot seats are armoured and proof against 7.62mm fire. In the period April 2004 to March 2005 the Oryx flew 5900 hours. In October 2005, the SAAF celebrated

	100,000 flying hours on the type. Project "Drummer", a midlife upgrade is currently said to be underway. An RFQ[39] was issued by Armscor to Denel in late 2005 and work on Phases 1 and 2 of three was in hand by March 2007. Aircraft placed in storage and cannibalised in anticipation of Drummer were also to be rehabilitated.

Table 10C.20: The Denel Oryx.

Eurocopter BK117

Type:	Light utility helicopter.
Countries of origin:	Germany, Japan.
First flight:	June 13, 1979.
Delivered to the SAAF:	April 27, 1994.
Associated project name(s):	nn.
Numbers:	10 received, six survive.
Cost:	nn.
Crew:	Pilot, co-pilot.
Major dimensions & weights	
• Wingspan (rotor diameter):	11m (36ft 1.1in).
• Number of rotors:	4.
• Main rotor disc area:	95.03m2 (1022.93 ft2).
• Wingspan (tail rotor diameter):	nn.
• Number of tail rotors:	2.
• Length (fuselage):	9.88m (32ft 5in).
• Length (rotor running):	13m (42ft 7.8in).
• Height:	3.36m (11ft 0.3in).
• Width:	nn.
• Basic empty weight:	1.695mt (3737lbs).
• Max take-off weight:	3.2mt (7055lbs).
• Max landing weight:	nn.
• Max internal fuel:	nn.
• Max external fuel:	nn.
• Max cargo weight:	mt.
• Passengers:	7 or 11.
Performance	
• Operating conditions:	-35degC to +50degC.
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Initial rate of climb:	nn.
• Service ceiling:	3050m (10,000ft).
• Max operating speed:	nn.
• Max cruise speed:	134kts (243km/h, 154mph) at sea level.
• Max range at cruise speed:	493km (306 miles) on internal tanks.
• Max endurance:	2hrs 45min.
• Stall speed:	nn.
• G-loads:	nn.

[39] RFQ: Request for Quotation

• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Avco Lycoming.
• Model:	LTS101-650B-1.
• Type:	Turboshafts.
• Number:	2.
• Compression ratio:	nn.
• Engine length:	nn.
• Engine height:	nn.
• Engine width:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower (max continuous):	550 (410kW) each.
• SHP (max contingency):	nn.
• Twin engine take-off rating:	nn.
• Single engine super contingency rating:	nn.
• Transmission rating (max continuous):	nn.
• Transmission rating (max take off):	nn. .
Hard points:	Normally none, although stub wings for ordnance can be fitted.
Armament:	None normally fitted, but the type can carry pintle-mounted door machine guns or machine guns, cannon, unguided rockets or various missiles in pods under stub wings.
Other attachments:	Ferry tanks can be carried internally.
Comment:	Another platform inherited from the Apartheid-era "homelands", the Ciskei having acquired 3 in 1983, Venda 2 in 1985, Transkei 2 in 1986 and Bophuthatswana 2 in 1987, making a total of nine. The origin of the tenth is a mystery. In the period April 2004 to March 2005 the BK117 flew 1100 hours. Two were lost to accidents in 2004/5. The platform also underwent an engine upgrade during that period to improve safety as well as hot and high performance. The Chief of the Air Force in March 2007[40] said the type would be phased out from September 2007.

Table 10C.21: The Eurocopter BK117.

Eurocopter SA316B/319BAlouette III

Type:	Light utility helicopter.
Country of origin:	France, most built under license in South Africa.
First flight:	February 28, 1959.
Delivered to the SAAF:	From February 1962.
Numbers:	58 in 1994, 30 in 2005, (officially) retired in 2006, 3 retained at 22 Squadron until August 2007[41].

[40] CAF briefing, AFB Makhado, March 9, 2007.
[41] SAAirForce.co.za reports the final flight ceremony was held at 22 Squadron on August 3, 2007.

Associated project name(s):	nn.
Cost:	nn.
Crew:	Pilot, co-pilot, flight engineer.
Major dimensions & weights	
• Wingspan (rotor diameter):	11.02 (36ft 1.9in).
• Number of rotors:	3.
• Main rotor disc area:	95.38m2 (1026.7ft2).
• Wingspan (tail rotor diameter):	nn.
• Number of tail rotors:	3.
• Length (fuselage):	10.03m.
• Length (rotor running):	12.84m (42ft 2.5in).
• Height:	3m (9ft 10.1in).
• Width:	nn.
• Basic empty weight:	1.143mt (2520lbs).
• Max take-off weight:	2200mt (4850lbs).
• Max landing weight:	nn.
• Max internal fuel:	nn.
• Max external fuel:	nn.
• Max cargo weight:	0.82mt.
• Passengers:	Five or two stretchers and two seated casualties/medics.
Performance	
• Operating conditions:	nn.
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Initial rate of climb:	260m/min (843ft/min).
• Service ceiling:	3200m (10,499ft).
• Max operating speed:	210km/h at sea level.
• Max cruise speed:	100kts (185km/h, 115mph) at sea level.
• Max range at cruise speed:	540km (336 miles) with max fuel at optimal altitude.
• Max endurance:	nn.
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	Turbomeca.
• Model:	Artouste IIIB.
• Type:	Turboshaft.
• Number:	1.
• Compression ratio:	nn.
• Engine length:	nn.
• Engine height:	nn.
• Engine width:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower (max continuous):	444.
• SHP (max contingency):	nn.
• Transmission rating (max continuous):	nn.
• Transmission rating (max take off):	nn. .
Hard points:	Normally none, although stub wings for ordnance can be

	fitted.
Armament:	None normally fitted, but the type can carry pintle-mounted door machine guns or machine guns, cannon, unguided rockets or various missiles in pods under stub wings. South Africa has also fitted a sideways-firing 20mm cannon in the cargo area, using the resulting platform as an *ex tempore* gunship.
Other attachments:	Ferry tanks can be carried internally.
Comment:	Nicknamed the "draadkar" (wire car), the type was officially retired on June 30, 2006. The type has faithfully served the SAAF for 44 years. Ten were to be retained as basic (*ab initio*) helicopter trainers, the A109 being adjusted too sophisticated for the task, but in the end the job was outsourced to a private flight school. Like the Puma, Super Frelon (hornet) and Alouette (lark) II, all previously used by the SAAF, the Alouette III was a product of Sud Aviation, now part of Eurocopter (hence the "SA" in the original designation). As an aside, the Puma was originally called the Alouette IV. When Sud and Nord Aviation merged into Aerospatiale, the designation changed to "AS". After Aerospatiale became part of Eurocopter, most product designations changed to "EC". In the period April 2004 to March 2005 the Alouette flew 2900 hours. The final tally for the type was 246,000 hours of 39.5 years.

Table 10C.22: The Eurocopter Alouette III.

Education, Training & Development Capability

Pilatus PC7 MkII Astra

Type:	Basic trainer.
Country of origin:	Switzerland.
First flight:	September 28, 1992.
Delivered to the SAAF:	October 17, 1994.
Number purchased:	60.

Associated project name(s):	nn.
Cost:	US175 million (1993).[42]
Crew:	1 pilot instructor, 1 pupil.
Major Dimensions & Weights	
• Wingspan:	10.12m.
• Length:	10.13m.
• Height:	3.26m.
• Propeller Diameter:	2.45m.
• Wing Area:	16.29m2.
• Basic Empty Weight:	1.67mt.
• Max Take-Off Weight, Aerobatic:	2.250mt.
• Max Take-Off Weight, Utility:	2.700mt.
Performance	
The Pilatus Astra performs as follows at sea level under international atmospheric conditions:	
• Take-Off To Clear 15m:	530m.
• Landing From 15m:	485m.
• Rate Of Climb:	824.5m/min.
• Max Operating Speed:	300kt (556km/h).
• Max Cruise Speed (At 10000ft):	250kt (463km/h).
• Max Range at Cruise Speed:	770nm.
• Stall Speed	
o Flap & Gear Up (Vs):	79kt (147km/h).
o Flap & Gear Down (Vso):	70kt (130km/h).
• G Loads:	+7.0g - -3.5g.
Engine Specifications	
• Make:	Pratt & Whitney
• Model:	Pt6a-25c.
• Type:	Free Turbine.
• Compression Ratio:	7:1.
• Engine Diameter:	0.483m.
• Engine Length:	1.575m.
• Dry Weight:	0.152mt.
• Power Turbine Rotor Speed:	33,000rpm.
• Shaft Horsepower:	750.
• Propeller:	Hartzell Hc-D4n-2a (4 Blade).
Armament:	none.
Comment:	Basic *ab initio* trainer for the SAAF. The airframe is based on that of the PC9 but fitted with the lower-powered PT6 engine. The contract was signed by then-Defence Minister Gene Louw on February 12, 1993 and provided for 55% offsets. In the period April 2004 to March 2005 the Astra flew 9605 hours. The type clocked up 100,000 flying hours at 10.45am on Monday, March 27, 2006.

Table 10C.23: The Pilatus Astra.

Future platforms

AgustaWestland Super Lynx 300

[42] Flug Revue, Datafiles, Pilatus PC7 MkII (M) Turbo Trainer, www.flug-revue.rotor.com/FRTypen/FRPC7II.htm, accessed on December 30, 2005, last updated on April 8, 1999.

Type:	Light utility helicopter.
Country of origin:	United Kingdom.
First flight:	March 21, 1971, SA ZK115/#191, April 24, 2006.
Delivered to the SAAF:	July 2007. Two arrived on an Antonov 124 from the UK on July 13 and two on July 27.
Numbers:	4.
Associated project name(s):	Sitron, Maulstic
Cost:	UK80-million (US132-million)[43].
Crew:	Pilot, co-pilot, flight engineer.
Major dimensions & weights	
• Wingspan (rotor diameter):	12.8m (42ft).
• Number of rotors:	Four composite, semi-rigid.
• Main rotor disc area:	129m2.
• Wingspan (tail rotor diameter):	2.36m.
• Number of tail rotors:	Four fully articulated, composite blades..
• Length (fuselage):	10.84m folded, 13.33m.
• Length (rotor running):	12.8m OR 15.16m.
• Height:	3.25m folded, 3.48 OR 3.67m.
• Width:	2.94m.
• Cabin length:	2.05m.
• Cabin width:	1.78m.
• Cabin height:	1.42m.
• Cabin volume:	4.85m3.
• Cabin floor area:	3.45m2.
• Basic empty weight:	3.291mt.
• Max take-off weight:	5.330mt.
• Max landing weight:	nn.
• Max internal fuel:	786kg.
• Max external fuel:	Multiples of 353kg.
• Max cargo weight:	nn.
• Cargo hook capacity:	1.360mt.
• Passengers:	Nine.
Performance	
• Operating conditions:	nn.
• Take-off to clear 15m:	nn.
• Landing from 15m:	nn.
• Initial rate of climb:	606m/min.
• Service ceiling:	Greater than 10,000ft.
• Max speed:	321.74km/h (1972 record).
• Max cruise speed:	138kts (254km/h, 157mph).
• Max range at cruise speed:	590km
• Max ferry range:	1045km
• Max endurance:	5.4hrs, 2hrs on antisubmarine warfare mission 20 nautical miles from ship, 3hrs 50min on surveillance mission 50 nautical miles from ship.
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.

[43] Defence Systems Daily, GKN Westland wins bid with Super Lynx 300, November 19, 1998, www.defence-data.com/dexsa/pagedx28.htm.

• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	LHTEC.
• Model:	CTS800-4N.
• Type:	Turboshaft.
• Number:	2.
• Compression ratio:	nn.
• Engine length:	nn.
• Engine height:	nn.
• Engine width:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower (max continuous):	kW each.
• Take-off rating:	kW each.
• SHP (max contingency):	nn.
• Twin engine take-off rating:	nn.
• Single engine super contingency rating:	nn.
• Transmission rating (max continuous):	.
• Transmission rating (max take off):	nn. .
Hard points:	Provision for hardpoints on each side of fuselage.
Armament:	
• Cabin:	Pintle-mounted machine guns can be fitted at the doors.
• Stub-wings:	Two torpedoes (Mk44, 46, Stingray or equivalent), or two depth charges (Mk11 or equivalent), or four Sea Skua or equivalent, or eight ZT3/Ingwe or equivalent.
Other attachments:	Ferry tanks can be carried internally.
Comment:	The type was selected in competition against the Eurocopter AS532 Cougar and the Russian Kamov Ka 28 Helix. A dark horse in the race, imagined or otherwise, was Kaman's SG-2G Seasprite, said to be cheaper but is equally effective. Super Lynx pipped them to the post and a deal to deliver the four from April 2007 was signed in Pretoria on August 14, 2003. The Super Lynx is the result of a programme launched in 1998 to produce a new generation of the rotorcraft. Malaysia placed an order for six in 1999 and the Royal Thai Navy confirmed its order for two in August 2001. The Sultanate of Oman signed an agreement in January 2002 for 16. According to the sales literature, the Super Lynx 300 was developed from the proven Super Lynx 100. It incorporates an all new integrated "glass" cockpit with a colour liquid crystal display system provides the crew with state-of-the-art technology increasing crew and mission effectiveness. The more powerful CTS800-4N engines, jointly developed by Rolls-Royce and Honeywell, complemented with a Full Authority Digital Engine Control (FADEC) delivers low maintenance, enhanced performance and excellent economy with over 30% more power. The airframe is expected to last 10,000 hours. South African components include a Sysdel electronic warfare

suite, a Saab Grintek Avitronics EW countermeasures system, an Aerosud armoured flight crew seats as well as an infrared exhaust suppression system – by the same company. Denel is supplying an electro-optical sighting system (EOSS) and Tellumat an Identification Friend or Foe system. Thales Advanced Engineering was contracted to supply a datalink as a well as a "video grabber", a dedicated bit of hardware that allows the transfer of video material taken by the EOSS to be transmitted to the mothership for further action. Reutech Defence Industries and Saab Grintek Communications Systems provided the HF and V/UHF radios. Also fitted are a 360 degree scan search radar and a nose mounted FLIR.

It was reported in August 2006 that pilot training was underway at AgustaWestland's facility at Yeovil in Somerset.

South Africa has ordered four Super Lynx 300 Mk 64 helicopters from AgustaWestland to operate from the SA Navy's Meko A200SAN class frigattes. The helicopters will provide a surface search capability in the anti-surface warfare roles, search and rescue (SAR), maritime patrol and utility duties.

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The helicopter's maximum all up weight (MAUW) is 5 330 kg and the cabin can accommodate up to 9 troops. The crew consists of a pilot and a tactical officer, while additional crew can be used to operate special role equipment as necessary.

The role equipment incorporates a hoist to assist with SAR missions, a cargo hook for under-slung loads for ship-to-shore and ship-to-ship replenishment and a powerful searchlight.

The Telephonics Ocean-Eye radar is the aircraft's primary mission sensor and allows the crew to detect and track small to large surface contacts at long ranges. Complementing the radar is the Sysdel Sea Raven Electronic Support Measures (ESM) suite, which is used for passive target detection and identification. A Denel Optronics Argos 410-M Electro Optic Sight System with a forward-looking infra-red (FLIR) sensor and a day camera is used for passive target identification and recording. Target tracks and video

images can be transmitted to the parent ship in real time using the Datalink unit supplied by Thales Advanced Engineering.

A 12,7 gun for self-protection will also form part of the current role equipment while growth options for surface and sub-surface warfare had been allowed for. This could include anti-ship missiles, depth charges, torpedoes, and rockets.

South African components include a Sysdel electronic warfare suite, a Saab Grintek Avitronics EW countermeasures system, an Aerosud armoured flight crew seats as well as an infrared exhaust suppression system - by the same company. Denel is supplying an electro-optical sighting system (EOSS) and Tellumat an Identification Friend or Foe system. Thales Advanced Engineering was contracted to supply a datalink as a well as a "video grabber", a dedicated bit of hardware that allows the transfer of video material taken by the EOSS to be transmitted to the mothership for further action. Reutech Defence Industries and Saab Grintek Communications Systems provided the HF and V/UHF radios.

The first two aircraft (193 and 194) arrived at Cape Town IAP on Friday 13 July 2007 aboard an An-124, while 191 and 192 arrived on 27 July 2007.

Table 10C.24: The AgustaWestland SuperLynx.

Airbus Military A400M

Type:	Medium strategic/tactical transport and aerial refueller.
Country of origin:	Pan-European.
First flight:	Scheduled for January 2008.
Delivered to the SAAF:	From 2010.
Associated project name(s):	Continent.
Numbers:	Eight ordered, six on option.
Cost:	R7,438,200,001.88 (2005 Rand) for eight[44], R11.3 billion for 14, €116.67 million[45] (2001 euro).
Crew:	Pilot, co-pilot & loadmaster.
Major dimensions & weights	
• Wingspan:	42.4m.
• Length:	42.2m.
• Height:	13.5m to tail.
• Wing area:	nn.
• Basic empty weight:	70mt.
• Max take-off weight:	130mt.
• Max landing weight:	nn.

[44] SAAF press release, reported on www.saairforce.co.za on June 30, 2005.
[45] Flug Revue, Airbus Military A400M, www.flug-revue.rotor.com/FRTypen/FRFLA.htm, last updated, June 11, 2003, accessed January 5, 2006. Arms deal dissident Richard Young costs the latest (1999-vintage) C-130J Super Hercules at US$60 million each new and the eight A400Ms at an average of US$270 million each, or 4.5 times more expensive than the C130J.

• Max internal fuel:	nn.
• Max external fuel:	nn.
• Refuelling capacity:	Two wing mounted drogues, suitable for helicopters and fast jets.
• Cargo hold length:	23.2m.
• Cargo hold width:	4m.
• Cargo hold height:	3.85m.
• Cargo hold volume:	356m3.
• Max cargo weight:	37mt.
• Cargo capacity:	Nine 88x108inch pallets and 54 troops, two Ratel ICV, one mobile crane or Rooikat armoured car, one dump truck & excavator, one semi-articulated truck with 20ft container, two Agusta A109, or one Oryx (rotor head removed).
• Passengers:	116 paratroops with full equipment, 66 stretchers with 25 medics.
Performance	
• Take-off to clear 15m:	4500ft.
• Landing from 15m:	2250ft.
• Rate of climb:	nn.
• Service ceiling:	40,000ft.
• Max cruise altitude:	11,278m
• Max operating speed:	nn.
• Max cruise speed:	780km/h.
• Max range at cruise speed:	4170km with 30mt payload, 6110km with 20mt.
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	
• Make:	EuroProp International (a Rolls Royce, Snecma Moteurs, MTU Aero Engines and Industria de Tubopropulsores joint venture).
• Model:	TP400-D6.
• Type:	Turboprop.
• Number:	4.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	10,000.
• Propeller:	Ratier Figeac FH386 with eight composite blades.
Hard points:	One under each outer wing for a Cobham 908E refueling drogue pod.
Armament:	none.
Other attachments:	none.
Comment:	Previously known as the Future Large Aircraft, the A400M has been long in the coming. A European Staff Requirement was drawn up as long ago as 1993 but only signed in 2003. Production was scheduled to start in 2001 with deliveries starting this year (2006), but has slipped to 2007 and 2009

respectively. Airbus argues that modern air forces have insufficient airlift capability – a fact most readily admit – and that they are often forced to supplement the shortfall through the *ad hoc* lease of commercial outsize freighters – often at a premium and often from dodgy operators flying machines of indeterminable flightworthiness. Alternatively, they are overly dependent on the US Air Force.

The aircraft was designed, Airbus literature say, to meet the "harmonised requirements of the armed forces of Europe as specified in the ESR". The literature also notes the procurement of military equipment can "often be an overly cumbersome and bureaucratic process, which can itself contribute to programme risk, delay and cost." As a result, Airbus Military is using a methodology borrowed from its commercial sister to keep the project within specification and cost. Advanced technology is only being used where its use can clearly demonstrate added value. For this reason fly-by-wire technology is included. Turboprop propulsion was selected as this is known to be 20% cheaper to operate than the equivalent turbofan. Airbus further argues that development cycles in civil aviation is shorter and occur more often than in military programmes. "A civil-based programme is therefore more likely to represent the current state-of-the-art." Airbus currently has bragging rights t 52% of the world's commercial aircraft market and, on average, develops a new aircraft every three years.

Explaining the choice of size, Airbus explains the A400M "has been sized to have the best balance of cargo load weight and volume. This enables the aircraft to achieve an average per sortie payload of around 70% of total aircraft payload. Only the A400M matches its maximum payload, and therefore aircraft weight, to the required 'outsize' volume of today's modern loads. This is important as an aircraft's weight largely determines its acquisition and lifetime maintenance costs." Size-wise the aircraft fills a niche between the Boeing C17 Globemaster III and the Lockheed Martin C130, arguably offering C130-type economy with a C17-type load capability. The C17 is enormously expensive, each costing the USAF US202.3 million (in constant 1998 dollars). To date, its only export success has been the lease, not sale, of four to the British Royal Air Force.

As a strategic/tactical airlifter, design considerations for the former includes long range, a high cruise speed and a large cargo hold with a high maximum payload. As a tactical transport, it has good short- and soft-field and low speed performance as well as autonomous ground operation.

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Airbus believes the aircraft is appropriate for South Africa as the "existing transport fleet of the SAAF does not respond to future airlift requirements". They add that the present fleet has an inadequate range and payload capability, that cargo hold cross sections are too small for modern loads and that the fleet

	is unable to perform tactical and strategic missions (Airbus emphasis). They emphasise that the A400Ms large load and volume capability means fewer sorties, its long range fewer stops, its high cruise speed fewer hours, its short & austere airfield capability a greater choice of airheads, its low-level tactical flight enhanced survivability and its autonomous ground operations self reliance. The South African Government is keen on the deal as it sees the resultant industrial participation as key to its aviation industry expansion plans. It has been reported that if South Africa bought all 14, it will have the right to supply 7.2% of the value of the about-200 A400M aircraft scheduled to be produced so far. The numbers are difficult to reject considering Denel's continued precarious financial position and government's continued commitment to its survival – motivated as much by the political need to retain jobs as stimulating the hi-tech sector of industry, supporting the military and just plain, old-fashioned pride. "The A400M initiative is truly a lifeline for the SAAF and will, together with future decisions on the transport aircraft mix, rejuvenate the SAAF's transport capacity," the CAF, LTG Gagiano said in April 2005.

Table 10C.25: The Airbus A400M.

The following is a (very) rough extract from an Afrikaans article that appeared in *Beeld*: (23 July 2007)

The aiforce will pay R11.9 billion for the eight new Airbus A400M cargo aircraft, more than the previous amount of R6.6 billion.

The airforce acknowledged the amount this past week, as well as details of the brand new squadron which will fly the aircraft from AFB Waterkloof.

Mr Alec Erwin, Minister of Trade and Industry, said in 2005, shortly after the contract was signed, that South Africa had options to purchase a further six aircraft, besides the initial eight ordered. This means that the amount of R11.9 billion is for 14 aircraft.

Mr Helmoed-Römer Heitman, a military analyst, said yesterday that no decision had been made regarding the additional aircraft.

Negotiations were still underway to determine if Waterkloof was the best base for new infrastructure, considering the surrounding terrain is susceptible to dolomite sinkholes.

According to Major Ronald Maseko, airforce spokeman, the cost of new buildings, hangers and workshops were included in their project costs.

Other options for the squadron include the Louis Trichard (AFB Makhado) and bloemfontein airforce bases.

The last mentioned already houses the multi-engine flying school and would be an obvious choice.

According to Maseko, Airbus' military division (AMSL) had already experienced various technical and engineering challenges during the development of the new model, airbus' first military transport aircraft. This was, according to him, normal and could mean that the first flight of the first aircraft could be delayed. Subject to delays, the first flight is expected in November 2010.

According to Maseko, the new aircraft will require between 10 and 12 aircrew.
A special eight month training course will be held next year. Airbus will carry all the airforces costs in connection with the training.
The airforce foresees that the current C-130 Hercules crew will not have a prbelm converting to the advanced A400M.
Maseko said that there was no truth in the rumour that commercial pilots would be contracted by the airforce if the current shortage of pilots continued.

Denel Bateleur

Type:	Medium altitude, long endurance (MALE) unmanned aerial vehicle (UAV).
Country of origin:	South African.
First flight:	Scheduled for early 2006. DID IT?
Delivered to the SAAF:	Not yet ordered.
Associated project name(s):	nn.
Numbers:	To be decided.
Cost:	To be determined.
Crew:	Unmanned.
Major dimensions & weights	
• Wingspan:	15m.
• Length:	nn.
• Height:	nn.
• Wing area:	nn.
• Basic empty weight:	nn.
• Max take-off weight:	1mt.
• Max landing weight:	nn.
• Max internal fuel:	nn.
• Max external fuel:	nn.
• Max cargo weight:	0.2mt.
Performance	
• Take-off to clear 15m:	395m.
• Landing from 15m:	nn.
• Rate of climb:	nn.
• Service ceiling:	Greater than 8000m (25,000ft).
• Max cruise altitude:	
• Max operating speed:	nn.
• Max cruise speed:	250km/h (115mph).
• Loiter speed:	120km/h.
• Max range at cruise speed:	Up to 750km (466 miles).
• Endurance:	18 to 24hrs.
• Stall speed:	nn.
• G-loads:	nn.
• Wing loading:	nn.
• Thrust:	nn.
• Bypass ratio:	nn.
• Thrust/weight ratio:	nn.
Engine Specifications	

• Make:	Rotax or Subaru.
• Model:	914 or EA82T.
• Type:	Piston.
• Number:	4.
• Compression ratio:	nn.
• Engine diameter:	nn.
• Engine length:	nn.
• Dry weight:	nn.
• Power turbine rotor speed:	nn.
• Shaft horsepower:	10,000.
• Propeller:	1.7m diameter three-blade variable pitch.
Hard points:	None known.
Armament:	None as yet.
Payload options:	Current payloads include the Argos 410 EO/IR system with optional laser rangefinder and the Goshawk 350 EO/IR, also with optional laser rangefinder. The system can also carry a laser designator, an ELINT/COMINT sensor package and synthetic aperture radar.
Comment:	Denel and the SA Air Force have hopes of bringing into service the Bateleur (snake eagle) in the next decade as a maritime and border patrol, electronic warfare and general surveillance platform. The Bateleur can potentially fill a number of roles and missions. These include real-time day and night electro-optical and infrared surveillance, ELINT and COMINT, airborne communications relay, photo reconnaissance, target location and target designation, maritime and coastal patrol, border patrol, search and rescue, battlefield surveillance, artillery fire support and (battle) damage assessment. A role not stipulated yet, but easy to add would be weapons platform. Take-off and landing are to be automatic on paved runways – which should be at least 400m long. Landing gear is retractable, construction is composite and modular. The entire aircraft, when dismantled, fits into a standard 6m ISO container. Current modules include: central fuselage, payload (forward module), propulsion (rear), tailplane, starboard and port main wing modules. One scenario under which the Bateleur can fulfil a naval MPA function is deploying the system to the coast, where it would be launched and retrieved by a naval shore party operating from one of the many airstrips that dot the South African coastline. Once out at sea and within range of a patrol corvette, the aircraft will start relaying data gathered to the ship for analysis and action – all four craft should by then have their own rotary UAVs and using a common interface, should encounter no problems downloading the data – or even taking over control of the UAVs flight operations. In this way, it will allow the ship to patrol a larger area than possible by any other means and will allow the ship a stand-off and even a mid-course guidance ability unrivalled by shipborne aircraft or UAVs. A putative armed model, fitted with a machine gun and one or more anti-tank guided munitions –

	say the Denel Mokopa – should be able to detain or delay even the most aggressive fisheries poacher while the ship – or some from the Department of Environmental Affairs – rush up to effect the arrest. Future designs, including a HALE (high altitude, long endurance) model, fitted with SAR and a datalink could meet a putative airborne command and control need, while UAVs fitted with an ELINT/COMINT suite – and a datalink – would obviate the need for manned EW aircraft.

Table 10C.26: The Denel Batteleur.

Ordnance

An index of SAAF arms:

Missiles
- Air-to-air
- Air-to-surface

Rockets
Bombs
Guns

Air-to-air Missiles

Denel V3D[46] Upgraded-Darter (U-Darter)[47]

Type:	Short-range third-generation all-aspect infra-red guided air-to-air missile.
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	From 1997.
Numbers:	nn.
Assoc. project name(s):	nn.
Cost:	nn.
System components:	Missiles, launchers O-, I- and D-level support equipment.
General:	The system consists of two or four missiles per aircraft. The missiles may be selected individually by the pilot or auto-selected by the system. The pilot may designate the target by using a helmet sight, the aircraft's radar or the missile's scan feature. When the target has been designated to the missile, its automatic lock-on feature enables it to track the target, and the pilot may fire at his convenience. The missile's seeker position is displayed in the HUD (head up display), enabling the pilot to confirm that the correct target is being tracked.
Integrates into:	Avionics data bus, e.g. MILSTD 1553.
Acquisition modes:	Cage, autoscan or helmet/radar designation.

[46] SAAF designation.
[47] Denel designation.

Guidance:	Two-colour IR plus processing for decoy rejection.
Missile:	
Range:	0.4 to 10km.
Dimensions:	
Length:	2.748m (8ft 38in).
Diameter:	0.16m (6.3in).
Wingspan:	0.66m
Weight:	96kg (launch).
Airspeed:	Greater than Mach 1.5.
Warhead:	17kg.
Fuze:	Active laser.
Penetration:	nn.
Launcher:	
Length:	2.7m.
Weight:	38kg.
Fitted:	Wing-tip or pylon.
Comment:	The SAAF's current short range air-to-air missile, the U-Darter has been developed from the V3C Darter. Changes include increased weight, warhead, speeds, a digital autopilot and an improved guidance seeker within the same dimensions of the Darter. The guidance unit consists of a dual-band cooled indium-antimonite IR seeker. Manoeuvrability is greater than 50g features three acquisition modes; cage, autoscan and helmet/radar designation.

Table 10C.27: The Denel U-Darter.

Denel (V3E) Agile-Darter (A-Darter) – in development

Type:	Short-range fifth-generation all-aspect infra-red guided air-to-air missile.
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	Not yet ordered.
Assoc. project name(s):	nn.
Numbers:	To be decided.
Cost:	Development cost reportedly US104 million (Brazil is providing US52 million on a 50:50 basis).
System components:	Missiles, launchers O-, I- and D-level support equipment.
General:	The A-Darter may be designated to a target using the aircraft's radar, a helmet sight, such as Denel's Guardian system, or the missile's autonomous scan feature id radar silence is required. The seeker's large look-angles and the airframe's agility makes high off-boresight helmet-designated firings possible. Long-range intercepts, beyond IR detection range, are possible using the lock-on after launch mode.
Integrates into:	LAU-7 launch rails and MILSTD 1553/1760 avionics databus.
Acquisition modes:	Cage, autoscan or helmet/radar designation.
Guidance:	Two-colour IR plus processing for decoy rejection.
Missile:	
Range:	0.4 to 10km.
Dimensions:	
Length:	2.98m (9ft 6in).
Diameter:	0.166m (6.3in).
Wingspan:	0.488m.
Weight:	89kg (launch).

	Airspeed:	Greater than Mach 1.5.
	Warhead:	17kg.
	Fuze:	Active laser.
	Penetration:	1m rolled homogenous armour with explosive reactive armour (ERA).
Launcher:		
	Length:	nn.
	Weight:	nn.
	Fitted:	Wing-tip or pylon.
Comment:		The A-Darter, expected to become the V3E upon entry into SAAF service, is a fifth-generation missile system, is currently in the development phase. It was in 2006 being jointly funded by South Africa and Brazil. In September 2006, BAE Systems announced Denel had selected its SiIMU®02 solid-state inertial measurement unit to provide mid-course guidance for the A-Darter. "We have found, in BAE Systems, an excellent partner to supply A-Darter with a state-of-the-art inertial measurement unit," said Deon Olivier, product manager for air-to-air missiles for Denel Aerospace Systems in a BAE Systems press release. "Because the development of a new missile is such a long-term commitment, it is important for us to select our key supplier partners with great care." SiIMU®02 is a proprietary product of BAE Systems. The micro-machined electromechanical system inertial measurement unit measures angular rate and acceleration on each of three axes, providing affordable mid-course guidance and navigation. SiIMU®02 has been proven to withstand extremely harsh operating environments, including the survival of gun-launch shock up to 20,000g (20,000 times the force of gravity) for guided projectiles. Engineering News[48] reported in May 2006 that the Brazilian Air Force (FAB) expected the missile to enter service in 2015. Brazil has reportedly committed US52 million to complete the project; the amount is said to be half the funding needed to complete the development of the missile and bring it into service. Engineering News further reported that the A-Darter programme had been initiated by Denel in 1995 and that talks about Brazilian participation had started in 2003. According to Brazilian Colonel Nelson Gomes da Silveira the project will also include technology transfer from SA to Brazil. The missile will incorporate a high-agility airframe, greatly improved manoeuvrability and an extended range. An imaging IR seeker will ensure excellent countermeasure rejection and very accurate terminal guidance. Capabilities include lock-on after launch and memory tracking. Designation may be via the aircraft's radar, a helmet sight or the missiles autonomous scan feature if radar silence is required. Long-range intercepts, beyond IR detection range, are possible using the lock-on after launch mode. Use is to be made of thrust-vectoring tail controls. It has also been reported that targeting algorithms include advanced spatial filtering techniques (that 'see' the difference in size and shape between an aircraft and a decoy) and velocity profiling (to sense the difference in speed between the target and a decoy). Initial developmental airframe firing tests have been undertaken from ground and air platforms. A-Darter will be integrated on the Gripen.

Table 10C.28: The Denel A-Darter.

[48] www.saairforce.co.za, Target date for missile service entry revealed, May 31, 2006.

Denel V4 R-Darter

Type:	All-aspect beyond-visual-range (BVR) active radar guided air-to-air missile.
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	Apparently from 1995.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	US1 million new in 2006[49].
System components:	Missiles, launchers, support equipment.
General:	The V4 medium-range fire-and-forget air-to-air missile is an all-aspect BVR weapon offering a look-down, shoot-down all-weather capability. It is currently the primary medium range armament of the SAAF's Cheetah C fighters. It is scheduled for retirement in 2010 and will not be integrated onto the Gripen. The V4 is designed to provide immunity against electronic counter-measures and has a growth path. The active radar seeker head, in conjunction with the radar onboard the aircraft, lets the pilot track multiple targets and launch missiles in quick succession. It is capable of two modes: lock on before or after launch. In the lock-on before launch for short-range engagements, the seeker can be slaved to the aircraft's radar or the pilot's helmet mounted cueing system. The seeker is activated before launch and guides the missile all the way to the target .In lock-on after launch mode, for long-range engagements, the missile employs inertial guidance immediately after launch until the seeker is activated and homes in on the target.
Integrates into:	MILSTD 1553 avionics databus.
Acquisition modes:	Radar, helmet cueing .
Guidance:	Inertial and active radar guided.
Missile:	
Range:	Greater than 60km.
Dimensions:	
Length:	3.62 m (11ft, 11 inch).
Diameter:	0.16m (6.3 inch).
Wingspan:	
Weight:	120kg
Rocket motor:	Boost-sustain, low smoke.
Airspeed:	nn.
Warhead:	nn.
Fuze:	Proximity or impact.
Penetration:	nn.
Launcher:	
Length:	2.7m.
Weight:	38kg.
Fitted:	Pylons or under belly.
Comment:	Despite repeated denials from Denel that the V4 is a version of Israel's Rafael Derby, South African engineers working on the project have always insisted the system was indigenous. However, a Cabinet decision in 2003[50] confirmed the continued need for Israeli assistance in the programme, belaying the denials. It is

[49] According to Engineering News quoting Brazilian sources in March 2006.
[50] Cabinet Memorandum No 3 of 2003, noted in the NCACC's July 2005 Submission to the Portfolio Committee on Defence on its activities for the years 2003/4, found at www.pmg.org.za/docs/2005/050802nacc.htm, posted August 2, 2005, accessed August 6, 2005.

	not clear, at the time of writing, if Armscor is sponsoring a successor system. Engineering News in March 2006 quoted the Brazilian aviation journal, Asas (wings), as saying South Africa had sold Brazil a batch of ten Denel V4 BVRAAM missiles for test purposes. The missiles were reportedly near their expiry date at the time and would soon have had to be fired or scrapped. Instead they were sold to Brazil for somewhere between US100,000 and US200,000 each. "The second-hand V4s will be used for test launches from the FAB's modernised F-5EM fighters. It is now looking almost certain that the FAB will adopt the R-Darter as its BVRAAM," the news journal enthused.

Table 10C.29: The Denel R-Darter.

MBDA Mistral ATAM (Air-to-air Mistral)

Type:	Short-range all-aspect infra-red fire-and-forget guided air-to-air missile for helicopters.
Country of origin:	France.
First flight:	nn.
Delivered to the SAAF:	nn.
Numbers:	nn.
Assoc. project name(s):	nn.
Cost:	nn.
System components:	Missiles, launchers, support equipment.
General:	Mistral ATAM is based on the Mistral 2 man portable air defence system and features a fire-and-forget engagement mode, ease of use and unrivalled kill probability. The system is based on two launchers, each containing two missiles. It can be operated in the whole flight envelope of the parent helicopter at speeds of up to 200 knots and at altitudes exceeding 15,000ft. The ATAM has a large off-boresight capability, together with the ability to aim the missile seeker "very precisely" at a given target. The missile has a shaped trajectory, in order to intercept targets top-down or at long range and the crew can select the proximity fuze mode.
Integrates into:	Databus.
Acquisition modes:	Cued.
Guidance:	Infrared passive homing.
Missile:	
Range:	0.6 to 6.5km.
Dimensions:	
Length:	1.86m.
Diameter:	0.09m.
Wingspan:	0.2m
Weight:	200kg (including four missiles), each missile 18.7kg.
Rocket motor:	Solid rocket booster.
Airspeed:	Greater than Mach 2.7.
Warhead:	3kg, high explosive with tungsten ball projectiles.
Fuze:	Laser proximity, impact.
Penetration:	nn.
Launcher:	
Length:	nn.
Weight:	nn.
Fitted:	Pylons.

Comment:	The ATAM can be fitted to attack helicopters as well as utility and lightweight helicopters.

Table 10C.30: The MBDA ATAM.

Air-to-surface Missiles

BAE Systems Sea Skua

Type:	Short-range, anti-ship missile.
Country of origin:	United Kingdom.
First flight:	c1982.
Delivered to the SAAF:	To be ordered.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Missiles, launchers, support equipment.
General:	The Sea Skua is the main anti-surface weapon of the Lynx-series maritime helicopter. The missile can be set to travel at one of four pre-set heights (chosen according to weather conditions). The firing sequence begins with the Lynx illuminating and designating the target with its onboard radar. The missile is then fired and homes on the reflected radar energy. Closer to the target, the missile pops up, acquires the target for itself and dives down. On impact, it penetrates the hull before detonating. Some literature credits the missile with being able to sink vessels of up to 1000mt displacement and disabling ships even larger.
Integrates into:	Databus.
Acquisition modes:	Radar.
Guidance:	I-band semi-active radar homing.
Missile:	
Range:	2-25km.
Dimensions:	
Length:	2.5m.
Diameter:	0.25m.
Wingspan:	0.72m
Weight:	145kg.
Rocket motor:	Solid fuel booster and sustainer.
Airspeed:	Mach 0.8+ (1050km/h).
Warhead:	20/28kg blast/fragmentation.
Fuze:	Delayed impact.
Penetration:	nn.
Launcher:	
Length:	nn.
Weight:	nn.
Fitted:	Pylons.
Comment:	Twelve were fired at the Iraqi navy during the 1991 Gulf War and 12 hits were recorded, the detonations sounding not only the death knell of Saddam Hussein's fleet but also of the Fast Attack Craft as a viable surface warfare combatant. Although primarily a helicopter-borne air-to-surface missile, ship-launched versions exist and can be fitted to small vessels, such as the SA Navy's T-Craft.

Table 10C.31: The BAE Systems Sea Skua.

Denel ZT6 Mokopa[51] (in development)

Type:	Long-range, precision-guided multi-purpose missile.
Country of origin:	South Africa.
First flight:	1999.
Delivered to the SAAF:	In development.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Missiles, launchers, support equipment.
General:	The Mokopa was designed as a state-of-the-art long-range, precision-guided anti-armour missile. "It may, however, be used effectively against other high-value ground, air or naval targets from a variety of launch platforms such as land vehicles, shore battery installations, naval vessels and fixed wing aircraft," a Denel sales brochure reads. The modular design of the missile allows for different warheads (e.g. penetration, fragmentation or anti-armour optimised for the type of target. "Furthermore, the modularity of the missile system facilitates pre-planned upgrades, such as mmW (millimetre wave) and IIR (imaging infra-red) seekers, ensuring a continued presence in the market." The current, developmental, version of the missile utilises semi-active laser (SAL) guidance, requiring either the launch platform or someone else to illuminate the target with a laser designator. Pre-planned upgrades include a millimetre-wave radar (mmW) seeker and a two-colour imaging infrared (IIR) seeker. The missile features two launch modes, lock-on before launch (LOBL) and lock-on after launch (LOAL). LOBL is the older, more conventional mode of missile launching, where the target has to be illuminated by the launch platform before launch.[52] LOAL, on the other hand, allows the launch platform to launch the missile even though it may not be in sight of the target. In the case of the SAL version, the launch platform would then have to illuminate the target prior to the missile arriving in its vicinity, or an airborne or ground-based party in sight of the target and equipped with a laser designator will have to guide the missile in. This second method of launching greatly reduces the time the launch platform s exposed to enemy observation or fire.
Integrates into:	Databus.
Acquisition modes:	LOBL, LOAL.
Guidance:	Semi-active laser homing.
Missile:	
Range:	10km.
Dimensions:	
Length:	1.995m.
Diameter:	m.
Wingspan:	
Weight:	49.8kg.
Rocket motor:	nn.
Airspeed:	nn.
Warhead:	Currently tandem high explosive anti tank; reference is made in sales literature to penetration, anti-ship and fragmentation warheads.

[51] Black mamba, South Africa's deadliest snake, and aggressive by nature too.
[52] Wikipedia, Mokopa, www.wikipedia/org/wiki/Mokopa, accessed on January 5, 2006.

	Fuze:	nn.
	Penetration:	>1.350m rolled homogenous armour.
Launcher:		
	Length:	nn.
	Weight:	nn.
	Fitted:	Pylons.
Comment:		Although the Euromissile HOT is reportedly cleared for use on the Rooivalk, the Mokopa has always been touted as the helicopter's primary armament. It is reported that "full scale" development began in November 1996, apparently due to the then-ongoing United States arms embargo against South Africa that made the acquisition of the AGM-114 Hellfire impossible. Partly a matter of pride and partly a jibe at the Americans, the missile's supporters like to disparage the latter of the two missiles and the former is often cited as superior, usually without corroborating evidence or reference to the model of Hellfire being criticised. The American missile has been in service since the 1980s and has gone through several iterations and a number of conflicts. The Mokopa is still in development and has neither a service nor a combat record. Hagiographers need to beware that they do not do the missile a disservice. The first air-launched tests from a Rooivalk helicopter took place in 1999, with the first guided tests following in 2000[53]. The missile is considered to be very accurate, with an accuracy believed to match that of the company's other anti-tank missile, the Ingwe, at around 300 mm CEP (circular error probable) at maximum range. Its range is also said to long for an anti-tank missile – at 10 km it is greater than that of most current competitors, including the Hellfire (max 9km).[54] The range is achieved through an advanced solid-fuel composite rocket motor that has a relatively slow burning rate compared to similar motors – as well as being largely smokeless.

Table 10C.32: The Denel Mokopa.

QUESTION 1046

WRITTEN REPLY

DATE OF PUBLICATION: FRIDAY, 26 JUNE 2007

INTERNAL QUESTION PAPER NO.: 23-2007

ADV H C SCHMIDT (DA) TO ASK THE MINISTER OF DEFENCE

(a) What is the current status of the SA Air Force (SAAF) (i) Project Impose and (ii) the Rooivalk attack helicopter programme and (b)(i) what is the (aa) development and (bb) financial status of the Makopa air-launched anti-tank missile and (ii) what is the related project called;

what projects other than Mutchkin are currently underway in the SA Medical Health Services (SAMHS) environment;

what are the relevant details on (a) Project Chamber (CMIS), (b) Metamorphosis (SA Navy), (c) Macaw (SAAF), (d) the SAAF Astra avionics upgrade and (e) plans to acquire side-by-side trainer

[53] Ditto.

[54] Note though that the MBDA Brimstone, the fast jet version of the Hellfire, can range to 32km.

for the SAAF including the (i) planned numbers of equipment and (ii) rand values for the above projects?
-------ooo0ooo------- N1506E

REPLY

(a)(i) The development of a local combat support helicopter is conducted under Project IMPOSE, and contracted to Denel to deliver twelve aircraft. All twelve aircraft have been delivered, but the development program has not been completed yet, and a series of fleet retrofits are scheduled to incorporate the changes as the engineering process releases them.

In order to allow for the earliest readiness for operational deployments, a Deployment Baseline was contractually agreed upon for delivery by the end of May 2008. After this date the system will be ready for operational use, even though the development of some aspects will continue until 2009.

(ii) Development progress on the Rooivalk program appears to be hampered by problems at Denel.

(a)(ii) The project name of the Rooivalk helicopter program is IMPOSE (refer to sub-par above).

(b)(i) Project IMPOSE was initially mandated to fund the production baseline and industrialisation of the missile, but due to funding problems at Denel a decision was made that Project IMPOSE would fund the allocated baseline and Denel the production baseline. The allocated baseline is nearing completion with a few deliverables outstanding. Denel has to provide the remainder of the funds to complete the development and industrialisation activities, and current best estimates by the company indicate that the first operational Mokopa missile will be available in July 2009.

(b)(ii) The SANDF has spent Rm 120 (2007/08 Rand value) to date on the Mokopa development program, with a further Rm 4,6 due to be spent in financial year 200/08. An amount of Rm 70 (2007/08 Rand value) has been reserved for the acquisition of operational Mokopa missiles once the development is complete. Denel is expected to spend a further Rm 98,25 (2007/08 Rand value) to complete the development of the missile. All figures exclude VAT and other statutory costs.

(b)(iii) The Mokopa missile is developed under the auspices of Project IMPOSE, the Rooivalk program, and does not have its own project designation.

Denel ZT3 Ingwe[55]

Type:	Multipurpose long-range beam-riding guided missile.
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.

[55] Leopard in isiZulu.

Numbers:	nn.
Cost:	nn.
System components:	Missile, laser projection unit (integrated with aircraft system) and guidance and control units (integrated with aircraft system), support equipment.
General:	The ZT3 is a laser beam-rider. The missile automatically determines its own position in the laser beam and manoeuvres onto the line of sight (LOS). The missile follows the LOS until the target is hit. Later models have tandem warheads capable of defeating ERA. The sighting system can vary from a non-stabilised optic sight for light vehicles to a stabilised day/night sight mounted on moving platforms such as helicopters. Automatic target modules can be added to ensure fully automatic missile guidance after target lock-on by the operator.
Integrates into:	Databus.
Acquisition modes:	Pilot designation.
Guidance:	Laser beam riding.
Missile:	
Range:	0.25 to 5km.
Dimensions:	
Length:	1.75m.
Diameter:	0.127m.
Weight:	28.5kg (launch).
Rocket motor:	nn.
Airspeed:	Over 200km/h.
Warhead:	Tandem high explosive anti tank.
Fuze:	nn.
Penetration:	1m rolled homogenous armour with explosive reactive armour (ERA).
Launcher:	
Length:	nn.
Weight:	nn.
Fitted:	Four-round box launcher fitted to pylons.
Comment:	A copy of the Israeli Mapatz ATGM, itself an improved version of the US TOW. The ZT3 is fired from a four round box that can be mounted on the Rooivalk, Oryx and A109. According to reports, Denel in 2002 made a number of improvements to the Ingwe, making it easier to fire from moving helicopters. During the subsequent validation tests, the Ingwe was fired at speeds in excess of 200 km/h and included firings with the helicopter manoeuvring after launch at various altitudes. In 2004 this shoot-on-the-move capability was also demonstrated on a ground vehicle. In May 2005 Denel introduced new hardware that allows easier software updates. In addition, the improved missile can now recognise whether it is being fired from the ground or air and adjust its trajectory algorithms accordingly. In mid 2005 Denel was working towards making multiple, simultaneous launches, reportedly up to four at a time.

Table 10C.33: The Denel Ingwe.

Denel Mupsow[56] (presumed in development)

Type:	Multipurpose precision-strike long-range cruise missile (sic).
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	nn.

[56] MUlti Purpose Stand Off Weapon

Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Missile, launcher, support equipment.
General:	The Unofficial SAAF website describes Mupsow as a “multi-purpose, surgical-strike weapon, designed to neutralize enemy targets such as airfields, bunkers and command-and-control centres at stand-off ranges. Pinpoint accuracy is achieved by using an advanced navigation and terminal guidance technology (data link, choice of TV [television], IIR [imaging infra-red] or mmW [millimetre wave] seekers).” The airframe is to be made out of composites and the missile powered by a turbine jet. System features listed on a 1997 sales brochure included Mupsow’s modular design “with choice of seekers and payload”, its stand-off capability that enhanced launch aircraft survival, its expected adverse weather and day/night capability and its ability to operate in “fire-and-forget” as well as “man-in-the-loop” modes. Mission preparation would have involved programming the weapon with navigation and targeting data, allowing the weapon to autonomously navigate itself to the target area (along a pre-programmed flight path) where its seeker can then acquire and designate the pre-selected target. Launch, from a variety of platforms can be at altitude, or at low level. It also appears Denel contemplated a ground-launched version of this cruise missile. Attack profiles would have included dive attack and “lay down” missions. It appears the missile would also have been capable of sending back sensor data to the launch aircraft for reconnaissance and battle damage assessment purposes.
Integrates into:	MILSTD 1553B databus.
Acquisition modes:	Designated.
Guidance:	“Advanced navigation and terminal guidance technology”.
Missile:	
Range:	Reportedly up to 150km.
Dimensions:	
Length:	4.92m.
Height:	0.480m
Width:	0.641m.
Wingspan:	1.9m
Weight:	1.2mt.
Turbo motor:	nn.
Airspeed:	nn.
Warhead:	Various under consideration, such as anti-runway, unitary and fragmentation .
Fuze:	nn.
Penetration:	nn.
Launcher:	
Length:	nn.
Weight:	nn.
Fitted:	Four-round box launcher fitted to pylons.
Comment:	The status of this weapon, as well the earlier “Torgos”, a word with no particular known meaning, is not known. Both entries have been deleted from Denel’s website. Development reportedly began in 1991 and was funded by the SAAF. The Mupsow is thought to be an extension of the H2 stand-off weapon program. The Torgos appears to have been a smaller successor to Mupsow, weighting around 980kg and ranging 300km with a reported 450kg fragmentation warhead. Pinpoint accuracy was to have been through GPS-INS (Global Positioning System – Inertial Navigation System) midcourse guidance and a thermal imaging terminal seeker that can operate autonomously or by remote control over a data link.

Table 10C.34: The Denel Mupsow & Torgos.

Rockets

Thales Forges Zeebrugge FZ90 Folding Fin Aerial Rocket

Type:	Unguided folding fin aerial rocket (FFAR).
Country of origin:	Belgium.
First flight:	nn.
Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	**R28 087 656,13**[57].
System components:	Rockets, pods, support equipment.
General:	.
Integrates into:	.
Acquisition modes:	.
Guidance:	none.
Rocket:	
Range:	6km (slant).
Dimensions:	
Length:	1.06m (3 ft 5¾ in).
Diameter:	0.07m. (2.75in).
Weight:	nn.
Turbo motor:	nn.
Airspeed:	nn.
Warhead:	Various: Includes high explosive (HE) anti tank (HEAT); HE general purpose; HE MPSM (multipurpose submunition) anti-armour/anti-personnel (nine submunitions); flechette (darts); target marking; smoke; chaff; illumination, and practice.
Fuze:	Various.
Penetration:	nn.
Launcher:	M159
Length:	1.687m.
Diameter:	0.48m.
Weight:	73kg.
No. of rockets:	19.
Fitted:	Pylons.
Comment:	Developed by Forges de Zeebrugge of Belgium from the General Dynamics Hydra 70. The FZ70 is considered superior o the SNEB 68mm FFAR previously used. These had a slant range of 1.6km. The US is developing a laser homing version of the rocket, essentially turning it into a low cost precision guided missile. The US Army's Advanced Precision Kill Weapon System is expected to have a CEP (circular error probable) better than 1m. The original programme, launched in 1996, was terminated in April 2005 because of poor test results. A new programme was then launched.

Table 10C.35: The Thales FZ70 FFAR.

[57] Armscor, http://www.armscor.co.za/abs/contractdetail.asp?Requirement_ID=10746, accessed January 10, 2008.

Bombs

Denel Raptor 2 (not in service)[58]

Type:	Precision guided bomb.
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	Not in service.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Bomb (guidance unit, warhead, rear fuselage, rocket motor set), communications pod, pylons, control kit (control unit, monitor, GPS antenna), support equipment.
General:	Raptor 2 is an upgrade of the Raptor 1 system, the later version being fitted with a rocket pod giving it greater range and manoeuvrability than the original. Navigation can be autonomous, by waypoint or by using GPS-assisted inertial means. The communications pod and control kit can be mounted on the launch aircraft or a second platform that can control the Raptor from a distance of up to 250km. The CEP (circular error probable) is said to be 3m ad the maximum launch altitude is given as 35,000ft.
Integrates into:	Dedicated weapons pylon.
Acquisition modes:	Various.
Guidance:	GPS-INS (Global Positioning System – Inertial Navigation System), passive television in terminal phase. Upgradeable to imaging infra-red or radar.
Bomb:	
Range:	Greater than 120km claimed.
Dimensions:	
Length:	3.650m
Wingspan:	3.7m (deployed).
Weight:	1.2mt.
Rocket motor:	Jettisonable underslung rocket pod.
Airspeed:	nn.
Warhead:	Unitary, fragmentation, penetration.
Fuze:	Various.
Penetration:	nn.
Launcher:	Pylons.
Comment:	A modern variation of the German Henschel Hs293 rocket glide bomb of World War Two. In production, according to a May 2000 Denel brochure, but not in SAAF service.

Table 10C.36: The Denel Raptor.

Denel Umbani[59] bomb kit

[58] This system is included here should the SAAF acquire the weapon.
[59] Lightning in isiZulu.

Type:	Precision guided bomb kit.
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Strap-on wing kit, guidance system, optional rocket motor, support equipment.
General:	Umbani is a low cost, high-performance bomb-kit that can be used with any Mk82 250kg or Mk83 500kg bomb and can be adapted to suit a range of missions and targets. Umbani is advertised as an all-weather, day and night system and is fitted with a GPS/INS (Global Positioning System – Inertial Navigation System) capability. Increased accuracy can be obtained using an imaging infra-red (IIR) sensor with an automatic target recognition capability or a semi-active laser seeker. The system can also be fitted with a radio frequency proximity fuse for area targeting, using a pre-fragmented warhead. Typical imagined mission sets include offensive counter-air such as demolishing hardened aircraft shelters – and parked aircraft or cratering runways. With the appropriate fuse the bomb can also be turned into a large anti-personnel or anti-material mine. On the battlefield, the kit can be employed against air defence units or supply columns. Buildings, bridges, refineries, industrial areas and dams would also make useful targets. Accuracy is said to be within 3m circular error probable (CEP) when using laser or IIR. The addition of a rocket motor extends the stand-off range for the mother aircraft or allows low-level launch. Denel says various seekers, fuze and warheads may be fitted. The bomb can manoeuvre during the glide phase.
Integrates onto:	Any Mk82 or Mk83 type aircraft bomb.
Acquisition modes:	Various.
Guidance:	Various.
Kit:	
Range:	Up to 120km claimed.
Dimensions:	nn.
Weight:	nn.
Rocket motor:	Optional.
Airspeed:	nn.
Warhead:	Any Mk82 or Mk83 or equivalent.
Fuze:	Various.
Penetration:	nn.
Launcher:	Pylons.
Comment:	According to Denel, the system was designed with ease of use in mind and has low maintenance and life-cycle costs. A deadly, but small package that can be delivered, as the name suggests, like lightning. The system was offered for sale at Idex2005 in the United Arab Emirates. It is assumed the system is fully developed. It is not known whether it is in SAAF service.

Table 10C.37: The Denel Umbani.

Denel 4.5kg practice bomb

Type:	Practice bomb.
Country of origin:	South Africa.
First flight:	nn.

Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Bomb, pylon, support equipment.
General:	This bomb has a fibreglass and polyurethane body filled with steel shot which disintegrates on impact, leaving little debris on the target. A pyrotechnic charge marks the point of impact with smoke.
Integrates into:	Dedicated pylon.
Acquisition modes:	none.
Guidance:	none.
Bomb:	
Range:	nn.
Dimensions:	nn
Weight:	4.5kg.
Airspeed:	nn.
Warhead:	0.92g pyrotechnic charge in tail.
Fuze:	none.
Comment:	This bomb was designed to simulate the ballistic profile of the 250 kg low-drag bomb.

Table 10C.38: The Denel 4.5kg Practice Bomb.

Denel 12.5kg practice bomb

Type:	Practice bomb.
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Bomb, pylon, support equipment.
General:	This bomb has a fibreglass and polyurethane body filled with steel shot which disintegrates on impact, leaving little debris on the target. A pyrotechnic charge marks the point of impact with smoke.
Integrates into:	Dedicated pylon.
Acquisition modes:	none.
Guidance:	none.
Bomb:	
Range:	nn.
Dimensions:	nn
Weight:	4.5kg.
Airspeed:	Up to Mach 0.95nn.
Warhead:	0.92g pyrotechnic charge in tail.
Fuze:	none.
Comment:	This bomb was designed to simulate the ballistic profile of the 460 kg low-drag bomb.

Table 10C.39: The Denel 12.5kg Practice Bomb.

Denel 120kg low drag fragmentation bomb

Type:	Ballistic bomb.
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Fuze, casing, tail assembly.
General:	The bomb is comparable with the Mk81 series 250lbs weapons. It has a layer of steel balls cast in epoxy between the outer fibreglass casing and the inner RDX/TNT (60:40) core, 19,000 of them in the case of the 8.75mm variety. The bomb was manufactured with ball bearings of various sizes for different target sets. The blast generates overpressure of 100kPa over a radius of 20m. The bomb can be released at IAS between 150 and 600 knots, a g-loading of between -1.5 and +4g, dive angles between -60 and +45 and a maximum altitude of 12,200m (40,000ft).
Guidance:	Ballistic.
Bomb:	
Range:	Ballistic.
Dimensions:	
Length:	1.78m.
Diameter:	0.228m.
Fin span:	0.52m.
Weight:	
Explosives:	27kg.
Casing:	90.5kg.
Tail fin:	7.5kg.
Fuze:	Varies.
Total:	122.2kg.
Airspeed:	Up to 600 knots.
Fuze:	Proximity, impact, delay.
Penetration:	nn.
Launcher:	Pylons.
Comment:	This bomb, depending on the type selected, performs five to ten times better than the comparable steel-casing weapon in the anti-personnel or anti-material role.

Table 10C.40: The Denel 120kg Low-drag Fragmentation Bomb.

Denel 120kg low drag bomb

Type:	Ballistic bomb.
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Fuze, casing, tail assembly.

General:	The bomb is comparable with the Mk81 series 250lbs weapons. Unlike the fragmentation bomb, this weapon has a forged or cast steel casing containing 47kg of RDX/TNT (60:40). It can be fitted with a nose cone and cap to maximise penetration of concrete or steel structures and is produced with front and rear charging tubes for electrical fusing and an arming wire for mechanical fusing. The bomb can be fitted with an SA771 mechanical nose fuse which allows point detonation instantaneous fusing, delay time or delay action. The back-up SA772 tail fuse provides impact fusing and arming delay time in milliseconds. The bomb can be released at IAS between 150 and 600 knots, a g-loading of between -1.5 and +4g, dive angles between -60 and +45 and a maximum altitude of 12,200m (40,000ft).
Guidance:	Ballistic.
Bomb:	
Range:	Ballistic.
Dimensions:	
Length:	1.78m (including 0.663m tail unit).
Diameter:	0.228m.
Fin span:	0.52m.
Weight:	
Explosives:	47kg.
Casing:	nn.
Tail fin:	7.5kg.
Fuze:	Varies.
Total:	approximately 120kg.
Airspeed:	Up to 600 knots.
Fuze:	Proximity, impact, delay.
Penetration:	nn.
Launcher:	Pylons.
Comment:	A 4.5kg bomb is used in practice to simulate this weapon.

Table 10C.41: The Denel 120kg Low-drag Bomb.

Denel 460kg low drag bomb

Type:	Ballistic bomb.
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Fuze, casing, tail assembly.
General:	The bomb is comparable with the Mk83 series 1000lbs weapons. And consists of a cast steel casing containing 213kg of Torpex 4B. It can be fitted with a nose cone and cap to maximise penetration of concrete or steel structures and is produced with front and rear charging tubes for electrical fusing and an arming wire for mechanical fusing. The bomb can be fitted with an SA771 mechanical nose fuse which allows point detonation instantaneous fusing, delay time or delay action. The back-up SA772 tail fuse provides impact fusing and arming delay time in milliseconds. The bomb can be released at IAS between 150 and 600 knots, a g-loading of between -1.5 and +4g, dive angles between -60 and +45 and a maximum altitude of 12,200m (40,000ft).

Guidance:	Ballistic.
Bomb:	
Range:	Ballistic.
Dimensions:	
Length:	1.841m (body), 1.059m (tail unit).
Diameter:	0.355m.
Fin span:	nn.
Weight:	
Explosives:	213kg.
Casing:	225kg.
Tail fin:	28kg.
Fuze:	Varies.
Total:	Approximately 466kg.
Airspeed:	Up to 600 knots.
Fuze:	Proximity, impact, delay.
Penetration:	nn.
Launcher:	Pylons.
Comment:	A 12.5kg practice bomb is used to simulate the ballistic profile of this weapon during training (up to Mach 0.95).

Table 10C.42: The Denel 460kg Low-drag Bomb.

Denel CB470 cluster bomb (probably no longer in use)

Type:	Cluster bomb.
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Fuze, casing, tail assembly.
General:	The CB470 was intended for low-level attacks by high-speed aircraft against soft and semi-soft targets, such as troops, buildings, radar installations and vehicles. Once released, it ejects 40 6kg spherical bomblets which bounce on impact to a height of between one and six meters (depending on surface) before detonating. The container was designed to combine release at extremely low levels with carefully controlled bomblet dispersal. As a result, the typical footprint of a single weapon released at 1000 km/h from 30m over level ground is 250m long by 70m wide. The bomb can be dropped in level flight at speeds between 700 and 1000 km/h and from heights between 30m and 300m. The bomblets are fused by correct functioning of the ejection system, their charge only becoming active at speeds over 400 km/h and after two independent fuses have armed. The bomb can be jettisoned at speeds of over 280km/h and has a service ceiling of 18,000m The weapon is also drop safe and will not release any bomblets if dropped onto a solid surface from an altitude of 6m or less, neither will any of the bomblets explode.
Guidance:	Ballistic.
Bomb:	
Range:	Ballistic.
Dimensions:	
Length:	2.6m (including tail assembly).

Diameter:	0.419m.
Fin span:	0.64m.
Weight:	
Casing:	185kg.
Tail fin:	11kg.
Other:	4kg.
Total:	450kg.
Airspeed:	nn.
Fuze:	Delay.
Bomblets:	
Range:	Ballistic.
Dimensions:	
Diameter:	0.419m.
Weight:	
Explosives:	1.4kg (RDX/TNT).
Total:	6.3kg.
Fuze:	Two delay fuzes.
Penetration:	nn.
Launcher:	Pylons.
Comment:	The CB470 had a five year shelf life. It is likely all are now time-expired and therefore no longer operationally useable.

Table 10C.43: The Denel CB470 Cluster Bomb.

Reutech Defence Industries 145kg "Superkill" rocket-boosted low-drag bomb

Type:	Rocket-boosted ballistic bomb.
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Fuze, casing, tail assembly.
General:	Superkill is a boosted pre-fragmented bomb optimised for "toss" bombing. According to RDI, pre-fragmented bombs deliver shrapnel three times more lethal and with six times the kill zone of steel bombs, even of larger size. Conventional casing bombs deliver fragments of varying number and random distribution, whereas pre-fragmented ordnance deliver lethal fragments of a consistent number and distribution. Once released, the bomb is boosted by its rocket motor up to a distance of 16km, allowing its launch aircraft to stay out of the target's short and very-short range air defence envelope. The warhead contains 10,400 12.5mm hardened ball bearings, capable of penetrating 6mm of armour at short range. The bomb can be released at speeds of up to 600knots and 12,000m above ground level (AGL) and release pitch angles of up to 50deg. To reach 16km, a release speed of 585 knots is required, combined with a 48 degree release angle, four second ignition delay, a release height of 1500m AGL and a load factor of 4G.
Guidance:	Ballistic.
Bomb:	
Range:	Ballistic.
Dimensions:	

Length:	1.1m (body), 0.663m (tail unit).
Diameter:	0.273m.
Fin span:	nn.
Weight:	
Explosives:	27kg (RDX/TNT).
Casing:	nn.
Tail fin:	8kg.
Fuze:	Varies.
Total:	Approximately 145kg.
Airspeed:	Up to 600 knots.
Fuze:	Proximity, detonated between 5 and 25 above ground level (increments of five metres).
Penetration:	nn.
Launcher:	Pylons.
Comment:	Unguided stand-off weapon. Can be fitted with Umbani kit, making it a precision guided, rocket-boosted fragmentation bomb. Complies with MILSTD 810E.

Table 10C.44: The Reutech Defence Industries 145kg "Superkill" Rocket-boosted Low-drag Bomb.

Reutech Defence Industries "Superstop" M9201 ADBS 145

Type:	Rocket-boosted area denial bomb system (ADBS).
Country of origin:	South Africa.
First flight:	nn.
Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Fuze, casing, tail assembly.
General:	Superkill is a boosted pre-fragmented bomb optimised for "toss" bombing. According to RDI, pre-fragmented bombs deliver shrapnel three times more lethal and with six times the kill zone of steel bombs, even of larger size. Conventional casing bombs deliver fragments of varying number and random distribution, whereas pre-fragmented ordnance deliver lethal fragments of a consistent number and distribution. Once released, the bomb is boosted by its rocket motor up to a distance of 16km, allowing its launch aircraft to stay out of the target's short and very-short range air defence envelope. The warhead contains 10,400 12.5mm hardened ball bearings, capable of penetrating 6mm of armour at short range. The bomb can be released at speeds of up to 600knots and 12,000m above ground level (AGL) and release pitch angles of up to 50deg. To reach 16km, a release speed of 585 knots is required, combined with a 48 degree release angle, four second ignition delay, a release height of 1500m AGL and a load factor of 4G. On its descent, the multifunction proximity nose fuze is programmed to release a drag parachute at 1000m AGL. This reduces the descend velocity of the bomb and brings the weapon to near vertical. Depending on the fuze setting, the bomb will now explode at a preset altitude, which dramatically increases the lethal area of the blast – up to 600%. In aerial denial mode, the bomb will peg into the surface and will then act as a large shrapnel mine. The eventual detonation can be delayed for up to 150 hours. Anti-handling devices can be fitted to deter explosive ordnance disposers.
Guidance:	Ballistic.

Bomb:		
	Range:	Ballistic.
	Dimensions:	
	Length:	1.1m (body), 0.663m (tail unit).
	Diameter:	0.273m.
	Fin span:	nn.
	Weight:	
	Explosives:	27kg (RDX/TNT).
	Casing:	nn.
	Tail fin:	8kg.
	Fuze:	Varies.
	Total:	Approximately 145kg.
	Airspeed:	Up to 600 knots.
	Fuze:	Proximity, detonated between 5 and 25 above ground level (increments of five metres).
	Penetration:	nn.
Launcher:		Pylons.
Comment:		Unguided stand-off weapon. Typical targets are air bases, bridges, mountain passes and similar narrows and key points. The attack profile of the ADBS 145 is a low, below radar approach, in 4g pull-up and a release of 16kms from the target. After release, the aircraft turns and drops down to below radar again and returns to base. The ADBS 145 is now in a "Toss" mode and after a pre-set time, a rocket booster motor is ignited, thereby increasing the normal 8kms stand-off distance to 16kms. Complies with MILSTDs 810E, 331B and 1316B. Shelf life is ten years (in packaging, five years for rocket) and operating temperature is -40deg C (-30 for rocket) to +70.

Table 10C.45: The Reutech Defence Industries 145kg “Superstop” Rocket-boosted Low-drag Bomb.

“Paveway 745”

Type:	Laser guided bomb kit.
Country of origin:	United States.
First flight:	c1968.
Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Computer control group, warhead, airfoil group.
General:	A 1991 US Air Force study found that during World War Two it required up to 9000 bombs to hit a target the size of an aircraft shelter. By Vietnam the number was down to 300 and by the 1991 Gulf War, it ostensibly took a single laser guided bomb (LGB).[60] The Federation of American Scientists’ Military Analysis Network notes the development of laser guidance for weapons has dramatically improved the accuracy of delivery. With the simple addition of guidance kits, general purpose (or “dumb”) bombs are turned into laser-guided (or “smart”) bombs. A LGB kit consist of a computer-control group (CCG), guidance

[60] USAF, Reaching Globally, Reaching Powerfully: The United States Air Force in the Gulf War (September 1991), p. 55.

canards attached to the front of the warhead to implement steering commands, and a wing assembly attached to the aft end to provide lift.[61] LGBs are maneuverable, free-fall weapons requiring no electronic interconnect to the aircraft. They have an internal semi-active guidance system that detects laser energy and guides the weapon to a target illuminated by an external laser source. The designator can be located on the launch aircraft, on another aircraft, or on the ground.

"All LGB weapons have a CCG, a warhead (bomb body with fuze), and an airfoil group. The computer section transmits directional command signals to the appropriate canards. The guidance canards are attached to each quadrant of the control unit to change the flight path of the weapon. The LGB flight path is divided into three phases: ballistic, transition, and terminal guidance. During the ballistic phase, the weapon continues on the unguided trajectory established by the flight path of the delivery aircraft at the moment of release. In the ballistic phase, the delivery attitude takes on additional importance, since maneuverability of the LGB is related to the weapon velocity during terminal guidance. Therefore, airspeed lost during the ballistic phase equates to a proportional loss of maneuverability. The transition phase begins at acquisition. During the transition phase, the weapon attempts to align its velocity vector with the line-of-sight vector to the target. During terminal guidance, the UGB attempts to keep its velocity vector aligned with the instantaneous line-of- sight. At the instant alignment occurs, the reflected laser energy centers on the detector and commands the canards to a trail position, which causes the weapon to fly ballistically with gravity biasing towards the target," the FAS says.

"Target designators are semi-active illuminators used to 'tag' a target. Typical laser guided bomb receivers use an array of photodiodes to derive target position signals. These signals are translated into control surface movements to direct the weapon to the target. An airborne detector can provide steering information to the pilot, via his gunsight, for example, and lead him on a direct heading to the target, finally giving him an aim point for a conventional weapon. Alternatively, a laser guided "smart" bomb or missile may be launched when a pilot is satisfied that the detector head has achieved lock-on and the launch envelope requirements are satisfied. In either of these cases, the pilot may never see the actual target, only the aim point as indicated by the laser. Laser designators and seekers use a pulse coding system to ensure that a specific seeker and designator combination work in harmony. By setting the same code in both the designator and the seeker, the seeker will track only the target designated by the designator. The pulse coding is based on Pulse Repetition Frequency (PRF)," the FAS explain. "The designator and seeker pulse codes use a truncated decimal system. This system uses the numerical digits 1 through 8 and the codes are directly correlated to a specific PRF. Dependent upon the laser equipment, either a three digit or a four digit code can be set. Coding allows simultaneous or nearly simultaneous attacks on multiple targets by a single aircraft, or flights of aircraft, dropping laser guided weapons (LGWs) set on different codes. This tactic may be employed when several high priority targets need to be expeditiously attacked and can be designated simultaneously by the supported unit(s)."

The FAS warns air power enthusiasts that LGBs are not a "cure all" for the full spectrum of targets and scenarios facing planners, but they do offer advantages

[61] Federation of American Scientists Military Analysis Network, Smart Weapons, http://www.fas.org/man/dod-101/sys/smart/lgb.htm, accessed January 8, 2006.

	in standoff and accuracy over other types of free fall weapons in the inventory. "In a high threat environment, LGB will be employed in a range of missions from close air support [CAS] to interdiction. LGB are excellent performers in dive deliveries initiated from medium altitude. A steep, fast dive attack increases LGB maneuvering potential and flight ability. Medium altitude attacks generally reduce target acquisition problems and more readily allow for target designation by either ground or airborne designation platforms. Medium altitude LGB dive delivery tactics are normally used in areas of low to medium threat. LGBs can miss the target if the laser is turned on too early. During certain delivery profiles where the LGB sees laser energy as soon as it is released, it can turn from its delivery profile too soon and miss by falling short of the target. To prevent this, the laser designator must be turned on at the time that will preclude the bomb from turning down toward the target prematurely. Normally, the pilot knows the proper moment for laser on. The specific LGB and the delivery tactics of the fighter/attack aircraft dictates the minimum designation time required to guide the weapon to the intended target. The effects of smoke, dust, and debris can impair the use of laser-guided munitions. The reflective scattering of laser light by smoke particles may present false targets. Rain, snow, fog, and low clouds can prevent effective use of laser-guided munitions. Heavy precipitation can limit the use of laser designators by affecting line-of-sight. Snow on the ground can produce a negative effect on laser-guided munition accuracy. Fog and low clouds will block the laser-guided munition seeker's field of view which reduces the guidance time. This reduction may affect the probability of hit." The FAS observes that there are presently (2006) three generations of Paveway. Paveway I was a series of laser guided bombs with fixed wings. Paveway II and III have preflight selectable coding. Paveway III is the third-generation LGB, commonly called the low-level laser-guided bomb (LLLGB). It is designed to be used at low altitude but at long standoff ranges. "Videotapes of LGBs precisely traveling down ventilator shafts and destroying targets with one strike, like those televised during and after Desert Storm, can easily create impressions about the effect of a single LGB on a single target, which was summed up by an LGB manufacturer's claim for effectiveness: "one target, one bomb," the FAS cautions. "The implicit assumption in this claim is that a target is sufficiently damaged or destroyed to avoid needing to hit it again with a second bomb, thus obviating the need to risk pilots or aircraft in re-strikes. However, evidence does not support the claim for LGB effectiveness summarized by 'one target, one bomb.' In one sample of targets from Desert Storm, no fewer than two LGBs were dropped on each target; six or more were dropped on 20 percent of the targets; eight or more were dropped on 15 percent of the targets. The average dropped was four LGBs per target."
Guidance:	Laser.
Bomb:	Mk80 series or similar.
Launcher:	Pylons.
Comment:	The origins of the South African weapons are obscure, as is the weapons' designation – the obvious guess for the former is Israel. It is not clear of what generation the South African munitions are. It is likely to be of the older as South African-Israeli defence cooperation ended in the early 1990s. It is likely the Paveway will be phased out in favour of the more modern Umbani as funds become (or are made) available.

Table 10C.46: The Paveway 745 LGB.

Guns

Denel GA1

Type:	Breech-loading gas operated automatic cannon.
Country of origin:	South Africa.
Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Gun and HM20 mount.
Calibre:	20x82mm.
Barrel length:	nn.
Mass (weapon):	39kg.
Mass (projectile):	205g.
Length:	1.76m
Width:	0.244m
Height:	0.19m
Muzzle velocity:	720m/s.
Rate of fire:	600-750rpm.
Recoil force:	4N (average).
Max range:	800-1000ft at 65-90 knots.
Accuracy & consistency:	Accuracy is not dependent on gun characteristics alone. Factors playing a role include variations in projectile mass, muzzle velocity, the accuracy of laying the gun in azimuth and elevation, meteorological conditions as well as barrel wear and history.
Feed:	Single feed with pawls driven by breech movement. Left or right hand feed.
Magazine:	150 rounds.
Reload time:	nn.
Ammunition:	The GA1 uses the MG151 range of HEI (High explosive incendiary), HEI-T (HEI-tracer), SAPHEI (semi armour piercing HEI), target practice (TP) and TP tracer.
Mount:	
Elevation:	+5 to -60deg.
Traverse:	100deg.
Mass:	169.5kg (total), 39kg (cannon), 37.9kg (150 rounds of ammunition), 93kg (platform, cradle, accessories).
Length:	1.42m (mount), 2.52m (cannon fitted).
Width:	0.58m (mount), 0.97m (cannon fitted).
Height:	0.72m (with cannon fitted).
Comment:	The GA1 fires from an open breech. During firing, the round is positively locked in the breech by a rotating bolt head. On firing, the bolt and barrel recoils and this motion unlocks the breech. He cannon can be fired mechanically or by means of a 20-29V solenoid. A conversion kit to 12.7x99mm HMG is available. Can be fitted to helicopters either as door or chin guns or to fixed-wing aircraft.

Table 10C.47: The Denel GA1.

DEFA 553

Type:	Breech-loading revolver cannon.
Country of origin:	France.
Delivered to the SAAF:	c1963.
Numbers:	nn.
Cost:	nn.
System components:	Gun.
Calibre:	30x113mm.
Barrel length:	nn.
Mass (weapon):	83kg.
Mass (projectile):	243g.
Length:	1.86m.
Width:	nn.
Height:	nn.
Muzzle velocity:	815m/s.
Rate of fire:	1300rpm.
Recoil force:	4N (average).
Max range:	800-1000ft at 65-90 knots.
Accuracy & consistency:	Accuracy is not dependent on gun characteristics alone. Factors playing a role include variations in projectile mass, muzzle velocity, the accuracy of laying the gun in azimuth and elevation, meteorological conditions as well as barrel wear and history.
Feed:	nn.
Magazine:	125 to 135 rounds.
Reload time:	nn.
Ammunition:	Ball, High Explosive (HE), HE-Incendiary (HEI), Armour Piercing HEI (APHEI), HE fragmentation (HEF).
Comment:	Developed from the DEFA 552 in 1957, the main differences included a decrease in muzzle pressure and greater ease of maintenance. The DEFA 552 was in turn based on the DEFA 551 developed in the late 1940s from the Mauser MG213C, an experimental revolver cannon developed for the Luftwaffe during World War Two. (The MG213 also inspired the British ADEN and the US M39. The weapon is essentially a five chamber gas operated revolver cannon capable continuous fire or bursts, a second or half-a-second in length.

Table 10C.48: The DEFA 553.

GIAT F2

Type:	Breech-loading gas-operated automatic cannon.
Country of origin:	France.
Delivered to the SAAF:	c1990.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	Gun.
Calibre:	20mm.
Barrel length:	nn.
Mass (weapon):	nn.
Mass (projectile):	nn.
Length:	nn.
Width:	nn.

Height:	nn.
Muzzle velocity:	1050m/s.
Rate of fire:	740rpm.
Recoil force:	nn.
Max range:	nn.
Accuracy & consistency:	Accuracy is not dependent on gun characteristics alone. Factors playing a role include variations in projectile mass, muzzle velocity, the accuracy of laying the gun in azimuth and elevation, meteorological conditions as well as barrel wear and history.
Feed:	nn.
Magazine:	nn.
Reload time:	nn.
Ammunition:	Ball, High Explosive (HE), Armour Piercing.
Comment:	The F2 cannon is well known for its versatility and fire power. It is a dual feed cannon, which allows the pilot to select either high explosive or armour piercing ammunition – depending on the target "Additionally, the unique mechanical layout of the turret system enables the pilot to slave the cannon through 220 in azimuth and 70 in elevation, in spite of the difficulty of accommodating dual ammunition feeding to the cannon at these extreme angles," manufacturer IST says of the F2 fitted to its Rooivalk chin turret.

Table 10C.49: The Giat F2.

Mauser BK27

Type:	Breech-loading revolver cannon.
Country of origin:	France.
Delivered to the SAAF:	On order for the Gripen.
Assoc. project name(s):	Ukhozi (eagle).
Numbers:	nn.
Cost:	nn.
System components:	Gun.
Calibre:	27x145mm.
Barrel length:	nn.
Mass (weapon):	100kg.
Mass (projectile):	260g.
Length:	2.31m.
Width:	nn.
Height:	nn.
Muzzle velocity:	1025m/s.
Rate of fire:	1000 to 1700rpm.
Recoil force:	nn.
Max range:	nn.
Accuracy & consistency:	Accuracy is not dependent on gun characteristics alone. Factors playing a role include variations in projectile mass, muzzle velocity, the accuracy of laying the gun in azimuth and elevation, meteorological conditions as well as barrel wear and history.
Feed:	Linkless.
Magazine:	nn.
Reload time:	nn.
Ammunition:	Ball, High Explosive (HE), Armour Piercing (AP), APHE, semi-APHE multi purpose, Target Practice (TP), TP Frangible, TP Tracer.

Comment:	The BK27 is a single barrel, gas-operated lightweight revolver cannon that fires electrically primed 27mm ammunition at up to 1700 rounds per minute. Developed by Mauser-Werke Oberndorf of Germany, its features include low volume, low system weight, high fire power in target (air/air, air/ground), low time of flight projectile and a long stand-off range.

Table 10C.50: The Mauser BK27.

Ground equipment

Radars

- 2 Air Control Sectors (Hoedspruit and Bushveld)
- 3 fixed and 6 mob radars (2 long-range - Ellisras and Mariepskop - and 4 tactical)

Reutech Radar Systems ESR360

Type:	Short-range 3D solid-state L-band surveillance and air defence radar.
Country of origin:	South Africa.
Delivered to the SAAF:	From 1995.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	nn.
General:	The ESR360 uses an 18 plank, 2.5m wide, six beam planar array antenna to form a number of spatially encoded beams in order to extract height information in real time.
Mass:	nn.
Length:	2.31m.
Width:	nn.
Height:	nn.
Range:	120km.
Comment:	In development is the medium range ESR360L (18 plank, 6m wide eight beam foldable antenna) with a range of 200km and the long-range ESR380 with a range of 400km.

Table 10C.51: The RRS ESR360.

"Tactical Mobile Radar"

Type:	Medium-range surveillance and air defence radar.
Country of origin:	nn.
Delivered to the SAAF:	nn.
Assoc. project name(s):	nn.
Numbers:	nn.
Cost:	nn.
System components:	The TMR is a containerised system. Containerised are the (1) antenna, (2) the

	transmitter cabin & power generator, (3) the operations cabin & power generator and (4) the M12 workshop. The support vehicles for the radar system can include: A MAN 8X8 Recovery, a Samil 100 Diesel Bowser, a Samil 50 Water Bowser, a MAN 19/280 with Domestic pack and light vehicles.
Mass:	nn.
Length:	nn.
Width:	nn.
Height:	nn.
Range:	64 nautical miles at 15 revolutions per minute and a 100 nautical miles at 7.5 revolutions per minute.
Comment:	When deployed in a tactical role, the radar system and its operators are equipped to sustain themselves, without resupply, for up to 20 days. During that time, they can be expected to move several times.

Table 10C.52: The TMR.

NATIONAL ASSEMBLY

QUESTION 1046

WRITTEN REPLY

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ADV H C SCHMIDT (DA) TO ASK THE MINISTER OF DEFENCE

(c) This project was started in August 1996 with the objective of upgrading, and replacing where required, the SA Air Force's airfield radar systems.

(c)(i) A total of six new airfield radar sets were delivered, and one transportable system was upgraded and given a life extension.

(c) (ii) A total of Rm 32,924 (2005 Rand value) was spent on this project, which is currently in the closure process.

An initial estimate made by logistic engineers indicated a relatively small upgrade of the Pilatus Astra avionics, since the central cockpit display started discolouring to the point where most of the displays were becoming unreadable. These displays were supplied in the early 1990's by a now defunct local company, and have become obsolete to the extent that they have to be replaced. Subsequent to the initial estimates, further engineering studies were conducted and it was concluded that the only lasting solution to the Astra avionics obsolescence problems was a total cockpit upgrade.

(d)(i) Only 35 of the Astra aircraft, are scheduled for an upgrade.

(d(ii) The multi-source tender was submitted to all interested parties, and the most cost-effective offer was received from Pilatus Switzerland, the original manufacturer of the aircraft, for

an amount of RM400; thus making Pilatus Switzerland the preferred bidder. They will have at the same time more than one client busy with the exact avionic sane avionic upgrade. The upgrade will extend the lifespan of the of the Pilatus Astra with a further 20 years. Armscor has been given the authority to negotiate timescales to meet the SA Air Force's requirement before the contract is placed. The tender is still valid and the plan is to carry out the midlife upgrade under the maintenance and support contract.

(e) There is a combination of factors, which lead the SA Air Force to believe that it would be beneficial if a number of side-by-side trainers could be procured. Firstly, most Air Forces have recognized the benefit of using a more basic side-by-side training aircraft for the initial phases of pilot training before exposing students to more advanced tandem high performance training aircraft. Not only is the learning environment less intimidating and more conducive to effective learning, these aircraft are cheaper to operate. Secondly, the current trainer aircraft, Pilatus Astra, is experiencing large scale obsolescence in the avionic suite.

(e)(i) It is expected that the 12 side-by-side aircraft would be sufficient to satisfy the training requirement.

(e)(iii) These aircraft cost between RM2 and RM3 each, this would translate to RM24 to RM36 for the fleet.