The Dassault Mirage III
in South African Air Force service

PART 5

SAAF Mirage III radar, aircraft protection systems, communications and radio, navigation and air data systems

This E-book was compiled by Malcolm Reid
Pretoria May 2022

In the compilation of this document, data has been obtained from various Internet sources and contributors. This data has been cross-referenced where needed to ensure, as much as possible, the consistency and correctness of that data. There have been many contributors to various Internet forums relating to the SAAF Mirage III, and in particular, the Unofficial SAAF Website (saairforce.co.za). Without the efforts by fellow enthusiasts, pilots and crews in providing this written and photographic documentation of the history of the Mirage III in SAAF service, this narrative would not have been possible. Many of the images sourced via Internet searches have been used without the specific permission from the originators as, in many cases, these are unknown. Others have been included with the originators' details retained and unedited as sourced from the Internet. The images have been included in this document on a "fair use" basis for the purposes of historical research and the recording thereof. This document is offered publically as a free E-book and in no way does it provide a source of income for the author or any other party.

As noted in Part 1, the quality of images in many instances is low due to the electronic file size, some less than 50kB. These images have been retained as sourced from the Internet and have not been subject to any adjustments (hue, saturation etc.) and have not been sharpened.

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Part 5 - SAAF Mirage III radar, aircraft protection systems, communications and radio, navigation and air data systems

1 Radar

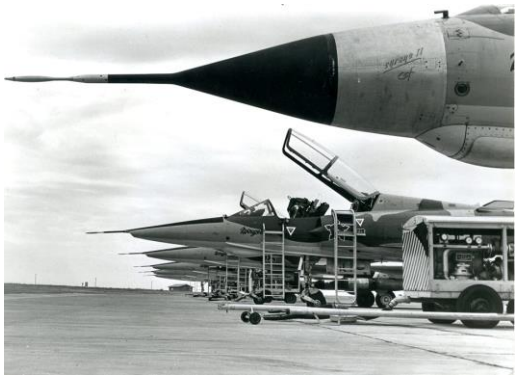
The Mirage IIICZ was equipped with a very simple avionics suite from the outset. A Thompson-CSF Cyrano I radar was mounted in the nose for use in the air intercept mode in conjunction with the Matra R530 Semi-Active Radar Homing (SARH) missile. Being an early generation aircraft radar, functionality and reliability of the Cyrano was not the best and often the IIICZ was restricted to clear weather day operations under control of ground radar (Dayton in South West Africa). Using cockpit photos as reference, BZ #818 does not have a radar scope on the instrument panel. The deduction is that the BZ was not equipped with the Cyrano radar.

The Mirage IIIEZ was equipped with the upgraded Cyrano II radar which offered a dual air / ground mode. The ground radar mode was introduced to support the Mirage IIIE's intended ground attack role.

As noted in Part 1 of this document, the entire nose (including the radar) could be removed for maintenance. In this case, a replacement nose with adequate ballast could be installed.

The Mirage IIIDZ, D2Z, RZ and R2Z were not equipped with radars.

Cyrano I radar fitted to CZ #813.

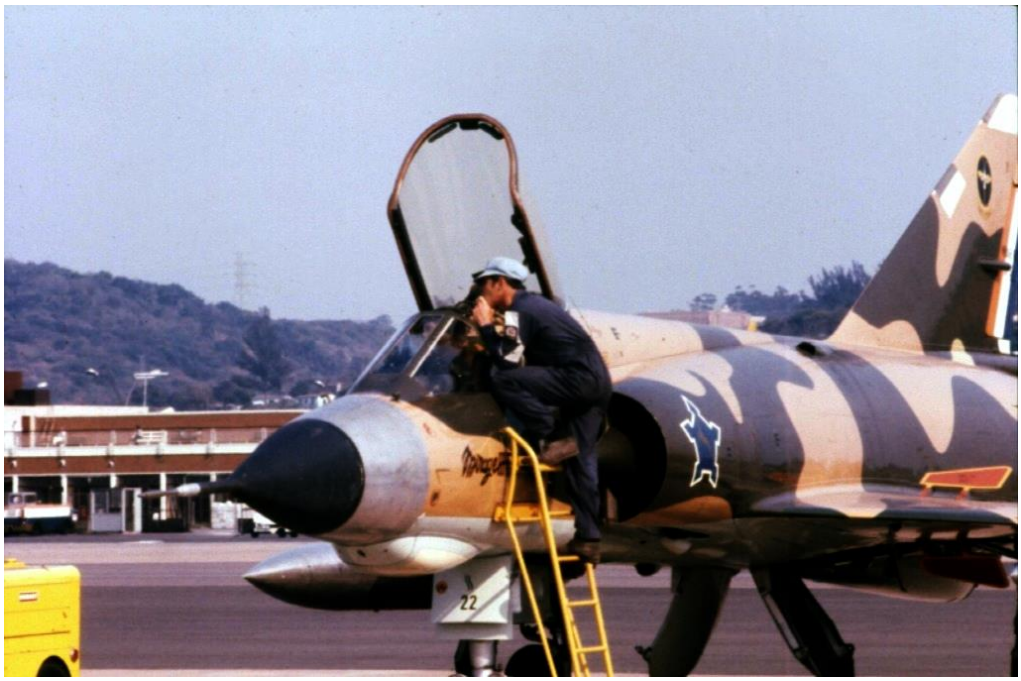


The nose in the foreground is that of an EZ with hard edge gloss camouflage and Cyrano II CSF on the nose. Note the characteristic doppler antenna located beneath the nose. The second aircraft is a DZ (note the doppler antennae) and the remainder appear to be D2Zs (no doppler antenna).

Unidentified CZ, in low visibility blue-grey camouflage, with radar exposed. Note the open latches for removal of the nose cone.

2 Doppler

The Mirage IIIDZ, EZ and RZ were equipped with a Marconi continuous-wave Doppler navigation antenna located in a distinct round fairing beneath the cockpit and forward of the nose gear. This uses the Doppler effect to accurately measure the aircraft's groundspeed and drift which is displayed on the cockpit Doppler radar control panel and used by the Position Homing Indicator (PHI) navigation computer to provide an accurate navigation plot. Doppler can function from 40ft to 50,000ft altitude and 80 knots to 800 knots air speed.



Doppler fairing on EZ #822. The dielectric antennae panel is cream coloured.

Doppler fairing on RZ #838. The teeth cover the dielectric panel.

3 Aircraft protection systems

Experience gained during operations in the Border War resulted in the SAAF implementing a fleet wide programme to equip certain aircraft with locally developed Radar Warning Receiver (RWR) and chaff / flare countermeasure systems. These were known in SAAF service as the Compact Radar Warning System (CRWS) and the Radar and Infrared Misleading System (RIMS) respectively. This was borne from necessity as the Angolans and Cubans began fielding significant numbers of the latest Soviet designed radar and infrared guided anti aircraft weapons systems.

3.1 Compact Radar Warning System (CRWS)

The CRWS consisted of a number of semispherical black antennae located as follows :

- 2 each side on the lower forward fuselage each facing 45 degrees outwards and forwards.
- 2 each side on the upper vertical stabilizer (above the rudder) facing 45 degrees outwards and aft.
- 1 on the nose gear door, providing additional azimuth coverage.

These antennae were colloquially referred to as "cat balls"[1]. Later CRWS fitted to Mirage F1AZ/CZs included a larger cylindrically shaped azimuth antenna located on the underside of the forward fuselage.

The Mirage IIICZ and BZ do not appear to have been delivered from France with any form of integrated aircraft protection systems. However, some of the CZs had the CRWS installed at a time that appears to have coincided with the application of the low visibility blue/grey camouflage.

The EZs were delivered with a round pancake shaped antenna facing aft and located immediately above the rudder. This was most likely a French developed RWR system. The EZ fleet did not appear to have been equipped with the South African CRWS.

The RZs were French Air Force aircraft redirected for sale to South Africa. They were delivered with a round pancake shaped antenna located immediately above the rudder and facing aft, similar to the EZ. The RZs were later equipped with the South African CRWS. These were located on the vertical stabilizer above the original pancake shaped antenna on RZ #837 and #838. For some reason, RZ #835 did not retain the original pancake shaped antenna.

The R2Zs were delivered with French designed Radar Warning Receivers (RWR) installed as standard with the bullet shaped antennae located on the leading and trailing edge of the upper vertical stabilizer. These were replaced with the standard South African developed CRWS.

The DZ and D2Z did not appear to be equipped with any form of CRWS.

[1] Small and round

3.2 Radar and Infrared Misleading System (RIMS)

The RIMS consisted of a chaff and flare dispenser unit located on the rear of the aircraft.

It appears that a limited number of SAAF Mirage III variants were equipped with RIMS :

- Mirage IIICZ – the chaff/flare dispenser unit was located in a modified ventral fairing on the rear fuselage underside. Only two CZs appear to have had the RIMS thus installed, apparently for test and evaluation purposes only. CZ #805 and #809 both exist with this configuration at the SAAF Museum at AFB Swartkop.
- Mirage IIIRZ – the chaff / flare dispenser pods were mounted either side of the outboard missile pylons. It is possible that RZ #835 is the only RZ to have been so equipped with RIMS.

In summary, CRWS and RIMS were installed as follows :

System	CZ	BZ	EZ	DZ	D2Z	RZ	R2Z
Compact Radar Warning System (CRWS)	Some Note 1	No	No	No	No	Yes Note 2	Yes Note 2
Radar and Infrared Misleading System (RIMS)	See below Note 3	No	No	No	No	#835 Note 4	No

Note 1 - Photos exist of the low visibility blue/grey CZs #807 and #809 at a weapons camp in Durban in 1990 clearly showing the installation of the CRWS antennae. #805, now resident at Swartkop, was similarly equipped. CRWS was, however, not applied to the entire CZ fleet.

Note 2 - CRWS was fitted to all RZ and R2Z aircraft.

Note 3 - It is not clear whether #805 and #809 were the only CZs equipped with RIMS (in the rear ventral fairing on rear fuselage). It is difficult to gauge from existing photos of other CZs in the blue/grey camouflage as to whether they were modified with RIMS.

Note 4 – RIMS installed either side of outboard wing pylons.

Underside view of CZ #805 clearly showing the simple blade ventral strake with the box like fairing to the rear which would house the RIMS chaff and flare dispenser.

Starboard view of CZ #809 clearly showing the box like fairing (beneath the aircraft number "809") which would house the RIMS chaff and flare dispenser. Note the forward CRWS antennae just aft of the nose cone break.

4 Comms / radios / navigation

The radio communications and navigation suite installed on the SAAF Mirage III fleet varied. Associated with these systems were various antennae. The most obvious antennae were the white conformal dielectric antennae associated with radio communications located on the tip and leading edge of the vertical stabilizer and just beneath the rudder. Later upgrades saw the installation of various prominent trapezoidal and triangular shaped blade antennae at various locations along the fuselage spine as well as beneath the nose and on the fuselage underside. It is therefore important to check photographic references of the various SAAF Mirage IIIs.

This section addresses the antennae configurations for each of the SAAF Mirage III variants. This would be of particular interest for the detailed modeler or Mirage III enthusiast.

Whilst the exact details / purpose of the various antennae are not known due to lack of SAAF specific reference material, it can be generally accepted that :

- The two conformal antenna located on the vertical stabilizer were for radio communications. The fin tip antenna was for the primary UHF (Ultra High Frequency) radio and the antenna below this on the leading edge was for the secondary UHF radio. This was common for all Mirage III variants when delivered to the SAAF.
- An additional conformal antenna was located on the vertical stabilizer leading edge fillet (specific to the BZ and CZ only as all other SAAF Mirage IIIs dispensed with this leading edge fillet). This was possibly for VHF (Very High Frequency) communications.
- A small white antenna beneath the rudder for VHF communications.
- A conformal dielectric panel was located on the avionic bay hatch aft of the cockpit. This was initially of large rectangular configuration on the earlier versions of the SAAF Mirage III, but was later replaced with a much smaller square shaped panel. These were later replaced with blade antennae in a similar location. The purpose of this panel is unknown.
- A circular conformal antenna on the nose gear door was likely the IFF (Identification, Friend or Foe) antenna.
- A trapezoidal shaped blade antenna (usually yellow) installed on the fuselage spine ahead of the vertical stabilizer was likely for the TACAN (Tactical Air Navigation) system. A second similar antennae was located on the starboard fuselage underside adjacent to the ventral fairing. This was particular to the EZ, DZ, D2Z, RZ and R2Z.
- Various other smaller blade antennae were added through the life of the various Mirage III variants in SAAF service. Details are provided in the following sections.

The Mirage III was equipped with a radar altimeter. Two small conformal antennae were located on the fuselage underside just aft of the nose wheel bay. One antenna was used to transmit radar pulses whilst the second one received reflected energy. It is likely that all SAAF Mirage III variants were so equipped.

An “impact temperature probe” was located on all Mirage IIIs on the fuselage underside aft of the nose wheel bay. This provided ambient temperature measurement for use by the aircraft’s air data computer.

4.1 Mirage IIICZ

The IIICZ, in both the delivery unpainted natural metal scheme and early gloss hard edge buff/green camouflage, appear to have had the following antennae configuration :

- Conformal antenna at the top of the vertical stabilizer (UHF).
- Conformal antenna on leading edge of vertical stabilizer (UHF).
- Conformal antenna on vertical stabilizer fillet (HF).
- White antenna beneath the rudder (VHF).
- Large rectangular shaped conformal dielectric panel on spine aft of cockpit.
- Circular conformal antenna on nose gear sideways opening door (IFF).

These are clearly demonstrated in the following photos.

Mirage IIICZs in delivery scheme clearly showing the various conformal antennae as noted in the text above.

IIICZ - note the circular conformal antenna on the sideways opening nose gear door as well as the large rectangular conformal dielectric panel located towards the rear of the avionics hatch aft of the canopy.

The white conformal antennae were painted over when the CZ received the later matt soft edge buff/green camouflage. This seems to have coincided with the installation of a number of blade antennae as follows :

- Large blade antenna aft of canopy – possibly to have replaced the original conformal dielectric panel.
- Two smaller trapezoidal blade antennae on the fuselage spine aft of the large blade antenna.
- One large and one smaller blade antenna located on the nose gear door, the larger one being in the same position as the original circular (IFF) antenna.

This was the same antenna configuration present on those CZs which were painted in the low visibility blue / grey scheme. At this stage, some aircraft had the CRWS “cat balls” antennae installed.

IIICZ in the later matt soft-edge buff/green camouflage - note that the conformal antennae have been painted over. The single large and two small blade antennae have now been installed on the fuselage spine.

IIICZ in final blue/grey low visibility camouflage - one large and two small blade antennae have been installed on the fuselage spine. This aircraft has now also been equipped with the CRWS "cat balls" antennae, located on the vertical stabilizer above the rudder and on the forward fuselage aft of the radome.

CZ #813 - the large blade antennae can be seen on the spine and on the nose gear door.

A small trapezoidal shaped antenna can be seen just aft of the nose gear bay – its purpose is unknown. Just aft of this is the impact temperature probe. The large blade antenna on the nose gear door has replaced the original circular conformal IFF antenna.

CZ #813 - this antenna is the underside TACAN antenna and is offset to starboard.

4.2 Mirage IIIBZ

The Mirage IIIBZ had a conformal antenna arrangement similar to that on the CZ in its delivery configuration. This did not appear to have been upgraded over the life of the BZ, with the exception being that the antennae were painted over in the later buff/green camouflage scheme.

CRWS was not fitted to the three BZs operated by the SAAF.

BZ #816 - note that the large white conformal dielectric panel does not appear aft of the canopy.

BZ #818 in fresh coat of hard edge gloss camouflage. The conformal dielectric panels have not been painted over. Note the large white panel aft of the canopy.

(Photo: 1 Military Printing Unit)

Mirage III CZ fitted with long-range fuel tanks. Four of these aircraft flew from Waterkloof to Ondangwa to take part in Operation REINDEER.

BZ #817 in hard edge camouflage. All conformal antenna have now been painted over.

Another view of BZ #817 in later non standard soft edge camouflage which covers all conformal antennae.

4.3 Mirage IIIEZ

For the EZ natural metal scheme delivery scheme, the conformal antennae arrangement on the vertical stabilizer was similar to that of the CZ delivery scheme as detailed above. An additional yellow blade antenna was installed ahead of the vertical stabilizer on the fuselage spine. This appears to have been for the TACAN (Tactical Air Navigation) system.

Early gloss hard edge buff/green camouflage : the conformal antennae had not been painted over at this stage. A further smaller blade antenna appears to have been added to the fuselage spine aft of the canopy.

Later matt soft edge buff/green camouflage : the original white conformal antennae were painted over. A large blade antenna was added to the nose gear door – this was likely to have replaced the original circular IFF antenna.

The EZs were not equipped with the CRWS “cat balls” antennae.

Two natural metal EZs in formation with a camouflaged CZ. The conformal antennae on the vertical stabilizer of EZ #820 are readily apparent. The doppler antenna beneath the nose of the two EZs are also apparent. The yellow TACAN blade antenna on the fuselage spine is visible on the closest aircraft. This is not present on the CZ.

Possibly EZ #825. An additional small blade antenna has now been added to the aft end of the avionics bay on the spine. The original yellow TACAN antenna is clearly visible ahead of the vertical stabilizer. The UHF conformal antennae on the vertical stabilizer are still clearly present.

Final EZ antenna configuration on EZ #819 which appears to have coincided with application of the late matt soft edge buff/green camouflage. The conformal antennae on the vertical stabilizer have been painted over. A large blade antenna has been added to the nose gear door. The two blade antennae are visible on the fuselage spine, the rearmost one being for TACAN.

4.4 Mirage IIIDZ

The DZ had the doppler antenna located beneath the forward fuselage.

The DZ conformal antennae configuration was similar to that seen on the early gloss hard edge buff/green camouflage EZ. The yellow TACAN antenna forward of the vertical stabilizer was also present.

The Mirage IIIDZ fleet was not equipped with the CRWS “cat balls” antennae.

DZ #840 - note the distinctive doppler antenna just ahead of the nose gear. The yellow TACAN antenna on the fuselage spine can just be made out in this photo just forward of the engine cooling intake scoops.

4.5 Mirage IIID2Z

Unlike the DZ, the D2Z did not have the doppler antenna located beneath the forward fuselage.

The D2Z antennae configuration was similar to that seen on the early gloss hard edge buff/green camouflage EZ, including the yellow TACAN antenna on the fuselage spine.

The D2Z also had two horizontal blade antennae installed either side of the vertical stabilizer just beneath the fin tip conformal antenna and may have been to do with an improved UHF communications suite. This was fitted only to the D2Z and R2Z versions of the SAAF Mirage III.

The IIID2Zs were not equipped with the CRWS "cat balls" antennae.

Differing from the DZ, this D2Z (#853) has no doppler antenna beneath the nose making it look much sleeker. It does have the yellow TACAN antenna installed on the fuselage spine as well as the white UHF conformal antennae on the vertical stabilizer. The starboard side horizontal blade antenna is also visible near the top of the vertical stabilizer. This was particular to the D2Z and R2Z.

D2Z #846. The white antennae panel on the leading edge of the vertical stabilizer has been painted over. The black stripe beneath the white fin tip is the horizontal blade antenna. Note the yellow TACAN antenna on the fuselage spine.

D2Z #848 with all UHF antennae painted over. The TACAN antenna is visible on the fuselage spine.

4.6 Mirage IIIRZ

The RZ had the doppler antenna located beneath the forward fuselage.

NATO grey/green delivery scheme :

- Conformal antennae were located on the vertical stabilizer (tip and leading edge).
- Yellow TACAN antenna on fuselage spine forward of vertical stabilizer.
- Small white rectangular conformal antenna aft of canopy.
- A large blade antenna on the nose gear door – possibly for upgraded IFF.

RZ with white conformal antennae on the vertical stabilizer, small white rectangular panel aft of cockpit and yellow TACAN antenna on the fuselage spine. The Doppler antenna is also visible beneath the nose. There is a round pancake shaped antenna barely visible immediately above the rudder. It is likely this was a factory installed French RWR antenna. This appears to have been only installed on the Mirage III EZ and RZ and were later replaced by the South African developed CRWS antennae.

RZ #835 in soft edge buff/green camouflage. The pancaked shaped antenna above the rudder has been removed and the locally produced CRWS "cat balls" antennae have been installed in its place. The missile on the wing is most probably a V3B.

The application of the soft edge buff/green camouflage to the Mirage IIIRZ possibly coincided with the addition of a smaller blade antenna aft of the canopy. This also seems to have coincided with the installation of the CRWS. The same configuration would have been present when the RZs were repainted in the final low visibility blue/grey camouflage schemes.

RZ #838 repainted in soft edge buff/green camouflage. All conformal antennae on the vertical stabilizer have been painted over. The yellow TACAN blade antenna is visible forward of the vertical stabilizer. There is also an additional white blade antenna ahead of this. The CRWS antennae are visible on the vertical stabilizer above the rudder and on the nose above the doppler fairing. Note the two small black antenna also associated with CRWS on the nose gear door. Ahead of these appears to be a large yellow blade antenna which may be an improved IFF antenna, replacing the earlier circular IFF antenna. The white missile is a Matra R530 which was not compatible with the RZ.

IIIRZ, likely #835 – note the small blade antenna added just aft of the avionics hatch on the fuselage spine. The TACAN antenna has been painted grey. A large blade antenna has also been added on the nose gear door to replace the original circular conformal antenna. CRWS antennae are also visible above the rudder and above the doppler fairing.

Round black CRWS antenna above the rudder on RZ #838. The original pancake shaped antenna has been retained.

Round black CRWS antenna above rudder on RZ #835. The pancake shaped antennae has been removed.

RZ #835 – three antennae on the nose gear door : large (possibly IFF) and small (CRWS) blade antennae and small round CRWS antenna to the rear. The CRWS and smaller blade antennae were originally black and may have erroneously been painted over when #835 was repainted.

Another close-up of RZ #83. A dual blade antennae can be seen just aft of the wing leading edge scoop. It is assumed that this was associated with navigation avionics specific to the RZ as it does not appear to have been fitted to the R2Z.
Aft of the nose gear door on the fuselage underside, a small blade antenna and the impact temperature probe can be seen.

4.7 Mirage IIIR2Z

Original delivery configuration :

- Conformal UHF fin tip and leading edge antennae in white with black leading edges.
- Two horizontally mounted blade antennae located on each side of the vertical stabilizer just beneath the fin tip UHF antenna.
- Yellow TACAN antenna on fuselage spine forward of vertical stabilizer.
- Small white rectangular conformal dielectric panel aft of canopy.

Later updated configuration – a large blade antenna was installed aft of cockpit.

The R2Zs were delivered with a French design RWR system consisting of forward and aft facing bullet shaped antennae on the upper vertical stabilizer. These were replaced with the locally developed CRWS, which provided semispherical antennae in 5 locations (two above the rudder, two on the forward fuselage and on the nose gear door).

R2Z #855 with white conformal antennae on vertical stabilizer, large horizontal blade antenna located near the top of the vertical stabilizer, yellow TACAN antenna on spine and large blade antenna aft of canopy. #855 has the original French forward and rearward facing RWR bullet antenna installed near the top of the vertical stabilizer. The South African CRWS had not been installed at this stage.

RZ #857 with the factory installed bullet shaped RWR antenna removed from the vertical stabilizer. In its place, the CRWS has been installed as witnessed by the round black antenna visible directly above the rudder. The forward CRWS antenna appears as a light buff round object on the nose.

R2Z #857 nose gear door antenna configuration was slightly different to that on the RZ in that the circular conformal IFF antenna has been retained. A black blade antenna and a semispherical antenna have now been added, both as part of the CRWS.

5 Air data probes

The Mirage IIIs were fitted with a dynamic and static air measurement system to feed primary instruments and the air data computing system.

All SAAF Mirage III variants were equipped with a nose mounted pitot probe. At the center of the probe is the total pressure inlet. This is surrounded by a number of circumferential static ports. Together, these provide data to the airspeed indicator (ASI) / mach meter, vertical speed indicator (VSI) and the air data computer. On the BZ, CZ and EZ, this was attached to the center of the nose. On the DZ and D2Z the pitot probe was mounted above the small nose intake. On the RZ and R2Z the pitot probe was mounted above the forward looking camera window.

For the BZ and CZ, the nose mounted pitot probe was supplemented with a single total pressure probe located on the lower left of the forward fuselage which provided data to the ASI / mach meter.

For the DZ, D2Z, EZ, RZ and R2Z, the single total pressure probe was replaced with two total pressure probes located ahead of the windshield. Those installed on the RZ and R2Z were much larger than those installed on the EZ, DZ and D2Z.

A single static port was located at the rear fuselage.

A small straight incidence probe was located on the forward fuselage below the windshield.

CZ #813 showing the pitot probe and its total pressure orifice. The supplementary total pressure probe can be seen on the lower fuselage offset to port. This was typical for the BZ and CZ.

The single total pressure probe located on the lower left forward fuselage of CZ #813. The round hole above this is the crash tow tube.

The dual total pressure probes located ahead of the windshield on RZ #838.

The dual total pressure probes located ahead of the windshield on RZ #838 with red FOD covers on. Just beneath the eye can be seen the thin straight incidence probe. Below that is one of the "cat balls" CRWS antennae.

EZ – the smaller total pressure probe is located ahead of the windshield. There are two of these, one each side of the windshield. These are visibly smaller than those fitted to the RZ and R2Z.

D2Z #848. The starboard total pressure probe is visible ahead of the windshield. These are similar in size to those on the DZ and EZ.

6 Rear fuselage probes.

The BZ and CZ had two small probes located on both lower sides of the rear fuselage. It is assumed this either had something to do with the aircraft's air data system or the Atar 09B afterburner. The DZ, D2Z, EZ, RZ and R2Z did not have these probes.

BZ #818 showing two probes on lower rear fuselage.

RZ #838 showing no probes – similar for DZ, D2Z, EZ and R2Z.

Probe on BZ #818.

Probe on starboard rear fuselage CZ #813.

7 References

The Unofficial SAAF Website – www.saairforce.co.za - both reference section and discussion forums including the following contributors – Dean Wingrin, Piet van Schalkwyk (SAAFColours), Greg Swart (GregAir), Alan Taylor (FlyingSpringbok), Vernon Vice (Spice), Joker, Brent Best (Kremlin), Sean Thackray (Madmax).

Other fine folks who shared their Mirage III information with me : Daan Conradie, Martin Strümpfer, Jon Durant (Battlebirds Models), John Weideman (ScaleWorx), Marc Conti, Herman Penderis.

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On Wings of Eagles – South Africa's Military Aviation History, D. Becker, ISBN 0947478477

Mirage IIIEO flight manual – this is the Australian version which was essentially similar in terms of systems to the SAAF Mirage IIIEZ.