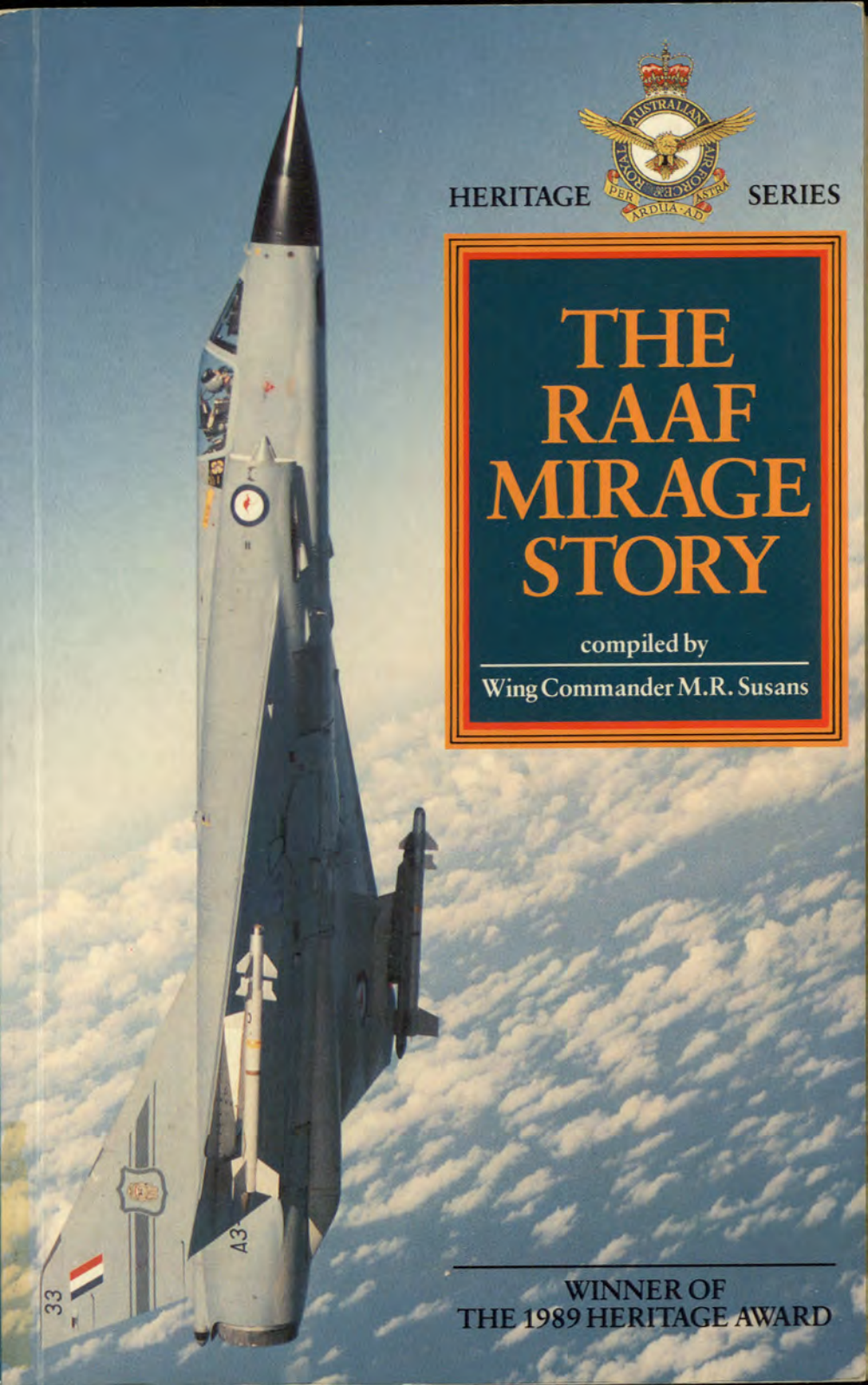
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ROYAL AIR FORCE
PER ARDUA AD ASTRA
HERITAGE SERIES
THE RAAF MIRAGE STORY
compiled by
Wing Commander M.R. Susans
WINNER OF
THE 1989 HERITAGE AWARD

THE RAAF MIRAGE STORY

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Wing Commander M. R. Susans

Royal Australian Air Force Museum

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FOREWORD

The Marcel Dassault Mirage III came into service with the French Air Force in the late 1950's. Thirty years later variants still fly in France and places like Israel, South Africa and The Argentine; other countries seek refurbished aircraft. The Mirage has been distinguished in war service, claiming somewhere between 600 and 1 000 kills, perhaps more.

This month after 25 years service with the RAAF, the Mirage III0 is to be withdrawn from operational service. The stories and impressions chronicled in this book testify to the importance of the Mirage to the RAAF and to Australia, to its quite specific limitations and most importantly to the affection that grew with experience with this great and beautiful aircraft. This spontaneous affection was common to all operators and linked them in a professionally useful way.

September 1988 is indeed a sad date in RAAF fighter history although sentiment cannot drive our force structure. I am delighted that Wing Commander Martin Susans has taken the initiative to produce this volume. The contributors form a nice mixture of those selected to acquire the Mirage and put it into service, and those charged with keeping it there; they speak with authority. The result is a valuable collection of important historical material and stories about interesting events and people. Many important contributors to the program are not mentioned by name. I'm sure they will appreciate the limitations of such a volume and will not mind. I compliment the authors on the excellence of their work. Many principles and lessons are both explicitly and implicitly stated.

There is ample mention of the Mirage's multi-role deficiencies, in particular for service in the Australian area. Yet the aircraft did a first class job as events transpired. The RAAF moved into new operational and technical regimes. Industry and the bureaucracy moved forward too; the spin- off covered a wider range of airframe, engine and electronic capabilities than we had expected. Cooperation between 'them and us' hurdled old barriers. The infrastructure grew in its widest sense; without the Mirage experience we'd not be capable of tackling new technology: building it, operating it and fixing it. Industry would not be so successful in meeting our full share

of military and civil offset opportunities, or in winning additional contracts in the fiercely competitive international free-bid arenas. So we grew up all round.

Ted Bennet's and Pierce Talbot's final statement appeals to me enormously – '. . . the most successful aircraft project undertaken'. Many times I reflected on this evident fact in my final years of service as yet another single service responsibility was transferred to the central committee system because 'it will be more efficient'. Some assertion, when we had clear evidence of a most successful cooperative arrangement established between men of good will and competence, without the 'benefit' of the gauntlet today's projects must run.

Earlier I alluded to unexpected spin-off and the Mirage's great combat record. I don't think Air Vice-Marshals Susans and Barnes or Air Marshal Rowland would have appreciated at the time the long term value of the liaison established so effectively with other countries during those early days in Paris. Our men were remembered twenty years later with evident professional respect. Doors opened that much easier when we sought first-hand comment on the Mirage's operational track record.

The Mirage turned out to be an honest aircraft. On reflection, I believe we failed the fighter force by not remedying deficiencies identified early in the aircraft's life (for example, providing an inertial system) and through being forced to reduce our permanent liaison staff in France, which I'm sure contributed to our slowness to stay on top of serious technical problems — another example of 'penny wise and pound foolish'. This neglect became more pressing as we extended and re-extended the Mirage's operational life when the F/A-18 date of introduction slipped several years

Notwithstanding these strictures and millstones, morale stood up when times were tough; the technicians worked harder to keep the Mirage flying, and the pilots continued to fly them hard and enjoy it. So passes an important era in RAAF history, and a much respected aircraft.

J.W. Newham
Air Marshal

Farrer, ACT
September 1988

PREFACE

The RAAF Mirage Story is a compilation of personal accounts by those who built, maintained and operated the RAAF Mirage. It is not an official history but is a story as recalled by those who took part. Throughout the text, the words of the authors appear in italics, whereas my own words of introduction or explanation appear in this standard font.

Before the introduction of the Mirage, the RAAF's operational fighter force comprised four squadrons and an OCU equipped with the Avon Sabre. Numbers 3 and 77 Squadrons were based at Butterworth, whilst 75,76 and 2OCU were based at Williamtown. The Butterworth contingent also provided aircraft, pilots and groundcrew on a rotational basis for No 79 Squadron, a permanent detachment of eight aircraft in Ubon, Thailand under a SEATO arrangement. A total of 112 Avon Sabres were built in Australia, the last one being delivered to the RAAF on 19 December 1961.

The requirement to replace the Avon Sabre arose early in the era of the US Century Series fighters when level supersonic flight became commonplace and a Mach 2 capability was regarded as a standard for a combat fighter aircraft. US-built aircraft of this calibre were the F-104, F-105 and F-106. In Europe, promising comparable aircraft were the English Electric Lightning, the Swedish Draken and the French Mirage III.

As a Sabre replacement, the F-105 and F-106 were disadvantaged on grounds of cost and complexity and the Lightning, although a sparkling performer with a high thrust/weight ratio, was at the time essentially a point defence interceptor; it was severely fuel limited and displayed little potential for further development. The F-104 was in service with the USAF and had been selected by the Belgian Air Force. The Draken was powered by the latest Rolls Royce engine coupled to a new Swedish afterburner. The airframe featured a unique 'double delta' design which promised, as well as Mach 2, extremely good low speed handling characteristics and consequently reduced runway requirements. It was, however, early days for the Draken which at the time was little developed from the prototype stage.

The Mirage III had first flown in 1956 and was the outgrowth of an

intense programme of French interceptor development following on from the Mystere series of aircraft and the previous Mirage I and Mirage II developmental types. These had been designed in an attempt to meet a French Air Force interceptor specification of achieving 60 000 feet in six minutes from take-off. The Mirage III was performing well and also showed potential for further development of external load and ground attack capabilities.

It was against this background that Wing Commander L.S. Compton (RESENG London) and Flying Officer G.W. Talbot (RAAF Exchange at RAF Boscombe Down) were tasked in December 1959 to visit France, Belgium and Sweden to evaluate and report on some of the contenders for the Sabre replacement.

After introductory briefings and factory inspections with Dassault in Paris, the pair proceeded to the GAMD airfield at Istres, near Marseilles for flight evaluation. The weather at the time was atrocious with heavy monsoonal rain and embedded thunderstorms covering much of the area. However, after much perseverance, sufficient flying was achieved to enable an appraisal to be made.

Flying Officer Talbot flew Mirage IIIA-01 on 8, 12, 14 and 15 December 1959. The first flight was a general handling and familiarisation sortie; the second flight included an acceleration to Mach 2 at 35 000 feet, the third was a heavy weight range validation and handling flight with external stores, and the fourth comprised some performance validation spot checks and further exploration of low speed handling characteristics. Continuing bad weather prevented any further flying during the visit. The airfield became flooded and the team moved on to Brussels and Stockholm.

A long report was prepared by the two-man team, not only on flight aspects, but on other areas of purchase interest; engineering, maintenance, costs and financing, potential for licence production, delivery schedule, etcetera, etcetera.

On completion of the European aircraft evaluation, Wing Commander Compton and Flying Officer Talbot returned, each to his respective job in the UK, with no further involvement in the Sabre replacement selection process.

Following this initial appraisal, a Fighter Evaluation Team toured Europe and the US from May-August 1960. The Team comprised the following members:

Air Marshal Sir Frederick Scherger, KBE,CB,DSO,AFC, – Chief of the Air Staff,

Group Captain D.R. Cuming, OBE,AFC – OC RAAF Base Edinburgh,

Wing Commander A.R. Hodges, AFC – Fighter Operations, Dept. of Air,

Mr I.B. Fleming, OBE – Controller of Aircraft and Guided Weapons Supply, Dept. of Supply,

Mr L.F. Bott, DSC – Assistant Secretary (Finance), Dept. of Supply, and

Mr H.H. Knight, Engine Superintendent, Commonwealth Aircraft Corporation Pty Ltd.

The Team initially examined five aircraft; the Republic F105, English Electric Lightning, Northrop N156 (later to become the F5), Mirage III and F104G. The choice for a replacement for the Avon Sabre was later narrowed to the Lockheed F104G and the French Mirage III.

The Team concluded that the Mirage III was suitable for the RAAF requirement. The F104G was considered unsuitable for a number of important reasons; the principal objection being that the F104 required airfields of a standard which did not, at the time, exist in sufficient number in the Australian area of interest. Other reasons included; aircraft handling qualities, engine reliability, ferry range and cost.

The choice of an engine for the Mirage III was closely studied by the Evaluation Team. The options were the French Atar or the British Avon. A decision on the engine was deferred until more information about the fitment and reliability of the Avon was forthcoming.

The Fighter Evaluation Team drafted a detailed report (The Scherger Report) which assessed the relative merits of each contender. Following consideration of The Scherger Report, Air Board recommended to Cabinet the selection of the Mirage III as the Sabre replacement.

On 22 November 1960, Federal Cabinet endorsed the selection of the Mirage III as Australia's new fighter aircraft.

M.R. Susans
Wing Commander

Melbourne,
21 October 1988

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Many people have assisted in producing The RAAF Mirage Story. Some have been acknowledged in the text, others will receive no formal recognition. One group, from the staff of the Directorate of Aircrew Publications, deserves special mention. They took a variety of authors' drafts and converted them into a recogniseable format. They warmed to this task and gave freely of their own time. Particular thanks to:

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Corporal Ian Guy — Compilation.

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THE FRENCH CONNECTION

AVM R.T. Susans, CBE, DSO, DFC

Although by late 1960 a decision had been made to purchase the Mirage III as a Sabre replacement, the new aircraft had not been specified in any detail; for example, suppliers had not been identified for either the powerplant, the avionics or the weapons – much work was yet to be done. The first step was to send a team of Australian experts to Paris to investigate the various options available and further define the RAAF requirement. The story of those early days in Paris is recalled by the first RAAF Air Attache to France – Air Vice Marshal Ron Susans(1).

"In December 1960 I was at the end of my fourth year in the SASO chair at Headquarters RAAF Edinburgh. The operation at Edinburgh Field was almost like that of a separate air force, its sole function was to provide air support for the joint project which embraced the Weapons Research Establishment at Salisbury and the Weapons Range at Woomera. In fact the RAAF Establishment at Edinburgh Field was often referred to unofficially as 'Boswell's Air Force' – Bill Boswell headed up the Joint Project as Controller at the Weapons Research Establishment at Salisbury.

It was also often said that because of our degree of independence from Canberra we had a very limited and narrow outlook about other developments then current in the RAAF. This criticism may or may not have been valid at the time, however, it would be true to say that we knew very little about some things that were current in Canberra, in particular about the decision to buy a French fighter aircraft to replace the ageing Sabre.

In view of what I have written above, the reader would understand my surprise when on 20th December 1960 I received a call from the then DCAS AVM McLachlan telling me that I was to head up the Mirage Team which was to go to Paris, France within 14

days. He went on to say that I was to be in Canberra the following Monday for briefing. This was my introduction to the Mirage and the beginning of an association which would take me to Paris for three most interesting years and stay with me at Williamtown, Butterworth, IADS, and until I retired some 16 years later.

When I arrived in Canberra I was surprised to find that a team destined for Paris already existed and had been working on some of the Mirage data which was then available. This team was made up of technical officers selected by the then AMTS, AVM Hey, who was of the firm opinion that the task was purely a technical one.

When I was briefed by CAS, AVM Scherger, he made it abundantly clear that he did not agree with this point of view and it was for this reason that he was sending a GD Group Captain fighter pilot to Paris to head up the team. This was not a popular decision in all quarters, however, as it was at the direction of CAS, this was how the Team was to be constituted for the task.

The initial Mirage Team to Paris was made up of the following members:

Group Captain	R.T.	Susans	GD Pilot
Wing Commander	J.A.	Rowland	Eng
Squadron Leader	F.W.	Jordan	Radio
Flight Lieutenant	V.J.	O'Brien	Eng
Flight Lieutenant	F.	Howie	Arm
Flight Lieutenant	G.	Grantham	Inst
Mr	G.	Darling	Engineer ARDU
Mr	L.	Turner	Quality Control

Now that the constitution of the team had been approved by the Minister, briefings completed, and directives signed and handed over, the time had come to seek answers to the many questions of a personal nature that we all had in mind. For example, would we be accompanied, if not, for how long would the tour of duty be, what allowances would we receive, and where would we live etc, etc. The answers to most of the questions were either, 'don't know, perhaps, it's with the Minister', or the 'Embassy in Paris will look after that'.

It is always awkward to tell your wife and family that you are going overseas for an unknown period and you do not know whether they will join you sometime in the future or if you will have to serve it out alone. Before we left Australia, however, we were given some assurances that approval would be forthcoming as it was expected that the RAAF would have a requirement to keep personnel in Paris for many years to come.

The language problem was discussed at length and whereas most of us had done French at school, this was many years ago in most cases and we felt that this sort of French would be of little use in dealing with the French aviation executives. Time did not permit attending a 'quickie' course at the Language School, however, personnel posted to Paris later in the project did have the advantage of having such a course behind them when they arrived. I discussed this problem with CAS and he told me that all the people he talked with when in Paris with the Evaluation Team, spoke good English. These English speakers, however, do have a habit of disappearing into the background when all contracts are signed and the sales pressures come off. We were offered some relief with approval to take French lessons on arrival in Paris at public expense.

We did not excite a lot of sympathy about the allowance problem, although I did take the matter up with Fred Sutherland the then ASecF on a number of occasions and pointed out that every publication we picked up to read about living in Paris proudly proclaimed it as the most expensive city in the world to live in. It seemed that most things would be sorted out by the Embassy when we arrived in Paris and as there was little to be achieved by remaining in Canberra I returned to RAAF Edinburgh to prepare for departure. I was surprised to learn when I arrived back that the Australian Ambassador to France, Dr Walker, was at that time on a visit to Woomera and had flown there with some reluctance in a Bristol Freighter. This was too good an opportunity to miss so I flew up to Woomera in a Canberra and brought him back to Edinburgh on the jump seat. He enjoyed the flight and afterwards we were able to have a long talk about things in Paris and what we could expect on arrival. He was not in a position to help us much about accommodation etc, as he was absent from Paris when the Government's decision about the purchase of the Mirage was announced. I was surprised to find that an expression that I had heard so often whilst in Canberra was also used by him – 'it would all be sorted out by the Embassy when you arrive in Paris'.

It was obvious that this was going to be a most unusual project and quite unlike any aircraft purchase project that had preceded it. The fact that we had no military representation in Europe meant that we had no guidelines to follow and no history of lessons learnt and mistakes made in dealing with the European aircraft production industry. In short, we all felt that this was going to be a challenge and the history of events over the next three years were to prove this assessment correct.

We were booked to fly out of Sydney on a Qantas flight on the 29th January 1961. When we arrived in Sydney, I was personally

delighted to find that CAS was travelling to Singapore on the same flight and that I had a seat next to him. This should offer an excellent opportunity to get a more informal briefing from him, particularly on arrangements he had made with GAMD of a more casual nature. This, however, was not to be, as sitting opposite with a spare seat alongside was Peter Thompson the champion Australian golfer, and as CAS was an enthusiastic golfer himself, I lost my travelling companion soon after the wheels came up.

We were met on arrival in Paris by Mr Geoffrey Price, First Secretary at the Australian Embassy who informed us that we were booked into the Hotel Palais D'Orsay which was built over the Gare D'Orsay railway station and which was quite close to the Embassy located at 13 Rue Las Cases. There was no car allotted for the Team's use at this stage. There was very little space at the Chancery for us to set up an office, but as no arrangements had been made to rent accommodation elsewhere, we would have to fit in until the whole thing was sorted out. And 'fit in' we did, all eight of us took over the Ambassador's office and struggled for a place to sit and for a table to put our papers on, a friendly but not very efficient arrangement.

However, in spite of our office accommodation problems, our unsatisfactory hotel arrangements and the lack of our own transport, our presence in Paris had become known and things began to happen. Representatives from GAMD, LMT, MATRA, Rolls Royce and a host of other associated aviation organisations were on our doorstep – *and they all spoke English.*

Our daily visits to GAMD at St Cloud revealed the progress being made on the modification of a Mirage IIIO airframe to take the Rolls Royce engine which had been sent over from UK. The President of GAMD, Monsieur Vallieres and Air Marshal Scherger had agreed that a Mirage should be fitted with an Avon Mk67 engine and a series of flight trials carried out to enable the RAAF to take a decision on which engine should power the Australian aircraft. The fitting of this engine into the Mirage airframe which had been designed around the French Atar was a major task and when the French advised us that they would complete the task in 28 days we were very surprised and a bit sceptical. However, in the next few weeks they proved their point and the aircraft was ready for flight trials. At the time I wondered about the wisdom of CAS's agreement to this proposal, we had had an expensive lesson on such a change with the Avon Sabre and with the large log of trials which followed. Modern fighter aircraft are weapons systems and the aircraft designer normally designs his airframe around the various components – the engine, the radar, etc, etc, and any major changes after the aircraft has been designed and built can be expensive in time, money and possibly in performance. Additionally the nation which requires the changes

to be made is responsible for the cost of associated mods that may follow.

I subsequently learned that M. Vallieres had made this recommendation to CAS as he did not believe that Australia would buy a fighter aircraft without a major British component. No doubt he based his reasoning on his knowledge of our Sabre programme. This also explained why we had not received any calls from the SNECMA team, the designers and manufacturers of the Atar engine with which the French aircraft was powered.

The fact was that they had been warned off by the Defence Ministry for the reason stated above and when I advised the Director that we were indeed interested in their engine they came to us en-masse. This of course meant more lunch appointments, more visits to the Lido, and much time spent on visits to their various factories and test centres. They were a pleasant group and were very kind to us in the early stages of our setting up office in Paris.

At the time, Pratt and Whitney in the US owned 20% of SNECMA and the Pratt and Whitney representation in Australia was with the Brown and Dureau Company. On hearing of the RAAF's interest in the Atar, Mr Norman Adler, an ex- RAAF Group Captain and a senior executive of that Company made his way to Paris at high speed and with a bulging bill fold and the best intentions. Like a number of other salesmen in Paris, I don't believe that Norman had learned that the RAAF *bought* what it needed to meet its requirements – we were not sold.

The Avon-powered aircraft would soon be ready for the trials programme and we met Jean-Marie Saget, a GAMD test pilot who was to fly the aircraft through the entire trial programme. Guy Darling who was with us in Paris for the express purpose of collating and assessing the test data from the trial as it progressed, established a close liaison with Saget. In fact, they are still very close friends, and as Guy visits Paris almost every year they have been able to keep this friendship alive.

Meanwhile, the language problem was worrying some of the younger members of the team and as it was these chaps who spent most of their time at the working level with the French technical staff, they did not find as many English speakers as for example I or Wing Commander Rowland found at the higher levels. There was also a security problem which was more annoying than hindering as Dinny O'Brien explains:

> 'The French authorities were reluctant to allow team members to approach French aviation industry members or units of the French Air Force for private discussions without prior approval. To this end, a member of the Deuxieme Bureau (French Security), M. Mangnon, was assigned to monitor our movements and

obtain security clearances for team members. As time was paramount, members were often required at short notice to visit equipment/component manufacturers. Strictly by FAF rules, this was not to occur without M. Mangnon's consent which often resulted in a time-consuming exercise while he referred the request to higher authority at the 2nd Bureau.

'The ability of some French personnel to provide inaccurate information had to be experienced to be believed. This frustrating habit was often used as a delaying tactic when the information was either not available or not to the predicted standard. On other occasions, it resulted from a lack of knowledge together with a reluctance to give a negative response for the fear of losing face.

'Perhaps the most startling aspect of the magnitude of the task confronting the team was the extent of decentralisation of the French Aeronautical Industry. Clearly, our experience of dealing with the industry at home had not prepared us for the time we were to spend travelling in France. Indeed, one could visit DEFAIR, HQSC, GAF, ARL, NIC, Dunlop etcetera without leaving Melbourne. On the other hand, the Mirage fuselage was manufactured at the western Paris suburb of St Cloud, the engine at the suburb of Argenteuil, the wings in Meault in the Somme area of northern France, the fin at Toulouse in the south, and the undercarriage and hydraulics near the Pyrenees. Aircraft assembly and production flights were completed at Bordeaux in the southwest, while manufacturers' proving and performance flights were conducted at Istres near Marseilles.

'Some team members were obliged to visit the bomb and weapons testing range at Cazaux on the southwest coast, whilst Group Captain Susans and Wing Commander Rowland observed missile firings in Algeria. FAF Bases visited included Mont-de-Marsan for arranging technical field training, Rochefort FAF School of Technical Training, Colman NATO Fighter Base near the German border and others.

'GAMD was contractually responsible for the provision of technical and other documentation in the English language. Consequently, RAAF staff were required to proof read translated copies of all aircraft and engine maintenance and overhaul publications. The bulk of the drafts of the first editions were proofread by Flying Officers Dinny O'Brien and John Macnaughtan.

'Professional translators were employed by GAMD on a part time basis. Few of these translators possessed any engineering or aeronautical knowledge or experience. Consequently, some very quaint words and expressions appeared in early drafts.

Furthermore, as the translators provided their own dictionaries and glossaries-of-terms uniformity of terminology was difficult to obtain and maintain. As a consequence, in the one document the AB system would be referred to as both 'afterburner' and 'reheat' and both 'undercarriage' and 'landing gear' were often used.

'After many frustrating hours trying to make sense of a particular draft, the translator responsible was found to be using an ancient glossary of aeronautical terms. Indeed, the forward of the glossary in this case was written by Lieutenant Charles De Gaulle in 1927!

'Despite all the trials and tribulations, the occasional visit to some of the more notable establishments such as the Lido, Follies or Crazy Horse Saloon tended to soothe shattered nerves.'

We had further problems associated with the release of classified information and the French Air Ministry was quite adamant that it would not release classified information on the Mirage and its development to a non- credited military organisation. The Mirage Team to Paris was not an accredited organisation and consequently did not meet their minimum requirements for information release. This was discussed with the Embassy where the problem was surprisingly and easily remedied by making arrangements for the Mirage Team to become the Office of the RAAF Air Attache in Paris and for the Group Captain to become fully accredited as the RAAF Air Attache. This arrangement placated the French Air Ministry but it did raise certain other problems as far as the Office and the Air Attache personally was concerned. Our job in Paris was to go about the task of purchasing the Mirage with no asides, but with full accreditation the Air Attache was inevitably involved in other activities arranged by the Attache Corps. The Ambassador also liked to have a uniformed man with him on his visits to the President, on Parades and on other very important occasions. To date, this small touch of shop window had not been available, however Dr Walker was a very understanding and intelligent man and he did not make calls on the Air Attache unless he felt that it was important to the Project and to Australia's involvement with it.

There were of course some inherent advantages associated with Diplomatic listing and although these advantages were much appreciated I do not believe that I need to spell them out in this document.

When we arrived in Paris we found that a number of other countries were interested in purchasing the Mirage. These were Israel, South Africa, India and Switzerland. We were told by GAMD that the Swiss requirement was very similar to our own and that they had shown an interest in the Rolls Royce/Mirage development.

We were also told that they were looking at the possibility of fitting the Hughes TARAN radar system instead of the French Cyrano which was fitted to the Mirage IIIC. We too had been asked to study this possibility.

It seemed that there could be mutual benefits in a group from our office visiting the Swiss Air Force Headquarters in Berne for discussions on possible Mirage developments, particularly in the Radar/Missile field. Approval was sought and obtained for the visit and a team of four flew to Switzerland. The Swiss were very interested in a Rolls Royce engine fit and indicated that they would be glad to go along with such a development if Australia did likewise. They were also well advanced in their study of the Hughes TARAN/Sparrow fit instead of the Cyrano/Matra and a decision to do this seemed to be imminent. As a matter of fact, we gained the impression that as the only aircraft available that met their requirement, the Swiss had decided on the purchase of the Mirage with some reluctance and would be glad to make any changes that would meet their requirement and also make the aircraft less French. The visit was well worthwhile as they were really after a Mirage IIIE, as we were in Australia, so we had a lot in common.

The engine trials started on time and Guy Darling was available to handle the trials data as it became available from GAMD. Guy has dealt with this phase of air operations in Paris in the following report:

'The proposal to install an Avon Mk67 engine in the Mirage was a private venture by GAMD and Rolls Royce based on a belief that Australia had indicated its receptiveness for such a programme with the Avon Sabre experience and, of course, it extended the potential to sell the Mirage elsewhere. A prototype installation was built to promote the virtues of this combination and consequently the terms of reference from Department of Air for the RAAF Mirage Team included the following:

'The team is to compare the performance and technical suitability of this installation by flight testing and detailed evaluation with that of the Atar-engined Mirage and recommend to the Department of Air which engine should be adopted for the RAAF."

'Detailed performance check points to be achieved by the Avon powered aircraft were established by Group Captain Cuming during the 1960 evaluation and a flight test team, comprising test pilot Jean-Marie Saget (subsequently Chief Test Pilot at Dassault) and engineer Bernard Sigaud, was set up by Dassault in early 1961 to carry out the necessary trials on the Mirage III0, modified for this purpose. The first engine test run in the aircraft was made on February 7, 1961 and the first flight was made at the

industry flight test centre at Villaroche, south east of Paris on February 13. By the end of April some 45 test flights had been completed at the official flight testing sites of Villaroche, C.E.V at Britigny (for measurement of take off performance), at Istres near Marseilles (for performance and engine handling trials) and at the weapons testing centre at Casaux near Bordeaux. These flights completed the flight test programme necessary for measuring aircraft performance against the check points and assessing engine behaviour over the full flight envelope, as well as some indication of the behaviour of the engine when firing guns at high altitude and low airspeeds.

'At the same time, the first Mirage IIIE fitted with an Atar 9C engine made its first flight on April 5 and, as it had became apparent to Dassault and SNECMA that Australia wanted the most suitable airframe engine combination available, the Dassault flight test team, comprising test pilot Jean Coureau and engineer Jean Costard, followed a similar test program to obtain comparable test data to that available for the Avon version. At the same time, SNECMA revealed the existence of a new Atar development, designated the Atar 9K, intended for the Mirage 1V, which was easily fitted into the Mirage III airframe and provided a significant improvement in thrust and a reduction in specific fuel consumption of the Atar 9C.

'Thus by early May, it was apparent that the expected advantages in take-off performance, rate of climb and range for the Mirage III with the Avon Mk67 engine were not a significant improvement over the Mirage IIIE, whereas overall performance at altitudes above 40,000ft was somewhat inferior, although the Avon version was able to achieve higher speeds without afterburner at altitudes below 45,000ft. On the other hand, the development potential of the Avon Mk67 engine was limited to the fitment of a larger tail pipe (36" diameter as opposed to 28.8" in the standard engine) and the expected benefits to thrust and fuel consumption were not comparable with those available from the Atar 9K. The Atar engine offered additional important benefits, being lighter and cheaper than the Avon and was perceived to have benefits due to ease of manufacture and servicing together with simplicity of operation associated with design for military operation exclusively.

'It was also apparent that other potential purchasers of the aircraft were not contemplating acquisition of the Avon engine version and the enormous benefits of standardisation with other users, and particularly the French, made recommendation in favour of the Atar straightforward.'

When the Avon/Mirage trials were complete and the data studied by Darling and members of the staff, it was clear that the only advantage, and this was marginal, that the Avon enjoyed over the Atar was in dry power at low altitude. It was also thought that the Atar was a more rugged engine and therefore more suitable for fighter operations. At altitude, and with afterburner at any height, the Atar was superior and when this was considered against the background of the risks inherent in going non standard with the Mirage as developed by the French, the decision to recommended the fitment of the Atar in the Australian aircraft was made.

There was a flurry of signals between my office and CAS and it was obvious that considerable pressure was being brought to bear by the Rolls Royce organisation at all levels in Australia. We had had some experience of this in Paris and I suggested in a signal to CAS that probably it would be appropriate if I returned to Australia with a full report to submit to the Air Board. His reply came over night and directed that I return to Australia by first available Qantas aircraft.

It so happened that a Team from SNECMA led by the Company President Monsieur Debrueres was on the same aircraft. They advised me that they were prepared to make a series of presentations on the Atar 9C and 9K as required at the Department in Canberra.

Debrueres and his team gave a number of presentations in Canberra and dealt with the Atar 9C, the Noelle starter and the development of the Atar 9K which they were now pushing ahead with in the hope that it could be available for fitment to the Mirage IIIO if Australia so wished.

I attended the Air Board Meeting with the Minister present and presented the case as we saw it in Paris. Copies of Guy Darling's report were circulated for the consideration of board members. The projected changes to the engine with overspeed and surcharge were discussed at length and the inherent benefits recorded. It had to be noted however that at this time these options were at an early stage of development and flying trials.

Bearing all these factors in mind, particularly the advantages in staying standard with the French aircraft and the costs inherent in switching to the Avon, the Board decided in favour of the Atar for fitment to the Australian aircraft. The decision to adopt the Atar was announced on May 17, 1961, with an option until 30th September 1961, to determine whether to install the Atar 9K or Atar 9C. In the event, progress with testing and development of the Atar 9K was such that it was not installed in an aircraft prior to the above deadline and, in the absence of any flight testing it was considered an unwarranted risk to contemplate purchase of the Atar 9K engine for the Mirage III0.

The contracts for the first batch of aircraft were signed with due ceremony and champagne in the Ambassador's office on the 30th March 1961. This was the first major milestone for the Mirage Team/Air Attache Office and was an appropriate time to look back over the three frantically busy months that had passed and at the Team's achievements during that period. We had now set up our office, made calls and established our contacts, followed the trials of the Avon Mirage and made the necessary comparisons between it and the aircraft powered with Atar and made our recommendations back to Australia. We had looked at and recommended against the fitment of the TARAN and Airpass radars with associate missile systems and given consideration to improvements that could be made to the aircraft navigation system. We were happy with results so far, particularly as we had just received advice that our wives and families would be joining us, and at last, separate accommodation was found by the Embassy for the RAAF Air Attache Office. An adequate section of an office building in Rue Raffet was rented for us and we moved our rapidly growing administrative unit into it. An equipment officer, Wing Commander Tom Walters and his assistant Squadron Leader John Surridge plus some equipment staff were posted in and a car was purchased for the office and a chauffeur engaged to drive it.

Now that we had our own offices with extra space we were joined by Mr Ted Bennett, the Department of Supply Representative and his staff. This permitted a close liaison between the RAAF and Supply/Production staffs which was to the advantage of the Project as a whole. With this closer association with Mr Bennett we found that he was also having trouble with some to the contractual staffs in relation to the accuracy of information given and promises made. It was at this stage that matters in this field had come to a climax as far as we were concerned and a couple of cases of blatant lies about problems the French were having took me to Vallieres' office in protest. I explained to him that his staff's problems were also our problems and if the facts were known instead of the oft repeated phrase 'il n'y a pas de problem' perhaps we could assist in sorting the problem out. In fact, we had learned by now that when this phrase was used it meant that things had really gone bad. He agreed and promised to push out some firm directives to all who were dealing with RAAF/Supply staffs. His directives raised a rather amusing reaction from one of his junior executives who in discussions with one of my officers made the following strange remark, 'I agree with what the Colonel has said, it is wrong to tell lies about important matters, as a matter of fact I only tell lies when it is absolutely necessary'. An unexpected and interesting insight into French habits and ethics.

We had a much happier team now that families had arrived or were soon to arrive to join their husbands. Members chose a variety of types of accommodation, some in the older types of apartments (with concierge thrown in), others, more modern units, whilst quite a number of members favoured the smaller villas on the outskirts of Paris. Most were taking French lessons with mixed results whilst those few with a language flair did famously and I can recall Jim Rowland in his second year chairing a conference with French technicians in their own language. I can still remember M. Dassault's discussion with me when I first arrived in Paris when he said, 'Colonel there is only one way to learn to speak French quickly – that is on the pillow'. But he went on to say 'unfortunately you gain a very limited vocabulary'.

Now that the engine trials and contracts were behind us, activity got down to a steady grind in the technical and equipment fields. However, in the very capable hands of Jim Rowland and Tom Walters I could foresee no problems that could not be solved by a joint approach. As Dinny O'Brien has pointed out, the production and translation of maintenance manuals was a problem, and as we were paying one million dollars for these documents we wanted to make sure that we got value for our money. This meant long hours of boring and tedious work for those involved, sometimes with translation problems that seemed to have no solution.

There were of course the good times and all the staff who came to Paris with me got to know the inside of all the best nightclubs and to dine at all the best restaurants. It seemed that everybody wanted to entertain us and I can remember an occasion when we were invited to a dinner party at the Lido and I told Dinny O'Brien that it was his turn to go and I got the following reply, 'Gee Boss do I have to go? I was there twice last week'. I had certain misgivings myself and every time I sat down at a stage-side table at the Lido I imagined the topless, bobbing and bouncing girls in the chorus nudging one another and saying 'there's the dirty old B _____ in the front row again'. Yes, we were looked after very well and to wine and dine at the finest tables in Paris is something that we all remember for many years ahead. I often wondered if all this social generosity was added to the Mirage bill.

However, back to the working scene. In the purely technical field, there was still a long list of possible fitments to be examined, evaluated and recommendations made back to Canberra for decision. These included the Sperry Twin Gyro platform instead of the French Crouzier which was fitted to the Mirage IIIC, fitment of the PHI, later development of the IFF, Tacan, Doppler Radar and the radar altimeter. There were of course other equipments to be considered, but the ones I have mentioned above were of first

priority. There was also a flight simulator to be built and LMT (Les Materieux Telephoniques) was very active in seeking the contract. Once again however, the security problem cropped up and the Air Ministry was reluctant to release aircraft performance data to LMT's chief technician who, incidentally, was an Englishman. This took some sorting out, however, LMT eventually got the contract to build the Mirage IIIO simulator.

At last, Jim Rowland and I had a chance to fly the Mirage. This opportunity took us down to Istres in the south of France near Marseilles. GAMD had a Test Centre there and the airfield looked very impressive to us as it was 9 000ft long and joined to an old runway which gave us another 6 000ft. The lead up to flying the Mirage IIIC was to be carried out in the SMB2, which was a fighter of the F100 class and looked like a pretty good copy. Neither Rowland nor I liked this aircraft and although it was supersonic it did not have many other attributes that would endear it to us. Jim always referred to it as the 'Butter Box', I do not know where this name came from, however, I do know that it was not meant to be complimentary. Eventually we both made a flight in the Mirage and although the flight was for only one hour in my case, I felt convinced that we had bought a fine aircraft to replace the old Sabre. The Test Centre had all the normal facilities such as a refrigerator filled with champagne which was uncorked when someone flew an aircraft for the first time. The French Test Pilot Jean-Marie Saget joined us in the Mess for lunch before we were due to fly and when I was asked if I would like a drink before lunch I referred the invitation to him, asking if he would like to join me. He answered very firmly saying that he never drank when he was due to fly. I felt suitably chastised and refused the offer. To my amazement however, when we sat down to eat, Saget grabbed a bottle of white and had a couple of helpings followed up by an attack on the red later in the meal. I was prompted to ask him if he had changed his mind about flying since he was drinking, to which he replied, 'But my Colonel, I am not drinking, this is wine'. I did not argue with him, I joined him.

The Mirage III0 No 1 was displayed in the air for the first time on 9th April, 1963 at Villaroche south east of Paris by Jean-Marie Saget. The weather on that day was absolutely foul and Saget did a first class job in showing the aircraft off under a low cloud base and often in rain. Afterwards, there was a great celebration in the hangar (French style) and the entire staff from the office was present. After a deal of speech making, M. Vallieres handed to me a parchment scroll fashioned in ancient style proclaiming the handing over of Mirage III0 No 1. This scroll is hanging on the wall in the foyer of the Officers' Mess at RAAF Williamtown, where I hope it will remain while the base stays in business.

With the project settled down to a normal daily routine, the visitors came. We realised that this was inevitable being in Paris and of course many visits were from staffs in Canberra and were of critical importance to us and the project as a whole. There were however, many freeloaders who wanted a trip to Paris and so causing a lot of work for all our staff and for the ever hospitable French contractors.

There was something about being in Paris that made things so different from being in New Delhi, London, Washington or Singapore. I mean this in the manner of consideration of requests made in relation to allowances, conditions of service etc. It always seemed that because we were in Paris people back home always started off by thinking that we 'were up to something'. In other words we had to work harder or talk faster to get what we needed than did our counterparts in other parts of the world.

Most people in Australia know something about the French town of Villiers Bretenoux, north of Paris, and of the gallantry of the Australian soldiers who fought there during World War I. We had a pleasant break from the project when the Ambassador asked me to attend, on his behalf, the Anzac Day ceremony, which is celebrated there on the 25th of April each year. We made this a uniform-wearing parade for all RAAF members of the staff and I believe that this practice continued whilst the Office was in existence. It was also very comforting to see that all civilian members of the staff also found their way to Villiers on that day.

This wonderful shrine of remembrance and war cemetery is something that all Australian visitors to Europe should include in their itinerary. The tall building of the shrine stands impressively on the hillside and looks down on the rows and rows of white crosses which display the names of the young soldiers who gave their lives in that terrible and critical battle. Age 18 seemed to be about the average with an occasional veteran of 24.

The Villiers public school was rebuilt after World War I and has been supported in its operation by collections taken from the school children in Victoria. The Australian Ambassador in Paris made a donation of sporting goods to this school every year on Anzac Day and it was my privilege to do this on his behalf whilst I was in Paris. It was very touching to hear the children sing Waltzing Matilda in their French English after the handing over ceremony and the speech making. All this was followed by a lunch at the Mayory hosted by the Mayor which always seemed to use up the remainder of the day.

On the way up to one of these visits, one of our assessing staff, Flight Lieutenant Jack Bennett ran off the road in his car and virtually climbed half way up a tree which unfortunately had been growing there for about 100 years. His Citroen broke in half and Jack

was in the middle of the break. When I saw him in the wreckage (I was travelling in the car behind) I did not like his chances, but now I understand that he is in retirement and in good shape.

Although we had chosen the Matra/Sidewinder/Cyrano combination we still lacked actual and positive trial results on the front hemisphere performance of the Matra all weather missile. M. Legardare, a Matra executive, advised us that some live firings against a Mistral (Vampire) target were planned shortly on the missile range at Colom-Besha in the Sahara desert. He invited us to attend. Jim Rowland and I accepted and Legardare went about getting clearances for the visit. We were impressed with the range when we eventually arrived there after a long and not too comfortable trip by air. The range was of special interest to me as I had spent four years at Edinburgh Field in support of the Weapons Range at Woomera. The trial was set up and we watched from a vantage point. We picked up the Mistral tracking in, then we picked up the Mirage coming in on a head-on attack. Legardare who was half Spanish and very excitable was jumping up and down in great excitement as the distance between target and attacker narrowed and finally on release uttered a few Spanish words of prayer. It seemed forever that the missile closed in on the target and just as Legardare screamed out 'it has missed!', there was a bright explosion and the old Mistral started falling to the ground in many pieces. It seemed that the missile did work when released in a head-on attack, just as the manufactures had claimed.

Wing Commander Alan Hodges who had been on the original fighter evaluation team when the Mirage was selected was posted in as Assistant Air Attache. We were glad to have him with us.

Large numbers of NCOs were now joining us for the spares assessing phase of the project. This is really the expensive part of the deal and I think one of the most difficult. The Mirage was a very different aircraft to the Sabre, and with the large number of new electronic devices in its inventory the assessors had difficulty finding a pattern with which they were conversant to use as a basis for their assessment. This equipment stage of the project went on and on and I imagine that the function of the final Office in Paris was largely equipment-related. It is unfortunate that in spite of my efforts, I have not been able to get an Equipment input to this paper.

We watched the trials of the arrestor barriers in France and I went on to Sweden to study the trials which were being carried out by the Swedish Air Force. As a result of further studies it was considered that the Swedish system was the best and these barriers were eventually purchased for installation at RAAF airfields. I was at Williamtown when the barriers were installed, and I thought how ironic that the barriers were to be permanently erected at the end of

the active runway when it was the electronic erecting system used by the Swedes which had swung the balance in their favour when all the barriers were being considered.

In the third year we moved into even larger offices at No 45 Avenue Kleber and I was advised that Group Captain Glen Cooper would be coming to Paris to take over from me. My posting would be advised in due course.

During the earlier part of our time in Paris I had got to know Air Marshal Weismann, Chief of Staff, Israeli Air Force and he suggested that before I left Paris for Australia I should visit Israel and see what they were doing with the Mirages and look at their aircraft production capability. He invited me as his guest. It was surprising how difficult it was to get approval to visit Israel in those days, and as it was in the hands of our Foreign Affairs Department I almost ran out of time before approval reluctantly came through. I know that Fred Barnes made a similar visit some years later when he was Air Attache and I often wonder if he had the same problem since the Israel/Egypt conflict was then over. I was impressed with all I saw, the underground hangars, the most impressive turnaround times achievable with the facilities in these hangers and the attitude of all involved in getting 110% out of the Mirage they had purchased, and in some cases improved. Their Defence production was also most impressive and I learned that they were keen to sell Australia the drop tanks we needed for our project. This I learned back in Paris was not in accordance with the conditions of our contracts. I had a sneaking impression however, that some of the supersonic tanks we bought from the French had a place of origin in Israel. They had a very good reason to produce a lot of the high usage spares for the Mirage as they knew that the French would cut them off if they engaged in war with Egypt. This was also the reason why they had such a modern and efficient munitions manufacturing capability. Australians were popular in Israel and I made a number of friends in the short time I spent there. I corresponded with Air Marshal Weismann for many years and saw him change from CAS to Defence Minister in the Israeli Government.

With Glen Cooper posted in and my posting due at any time I managed to take a week off and do some Mirage flying at the French Air Force Base at Mont de Marsan on the west coast. This was a nice finish to my tour in Paris and spending a week on an Air Base made me feel I was back in the Air Force once again. We made this visit as a family and enjoyed the drive through some of the finest and most interesting country in France. My son, Martin, then at school in Paris and with aspirations to join the RAAF spent the week at the Test Pilots Lodge at Meringac as a guest of GAMD. As he watched with fascination the flight testing of the Mirage at Merignac, I wonder if

he would have believed that one day he too would be an RAAF pilot with almost 2000 Mirage hours in his log book.

When my posting came, I felt after three years in Paris I was ready to leave. As my next posting was as OC RAAF Williamtown I was happy that my three- year association with the Mirage in Paris was to continue back in Australia.

It has been a rewarding experience to be taken back 27 years in preparing this account for the Mirage Story; it is however, a long way to go back and trust one's memory. With no files or records at hand occasionally one feels that it is a bit dicey at this stage in life to try to accurately tell the story of those first three years of the Mirage Project, however, I am sure that those who read the Mirage Story in the years ahead will forgive me if I have fluffed some of the dates, elaborated with some of the stories or spelled some of the French names or places incorrectly.

It was a privilege to be associated with the early days of the Mirage and in my case to have the fortune to continue to be so associated right up to the time of my retirement in 1975. As I write this paper the Mirage is bowing out and I witnessed one of its last flights when I was at Williamtown quite recently. The F/A-18 has taken its place and one can only hope that it will satisfy the need of the RAAF in the years ahead as ably as its predecessor has done. The F/A-18 is a great fighter aircraft with unbelievable operational capabilities but will it last 25 years in service like the aircraft it is replacing? I hope that it does, and that it will be remembered with the same affection as we all remember the 'French Lady'."

Notes: (1) AVM Ronald T. Susans was born in Manly, Sydney on 25 Feb 17, graduated from Pt Cook on 28 Cadet Course and was commissioned on 20 Jun 40.

1940 – No 3 Flying Instructors Course.
1940 – Instructional duties, Pt Cook, Geraldton, Uranquinty.
1942 – 3 Sqn Middle East, saw service in North Africa, Malta, Sicily and Italy.
1944 – 79 Sqn, West Pacific area
1945 – Commanded 79 Sqn, Wing Leader Spitfire Wing.
1946 – Commanded RAAF Station Parafield.
1946 – Commanded Mustang Conversion Unit Williamtown.
1947 – Commanded 77 Sqn, Japan.
1949 – Commanded 25 Sqn, Perth, WA.
1950 – Staff Course and Staff Duties.
1951 – Day Fighter Leaders Course, West Rayhnam, UK.

1952 – Commanded 77 Sqn, Korea
1953 – Staff Duties
1954 – Air Attache Washington.
1956 – SASO RAAF Edinburgh, SA.
1961 – Air Attache Paris.
1964 – OC RAAF Base Williamtown.
1966 – DGOR Dept of Air.
1969 – OC RAAF Butterworth.
1971 – Commander IADS, Butterworth.
1975 – Retired.

Awarded CBE, DSO (immediate), DFC, American DFC with Cluster, Air Medal with 3 Clusters, granted Honorary Commission in the French Air Force with the rank of Colonel.

2

PRODUCTION ASPECTS

Mr E.R. Bennet and Mr P.B. Talbot

Ted Bennet and Pierce Talbot were two of the key members in the large team from the Department of Supply that produced the Mirage IIIO in Australia. Mr Bennet went to Paris as the Supply Attache in 1961, and on return to Australia became the Area Manager at Avalon. Prior to the start of Mirage production, Mr Talbot managed, as Production Superintendent, the extensive preparations that were required at the Avalon site, and went on to become the Area Manager from 1975 until his retirement in 1978. These two distinguished engineers have pooled their collective memories to provide this account of the Production Aspects of the Mirage Story.

"At the time the decision was made to re-equip the RAAF with the Mirage fighter, Government Aircraft Factory was mainly engaged in the design, development and production of the Jindivik Target aircraft and Ikara anti-submarine guided weapon.

At Commonwealth Aircraft Corporation, the Sabre production programme had been completed but the factory was active on aircraft servicing and engine overhaul and commercial ventures. Staff skilled in the production of aircraft structures and jet engines were available and the opportunity to become involved in the production of a supersonic fighter was received with great enthusiasm.

Previous aircraft projects had been of either British or American design and the challenge of the language problem and the rapid adaptation to the metric system several years before the general introduction of the metric system into Australia was appreciated.

A supply Attache was appointed to Paris with a staff of three, later to be increased to five to monitor cost control, progress the supply of production drawings, technical data, aircraft parts, material and equipment from Generale Aeronautique Marcel Dassault, negotiate

contracts and work in close cooperation with the Air Attache and his staff, particularly on supply and technical matters.

Arrangements were made for key personnel from Australia to visit France to study technical data, material specifications, production and quality control methods in the French factories, and function testing of complete aircraft.

The first agreement with Marcel Dassault was for the supply of material, parts and components to produce thirty aircraft.

The parts to be completely manufactured in Australia were based on the ability to compete at a competitive price and mainly confined to those items assessed as life-of-type spares considered necessary to maintain an aircraft for its complete service life.

Past experience indicated that aircraft are maintained in service by RAAF for long periods, often after production of the aircraft had ceased and the cost to refurbish tooling to produce small quantities could be very high.

Later agreements were to increase the order to 100 Mirage IIIO and 10 Mirage IIID trainers. Had this information been known earlier the number of items to be completely manufactured in Australia could have been considerably increased.

Australia's decision to re-equip with a French aircraft came as a shock to the British aircraft industry which traditionally had been able to exercise considerable influence in the supply of Australian defence equipment.

Efforts were made to have the Mirages equipped with a Rolls Royce engine; however, the RAAF decision was that the French ATAR engine should be retained.

Commonwealth Aircraft Corporation had acquired wide experience in the production of jet engines in their well equipped engine division and were confident they could quickly adapt to advanced techniques and problems that may be presented by the language and change over to the metric system necessary to produce the ATAR engine.

Mirage manufacture in France was over a dispersed area. Parts manufacture, fuselage construction and engine manufacture were around the Paris area, but the wings were manufactured by a contractor in Northern France in the Somme area, whilst final assembly and flight testing took place near Bordeaux in the South West.

As is usual with most aircraft manufacturers much of the work was farmed out to sub-contractors. In France, however, this was extended to work carried out in Dassault's own factories. All electrical installations and function testing was carried out by a sub-contractor using his own work force. This also applied to other systems such as hydraulics, engine installation and testing etc.

In most cases this meant negotiating separate contracts for the manufacturing rights. Although these negotiations were carried out through interpreters to avoid any misunderstanding they were very time absorbing and often frustrating. The interpretation of one word could result in long discussion.

A typical example was a clause in an agreement where it was stated that if the Contractor was to send a technician to Australia he would be paid a certain sum and the cost of the return fare. This immediately raised the query, but what about the fare out there? In France if you asked for a return rail ticket Paris – Bordeaux, you would receive a ticket from Bordeaux to Paris. To obtain what we understand as a return ticket, it is necessary to specify Allez et Retour – Go and Return.

The French were so elated at winning a contract to sell aircraft to Australia against the traditional British and American companies, they were inclined to agree to what were to become unachieveable delivery dates rather than possibly offend and the term 'pas de problem' instead of meaning 'no problem' we came to interpret as 'no immediate solution'.

These late deliveries, together with early production problems in Australia were to result in late delivery of scheduled aircraft to the RAAF and severe criticism for hold-ups in their conversion training programme. The monthly progress report from Dassault on promised deliveries often extended dates by a further month with each report and became so unreliable that a show down with Top Management became necessary. This resulted in a realistic recovery schedule being agreed to, after which conditions gradually improved.

With experience gained over many years with both UK and US aircraft projects, Dept of Supply had built up well proven methods to monitor cost control, delivery schedules etc, whereas most French contractors were mainly concerned with one customer, the French Air Force.

They were quick to appreciate and adopt many of our methods and so although we were to learn a lot from them, they were also to learn a lot from us. A close cooperation was to develop with the company with warnings in advance when any problems were anticipated. This confidence and trust which was built up with Top Management was to result in a long lasting friendship.

The settling of financial accounts was controlled from Australia House, London who demanded that the Paris Office certify all documents to the effect that manhours and prices quoted were fair and reasonable. With the staff available and time involved it was not possible to reach such a decision by close study of the design drawings. However, the Paris staff had been selected because of their

sound practical experience on production activities and by viewing identical equipment in the French factories were able to make a fairly accurate valuation.

On one occasion there appeared to be quite a discrepancy on a very expensive item of equipment and after considerable discussion, it was admitted that a mistake had been made and the cost of the equipment was reduced by fifty percent. In general however, the quality was found to be of a high standard and prices reasonable.

Problems were also to develop on the engine side with manufacturers SNECMA. Previously their only customer was the French Air Force and they had established only one manhour rate for their production so that simply-produced parts carried the same manhour cost as the more complex items. Whilst this balanced out if you purchased a complete set of engine parts, it led to a lot of confusion and difficulties with cost control and resulted in continuous negotiation to reach a satisfactory arrangement right up till the end of the contract.

Packaging and transport was to play a very important role. Rigid specifications were used to control protective treatment, packaging material and containers. This particularly applied to machined parts, engine components, electrical, hydraulics, instruments, etc. Contractual arrangements were negotiated which proved very reliable with supplies arriving in Australia in first class condition. Supplies were generally transported by rail to Marseilles and ship to Melbourne. Air freight was only resorted to for critical shortages.

France is quite a large and beautiful country and Paris probably the most beautiful city in the world. The people over the years have developed the art of gracious living with good manners, fine food and wine and an appreciation of beautiful things. Once you got to know the people they were very friendly and close ties were established with many French families. It was not surprising that such a beautiful looking aeroplane as Mirage should be conceived by French designers.

From the numbers of queries generated in Australia which flowed through the Paris Office, it was evident that the stress and high pressure to which the staff was subject was not appreciated. A posting to Paris was obviously regarded as the ultimate, where champagne flowed from the fountains and the girls strutted around with mattresses strapped on their backs. What an illusion.

PRODUCTION IN AUSTRALIA

GAF was nominated as the Prime Contractor with responsibility for the delivery of complete aircraft to the RAAF. The aircraft establishments of GAF and CAC are located at Fishermens Bend

adjacent to one another. These factories were established just prior to the war, with CAC to produce Wirraway and P & W Wasp engines and GAF Beaufort and Beaufighter. At that time an airfield was available at Fishermens Bend for flight testing. Aircraft projects which had been undertaken by these factories included Lincoln, Canberra, Jindivik, Mustang, Winjeel and Sabre. Engines included Twin Row Wasp, Rolls Royce Merlin and Avon jets.

With the introduction of jet aircraft, the Avalon Airfield was established near Geelong on a 4500 acre site with four large hangars well equipped to handle aircraft final assembly and servicing.

The production plan for Mirage was for GAF to produce the fuselage. CAC would produce the wings, fin, rudder and tail cone and engine. These major items would be delivered to Avalon for join-up, final assembly, fitting out, function tests and flight testing.

Lead in supplies would be obtained from France to provide time for jig installations, production planning, training personnel and production of the locally manufactured items. These would include two complete aircraft ready for final assembly, some fitted out structures and some shells ready for fitting out. A similar plan would apply for engine manufacture.

Like most large production establishments, the production department and success of the end product relies on the support provided by other groups such as Design, Engineering, Tooling, Purchasing, Supply, Quality Assurance, Maintenance, etc.

Consideration was given to converting the French drawings to English, but this would have been very time-absorbing and costly. The planning section did an excellent job in the issue of production control documents and the tradesmen soon adapted to working from French drawings and to the metric system. Some of the workforce were migrants from Europe who had worked in aircraft factories and were able to make a great contribution.

All sub-assemblies and structures were built in jigs which accurately controlled the shape and join up locations. The foundations on which major jigs were established must remain stable and great skill and care exercised during installation. All jigs and tooling were subject to regular inspection to ensure that no movement or wear had taken place.

The three major components Front Fuselage, Centre Fuse and Rear Fuse formed the completed fuselage. These structures were of stressed skin design with formers and stringers of high strength light alloy sheet material and extrusions.

Former 26 in the centre fuselage formed the centre piece.This was made up of two 75mm deep machined forgings joined back to back with a peripheral band, to become the wing join up section, carry the undercarriage loads and form a box section for the engine trunnions.

High strength forgings machined to fine limits were also built into major stress areas such as join up points, nosewheel attachment, bomb and gun bay areas, etc. In some cases it was necessary for these fittings to be line bored 'in situ' on the production line to a high degree of accuracy and finish. These operations were carried out in the evening when the temperatures were more stable and there was no vibration from factory traffic or rivet guns.

The riveting of external skins required a high degree of skill to maintain the smooth contour and finish essential for supersonic aircraft. All aircraft parts are subject to protective treatment such as anodising, cadmium plating, dichromating, etch primes and paint. During assembly, care must be taken to ensure that dissimilar materials do not come in surface contact and possibly generate corrosion due to electrolytic action.

Special attention was given to the semi-circular air intake structure on each side of the fuselage which housed a moveable half cone intake shock cone, which was electrically operated and computer controlled and could move automatically forward and backward like a needle valve and regulate the correct flow of air to the engine and prevent turbulence under all conditions of a flight pattern and nose up during landing.

A narrow section between fuselage and air intake allowed boundary layer air to be ducted to provide air for the two separate air condition systems for cockpit and avionics, before circulating around the engine compartment to provide cooling for the structure and passing out through the tailcone.

All fitting out items in the fuselage were required to be fitted out in a precise sequence and one item in short supply could hold up a complete stage. It was not possible to fit the item later when it became available. Further work could close the area off or render it inaccessible by subsequent fittings.

There were eight large looms in an aircraft containing over thirty two kilometres of wire. These were manufactured in a well equipped loom shop and thoroughly tested on GAF designed equipment before being assembled.

A Mirage contained approximately 1500 pipes ranging from 3mm to 75mm diameter. These were fabricated from light alloy, tungum, copper and ferrous alloy to complex configurations, and tested on a mock up board simulating the aircraft. All pipes were pressure tested, some to 3500 PSI. Extreme care was taken regarding cleanliness, any trace of oil in an oxygen pipe could cause an explosion.

The fuselage final assembly jig was mounted on rollers and could be rotated to remove swarf and rivet mandrels and detect any foreign objects prior to final vacuum cleaning.

GAF had built up considerable expertise in the vacuum or contact forming of acrylic sheet in which the maintenance of high optical qualities was a pre-eminent requirement. The cockpit canopy was an item chosen for local manufacture and was a most important item as a life of type spare.

All aircraft manufacture is subject to a very rigid system of quality control. Raw material is required to be certified conforming to specification and is often verified by a check test in the laboratory by Quality Assurance on receipt from the supplier. Each manufactured part and assembly is inspected and carries an inspector's stamp. This also applies to every stage of production and factory control documents are stamped and complete records maintained.

The Air Force Directorate of Quality Assurance maintain their own inspection staff in the factories to monitor quality control and in critical areas completely duplicate the inspections carried out by the factories quality control staff. A complete history is maintained of all items and the particular aircraft in which they were installed. Should any subsequent defects develop in service, records are available right back to the raw material from which a part was made and the aircraft to which it was fitted. Any suspect items can be readily pin-pointed to specific aircraft for investigation and so avoid a possible grounding of the complete fleet.

WINGS

The cantilever wings of delta plan form were manufactured at CAC in pairs in two large horizontal jigs. The structure formed a torsion box with stressed skins. The skins were machined from solid slabs, sculptured so that the stringers and reinforcements were integral, thus avoiding the possibility of leaks which could occur within a riveted structure.

The main spar which was machined from a forging, formed a right angle with the fuselage centre line and carried the undercarriage attachment. The rear spar was also normal to the centre line with the leading edge spar forming a diagonal (see General Arrangement at Annex A).

Transverse fore and aft ribs supported the skin profile and also acted as fuel baffles. The accurately profiled leading edge was supported by closely spaced ribs normal to the spar. Apart from the narrow sealed tunnel which housed the actuator for the elevon controls, practically the whole area behind the leading edge formed the integral fuel tank. The electro-hydraulic actuators were very accurately adjusted and tested on a special test rig by personnel trained in France in the Dassault factory.

With the high stress placed on wings due to high speed

manoeuvres a theoretical service life had been placed on wings. A number of aircraft were building up the flying hours nearing this limit, so an order was placed for additional spare wings.

One of these aircraft was made available to Avalon and fitted out with a complex system of strain gauges by the Aeronautical Research Laboratories and a test flying programme undertaken by ARDU. The result from this analysis indicated that the theoretical figure was very conservative and that the life of the wings could be considerably extended, and the order for additional wings was cancelled. Fortunately, this did not cause an upset to production at CAC as the wings were sold to France and the order completed.

ENGINE — ATAR 9C

The engine was produced at the Commonwealth Aircraft Corporation Engine Division. It was a single shaft turbo jet with nine stage axial compressor, two stage turbine and after burner. The main components being:

Intake

One piece air intake casing housing the fixed inlet vanes and hot bleed anti-icing system with six struts supporting the front main bearings and starter.

Compressor

Two piece magnesium alloy casing with steel and aluminium alloy blades. Drum type rotor with steel blades.

Combustor

Steel casing of two concentric liners housing twenty flame cups and fuel burners.

Turbine

Steel casing with hollow nozzle vanes. Turbine wheels bolted to the drive shaft and supported in roller bearings ahead of the wheels.

After burner

Detachable convergent — divergent type with downstream injection. Fully variable nozzle with eighteen segment-type shutters operated by nine actuators. Blade forgings were produced by local sub-contractor — National Forge. The blades were machined, ground and polished in special purpose machines to the complex contours and accuracy required. Extreme care was exercised during assembly to ensure perfect balance.

With the high speed and operating temperatures of jet engines with regular overhaul periods, the demand on spares was fairly high and this led to local content being progressively built up until the engine was eighty five percent Australian manufacture.

After assembly the engine was passed on to the test house where final adjustments were made and the engine certified as meeting the thrust, acceleration, fuel consumption etc specifications.

A total of 160 engines were produced in Australia and engines were passed back through the CAC Engine Division on 1390 occasions for overhaul, repair or bay servicing.

AVALON

At Avalon the join up of major components was carried out in a large, well equipped hangar with a clear floor area of 90 X 90 metres.

In the early assembly stages the fuselage was mounted on a mobile trolley until the wings, undercarriage and nosewheel were installed and tested. This allowed the assembly line to be moved until the aircraft was mobile.

Attachment of the wings to the fuselage was a very accurate operation. This involved the fitting of a large diameter split bush with a tapered bore into which a tapered bolt was fitted and adjusted so that there was a 100 percent bearing area in the attachment fittings.

In the French factories the complete assembly line was moved at precise intervals. With the lower rate of assembly at Avalon it was found to be more expedient to have less aircraft movement and move the special trade groups.

The fuel system comprised the integral wing tanks, flexible fuel tanks in the fuselage cavities, a drop tank under each wing and an under fuselage drop tank. These were all interconnected and controlled by a simple automatic system to control the consumption in the correct sequence and maintain centre of gravity.

There were two independent hydraulic systems for flying controls, landing gear and brakes.

Instruments and avionics were marshalled in aircraft sets and tested in a clean area section remote from the main buildings.

CAC maintained a small section at Avalon to fit the final accessories and prepare the engine for installation. This involved an engine run in a mobile test stand.

When the engine was cleared and handed over, it was mounted on a mobile tubular structure and wheeled to the rear of the aircraft, jacked up to the correct height and temporarily located to the tail cone attachments with pins. The engine was then rolled along the inbuilt rails in the fuselage on the rollers which formed part of the engine and attached to a trunnion on each side of the fuselage centre line and feed lines and controls connected. The third attachment point was an adjustable link from the fuselage which allowed for expansion or contraction. The mobile trolley was removed and tail cone installed. For an engine change, the operations were reversed and an engine change could be effected quite quickly.

Following final assembly and function testing, the aircraft was transferred to the Flight shed section where engine runs, compass swing and preparation for flight were carried out.

No armaments were installed in the factory and aircraft were flight tested and delivered with a gun bay fuel tank installed. However, a complex gun sight harmonisation was carried out using a master gun pack.

On previous projects GAF had provided its own test pilot, but for Mirage the RAAF provided test pilots from ARDU, the Aircraft Research and Development Unit at Laverton, who were stationed on area. This close contact between the factory and the RAAF proved very beneficial with greater understanding of one anothers' problems and the availability of factory facilities for common use.

Following a test flight key personnel in the Flight shed conferred with the test pilot on any flight snags. These personnel had built up a complete mental picture of the aircraft systems and controls and could carry out an analysis with computer-like precision and determine where adjustments and fine tuning should be carried out, or if any equipment should be replaced.

Following test flying the aircraft was transferred to the very up-to-date paint shop for painting under temperature and humidity controlled conditions by personnel skilled in the preparation and application of paint finishes to the requirements for supersonic aircraft. The area was completely dust free and any overspray was directed by airflow into a water curtain and most operations could be carried out without the encumbrance of masks and goggles.

Mirage production was completed on schedule and within estimate(1) with the delivery of A3-100 in January 1969. Aircraft deliveries were achieved in accordance with the following table: (2)

1963	1964	1965	1966	1967	1968
1	9	20	22	33	24

MODIFICATIONS

The production status of service aircraft never remains static and is subject to constant refinement by the introduction of modifications. Modifications can originate from the aircraft designer, to improve performance, maintenance, safety etc, or rectify faults which may have shown up in service. The customer may also request modifications to meet special needs.

During the period Mirage was in service over one thousand modifications were issued, the majority being adopted. Mirage aircraft were returned to the factory for modification and servicing on 348 occasions.

Where the modification is to apply retrospectively to aircraft already in service,a programme is drawn up for the aircraft to be progressively returned to the factory or if the modification can be introduced during RAAF maintenance, a modification kit is issued for each aircraft.

About halfway through the production programme a RAAF requirement arose for Mirage, in addition to its interceptor role, to acquire a ground attack capability. This major change affected all instrumentation and introduced additional navigation and radar components and a camouflage paint scheme.

Later, wet leading edge wings were also introduced to further increase fuel capacity. These major changes were introduced at production aircraft 48 onward and were given the designation Mirage IIIO(A). Aircraft prior to 48 were returned progressively to the factory for some of these changes and were given the designation III(FA).

Early in service Mirage A3-4 was involved in a major accident when the brakes failed to hold during landing and crashed heavily into the Arrestor Barrier causing the nosewheel to collapse and the fuselage to be badly bent near the complex engine intake and gun pack installation area. An initial survey indicated that it was a complete write-off and its only future seemed to be in providing spare parts. However it was transported back to the factory and following some stripping and a more detailed survey, GAF Engineers decided repairs should be attempted.

A special jig in which the fuselage could be straightened and major pick up joints be aligned, was constructed in order to avoid any disruption to regular production. Gradually the structure was realigned and damaged areas cut away and replaced. The complete repaired fuselage was transported to Avalon and followed the same procedure as applied to production aircraft. Following test flights, the Test Pilot accepted it as meeting the same performance standards of a new aircraft.

This major repair and restoration was carried out at about five percent of the cost of a new aircraft and demonstrated the service that the well equipped local facilities could provide.

Avalon was gazetted as a security area and was often used by the Prime Minister and Ministers of the day. On such occasions they usually took the opportunity to walk through the final assembly hangar, view the activities and talk to the workmen; and no doubt gained a much better appreciation of the Mirage project than could be obtained by reading reports or from the rare official visits they were able to make.

Because of the constant advancement of aircraft design and the

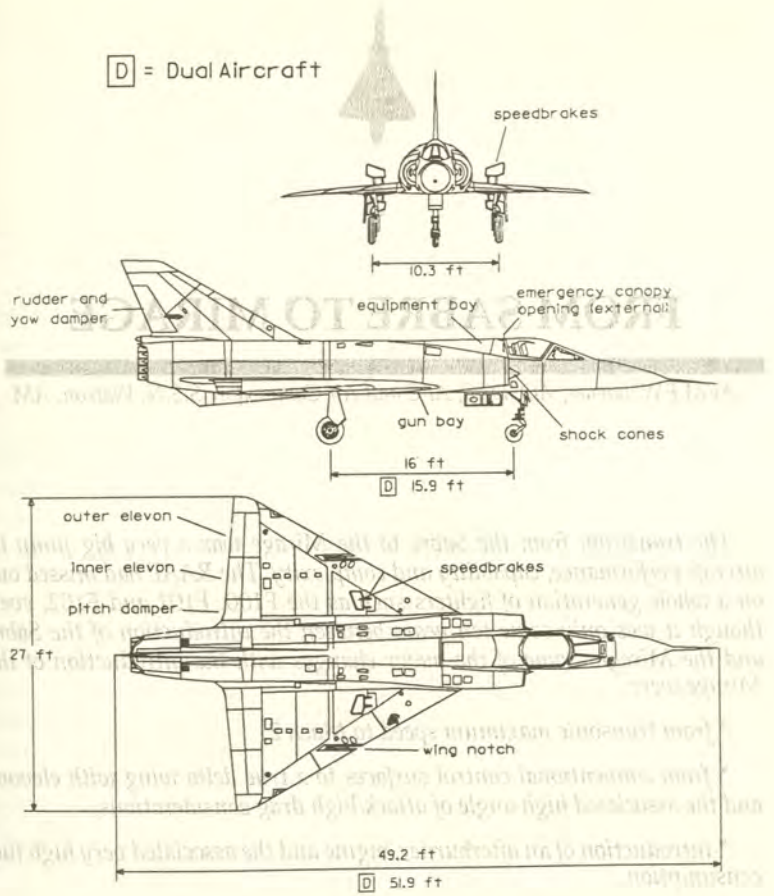
challenge to keep abreast of development and new techniques, the aircraft industry attracts a breed of very dedicated people. It can often be frustrating but never dull.

People who were involved in this project invariably look up when there is a Mirage fly past and feel a great sense of pride in the contribution they made towards their production. It will be a sad day for them when this beautiful looking aircraft vanishes from our sky.

Without a doubt Mirage was the most successful aircraft project undertaken in Australia."

Notes: (1) The approved estimate for the 110 Mirage aircraft was $M270; final cost was $M266.928; average cost per aircraft $M2.427.

(2) In November 1970, Cabinet approved the procurement of an additional six IIID aircraft bringing the total number of dual trainers to 16. Production took place during 1971/73 and was on a similar basis to previous Mirages, although engines and some avionics were provided from RAAF spares stocks. Also, the build standard was later amended to provide for manufacture in Australia of some parts previously made in France.



AIRCRAFT WEIGHT - (CLEAN, EMPTY) - 15 320 lbs (6949 kg)
- (MAX AUW) - 27 500 lbs (12 474 kg)

FUEL CAPACITY - (INT + LE) - 727 gals (3305 litres)

WING - TOTAL AREA - 374.5 sq ft (34.79 sq m)
- LE SWEEP - 60 DEG 34' 45"
- T/C RATIO - 4.5 to 3.5%
- ANHEDRAL - 1 DEG
- LOADING (CLEAN) - 53.6 lb/sq ft (2.56 k Pa)

3

FROM SABRE TO MIRAGE

AVM F.W. Barnes, AO, DFC, AFC and Air Commodore S.S.N. Watson, AM

The transition from the Sabre to the Mirage was a very big jump in aircraft performance, capability and complexity. The RAAF had missed out on a whole generation of fighters such as the F100, F101 and F102, even though it was only some ten years between the introduction of the Sabre and the Mirage. Some of the major changes with the introduction of the Mirage were:

** from transonic maximum speed to Mach 2,*

** from conventional control surfaces to a true delta wing with elevons and the associated high angle of attack/high drag considerations,*

** introduction of an afterburner engine and the associated very high fuel consumption,*

** introduction of TACAN and a navigation computer,*

** introduction of an air intercept and ground attack radar coupled to cannon and two different missile characteristics.*

The task of initiating this transition process to a much more capable aircraft was vested, on the aircrew side, with a small team of experienced pilots who went to France to learn first hand about the Mirage. On return to Australia, this team started up the Mirage Conversion Unit and initiated the transition of the RAAF fighter force from 'day fighter' to 'all weather interceptor'.

The flying training team was lead by Wing Commander (later AVM) Fred Barnes(1) who takes up the story of transition – From Sabre to Mirage.

"After a joyful fourteen years of fighter squadron flying, plus a tour with ARDU at Woomera, Staff College was a pleasant interlude for me in 1958. However, subsequent work as a personnel staff officer was beginning to wear a bit thin when, around mid 1962, I was told that I was to lead the flying training team for the new French fighter aircraft. At that time I knew very little of the project and, as I had been the first CO of 3 Squadron when it reformed and became the first Sabre squadron, I hadn't even thought of also being involved early in the Mirage programme.

The first step was refresher flying at CFS over ten days in July 1962 and the issue of a White Card. Jimmy Wilson did the test I recall and it was great to be airborne again.

On 5 September 1962 I was posted to Williamtown where I met up again with Tex Watson(2) and Col Ackland who were also to be on the team. The fourth member of our team was to be Vic Oborn who was already in Paris on the staff of the Air Attache – then Ron Susans. Tex was to be the Operations Officer of the proposed Mirage training flight, Col was to be the Training Officer and Vic was to be the Weapons Officer. I was happy to be back in the Sabre doing refresher flying training at No 75 Squadron under the guidance of the USAF exchange officer of the day, Major Joe Turner.

October and November 1962 saw the team trying to learn French during an abbreviated course at the School of Languages, Point Cook. I hadn't done any French at school, even dropping Latin after two years and apparently the Barnes' ears were already lacking in some vowel sound discernment. Tex, Col and I were joined at the course by Bill Collings, who was going to be the project test pilot and also by Alan Hodges who was going to the Air Attache's staff. During the course, Language School put a deal of emphasis on technical language translation which was to be of great help later.

Bill Collings was something of an embarrassment to the rest of us at Language School as he was already fluent in French and spent some of his time learning seedy stories from a young airman on staff who was a French speaker. It was at that time that the La Rousse French/English dictionary became an essential part of my kit and was to remain so for many years.

I was posted to be CO of No 75 Squadron on 4 March 1963 as it was to be the first Mirage squadron and we were then off to France, arriving on 28 May 1963. Alan Hodges was already there, although suffering from a back condition initially and he became a great help to the team. Unfortunately, however, Vic Oborn had suffered a brain tumour and was still in hospital recovering after major surgery. Subsequently, he was evacuated back to Australia. It so happened that Mick Parer had recently had the misfortune to prang an aircraft, a Canberra I think, while undergoing the Empire Test Pilots' School

and, although the task he had been set was somewhat unrealistic in view of his previous experience, the dogma called for automatic scrubbing. The result was that Mick was available to take over the fourth place on the team from Vic Oborn.

The short-term visitors to France were all accommodated at a moderate hotel in Paris named, somewhat grandly, The Hotel Pierre, Premier de Serbie, which worked out pretty well. Our RAAF technical training teams were also living in the same hotel when, like us, they were not out on a French Air Force (FAF) Base or at a factory training establishment.

The Instrument training team was led by one of the great characters of the RAAF, Keith (Sully) Sullivan. One of the stories then current about Sully was that he found himself on the wrong side of Paris late one night and somewhat short of cash. He allowed himself to be picked up by one of the 'ladies of the night' prowling in a car and suggested 'his place'. When the 'lady' reached the Hotel de Serbie, Sully simply scarpered through the door calling out thanks for the lift, which was drowned by the tirade of abuse from the unwilling taxi driver.

Our training in France was broken down into the three facets of ground school, simulator training and then flying training, with each facet taking place at a different FAF base. Our travel was all by train and the first move was to the North-Eastern border of France to Strasbourg, in the Alsace-Lorraine district. We were booked into the Officers' Mess and that started our real experience of France. The accommodation, particularly the bathroom, was a bit 'grotty' but the dining room was superb and for the first time we encountered splendid red wine in carafes on the table as the norm.

The ground school at Strasbourg was excellent, with the FAF NCO instructors being assisted by a hired interpreter, an avowed and multi-lingual Communist Pole who was able at his task. Even so, there were occasions when, thanks to the technical language training at Point Cook, persistent questioning by the RAAF team resulted in quite a different final translation. I am sure that most people have heard the story of Eskimos having many different words to describe 'snow'. Well, it seemed to me at times that the French had a similar situation with words like 'wire'.

The lecture programme at Strasbourg was well supported with technical manuals of great complexity in French and we were able to get a very good basic understanding of the Mirage and its systems. However, at that stage the French hadn't received their own Mirage 111 E aircraft so, while they were very sound on the 111 C pure interceptor, they had to rely on technical reports about what was to come in their 111 E and our 111 O. In the event, Australia was forced to make some decisions ahead of the French and such things as Doppler, the Navigation Computer and, most significantly, the

Twin Gyro Platform, were not the same. Incidentally, we did not cover the Cyrano radar at Strasbourg – that came later after our simulator training.

While we were at Strasbourg, the FAF officer who had been appointed our flying training liaison officer came to see us and brief us on the intended programme. He was Capitaine Mark Yoh, obviously Chinese by race, multi-lingual and a bright, breezy fellow. He advised us that our flying training would be conducted in French which caused us some consternation. With his help we compiled a list of common phrases used in the air which we then attempted to commit to memory. More importantly, however, he agreed to have set up an air/ground radio link so that a RAAF pilot on the ground could intervene as necessary.

An amusing insight into French humour was revealed to us when we asked why the Australian aircraft was to be the Mirage 111 O? What happened to all of the letters after 111 E? The answer was that since A was already taken up, and the Australian accent had the country as 'ORSTRIGHLIA', 111 O was the obvious choice. A further comment was that the choice of 111 Z for the South African aircraft was quite simply Z for Zulus. Later we were to find that the developed Atar engine which they had hoped to sell us, was known as the 9 K, K being for Kangaroo!

After we completed our ground school at Strasbourg there were several days before the next stage so Tex, Col and I hired a small car and did some touring into Germany, Switzerland and Austria, mostly in the Black Forest area of Bavaria. Unfortunately, this upset Ron Susans, who may have been badly briefed and we were summonsed post haste back to Paris for chastisement. But the trip into Germany was well worth it.

After drying out our laundry, which we had had to pack wet at Strasbourg, and a little other reorganising at Pierre de Serbie, we were off in pairs to the two FAF fighter bases of Colmar and Dijon in the East of France for simulator and Cyrano training. The two of us at Colmar found the simulator training to be quite good, probably because our French had improved, and staying at a small hotel in town was also a bonus. The second week of lectures and demonstrations on the Cyrano radar was quite a revelation, possibly largely because of our lack of previous air interceptor experience. We discovered that French technology and expertise were highly developed and we had much to learn. Our training had to be based on the existing Cyrano 1 C as fitted to the Mirage 111 C but the lectures also covered the improved Cyrano 11 B, scheduled for fitment to our Mirage 111O.

An earlier stage of our training had been a visit to the FAF Flight Test Centre (C.E.V.) at Brettigny, not far out of Paris, which was where Bill Collings did a lot of his flying. We had been supplied

with French flying equipment, including their partial pressure suit and helmet and, at Brettigny, we underwent a chamber run to 70,000 feet. It was an interesting experience, observers and the indoctrinee being face to face through a glass panel. The suit remained comfortable and reasonably flexible under pressure.

Finally, we were off to C.E.A.M. (Centre d'Experiences Ariennes Militaires) at Mont-de-Marsan, down in the South of France, close to Bordeaux, Biarritz and the Basque area. We were there from 8 July 1963 to 30 August 1963 and were accommodated at a very nice hotel called the Richelieu. The unit at Mont-de-Marsan was commanded by a Commandant LeNain ('the dwarf', which he certainly wasn't) and the Operations Officer was Bernard de Roussieres, a fluent English speaker who was of tremendous help to us, both on the job and socially. Some of the other FAF pilots involved in our training made up a quaint collection of names and backgrounds. My Fouga Magister instructor was a Sous Lieutenant Pilot, my Mirage 111 B instructor was Capitaine Popov of dour Russian background and some of the team flew with our cheerful Chinese friend, Capitaine Mark Yoh.

Our first two flights at Mont-de-Marsan were in the Fouga Magister, a light twin engine jet trainer; the very small engines going at enormous revolutions of some 36,000. The first flight in the Fouga for me was on 8 July 1963 and involved local area familiarisation. The second flight on the following day was a climb to 36,000 feet and then descent for instrument flying and GCAs. Language problems arose straight away and great care had to be taken to understand the French air traffic and GCA controllers. Part of this came from the practice of giving headings in full, such as 'two hundred and seventy two degrees' instead of 'two seven two' as we would. Information during a GCA approach was less than we had been used to, being mainly either increase or decrease your rate of descent and headings to fly. When rattled out in French, such directions became hard to understand. Fortunately, a plaintive cry of 'speak slowly please' in French usually resulted in either very slow French or a switch to the compulsory NATO English (although by then the French had deserted NATO). My total Fouga flying time was 2 hours and 10 minutes.

My first flight in a Mirage 111 B with Capitaine Popov was on 10 July 1963 and included a non-afterburner climb to 36,000 feet, an afterburner acceleration to 1.4M and minimum speeds. The second dual on 15 July 1963 was an afterburner climb to 36,000 feet, rapid descent, aerobatics and forced landing practice. Both flights involved ten minutes of actual weather and totalled one hour and thirty five minutes.

Solo on a Mirage 111 C (A/C No 1) was on 15 July 1963 and the second flight on 17 July 1963, both a repeat of the two 111 B flights.

The rate of progress then accelerated rapidly in the remaining ten 111 C sorties. Flight 4 was the first Cyrano exercise, Flight 5 was ninety degree intercepts on a Super Mystere B 11 target (Ess Emm Bay Dur), Flight 6 involved a captive Sidewinder, Flight 7 was supersonic intercepts from a scramble, Flight 8 was rocket motor and partial pressure suit to 56,000 feet and 1.75M, Flight 9 was air to ground gunnery and formation flying, Flight 10 was rocket motor and Cyrano intercepts at 40,000 feet and 1.4M and the last two were snap up attacks, head on, with a height differential of 20,000 feet, using the rocket motor to climb at 1.4M.

I remember being quite impressed with my first Sidewinder intercept. Having achieved a successful lock-on, I looked up to the combining glass to follow sight orders and then expected to see the target aircraft but without success. Shortly afterwards it emerged from behind the pipper where it had been hidden, previously being too small to see.

Total Mirage 111 C flying was 9 hours and 15 minutes, including 1 hour 15 minutes 'actual' and a number of GCAs. I also had two back seat rides in a Mirage 111 B dual as rear seat familiarisation, one being a bonus. In this regard we had been tasked by the RAAF with assessing the value of the dual Mirage and we were unanimous in our recommendation that these aircraft be added to the order.

My last Mirage flight was on 28 August 1963 and on 30 August 1963 C.E.A.M. gave us a little farewell in the usual FAF fashion. This consisted of champagne and sweet biscuits, laid on in the hangar, with a few small speeches. We had noticed the FAF practice of having such functions on all manner of occasions – such as promotions – and we had long become used to the practice of the French drinking wine or beer at the midday meal. There was in fact an attitude which was to the effect that of course one didn't drink alcohol before going flying, but alcohol was hard liquor such as Scotch or Brandy and certainly not wine or beer. Nevertheless, we were somewhat surprised to be offered some special local flights at the end of the farewell function. I went with Commandant LeNain in an Alouette helicopter for what became a sight seeing tour along the very lovely local river valleys.

The flights using the rocket motor and the partial pressure suit are worth further mention. The FAF was unaware as to whether we would include the rocket motor in our buy so naturally it was included in the programme. The unit has a thrust of about 3500 pounds which lasts for three minutes at full power or twice that at half power. It certainly gives a tremendous increase in effective thrust at height and enables a zoom climb to reach a very high altitude target. The rocket motor uses a bi-fuel system, one agent being a corrosive acid. An example of the French practical approach to many things was to be seen in their safety precautions

while servicing and refuelling the rocket motor. The servicing was conducted using a tractor towing a train of trolleys carrying associated items. The last trolley had on it an old fashioned porcelain bath filled with cold water. Presumably, anyone unfortunate enough to be splashed or worse with acid simply took a header into the bath.

The aspect relating to the partial pressure suit was to have significant implications for us later. As used by the French it became very hot indeed during flight and, although there was an air ventilated cooling system, it was only connected to an inner flying suit and not to a ventilated skull cap which came with the helmet. (Incidentally, the outer flying suit was a very sexy affair made of a beautiful fine leather and finished in silver). I tend to get very hot around the head and during use of the suit, I developed a pool of sweat in the lower half of the face-plate which, by the end of each flight, had me holding my head back to avoid drowning myself.

Of great importance to us as a training team was the very generous access given at Mont-de-Marsan to FAF procedures and operations manuals. Bernard de Roussieres was responsible for this access and Tex Watson spent many hours making notes from publications which we could not possibly have obtained formally and which would have taken us years to compile from our own experience. Mick Parer also spent long hours looking at weapons, weapons configurations and weapons procedures and we all spent a lot of time studying Matra. We also took note of a number of interesting FAF training procedures and systems, including the circular air-to-air target towing concept and their air launched banner. A number of the things we saw were later introduced to the RAAF.

The same Bernard de Roussieres, who was so much help to us in France, later became the French Air Attache in Canberra and he flew regularly at Williamtown. Later still, he was employed by the Dassault Company and was again resident in Australia for some years. He and his wife, Brigitte, were marvellous hosts to the training team while we were in France and had us as guests to their home in a delightful rural area and also took us into the local tennis scene. Tennis was big socially, both in the area and at Mont-de- Marsan, where Col Ackland upheld the good name of Australia by beating all comers.

We were to repay the FAF to some extent later on for their indulgence in our access to operational information. When we were there in 1963, they had not developed tactics suitable for use against a low level intruder but, under Tex Watson's lead, such tactics were developed back in Australia. Bernard de Roussieres was later taught them at Williamtown and subsequently he informed us that they had been adopted en toto into the FAF tactics manual.

Our stay at Mont-de-Marsan happened to coincide with two

regular annual events of quite different sorts. The first of these was the Fete de Madeleine which saw the whole town transformed into an open air cabaret with many visitors. Dance bands were located along the main street at regular intervals, there was literally dancing in the streets, great quantities of confetti and streamers were thrown and of course there was a deal of red wine drunk, often by pouring straight into the mouth from the spout of a leather wine pouch. I have two particularly vivid memories of the 'Fete'. Firstly, of a very nice and proper French lady, who we had previously met socially, who simply hitched up her skirt in the main street and proceeded to divest herself of large amounts of confetti that had gone down her neck and into the top of her panties. The second sight I recall, with some joy, was of Tex Watson late at night doing a solo adagio dance on top of a small round metal table outside one of the cafes.

The other regular event to occur at Mont-de-Marsan while we were there was the bull fight. There is a bull fight arena in Mont-de-Marsan, as indeed there is in a number of other towns in that part of France. The event had been advertised for some time and it seemed that the bull fight tour simply swung up from Spain and through Southern France as part of its annual programme. Very big crowds were present each day and the local police participated in crowd and traffic control. When I asked about the legality of bull fighting in France I was told that of course it was illegal and in due course the promoters would be fined – another example of French logic or pragmatism?

Before returning to Australia we sought and were given a week in the UK to compare some of the FAF tactics and procedures with those that the RAF had developed. It was a busy and most useful week. We found that the RAF and the FAF were very similar in their procedures, although the RAF were leaning more towards cut-off attacks in order to reduce the time required to make an intercept. However, we also found that the French were ahead in systems and weapons and that the RAF weapon did not have the Matra all round capability, requiring them to emphasise the stern approach.

On return to Australia we found that the previous idea of the first Mirages going to No 75 Squadron had been changed and they were now to go to a new flight in No 2 OCU. I was posted to be CO of OCU on 21 October 1963. However, deliveries of our own Mirage 111 O aircraft were still to be some time away and I found myself becoming fully involved in the activities of the OCU, which was still occupied in the the production of Sabre pilots and was also operating a Sabre holding flight in which young OCU graduates gained experience pending posting to one of the Sabre squadrons. This was related to the delay in Mirage training resulting in the planned vacancies not occurring in the Sabre squadrons.

Tex Watson was appointed Mirage Flight Commander and,

together with Col Ackland and Mick Parer, he started to set up the new organisation in two old huts which were located where the dog compound was later sited. These huts were initially bare and Tex and the team had, among other things, to arrange and personally get involved in their refurbishment into lecture rooms, crew rooms and all the other facets needed for the job ahead. One such facility was a radio room complete with tape recording facilities.

Between September and December 1963 no Mirage aircraft were available for the RAAF to fly so the members of the Mirage training team flew with the OCU in Sabres and Vampires, including normal instructional duties. While I was largely committed to the running of the OCU, while not flying, the rest of the team were flat out developing the proposed Mirage conversion and operational training syllabus, often with a paint brush in their hand. Most of the early effort was spent on reviewing the copious notes from France, drafting reports and setting up the training facilities. Our ground crews were also coming back to Williamtown from their own training courses in France and there was a great deal of discussion between them and the pilots about aircraft systems and their operation. This proved to be a very valuable exchange of information.

The first two Australian Mirage aircraft were held in France in relation to further development testing of the proposed ground attack version. In this regard the original plan was for an initial buy of pure interceptors with Cyrano 11A (air-to-air modes only) and a second buy of ground attack/interceptor aircraft with Cyrano 11B.

In December 1963, Bill Collings test flew our first aircraft to become available, No 3, at Avalon, but as there was then no ground handling or test equipment at Williamtown, it stayed at Avalon for the time being.

However, the Mirage team began commuting down there, usually by Vampire, to reconvert themselves, under the watchful eye of Bill Collings. In this regard it had been over three months since they had flown a Mirage and there was a number of significant differences between the French 111C and our 111O, particularly the Atar 9C engine with a quite different afterburner system. In addition, the first aircraft were not fitted with Cyrano but had a dummy nose cone incorporating an artificial electrical load to absorb the excess power available. I did my first flight on A3-3 at Avalon on 24 January 1964 and each of the four of us got about ten flights over a six week period in January/February 1964. We concentrated on aircraft handling, circuits and TACAN instrument procedures and let-downs, with some initial investigation of the proposed conversion part of the syllabus.

On 26 February 1964, Tex Watson generously set me up to do the

delivery flight of A3-3 to Williamtown (3). It was a great day to see the first one there and we had a little celebration. Unfortunately, by the following week it had to be flown back to Avalon for a scheduled engine change but was back at Williamtown within the week. On 13 March 1964, I also flew the second aircraft, A3-4, to Williamtown and we were then able to make a little more progress. Our third aircraft, A3-7, arrived at Williamtown on 25 June 1964 and the fourth, A3-8, arrived on 12 August 1964, so initial deliveries were pretty slow.

Between March and October 1964, Tex, Col and Mick worked very hard indeed on the preparation of the conversion course, training notes, definition of the lectures, including preparation of lecture material, conversion flight missions, instrument flight procedures (including TACAN at Williamtown), AI radar familiarisation and operational training missions. They also assisted extensively in the ground and air training of GCI controllers. It was a heavy but rewarding workload, involving the generation of new concepts and procedures stemming from open debate of possible ways of satisfying the demands ahead of them. There was very much a 'devil's advocate' approach to any concept before adopting it. In addition, the team flew each of the proposed sorties of the flying syllabus to ensure that it was practicable within the fuel and flying time allotted to it and was also appropriate to the developing skill level of the pilot under training.

Throughout this period of preparation I participated as much as I could in the activities of Mirage Flight and flew most of the proposed conversion sorties before agreeing them. However, I had no trouble in approving any of the planning of the team, no doubt because of the very careful work that had been done. It certainly worked out well when put to the test later and there were no significant changes found to be necessary. My log book tells me that I first flew conversion sortie No 1 on 23 September 1964 as a trial.

The Mirage Flight also spent a lot of time in the early part of 1964 investigating aspects relating to Mirage operational flying. TACAN was quite new to the Fighter Force and we had found that the ideal TACAN let-down and approach for the Mirage was not suitable as a published Williamtown procedure for all TACAN equipped aircraft. Another area that required development was test flying procedures as no test flight profiles were available for checks after such routine engineering work as an engine roll-back, an engine change or a scheduled servicing.

There were several incidents which got my adrenalin flowing during the early flying stages which are worth recalling. The first of these occurred early in April 1964 when Tex Watson was about to test fly a Mirage after the first engine change at Williamtown. We hadn't then streamlined the test flight requirements by use of radio recording and it was expected that he would need all of the fuel on

board to complete what was expected to be done. The Army Staff College was visiting Williamtown and, as Tex was climbing into the cockpit, the Officer Commanding the Fighter Wing, Mick Mather, asked him to put on a demonstration at the base on his return. After some protest from Tex about no planning, fuel shortage, etc, etc, it was agreed that a fast and slow run overhead would suffice. Tex planned a fast run down the strip into a tight turn, slowing down for a slow run at right angles and then onto down-wind for landing. Following the fast run, the aircraft wasn't slowing quickly enough in a tight 4 'G' turn so Tex did what he would have done in a Sabre and dragged the throttle back. At that stage, the 'Delta' drag also took over and he found the airspeed unwinding very rapidly. He ended up with a slowly accelerating engine in a nasty, nose high attitude only some fifty feet above the Mirage hangar before being able to climb away and complete a very sedate circuit. We all learnt a lot from that episode – not only with respect to the characteristics of the Delta wing, which Tex may have tended to stress during subsequent lectures at Mirage Flight. It is perhaps only fair to note that, at that time, we each had only some eleven hours of flying our own Mirage over some four months. There were, of course, a number of subsequent calls for demonstration flights, something like once a fortnight, but they were tightly controlled and planned, with the most current of the three Mirage instructors being selected to do the task.

Another episode involved our only use in my days of the partial pressure suits we had brought back from France with us. I remembered my problems with heat and sweat and decided to use the provided connections and equipment to get in-flight ventilation of the rear half of the helmet as well as the body. In this regard the front half of the helmet, including the transparent face-plate, is sealed off from the rear. Our planned flight was an afterburner acceleration to maximum speed at the tropo-pause and then a high angle zoom to maximum height with a bunt-over just before reaching minimum speed. At the height reached of around 75,000 feet, there was little pitch control and full recovery was obtained as height was lost in the ensuing dive. During my bunt-over, I experienced a degree of tunnel vision and some feeling of unreality which abated as I dived. I discussed this experience on return and neither Tex nor Mick used the head ventilation facility in their subsequent flights which were without the abnormalities I had experienced. Unfortunately, Col Ackland did have his head ventilation connected and, as he bunted at 75,000 feet, he felt himself losing consciousness. He pulled the throttle back as he blacked out and regained consciousness at 20,000 feet in a near to vertical dive. He got out of the dive at about 5,000 feet but apparently he had well exceeded the maximum speed limit as both intake suck doors were

blown outward and there was other damage to the bifurcated inlet ducting. We had not had the services of an Aviation Medicine expert during our training in France, which perhaps we should have, and subsequent investigation indicated that the cause of the problem was hypoxia resulting from dilution of the oxygen supply to the front of the helmet by a leak of ventilating air past the one-way face seal. Presumably, this was why the French didn't use the system fully but they hadn't told us. However, it was by then apparent that such very high altitude flying was of little value without the rocket motor and subsequently any high altitude flying above 48,000 feet was done using the Canadian partial pressure waistcoat.

I had a further unwanted experience when I flew A3-4 with two 1700 litre (374 gallons) wing tanks and a 1300 litre (286 gallons) centre line tank on 8 September 1964. The handbook said it could be done and gave performance parameters, including nose wheel lift-off speed, unstick speed, take-off run, etc. My first surprise was the very poor longitudinal stability immediately after take-off and until climbing speed was reached, which took a long time with very little height gain. The performance continued to be very sluggish indeed and the aircraft ceased to climb at about 25,000 feet on full afterburner. Some twenty minutes later, still on full afterburner, I had been able to climb progressively up to 36,000 feet. The flight lasted three hours but it clearly wasn't a practical proposition. I heard, some years later, that Dick Waterfield had tried the same exercise and suffered a blown nose- wheel on take-off.

Col Ackland was also involved in another incident when he lost brake pressure on landing, also an early repeat problem, which resulted in him engaging the barrier in the same voodoo aircraft – A3-4. The bottom cable of the barrier rode up over the nose-wheel of the aircraft, collapsed the nose strut and slammed the nose of the aircraft onto the ground, breaking its back in a seemingly mild engagement. A3-4 was a year at the factory before it became available again. As a result of this accident, a modification was made to the barrier to prevent early pick-up of the bottom cable by the nose-wheel.

Another early problem, which caused little damage and even some amusement, related to an abnormality of the hydraulic system. When external power was applied with any residual utility hydraulic pressure, the undercarriage moved into the forward position and the aircraft tried to sit on its tail. When this first happened, an airman attending the start-up managed to hold the aircraft in balance but was beaten when he tried to get a jack under the tail. The damage was restricted to some bent afterburner eyelids and, pending modification, it became an essential part of start-up procedures to ensure that hydraulic pressure was zero before having external power connected.

We also encountered two other problem areas in the early flying experiences which were to remain with the aircraft throughout its life in the RAAF. The first of these related to the inability of the engine starting system to tolerate a wind blowing up the tail pipe; or sometimes even just a very hot day. In the former case, the starter, which was itself a little jet motor, swallowed its own exhaust gases and simply choked itself and in the other case, the electrical starter for the jet starter overheated and died. A higher capacity electric motor fixed that second aspect but a number of fixes were tried with varying degrees of success for the choking of the jet starter. The French developed a latex diaphragm which was supposed to be fitted across the tail pipe during starting to prevent any reverse air flow. The concept was that the diaphragm would melt when the engine itself started. Unfortunately the device deposited melted latex around the tail area and was rather clumsy to install. It also attracted some caustic nick-names from our irreverent ground troops. Our own engineers developed a canvas tube to be run from the exhaust of the ground power cart to one of the air intakes of the Mirage. This was also clumsy and only partly successful. Shortly later, the use of a small back-pack petrol engine blower was tried with great success and became the standard Mirage starting procedure.

A much more serious problem was found to exist in the RAAF Mirage stemming from the selection of the Sperry Twin-Gyro Platform as the aircraft's space reference system. It may have been an adequate system for a simple flight profile involving little turning and acceleration but it proved to be quite inadequate for a typical Mirage flight profile. Large verticality errors were induced during flight which caused unacceptable errors to the navigation computer, the radar and weapons system and even to the flight instruments. The technicians and engineers tried to find some way of overcoming the problem, using super-clean servicing methods and introducing gold slip rings but with very little improvement. By 1967, it was concluded that the only fix was installation of a better space reference system and Mirage units were instructed to cease submitting failure reports because it was a design problem. As a result there was no continued reporting history of TGP problems in 1980 when refurbishment of the Mirage was being considered and thus there was no strong technical support for an inertial system which could have made a dramatic improvement in the Mirage's capabilities.

Progress continued in Mirage Flight during the first half of 1964 with the thrust turning to development of tactics in the air-to-air role. There was, at the time, a school of thought at air staff level that air combat tactics would no longer be required with the introduction

of all-weather air intercept radar and all hemisphere weapons. Fortunately, the Mirage instructors didn't accept this view and quietly continued with tactics developments. This was subsequently vindicated when the USAF rediscovered the need for air combat tactical manoeuvering during the Cuban missile crisis. However, during the work on air combat tactics, Tex Watson had some more excitement. He and Col Ackland were investigating the use of the High 'G' barrel roll or 'vector roll' with the Mirage at low speed when Tex got into a nose high, lots of rudder and very low speed condition from which he expected to spin. Instead, the Mirage began to gyrate very roughly and only persistent in-spin aileron resulted in recovery after some two and one half turns. The experience resulted in a valuable lesson on Delta wing stall characteristics and, of course also in another lesson to be emphasised during briefings at Mirage Flight.

We did not receive our first Cyrano 11A radar at Williamtown until late July 1964 and development of radar tactics then became a priority for the first conversion course scheduled to be early in the New Year. As much work as possible had been done with the GCI unit without radar and arrangements were made to have Canberras and Sabres as radar targets so that maximum use could be attained with the three or four radar-equipped Mirages we could expect to have available. In a further attempt to achieve maximum possible training, mission patterns were designed so that a target was available to each radar scope every four to six minutes. This resulted in each Mirage pilot getting at least six radar attacks during a sortie of some 55 minutes. Two of the senior radar controllers, Ron Guthrie and Val Turner, who had gone to France to study FAF tactics, were key figures in developing the most effective and efficient patterns. As a result of his close participation in this facet of training, Tex Watson became a proficient GCI pattern controller.

Some specific RAAF air-to-air tactics and profiles were also developed at this stage in late 1964, such as the front cut-off using the Matra forward hemisphere capability. Snap up attacks and climbing attacks were other vertical profiles which were developed as peculiarly RAAF (the French had developed such attacks with the rocket motor but not without it). Our own development of low-level attacks, previously mentioned, showed the need to achieve a 'look angle' which gave the strongest radar return from the target.

Throughout the early months, the three Mirage instructors, Tex, Col and Mick, were spending a good deal of time after work time writing up the developing procedures and techniques to be used during the Mirage course. Lecture notes also had to be prepared and practiced, briefings and debriefing slides drawn up and some thought given to assessment of training results. The intention was to be somewhat over-detailed with the first course, expected to consist

of future Mirage squadron executives, so that they might participate in further refinement of the programme.

In addition to this development work, Tex Watson also managed to write a tactics manual to record all aspects of RAAF tactics for both Mirage pilots and GCI controllers. When published in 1965, after the first Mirage course had been completed, it was well received and became the universal guide. Unfortunately, at a later date some over-zealousness resulted in it being divided into two parts, one being classified Secret, which sadly detracted from its day to day use.

Although the first Mirage course was not scheduled until January 1965 pressures began in about mid-1964 to have a trial course in late 1964. Mick Parer was under warning of a posting early in 1965 and his successor was to be Brick Bradford. The new USAF exchange officer, Major Bob Liotta, had arrived and was allotted to become the Mirage Flight Commander. Incidentally, soon after his arrival at Williamtown Bob Liotta became a very useful contributor to the development of Mirage tactics, particularly low level work. In addition, the OC Fighter Wing, Mick Mather was anxious to be converted to the Mirage. Finally, Cedric Thomas had been posted to Williamtown as the CO elect of No 75 Squadron. The result of all of these moves was that the first Mirage Course started in the first week of October, 1964 and consisted of Mick Mather (OC 81 Wing), Cedric Thomas (CO elect No 75 Sqn), Brick Bradford (replacing Mick Parer in Mirage Flight), Spike Jones (OCU staff instructor), Bob Liotta (OC elect Mirage Flight) and LtCol Monte Davis (USAF Exchange Officer – Staff at HQOC). I was never too sure why Monte Davis got a guernsey as we didn't see that much of him subsequently.

My log book tells me that I chased a student on his first solo on on 7 October 1964, but I don't recall who it was. We didn't have any dual aircraft of course and chasing along behind was the best we could do. The course ran for seven weeks and at the start we had five Mirage aircraft on strength and finished with seven. During those seven weeks, each student flew some sixty sorties for about forty flying hours. Two of the aircraft flew over fifty hours each which meant two 'D' servicings in December. During the same period, each of the Mirage instructors flew about twenty hours a month, mostly on chase rides for first solos, instrument flying, development of early radar sorties, and also some air-combat development work.

Not unexpectedly, flying days were long and there were many delays to programmes, because of unserviceabilities and a schedule that was too tight in the circumstances. It was a great tribute to the ground crews that they managed to produce the sorties required to meet the course commitment, which was obviously premature. It required constant co-ordination and often flying went on until long after normal stand-down. Keith Sullivan won a few twenty cent bets

(or then two shillings) with the pilots that he couldn't produce all of the aircraft needed to meet a particularly heavy schedule – until they learnt that he held all the marbles.

The first twenty five sorties of the first course were devoted to straight conversion to the Mirage, including instrument flying and the next twenty covered introduction to Cyrano and its capabilities. The last fifteen sorties included air-to-air gunnery, air-to-ground gunnery and dive bombing. At the time, the RAAF only held a limited number of Cyrano 11 A radars and they had to be fitted to serviceable aircraft as needed. Most flying was with the dummy nose cone. For all that, it was a successful course with no significant difficulties and very few changes were made for the first official course in 1965.

My main memory of the first course relates to one of the final exercises, a local high-level night cross country. I went around it first to make sure everything went as planned and, except for some high level thunderstorm activity on the final leg, all went well. However, by the time Mick Mather went up around about an hour later the thunderstorms had apparently built up considerably and he experienced a pretty rough ride. On getting back onto the ground, Mick had some very forthright things to say which, being Mick, were very forthright indeed. However, he was a very good commander of the Fighter Wing throughout the initial Mirage period and gave us great support with a minimum of interference.

The Mirage Flight became known as 'Upper Yatton' after a widely distributed cartoon strip of the day because of its rather scruffy buildings and remoteness but it worked very well. Major Bob Liotta took over command of the flight in January 1965 but Tex Watson stayed on to assist. In this regard, Bob Liotta was able to contribute a lot to RAAF understanding of air defence tactics and techniques because of his experience in the USAF Air Defence Command but he didn't have the flying instructional and lecture technique training of his RAAF contemporaries.

Inevitably, the RAAF posting cycle got among members of the original organisation just as it was reaching a peak. Mick Parer had been dragged out at the end of 1964, Col Ackland was off to HQOC in early 1966 and I became OR (Fighter) at the Air Office in June 1965. Tex Watson managed to stay on longest, working with Bob Liotta until mid-1966, although he had been promoted to Squadron Leader in January 1966. Bob Liotta went home in mid-1966, being replaced by the then Major Andy Patten who fitted into the RAAF scene with remarkable ease and who is now resident in Canberra and deeply involved with the F/A-18 programme.

Great credit was due to the instructional staff of Mirage Flight – Tex, Col and Mick – as well as to the pilots who converted to the Mirage without accident or significant problem in the early days,

particularly before we had the dual aircraft. The efforts of the Mirage flight staff could well have been recognised more formally by the RAAF and, in particular, an AFC would not have been out of place for Tex. Our airmen and engineers were simply quite magnificent.

Looking back on the effort now, I wonder whether the same skills exist in the RAAF today, not because of any lowering of inherent capability in current fighter pilots, but because of the much more limited flying they have been getting over some years in the fighter squadrons and then the more recent high wastage, particularly of those highly skilled equivalents of Tex Watson, the ones who had been through both a Flying Instructor's Course and a Fighter Combat Instructor's Course."

Notes: (1) AVM F.W. Barnes (Ret.) born 19 Nov 24, RAAF from Apr 43 to Nov 81. AO, DFC, US Air Medal. No 77 Sqn on Kittyhawks late in WW2 to Japanese occupation. Korea with 77 Sqn 1950/51 (DFC). Woomera 1951/53 as test pilot flying Pika for Jindivik project (AFC). USAF exchange 1954/55 on F86F and F100A. CO 3 Sqn Sabres 1956/57. Staff College 1958. Personnel Staff 1959 then Mirage project from mid-1962. CO 2 OCU 1963/64. Air Staff 1965/66 then Air Attache Paris 1967/68. Air Staff Officer Butterworth 1969/71. RCDS London 1972 then DGP at Air Office 1973/75. OC Williamtown 1976. AOC Support Command 1977/78. DCAS from 1979 until retirement. Now retired at Banora Point, near Tweed Heads and plays golf.

(2) Air Commodore S.S.N. Watson, AM (RAAF Ret.) Graduated RAAF College Dec 55, Vampires, Meteors and Sabres, 3 Sqn Butterworth 1958, FCI, QFI Pearce 1960, 2(F)OCU (Sabre, Mirage) 1962-66, RAAF Staff College 1967, SO Ftr Ops 1968, CO 75 Sqn 1969-71, JSSC, Dir Studies RAAFSC 1972, Leader Air Defence Study Team CSE, USAF Air War College (M Pol Science) 1976, ExO RAAF Williamtown 1976-78, Dir Operational Requirements'A' 1978-81, OC RAAF Richmond (AM) 1982-85, left RAAF Mar 85.

(3) A3-3 is now on static display at the Fighter Squadron's Museum, Williamtown, after having flown 3581 hours in RAAF service.

4

THE EDGE OF THE ENVELOPE

Air Commodore G.W. Talbot, AFC

Air Commodore Geoff Talbot (1) was the first RAAF pilot to fly the Mirage III, when in 1959 as a Flying Officer, he carried out an evaluation of the three European contenders for the Sabre replacement. Air Commodore Talbot rejoined the RAAF Mirage project in 1964 as one of the production test pilots at GAF Avalon. During the period 1964-1969 he flew all of the Australian production Mirages except for the final six trainer aircraft. Below, Air Commodore Talbot recalls his experiences at The Edge of the Envelope.

"An aircraft 'flight envelope' is a pictorial diagram of the flight capabilities of a particular aircraft. It shows the limits of just how fast, how high and how slowly the aircraft can be flown. Altitude is shown vertically and speed horizontally, increasing to the right. Thus, a low performance aircraft – say a Tiger Moth – has a very small flight envelope and a supersonic fighter (Mirage), a very much larger envelope. This diagram is used as the basic yardstick for the comparison of various aircraft (there are also other more complicated charts for each aircraft).

Once an aircraft has been acquired, the flight envelope diagram is used as a standard against which all subsequent performance can be validated. The boundaries of each diagram are established by particular limitations; in the case of the Mirage, the maximum speed (RH Boundary) by the aerodynamic heating limitations of the construction materials, the altitude limit by engine thrust considerations and the low speed boundary by a combination of engine operating limits and aircraft handling limitations. Invariably, most problems occur in the 'top left-hand corner' of the envelope (high and slow). The Mirage is no exception to this rule.

Mirage flight testing involved, initially, flights at the manufacturer's airfield to check that the performance was 'as advertised' and for comparison with other contenders for the RAAF programme. These flights also established that the handling characteristics were acceptable.

Next, when in production in Australia, flight testing involved checking that each aircraft performed to specification before handover to the RAAF. Then, once in service with the RAAF, a continuous flight test programme was necessary to determine the performance of the aircraft under Australian atmospheric conditions, to modify and correct installed equipment deficiencies, and to safely clear the carriage and release of armaments and external stores, as required by the RAAF and not previously tested by the designer. These requirements were not peculiar to the Mirage, but are common to the purchase and service operation of any aircraft.

PRODUCTION TESTING

The principal contractor for Mirage production in Australia was the Government Aircraft Factory (GAF) at Fisherman's Bend in Melbourne. Final assembly and flight test was completed at Avalon airfield near Geelong. The initial RAAF order was for 30 interceptor aircraft, and of these, the first two (A3-1 and A3-4) were airfreighted complete from France to Avalon by RAAF C-130 aircraft.

As the lead Mirage IIIO aircraft, A3-1 had been flown in France by RAAF pilots in 1963; Wing Commander Al Hodges and Flight Lieutenant Mick Parer representing the fighter force and Squadron Leader Bill Collings representing ARDU interests. Together, they were responsible for solving the many operational problems of introduction of the aircraft to the RAAF.

Subsequent to these first deliveries, further aircraft were assembled by GAF, each including an increasing content of locally manufactured components until the planned mature Australian component level was achieved. A schedule of flight test requirements was developed (the standard to be achieved) and a new flight test facility was constructed and manned by GAF flight test engineers. As a departure from previous practice, test pilots were provided by the RAAF – from ARDU. Thus the RAAF test pilots became 'two-hatted'; as company test pilots when production test flying for the manager GAF (Mr Geoff Churcher), and then as RAAF test pilots when accepting the newly tested aircraft on behalf of the RAAF, or when working with the RAAF on normal flying duties. The system worked well, was commended by GAF and obviously saved the enormous costs of flying duplication had a parallel civilian

test pilot structure been especially established for the programme. There were no severe conflicts of loyalty (or interest) within the test pilot fraternity and, generally, the programme ran very smoothly. Squadron Leaders Bill Collings and Ron Green were the foundation pilots of the system and were largely responsible for developing the agreed methods and procedures.

Within the system, a minimum of four test flights was required by each aircraft to achieve complete coverage of the test schedule requirements. This was later extended to a fifth test flight to calibrate the Doppler Navigation system when it was introduced on later aircraft. Many aircraft were accepted within the minimum number of flights, while others, because of performance or equipment shortfalls, required additional rectification flights – up to an exceptional 13 flights in one memorable example.

The first operating activity when a new aircraft appeared on the flight line was not a flight but a thorough ground check. After an exhaustive test of all systems and controls, the aircraft was subjected to a series of taxy and braking tests, culminating in a maximum power acceleration to 200 knots, followed by brake chute deployment and a function test of both normal and emergency braking systems.

The first flight included some performance measurement but was concerned principally with the successful functioning of all the installed systems. Thus, this was a very busy flight which included many overlapping tasks – such as, for example, testing all radio frequencies and functions on two receivers and transmitters, and all TACAN functions, while simultaneously timing cockpit pressurisation leak rates and conducting control damping checks. As with all tasks, competence increased with experience and pilots soon became adept at discovering anything out of the ordinary.

A comprehensive flight instrumentation package was fitted to each aircraft which recorded on paper tape all the necessary flight information. This system proved invaluable during the early days of newly introduced pilots or whenever post flight analysis was required. It also provided a very valuable record of the achieved performance of each aircraft.

The test pilots were also in continuous radio contact with the Flight Test Centre and relayed all in-flight actions and timings to the controlling engineer, who also maintained a navigation plot of each flight. Thus, after having achieved a basic level of proficiency, the majority of test results could be available immediately. However, because of the intensity of activity during the first flight, any small fault or failure which broke the rhythm of events usually presupposed a further rectification flight unless the 'snag' and lost

time were small enough to be including somewhere in the following flights.

The second production test flight included more performance measurement – flight envelope validation – as well as handling assessment. It included a measured performance climb and a timed level acceleration to Mach 2. This was also a high activity flight because of the rapidity of events, particularly during the supersonic phase, but was normally uncomplicated and of short duration. Any performance shortfalls were usually obvious; one continuing minor problem was the sensitivity of the aircraft to directional trim effects at high supersonic speeds.

The third flight was a high altitude flight. The pilot was equipped with a partial pressure suit and helmet and duplicated the previous flight up to the attainment of Mach 2, when a ceiling climb was initiated. All the aircraft were flown to above 70 000 feet to test control, engine, equipment and pressurisation functions. It was in this 'top LH corner' of the envelope that problems were most likely to occur as the aircraft was operating on the boundaries of several design limitations. For example, at 75 000 feet, because of reduced atmosphere the engine idle speed had been gradually and automatically increased until it equalled the maximum operating RPM – the two limiting engine speeds had come together and the throttle no longer controlled the engine. Also because of the low speed and temperature, the engine compressor was operating at its design stall boundary and even in brand new condition would not tolerate any induced airflow disturbances, even of the most minor nature. Concurrently, because of the speed-altitude combination, the control column was in the fully rearward position (elevons fully up) to maintain altitude at the low speed. At about 200 knots indicated, the aircraft was still supersonic at Mach 1.3 and thus, as an added complication, this corner point had to be attained well out to sea where a sonic boom from the inevitable supersonic descent would not generate environmental complaints. At the same time, the aircraft needed to be positioned within gliding range of home base to enable safe recovery in the event of engine failure; this possibility also dictated the need for flight with continuing visual reference to the ground – a tall order considering the locality, but a precaution which paid dividends on several occasions.

The fourth production flight by contrast, was quite a leisurely affair. The navigation system was calibrated by steady level cruise flight at various speeds at both 5 000 feet and 35 000 feet. As Doppler navigation equipment was progressively introduced to the fleet, this too required calibration. This was achieved by steady flight between accurately surveyed ground points (usually the Avalon control tower and the Cape Otway lighthouse) and the comparison of

the system performance with the known geographical coordinates. Because of the required endurance, this flight was undertaken with 2 X 374 gallon drop tanks and thus proved the functioning and integrity of the external fuel supply system.

Although at times frustrating to the participants, principally because of weather delays, the Mirage production programme proceeded according to plan – both in time and cost – and 100 fighter and 10 trainer aircraft had been delivered to the RAAF by the end of 1968; A3-100 completed its final production test flight (Squadron Leader Talbot) on 30th November 1968. A further six trainer aircraft were purchased by the RAAF in later years.

Old Charlie James, the Laverton Met man, always maintained that if you could see the You Yangs (a range of hills to the west), it was going to rain; if you couldn't, it was raining. He wasn't far wrong, and the Melbourne weather was the single most continuing impediment to the Mirage production programme; it was seldom perfect, often totally unsuitable and never able to be forecast with accuracy. The two offending elements were cloud cover and cross-wind on the Avalon airstrip. The runway is constructed in a North-South direction, while the prevailing wind, from all available meteorological records, averages out at about 35 knots from the WSW. First flights in particular require light or nil wind conditions because of the need to assess brake and engine thrust alignments during the first movement of the aircraft under its own power. A howling crosswind could easily disguise any system deficiencies and in combination, cause handling difficulties. Thus, many wasted hours were expended by the test pilots in driving from Laverton to Avalon only to sit and gaze mesmerised at the steadily wavering stylus of the Avalon recording anemometer, watching for some diminution of wind strength or directional change which might remotely indicate some possibility of flying. These conditions often continued for days on end, much to the consternation of the GAF workforce, in particular the Production Superintendent, Mr Pierce Talbot, and the Area Manager, Mr Ted Bennet who were concerned to see serviceable aircraft banking up in the hangar while their flight production schedule continued to fall below the red line.

Invariably, Murphy's Law prevailed and the weather improved at weekends when many special out-of-hours arrangements were required to set up flying operations. Perversely, rarely on the odd perfect day would there be any aircraft available for flight! In all, the combined vagaries of wind, cloud and aircraft availability caused short term management difficulties, but in the longer term the production rate of about two aircraft per month was maintained.

Technical problems of Mirage production although seemingly significant at the time, were not too severe in retrospect; largely

because of the good working relationship between the Flight Test Section and the Flight Line Foreman, Mr Stan Lewkawski, an engineer with a wealth of practical aviation experience. A spate of air conditioning system turbine failures was responsible for many repeat test flights: imminent turbine failure was evident to the pilot by an increasing howling noise under the cockpit, accompanied by a characteristic burning smell as the small alloy blades of the turbine ground away and disintegrated into the air conditioning ducting – as a result of bearing failure. Controlled air conditioning was unavailable after failure (no cold air) and any high speed operations had to be aborted. The problem occurred throughout the fleet at the time and was eventually cured by component improvement.

Engine vibration problems also occurred in early aircraft. Some new engines vibrated from birth (even uninstalled) and others ran extremely smoothly. Sometimes the bad ones damped down when installed in an aircraft and at other times the vibrations were amplified to unacceptable levels. The problem was overcome by improved balancing techniques, particularly between the harmonics of the turbine and compressor frequencies and the introduction of diagnostic instrumentation by Mr Ern Harvey of CAC.

The unexpected emergency is always the worst and one more serious example was the disintegration of the canopy of A3-105 at Mach 2 during its second production test flight. Flight Lieutenant 'Stew' Fisher was flying the aircraft with the Chief Flight Test Engineer, Mr Rex Whally in the back seat. They both received a bad fright from the explosive decompression, shower of perspex pieces and windblast, but neither were injured. Trainer aircraft were subsequently speed-restricted (dynamic pressure) for many months until strengthened canopies were supplied by the manufacturer from France.

As a further example of the unplanned diversion, the first flight of A3-104 took place on 24th January 1967. When the aircraft took off, a civilian twin jet aircraft was on final approach to land. This aircraft proceeded to make an unintentional wheels-up landing which effectively blocked the single runway for the remainder of the day, until lifting equipment was obtained. The Mirage diverted to East Sale, accomplishing only fragmentary portions of the test schedule en route and was returned to Avalon next day.

Although some engine failures and dead stick landings were experienced, usually following deliberate engine shut down to test systems, or as a result of engine lock-up during a long idling descent from high altitude, these were not unduly noteworthy because of the pre-planned positioning of the aircraft to put it in the most favourable position for such a possibility.

A nagging background problem of Mirage testing was the age-old

question of equipment tolerances. Formal agreement had been reached on the exact tolerances applicable to each equipment – usually of the order of a permissible error of three percent. Thus, to gain service acceptance, the overall system, too, had to fall within this limit. For example, the navigation system was unacceptable, if after flying for 100 miles, it was more than three miles in error. Large errors were usually easy to diagnose and rectify by component replacement. If, however, the system was only marginally out of tolerance, say 3.1%, then much additional dialogue, repeated recalculation and system analysis was engaged upon in an attempt to avoid a further expensive test flight and inevitable production delay. The renowned test pilot commitment to exactitude and impartiality was sorely tested! The problem was applicable to all systems, but was most evident with the navigation system because all production personnel were aware that the complete system with its painstakingly matched components would be dismantled immediately on delivery to the RAAF for engineering acceptance inspection. The new system components were then cannibalised to make good spares shortages within the squadrons. The squadron pilots then complained that the navigation systems were inaccurate!

THE RETRO-MOD PROGRAMME

As the Australian Mirage project proceeded, so too did the number of modifications required for the aircraft. Some changes were minor, while others were so extensive as to be beyond the resources of the RAAF. The number of required modifications soon reached the 1000 mark and a retrospective modification programme was arranged with GAF. Aircraft were returned to the factory to undergo a package of modifications including, for example, the fitment of Doppler navigation systems to the original 30 aircraft, extensive corrosion control treatment, camouflage painting, electric throttle control of the engine and later, the fleet-wide fitment of electrically heated windscreens.

Several 'Retro-mod' programmes were conducted and because of the extensive dismantling, modification and reassembly, a complete flight test schedule – as for a new aircraft – was decided upon for each 'retro-mod' aircraft. The first of these aircraft entered flight test in the Spring of 1966 and they continued to recirculate through Avalon throughout the duration of the production programme. Altogether, aircraft were returned to the factory for modification or servicing on about 350 occasions.

Even Blind Freddie could see the need for flight testing a new French fighter aircraft when it was required to carry British, American and Australian ordnance in a new environment. However, at the inception of the Mirage programme, ARDU had great difficulty in convincing superior headquarters that there would be a need for flight testing in Australia. Similarly, difficulty was experienced in gaining approval to have the first two aircraft fitted with instrumentation wiring (an enormous cost saving) during their manufacture in France. Later, the same resistance was raised when the need for tropical trials was exhibited. Wing Commander Jim Rowland was the lead proponent for ARDU in overcoming each of these obstructions as they arose.

There was an immediate need to determine the performance of the aircraft under Australian tropical conditions and for the carriage and release clearance of external stores not previously tested in France. From experience, it was also known that additional testing would be required to analyse and correct the inevitable, but as yet unforeseen, failures and deficiencies.

Soon after the RAAF began flying the aircraft, the Mirage began to experience engine stall problems when manouevering at low speed, at altitude ('top LH corner'). A3-1 was employed immediately on engine surge (stall) trials, firstly to determine the exact surge boundary, and then to find a cure for the defect. Two engines were used in the trial, one a standard engine, and the other fitted with an expanded compressor outlet area to unload the compressor under the specific conditions at which the stall occurred. The trials proceeded satisfactorily until 7th December 1964 when A3-1 crashed and was totally destroyed. On the final flight of A3-1, the pilot, Squadron Leader Tony Svensson (an RAF exchange pilot) had successfully carried out two engine surge manoeuvres when during the third at 36 000 feet he entered a spin which rapidly translated into a fast, rolling vertical dive. He was unable to recover and ejected just before impact. The whole sequence of events occurred in less than one minute and he suffered multiple serious injuries from wind blast during the 750 knot supersonic ejection.

The ARDU system in general became the subject of much criticism by the RAAF fighter pilot fraternity because of Squadron Leader Svensson's low experience on Mirage aircraft at the time of his accident (eleven hours), which was perceived by them to be a predominant contributory cause. This was not the case. The pilot was physically unable to recover from the gyrations because of the violence of the manouevres – the aircraft motion exceeded human recovery capabilities. Many unqualified observations were

pronounced by the critics, none of whom were in current spinning practice and few of whom had performed a sustained spin since their pilot training days (the Wirraway was the last aircraft cleared for continuous stable spinning practice by the RAAF, subsequent training aircraft were limited to shorter duration manouevres). By contrast Squadron Leader Svensson had been lead pilot on the RAF Lightning spinning trials, had previously conducted Hunter and Provost spinning trials, and immediately before the accident, had conducted RAAF Sabre spinning trials. He was also co-author of the first known publication on inertia coupling in supersonic aircraft – a new phenomenon at the time, which resulted from the Lightning trials, and was assessed to be a factor in his own accident. There was probably no one better qualified than he to conduct the trials at that time.

Following the loss of A3-1, RAAF Mirage testing was continued at ARDU with A3-2. The engine surge problems were largely overcome by engine modification, improved maintenance procedures (improved compressor cleanliness) and a pilot education programme on stall avoidance, and if unsuccessful, the best recovery procedure. The engine air intake geometry of the Mirage, however, was always sensitive to low speed airflow disturbances and under the right conditions, surge (or stall) could be induced at will by just a light touch of rudder to induce even the mildest cross-flow at the air intakes. The 'top LH corner' of the Mirage flight envelope was not the domain of the ham- fisted pilot.

By tradition – and international convention – the measured performance of an aircraft is always 'reduced' (amended) to that which would be achieved if the aircraft were operating in a 'standard' atmosphere, and the defined 'standard' atmosphere is a temperate atmosphere. This engineering convention provides a convenient yardstick for the performance definition of a particular aircraft, or comparisons between aircraft types. The flight envelope diagram utilises standard atmosphere parameters. RAAF aircraft flight testing down the years had, however, shown that the Australian tropical atmosphere differed so much from 'standard' that perhaps a different yardstick was required, especially for supersonic aircraft where the effects of temperature could produce large performance variations. For example, the Australian tropical temperatures were often twice as hot as 'standard' at sea level, and nearly twice as cold at high altitude. From ARDU research and largely on the initiative of Squadron Leader Tony Dietz, the ARDU tropical atmosphere was evolved, was precisely defined and eventually gained international acceptance as a new international standard.

A3-2 was used for the majority of Mirage tropical performance evaluation and was deployed to Darwin almost on an annual

basis throughout the 1960s. The Darwin meteorological conditions were quite predictable in both the 'dry' and the 'wet' seasons and 'wet' season deployments soon became the norm as they enabled testing of the various airconditioning systems concurrently with performance measurement. A typical 'wet' season flying day experienced high surface temperatures with 100% humidity and very cold temperatures (minus 80 degrees Celsius) at high altitudes.

Performance testing involved precise flying of measured climbs and descents, accelerations and decelerations and interminable 'stabilised levels'; all were repeated for each required configuration of the aircraft. The flying was demanding with additional interest provided by the need to depart from, and arrive back at the airfield between the frequent tropical thunderstorms. These could develop to 50 000 feet very rapidly, and with the aircraft usually short of fuel, the latter part of each flight was usually conducted very close to home base. The only available alternate airfield was the old wartime strip at Satler, about 14 miles down the highway.

A3-2 was heavily instrumented with, at times, up to four photographic trace recorders mounted in most of the available space within the fuselage. Thus, most required in-flight parameters could be recorded for any particular test, by simply patching in the necessary connections. Mr Mike Dinn of ARDU was the instrumentation specialist responsible for the design, fitment and maintenance of this advanced system. It was early in these performance trials that the aircraft instrumentation output was first transferred to the ARDU computer (by punched tape and PMG lines) for immediate processing of the raw data and production of the finished product (the 'reduced' data) in time for the following days' test programme. The flexibility provided by this system greatly assisted the management of the trials and overall produced substantial savings of valuable flying hours. From this data, performance information (usually in graphical form) was provided for inclusion in the Mirage Flight Manual. The manufacturer (GAMD) usually sent performance engineers to observe these tests and to share the results.

A practical example of the need for performance testing was the RAAF requirement to determine the maximum ferry range of the Mirage and what combination of external tanks would be required to produce this range - especially in the light of proposed deployments to Darwin and Butterworth. Theoretical studies indicated that the maximum range would be achieved by the use of 2 X 374 gallon tanks under the wings and one 286 gallon tank under the fuselage. A 'step' or 'cruise' climb would be included in the flight, to gain altitude as weight was reduced. After the trials and to validate the results, ARDU flew a series of long range proving

flights, usually on redeployment to Darwin where the leg distances where representative of the RAAF requirements.

It has long been known in aviation circles that in World War II, the only thing that got a fully laden Liberator bomber (B-24) airborne was the curvature of the earth; its maximum weight take off performance was marginal. Compared to the Mirage with three big tanks, the Liberator was a sparkling performer! With the Mirage in this configuration, the weight and drag was such that all the dynamic forces coming into play during take-off developed a perfect equilibrium at 184 knots. The aircraft slowly accelerated to that speed and stayed there. Any attempt by the pilot to raise the nosewheel to become airborne caused a deceleration and as the nosewheel rotational speed limit was 160 knots, neither could the nosewheel be allowed to touch the runway for fear of its disintegration. Thus, the pilot could do little but just sit there 'bug eyed' with the control column delicately balanced between two fingers holding the nose as low as possible without letting the nosewheel touch the runway. The only two remaining variables were fuel consumption (disappearing at about 80 gallons a minute) and runway usage (disappearing at about 300 feet per second). High ambient temperatures extended the whole process. Word soon spread along the aviation grapevine when one of these take- offs was about to be attempted and many otherwise absent spectators soon drifted towards the airfield from adjoining buildings – especially at Williamtown. Somehow, the aircraft always became airborne just before the end of the runway and disappeared from view, raising dust, at an extremely low altitude. At lift off (there was no such thing – it just became airborne), the pilot was faced with a further conundrum; when to raise the undercarriage? With marginal performance and only a few feet off the ground, it would be expected that removal of the drag produced by the extended undercarriage would be an aid to acceleration. However, there was a good chance that the aircraft might touch down again (better with wheels) and it was suspected that the opening of the undercarriage fairing doors at the start of the retraction sequence would initially increase the drag and cause touchdown anyway. To further complicate affairs, at about this time the engine, which was operating in a max-afterburner overspeed condition was due to automatically revert to normal, 100% thrust operation. The consequences of jettisoning the three big tanks at this stage were too horrific to contemplate. It was best to just sit and wait and by remaining low, the speed gradually increased away from the 184 knot stagnation point; by 220 knots the aircraft climbed away normally.

The 'three big tanks' configuration was not cleared for RAAF

operations, but the range loss was not severe as the 'two big tanks' configuration provided only a slightly reduced range with much improved take off performance – the third tank really only provided the fuel to compensate for the additional drag that it produced.

The 'big' (374 gallon) fuel tanks were used only by the RAAF. This special provision was made to meet our longer range requirements. Thus, these tanks had not been flight tested elsewhere and had to be subjected to carriage and release trials to determine the feasibility of the theoretical flight limitations and the dynamics of their ejection from the wings before release for general operations. Squadron Leader Doug Cameron flew the majority of these trials at Avalon, using an ARDU developed photo-recording system mounted under the aircraft in the fuselage and in a specially modified drop tank. By a system of triangulation between each of the set of high speed cameras (up to 3000 frames per second), the release disturbance angles and tank trajectories could be accurately measured. The system was further developed for use in all external stores dropping trials.

The special photographic drop tank had four big windows in it for the cameras to look out. On one memorable 'open day' when the aircraft and all its accompanying paraphernalia was polished and lined up on static display, the RAAF 'explainer' in attendance, Corporal Niel Gage, grew sick of answering for the one hundredth time 'What are the windows in the tank for?' Spontaneously, to the next questioner, he replied, 'To bring the wounded back from Vietnam - they like to see where they're going!' This answer was apparently provided for the remainder of the day – unchallenged! Perhaps all those people still think that such was the case!

One of the more noteable unexpected emergencies happened to Flight Lieutentant Ron Green shortly after take off at Avalon in A3-2 on a performance test flight. The engine stopped dead as he was climbing through about 6 000 feet. Luckily he had just sufficient altitude to reverse turn and land back onto the departure runway without further incident. Had the failure occurred any earlier, he would not have been able to return and the aircraft would have been lost. The failure was caused by a complete fuel blockage. With the Mirage, when disassembled, the fuel pipes were all provided with red plastic caps at each end to prevent the entry of dirt or foreign objects during maintenance. These caps were moulded to fit inside the pipe ends in bath plug fashion. One had been left inside a pipe on reassembly (Murphy's Law) and had moved through the system to lodge in the plenum chamber of the fuel pump where it had recirculated in the turbulent fuel for four previous flights (since the last breakdown inspection of the system) before finally doing its job from the inside and lodging in the pump outlet pipe to the engine.

A system of external fuel blanking caps was introduced after this incident.

Air conditioning problems consumed many Mirage flying hours, again, in the tropics. The basic problem was one of inadequate internal airflow – both volume and temperature. Things got too hot on the ground or in flight at low level, and too cold during prolonged flight at altitude.

Overheating of the pilot in the cockpit on the ground was alleviated by using external shade systems (umbrellas!) and the design and fitment of a canopy latch which propped the canopy part-open during ground operations. Trials were also conducted with a range of air and water cooled inner flying suits for the pilots. Most of these produced more problems than they solved and none were entirely satisfactory. None were adopted for RAAF use.

In-flight cockpit conditioning problems occurred in three areas; the pilot was too hot in high speed, low level operations; because of cold soak at high altitude, the pilot's instruments fogged up (internally) during descents; and, most critically, the windscreens and canopy, for the same reasons, clouded over with condensation during descent to the extent that all external vision could be lost. Thus, in the worst case – and it happened in service – the pilot could be faced with total loss of external visual reference when making an approach to land in bad weather conditions and at the same time be denied the use of essential flight reference instruments in the cockpit. The aircraft was usually short of fuel at the same time.

Each of these problems was overcome after diagnosis and modification. The windscreen fogging was the most difficult to rectify and was only resolved by the fleet-wide fitment of internally heated (electric) windshields and front side panels. This was a major and expensive modification, not in itself without problems because of the difficulty of manufacturing the new transparencies to the required optical standards.(2)

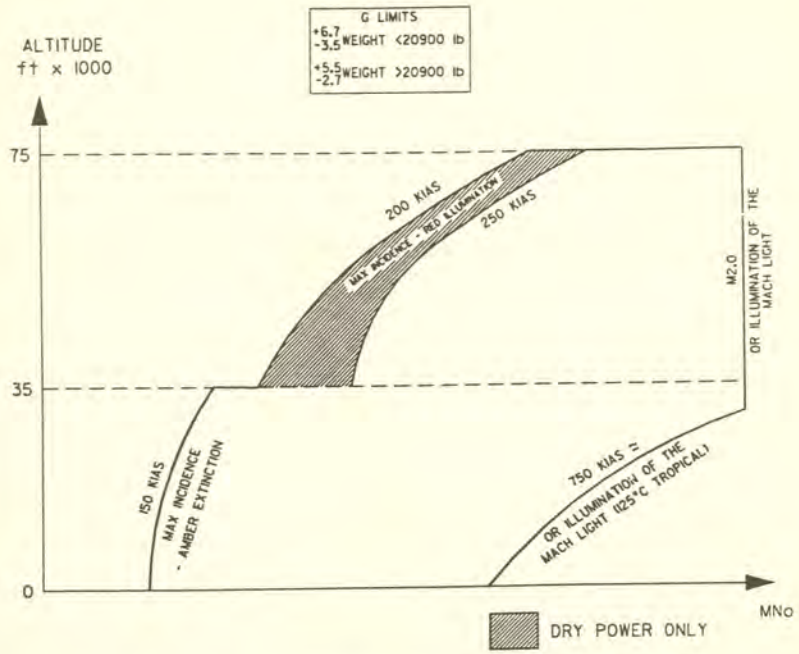
As soon as the Mirage was operated in the tropics it was found that many on-board equipment failures were caused by water collecting in the many electronic 'black boxes'. Being of relatively advanced technology at the time, with little or no internal heat generation, these components became very cold during prolonged flight at high altitude. A typically rapid descent into the high temperature/high humidity air at low level produced internal condensation at such rates that water could be poured from these boxes after flight; they would continue to make water until their temperature increased to above the ambient dewpoint temperature. The problem was solved by raising the continuous equipment conditioning temperature to a level above the anticipated low level dewpoint temperature (usually about 26 degrees Celsius).

Although the foregoing examples of in-service flight trials are described as separate activities, in practice and to best utilise the available flying hours, several trials were usually incorporated in any one flight. Thus, for instance, the annual programme to Darwin for tropical performance testing was also used for ferry range validation and navigation system trials. The many air conditioning trials were mostly run conjointly with performance checks. ARDU became very competent at mounting trials deployments as a matter of routine; the deployments were enjoyable and competition for inclusion in each team was keen. The team was always well received with great hospitality in Darwin and as an added deployment bonus the 'top end' fishing in the 1960s was still undiscovered by the southern and international multitudes. Barramundi which had difficulty fitting into the boot of an EJ Holden were not uncommon. In those days, too, QANTAS ran a very hospitable crew motel at Berrimah, just down the track – with a swimming pool – and on the way home from fishing!

The Mirage is still the best looking aircraft to serve with the RAAF since the Spitfire, and despite the foregoing catalogue of selected deficiencies it served well in training a complete generation of RAAF fighter pilots in supersonic air defence operations. It is to be hoped that those who now make the decisions decide to retain sufficient examples of the Mirage for the educational benefit of future aviation enthusiasts."

Notes: (1) Air Commodore G.W. Talbot, AFC – Following a five year engineeering apprenticeship with the RAAF, Air Commodore Talbot transferred to pilot training followed by tours of duty with four different fighter squadrons. He was commissioned in 1956 and continued flying as an instructor at RAAF College and then at Central Flying School. In 1959, he attended the Empire Test Pilots School at Farnborough, followed by two years test flying of fighter aircraft at Boscombe Down. He then spent five years at ARDU rising to be OC Test Flight and Chief Test Pilot at Government Aircraft Factories. In 1973, he was involved in the initial acceptance and delivery of F-111 aircraft to the RAAF, followed by three years as CO of No 1 Squadron at Amberley. After promotion to Group Captain, he spent the remainder of his service in various executive posts in Canberra. He retired in 1986 with 6 000 hours and 75 different types of military aircraft in his RAAF Flying Log Book and now lives within earshot of the sea and Moruya airfield on the NSW South Coast.

(2) This modification was eventually discontinued because of the high cost and difficulties in reaching the required optical standards. A solution to the windscreen misting problem was achieved through use of the airconditioning system.



COMBAT PERFORMANCE - (ARDU TROPICAL)

	AUW	GROUND ROLL (SL, NIL WIND)	SPECIFIC AIR RANGE
AIR DEFENCE (3 missiles, guns, 875 gals) -	24 600	4 300 ft	1.1 NAM/gal
GROUND ATTACK (4 bombs, guns, 875 gals) -	26 300	5 100 ft	1.1 NAM/gal

STATIC THRUST (ATAR 9C)

DRY ENGINE	-	9 480 + 165 lbs
MAX A/B	-	13 288 +375 -275 lbs
OVERSPEED	-	14 180 lbs

5

OPERATION 'FAST CARAVAN'

AVM J.H. Flemming, AO

The first operational Mirage squadron, No 75 Squadron, re-equipped with the Mirage at Williamtown during 1966/67. From the outset, 75 Squadron was earmarked for deployment to Butterworth to replace No 3 Sabre Squadron. This deployment was code-named Operation 'Fast Caravan' and its story is told here by the man who led the operation, the Commanding Officer, Wing Commander Jim Flemming (1).

"In April 1967 an Operation Order, code named 'Fast Caravan', was received by the Commanding Officer of No 75 Squadron. The order, in part, directed as follows: "No 75 Squadron will deploy from RAAF Base Williamtown, NSW to RAAF Base Butterworth, Malaysia". This rather succinct directive culminated a year of intensive training by No 75 Squadron which included permanent detachments of aircraft and crews, both air and ground, to Darwin and extensive planning and trials for every possible contingency involving the movement of a large force of modern air defence fighters through the South East Asia area.

Consequently, at 0900 on the 15th May 1967 twenty three Mirage 111-0 aircraft departed Williamtown on the first leg of what was to be an epic deployment for the RAAF.

During the previous year many trials had been carried out and various deployment routes considered. The first, proposed by Headquarters Operational Command, was similar to that used for the deployment of the RAAF Sabre Squadrons to Malaysia in the late 1950s. The route proposed was: Williamtown, Townsville, Lae, Guam, a base to be decided in the Philippines and thence to Malaysia. However, actual trials carried out by the Squadron from Darwin proved that this route was impractical for flight safety reasons in that the fuel reserves would be too low and there was

a complete lack of navigational aids. An alternate route, proposed by the Squadron, was the well known transit through Townsville to Darwin followed by a leg to Learmonth in Western Australia, thence to Cocos Island and across the tip of Java to Butterworth. While this route was considered acceptable it involved an overfly of Indonesian territory and a long over-water flight to Cocos Island, again without navigation aids. However, if this route were to be approved, the Squadron had requested that the RAN provide one of the Hobart class vessels to be positioned at the half-way point, Learmonth – Cocos, where the air defence radar capability of this type of ship could provide essential en-route navigation information as well as being a morale booster for the aircrews as regards rescue and survival.

Inter-Departmental discussions and Government to Government negotiations regarding the use of Indonesian air-space took place and the Squadron was very pleased to receive advice that these negotiations at high Government level had resulted in the Government of Indonesia granting approval for a one-time stopover in Indonesian territory; a major diplomatic breakthrough as regards transit for RAAF aircraft as it had not been too long since the days of 'confrontation'.

The route approved was from Darwin to Djuanda, an Indonesian Navy controlled airfield outside Surabaya, thence direct to Butterworth. The provision of this Indonesian facility meant that only one stop was required between Australia and the destination at Butterworth and, apart from the relatively short crossing of the Arafura Sea, the route followed the Indonesian island chain thus easing the task of navigation and provided a better chance of survival and rescue in the event of a major emergency requiring ejection.

On the morning of the l5th May 1967 twenty three Mirage aircraft beautifully prepared by the pilots and ground crews of No 75 Squadron were ready for the first leg, Williamtown to Townsville. The air crews, resplendent in their day glow flying suits, their black scarves and squadron caps, were all in cockpits prepared to start when a major crisis developed. The Commanding Officer's aircraft, the well known A3-40, refused to start at the appointed time of 0800 hours. This occurred despite a test flight and a fly-past which had proved the aircraft to be completely serviceable until this eventful occasion. A decision to delay start-up for one hour was made during which three separate and relatively minor electrical failures were rectified in A3-40. At 0900 hours in front of television cameras and many families, friends and well- wishers, the twenty three aircraft, without further incident, departed in an orderly fashion on the first leg of their long journey.

The leg to Townsville, flown in beautiful Australian autumn weather, was uneventful until approaching Townsville when air traffic control advised that very strong winds with gusts of 25 to 35 knots across the landing direction could be expected. On touchdown the Commanding Officer's braking parachute pack came out of the aircraft without deploying with the result that the aircraft, which was carrying large long-range tanks, proved very difficult to stop on the runway in the prevailing weather conditions. Fortunately, little damage was done apart from badly scalded nose and starboard main tyre. The other twenty two aircraft landed without incident.

After a very proficient refuel and turnaround by the ground crews under the command of Group Captain J.I. Adams, the Officer Commanding RAAF Townsville, the aircraft were ready for the second leg to Darwin. It might be interesting to note at this stage that this whole operation was conducted as a complete joint force under the command of the Commanding Officer of No 75 Squadron. This was a new, innovative move by Headquarters Operational Command and had not been done previously. The force, in addition to No 75 Squadron, comprised three C-l3O Hercules aircraft from No 37 Squadron, Richmond, two Canberra bombers from No 2 Squadron, Amberley and two Neptune maritime reconnaissance aircraft from No 10 Squadron, Townsville.

One C-130 had deployed ahead of the formation to Darwin; one had gone direct to Butterworth with an advance group commanded by Flight Lieutenant Rex Hubbard, the Squadron Equipment Officer, for preparation of facilities and reception, and the third was being used as a support aircraft following behind the main Mirage force. The Neptunes were used for air-sea rescue purposes and en-route navigation assistance, one stationed between Darwin and Djuanda and the other between Djuanda and Singapore. The Canberras flew ahead of the main Mirage force and used their navigation facilities to pass back estimated winds and ground speeds to the Mirage formation. From the time of the initial comprehensive briefings at Williamtown in early May this force operated as a cohesive group rejoining as required for briefing at Darwin before the move through Indonesia.

Prior to departure from Townsville, the Commanding Officer decided to fly direct to Darwin. A formation of twenty three aircraft caused some consternation to the civil air traffic controllers as the normal route was to follow the coastline after Normanton but the direct flight across the Gulf was decided to save time and keep the formation away from the civil traffic (approaching Darwin from the south east) and so prevent any problem for air traffic control. Again the flight was delightful and uneventful in beautiful clear

northern skies. On arrival at Darwin all aircraft landed safely with one exception. The aircraft flown by Pilot Officer Peter Condon burst a tyre on touchdown. This is not an unusual occurrence when operating the Mirage under high load conditions and Peter Condon stopped his aircraft without any further damage.

In Darwin, the force, with the exception of the advance party Hercules which by now was in Butterworth, regrouped and briefed on the impending flight to Djuanda. The importance was stressed of the transit through Indonesian territory and it was decided that only the Mirage force of twenty aircraft, this being the No 75 Squadron complement, the No 2 support Hercules and the Canberra navigation aircraft would land at Djuanda. The No 3 support Hercules would remain at Darwin until all the No 75 Squadron Mirages had departed. It would then leave for Butterworth, over-flying Djuanda, so that it could be called in for support if required. The other three Mirage aircraft being flown in support as far as Darwin to be used as spares to ensure that twenty aircraft left Darwin for Butterworth. The three extra Mirage aircraft were flown by pilots of No 2 OCU who were attached to the Squadron for this part of the operation. After No 75 Squadron had departed, the remaining three Mirages would be flown back to Williamtown by the 2OCU pilots.

While at Darwin, the old inherent rivalry which is so healthy amongst fighter squadrons was quite evident when the Commanding Officer discovered that the imposing magpie, normally in stark black and white on the tailplane of his aircraft had been subtly altered to the colours of black and yellow of No 2 OCU and two musical notes were emanating from his beak thus turning the proud fighting magpie into a domestic canary. The Commander of the No 2OCU detachment, Major Andrew Patten, an officer on exchange from the USAF, was briefed by Wing Commander Flemming on the importance of the RAAF image in Indonesia and next day all the 75 Squadron's magpies had been reverted to their original colours. Two days in Darwin for final preparation and fine tuning proved to be a very worthwhile investment as on the morning of the 18th May all twenty three aircraft were ready and available for the flight.

Planned departure from Darwin at 0600 hours on the morning of the 18th May went well considering the number of aircraft involved. The No 2 Hercules support aircraft had departed some hours before for Djuanda and a voice-to- voice over the single sideband radio between this aircraft on the ground at Djuanda and the Hercules on the ground at Darwin enabled the Commanding Officer to have a very accurate weather forecast for the coming flight. Both Neptunes departed as planned and at 0600 the commanding officer started A3-40 followed by the other two in the first flight. The flight of

twenty aircraft was planned to be in two flights of three, followed by one pair, followed by four more flights of three; the rationale being that in any eventuality each aircraft had at least one for mutual support. On start-up, Squadron Leader Alan Taylor, the C Flight Commander, advised that his aircraft A3-31 would not start. As pre-briefed one of the three OCU pilots started his aircraft, the 21st in line, and Alan Taylor made a rapid change to this other aircraft taking what he thought was all his personal equipment with him. An interesting aside is that some two years later, after A3-31 had been in service with other units at Williamtown and had been sent to the Government aircraft factory at Avalon for a major overhaul, Alan Taylor's black dress shoes were found in a vacant camera compartment behind the main radar head where they had rested undisturbed since that morning on the 18th May over two years previously. Whether Alan Taylor ever claimed recompense for the loss of his shoes as an operational incident has not been determined.

Departure from Darwin at that early hour on a superb tropical morning was an event that few are privileged to experience; heading out over the Timor Sea the only inconvenience being that the Darwin air-defence was not on the air to assist in the outward navigation of the Mirage force. About the same time as the Darwin TACAN broke lock, 130 nautical miles approximately, an air defence controller called and made contact with the Mirage leader. This did not contribute to the operation apart from giving the leader a chance to say a final farewell. After this last contact there were no navigational aids between there and the destination where a portable TACAN unit had been placed by a crew from Headquarters Operational Command for the purpose of this deployment. Fortunately the weather was very kind; no evidence of the forecast inter-tropic front being visible. A call by the "B" Flight Commander, Squadron Leader Bill Monaghan, saying that all were airborne, serviceable and climbing was received with a degree of relief by the Commanding Officer.

All aircraft made contact with the Neptune which was flying south of Koe Pang on the island of Timor. By interrogating the IFF of each Mirage as they passed overhead the Neptune was able to provide valuable navigational assistance. Special note should be made here of the dedication and professionalism of the captain and crew of this Neptune flown by Squadron Leader Peter Brown from Townsville. This aircraft experienced failure of one of its two piston engines but Peter Brown, although told by the Mirage leader to return to Darwin, insisted on remaining on station until all Mirage aircraft had passed before making the long trip back to Darwin in what can only be described as an emergency condition. This attitude and dedication to duty reflected very highly on the spirit of this

operation and No 75 Squadron advised the Officer Commanding, Townsville, the Commanding Officer of No 10 Squadron and Headquarters Operational Command of their gratitude for this most professional assistance recommending that Squadron Leader Brown and his crew receive official recognition for their actions.

The long flight from Darwin, some two and a half hours, was interesting and fortunately incident free. The weather was mainly fine with patches of cloud at various altitudes which, although extensive, permitted glimpses of the Indonesian islands and so enabled reasonable positioning. Approaching the island of Bali the aircrews were fortunate in that the weather cleared and they were able to look directly into the crater of the 12,000 foot plus active volcano on the small island of Lombok. The crater has a superbly blue lake surrounding a small island which has a smoking lava cone in the centre; indeed an impressive sight and again one only available to a fortunate few.

Some 60 nautical miles from Djuanda a reading from the portable TACAN transmitter was received. Also voice contact with Squadron Leader Ken Murray from Headquarters Operational Command was made. A descent and landing into the airfield through very reduced visibility was uneventful and shortly after 0930 local time all aircraft were parked awaiting fuel on the fighter replenishment area of the Djuanda airfield, while the aircrews received refreshments and a warm welcome from the Indonesian Naval Base Commander and his staff.

The Commanding Officer, the Engineering Officer of No 75 Squadron and representatives of Headquarters Operational Command had previously made a visit to Djuanda to assess the facilities. The base proved to have an excellent runway, high speed taxiways and all the necessary hard standing to provide satisfactory turnaround for the Mirage force. The airfield itself was badly overgrown and showed obvious signs of neglect and it was interesting to see derelict ex-Russian Mig-15s, Horse helicopters and Badger bombers parked all over the taxiways and run up areas obviously in the place where they had last stopped a long time before. There were also excellent buildings and facilities on the Base but all of these were in a state of neglect. The Indonesian naval authorities on the other hand made us extremely welcome and proved to be excellent hosts. This was also most evident on arrival on the morning of the 18th May when the Squadron was greeted by senior Indonesian Naval officers who offered every possible assistance.

There were two major incidents at Djuanda, both of which reflect the initiative and ingenuity of the RAAF personnel involved. When the fuel filter unit provided by the Indonesian authorities

proved to have a flat tyre with no replacement available and no means of towing the vehicle between aircraft for refuelling, the Squadron Engineering Officer, Squadron Leader Jack Holden, overcame this major problem by pushing the filter cart sideways using the squadron mini-tractor and refuelled all the Mirages to capacity in record time despite the fact that for the last four aircraft the filter cart was being pushed on bare rims, the tyres having been rolled off it on the way down the line. After refuel, as all Mirage aircraft were serviceable, as were the Canberra and the No 1 support Hercules, the Engineer Officer was able to advise the follow-on No 2 support Hercules from Darwin that they could over-fly and go direct to Butterworth.

After the Commanding Officer had reported on his earlier visit to Djuanda, No 75 Squadron personnel of all ranks had commenced a project at Williamtown to collect items of amenities as a gift to the Indonesian Navy at Djuanda as they were aware of the lack of facilities at the base. A large container of books and magazines, games, sporting equipment and items such as snooker balls and cues, dart boards, bowls, etc were provided by the Squadron personnel and given as a token of friendship to the Indonesian Naval staff at Djuanda. This proved to be a most rewarding gesture as very strong friendships were made between the two services and resulted in complete rapport and a sense of warm friendship and co-operation during the whole time spent on the ground at Djuanda.

The estimated time of departure from Djuanda was delayed at the request of the Indonesian Government as the Indonesian Minister for Defence had decided to pay a personal visit to inspect the aircraft while they were being refuelled. It must have been an imposing sight for the Minister to see twenty two RAAF aircraft, twenty of which were the world's top line fighter interceptors, standing together all serviceable and ready for operation and being maintained by the absolute minimum number of ground staff.

Diplomacy required the Commanding Officer to delay takeoff by some hour and a half but when ready, all aircraft started on cue and commenced taxi- ing. When the first three lined up for takeoff, the No 2 to the Leader, Flying Officer Alan Walsh, reported that his canopy would not seal and the unlock light was showing. This transmission was heard by Flight Lieutenant Ian Whisker who was leading the second flight of three having taken the place of Alan Taylor on leaving Darwin. Ian Whisker reported the problem to the engineering officer who took appropriate action. A sight which impressed the commanding officer and no doubt amazed the Indonesian hosts was to see Sergeant Des McGrory come hurtling down the ramp of the Hercules mounted

on the Commanding Officer's personal bicycle which was being transported to Butterworth. He rode the full length of the taxiway up to the back of the problem Mirage whereby he jumped on to the rear of the mainplane and very noticeably sat with some determination on Alan Walsh's canopy; the result being that No 2 reported, 'canopy closed and locked sir'. A sight that will always be remembered as the first three aircraft thundered down the runway on the last leg to Butterworth was Sergeant McGrory blissfully riding the Commanding Officer's bike back up the taxiway at Djuanda having contributed far more than he realised to the success of the operation.

All aircraft became airborne and when the A flight commander, Squadron Leader Peter Scully, reported all serviceable and climbing the Commanding Officer breathed a sigh of relief and experienced a degree of elation. It was not until arrival at Butterworth that it became known that Flying Officer Ron McGrath had experienced an alternator failure on climb out from Djuanda. This would normally have meant a return to base as several major systems are rendered inoperative by such a failure, not the least being the complete loss of cabin pressurisation and heating. Again the dedication of the members of No 75 Squadron was evident as Ron McGrath decided that, rather than commit his flight to a return to Djuanda and a subsequent delay possibly for an extended period due to the forecast weather, he elected to fly the remaining leg of over two hours without pressurisation. Needless to say he had a most uncomfortable trip and was part frozen prior to his descent into Malaysian air space. This was the only incident on the last leg of the epic flight to Butterworth.

Shortly after passing the top north east coast of Sumatra the second support Neptune was spotted and the dollar pool for this first sighting was won by the Commanding Officer. This Neptune, flown by Squadron Leader Kevin Rodd, gave helpful en-route information advising that there would be cloud at operating altitude for the major part of the flight. This proved to be true and apart from the clear hole where the Neptune was seen, all aircraft flew in instrument conditions until some 30 or 40 nautical miles south east of Butterworth. The Singapore authorities, particularly the air traffic control organisation, were outstanding in their assistance and provided clear passage through their area directly into Malaysian air space. The voice of Group Captain Ross Glassop was heard some 20 minutes out of Butterworth and his advice to the flight leader that 'oranges are sweet', a code phrase meaning that the weather is good, was very welcome to the Mirage pilots who were not looking forward to the instrument landing which had been forecast. Due to the long day and fatigue factor the arrival at Butterworth

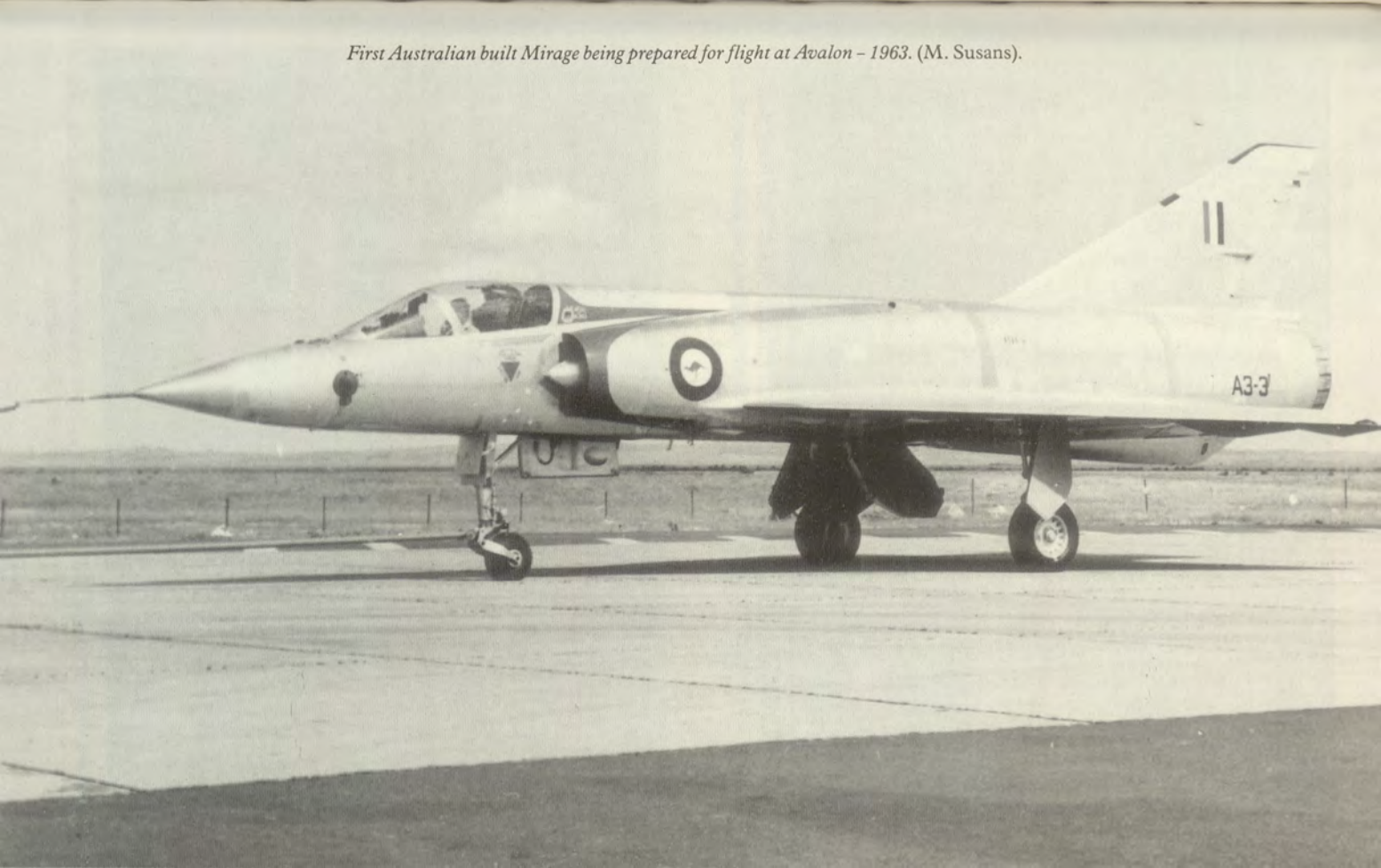
was as briefed, there being no major fly past the aircraft arriving on initial approach by flights with normal operating separation between flights. All aircraft landed without incident approximately one and a half hours later than an ETA set some months before. This was most gratifying and reflected great credit on the Squadron maintenance crews who worked tirelessly to ensure such a result.

The 75 Squadron personnel of the advance party, including some of the wives, were at hand to meet the crews as were the Officer Commanding RAAF Base Butterworth, Air Commodore Norman Ford, the Officer Commanding No 78 Wing, Group Captain Ross Glassop and the Commander, Royal Air Force Butterworth, Air Commodore Hyland-Smith.

After landing and refuelling, eighteen of the twenty aircraft were serviceable for flight. So in all respects the deployment was obviously successful. The arrival of the No 1 supporting C-130 Hercules from Djuanda and the No 2 support aircraft which had come direct from Darwin, plus the No 2 Neptune crew and Canberra crews, started a welcoming party put on by RAAF Base Butterworth for all squadron personnel. This proved to be an experience which would best be written about on another occasion. Suffice to say that no decisions were made and very little activity took place in No 75 Squadron on 19th May 1967.

After five days of setting up and establishing a Squadron headquarters and flight line facilities for operations the Squadron went on to full flying status and within six weeks of arrival had flown the full complement of hours required for the approved flying rate set down by Headquarters Operational Command. The only minor problem encountered during this initial period being the influx of water from the heavy monsoonal storms which caused maintenance difficulties. Again the ingenuity of the ground staffs of 75 Squadron came to the fore and it was an interesting sight to see each Mirage being put to bed at night plastered with a multitude of bandaids made up of masking tape covering every available orifice. While time consuming and a maintenance nuisance, this nevertheless enabled the Squadron to meet its flying commitment in the shortest possible time.

Arguably the most successful RAAF deployment ever undertaken and certainly the most impressive; the move of No 75 Squadron from Williamtown to Butterworth to become the first independent specialised air defence aircraft unit to operate in the area reflected great credit on the RAAF and on all who took part. One must wonder why not one of those, including all levels of rank, who played such an important and significant role, often well beyond the expected, in this major operation ever received any official recognition despite the numerous submissions for appropriate awards.



First Australian built Mirage being prepared for flight at Avalon – 1963. (M. Susans).

First Test Flight of the Mirage IIIO on 9 April 1963 at Villaroche Airfield near Paris, France. Pictured L to R, GPCAPT R. T. Susans, Jean-Marie Saget (Test Pilot), M. Valieres, and M. Serge (Dassault) (M. Susans).

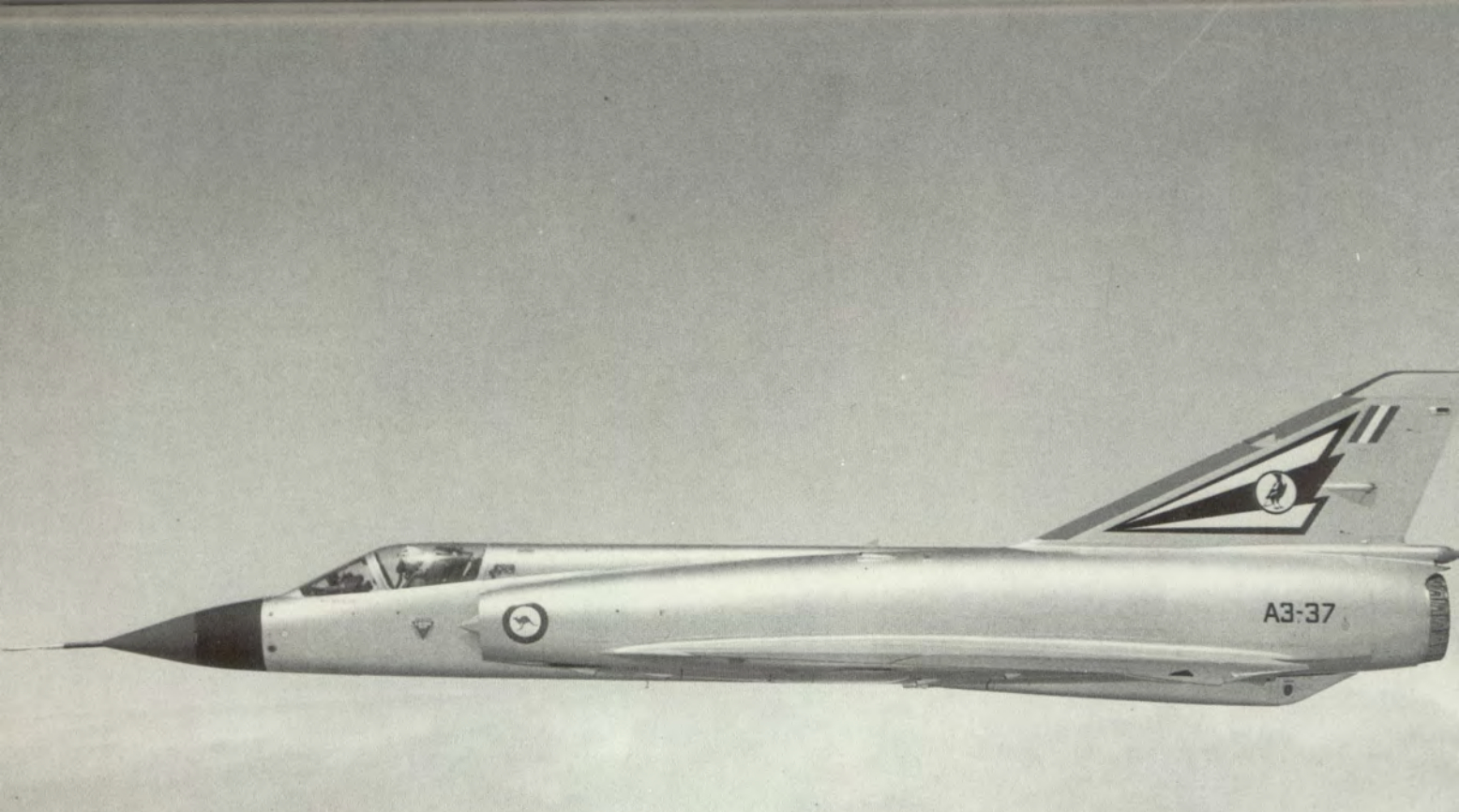
French Mirage III fitted with Rolls-Royce Avon Mk67 Engine for Australian Flight Trials in France – February 1961 (M. Susans).

Fuselage production at Government Aircraft Factory at Fishermens Bend, Melbourne (M. Susans).

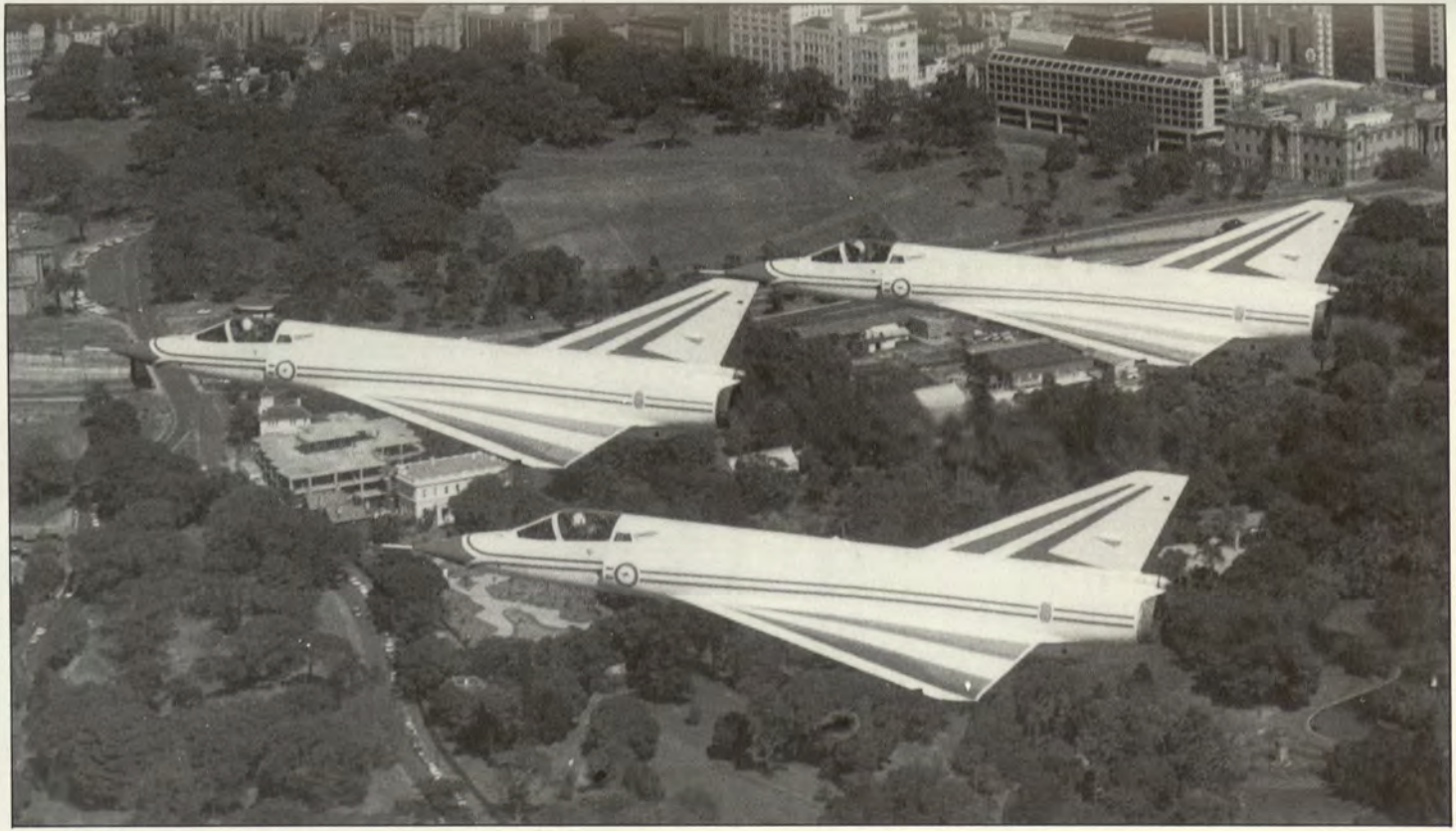
Mirage (Atar) Engine Assembly Line at Commonwealth Aircraft Corporation at Fishermens Bend, Melbourne (M. Susans).

Final assembly line of the Mirage at the Government Aircraft Factory, Avalon. (M. Susans).

Butterworth based Mirages of No 3 SQN lined up beside Amberley based F111s during an Air Defence Exercise at Butterworth. These exercises are essential to maintain the operational readiness of our fighter and bomber squadrons (D. Hersey).



The smooth sleek lines of the Mirage Fighter A3-37 bearing the No 75 SQN Tail Feathers (M. Susans).



The three specially painted Mirages from 77 Squadron used in the RAAF's Diamond Jubilee celebrations.

Flight Line at RAAF Williamtown, NSW in November 1967. Mirages of No 2OCU, No 76 SQN and No 3 SQN. The Sabres shown were operated by No 5 OTU. (M. Susans).

FLTL Be Va Donkelaar (right) discussing tactics with FLGOFF Rob Porteous of Hamilton, Brisbane (left), and FLGOFF Tony Allen of Noosa Heads (RAAF Pictorial Library).

RAAF ground crew assist as a line up of 77 Mirage Fighters prepare for take-off from Darwin during a Defence Exercise (RAAF Museum).

An impressive line-up of Mirages at Butterworth mid-1969 (M. Susans).

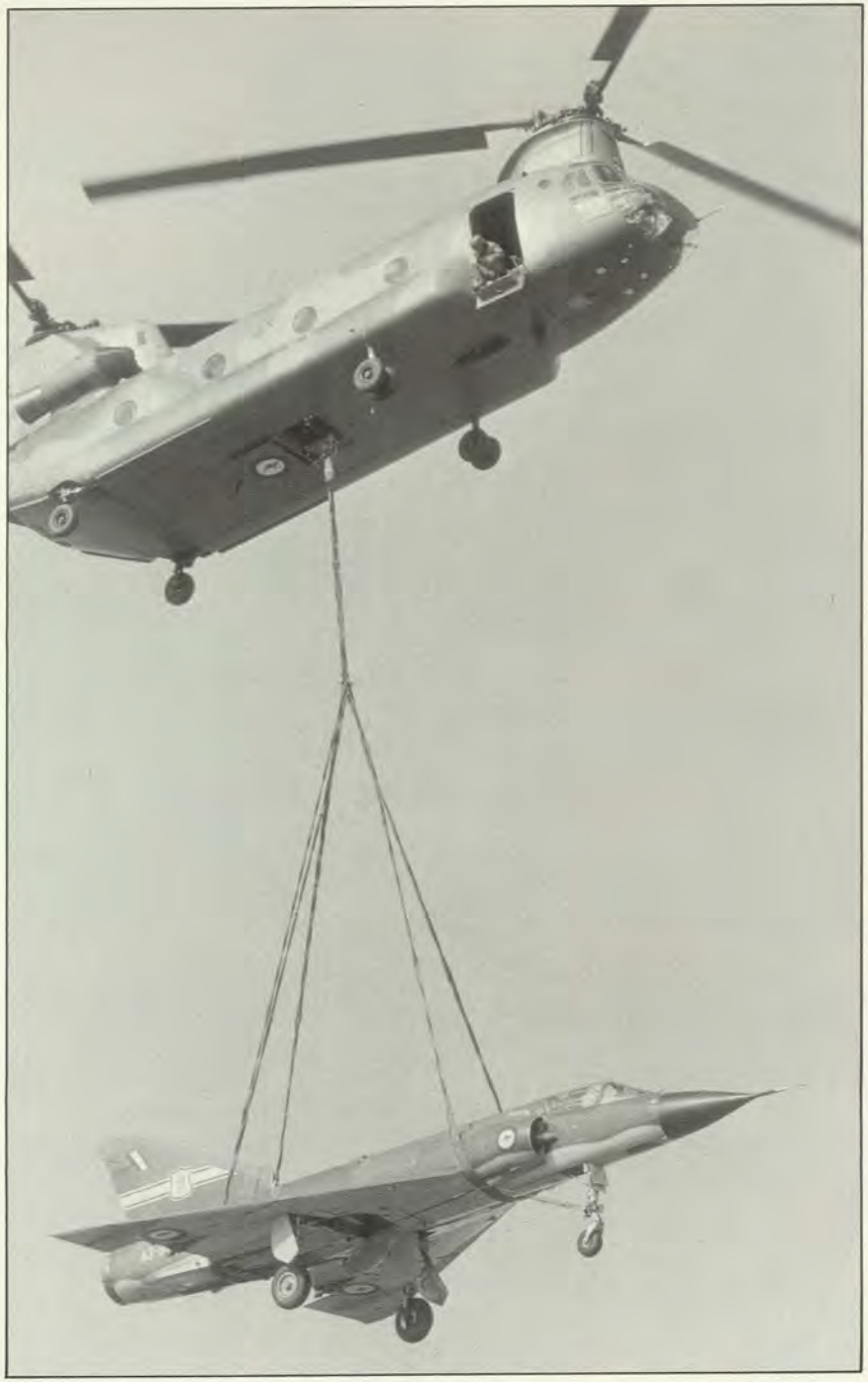
Six Mirage Fighters photographed in formation over Butterworth in December 1977, for the 21st Anniversary of the French-designed aircraft. L to R. No 77 SQN, No 3 SQN, No 76 SQN, No 75 SQN, No 2 OCU, and ARDU. These represent the Squadrons which operated the aircraft during Australian Service (D. Hersey).

"Cooling Off" whilst waiting to take off. Mirage ready on standby during an Air Defence Exercise at Butterworth, Malaysia. An Amberley based F111 taxies past (RAAF Museum).

First RAAF Mirage to be loaded with Matra "Magic" Missile. Standard Matra Missile fitted under centre fuselage.

First Live Firing of a Matra "Magic" Missile 25 October '84 from Aircraft A3-45 by WGCDR B. Wood (RAAF Museum).

A 77SQN Mirage, with drogue chute blossoming, comes in to land at RAAF Williamtown, NSW (Bill Cuneen).



Mirage A3-84 on its final flight from Avalon to RAAF Museum Point Cook July 1988, rather ungraciously below a Chinook (RAAF Museum).

Perhaps it was the very success of the operation, whereby highly trained, well disciplined and dedicated airmen made a difficult and demanding exercise appear so easy, that prompted those in power to respond and show their appreciation by no more than a message to the Squadron at Butterworth which read 'Congratulations No 75 Squadron on your deployment. It was indeed a Fast Caravan'."

It was not until 1969 that the second RAAF Mirage squadron, No 3 Squadron, deployed to Butterworth. This deployment, led by the CO, Wing Commander Ted Radford (2), departed Williamtown on 14 Feb 69. Whilst staging through Darwin, 3 Squadron welcomed home the last of the 77 Squadron Sabres on their way south from Butterworth.

The 3 Squadron deployment which followed the same route as that of 75 Squadron was also a complete success, resulting in the arrival at Butterworth on 17 Feb 69 of aircraft A3-81 through A3-100 inclusive, plus the dual A3- 107.

The only drama on 3 Squadron's deployment resulted from damage on landing at Djuanda to the 374G ferry tanks on A3-97. Of all the spares available on the accompanying C130's, there were no extra ferry tanks. Noting the CO's obvious keeness to avoid leaving an aircraft on the ground at Djuanda, the Squadron NAVO pulled out the clean configuration range graphs. After considerable pondering of the graphs by the Squadron executives, it was decided to launch A3-97 in the clean configuration to Singapore.

After meticulous topping up, the aircraft complete with the chosen pilot, Squadron Leader Bob Walsh (3), was towed to the departure threshold. A dry take-off was executed and heading set on the direct track to Changi some 745nm distant. Once settled at height, the clean Mirage revelled in the cold tropical atmosphere and Bob's fuel graph started to look good. He actually arrived over Changi with sufficient fuel to press on to Butterworth, but given a typical late afternoon forecast for Penang, prudence dictated a refuel at Singapore.

It was an enthusiastic welcoming party, complete with cold towels and Tiger beer, which met Bob on the Butterworth tarmac. The last piece was in place and twenty one 3 Squadron Mirages were lined up next to their older stable mates at Australia's only overseas Air Base. (4)

This force of 40 front-line fighters was a major contribution to the Far East Air Force prior to the British redeployment west of Suez, and was the cornerstone of the Five Power Defence Arrangement in the years that followed. Up until their withdrawal from the region in May 88, the RAAF Mirages formed the major firepower of the Integrated Air Defence System, and played an important peacetime role in the development of the Malaysian and Singaporean Air Defence Systems.

Notes: (1) Air Vice Marshal J.H. Flemming, AO – Born Randwick, NSW 4 Dec 26, enlisted RAAF Jul 43, graduated Empire Air Training

Scheme in 1944 as Sergeant, based in New Guinea and Darwin. Converted to Mustangs 1946, then to 78 Squadron. Mustangs in Japan when Korean War began, flew first RAAF mission. Awarded American DFC, Air Medal and MID in Korea. Commissioned Nov 50. 3 Sqn Fairbairn 1951. Flying Instructor, FCI 1955. CO 75 Sqn 1956, formed and led RAAF's first official aerobatic team – the Meteorites. CFS 1957. USAF Exchange 1958, F100 and F104. CFI 2(F)OCU, CO 76 Sqn. RAAF Staff College 1962. Director Operational Research. CO No 75 Sqn (Mirage) 1966. OC Ubon 1968. HQ Support Command 1969, PSO and S Admin SO. OC RAAF Williamtown 1973. RCDS, and awarded AM 1975. DGCO, DGNTFP 1976. Commander IADS 1977. CAFOPS 1981. Awarded AO 1982. Director Australian War Memorial 1982.

(2) Later Air Vice Marshal E.A. Radford, AO, Air Commander, Australia.

(3) Later Air Commodore R.J. Walsh, AFC, Commander Strike Reconnaissance Group.

(4) These successful early deployments were to be emulated many times in succeeding years by replacement aircraft being ferried to and from the region. Later deployments favoured the international airport at Bali as a staging post in Indonesia, and by also using a Singaporean base, the Indonesian segment of the journey was reduced from two legs of approximately 1100nm to two of just under 1000nm. Although these deployments were at the limit of the Mirage ferry range and through tropical weather zones with portable navigation aids, no major incidents occured.

6

ROLES AND DISPOSITION

Air Vice Marshal R.J. Boomball, AFC et al

During the Mirage era, the operational Mirage squadrons were based at Butterworth and Williamtown, with a period at Darwin from 1983 after Butterworth was reduced to one Squadron. The squadrons' roles varied over the years, and to some extent were influenced by their location. For example, the Butterworth squadrons were heavily committed to developing a burgeoning air defence system, whilst the mainland squadrons were constantly on demand for Army and Navy cooperation.

This Chapter reviews the roles and disposition of the Mirage squadrons over the years, and examines some of the peculiarities of operations at Butterworth.

The following transcript of a presentation given to the 1985 Fighter Symposium by the then Air Commodore Dick Bomball (1) deals in some detail with the way in which the Mirage was employed during its service life, and gives a view on the vexed question of multi-role versus role specialisation.

'We have now operated the Mirage for some 21 years and we are about to embark on what we hope is going to be 21 years of Hornet operation. What I propose to do in the next half hour or so is to look back over our Mirage operation, assess whether or not we made any mistakes and see if there are any lessons for the future. What I am going to say is purely my own opinion, it is based on three periods of observation spread over almost the whole span of our 21 years of Mirage operation. The first period as an air intercept and ground attack instructor at the OCU for about four years in the late sixties during the early conversion stages. The second period of two years in command of 3 Squadron at Butterworth in about the mid

seventies, and the third as OC Williamtown as we are winding the operation down. Those three occasions, each very well separated in time, have clearly indicated to me a decline in the standard of our operation and, with that wonderful gift called hindsight, I believe we did make mistakes, there are indeed very valuable lessons for the future if my assessment of where we did go wrong is correct.

What I want to do is look at three periods of the Mirage project: first of all the build up to the mature force from about 1965 to 1970 then the first five years of the seventies where some very important and far reaching decisions were made, then from about the mid seventies to the current period when other pressures came to bear on the Tactical Fighter Force.

Looking first at the sixties. The early part of the sixties was of course the twilight of the Sabre, the decision to buy the Mirage had been made, and by the mid sixties we had begun Mirage conversion training. By about the end of the decade we were approaching an established Tactical Fighter Force with four squadrons; two role-emphasised into air to air operations, and two role-emphasised into air to surface operations.

Perhaps here I should explain what I mean by 'role-emphasised'. Very simply it was a thirty percent core of common skills – air combat tactics, navigation and some weapons training – and seventy percent being the primary role which was devoted to one of two specialised roles. For example, the air to surface squadrons specialised in such things as visual and radar combat profile missions,(the latter in those days terrain avoiding down to 500 feet, in all weather, day or night), offensive air support, tactical visual reconnaissance, and photographic reconnaissance. In the air to air squadrons it was simply the whole spectrum of intercepts covering all altitudes, speed ranges, hemispheres and again in all weather. So by the early seventies the Tactical Fighter Force had reached its mature state with two squadrons at Butterworth and two squadrons at Williamtown, one being air to air and one air to surface in each location.

Deployment was now reasonably well placed, albeit not ideally to support the air defence ground environment which at that stage had a permanent unit in Sydney, later to become Williamtown, another permanent unit at Darwin and a mobile unit had returned by then from Butterworth to Amberley. So at that point I believe we had reached the zenith of our operation. In the air to air squadrons the combination of pilots and controllers was extremely proficient and could handle the whole spectrum of intercepts under just about any conditions. The air to surface squadrons were capable of mounting four aircraft combat profile missions, again in all weather, day or night, and achieved a very high standard in tactical photographic

and visual reconnaissance.

Now the applicability of some of those activities to our strategic circumstances could be argued but that is not really relevant to my point, which is simply that in a role-emphasised squadron, with the technology available in the Mirage, pilots were able to achieve an exceptionally high standard in their primary role and were exploiting the full capability of the aircraft in that role.

As we entered the seventies – we are now coming into the second period that I spoke of – things began to go wrong. Two decisions were taken about that time which were to have a very profound effect. Firstly, the disbandment of No 76 Squadron which was one of the squadrons at Williamtown, and that was a political decision taken for economic reasons; and, secondly, a decision was taken about that time to make the three remaining squadrons multi-role.

The first decision, the disbandment of a mainland squadron, was I believe tragic for our air defence ground environment. It left it high and dry with little training support. One squadron in mainland Australia to support the Navy, the Army, our own air defence ground environment, to undertake tactical visual reconnaissance and photographic reconnaissance operations and conduct associated training courses, and at the same time retain multi-role proficiency was, albeit in hindsight, simply ridiculous. The decision typifies thinking that unfortunately still exists which doesn't seem to recognize both the air defence ground environment and the tactical fighter force squadrons as integral and inextricably interdependent parts of the same weapons system.

The second decision, the decision to go multi-role, was perhaps of greater importance with more serious longer term effects. In very simple terms that decision just added another primary role to the squadrons. Nothing was dropped, there was no increase in hours. It meant that in a six month categorization period pilots had to cover the field in common core skills, the two primary roles, and in two of the three squadrons, tactical reconnaissance, visual reconnaissance and photographic reconnaissance operations as well as conducting training courses. There was simply too much to cover. In four short years we had become jacks of all trades and masters of none. The four short years simply refers to the period when I had been out of the force. I came back and the changes were very starkly apparent over that period.

The Mirage simply didn't have the technology; it's hard work to get the best out of what's essentially a manual system in two primary roles and it takes a lot of time. That meant that in order to cover the whole spectrum in a six month categorization period, you couldn't peak in anything before having to go onto the next training element. As a result, the more difficult intercept profiles

disappeared. We gradually scaled down our operations at low level in weather and at night in both roles. Tactical visual reconnaissance and photographic reconnaissance became the province of the very few recent reconnaissance course graduates. A series of unfortunate accidents occurred in the early seventies before we learnt the hard way that we could no longer operate in either role to the limits that we had previously enjoyed.

Now turning to the final period, the mid seventies to the present. What happened up to the mid seventies had simply made the Tactical Fighter Force hypersensitive to the two main problems it was to face thereafter. Firstly, reductions in flying hours. Financial constraints in the late seventies eroded flying hours until they reached the 17.5 hours per pilot per month in the last couple of years. With the already existing pressures of multi-role operations, those reductions meant that something had to give and our operating standards decreased even further. As the hours declined the accident rate increased and there is little doubt in my mind that the increased accident rate of a year or so ago was part of the problem. Finally of course, last year, we did revert back to seventy/thirty operations in favour of air to air. But it is worth noting that at 17.5 hours per pilot per month our level of achievement is still relatively low except perhaps in air combat tactics and I'll talk more about levels of achievements and minimum levels of hours later.

The second problem we faced in this latter period was reduction in pilot manning. During the seventies higher priority was given to other elements of the force. To helicopters and transport in Vietnam and to the maritime force when the Indian Ocean became important in the post-Afghanistan period. Now the effects of reducing our fighter pilot training rate were really not seen until the later seventies because in the early part of the decade we lived off the manpower of No 76 Squadron. Low pilot manning which reduced eventually to 10 to 12 pilots per squadron made squadrons hypersensitive to what were normal demands in better times. For example, deployments, and I think the classic example here is the permanent deployment at Singapore, which became a whole squadron effort rather than that of a single flight. Exercises, fleet support and all those other minor tasks also became whole squadron affairs. And so, very frequently, training was totally disrupted further compounding the deterioration in standards. Squadron supervision suffered as executives were forced to fly as line pilots. So on the eve of re-equipment with the Hornet we find ourselves with low manning, low hours, and I believe the lowest level of proficiency we have probably seen in the last 20 years of Mirage operation.

Now all of that begs the question why did we go multi-role? Well, there were several influencing factors and there was a main

rationale. I'll talk about the influencing factors first. With the decision to acquire the Cyrano 2B radar, which added a ground mapping capability to the intercept radar, all aircraft theoretically had a multi-role capability but with the very real limitation of the technology of the day. But multi-role operations became feasible. There was a school of thought that multi-role operations would be more challenging, and that's to put it perhaps charitably. I recall a senior officer who when speaking to a staff course about that period of Mirage operations made the comment that,'well we have gone multi-role, we don't seem to be operating as well but its more fun'. The idea that multi-role operations would be more challenging, in fact, I believe, came up as a result of the experience by some people particularly in the intercept squadrons in the very early days when the role had not been developed fully and in fact air combat was given very little emphasis. Those people moved up to decision-making levels and quite rightly on the experience that they had at squadron level, felt that perhaps there wasn't a full role in the intercept squadrons.

Perhaps with only one squadron in Australia with its responsibility to Army on the one hand for offensive air support, and to the air defence ground environment on the other hand for intercept support, some degree of multi- role operations with 77 Squadron here at Williamtown was inevitable. The main argument however was that a force as small as ours demanded the flexibility to respond in either role at short notice, the concept being that pilots must have a basic currency in all roles at all times. That same argument I believe forgot that a small force also demands that the pilots in any one element must remain in that element usually for their whole flying career. The result being that our fighter pilots sometimes do 2, 3 even 4 tours on end simply rotating between squadrons. I contend that that factor would have allowed us the flexibility to respond in any role at a much higher level of competence just as quickly with single role squadrons as with multi-role squadrons. For example, after full tours as a specialist in both roles a pilot could adapt to either in a few short weeks. In fact there is in existence, I believe, a Central Studies Establishment paper which showed just that. With Mirage technology, pilots could reach for example ninety percent efficiency in a primary role in a specialist squadron, falling to say sixty percent during the two year period in an alternative role. But in multi-role operations, he could never get above about fifty-five percent across the board. Now I emphasise that I am talking about Mirage technology and that those figures are illustrative, they are used only to make the point.

Why didn't multi-role operations work? What are the lessons for the future? And here I want to look first at the early part of the

seventies and then the final period. Up to the mid seventies it wasn't manning. The squadrons, to about 1975, were very well manned. It wasn't flying hours, we had 22.5 hours per month nominally, but most pilots were getting about 30 hours per month. And there is a very important point here. I believe that at the maximum end of the scale there is a level beyond which flying hours won't solve the problem. The crux of the matter is what you can cover in a six month categorization period, and in my opinion a training cycle longer than six months becomes counter-productive.

Well if it wasn't flying hours or manpower up to that point, what were the reasons? The obvious pervasive underlying factor of course was the limited technology of the Mirage, but there is a lot more to it than that. Firstly, it was the way we went multi-role. The goal was decided; that is to maintain a force capable of responding quickly in either role; but there was no analysis of how best to achieve that goal or of our capability to do so. Nobody stated the level of expertise that we were required to achieve in each facet of operations, nobody assessed how many hours that was going to take, nobody added up those hours to see if it was physically possible to achieve them in a six month categorization period. Rather, in effect, squadrons were simply given the extra primary role, the hours split down the middle and the task set to do as well as you could.

Another major factor was the Categorization Scheme; our decline unfortunately went largely unnoticed, the reason being the undermining and weakening of the Pilot Categorization Scheme. The Categorization Scheme was originally accused of driving the squadron mission by mission. As we became no longer able to achieve the missions, we took the easy way out and the scheme was gradually weakened until it became no more than a broad guide to squadron commanders. A good Categorization Scheme should do two things: it must ensure squadron commanders direct training toward what our commanders at high level require; and it must highlight to those higher level commanders when and where we are not meeting their objectives and why. From the mid to late seventies the Mirage Categorization Scheme did neither. To those who argue against a demanding categorization scheme, I suggest that if you have a clear yardstick against which to measure your shortfalls then you are able to support much more strongly your arguments for hours, manpower and weapons.

Turning now to the final period, what are the lessons? Well the latter part of the seventies to the present should have taught us something about minimum manpower and flying hour levels. Let's look at manpower first. When you reduce your manpower below that level which allows you to operate our traditional two flight system, then you cannot maintain the normal frequency of activities

such as deployments and exercises. If you try to, efficiency, training, supervision and safety have to suffer. All activities must now be supported by a whole squadron and there are just too many options in the categorization training cycle. The lesson: significant changes in pilot manning require a reappraisal of squadron tasks and roles; and there is nothing new or revolutionary about that.

Turning to flying hours. The cost of reducing from 22.5 to 17.5 hours per pilot per month can best be illustrated I believe by the circumstances which forced us last year to finally return to role-emphasised operations favouring air to air. I would summarize our capabilities then and now as a high level of skill in air combat tactics, a medium level of skill in intercepts, and a visual strike capability; across the board, all weather operations are virtually now beyond us and not possible or even practiced in the air to surface role. That situation is far short of multi-role operations and yet it really had existed for several years. The reason nothing has been done comes back to our ineffective categorization scheme.

So what of the future? Can we bound off this somewhat sagging springboard into the Hornet era or are we going to fall flat on our back-sides? Well there are a lot of things going for us. Fortunately the financial constraints that have so often been our nemisis are working to the advantage of the Tactical Fighter Force at long last. We have already deployed one of the Butterworth squadrons back to Darwin and the second one, 3 Squadron, is coming back to Williamtown next year so we will finish up with two Hornet squadrons at Williamtown and one Mirage squadron at Darwin. So that at long last the Tactical Fighter Force is back where it ought to be and that is, in Australia in support of its own air defence ground environment and in the right location to support our Army and our Navy.

In terms of force disposition therefore we are far better placed than at the same time in the Mirage program. We have also recently revamped our categorization scheme. It is vital that we make it work, and remember, it has to do those two things, guide our squadron commanders and also inform our chiefs of our capabilities and our deficiencies at all times. It should equip the high level commanders to be active rather than reactive as they have had to have been in the past in terms of command of the Tactical Fighter Force. They simply haven't had the information to tell them where we haven't been able to cut the mustard. The Tactical Fighter Force now has a high manpower priority but that build up of course is going to take a little bit of time. We have already made significant in-roads. Again, I believe there are good signs that we are going to be a lot better off in the not too distant future.

The fifth and major point in our favour is that we now have a far more capable aircraft. One which may allow us to achieve what

we failed to do with the Mirage. It would be foolish to conclude from what I've said that because we couldn't operate multi-role successfully in the Mirage we can't do it with the Hornet. They are vastly different aircraft. The Hornet represents an advance in technology of some 25 years. Now the Hornet may well be capable, but what we need to very carefully assess is our ability to exploit its potential. And by that I mean our goals must be clearly set and the guidance also must be very clear and very detailed. The required levels of achievement and proficiency have to be defined, the hours required to reach those levels must be assessed. Then if the hours aren't available or can't be achieved in a six month categorization cycle, we would then need to look at other options such as role emphasised squadrons.

The multi-role squadron option of course is not the only way to achieve a multi-role TFF. Role emphasis might be feasible with two squadrons at Williamtown, it could logically divide Army and Navy support, it might solve some of our airspace problems, but what of the Tindal squadron. Multi-role? I don't know. There is a third short term option and that could be, to coin an Australian phrase, "two bob each way". Perhaps begin the first squadron air to air or air to ground and the second the reverse and then when we develop each discipline to the full, carefully meld the two and assess what is feasible. Whatever we do, the Mirage experience suggests a need for very careful analysis before we commit, and then very rigid ongoing assessment. An effective categorization scheme should look after the latter requirement.

Finally, if I have to commit myself on the issue, I would say that we should aim to go multi-role and use the Hornet's full capability, but only if careful analysis supports the feasibility of that course. Just as it would be tragic to unnecessarily operate single role and leave unused the latent capability in the other role, it would also be foolish to go multi-role and be unable to use the full extent of Hornet capabilities across the spectrum as occurred with the Mirage. To summarize what I have said, to use a cliche, 'we should look before we leap'. The way we choose to achieve a multi-role TFF must be based on analysis not opinion. Gentlemen, I hope I've given you some food for thought."

BUTTERWORTH OPERATIONS

Throughout its life in the RAAF, the Mirage maintained an operational capability at Butterworth, Malaysia. The RAAF's presence at Butterworth from 1958 was initially by way of contribution to the Commonwealth's Far East Strategic Reserve, with air operations controlled from HQ Far East Air Force in Singapore. On 31 March, 1970, the Butterworth Air Base was formally handed over to the Malaysian Government under arrangements covering the return of British military bases. After the British withdrawal, the RAAF presence was under the auspices of the Five Power Defence Arrangement between Australia, Malaysia, New Zealand, Singapore and the UK.

On arrival at Butterworth, the two Mirage squadrons were role-specialised. 75 Squadron concentrated on all-weather air defence; 3 Squadron on strike/ground attack. At that time, 75 Squadron's IIIO(F) aircraft were painted silver and were equipped with the Cyrano IIA air intercept radar, whilst 3 Squadron's IIIO(A) aircraft were camouflaged and were equipped with ground-mapping radar, doppler and radar altimeters for all-weather, low-level penetration. 3 Squadron also configured up to two aircraft with nosecone-mounted cameras to accommodate their reconnaissance sub-role.

Late in 1969, No 75 Squadron was re-equipped with Mirage IIIO(A) aircraft and both squadrons converted to multi role. Thus, for the remainder of their time at Butterworth, the two Mirage squadrons operated in similar roles, although 3 Squadron retained the sole reconnaissance capability.

Wing Commander Bill Fitz Henry (2) is a pilot who has seen Butterworth Mirage operations over three tours, as Fighter Combat Instructor, a Flight Commander and a Squadron Commander. Below, Bill provides an overview of twenty years of fighter operations at Australia's forward air base.

"The pattern of activities for Butterworth Mirage squadrons was promulgated in the Base Six Monthly Flying Programme. This programme co-ordinated activity between all Butterworth squadrons including the RMAF units, and ensured that optimum use was made of all airspace and other common training resources. Standing commitments, such as the requirement for each Mirage squadron to alternate at Singapore for three months, the periodic IADS exercises, and air to air gunnery after the Christmas holidays, reduced the options available in much of the programming. Other roles at Butterworth included application air to ground weaponry, intercepts and air combat tactics (ACT), missile firings, and navigation and strike exercises. These exercises were programmed to meet categorization scheme requirements while achieving as much continuity as possible.

Until the early eighties, RAAF Mirages maintained a permanent presence in Singapore. This was achieved by sharing the task between the two Butterworth squadrons, generally on about a three-monthly basis. Because of this task, the two squadrons had much difficulty in generating common flying training as considerable effort was always required by one squadron to provide serviceable aircraft and pilots for the Singapore detachment; this usually took priority over Butterworth operations.

With its European heritage, the Mirage was not really designed to operate in tropical weather conditions such as at Butterworth. When taxying, airconditioning for the electronic bay was inadequate after about five minutes, and for the pilot, there was none. In the single seater, the canopy could be latched open a few inches and this provided some relief. However, the canopy for the dual was so large and heavy that the latching device was not fitted at all.

Another problem concerned weather-proofing, or lack of it. During heavy downpours, water could quite easily ingress around the many access panels and cause havoc with the electrical system. Opening the canopy after a rain shower would cause water to run down over the radar electronic boxes. Some said that Mirage serviceability was inversely proportional to the daily rainfall, and this often seemed the case. It became standard practice to seal up all the important panels at the end of each flying day by using airframe tape, and then remove it before flying the next day. But despite that, water always seemed to be able to find its way to the alternator!

Temperatures on the flight line were always in the 27-33 degrees Celcius range and cockpits were always hotter, but of course no hotter than in any Australian summer. The difference was the humidity, which was generally 80-100 per cent, but dropped off in summer to around 60 per cent.

Heat exhaustion and dehydration were ever present problems for pilots at Butterworth. The flight surgeons from 4 RAAF Hospital were always concerned for flight safety. Still, aircrew were generally well aware of the problems and paced themselves accordingly. Thankfully, all the crewrooms were airconditioned which provided some relief.

As with most tropical countries, Malaysia had considerable precipitation. Throughout the year, tropical downpours could be experienced at almost any time apart from the dry season, just after Christmas. Attempts at landing under such conditions were best avoided as generally the Ground Controlled Radar (GCA) could not "see" a Mirage in heavy rain due to its small radar size.

From the cockpit, there was not too much drama flying the Mirage in rain. The difficulty came with the landing. The front of the windscreen was made of flat plate armoured glass; on either side of that was a curved quarter panel. When flying in rain, water would stream up the front of the windscreen reducing visibility ahead to about zero. However, it was still possible to see out of the two quarter panels.

Twenty miles north west of Butterworth lie four small, uninhabited islands which were very well known to RAAF Mirage pilots. From south to north, they are Bidan, Telor, Song Song and Bunting. Those islands defined the air to ground weapons range at Song Song. The bombing target was a small raft about six feet square, painted dayglo orange. It was framed by a diamond of four white marker rafts and the whole group could be found by locating the sand spit at Song Song which pointed to them. The air to ground gunnery targets were located on the sand spit and consisted of dayglo orange banners which were strung between poles. An acoustic scoring device was used to give an instantaneous read out of hits. On the other hand, the position of a bomb impact had to be computed manually from bearing readings on the water splash which were taken from the two quadrants.

The range was nice and handy to Butterworth but was not without its problems. Malaysia has thousands of fishing boats and many of them found that the target and marker buoys provided an excellent overnight anchorage. Unfortunately, they were not designed for that and the weights would drag on the seabed altering the buoys' positions in relation to the quadrant huts.

In-flight visibility at low altitude was rarely good in peninsular Malaysia. The situation was exacerbated early in the year when the old rice crops were burnt off in preparation for the next sowing. At Song Song, the thick haze would combine with a similar colour for the sea leaving no visible horizon. This was quite a problem for high angle dive bombing.

After dropping six 25 pound practice bombs from the SUU carrier, the formation would change pattern directions for the strafing target. The attack heading of 165 deg magnetic was fairly critical. If one was too far to the right, the southern bombing quadrant picked up ricochets; if too far to the left, then the empty shell cases which were ejected overboard could hit either the boat manning the foul line or the northern quadrant hut. On a firing pass, it was essential to cease fire by the foul line (2,000 feet), and wait in the dive to see the fall of shot before hauling on six "G" to miss the ricochet envelope. During the following wing-over to downwind, one could see the ricochets splashing into the water some mile and a half down-range. The more prudent fishing boats certainly gave the area a wide berth.

High Explosive Bombing

The only weapons ranges in West Malaysia cleared for HE weapons were WSD42 Pulau Yu, a small rock island off Mersing,

and Asahan Range near Malacca. Asahan was in heavy use by the Malaysian Army, so Pulau Yu was more commonly used. The island was about 150′ wide and 500′ long, and the designated aimpoint was about 150′ from the north east tip, between two small inlets.

Sorties to Pulau Yu were normally flown as fours using a high-low-low-high profile. Each aircraft was configured with two 286 gallon external fuel tanks and two MK82 bombs on the centre line station. Unfortunately, after the first few sorties, the transits either way became rather boring as the range was some 300 nm away and our fuel didn't allow that much flexibility in mission planning. When possible, the Mirage squadron in Singapore would add interest by providing aircraft to bounce the strike. The low level run in was always a spectacle as it took in numerous tropical islands with shimmering white beaches set in clear blue waters.

One of the variations to that sortie pattern was to recover to Singapore and get a turnaround from the deployed squadron. Then a low level sortie could be flown back to Butterworth with some operational straffing at Song Song to complete the weapons practice.

IADS Air Defence Exercises

The Five Power Defence Arrangement provided the basis for the formation of the Integrated Air Defence System (IADS) headquartered at Butterworth. IADS was commanded by an RAAF Air Vice Marshal and the Headquarters comprised personnel from all the signatory countries. Each year, IADS conducted two major and four minor air defence exercises (ADEX's) in both Malaysia and Singapore. These exercises involved assigned forces based in the region, and visiting forces from the three services of the signatory nations.

Training under IADS helped develop an integrated approach to air defence in the region. The two Mirage squadrons in Butterworth, and the detachment in Singapore, played an important part in that process. Operating from both countries and in all roles, the Mirage squadrons assisted with the development of tactics and procedures for the benefit of all. The scope and complexity of the exercises increased markedly over the years, eventually reaching a scale considered large even by world standards.

One important part of IADS training was Exercise Kumpul – a no-notice recall exercise which could be activated at any hour. The broad aim was to produce the maximum number of combat-ready air defence weapons in the minimum time. Many of those who served in the two Mirage squadrons at Butterworth will cherish some memorable tales of where they were, and what happened, when Exercise Kumpul was activated.

Air To Air Gunnery

For application gunnery, a circular pattern was set up in the air to air range approximately 40 nm west of Butterworth by the tug flying an orbit at 10,000 feet. For most of the Butterworth era the tug was a Canberra detached from No 2 Squadron, Amberley. In later years, Learjets on contract from Australia performed the task.

After a few weeks of circular tow, the programme normally included a week of more exotic offerings. These included butterfly and combat banner. Butterfly required hits on both sides of the banner in the minimum time; combat banner allowed the tug to manoeuvre freely in the role of an enemy fighter.

Intercepts and Air Combat Tactics

The main training area for intercepts and air combat tactics (ACT) was the sea area to the west of Butterworth. The lack of land features was an operational disadvantage, however, noise complaints were not a problem and the average Malaysian fishing boat had no windows which could be broken. The Control and Reporting Unit (CRU) at No 1 Air Defence Centre (RMAF) helped set up and control these exercises. Initially, RAAF controllers from No 114 MCRU provided this service, but as RMAF controllers became more proficient, RAAF manning was progressively reduced to zero.

Air combat training exercises would commence with maximum performance handling sorties and work through the basic 1v1, 2v1, 1v1v1, and 2v2 missions. The more advanced 4v2, 4v4 and larger missions would follow on. Dissimilar Air Combat Tactics (DACT) training was also most important and concerned flying the Mirage against other (dissimilar) aircraft types. In Malaysia, this translated to A4 Skyhawks and Northrop F5Es.

Tengah Operations

Until late 1982, the Australian military presence in Singapore was achieved in part by basing a flight of RAAF Mirages at Tengah Air Base, with the flight being drawn from either 3 or 75 Squadron at Butterworth. Tengah Air Base was constructed before WW II by the Royal Air Force and was used by them until the early seventies as a base for Canberra, Hunter and Lightning aircraft. Thereafter, the Republic of Singapore Air Force (RSAF) based various training and fighter aircraft at Tengah including Hunter, A4S and F5E.

The RAAF Support Unit Tengah (RAAFSUTG) provided administrative and limited logistic support for the Mirage detachment and

other RAAF personnel in Singapore.

Detachments to Singapore were highly valued by our pilots and groundcrew, not only for the excellent flying operations, but also for the shopping opportunities and as a break from Butterworth. Squadron personnel were rotated through the detachment and each person could expect to stay at Tengah for about three weeks straight, although in some cases it was six.

Mirage operations in Singapore were generally limited to intercepts and ACT. Early on, intercept control was provided by RAF controllers at the Bukit Gombak radar site, and in later years by RSAF controllers from Gombak or the mobile CRU, usually situated at Seletar. There was also plenty of dissimilar ACT available with the RSAF squadrons, involving Mirage versus F5E, Hunter and A4.

Singapore had some drawbacks for flying operations. The air training areas were crowded and small. For compact execises, we were able to conduct many of our operations from Tengah to the west over the Straits of Malacca. However for multiple aircraft engagements, one had to go east to the South China Sea which meant long transits and thus reduced time for the air exercise.

Paya Lebar Operations

In October 1983, following a Singapore Government directive, the RAAF's operating base in Singapore changed from Tengah to Paya Lebar - previously the international airport. At that stage, work at Changi had progressed well enough for it to take over as the new international airport. The RAAF presence also changed from continuous to periodic and the deployment to Paya Lebar was called Exercise Churinga. Three deployments of one month were made each year; two were mounted from Butterworth by 3 Squadron (later 79 Squadron) and one from Darwin by 75 Squadron.

The change in operating base from Tengah to Paya Lebar also affected our flying operations, although the air exercise remained much the same. The training airspace to the west was no longer available and so all operations were conducted in the South China Sea. Additionally, from an air traffic control perspective, our new base was sandwiched between Tengah to the west, Changi International to the east and Seletar to the north. All flights were under positive radar control, and given tropical thunderstorms and the normal poor visibility, considerable care and good airmanship were required to effect safe formation recoveries.

Accommodation for the deployment was initially at RSAF Base Sembawang. The buildings there were old and in a poor state of repair and, despite everyones best efforts, a satisfactory standard of accommodation for all ranks was never really achieved. (One

morning, one of our troops discovered that his shaving brush had been eaten by a rat!). Consequently, there was much rejoicing in mid 1987 when hotel accommodation was adopted. The move was in preparation for future deployments by Australian-based Hornet squadrons when Butterworth would have reduced facilities and support capabilities. The Dai-Ichi Hotel off Shenton Way became our new home and this helped maintain high morale.

Cope Thunder

Exercise Cope Thunder was a major USAF exercise in the Phillipines for tactical aircraft. Mirage squadrons were fortunate to be invited to participate on three occasions. The transit across to Clark Air Force Base was made from Butterworth through Brunei airport.

In general, each flying day consisted of two main missions – one each in the morning and afternoon. Each mission required a dedicated shift of pilots as the process of briefing, flying, and debriefing could take five or six hours. Each main mission would involve between forty and sixty aircraft including F4, F15, F5, A6, T33, F111, F16, airborne early warning and air to air refuelling aircraft.

Needless to say, the training derived from these exercises was excellent, and could not be duplicated in Malaysia or Australia. Our fighter pilots gave a good account of the Mirage and themselves. In comparison with the American aircraft, the Mirage was short on radar performance and endurance. On the other hand, it was small and easy to throw around, and Aussie pilots were probably more flexible than the others. Still, the Mirage's biggest asset was it's speed which we exploited fully and which allowed us to set up many exercise kills.

End of an Era

By early 1988, preparations were in full swing at Air Base Butterworth for the repatriation of the last Malaysian-based Mirage squadron, No 79 Squadron. The squadron would ferry their ten Mirages via Paya Lebar, Bali, Darwin, and Tindal, to Woomera, where they were to be mothballed awaiting prospective purchasers. This inglorious finale certainly seemed inappropriate to those involved.

The final day came on the 3rd of May 1988, twenty one years (less two weeks) from the day they arrived. It was rainy with low stratus down to 400 feet and friends and well wishers were getting wet beneath their umbrellas as the pilots strapped in. A stab of the

finger and the Atar engines came to life. After a few minutes, eight aircraft taxied, leaving two enveloped by maintenance personnel as they tried to rectify last minute hitches. The ninth Mirage taxied, and then the tenth. The twenty minutes it took to get the aircraft from the flight line to the end of the runway saw the weather improve a little. The cloud had lifted to 1500 feet and the rain was replaced by a light drizzle.

The first aircraft rolled on full burner. As it accelerated down the runway it left behind clouds of spray and an enormous rooster tail. It was followed twenty seconds later by the second, also spraying water everywhere, and then the third, and the rest – until they were all airborne four minutes later. Silence followed while the aircraft rejoined, out of sight to the north. Eyes were straining to pick them up for their parting flypast. And then there were five dots at low level closing fast. No noise was audible as they reached the perimeter fence, spread out across the field. A further five were about two miles behind. From the ground, it was an incredible sight – transonic speed and super-saturated air produced five large balls of cotton wool – only the cockpit, radar and wing tips sticking out! They passed with a tremendous roar, almost disappearing in their own clouds as they rotated skywards. Then the low clouds snatched them away from view.

The last flypast produced a fitting spectacle for all to remember the end of the Mirage era at Butterworth."

With the introduction into service of the F/A-18 Hornet, the disposition of the RAAF fighter force changed. The Hornet was not to be based at Butterworth, but rather was to make regular deployments to that region. Hence, the RAAF's permanent fighter presence at Butterworth dating back over thirty years was to come to an end.

The Mirage withdrawal form Butterworth was staggered. In August 1983, No 75 Squadron redeployed to Darwin where it continued to operate the Mirage until September 1988. No 3 Squadron withdrew to Williamtown in March 1986 to re-equip with the Hornet. 3 Squadron's Butterworth assets reformed as No 79 Squadron from 31 March 1986 until the Squadron's disbandment in April 1988.

At Williamtown, No 2 OCU relinquished its Mirage training role from January 1985; this task being taken up by a greatly expanded No 77 Squadron. At that time, 77 Squadron comprised 505 personnel (68 officers and 437 other ranks) and operated 56 aircraft (40 Mirages and 16 Macchis). Apart from Mirage conversion training, 77 Squadron also conducted Fighter Combat Instructor and Introductory Fighter courses. In addition, 77 Squadron met its operational training commitments which included a substantial increase in Fleet Support flying following the demise of the RAN fixed wing capability.

Williamtown Mirage operations effectively ceased in June 1987 with 77 Squadron's last flight prior to re-equipping with the Hornet. From that date, only ARDU and No 75 Squadron continued to operate Mirages in Australia. 75 Squadron ceased Mirage operations in September 1988, and after ferrying its aircraft to Woomera for disposal, regrouped at the newly-opened Tindal Air Base to commence Hornet operations. ARDU continued to operate the Mirage into 1989.

Notes: (1) Air Vice Marshal R.J. Bomball, AFC –

Apr 56	Enlisted RAAF, 1BFTS Uranquinty, 1AFTS Pt Cook.
May 57	25 Sqn Pearce
Apr 58	78 Wing, Sabre Ferry II, Butterworth
Feb 61	CFS (FIC)
Jun 61	Flying Instruction, Pearce, WA.
Jul 64	FCI, 2(F) OCU
Jan 69	RAAF Staff College
Dec 69	Staff Duties, Canberra
Jan 73	CO 3 Sqn, Butterworth
Dec 74	JSSC
Jun 75	DS RAAF Staff College
Jan 78	Language Training, Point Cook
Dec 78	Air Attache, Japan
Dec 81	DORA-AF Canberra
Feb 84	OC RAAF Williamtown
Dec 86	RCDS, London
Feb 88	Chief of Air Force Development

(2) Wing Commander W.G.A. Fitz Henry –

Jan 61	Enlisted as Radio Apprentice.
Sep 66	Posted to RAAF London for flying training with the RAF on Chipmunks, Jet Provosts and Hunters.
Sep 68	Advanced flying training on Vampires and Sabres at 2OCU.
Oct 70	No 17 Mirage Course
Jan 73	No 12 Mirage FCI Course, thence FCI duties with 2OCU, 75 SQN AND 3 SQN
Jan 79	FLTCDR 3 SQN
Dec 80	Air Force Office: DPO and DGOR
Jul 86	CO 79 SQN Butterworth
Jun 88	Air Force Plans – JEPS

Annex A to Chapter 6

OPERATIONAL HIGHLIGHTS

26 Feb 64	2OCU's first Mirage, A3-3, arrived at 1640hrs escorted by Sabres and Vampires.
Sep 64	The first Mirage Experimental Conversion Course began ground lectures lasting 10 days, followed by a week on the simulator.
Jan 65	No 75SQN received its first Mirage.
20 Oct 65	FLTLT A.M. Parer delivered A3-22, the first silver painted Mirage to 75SQN.
26 Jan 66	Four 75SQN aircraft flew the inaugural Mirage flight from Williamtown to New Zealand. The configuration was 2 x 374G ferry tanks, the flight took 2hrs and 9mins.
Feb 66	Live Matra firings were conducted at Woomera by 75SQN.
15 Aug 66	76SQN officially became a Mirage unit with five aircraft on establishment.
11 Nov 66	The RAAF's first dual Mirage A3-101 was delivered to 2OCU.
15 Mar 67	The first camouflaged ground attack Mirage arrived at 2OCU.
15 May 67	75SQN deployed to Butterworth.
1 Aug 67	3SQN commenced flying the Mirage with A3-52, A3-73 and A3-107. Later in the month A3-63 arrived. SQNLDR R. Walsh and PLTOFF M. Susans flew the first 3SQN Mirage sortie.
17 Nov 67	A3-63 (3SQN) arrived back from Avalon fitted with the first radio altimeter.

23-27 Nov 67	3SQN and 76SQN deployed to Darwin for Exercise High Mars, during which they participated in 24 hour operations for the entire period. High-low sorties were flown against Canberras and Vulcans.
11 Feb 68	Five 76SQN aircraft flew to Hobart for the Hobart Regatta.
Apr 68	The first use of 1000lb bombs from the Mirage was made by members of 2OCU 11 Mirage Course.
17-26 Jun 68	76SQN and 3SQN deploy to Darwin and Tindal respectively to take part in Exercise High Jupiter, a 'war' between Tindal and Darwin. High-low strikes were shown as a most successful penetration tactic, with a pop-up at the target the most appropriate release tactic.
24 Jul 68	A3-83 (3SQN) returned to Avalon for reconnaissance camera modification.
25 Sep 68	Three live Sidewinder missiles successfully fired by 3SQN aircraft at varying altitudes and Mach numbers.
7 Nov 68	Night bombing sorties flown for the first time at 3SQN.
22 Jan 69	A3-100, the last production Mirage IIIO, delivered from Avalon and issued to 3SQN.
14 Feb 69	25 Mirages deploy to Darwin for Operation Thoroughfare – the 3SQN deployment to Butterworth.
4-13 Mar 69	All available Mirage aircraft ferried to Tengah due to resealing of the runway at Butterworth.
27 Mar 69	A3-76, the aircraft selected to undergo fatigue investigation was returned to ARDU for completion of the investigation.

5 Apr 69	3 and 75SQN at Tengah combined to form a mass formation of 32 aircraft over Kuala Lumpur to mark the departure of the King and Queen of Malaysia overseas. Formation leader – WGCDR Ted Radford (1).
1-9 Jul 69	3SQN aircraft A3-81 and A3-82 transferred to 75SQN for radar navigation training.
7 Jul 69	The pilots with the honour of being the first to fly the 77SQN Mirage aircraft were FLTLT K.I. Semmler, FLGOFF T.P. Body and FLGOFF N.J. Ford.
20 Jul 69	FLGOFF Norm Goodall (75SQN) became the first RAAF pilot to exceed 1000 Mirage hours.
12 Aug 69	Four 3SQN aircraft deploy to RAF Tengah on Exercise Tiger Rag'.
16-30 Sep 69	Williamtown pilots ferry Mirage IIIO (A) aircraft to 75SQN Butterworth and return with Mirage IIIO (F) aircraft due for conversion to IIIO (FA). With the departure of the last Mirage IIIO (A) aircraft, 77SQN reverted to the role of Air Defence until Jul 1970, when it was due to receive Mirage IIIO (A) and Mirage IIIO (FA) model aircraft.
28 Nov 69	77SQN carried out its first photo reconnaissance mission using the KA56B camera. This mission was flown by SQNLDR Treadwell in aircraft A3-79.
10 Apr 70	Visit to Butterworth by a team from ARL demonstrating their design for a tree escape harness to be fitted to the ejection seat.
27-30 Apr 70	3SQN introduced photographic and tactical reconnaissance missions into a bombing programme.
4-6 May 70	First use of the Mk82 500lb practicebomb.
3-7 Jun 70	Level bombing successfully trialled by 3SQN at 1000ft and 550K using Mk82 500lb bombs.

21 Jan 71	The first 75SQN Hash Run.
11 Feb 71	FLTLT Les Dunn set a new Tengah-Butterworth record of 24mins 13secs, beating 74SQN (RAF) by 4secs. The winning profile was: departure 500kts overhead Tengah tower, climb M.95 to FL 390, bunt to gain M1.3 at FL 340, cruise climb to FL 460, cruise half afterburner at M1.8, 600kts descent to overhead Butterworth tower.
16 Mar 71	The first Deltas airshow performance at Williamtown. The display team consisted of the following members: Team Manager and spare pilot – SQNLDR Hugh Collits, Team Leader – SQNLDR Bruce Grayson, No 2 – FLTLT John Archer, No 3- FLGOFF Chris Mirow, No 4 – FLTLT Alf Allen, No 5 – FLTLT Nick Ford, Solo 1 – WGCDR Bill Simmonds, and Solo 2 – FLTLT Dave Robson.
23 Mar 71	Ten 77SQN and four 76SQN aircraft flew to Pearce via Alice Springs. Their arrival coincided with the arrival of cyclone 'Mavis'. The rain remained and the Pearce display, with His Royal Highness the Duke of Edinburgh as the official guest was carried out below 800 feet cloud base and limited visibility due to rain.
25 Apr 71	The Deltas disbanded after a flying effort of 331 sorties for 328.4 hours flying. The Squadron had deployed a minimum of 11 Mirages to seven different locations and performed before a total estimated audience of 750,000 people.
12 Jul 71	77SQN carried out FAC controlled strikes on Singleton Range employing both low and high angle attacks. The aircraft were equipped for the first time with the SUU20A bomb carrier and BDU-25lb practice bomb.
9 Sep 71	Flying radar trail while ground mapping tried by 3SQN pilots.
19 Oct 71	3SQN 45 Degree dive bombing programme commenced after armament master switch modifications completed.

4 Dec 71	77SQN fired off its allocation of three live Sidewinder missiles. Firings were at 30,000ft, 15,000ft and 1,500ft with all three missiles scoring direct hits on their targets.
Dec 71	77SQN pilot strength was increased to 18 pilots which was necessary to fly all the allocated flying hours for the rest of the financial year.
10 Jan 72	First permanent Mirage detachment to Tengah under the ANZUK Defence System.
9-15 May 72	Exercise Top Limit was carried out. The exercise consisted of 13 Mirages from 77SQN, 12 Phantoms (1 and 6SQNs Amberley), four Vulcans from the RAF (Waddington, England), six Skyhawks from 75SQN (RNZAF) and six Canberras (2SQN, Amberley). All the squadrons operated out of Darwin except 75SQN and 2SQN which were based at Tindal.
17 Jul 72	All Mirages were grounded after an incident in Butterworth involving disintegration of a spacer in the compressor stages of an engine.
4 Sep 72	3SQN commenced air to ground strafe and 40 degree dive bombing using the new roll-in technique.
11 Sep 72	77SQN deployed nine aircraft to Townsville. The programme consisted of bombing strikes on Cordelia Rock. HE/HES 500lb bombs were used on all strikes, and the missions comprised twos and fours flying a radar navigation route ending with strikes on the rock.
Dec 72	77SQN carried out live firing of three sidewinder missiles. The three missiles were fired at target rockets launched by another of the aircraft in the section.

21 May 73	77SQN deployed 12 aircraft to Darwin for exercise Blue Denim. The exercise was planned to run in three phases: Phase one consisted of a workup series of intercepts under the control of 2CRU, Phase two comprised level HE/HES 500lb bombing strikes on Quail Island; and an air defence exercise was planned for phase three.
4 Jul 73	Another 77SQN 'first' occurred when during range missions at Saltash Range, FLTLT B.W. Turner achieved a perfect result during his mission by scoring six out of six on skip bombing and sixty hits out of sixty rounds on the straffing.
Aug 73	77SQN deployed three aircraft to Nowra to carry out live Sidewinder firings in conjunction with elements of the Weapon Research Establishment (WRE) and the RAN. In each case the missile was fired at a flare on a target being towed by a Jindivik pilotless aircraft.
20 Aug 73	During August, 77SQN flew 593 hours, the highest yet achieved by the Squadron.
24 Aug 73	76SQN disbanded.
12 Dec 73	During the early hours disaster struck 77SQN when the crewroom and change room building was destroyed by fire. Many squadron records and plaques were lost but, surprisingly, a considerable amount of historical items were salvaged.
Feb 74	77SQN formed another formation flying team for the forthcoming Anniversary Air displays during Apr 74. February also saw the squadron dispatch aircraft A3-9, A3-19 and A3-33 to Avalon to be placed in long term storage.

8-17 Jun 74	77SQN deployed ten aircraft to Townsville for Exercise Kangaroo One. This was advertised as the largest combined services exercise carried out in Australia in peace time. During this period ground attack sorties were flown as close air support with FAC control. Also a number of Photo Reconnaissance sorties were flown against targets in the Shoalwater Bay area.
22 Nov 74	Trials commenced with Mirage aircraft from 2OCU involving the LUU-2B flare.
Nov-Dec 74	A new radio procedure was introduced to limit the target aircraft's capability of determining the inbound interceptors position relative to the target. The devastation of Darwin by Cyclone Tracey caused future Mirage deployments to be cancelled in that area and Amberley was selected to be used as a deployment base for the immediate future.
24 Mar 75	77SQN began to use the 'Butterfly' air to air pattern for the first time. The exercise involved passing the target head on and obtaining hits from a right hand pass, calling the target to reverse, then obtaining hits from a left hand pass with the object being to obtain a minimum of one hit from each pass in the shortest possible time.
28 Apr 75	77SQN flew night dive bombing missions on Saltash Range for the first time.
May 75	77SQN carried out live FAC controlled bombing strikes on Beecroft Naval Range. This was the first opportunity for most pilots to use the Mk82 500lb high drag bombs.
26 May 75	3SQN flew two missions to fire four Sidewinder missiles at starshells fired by HMAS Derwent. This was the first occasion on which illuminent flares had been used as targets for RAAF missile firings.

2 Jul–8 Aug 75	77SQN deployed five aircraft to Darwin for Exercise Winter Swan which was the first visit since Cyclone Tracy. Despite the damage incurred, Darwin was still able to offer excellent domestic and operational facilities.
Oct 75	77SQN flew night dive bombing at Beecroft Range Nowra on targets illuminated by flares dropped from Navy A4 Skyhawks. It was the first use of parachute flares for Mirage night bombing.
Dec 75	The 77SQN SENGO SQNLDR N.A. Smith flew his final mission. He was the first and last SENGO to fly Mirages whilst holding down an engineering post with the squadron.
16 Feb 76	Fourteen 77SQN aircraft deployed to Amberley for exercise Summer Rain. Numerous intercept sorties were flown in an effort to polish up the operations of 114 CRU. Flying during the exercise consisted mainly of night missions with simulated kills mounting steadily against the USAF F4 Phantoms based at Williamtown. A total of 75 scrambles were ordered with only one abort.
16 Aug 76	77SQN deployed 14 aircraft to Amberley for the work up and participation in Air Defence Exercise Pacesetter. On the same day F-111C aircraft of 6SQN deployed to Williamtown to become the 'Orange Land' strike force and both units utilised the other's base facilities. Phase One was planned as an aircraft identification phase. Phase Two was conducted in the evening, with 20 missions being flown from scrambles and combat air patrols (CAP). Many missed intercepts occurred because of the realistic operational approach taken by the F-111. This highlighted the limitations of the air defence system against modern tactical aircraft. The final phase resulted in a more pleasing result. CAPs were employed to pleasing result. CAPs were

employed to enhance the early warning system and these were successful because of the excellent visibility and the requirements for F-111 to display their navigation lights on bright and flashing.

Oct 76 — 77SQN aircraft engaged in combat and intercepts against eight types of aircraft belonging to the US and Australian Navy as part of the Kangaroo 2 exercise. The highlight was the dissimilar aircraft combat tactics against the USN F-14 Tomcats. Before the programme commenced ten base pilots flew out to the USS Enterprise for a face to face briefing with F-14 aircrew. The missions flown highlighted the superiority of the Tomcat's long range kill capability, however, its vulnerability at close range against the Mirage was evident with some convincing gun kills by 77SQN pilots.

15 Oct 76 — For the final phase of Exercise Kangaroo 2, 77SQN deployed to Townsville. The role of the Mirages was that of close air support and tactical photographic reconnaissance in support of Orange forces. Most of the hours flown were in transit from Townsville to the Shoal Water Bay exercise area. The F-14 Tomcats were successfully employed as air defence for Blue forces and claimed many Mirages in transit to the exercise area.

24 Nov 76 — Two 77SQN aircraft (A3-36 and A3-73) together with one from 2OCU flew from Williamtown to Darwin as the first stage of a deployment to replenish Butterworth with aircraft that it had lost that year.

Jan 77 — A3-3, which had been in storage at Avalon since the disbandment of No 76SQN in 1973 arrived at Williamtown. The aircraft had been completely refurbished before being released from storage and had successfully passed an acceptance test flight. During an acceptance 'A' servicing a bird strike which was approximately five years old was found painted over in one of the auxiliary intakes.

8 Mar 77 — The Silver Jubilee Parade flypast before Her Majesty the Queen was held. The high speed section of the flypast was led by four F-111 aircraft followed by four Navy Skyhawk aircraft and 12 Mirage aircraft in the rear slot. Formation Leader – WGCDR Dennis Stenhouse CO 77SQN.

15-20 Apr 77 — Four 77SQN aircraft departed for Townsville for Exercise Shifting Sand. The exercise was designed to evaluate helicopter tactics against hostile fighter aircraft.

27-28 Apr 77 — Exercise War Bonnett was carried out at Williamtown between 1300 hours and 0600 hours. The exercise was run much more realistically than previous air defence exercises. The whole base was placed on a war footing, rather than just 77SQN and 3CRU. An aircraft dispersal plan was used and at nightfall base blackout procedures were observed. 77SQn defended Williamtown against F-111 aircraft from Amberley and A4 Skyhawk from Nowra.

27 Oct 77 — 77SQN deployed ten aircraft to Learmonth for Exercise Golden West.

13 Dec 77 — 21st anniversary of the first flight of the Mirage III.

14 Aug 78 — F5E Tiger 2 aircraft from the USAF Aggressor Squadron arrived to conduct dissimilar aircraft tactics against the Mirages at Williamtown.

5 Oct 78 — A3-32 and A3-101 (3SQN) arrive in Butterworth from Australia to replace A3-94 and A3-107.

15 Oct 79 — 77SQN deployed North for Exercise Kangaroo Three. Eight aircraft arrived at Rockhampton as part of the 'Blue' task force operating in the Shoalwater Bay area. Two aircraft were also deployed at the same time to Amberley to operate in the photo-reconnaissance role. Exercise flying out of Rockhampton consisted mainly of air defence, combat air patrol and close air support.

29 Nov 79 — Six 77SQN aircraft departed for Ohakea, New Zealand for exercise 'Willoh Two!' This was the first time that the Squadron had deployed Mirages out of Australia in 13 years. Flying comprised air to ground and dissimilar air combat tactics sorties against the A4 Skyhawks of 75SQN RNZAF. On 14 Dec the detachment returned via Noumea and created history by being the first Mirages to visit the French colony.

11 Feb 80 — Five 77SQN aircraft deployed to RAAF Base East Sale. The following day they overflew Melbourne in formation as part of the funeral service for Sir Richard Williams (the father of the RAAF).

2 Jun 80 — 77SQN commenced a live air to air gunnery programme. Targetting was provided by Canberra's from 2SQN but several sorties were flown against a special trial target towed behind an ARDU Mirage. The Canberra continued as the target towing aircraft for Mirage air to air gunnery until its withdrawl from service in mid 1982.

17 Jun 80 — Due to the introduction of the RAAF Analytical Maintenance Programme (RAMP) servicing policy in April the 'D' servicing was a thing of the past. These were now replaced by 'R' servicings and on 17 June FLTLT Dave Halloran 77SQN flew the last 'Post 'D' Airtest' at Williamtown. The aircraft returned from the test flight totally serviceable.

28 Jul 80 — Four A4 Skyhawks arrived from RNZAF Ohakea for a ten day detachment. The exercise code named Willoh III was a joint strike programme on Saltash Range with the Mirages and A4 Skyhawks alternating between bounce, escort and strike roles. The dissimilar tactics with the A4s continued into early August.

27 Aug 80 — Exercise Pacific Consort involved 77SQN flying air to air tactics with F-15 Eagle aircraft of the USAF, and defending the base against low level attacks from F-111C aircraft operating from Amberley.

18-18 Oct 80 — Twelve 77SQN aircraft departed for Learmonth via Alice Springs for Exercise Western Reward. Flying involved strike missions using Mk82 and laser guided bombs. It was the first time the 77SQN had used the laser guided bomb system which involved a ground-based laser designator to 'spot' the target.

26 Nov 80 — 3SQN Mirages become the first Australian aircraft to operate at Penor Air to Ground Range near Kuantan.

26 Feb 81 — Four aircraft from 77SQN and support crew deployed to New Zealand to participate in the RNZAF 'Air Force Day 1981'.

28-29 Mar 81 — SQNLDR Steve Low and SQNLDR Dave Pietsch (77SQN) took part in the Schofield Air Show. Sporting the new Diamond Jubilee red, white and blue paint scheme, the two aircraft carried out a synchronised aerobatics programme.

2 Apr 81 — Seven 77SQN aircraft deployed to Amberley for the RAAF Diamond Jubilee Airshow. The squadron contributed to the Airshow on 5 April with the opening formation flypast, synchronised aerobatics and close air support during the Mock War! The small ground crew contingent was stretched to the limit when some twelve extra Mirage aircraft from 2OCU landed at Amberley after the final flypast because of poor weather at Williamtown.

20 May 81	The flying programme ceased for almost three weeks when all Mirage aircraft were grounded due to flight control problems.
23 Jun 81	Four aircraft departed for Butterworth to replace aircraft returning for major servicings. The four aircraft returned to Williamtown from Townsville the following day however, after the Indonesian diplomatic clearances were revoked.
3 Jul 81	Aircraft A3-87 ferried from 3SQN Butterworth to Williamtown. A3-21, A3-24 and A3-31 ferried by 77SQN to Butterworth.
9-24 Sep 81	Four 3SQN aircraft deploy to the Phillipines for Exercise Cope Thunder.
15 Oct 81	Five 77SQN aircraft departed for Rockhampton to participate in Exercise Kangaroo 81. During the exercise, close air support and battlefield air defence sorties were flown as the Squadron's contribution to the war effort. Flying operations at Rockhampton also included dissimilar air combat tactics missions against American F-15 and RNZAF Skyhawk aircraft. Also during the exercise several photo-reconnaissance missions were flown.
Feb 82	The first changeover of Mirage aircraft from Butterworth for 1982 commenced when four Mirages departed for Malaysia as part of Project Mural.
9 Jul 82	Two aircraft of four ferried up from Australia were allocated to 3SQN.

26 Aug 82	77SQN deployed 13 aircraft to Learmonth via Alice Springs for Exercise Western Reward. The maintenance support party of 145 personnel departed on a RAAF B707 aircraft the following day. The initial programme at Learmonth involved a working up phase with 114CRU from Amberley. During the same phase some aircraft were flown on missions against the Army Rapier Missile teams in readiness for the next stage of the exercise. Initially many maintenance problems were encountered due to the lack of a hangar, but these were eventually overcome. The entire aircraft servicings and repairs had to be carried out on the tarmac using a large tent as a repair section and due to the lack of lighting all maintenance had to cease at nightfall.
1-9 Sep 82	Butterworth aircraft participate in a 'mini war' with 3SQN, 75SQN and 12SQN RMAF. Missions included strike, close air support and combat air patrols.
29 Jan 83	Flying was suspended for both the Mirage IIIO and IIID because of excessive pull forces and possible binding of the ejection seat actuating mechanisms.
Apr 83	Butterworth aircraft participate in Exercise Cope Thunder in the Phillipines.
Jul 83	The introduction of Fleet Support tasking began following the disbandment of the RAN Fleet Air Arm and resulted in changes in 77SQN's operations. An increase in configuration changes and message traffic (of high precedence) were two noticeable areas.

16 Sep 83 — 77SQN deployed six aircraft to Learmonth to participate in Exercise Kangaroo 83. The exercises involved air defence and tactical reconnaissance against 'Kamarian' forces. The enemy included RAAF Caribou, F-111, ARA Porter and USMC Hercules aircraft. The Squadron was joined by RNZAF Skyhawks to assist in the air defence of Learmonth and the battlefield. RAAF P3 Orions and RAN Guided Missile Frigates provided naval input with the Squadron involved in combat air patrols over designated areas.

27 Oct 83-16 Nov 83 — Six 3SQN aircraft deploy to Paya Lebar to form the first 3SQN detachments in Singapore since Nov 82.

21 Nov 83 — Minor Adex 5/83 – four Mirages were deployed to Bayan Lepas to test operations form a dispersal airfield.

16 Mar 84 — To celebrate 77SQN's 42nd birthday the Squadron staged an 18 aircraft flypast over Port Stephens and Newcastle. These aircraft constituted the Squadron's total aircraft strength less one aircraft which was at GAF undergoing an R4 servicing.

16 Apr 84 — Three Mirages deployed to Kuantan for one week. Aircraft carried out bounce sorties on Butterworth-based aircraft.

3 May 84 — All aircraft were grounded due to problems with the main undercarriage lateral jacks, which had resulted in the loss of two Australian-based aircraft within one week.

28 Jun 84 — 3SQN conducted live missile firings. This was anticipated to be the last firing of the AIM-9B missile which has been replaced by the Matra R550 (Magic).

Jul 84 — The beginning of July marked the commencement of a three month workup for Exercise Triad to be held in New Zealand in October. During the first week of July a ten aircraft ferry to Butterworth was accomplished.

20-23 Aug 84 — Butterworth aircraft participate in Major Adex 3/84. The new missile, the Matra R550 Magic, was carried for the first time in an Adex.

1 Oct 84 — 77SQN deployed to New Zealand and several Squadron records were broken before arrival at Ohakea. The number four aircraft had substantial difficulty joining his formation thus establishing the Squadron's longest rejoin (1000 miles and 1.9 hours) and the first solo crossing of the Tasman Sea by a Mirage.

24 Oct 84 — The first Matra R550 Magic missile to be fired in the RAAF was fired by CO 3SQN, WGCDR B. Wood.

1 Jan 85 — From 1 January, 77SQN assumed responsibility for operational Mirage and Macchi flying in order to allow 2OCU to re-equip with the Hornet aircraft.

17 Jan 85 — No 45 Mirage Operational Conversion course began, the first Mirage course to commence in any fully operational fighter squadron.

14 Feb 85 — 77SQN deployed eight operations flight Mirages and associated maintenance personnel to Ohakea for Exercise Willoh. The two week exercise focused primarily on dissimilar air combat tactics with participation from 75SQN RNZAF A-4 Skyhawks and 14SQN RNZAF Strikemaster aircraft. In addition some photo reconnaissance and navigation exercises were flown. Valuable lessons in all aspects of large dissimilar type formation tactics were learnt by all pilots concerned. The aircraft were redeployed to Williamtown via Auckland on 17 February, completing what the Squadron believes is the first East-West Tasman crossing by Mirage aircraft in a single stage.

6 May 85 — Six 77SQN Operational Flight Mirages were deployed to East Sale for Exercise Night Owl which was aimed at exposing Squadron pilots to night trail navigation and dive bombing techniques. HiLo strikes and application patterns were flown onto Dutson range in preparation for the night work, which was initially carried out on ground illuminated targets. Later in the exercise, night trail navigation exercises were flown to Puckapunyal range, where bombing under air dropped flares was carried out. In addition, trials using searchlights mounted on Leopard tanks to illuminate designated targets were undertaken. The aircraft redeployed to Williamtown on 17 May and the return coincided with the arrival of the RAAF's first two Hornet aircraft. The Mirage aircraft participated in a flypast to commemorate the F-18 flight from the US.

31 May 85 — Aircraft grounded because of an engine stop corrector problem with the entire Mirage fleet.

Oct 85 — The beginning of October saw twelve F15 Eagles from the USAF's 13th Air Force arrive at Williamtown from Kadena, Japan for Exercise Coral Sea. Flying against the Eagles commenced with one day of performance comparisons whilst five days were set aside for ADEX flying, and the remainder of the three week detachment was taken up with multi-ship DACT missions.

10 Nov 85 — 77SQN Operations Flight deployed to Townsville with twelve Mirages and maintenance personnel. Multi-ship strikes carrying Mk82 500lb bombs were flown using two escort aircraft to protect the bombers. The air threat consisted of a two aircraft bounce using simulated air to air weapons. Missions were made more complex by not giving leaders the navigation route details until after the pilots were strapped in. This meant that rapid and accurate in-cockpit planning was required in order to reach the target on time.

13 Dec 85 — A3-59 (3SQN) flew its last flight. It is the first Mirage to be scrapped.

20 Jan 86 — The first changeover of Mirage aircraft to Butterworth for the year commenced when five aircraft departed for Butterworth. Despite adverse weather all the way, the changeover was completed in six days.

13 Jan 86 — No 20 Fighter Combat Instructors (FCI) course commenced with six students. This course would be the last FCI course to be trained on Mirage aircraft and marked the beginning of the phasing out of the Mirage.

22-23 Jan 86 — 77SQN arrived at Butterworth with five Mirage and depart with seven aircraft as part of a changeover ferry.

10 Mar 86 — Eleven 77SQN Mirage aircraft deployed to Ohakea via Norfolk Island. Norfolk Island had to be used as Noumea was unavailable due to political problems.

26-27 Mar 86 — Last 3SQN Mirage flight.

30 Mar 86 — 3SQN returns to Australia.

31 Mar 86 — No 79SQN reformed at Butterworth with eleven Mirage III0 and one IIID aircraft, one Caribou and eleven aircrew.

May 86 — 79SQN fired 5 Matra R550 missiles.

20 Jun 86 — 77SQN deployed twelve aircraft to Darwin via Townsville. This deployment included the last Mirage – Butterworth ferry with replacement aircraft. Operations in Darwin included low level navigation sorties and simulated strikes as the primary mission, and intercepts with 2CRU as the secondary missions.

Jul 86 — No 77SQN delivered aircraft A3-25, 56, 62, 68 and 81 to Butterworth and recovered 7 Mirages to Australia.

31 Jul 86	The beginning of the wind down of Mirage operations of 77SQN began when the CO WGCDR R.A. Wilson, DFC flew aircraft A3-90 on its last mission before being dismantled for spares. The last flight of A3-90 marked the first 77SQN Mirage to be phased out in anticipation of re-equipping with Hornets in 1987.
Apr 87	3 Matra R550 missiles fired by 79SQN.
11-29 May 87	79SQN deployed to Clark AFB for Exercise Cope Thunder. The Mirages flew with the 26th Aggressor Squadron as 'Red Air'.
Jun 87	Following the discovery of cracks, wings were changed on A3-34 and 81 by No 79SQN.
9 Jul 87	During combat turnaround practice, 79SQN refuelled and re-armed a Mirage with guns and R550 in less than 10 minutes.
Aug 87	79SQN conducted HE bombing at Asahan Range – the first HE bombing on the Range since May 83. The final Butterworth HE bombing programme was conducted at Pulan Yu in Oct 87.
Nov 87	79SQN conducted the last air to air firing programme in Butterworth. Combat and Butterfly firing pattern were flown and five R550 missiles were fired at Tectonic targets towed by a Lear Jet.
Jan 88	Five 79SQN pilots returned to Australia to fly with 75SQN in the Bicentennial Australia Day Flypast over Sydney Harbour.
Apr 88	79SQN conducted DACT flying with 77SQN Hornets visiting Butterworth.
16 Apr 88	79SQN mounted a flypast comprising Mirages, F-111s, Hornets and a P3 at a parade to mark the completion of permanent RAAF fighter operations at Butterworth.

May 88	All ten 79SQN Mirages departed Butterworth via Paya Lebar, Bali, Darwin, Tindal to Woomera for long term storage. Most squadron personnel returned to Australia in late May.
30 Jun 88	79SQN disbanded.

Note: The above information has been extracted from Unit History Sheets. (2)Formation lineup:

PRISON	(3Sqn)	CLASSIC	(75SQN)
Cobra	1 Radford	Magpie	1 Taylor
	2 Owens		2 Worth
	3 Schulz		3 Goodall
	4 Roberts		4 Sweeney
Taipan	1 Wilson	Mohawk	1 Moore
	2 Smith		2 Walsh
	3 Susans		3 Bastick
	4 Fry		4 Colman
Rattler	1 Walsh	Falcon	1 Carter
	2 Bowden		2 Gregory
	3 O'loghlin		3 Langton
	4 Astley		4 Fooks
Dugite	1 Johnston	Eagle	1 Warrener
	2 DeRuyter		2 Robson
	3 Searle		3 Ring
	4 Ennis		4 Carswell
Spotter:	Jones		

7

A PILOT'S VIEWPOINT

WG CDR J.A. Smith et al

During its years in the RAAF, the Mirage IIIO became known as 'The French Lady' – this was a more apt description than most realised. Certainly, she was a good looker, with all the right curves in the right places and moving with a certain dignity and poise. But our French Lady also had some of the less celebrated traits of her Gallic counterparts. For example, the Mirage IIIO was occasionally guilty of doing things which were not entirely logical or predictable; she was sometimes moody, often spiteful and always very expensive to keep. But, in her more intimate moments, she put beyond question any debate as to her usefulness. For all her faults, she was still admired by all who met her.

Some 356 pilots converted to the RAAF Mirage during its 25 years of service, flying approximately 352 000 hours from the 116 aircraft fleet. There were at least seven RAAF pilots who logged the remarkable tally of 3 000 hours on the Mirage III (see Annex A). It would be an understatement to say that pilots of this experience level knew the Mirage intimately; even pilots with 1 000 hours on type felt that they knew the aircraft's every nuance.

Below, some of the RAAF's most experienced Mirage pilots give their impressions of the strengths and weaknesses of 'The French Lady'. The major scribe is Wing Commander Jack Smith (1), who apart from logging almost 3 000 hours on the Mirage, also qualified as a Fighter Combat Instructor, Forward Air Controller, Instrument Rating Examiner and Tactical Photographic Reconnaissance Pilot on the Mirage. During his twenty year association with the aircraft, Jack served with each of the RAAF Mirage units and held a number of associated staff appointments.

"Several fighter aircraft types have established themselves as being worthy of their own special niche in the history of The RAAF. I believe the Mirage to be one of these select few, despite the fact that in RAAF service it was never used in combat. However, for a period of over 20 years it was the RAAF's front line fighter aircraft and served the air force well during this time. Furthermore, it was a superb example of the aerodynamiscist's art and a pilot's aircraft. This is not to say the Mirage was without fault. The basic design of the aircraft had inherent limitations as well as strengths, and in the notes that follow I will give my views on the aircraft, 'warts and all'. In doing so, I must emphasize that the vast majority of my RAAF flying experience was on the Mirage, the only other fighter type I flew being the Avon Sabre. Consequently, I am in no position to draw comparisons between the Mirage and contemporary fighter aircraft of that era based on personal experience. Some opinions will be, necessarily, based on 'hearsay' from pilots of other types, plus general knowledge gleaned from reading aviation journals and books.

I was fortunate to have flown the Sabre for just over two years, gaining 585 hours on that type before starting my long association with the Mirage. In comparison to the Sabre, my initial impressions of the Mirage were its exhilarating acceleration and rate of climb in full after burner (the performance in 'full dry" power was about the same as the Sabre), and the crisp handling, particularly the rate of roll. In fact, very few aircraft could match the Mirage in roll rate, and over– controlling in roll on initial flights was common for pilots converting to type. However, once accustomed to the sensitivity in roll, the aircraft was delightful to fly, and was remarkably free of handling vices that beset many aircraft of similar performance. Overall, I consider the Mirage had better handling characteristics than the Sabre, and certainly had a nicer 'feel' built in to the fully powered flight control system.

As an example of aeronautical design, the Marcel Dassault design team excelled with the Mirage, the aircraft in clean configuration having a sparkling performance despite a relatively modest thrust/weight ratio. In evaluating the Mirage, it should be remembered that the aircraft was designed as a medium to–high level interceptor to counter the nuclear bomber threat in the European environment, the Matra R530 missile being its primary weapon, backed up by the 3Omm gunpack. In this configuration, the aircraft performed well.

However, when configured with a pair of 'supersonic' (110 gallon) tanks and Sidewinder missiles in addition to the Matra, the need for more power became apparent. In this configuration,

speeds in excess of Ml.2 and altitudes above 45,000 ft were difficult to achieve if intercept geometry required continual manoeuvering. This lack of power was also evident in the typical air combat configuration of supersonic tanks and Sidewinders only. The induced drag of the delta wing at high angles of attack would quickly cause a loss in aircraft performance if harsh combat manoeuvering was continuous.

It goes without saying that all fighter pilots always want more power from their 'mounts', regardless of how much power is available. In this respect though, the Mirage IIIO could well have done with an increase in power of about 25%. Certainly, later generations of the basic Mirage III design, such as the Mirage 50 and Mirage III NG have benefited from such an increase in power available from the ATAR 9K 50.

In the air– to– air combat role, the forte of the Mirage was its speed and relatively small size. The aircraft was best employed at high speed in co– ordinated 'hit and run' tactics, where its small frontal aspect and smokeless engine made it difficult to see until approaching missile launch range, giving it a good element of surprise. Even in their 'geriatric' years, RAAF Mirages gave a good account of themselves using such tactics against the highly regarded and manoeuverable F– 16 Falcons of the USAF in the 'Cope Thunder' series of exercises. With good GCI control and maintaining 'hair– on– fire' performance, Mirages used the element of surprise to be credited with missile 'kills' against F-16s on several occasions.

Although you could bleed-off performance and still safely fly and manoeuvre the Mirage at slow speeds and high angles of attack, such grovelling was usually restricted to an eyeball-to-eyeball gun fight against another Mirage in a 1 V 1 situation, where 'last ditch' manoeuvres were being used. In a real combat situation, such manoeuvres would, of course, leave you wide open to attack by an unseen opponent with an energy (sic performance) advantage. Furthermore, the majority of fighter aircraft in the areas of the world where RAAF Mirages operated were lower performance but more agile types, against which the use of low speed tactics placed the Mirage at a definite disadvantage.

I recall one ignominious occasion during a 2 V 4 against A-4 Skyhawks when I slowed down to try for that 'easy' guns kill. Not so! During the next two minutes I featured on more gun camera film than I had in the previous decade. Conversely, I also recall a 4 V 4 against that thoroughbred, the Hawker Hunter, during the course of which another four Skyhawks also became embroiled. By operating our Mirages as co-ordinated pairs at supersonic speed and using GCI control plus our AI radars, we were able to disorganize

the opposition, and during two very short but decisive 'hit-and-run' engagements claimed four missile kills without being seriously threatened at any time.

In the South-East Asian region, the Northrop F-5E was, perhaps, the most worthwhile Mirage adversary. Like the Mirage, the F-5E was small and difficult to see, and combined better agility with speed and acceleration which matched that of the Mirage up to about M1.1. This made it difficult to safely disengage from combat with an F-5E if the advantage was lost. The only 'next generation' fighter I had the opportunity of fighting against in the Mirage was the F-14 Tomcat, and this experience was limited to one sortie only in a multiple bogy environment. No conclusions can be drawn from such a limited exposure, but my initial impressions were that the F-14 was at a definite disadvantage if it slowed down. The wing sweeping forward gave advance warning of this happening, and at low speeds the F-14 exhibited a lethargic rate of roll. On the other hand, if kept at high speed the F-14 constituted a definite threat, being at least as maneouverable as the Mirage, but possessing better acceleration and speed.

In summary, the Mirage was a capable interceptor and an even more capable air superiority fighter. It possessed good handling characteristics throughout its entire performance envelope, but was obviously best used at high subsonic to low supersonic speeds (M0.9 - M1.3) at high level or at 450-550 KIAS at lower levels. When operated on these terms by a competent pilot, the Mirage was a formidable opponent when compared to other fighter aircraft of the same era.

Although designed as a high-level interceptor, the RAAF (as did many other Mirage III operators) also used the aircraft in the ground attack/strike role. Modifications for this role included a ground mapping radar and a doppler ground speed/drift input to the DR navigation system. The final production run of III0-A aircraft (from A3-80 onwards, plus A3-78 if memory serves me correctly) also incorporated wet leading edges which gave an extra 55 gallons of fuel.

As a ground attack/strike aircraft, the Mirage was a reasonable weapons platform, although in turbulent conditions it lacked the rock-like stability of dedicated strike aircraft types with their high wing loading. However, the origins of the Mirage III0 as an interceptor, together with its relatively small size , placed inherent limitations on payload and range when used in the strike role. Quite simply, the aircraft did not carry enough, far enough to be taken seriously as a ground attack/strike aircraft, at least not under envisaged Australian operating conditions which required an aircraft with 'long legs'. Nevertheless, the Mirage III0 operated

as a multi-role fighter for most of its career in the RAAF. No 3 Squadron even specialized in this role for a period of two years after re-equipping with the Mirage in 1967, and built up a high level of expertise in multiple aircraft radar navigation to a target area, followed by visual weapons delivery.

The variety of air-to-ground weapons in the RAAF Inventory available for Mirage usage also remained disappointingly small throughout the life of the aircraft; initially, 1000lb Mk 10 or 500lb Mk 82 bombs could be carried on the Alkan centreline bomb beam. With the delivery of the RPK-10 bomb carrier/fuel tank (itself a doubtful piece of equipment), four 500lb Mk 82 bombs could be carried - hardly an awe inspiring weapons load. Given a benign scenario, bombs could be delivered over a radius of action of about 300NM. However, in practical terms a radius of action of 150-200nm was far more realistic.

Perhaps the biggest potential advance in effectiveness came with the advent of the 'Paveway' series of laser-guided bombs, RAAF Mirages carrying two of these weapons, one on each RPK-10 carrier. Even then, RAAF Mirages never received an autonomous laser designating capability, and always had to rely on a third party to designate the target. The only other HE weapon ever used by RAAF Mirages to my knowledge was napalm, and then only briefly. I believe trial drops were made at Woomera, and I do know for a fact that BLU-27/B finned napalm was delivered from 3SQN Mirages at a fire power demonstration at Singleton Range on 30 May 1968. I was one of four pilots who participated in this unique event.

Ironically, as the Mirage approached the end of its RAAF service, an Australian designed and manufactured semi-conformal centre-line bomb rack capable of carrying 6 x Mk 82 bombs was successfully trialled on the Mirage. This rack, known as AMSER (Australian Multiple Store Ejector Rack), was built as a technology demonstrator in a project to develop a multiple store bomb rack for the F/A-18 Hornet. Had a rack such as AMSER been available ten years earlier, it may have given RAAF Mirages more credibility in the short range strike role.

If I have been harsh in my judgment of the Mirage as a strike fighter, it is simply because the aircraft was not conceived for this role in the likely RAAF theatre of operations. After having been so negative, I should mention two attributes the aircraft possessed for the strike role. Firstly, even when fully laden with bombs and tanks it exhibited a good turn of speed, and if the fuel to use afterburner was available, target approach speeds in the region of 550-600 knots were possible. Secondly, the airflow around the superbly designed airframe was smooth, and guaranteed clean stores separation from the aircraft over the full range of delivery speeds. The same could

not be said of some purpose designed strike aircraft of the same era as the Mirage III.

Allied to the strike role was the use of RAAF Mirages in the tactical photographic reconnaissance (TAC PR) role, where much of what has been said about the aircraft as a strike fighter is also applicable. Namely, the Mirage was short on range, carried few cameras, but possessed the speed necessary to give a better chance of survival in a hostile environment. In the TAC PR role, a photographic nose cone carrying a KA-56 panoramic camera designed for low level work replaced the radar nose, and in the cockpit a camera control panel replaced the radar scope and controls. Consequently, the TAC PR pilot relied on both map reading and dead reckoning to accurately navigate to the required target, which in some cases could not be acquired visually and only became apparent when the film was developed (provided the navigation was accurate). In the mid 1970s, a locally-developed modification supplemented the KA-56 with two F-95 split vertical cameras installed in a specially modified gun bay tank. This modification gave the Mirage more versatility in the TAC PR role, the F- 95 installation giving the aircraft a capability for medium level photographic coverage in addition to the low level coverage available from the KA-56. However, the lack of a gun bay fuel tank in this configuation further reduced the already restricted radius of action.

Having given my views on the various roles in which the Mirage served the RAAF, a few words about the aircraft itself and its systems would be appropriate. I have already commented that, in my view, the airframe design was aerodynamically superb, well suited to the interceptor role the aircraft was designed for, and having a low radar cross section from most aspects.

Similarly, the Mirage engine, the ATAR 9C, was also a good design, being rugged, reliable, and placing few limitations on engine handling by the pilot, particularly at medium and low levels. At high levels and low indicated air speeds, some caution in engine handling was necessary, and if incidence limitations were exceeded, a compressor stall and subsequent flame-out were a definite possibility. My own experience of this occurred when attempting to intercept a RAF Vulcan cruising at 47,000ft. The target turned toward me on the attack leg of the intercept, leaving little room to accelerate, and during the following 'snap-up' manoeuvre I quickly ran out of energy. Having 'blood in my eye' and adhering to the old adage of MMSOBGYTAST, I persisted in the manoeuvre despite the decaying airspeed (furthermore, no 'Pom' bomber pilot was going to outfox me). Approaching 45,000ft and at about 200 KIAS, the engine gave a gentle hiccup, the auxiliary intake doors flapped once, and I was suddenly in charge of a glider. The next

lesson I learned that day was the validity of the flight manual procedure which stated relight should only be attempted when below 25,000ft (it certainly didn't work at 35,000ft). The 'Pom' meanwhile, continued majestically on to the target.

The question of two engines versus one engine for fighter aircraft as a means of reducing attrition has long been a source of debate. My own RAAF flying career of almost 4,000 hours was spent entirely on single engined aircraft, and mostly on the Mirage. Although the prospect of engine failure was always at the back of one's mind, it was never the cause for any concern - it was more of an awareness that it might happen; particularly, at the start of a heavy weight take-off on a hot day, or at low level over the ocean on a winter's night. Statistics on the relative attrition rates of two engined versus single engined fighters can be contradictory. I do not place much store by these as statistics can be manipulated to 'prove' one's point of view.

However, when I look back over the life of the Mirage in RAAF service, I reach the inescapable conclusion that many of the aircraft lost following engine failure (whether due to component failure, servicing error, birdstrike, foreign object damage) could have been recovered safely had the Mirage been a twin-engined aircraft. I do not make this statement as a criticism of the Mirage, but simply as an observation. Given the opportunity, I would quite happily continue to fly single-engined high performance aircraft, although conceding that a second engine would give that extra measure of reassurance on some occasions.

In case I have given the impression that ATAR 9C was less than reliable, I again emphasize the rugged and reliable nature of this engine. Those engine failures that could be directly attributed to component failure (as distinct from failure due FOD, birdstrike, etc) were mainly due to failures in engine ancillary systems such as the accessory gear box and main fuel control unit. The basic engine design was sound and remained remarkably trouble free throughout its service life.

The combat systems, (radar, navigation and weapons systems) used on RAAF Mirages were representative of the latest technology available from European sources in the late 1950's/early 1960's. As such, the aircraft radar, navigation and weapons systems were reasonably state-of-the-art when the Mirage entered service with the RAAF in 1965, but were definitely passe by the mid-1970's when it was originally envisaged the Mirage replacement would be coming into service.

When judged against the standard of what was available in the 1970's, the effectiveness of the Mirage AI radar was limited by low power (hence low detection ranges), lack of frequency agility and

virtual lack of ECM features. These limitations generally dictated close control of the Mirage until the final stages of an intercept, and in training for operations in an EW environment it became common practice to leave the radar in standby until such time as some benefit could be assured by its use.

The weapons and navigation information available to the pilot via the gunsight heads-up display was comprehensive, the system being relatively sophisticated for a product of its era, and giving a glimpse of what was to come in the next generation of fighter aircraft. Likewise, the cockpit, although small was reasonably well designed, consideration obviously having been given to the difficulties of single pilot IFR operation. Most system controls were within easy reach and the instrument flying during all weather intercept operations relatively easy. The major deficiencies were the lack of an 'OFF flag' or other warning device to indicate a BEZU malfunction (a potentially disastrous deficiency), and the sub-standard level of cockpit lighting for night operations. Another annoying aspect, particularly by night, was the location of the radio control boxes well forward on the left hand side panel. However, the Mirage cockpit exhibited relatively functional design overall. In this regard, I recall sitting in the cockpit of the RAF Lightning fighters on several occasions, and on one occasion the cockpit of a MIG 21. My conclusion each time was that, relative to the Mirage, the Lightning and MIG 21 cockpits were ergonomic disasters.

Visibility from the Mirage cockpit was good forward of the 8 o'clock through to the 4 o'clock position. Aft of this area, visibility was poor due to the flush canopy design and delta wing. In this respect the Mirage was similar to other aircraft of its era, the majority of which suffered from lack of rearward visibility. Again, my impression after sampling the cockpits of the Lighting and MIG 21 was that the visibility from both these types was inferior to that from the Mirage.

As an air-to-air guns platform, the Mirage was an effective vehicle. The gunsight in air-to-air guns mode lacked the sophistication and ranging accuracy of the Sabre gunsight, but it was well matched to the offset 'figure of eight' harmonization pattern of the Mirage gun pack. Although this harmonization pattern was a little akin to the blast from a double barrelled shotgun, it still had reasonable bullet density at typical firing ranges, and to some degree compensated for inaccuracies in the gunsight's solution to the sighting problem, and also for deficiencies in sight handling by the pilot. Quite impressive scores could be achieved on the banner in air-to-air gunnery practice by a skilled pilot, while the inexperienced tiro could also manage to plug a few holes in the banner despite coarse sight handling. Samples of Israeli Air Force Mirage combat

film taken during the 1967 and 1972 Arab- Israeli wars certainly tend to confirm the view that 'kills' could be achieved by the Mirage despite the lack of steady target tracking.

This, then, was the Mirage as I viewed the aircraft. Admittedly, it had deficiencies in some of the roles in which it was exercised by the RAAF, but was, nevertheless, a very effective aircraft in other roles. These strengths and weaknesses merely reflected the philosophy of the design as an interceptor for the European operational scenario. The Mirage has now served for a total of 23 years in the RAAF fighter squadrons, with most remaining aircraft accumulating flying hours well in excess of what the Marcel Dassault design time originally envisaged. If nothing else, the longevity of the Mirage in service with the RAAF, and other air forces, reflects the soundness of the basic design. There is an old adage concerning aircraft, 'If it looks right, it probably is right'. The Mirage was, and still is, a beauty."

I expect that most RAAF Mirage pilots would agreed with Jack's impressions of the aircraft. When pressed for a one line summary of the RAAF Mirage experience, AVM Dick Bomball stated, 'a fine aircraft to fly, a great operational trainer, but perhaps it was just as well we never had to go to war with it.' AVM Bomball goes on to elaborate, 'the Mirage's short range and endurance and limited load carrying capability would have placed severe limitations on its operational employment. Designed, built and acquired by the RAAF as a point air defence interceptor, quite obviously the Mirage had to have severe operational limitations as a multi-role fighter. Having said that, there is no doubt that the Mirage allowed the RAAF to develop and train effectively across the broad spectrum of fighter roles particularly while we retained role-emphasised operations.'

My own impressions of the Mirage are viewed from a slightly different perspective. Although I don't have the extensive Mirage experience of the RAAF's high timers, I was fortunate to have operated some of the other front- line combat aircraft of the era - notably the F4E and F111C. This experience, which Jack Smith notes he lacks, gives an interesting basis for comparison.

In my view, the Mirage's strongest feature was its flight control system which gave an excellent 'feel' throughout the flight envelope, although there was a tendency to 'tuck' at high IAS. The control system was also very reliable, resulting in few aborted sorties. By comparison to the F4E, the Mirage artificial feel system was much more advanced, with the result that the Mirage suffered none of the out-of-control incidents that blighted the Phantom. The F111 flight control system was, of course, much later technology which performed extremely well, but at the cost of great complexity.

Perhaps the Mirage's greatest weakness was its ground performance, both take-off and landing - not to mention taxiing. The F4E and F111 had similar

combat power to weight ratios to the Mirage, yet both managed significantly better take-off and landing performance. This was primarily a function of high lift devices which Marcel Dassault deliberately left out of his Mirage design (with attendant weight saving once airborne). The designer may also have had weight in mind when he decided the marginal thermal capacity of the Mirage wheel brakes. Both the other types mentioned had vastly superior stopping power, and a hook to boot. Given these aspects of ground performance, I often felt that at the weights and temperatures at which the RAAF operated the Mirage, and bearing in mind the unreliability of the drag chute system, that runways in the order of 9 000 feet would have been justifiable for Mirage operations. As far as taxying is concerned, I am confident that there will never be another fighter aircraft built without nose wheel steering.

Squadron Leader 'Jorge' Washington (2) shares this view of the Mirage's taxying limitations as he mentions below in his treatment of some of the more practical aspects of operating the Mirage IIIO. Jorge was one of the RAAF's most experienced Mirage pilots amassing over 3 200 Mirage hours in his 17 year association with the aircraft.

"Taxying the Mirage always had a hint of being a slightly untidy affair due to the lack of nosewheel steering, and turning the 11,OOOkg plus fighter was a case of differential braking and sufficient engine power to keep her moving while under brakes. However, any doubts about the Mirage's handling on the ground were soon forgotten when the "Miracle" blasted into her element with an ear-splitting crescendo from the afterburner. With all this thunder shattering the surroundings on the outside, the cockpit noise levels were quite reasonable for the pilot, such that the ticking of the debi-meter - recording gallons of fuel used - could easily be heard above the engine noise. The debi-meter itself became the proverbial blur during take-off as it counted off fuel consumed at the rate of 60 gallons per minute in full afterburner.

Once airborne, the aircraft rapidly accelerated to its standard climb speed of 400 knots, with afterburner deselected, giving an initial rate of climb in the vicinity of 25,000 feet per minute. Other climb schedules were the maximum rate climb with full afterburner of 45Okts into 0.95 Mach, and an initial rate of climb of 50,000 feet per minute; and the 370kts/0.85 Mach climb for use when external stores such as bombs or large fuel tanks were carried.

The Mach 2 flight always proved an exhilarating experience. A maximum rate climb in a clean Mirage had you at 36,000 ft and 0.9 Mach in two and a half to three minutes from brakes release on the runway. An energy-enhancing manoeuvre involving a zero "g" bunt over the top had the Mirage through Mach 1 as the nose came

down through the horizon. Once through "the number" a gentle descent had the Mach accelerating at a pleasing rate and above 1.3 the whole airframe seemed to produce a hum. At 1.4 Mach the engine overspeed cut-in, increasing thrust by 7% and RPM by 250. The pilot could then ease out of the descent and from there it was simply a matter of holding 5OOkts and raising the nose to around plus 10 degrees and let the Mach build up, so that in just under 6 minutes and 400 gallons from sitting on the end of the runway, you would arrive at Mach 2 at 50,000 feet. I always found it intriguing that at Mach 2, you could pull full back stick and watch the big slab elevons on the Mirage sit way up high, but very little would happen apart from a meagre 3G on the G- meter, due to the shockwave blanketing the elevons.

Back in the circuit for landing, the delta wing made the Mirage handling akin to that of a laden gravel truck. The aeroplane clearly loathed anything below 3OOKTS. Plenty of back-stick was required to keep the nose up such that the hydraulic pumps working the flight control surfaces, combined with the buffetting from the high angle of attack produced a noticeable "groaning" throughout the airframe. Landing was generally a matter of getting the aircraft on the ground with reasonable haste as the high ground speed (16OKTS IAS) consumed the the remaining runway at a great rate."

The first RAAF pilot to reach 3 000 hours on the Mirage was Squadron Leader 'Bazz' Turner (3). Bazz specialised in the Tactical Reconnaissance role of the Mirage, originally under the guidance of Squadron Leader Jimmy Treadwell, and thence as an instructor throughout the remainder of his Mirage experience. Bazz was never inhibited by conventional wisdom in his approach to fighter operations. He thoroughly examined each tactic and made many innovative changes to Squadron procedures throughout his long association with the Mirage. Below, Bazz Turner sums up the significant operational characteristics of the Mirage IIIO.

Together with its contemporary, the F-lO4, the Mirage enjoys the highest minimum drag speed in comparision with all other fighters (ie.Vmin drag = 3OOKIAS), and the Mirage III possesses possibly the highest critical Mach Number (ie. Mcrit = M0.97) of all fighters.

Basically, the Mirage III could fly at transonic speed with ease and economically, without afterbunner usage. Carriage of external stores made little difference to the Mirage's Min Drag Speed characteristic. I recall numerous formations of Mirage IIIO's ferrying at 36,OOOft with 2 x 374 ImpGal external tanks and cruising at MO.95 with ease whilst F-lllC's escorting same were continuously in and out of

afterburner in order to remain with the Mirage formation.

An aircraft's Climb Schedule is an excellent indicator of Vmin drag and Vmax lift/drag ratio and the Mirage III's Climb Schedule is no exception. The clean Mirage climb is flown at 45Okts/MO.9.

The Mirage III in its Air Defence configuration possesses a wider Indicated Airspeed and Mach margin than the modern US fighters of the 1980's. The airspeed margin (ie. Max KIAS less Min KIAS) equals 6OOkts of workable speed range and the Mirage's workable Mach range was basically the whole Mach 2. The modern fighters don't like exceeding 55Okts on the deck due to serious 'birdstrike' limitations and they max out at Ml.6 to Ml.8 Mach Limit speed.

A Mirage IIIO could be controlled ballistically at lOO KIAS at less than lG. Dave Freedman may be able to comment on the Max Speed score after bugging out from a dogfight engagement. On looking back in from a 'eyes out' situation Freddo witnessed 79O KIAS reducing airspeed. Freddo now claims that Mirage IIID (dual) felt like it didn't wish to stop accelerating.

Energy conservation is critical to Mirage III performance management and unlike modern fighters, the Mirage IIIO could not climb, turn and accelerate simultaneously. In fact, during air combat the Mirage pilot had to decide on a priority basis which energy demanding manoeuvre he wished to perform next, either climb, turn or accelerate, and then fly it efficiently rather than compromise one manoeuvre to include another. This aspect made the Mirage III an acquired skill to operate as all pilots found it only too easy to lose speed during prolonged high 'G' turns.

The standing joke being that the Mirage III gets airborne (due to the curvature of the Earth) and flies on its Vertical Component of Induced Drag, with the pilot constantly wrestling with the retardation effect of the Horizontal Component of Lift.

Manoeuvering was never the Mirage III's forte and that's why it was ultimately modified into the Israeli Kfir C2 and South African Cheetah versions of recent times. The Mirage III's problem being that the elevon and pitch damper control surfaces actually dump lift to achieve adequate nose-up authority. This process effectively reduces the Mirage Wing Area from 374.5sqft to 3l4sqft: thereby increasing the Wing Loading of a clean Mirage from 53.6 lb/sqft to 63.9 lb/sqft. This siqnificant item was often overlooked in comparitive analysis with other Fighter types.

Notwithstanding the above, the Mirage IIIO is very slippery in a straight line and even a slight dive at idle power setting will cause an airspeed gain. In a steep dive the Mirage gains airspeed very rapidly, especially with afterburner selected, and the pilot finds it easy to exceed flight envelope limitations. To this end, supersonic flight in excess of a 30 degree dive is prohibited as recovery is doubtful with

speed brakes retracted (or failed).

In good hands the Mirage IIIO would acquit itself well against any adversary provided all aircrew were forced by Rules of Engagement to visually identify and confirm the threat in lieu of engaging beyond visual range with long and medium range semi-active radar homing air-to-air missiles.

The reasons for the Mirage IIIO's lethality and survivability as a Fighter weapons platform may be summarised as follows :

a. The Mirage is uncomplicated due to its 'solid wing' and technology of the day.
b. The Mirage is interfaced with a robust, reliable and forgiving engine by good marriage.
c. The Mirage is interfaced with its Forward/Rear hemisphere AAMs and on-board Cannons by simplicity.
d. The Mirage is a delight to fly by feel due to it being customised to test pilot requirements.
e. The Mirage is small and light due to the thrust availability of the day.
f. The Mirage is fast by design.
g. The Mirage is stealth by default (before the term applied to aircraft).
h. The Mirage possesses adequate systems reliability by chance.
i. The Mirage possesses adequate all round performance by conservation of energy.
j. The Mirage is illusory in its speed and direction of turn by its very.shape and planform; and
k. The Mirage possesses multiple camouflage for environmental adaptability by Aussie cunning."

Sadly, 14 pilots lost their lives flying the RAAF Mirage. By far the largest percentage of the fatalities (36%) were night related accidents; all were operating below 5000 feet in high workload situations on dark, rather than moonlit nights. However on a more positive note, all 26 known ejection attempts were successful, with one pilot successfully ejecting twice.

In the final analysis, there were 45 major accidents (Category 4 or 5) involving 47 Mirage aircraft. Forty of these accidents were Category 5 in which 42 aircraft were destroyed. The overall loss rate of the RAAF Mirage was 11.96 per 100 000 hours, slightly higher than the predicted attrition rate of 11.0. A graph of the loss rate is at Annex B, a summary of Major accidents at Annex C and a breakdown of Major accidents at Annex D.

Noteworthy is the higher than normal percentage of material failures. These data have been provided by the Directorate of Air Force Safety by courtesy of Squadron Leader J.F. Herbertson.

As a final word on the Pilots' Viewpoint of the Mirage IIIO, I could do no better than quote a recent anecdote related by Jorge Washington. "In 1986 I felt deep satisfaction that my love of the Mirage was not alone when the final Mirage Conversion Course was about to commence and the group of young fighter pilot hopefuls were asked whether they wanted to be on the last Mirage course or the first F/A-18 Hornet course - to a man they chose the Mirage!"

Notes: (1) WGCDR J.A. Smith –

No 2OCU	JAN	– MAR 67 – No 8 Mirage Cse (A/D)
No 76 SQN	APR	– JUN 67 – Air Defence
No 2OCU	JUN	– JUL 67 – No 9 Mirage Cse (G/A)
No 3 SQN	AUG 67	– JUL 70 – G/A, A/D
No 2 OCU	AUG 70	– DEC 70 – No 11 FCI Course
No 77 SQN	JAN 71	– MAY 75 – Squadron FCI
No 2 OCU	JAN 77	– FEB 77 – Mirage Refresher
HQ BUT	MAR 77	– DEC 77 – Air Staff
No 75 SQN	JAN 78	– DEC 79 – A FLT CDR

Total Mirage – 2 909 hours

(2) SQNLDR J.W. Washington –

No 2OCU	JAN	– AUG 70 – No 15 Mirage Course
No 76 SQN	AUG 70	– MAR 72 – A/D, G/A
No 75SQN	MAR 72	– MAR 74 – A/D, G/A
No 2OCU	NOV 75	– DEC 75 – Mirage Refresher
No 77SQN	DEC 75	– SEP 76 – A/D, G/A
No 3 SQN	SEP 76	– NOV 78 – A/D, G/A, P/R
No 77 SQN	NOV 78	– JAN 82 – A/D, G/A, P/R
No 2OCU	NOV 84	– Mirage Refresher
No 77 SQN	JAN 85	– MAR 87 – A/D, G/A,P/R

Total Mirage – 3 128 hours

(3) SQNLDR B.W. Turner –

No 2OCU	JAN	– JUN 69 – No 13 Mirage Course
No 75 SQN	JUL 69	– JUL 71 – A/D, G/A
No 77 SQN	JUL 71	– JUN 74 – A/D, G/A, P/R
No 77 SQN	SEP 75	– FEB 77 – A/D, G/A
No 3 SQN	FEB 77	– FEB 79 – A/D,G/A
No 77 SQN	FEB 79	– JAN 81 – A/D, G/A
HQWLM	JAN 81	– JAN 82 – Maint Air Testing
HQBUT	JAN 82	– AUG 83 – Maint Air Testing
No 3 SQN	AUG 83	– JAN 85 – A/D, G/A

Total Mirage – 3 020 hours

AIRCREW LIST

Annex A

The RAAF Mirage Story is not complete without recognition being given to those who flew the aircraft, including the RAF, RCAF, USAF, USN and USMC exchange pilots on temporary duty/posting to RAAF Mirage Units. Some RAAF test pilots did not complete the formal 2OCU Mirage Air Defence and Ground Attack Conversion Course, hence their names may not be included on the following list of graduate Mirage aircrew. Some test Pilots who completed ARDU conversions onto the MIRAGE were Greg RULFS, Terry FARQUHARSON, Mark SKIDMORE, Bob JENKINS, Gordon BROWN, Bob HOWARD and Pete SADLER. The names on each Mirage Course are in no specific sequence as they have been taken, in the main, by Barry Turner from the end of course photographs displayed at 2OCU RAAF Base Williamtown.

The Mirage Project Team Members who flew the MIRAGE in France:

Pilot's Name		Then Rank/Remarks
R.T.	Susans 'Ron'	GPCAPT, Air Attache AUSTEMBA Paris.
J.	Rowland 'Jim'	WGCDR, Test Pilot
G.W.	Talbot 'Slim'	FLTLT, Test Pilot

The Initial French Conversion Course & Project Members

F.W.	Barnes 'Fred'	WGCDR
C.	Ackland 'Col'	FLTLT
S.S.N	Watson 'Tex'	FLTLT
A.M.	Parer 'Mick'	FLTLT

The Initial MIRAGE IIIO Test Pilots at GAF (ARDU Conversion):

B.H.	Collings 'Billy'	SQNLDR
I.A.	Svensson 'Tony'	SQNLDR (RAF), A3-l Ejectee, Avalon VIC.
S.	Fisher 'Stew'	SQNLDR, Subsequently killed in RAAF F4E off Evans Head.

No 1 MIR 2OCU Crse – 7 Oct 64

E.R.	Jones 'Spike'	FLTLT
A.E.	Mather 'Mick '	GPCAPT
M.	Davis	USAF LTCOL
C.J.	Thomas 'Cedric'	WGCDR
R.J.	Liotta 'Bob'	USAF MAJ
R.W.	Bradford 'Brick'	FLTLT

No 2 MIR 2OCU Crse – 6 Jan 65

B.A.	Carter 'Bruce'	FLGOFF
R.A.	Waterfield 'Dick'	FLGOFF
I.H.	Whisker 'Whisk'	FLTLT
R.F.	Lowery 'Roodle'	FLGOFF
D.M.	Johnson 'Doug'	SQNLDR, A3-28 Ejectee, Canberra ACT.

No 3 MIR 2OCU Crse – 16 Apr 65

T.R.	Richardson 'Trev'	FLGOFF
E.J.	Walker "rrol'	FLGOFF
I.R.	Burke 'Ian'	FLGOFF
R.C.	Moore 'Dick'	FLTLT
P.J.	Scully 'Pete'	SQNLDR

No4 MIR 2OCU Crse – 23 Aug 65

G.L.	Colman 'Speedie'	PLTOFF
N.M.	Goodall 'Normie'	FLGOFF
J.D.	Edwards 'Dougwards'	FLGOFF
A.F.	Taylor 'Squizzy'	FLTLT
A.	Hodges 'Big Al'	WGCDR
R.J.	Bomball 'Dickie'	FLTLT

No 5 MIR 2OCU Crse – 3 Jan 66

T.J.	Carter 'Terry'	FLTLT
J.H.	Flemming 'Jim'	WGCDR
G.A.	Warrener 'Geoff'	FLTLT
J.W.	Hubble 'John'	WGCDR
J.L.	Ellis 'Jack'	FLGOFF, A3-46 Ejectee near Darwin.
G.C.	Cooper 'Garry'	FLTLT
A.	Karpys 'Tony'	FLGOFF, Killed in A3-43, Williamtown.

No 6 MIR 2OCU Crse – 30 May 66

R.	Slater	'Slats'	FLGOFF
O.G.	Worth	'Ogy'	SQNLDR
A.P.	Walsh	'Al'	FLGOFF
W.C.	Horsman	'Bill'	WGCDR
R.A.	Butler	'Blue'	FLGOFF
K.I.	Semmler	'Sembles'	FLGOFF
W.D.J	Monaghan	'Bill'	SQNLDR
B.J.	Sweeney	'Sweens'	FLGOFF

No 7 MIR 2OCU Crse – 29 Aug 66

P.D.	Condon	'Pedro'	PLTOFF
J.A.	Treadwell	'Jimmy'	SQNLDR
R.J.	Meissner	'The Mice'	FLGOFF, Achieved 3OOOHrs MIRAGE l4Jun86.
J.T.	Carswell	'Tassie'	PLTOFF
B.C.	Searle	'Surley Bruce'	FLGOFF
A.L.	Patten	'Andy'	USAF MAJ
J.W.	Newham	'Jake'	SQNLDR
R.J.	McGrath	'Magilla'	FLGOFF
H.A.	Collits	'Hugh,	FLTLT
D.D.	Madden	'Dwayne'	USAF CAPT

No 8 MIR 2OCU Crse – 16 Dec 66

K.J.	Mitchell	'Ken'	FLTLT
P.G.	Smith	'Pete'	FLTLT
B.A.	Wilson	'Bazz'	FLTLT
B.H.	Fooks	'Fooksie'	FLGOFF
J.A.	Smith	'Jack'	FLGOFF
J.R.	De Ruyter	'Hairy'	PLTOFF
R.N.	Kelloway	'Dickoway'	PLTOFF
B.M.	Schulz	'Bazz'	PLTOFF
T.D.	Thomas	'Trevor'	FLGOFF
R.A.	Dannatt	'Bob'	FLTLT

No 9 MIR 2OCU Crse – 10 Apr 67

V.	Drummond	'Vance'	WGCDR, Killed in A3-77 on course.
R.A.	Wilson	'Roger'	FLTLT
C.P.	Ring	'Pete'	FLTLT
D.J.	Riding	'Doug'	FLGOFF
E.A.	Radford	'Ted'	SQNLDR
M.R.	Susans	'Marty'	FLGOFF, A3-52 Ejectee, Barrington Tops.
N.A.	Naylor	'Nails'	FLTLT

N.B.	Williams	'Nobby'	SQNLDR
R.J.	Walsh	'Bob'	FLTLT
C.S.	Langton	'Langers'	FLGOFF

No 10 MIR 2OCU Crse – 7 Aug 67

F.R.	Fry	'Frank'	PLTOFF
J.S.	Back	'Stew'	SQNLDR
J.P.	Hayden	'Sniffy'	FLGOFF
R.B.	Gregory	'Dick'	PLTOFF
D.P.	Robson	'Lurch'	PLTOFF
M.	Cottrell	'Mac'	FLGOFF
P.C.	Astley	'Phil'	PLTOFF
G.J.	Ennis	'Huck'	PLTOFF
D.W.	Owens	'Dave'	FLTLT

No ll MIR 2OCU Crse – 8 Jan 68

D.W.	Bastick	'Sam'	FLTLT
B.D.	O'Loghlin	'Bol'	FLGOFF
E.J.	Myers	'Johnnie'	WGCDR, Killed in A3-37, Singapore area.
B.J.	Roberts	'Bren'	FLGOFF, A3-70 Ejectee, Williamtown.
R.V.A	Johnson	'Zip'	SQNLDR
I.S.	Parker	'Ian'	GPCAPT
D.T.	Bowden	'Dave'	FLGOFF
P.C.	Spurgin	'Pete'	FLGOFF
L.N.C	Dunn	'Les'	FLGOFF
A.C.	Turner	'Andy'	PLTOFF

No 12 MIR 2OCU Crse – 6 Jun 68

P.J.C	Wagner	'Wombat'	PLTOFF
R.D.	Phillips	'Thatch'	FLGOFF
K.J.	Doyle	'Kev'	FLTLT
R.E.	Trebilco	'Ray'	WGCDR
C.E.	Rowland	'Clint'	FLGOFF
T.C.A	Wilson	'TC'	FLGOFF
P.A.	Riddel	'Pete'	FLTLT
M.A.	Turnbull	'Murray'	SQNLDR
H.J.F	Roser	'Hans'	SQNLDR

No 10 FCI MIRAGE Crse – 19 Aug 68

T.R.	Richardson	FLTLT
R.A.	Waterfield	FLTLT
P.G.	Smith	FLTLT
C.P.	Ring	FLTLT

L.A.	Naylor	FLTLT
B.M.	Schulz	FLGOFF

No 13 MIR 2OCU Crse – 13 Jan 69

L.H.	Ferguson 'Fergie'	PLTOFF, Killed in Winjeel on Course.
T.P.	Body 'Bods'	PLTOFF
B.W.	Turner 'Bazz'	FLGOFF, Achieved 3OOOHrs MIRAGE 9Nov84.
C.B.	Mirow 'Slack Jack'	PLTOFF
D.J.	Fickling 'Dave'	FLTLT
J.W.	Alder 'Jim'	USAF MAJ
K.J.	Janson 'Ken'	WGCDR
N.J.	Ford 'Nick'	FLGOFF
C.J.	Hudnott 'Chris'	FLGOFF
J.T.	Archer 'Starch'	FLGOFF
M.A.	Lavercombe 'Kombi'	PLTOFF
B.R.	Wood 'Poodle'	PLTOFF, A3-114 Ejectee, Williamtown.
K.N.	Pyke 'Kev'	SQNLDR

No 14 MIR 2OCU Crse – 30 Jun 69

W.H.	Simmonds 'Bill'	WGCDR
P.R.	Fleischacker 'Flash'	USAF CAPT
G.A.	Kubank 'Kubes'	FLGOFF, A3-14 Ejectee, Williamtown.
N.A.	Smith 'Neil'	FLTLT
B.J.	Reynolds 'Bernie'	WGCDR
D.G.	Cassebohm 'Cass'	FLGOFF
G.F.	Morrison 'Hank'	FLGOFF
W.D.	Vandenberg 'Bags'	PLTOFF, Killed in A3-67, Williamtown.
J.M.	Edwards 'John'	FLGOFF
B.J.S	Mouatt 'Mutt'	FLGOFF
B.M.	Connell 'The Colonel'	FLGOFF
R.L.	Perry 'Ferret'	FLGOFF, A3-74 Ejectee, Darwin.
D.J.	Friedrichs 'Fried Rice'	PLTOFF, Killed in A3-50, Myall Lakes.
K.F.	Johnson 'Kage'	FLGOFF
G.A.	Thoms 'Gav'	FLTLT

No 15 MIR 2OCU Crse – 12 Jan 70

M.	Cavenagh 'Cav'	FLTLT
R.D.	Phillips 'Roger'	SQNLDR

W.G.	Richardson 'Bill'	WGCDR
K.G.	Smith 'Ken'	SQNLDR
J.W.	Washington 'Jorge'	FLGOFF, Achieved 3OOOHrs MIRAGE l4Jun86.
B.G.	Weston 'Bege'	FLTLT
A.S.	Allen 'Hoof'	PLTOFF

No l6 MIR 2OCU Crse – 11 May 70

P.G.	Nicholson 'Pete'	FLGOFF
I.R.	Wilkie 'Wilks'	PLTOFF
S.T.	Low 'Slow'	PLTOFF
P.N.	Tippett 'Pete'	FLGOFF
R.D.	Hood 'Hoodie'	PLTOFF

No 16A MIR 2OCU Crse

K.J.	Bricknell 'Brick'	FLTLT
L.R.	Klaffer 'Lovable Lyle'	WGCDR
R.V.	Richardson 'Pin'	FLTLT, A3-4 Ejectee, Avalon VIC.
J.H.	Daly 'John'	SQNLDR
M.B.	Nixon 'Nox'	FLTLT
B.G.	Grayson 'Bruce'	SQNLDR

No 11 FCI MIR Cse – 10 Aug 70

J.A.	Smith	FLTLT
L.N.	Dunn	FLTLT
P.C.	Spurgin	FLTLT
T.C.	Wilson	FLTLT
R.J.	Meissner	FLTLT
G.L.	Colman	FLTLT

No 17 MIR 2OCU Crse – 19 Oct 70

L.D.	Boyd 'Boyd lah'	FLGOFF, A3-79 Ejectee, Butterworth.
P.G.	Larard 'Pete'	WGCDR
J.R.	Jacobsen 'Jake'	FLTLT
R.G.	Heideman 'Heidi'	FLGOFF
J.S.	Puleston-Jones 'PJ'	WGCDR
C.J.	Patching 'Patch'	FLGOFF
W.G.A	Fitzhenry 'Fitz'	FLGOFF
G.P.	Keogh 'Koff'	FLGOFF
L.M.	Smith 'Lloyd'	FLGOFF, Killed in A3-85, Malaysia.
T.B.	Jacobs 'Terry'	FLTLT

No l8 MIR 2OCU Crse – 15 Feb 71

W.A.	Evans 'Bill'	FLGOFF
I.R.	Bailey 'Bails'	FLTLT
G.R.	Gent 'G Squared'	FLTLT
A.P.	Ford 'Tony'	FLTLT
P.J.	Criss 'Pete'	PLTOFF
K.J.	Tuckwell 'Ken'	WGCDR
M.E.	Ryan 'Mike'	USAF CAPT
J.W.	Kindler 'JK'	PLTOFF, Ejectee A3-98 Malaysia, A3-82 near Nowra.
I.C.	Watson 'Watto'	FLTLT
G.R.	Lee 'Spike'	FLGOFF, A3-47 Ejectee, Williamtown.

No 19 MIR 2OCU Crse – 10 May 71

P.R.	Nuske 'Nusk'	FLGOFF
D.J.	Leach 'Leachy'	FLTLT
B.A.	Brown 'Bomber'	FLGOFF
S.S.	Welsh 'Shane'	FLGOFF, Achieved 3OOOHrs MIRAGE 28Sep87.
M.A.	Lahy 'Matt'	FLTLT
E.A.	Turner 'Ted'	GPCAPT
J.T.	Owens 'Joe'	SQNLDR
D.A.	Robertson 'Robbie'	SQNLDR
R.J.	Chaplin 'Chappers'	FLGOFF, Achieved 3OOOHrs MIRAGE 4Feb87.

No 20 MIR 2OCU Crse – 12 Aug 71

R.J.	Conroy 'Con'	FLTLT
D.A.	Pietsch 'Peachy'	PLTOFF
R.B.	Treloar 'Trudy'	FLGOFF
J.	Lynch 'Jack'	FLGOFF
R.G.	Warne 'Ross'	FLGOFF
D.G.	Stenhouse 'Stinky'	SQNLDR
J.T.	Rothwell 'Jim'	PLTOFF
I.R.	Thompson 'Tommo'	FLGOFF

No 21 MIR 2OCU Crse – 13 Sep 71

J.W.	Sexton 'The Wreck'	FLTLT
A.W.	Titheridge 'Tith'	FLTLT
M.R.	Tardent 'Tardo'	FLGOFF
T.	Walsh 'Tom'	USAF CAPT
C.L.	Mills 'Chris'	FLTLT
B.A.	Robinson 'Robbo'	FLGOFF
J.A.	Simmonds 'Simmo'	FLGOFF

K.	Dale 'Ken'	FLGOFF, Killed in A3-109 near WLM.

No 22 MIR 2OCU Crse – 17 Jan 72

P.	Fairbrother 'Pete'	FLTLT
I.	Gonsal 'Gonz'	FLGOFF
S.J.	Fenton 'Stan'	FLTLT
N.A.	Furber 'Furberger'	FLGOFF
W.	Scott 'Bill'	FLTLT

No 23 MIR 2OCU Crse – 10 Apr 72

J.	Ward 'Wardo'	FLGOFF
L.J.	Evans 'Strop'	PLTOFF
D.C.	Freedman 'Freddo'	FLTLT
D.P.	MacNeall 'Mac'	PLTOFF
T.R.	Jones 'Pejabit'	PLTOFF
D.J.	Dunlop 'Dave'	FLGOFF

No 24 MIR 2OCU Crse – 1 Jul 72

0.	Stickels 'Sticks'	PLTOFF
M.	Hayler 'Mark'	FLGOFF
S.	Groom 'Stan'	FLGOFF, Killed in A3-18, Gloucester.
W.N.	Higgenbotham 'Higgy'	PLTOFF, Achieved 3OOOHrs MIRAGE 8May85.
R.	James 'Rhys'	FLGOFF

No 12 FCI MIR Crse – 8 Jan 73

M.B.	Nixon	FLTLT
W.G.	Fitzhenry	FLTLT
B.J.	Mouatt	FLTLT
B.G.	Weston	FLTLT
G.R.	Lee	FLGOFF

No 1 Short Mirage Cse – Mar 73

P.J.	Hackett 'Pidge'	SQNLDR
N.C.	Cameron 'Neil'	FLTLT
G.L.	Bourman 'Graham'	FLTLT

No 25 MIR 2OCU Crse – 18 Jun 73

R.A.	Clark 'Roger'	FLTLT
W.	Nesbitt 'Bill'	RCAF CAPT
R.P.	Thoroughood 'Herbie'	FLGOFF
P.	Kelly 'Perry'	PLTOFF, Killed in A3-26 Butterworth.

A.A.	Page	'Al'	SQNLDR
K.F.	Clarke	'Clak'	FlTLT
W.E.	Guy	'Weg'	FLGOFF

No 26 MIR 2OCU Crse – 11 Sep 73

E.	Fice	'Egg on Face'	FLGOFF
C.	Richards	'Chris'	FLTLT
G.R.	Ryan	'GR'	FLGOFF
D.	Halloran	'H Ran'	FLGOFF, Achieved 3OOOHrs MIRAGE 310ct85.
H.F.	Freeman	'Fred'	WGCDR

No 27 MIR 2OCU Crse – 14 Jan 74

L.M.	Gordon	'Leroy'	FLGOFF
W.M.	Johnson	'Wide Body'	FLGOFF
F.	Atkins	'Frank'	PLTOFF
W.G.	Pearcy	'Bill'	WGCDR
R.B.	Haack	'Rhone'	FLGOFF
J.	Fauske	'Foreskin'	USAF CAPT

No 13 FCI MIR Crse – 22 Jun 74

G.P.	Keogh	FLTLT
P.R.	Nuske	FLTLT
B.A.	Robinson	FLTLT
I.C.	Watson	FLTLT
C.B.	Mirow	FLTLT

No 28 MIR 2OCU Crse – 11 Nov 74

B.M.	Hartwich	'Brucewich'	FLTLT
P.F.	Devine	'Device'	FLTLT
P.	Kaye	'PK'	FLGOFF

No 29 MIR 2OCU Crse – 20 Jan 75

P.G.	Webb	'Spider'	FLGOFF
E.J.	Parker	'JP'	PLTOFF
A.R.	Begg	'Al'	FLGOFF
P.J.	Becker	'Phil'	FLGOFF
B.A.	Johnson	'Tart'	PLTOFF

No 30 MIR 2OCU Crse – 19 May 75

M.R.	Hurmann	'Mal'	FLGOFF, A3-61 Ejectee, Butterworth.
L.G.	Clayton	'George'	FLGOFF
H.N.	Burlinson	'Burls'	FLGOFF
J.F.	Herbertson	'Herbie'	FLTLT

No 14 FCI MIR Cse – 19 Jan 76

L.J.	Evans	FLTLT
R.B.	Treloar	FLTLT
W.E.	Guy	FLTLT

No 31 MIR 2OCU Crse – 9 Feb 76

A.M.	Parer	'Mick'	WGCDR
W.	Zimmerman	'Wes'	USAF CAPT
G.W.	Neil	'Graham'	WGCDR
J.W.	Carr	'Truckie'	PLTOFF, A3-75 Ejectee, East Sale.
W.D.	O'Grady	'Grades'	FLGOFF

No 32 MIR 2OCU Crse – 19 Jul 76

B.P.	Crowhurst	'Crow'	FLGOFF, A3-94 Ejectee, Butterworth.
R.	Ambler	'Killer'	PLTOFF
D.G.	Stenhouse	'Stinky'	WGCDR, Also No.20 MIR 2OCU Crse.
J.F.	McCormick	'J Mac'	PLTOFF
G.D.	Shepherd	'Shep'	FLGOFF, A3-l14 Ejectee, Williamtown.
B.A.	Austin	'Bruce'	PLTOFF

No 33 MIR 2OCU Crse – 2 Jan 77

G.	Sheehan	'Geoff'	PLTOFF
S.C.	Trestrail	'T-Tail'	PLTOFF
J.N.	Blackburn	'JB'	PLTOFF
R.	Veneziani	'V8'	PLTOFF

No 34 MIR 2OCU Crse – 6 Jul 77

P.J.	Proctor	'JP'	FLGOFF
T.J.	McCormick	'T-Mac'	PLTOFF, A3-76 Ejectee, Edinburgh.
R.J.	Fox	'Foxy'	FLGOFF
A.C.	Adkins	'Bograt'	PLTOFF
A.B.	Buttenshaw	'Butts'	FLGOFF

No 35 MIR 2OCU Crse – 16 Jan 78

S.A.	Bihary	'Berhenti'	PLTOFF
B.	Durieu	'Harvey'	PLTOFF
K.	Beach	'Beachy'	FLTLT
T.J.	Absolon	'Jabs'	FLTLT
C.L.	Mitchell	'The Dude'	PLTOFF

I.	Cobb 'Cobby'	FLGOFF
C.C.	Matters 'Chris'	PLTOFF

No 36 MIR 2OCU Crse – 3 Jul 78

J.F.	Barden 'Jimbo'	FLGOFF, A3-105 Ejectee, Darwin.
G.W.	Rudolph 'Greg'	USAF CAPT
H.R.	Champness 'Hugo'	FLGOFF

No 16 FCI MIR Crse - 17 Aug 78

L.G.	Clayton	FLTLT
R.A.	Clark	FLTLT
D.A.	Pietsch	FLTLT

No 37 MIR 2OCU Crse - 15 Jan 79

N.G.	Alexander 'Country'	PLTOFF, A3-80 Ejectee, Williamtown.
R.A.	Hiser 'Dick'	PLTOFF
R.J.	Douglas 'Rod'	FLGOFF
R.J.	Waugh 'Dick'	FLGOFF
B.A.	Devenish-Meares	PLTOFF

No 38 MIR 2OCU Crse - 2 Jul 79

G.C.	Standen 'Stando'	FLTLT
M.	Compton 'Mark'	PLTOFF
B.G.	Van Eyle 'BVE'	FLGOFF
C.	Wilson 'Craig'	FLGOFF
G.R.	Butterworth 'Butts'	PLTOFF, A3-58 Ejectee, Williamtown.

No 39 MIR 2OCU Crse - 14 Jan 80

G.	O'Brien 'Gerry'	PLTOFF
A.G.	Larad 'Gus'	PLTOFF
B.J.	Kelly 'Kelz'	PLTOFF
P.G.	Bishop 'Bish'	PLTOFF
E.J.	Batten 'Bats'	PLTOFF

No 4O MIR 2OCU Crse - 19 Jan 81

D.J.	Willcox 'Willox'	FLGOFF
C.R.	Wylie 'Smiley'	FLGOFF, Killed in A3-29, Townsville.
L.	Knox 'Les'	FLTLT
B.J.	Voysey 'Bernie'	FLGOFF
J.T.	O'Halloran 'JOH'	FLGOFF, A3-69 Ejectee, Tengah Singapore.

E.J.	Groeninger 'Ed'	USAF CAPT
D.W.	Hume 'Rhino'	FLGOFF
B.T.	Wiley 'Slug'	PLTOFF
C.	Simmonds 'Cliff'	PLTOFF, Killed in A3-32, Butterworth.

No 4l MIR 2OCU Crse - 13 Jul 81

I.R.	McKay 'Mook'	FLTLT
D.S.	Lambert 'Scrote'	PLTOFF
B.G.	Van Donkelaar 'BVD'	FLGOFF
P.C.V	Frawley 'Frawls'	FLTLT

No 42 MIR 2OCU Crse - 18 Jan 82

M.D.	Binskin 'Binney'	RAN SBLT
B.D.C	Siciliano 'Bob'	FLGOFF
R.F.	Lea 'Rick'	FLTLT
P.J.	Batten 'Snake'	FLTLT, A3-95 Ejectee near Williamtown.
E.P.	Brackenreg 'Bracks'	PLTOFF
D.W.	Princehorn 'Sonic'	PLTOFF
B.A.	Wilson 'Bazz'	SQNLDR, Also No.8 MIR 2OCU Crse.
P.C.V	Frawley 'Frawls'	FLGOFF, Also No.41 MIR 2OCU Crse.

No 18 MIR FCI Crse - 15 Jun 82

B.P.	Durieu	FLTLT
J.F.	Barden	FLTLT
S.C.	Trestrail	FLTLT
R.A.	Hiser	FLGOFF
B.J.	Kelly	FLGOFF

N0.43 MIR 2OCU Crse - 17 Jan 83

K.W.	Dybing 'Muff'	FLGOFF
R.K.	Coleman 'Dick'	FLGOFF
F.J.	Haes 'Fred'	FLGOFF
A.J.	Qaife 'JQ'	PLTOFF, A3-36 Ejectee, Darwin.
K.W.	Rushworth 'Krusha'	FLTLT
M.A.	Gardner 'Murray'	FLGOFF
P.L.	Rim 'Paul'	FLGOFF, Killed A3-30 Townsville.

No 44 MIR 2OCU Crse - 11 Jul 83

P.L.	Barfield 'Barf'	FLGOFF

S.L.	Goodier 'Otto'	FLGOFF
M.G.	Pearsall 'Purse'	FLGOFF
I.W.	Davidson 'Davo'	FLGOFF, Killed in A3-89 near Darwin.
W.F.	Henman 'Bill'	FLGOFF
R.D.	Witman 'Bacchus 2'	FLGOFF
K.B.	Sullivan 'Sully'	USN LT
A.C.	Combe 'Kombi'	PLTOFF
J.C.	Hunter 'Kip'	USAF CAPT

No 19 MIR FCI Crse - 16 Jan 84

P.G.	Bishop	FLTLT
M.D.	Binskin	FLTLT
R.A.	Veneziani	FLTLT
A.G.	Larard	FLTLT

No 45 MIR 2OCU Crse - Jul 84

J.P.	Conlan 'JP'	PLTOFF, A3-105 Ejectee, Darwin.
M.E.	Hupfeld 'Melz'	FLGOFF
L.	Champagne 'Lyn'	USMC CAPT
M.A.	Evans 'Ma'	FLTLT
N.J.	Pierson 'Mole'	PLTOFF
S.	Riley 'Steve'	RAF FLTLT
P.R.	Elliot 'Philbo'	FLTLT
N.S.	Hughes 'NSU'	FLGOFF

No 46 MIR 2OCU Crse - 21 Jan 85

G.P.	Mahoney 'Greg'	PLTOFF
P.J.	Hutchinson 'Hutch'	PLTOFF
S.A.	Last 'Shark'	FLGOFF
M.P.	Frohlich 'Milo'	FLGOFF
J.T.	Lonergan 'Lono'	PLTOFF
N.J.	French 'Nev'	SQNLDR
C.D.	Mackelmann 'Craig'	PLTOFF, Killed in A3-40 near WLM.
M.W.	Buddery 'Marty'	FLTLT
M.S.	Maher 'Mick'	FLTLT
J.N.	Eaglen 'Jim'	FLGOFF
M.F.	Edwards 'Fish'	PLTOFF
R.J.	France 'Mondo'	FLGOFF

No 47 MIR 2OCU Crse - Jul 85

B.M.	Heslin 'Bren'	FLGOFF
K.J.	Smith 'Smithy'	PLTOFF

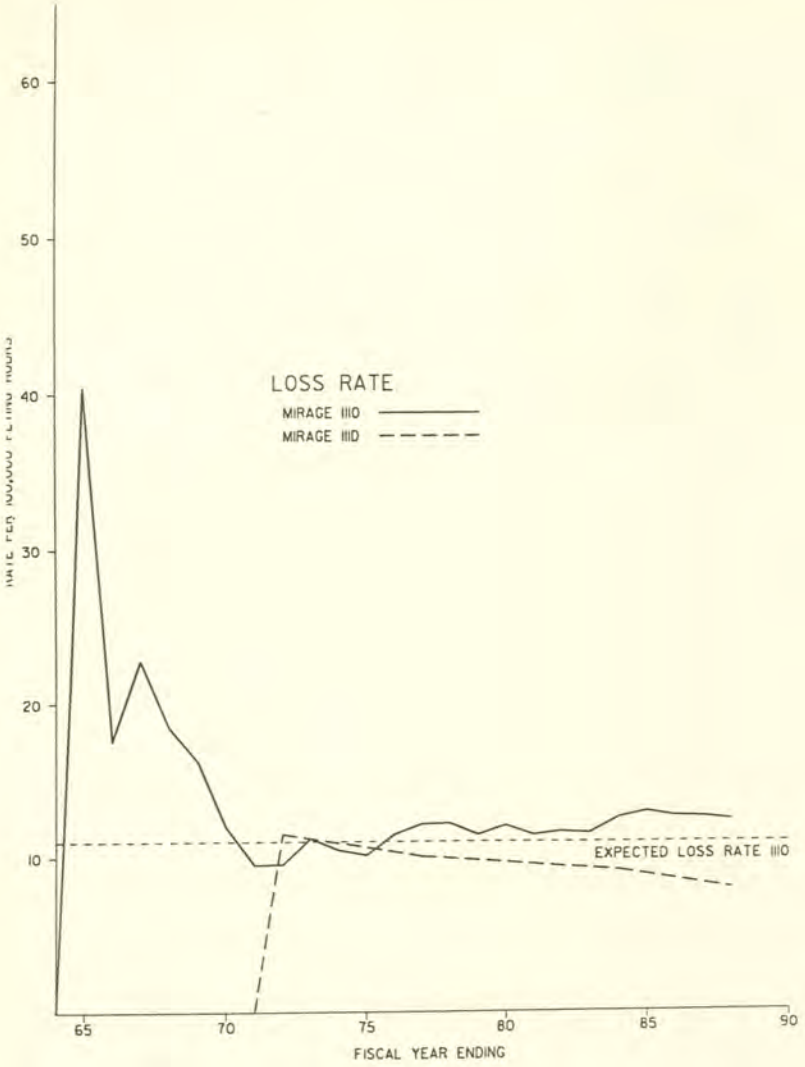
G.S.	McKenzie 'Bazza'	PLTOFF
S.D.	Miller 'Scott'	PLTOFF
R.M.	Jeffreys 'Rick'	PLTOFF, Killed in F/A-l8.

No 20 FCI MIR Cse - 13 Jan 86

M.A.	Gardner	FLTLT
P.J.	Batten	FLTLT
B.G.	Van Donkelaar	FLTLT
M.S.	Maher	FLTLT
K.W.	Rushworth	FLTLT
A.J.	Quaife	FLTLT

No l/86 MIR 77SQN Crse

A.G.	Allen 'Shabba'	PLTOFF
N.C.	Hart 'Nev'	FLGOFF
R.K.	Porteaus 'Loop'	FLGOFF
G.K.	Todd 'Toddy'	FLTLT
R.	Vadiveloo 'Renga'	FLTLT
D.	Wong 'Danno'	FLGOFF



Annex E

No 3 Squadron

WGCDR	V.	Drummond, AFC	02 Feb 67	Williamtown
SQNLDR	E.A.	Radford (T)	22 May 67	"
WGCDR	J.W.	Newham	03 Jul 67	"
WGCDR	E.A.	Radford	11 Oct 68	"
WGCDR	P.J.	Scully	24 Dec 70	Butterworth
SQNLDR	K.J.	Bricknell (T)	20 Dec 72	"
WGCDR	R.J.	Bomball, AFC	10 Jan 73	"
WGCDR	D.W.	Owens	09 Dec 74	"
WGCDR	R.J.	Phillips	05 Jan 76	"
SQNLDR	R.J.	McGrath (T)	18 Dec 76	"
WGCDR	B.G.	Grayson	14 Mar 77	"
WGCDR	K.J.	Bricknell	07 Mar 79	"
WGCDR	R.B.	Gregory, AFC	16 Jun 81	"
WGCDR	R.J.	Conroy	10 Aug 83	"
WGCDR	B.R.	Wood	12 Jun 84	"

No 75 Squadron

WGCDR	C.G.	Thomas	13 Feb 64	Williamtown
WGCDR	J.H.	Flemming, DFC	26 Apr 66	"
WGCDR	E.J.	Myers	21 May 68	Butterworth
SQNLDR	A.F.	Taylor (T)	19 Mar 69	"
WGCDR	S.S.N.	Watson	28 Apr 69	"
WGCDR	J.S.	Puleston-Jones	17 Apr 71	"
WGCDR	H.J.F.	Roser	08 Jan 74	"
WGCDR	A.M.	Parer	16 Jul 76	"
WGCDR	D.T.	Bowden	12 Jul 78	"
WGCDR	B.G.	Weston	26 Jun 80	"
WGCDR	R.J.	Conroy	14 Apr 82	"
WGCDR	P.D.	Condon	12 Aug 83	Darwin
WGCDR	W.A.	Evans	12 Aug 85	"

No 76 Squadron

WGCDR	W.C.	Horsman, DFC	21 Feb 66	Williamtown
WGCDR	D.M.	Johnston (T)	01 Apr 66	"
WGCDR	W.C.	Horsman, DFC	15 Aug 66	"
SQNLDR	J.A.	Treadwell	04 Dec 68	"
WGCDR	K.R.	Janson	07 Jul 69	"
SQNLDR	J.S.	Back, AFC (T)	04 Nov 70	"
WGCDR	P.J.	Larard	07 Apr 71	"
SQNLDR	J.T.	Owens	07 Dec 71	"

WGCDR	N.B.	Williams	14 Dec 71	"

No 77 Squadron

SQNLDR	J.A.	Treadwell	30 Jun 69	Williamtown
WGCDR	W.H.	Simmonds	30 Nov 69	"
WGCDR	R.W.	Bradford	01 Jan 72	"
WGCDR	R.V.A.	Johnston	12 Feb 73	"
WGCDR	A.F.	Taylor	02 Jan 75	"
WGCDR	D.G.	Stenhouse	14 Dec 76	"
WGCDR	L.A.	Naylor, DFC	07 Dec 78	"
WGCDR	G.R.	Gent	04 Mar 81	"
WGCDR	M.R.	Tardent, DFC (T)	03 Mar 83	"
WGCDR	A.W.	Titherridge	01 Aug 83	"
WGCDR	R.A.	Wilson, DFC	05 Aug 83	"

No 79 Squadron

WGCDR	B.R.	Wood	31 Mar 86	Butterworth
WGCDR	W.G.A.	FitzHenry	22 Jul 86	Butterworth

No 2 Operational Conversion Unit

WGCDR	F.W.	Barnes, DFC, AFC	30 Oct 63	Williamtown
WGCDR	A.	Hodges, AFC	04 Jun 65	"
SQNLDR	J.W.	Newham (T)	06 Jul 65	"
WGCDR	A.	Hodges, AFC	26 Apr 66	"
SQNLDR	E.R.	Jones	28 Apr 68	"
WGCDR	R.E.	Trebilco, DFC	09 Sep 68	"
WGCDR	W.G.M.	Richardson	28 Jun 70	"
WGCDR	K.J.	Tuckwell	30 Jun 71	"
WGCDR	H.F.	Freeman	21 Jan 74	"
WGCDR	G.W.	Neil, DFC	01 Jul 76	"
WGCDR	R.A.	Waterfield	20 Dec 77	"
WGCDR	T.R.	Richardson	08 Jan 80	"
WGCDR	M.B.	Nixon	07 Jul 82	"

8

AN ENGINEER'S VIEWPOINT

GROUP CAPTAIN G. GRANTHAN

RAAF Engineer involvement with the Mirage started when the Air Staff Requirement (ASR) for a fighter aircraft to replace the Avon Sabre was issued in the late 50s, and continued until the aircraft's disposal in 1988. This account of the engineering history of the RAAF Mirage has been compiled by Group Captain Greg Grantham (1), with a little help from some of the many Engineering Officers who so ably ensured the airworthiness of the Mirage III during its long history with the RAAF. Group Captain Grantham was a Flight Lieutenant Engineer with the Mirage Specification Team that went to Paris in January 1961.

"The capabilities and technology of the Mirage aircraft and its equipment were a considerable improvement on those of the Sabre. The associated mobile aircraft flight simulator built by LMT was also of advanced design. In engineering terms, the RAAF had acquired an aircraft with supersonic capability, a modern engine and afterburner, complex and innovative flight control systems and the latest in weapons, radio, radar, instruments, electrics and support equipment. Many of the systems were integrated and, for the first time, aircraft tradesmen were required to gain an understanding of technologies across traditional trade barriers. New technologies introduced with Mirage included transistor-based electronics, printed circuit boards, fly-by-wire flight control, auto stabilisation, an integrated fire control system and the first automatic test equipment (ATE) (for Auto-commande). This upgrading of technology in turn affected a wide range of engineering responsibilities including manning levels, training standards, technical skills, technical facilities, spares assessing and maintenance policies. Manufacture and assembly of a major part of

the aircraft and engine in Australia also introduced new engineering skills and techniques to industry. The Commonwealth Aircraft Corporation (CAC) was to be responsible for the engine, wings and fin while the Government Aircraft Factories (GAF) would make the fuselage and be responsible for final assembly and testing.

Introduction of the Mirage came at an awkward time for the RAAF Engineer Branch. A major re-organization involving a move of policy staff to Canberra and a new command structure was introduced in 1960-61. This made communication between policy staff in Canberra and the bulk of the engineering and maintenance staff in Melbourne more difficult at a time when new policies for Mirage maintenance, spares assessing, and the division of work between Industry and the RAAF were being formulated. However, by early 1962 most major operational and technical policy decisions had been made, and the aircraft was reasonably well defined. Attention was being directed more towards processing aircraft and equipment modifications, and planning new technical facilities, spares assessing, training and publication needs. An added complication at this stage was the need to provide French language training and translation facilities for members training or working in France. For example, over 50 Engineer Officers and Airmen undertook French language training courses of various lengths at the RAAF School of Languages Point Cook before leaving for France. Many other RAAF personnel were involved in spares assessing and publications vetting in France for varying periods.

Lack of firm technical data (including NATO codification of components) was a problem with initial spares assessing and delayed the ordering process. At this time the RAAF Assessment Code (RAC) system had just been introduced and it proved an invaluable aid to Mirage spares assessing and procurement as it was the only stable identifier of a part. This code was the forerunner of the Technical Management Code (TMC). It became evident early in the project that the French aeronautical industry had a poor appreciation of the logistics needed to provide an adequate life of type support service for the aircraft and its weapons systems in Australia. This, coupled with the language difference, made logistic planning very difficult until RAAF requirements became more widely known and accepted by the French. Delays were also encountered in the preparation, translation and verification of technical publications, mainly because the data required was more comprehensive than that usually supplied to customers by the French Aeronautical Industry. Fortunately, much valuable data was obtained unofficially by officers and technicians during their training and this allowed maintenance to proceed in the absence of officially approved publications. The presence of Field

Service Representatives (FSRs) from French companies helped to compensate for the initial lack of technical data and spares, for FSRs usually had direct access to their companies and factory servicing data, and had a range of 'suitcase spares' in their possession. Nevertheless, most major publications were received by the end of 1965 and arrangements for the continuing update of drawings and associated data, by GAMD, had been covered in contractual documents.

When Phase 1 of Mirage spares assessing started late in 1961, overhaul times for many of the major items were low and failure rates unknown due to insufficient or non-existent statistical data on aircraft operations. Further, production design of many items, including the engine, was not frozen until late 1962 thus aggravating the difficulties associated with identifying and ordering the actual parts that would eventually be in the RAAF Mirage. The Atar engine entered service with a life of 225 hours and a 'P' inspection at 75 hours. Major airframe servicing was set at 600 hours for an 'E' inspection. Of course some items were not given a 'life' as such, instead they were repaired or overhauled 'on condition'. Comprehensive servicing data for the Mirage was given in one of the first 'Servicing Plans', now Technical Maintenance Plans (TMPs), compiled by the Engineer Branch.

Maintenance philosophy for the Mirage favoured total on-site maintenance responsibility, given the name of Intermediate Level Maintenance (ILM), in order to reduce turn around times and pipeline requirements for high cost items and so control costs. This philosophy applied particularly to CSF Cyrano, Radio and Instrument items and its implementation was the reason behind development by 481 (M) Squadron of the first Maintenance Supply Item (MSI) asset control system in the RAAF. Major engine overhaul and modification work was done by CAC at Fishermen's Bend, while the Maintenance Squadrons undertook most of the routine airframe servicing work. GAF also carried out airframe inspection and modification at various times when RAAF capacity was over-extended.

Many of the existing technical facilities at the Williamtown fighter base were of World War II vintage and needed upgrading for an aircraft such as the Mirage. New technical works for Williamtown included a large air conditioned Fire Control and Instrument Workshop, Engine Workshop and Storage building, radio, safety equipment and electrical workshop, simulator building, 'E' servicing hangar engine run-up facilities, hard standing and enlarged domestic works to accommodate additional technical personnel. Later, a combined Matra R530 and new Instrument Workshop was added. The RAAF adopted the concept of open area workshops for the first time in the design of many of these buildings and

modular test benches were widely used. Clean room facilities were also used for the first time at an operational unit. Early commissioning of some of the maintenance facilities at Williamtown was essential as the RAAF had total responsibility for maintenance of many aircraft components. For example, the RAAF supplied CSF radars to GAF for installation on the aircraft, as well as being responsible for maintenance of certain items found unserviceable during production, eg. BEZU Output Multiplier Box (Bomb) Air Data Computer (ADC), IFF, TACAN, PHI etc.

An important engineering aspect of the early life of the Mirage was the involvement of Quality Assurance staff in production, testing and acceptance of the aircraft, engine and locally made components. In conjunction with the RAAF Resident Technical Officer, QA staff were responsible for oversight of RAAF interests. DQA engineers were located in France and in Australian factories such as GAF, CAC, H de H, Dunlop and NIC. Lack of detailed knowledge of the French QA system and its associated documentation was an early difficulty which was eventually overcome. While there were a number of QA problems during production, corrosion of raw materials imported from France was probably the most contentious for a time and brought about more stringent inspection requirements both in Australia and France. Aluminium rivets and skin were most affected.

Another interesting area was local manufacture or assembly of selected high usage spares and other items for which an industry repair capability was desired. Results were mixed. Delays and cost increases caused abandonment of local manufacture of the Noelle Starter. Other items such as tyres and rubber fuel tanks, wheels and brakes, brake parachutes, standby compass, standby AH and rate of climb (ROC) indicator were successful. However, some of the items had difficulty initially meeting French Specifications and Standards, eg. NIC had difficulty in calibrating the ROC to meet Type Test requirements at other than ambient temperatures, and the first cockpit canopies made by GAF were also marginal. Later, CAC unsuccessfully attempted to manufacture the RPK 10 Combined Tank/Bomb Carrier under licence, failure being due to an inability to produce the main alloy casting without flaws - but then to be fair, neither could the French manufacturer. Notwithstanding these specific difficulties, production of major aircraft assemblies, components and the Atar engine proceeded satisfactorily.

At Williamtown, 481 (M) Squadron started to prepare for the new Mirage from the latter half of 1961 onwards. Technical training preparations required a new approach as the Mirage was much more complex than the Sabre and more formal and on-the job training would be needed. For example, while the Mirage had many more equipments and systems than the Sabre, it was designed

to allow fast replacement of defective items rather than in situ maintenance. The concept of Field Training was introduced into the RAAF for the Mirage, ie. technicians were required to undergo special unit run courses before being allowed to work on the aircraft or its equipment. In the long term, 481 Squadron would be responsible for all technical training on Mirage, including rotation of trained personnel to Butterworth, and permanent training facilities were included in the building programme for Williamtown. Personnel trained in France formed the initial cadre of instructors needed for Williamtown courses and, during the early years, specialist French Field Service Representatives provided a higher level of expertise in selected areas. It should be noted that 481 (M) Squadron was maintaining Sabre and Vampire aircraft, as well as the Mirage, until the Sabre was phased out in 1971.

The first Australian built Mirage arrived at Williamtown in February 1964, and by July 1965 there were 13 aircraft at 81 Wing and hours flown exceeded 2 500, with A3-3 having flown over 400 hours. In July 1964, the first mobile Mirage Flight Simulator was commissioned at Williamtown while 12 months later the Mirage Flight Control Training Aid was installed to assist in training pilots and fitters and also help in the diagnosis of flight control system faults. Once in service, the Mirage followed a normal maintenance and repair pattern even though many of the support concepts were new and innovative. Some of the newly designed equipments such as the CSF Cyrano, Sperry TGP, PHI, ADC, Bomb, UHF radios, Auxilec Constant Speed Alternator and SFENA auto command had teething problems and suffered higher failure rates than expected - repair facilities were extended to the limit. Complete units and breakdown spares were in short supply as a consequence of earlier delays in spares assessing and ordering, coupled with production bottlenecks in French factories. During 1965/66 there was considerable engineering activity at both 481 (M) Squadron and HQSC as attempts were made to overcome defects and shortages.

Of particular interest was an intermittent fault in the TGP brush assembly which caused errors in the Bezu Ball attitude indication - a most disconcerting and dangerous fault for the pilot. An exhaustive engineering examination eventually discovered that a foreign substance was contaminating the main brush and slip-ring assembly and causing intermittent open circuits with consequent erratic Bezu Ball (Artificial Horizon) behaviour. Investigation of this phenomenon was protracted and inconclusive and it was some years before TGP MTBF rates improved to an acceptable level. Rate gyros in the Cyrano Radar also gave trouble and had to be replaced with more reliable UK built versions of the same item. Other items with poor reliability included the Auxilec Alternator and Trap 21/22

UHF Radios. The Brake Parachute and jettisonable container cover were also subject to early problems and required modification to improve reliability.

In the air defence role, Mirage was armed with a short range infra-red seeking missile (Sidewinder AIM 9B), the medium range semi-active guided missile (Matra R530K) and a 30mm gun system. Mirage was first armed with the AIM 9B originally bought for the Sabre in 1962. With the selection of the Matra R530K in 1963 there was a requirement for high altitude trials of this weapon at Woomera against Jindivik targets. At Williamtown, aircraft were fitted with Matra computers, launchers and harmonization units as they became available from mid 1965 and the trials were held late in 1965. An interesting improvement in capability was the purchase of six nose cones designed to take the KA 56 Panoramic Reconnaissance Camera. A few aircraft at each location were modified to accept this equipment.

From late 1966, Mirage maintenance effort at Williamtown was extended to include the Mirage IIIO (A) variant and the Mirage IIID Trainer aircraft which were then coming off the production line. Introduction of these aircraft added a number of new items to the Maintenance Plan including IIID items as well as the APN 153 Doppler Radar, Radio Altimeter, Cyrano Ground Mapping Radar and integration of the navigation/weapons system. Proposals for the retrospective modification of existing Mirage III0 (F) to the (A) version were also under active discussion at this time, especially as the versatility of the (A) version became apparent. The GAMO 2 Servicing Vehicle, a variant of a French Air Force unit designed to provide power and cooling for aircraft and crews on air defence alert was introduced into service but this vehicle could not be made to operate properly under local conditions and was an expensive failure.

In May 1967, 75 Squadron deployed to Butterworth with Mirage aircraft. This deployment, and the others that followed, required a considerable amount of planning by technical and equipment staff, particularly for the provision of fuel and maintenance facilities at Indonesian aerodromes. At Butterworth, additional facilities mainly in the form of transportable cabins, were provided to supplement existing buildings at the base - particularly for Operating Level Maintenance. The deeper level maintenance activities undertaken by 478 (M) Squadron necessitated extensive refurbishment of existing facilities and provision of some new workshops. Although it took some time before these facilities were operating efficiently, the base was fortunate in that only fully trained and experienced technicians were posted to the Butterworth squadrons. In mid February 1969, 3 Squadron deployed to Butterworth with Mirage aircraft. Both 3 and 75 Squadrons

maintained short term deployment capabilities independent of support from the maintenance squadron and exercised these capabilities regularly.

No 77 Sabre Squadron returned to Australia in 1969 and re-equipped with Mirage soon after arrival. With four squadrons and the OCU operating at two major bases (nearly 8000 kms apart) there were chronic shortages of both spares and support equipment at Squadron level - a situation that continued until 76 Squadron was disbanded in 1973. The modification programme to convert all IIIO (F) aircraft to the (A) configuration started at GAF Avalon late in 1969 as the last of the Mirage III0(A) came off the production line. Six additional Mirage IIID were ordered in 1973, taking the number of Mirages bought to 116.

Early in 1973, an AMTS Working Party was formed to review factors affecting Mirage Life of Type (LOT) to 1980/1990 and look at technical aspects of improving capability in line with current Air Staff Requirements. The WP identified a number of factors affecting LOT and made some interesting observations concerning the reliability of existing items in the Mirage being supported to a LOT of 1980. While some systems were costly to maintain, at the time only replacement of the Auxilec Alternator would have been cost-effective. For a LOT to 1990, the WP concluded that either the wing or wing spar would have to replaced about 1980, and that support for the existing Sidewinder and Matra missiles would become difficult and more expensive. The WP also assessed that support for other items could be maintained until the late 80s without much difficulty. Replacement of the alternator would become a far more attractive proposition for a LOT of 1990, but replacement of unreliable equipments such as the Radio Altimeter, Dual UHF and TACAN could not be supported on engineering grounds alone - even to a LOT of 1990. A further paper was prepared during 1977 - The Mirage Asset Report, and this reached similar conclusions except that replacement of the UHF Radio and TACAN was now recommended.

Recording of fatigue data is a normal engineering activity undertaken to monitor the effect of service life on structural fatigue of an aircraft. A counting accelerometer or fatigue meter was fitted to each Mirage from new and flight data sent, with comments as appropriate, to the Director of Aircraft Engineering (Air Eng 5) and the Aeronautical Research Laboratories (ARL) at Fishermen's Bend. Between 1979 and 1981 eight Aircraft Fatigue Data Analysis Systems (AFDAS) were installed to provide more accurate flight load data on all aspects of Mirage operations. Analysis of this data, together with fatigue testing of major structural components, allowed predictions of fatigue life to be verified.

The Mirage was initially assessed as having a safe fatigue life

of 4000 hours which meant that barring unforeseen circumstances, no structural components, except those requiring normal repair or maintenance, would need replacement before about 1980. The wing and frame 26 were assessed as the most likely problem areas. A collaborative fatigue test undertaken in Switzerland during the late 70s resulted in abandonment of the safe life fatigue analysis philosophy in favour of a safety-by-inspection philosophy. Using results from the Swiss fatigue test, numbers 1 and 2 bolt holes in the main wing spar were regularly examined. During 1979, cracks in the lower wing skin panel were discovered emanating from the area of the fuel decant plug hole. In most cases this cracking was either prevented or arrested by the application of a bonded composite Boron fibre reinforcement doubler patch developed by ARL. Subsequently more cracks were discovered in the wing main spar in the lower skin attachment holes near the wing attachment point. This fault lead to a fleetwide wing repair/replacement programme which extended from late 1980 through to 1984 and became known as the Wing Life of Type Extension (LOTEX) programme.

The decision to undertake the Wing LOTEX Programme was a direct consequence of deferral of the decision on selection of the replacement tactical fighter and Project Air 5050 was raised to authorise the LOT extension and replace some equipment that was either obsolete or becoming difficult to support. Major elements of the LOTEX programme were the purchase of some replacement wings, repair of salvageable wings, refurbishment of the Matra R530K AAM and the acquisition and installation of the Matra R550 'Magic' AAM to replace the Sidewinder AIM 9B. Some of the replacement wings were made by CAC and others were made in France. The Matra R550 upgrade required structural reinforcement of the wing hardpoint and some additional wiring. The R550 part of the programme started late in 1983 and took almost 15 months to finish. While the Matra R550 was eventually fitted to the Mirage, the initial choice was either the Sidewinder AIM 9L or AIM 9M - weapons which would be compatible with an American aircraft which at the time was the most likely Mirage replacement. However, fitment of these new-generation highly manoeuvrable missiles with their large wing areas would require investigation of the strength of the Mirage wing hardpoint. Unfortunately, AMD-BA were reluctant to release stress and aerodynamic data for the wing; thus the Matra R550 was selected by default.

Mirage weapons were very effective even though some weapons suffered significant engineering problems. The Sidewinder AIM 9B was carried on Aero 3B Launchers fitted to the outer wing stations. Integration of this US-designed weapon with the Mirage system posed difficulties, some of which remained through to

the R550 conversion in 1984, eg. missile preheat circuitry. The only major AIM 9B-related problem encountered in 20 years was erosion of the training missile IR seeker dome glass and this was resolved by a RAAF modification adding a brass protection cover to the seeker dome. The R530K AAM was carried on a single Type 14 Launcher on the centreline station and even though properly integrated with the aircraft, the weapon had some significant problems including premature detonation of the PJE2 proximity fuse, warhead degradation and eventual life expiry of the rocket motor. Both warhead and rocket motor were replaced with Australian produced and assembled components and performance was improved. Premature detonation of the PJE2 fuse was not solved until 1985 when DSTO and the RAAF found a design fault in the fuse amplification circuit. However, withdrawal of the R530K missile from service in 1985 prevented full operational evaluation of the modification. The Sidewinder was withdrawn from service in 1984 and replaced by the short range IR Matra 550 'Magic' missile. Although easily integrated into the Mirage system and initially successful, the missile encountered problems later with premature detonation and breakup of the rocket motor in flight but the aircraft was phased out before these problems could be resolved.

Originally the Mirage was equipped with the type 552 30mm Defa Cannon but this was replaced in the late 70's, for HE ammunition, by the type 552A. The cannon and gunpack system remained operationally effective throught the life of the Mirage. Minor engineering problems were encountered with malfunctioning electronic firing units, cracked breech cylinder housings and gunpack feed chute gauging errors. However, over-all the Defa gun proved to be a highly reliable and accurate component of the weapon system. A unique engineering feature of the Defa system was the left and right hand configuration of the guns and corresponding left and right linked ammunition. This feature required ground crews to be continually alert during firing exercises, and particularly so for practice ammunition firings, where colour tipping of ball rounds on left and right hand ammunition belts required additional care and coordination.

During 1980, the RAAF Analytical Maintenance Programme (RAMP) was applied to Mirage maintenance activities. The aim of the programme was to examine all aspects of maintenance to ensure that unnecessary activities were eliminated and servicing periods more closely aligned with predictable failure rates and wear patterns. This resulted in many changes to servicing schedules and a slight reduction in maintenance effort.

Like most fighter aircraft, the Mirage had a predictable attrition rate. However, between 1976 and 1984, five Category 5 accidents (write-off) and one Category 2 accident, as well as several air

incidents, occurred as a result of pilots being unable to obtain locked indications for either the port or starboard undercarriage. Even though the exact cause of these accidents remained obscure, all malfunctions were attributed to the lateral jack not being properly locked mechanically although fully extended. A major engineering investigation started by HQSC in May 1984 as the result of an accident earlier in the year soon found that the RAAF was the only Mirage operator experiencing this problem. Furthermore, while the lateral jacks were all fully modified, they did have two extra RAAF unique modifications, one of which was a bearing introduced in 1974-76 to combat corrosion. After sifting through over 20 potential causes, attention was focussed on the four most likely as being; wear, corrosion of the jack ram, misalignment of the RAAF- introduced bearing and overtightening of the locking claw. A significant contributing factor pin-pointed during the investigation was the poor engineering and administrative control being exercised over the amendment of technical data. Errors had been allowed to creep into maintenance publications, particularly in relation to accuracy of translation, content and amendment status, and this in turn had lead to the gradual introduction of faulty maintenance practices and procedures - a recurring problem with aircraft and one not confined to Mirage.

No 75 Squadron was withdrawn from Butterworth in 1983 and redeployed to Darwin. Transportable buildings were installed there to augment Base facilities for the Squadron. Although 481 (M) Squadron Williamtown was tasked to provide deeper levels of maintenance support, 75 Squadron expanded to take on some of the maintenance tasks formerly done by 478 Squadron. In October 1983, No 478 (M) Squadron was disbanded at Butterworth and the maintenance capability of the remaining squadron (3 Squadron) was enhanced to include the deeper levels of servicing previously undertaken by 478 Squadron. Later, when 3 Squadron started to re-equip with the FA18 Hornet at Williamtown in 1985, No 79 Squadron was formed to take over the Mirage assets from 3 Squadron at Butterworth.

478 and 481 Maintenance Squadrons carried out the majority of D and E Servicings on the aircraft (now known as R3 and R4 Servicings), P Servicings on the engine and were responsible for maintenance of many major Radio, Instrument, Electrical, Armament and Safety Equipment items. However, between 1981 and 1983, No 2 Aircraft Depot undertook a large number of extensive Mirage R4 servicings, including rework of Frame 26 on certain aircraft and fitment of new or refurbished wings as part of the Wing LOTEX programme. When 2 OCU started to re-equip with FA18 Hornets, 77 Squadron took over the Mirage training role from 2 OCU and became Australia's largest peace-time squadron with a

UAE of 59 aircraft (43 Mirage and 16 Macchi). With the last Mirage conversion course in 1986, the squadron gradually ran down in 1987 and the last Mirage left Williamtown on the 27th November 1987. Mirage aircraft ceased operations at Butterworth on the 8th May 1988 when 79 Squadron was disbanded, and the last Mirage left Darwin on the 30th September 1988 when 75 Squadron reformed with the FA18 at Tindal.

Of the original 100 Mirage III0 and 16 Mirage IIID aircraft purchased, 71 were held to account on the inventory at the time they were withdrawn from active service as a frontline fighter. Of these 71 aircraft, 50 (42 III0 and 8 IIID) were placed in long term storage at Woomera, SA pending disposal. The remaining 21 aircraft were either allocated for use as technical training aids or went to museums and other static displays. Initial planning for disposal of the Mirage fleet was undertaken by an RAAF Equipment Disposal Committee. Responsibility for disposal of the aircraft and all associated assets including spares, Ground Support Equipment (GSE) and tooling was passed to Department of Defence (Central) where a small team of Defence logistics personnel (including RAAF technical and supply staff) was assembled to handle the project. So far, two countries, France and Pakistan, have shown interest in acquiring the aircraft and have sent teams to evaluate the equipment offered for sale.

By the time the Mirage was phased out of service, the high time aircraft A3-17, which was placed in storage at Woomera in November 1987, had accumulated 4554 Flying Hours. Many aircraft had exceeded 4000 Hours. The Atar 9C engine (and afterburner) had proved to be rugged and reliable and ended its RAAF service life with a Time Between Overhaul (TBO) of 630 hours, while the major airframe servicing period (formerly E then R4) was set at 960 hours.

Throughout the life of the Mirage, strong engineering links were retained with the French Aeronautical Industry and Air Force through the efforts of RAAF engineering staff at the Australian Embassy, Paris. Australian Industry and Government Authorities also made significant engineering contributions to the operation of the Mirage, particularly the Government Aircraft Factories, Commonwealth Aircraft Corporation, Aeronautical Research Laboratory, Dunlop, National Instrument Company, Normalair and Lucas Rotax."

Notes: (1) Group Captain G. Grantham joined the RAAF in July 1948 as an engineering apprentice. He graduated as an Instrument Maker from Ground Training School, Wagga in June 1951, and served as an Airman until 1955 when he was commissioned in the Engineer Branch. He served in a number of Unit and Staff appointments including four years as a Mirage Project Officer at the Department of Air (1961-64), CO 1 Aircraft Depot, SOTSA, DDTS-AF, DAEENG-AF and DTP-AF. He attended RAAF Staff College in 1967 and JSSC in 1972.

Annex: A. RAAF Mirage Disposition as at 18 Jul 88

Annex C

SUMMARY OF MAJOR ACCIDENTS

MIRAGE IIIO

DATE	UNIT	AIRCRAFT	PILOT	CAT	SUMMARY
7 Dec 64	ARDU	A3-1	Svensson	5	Ejected. Stall/spin — high speed ejection
29 Jul 66	75 SQN	A3-28	Johnston	5	Ejected. Engine failure in cruise, spline drive shaft failed.
3 Apr 67	76 SQN	A3-46	Ellis	5	Ejected. Engine flamed out on air test — splined drive shaft disconnected.
11 May 67	2 OCU	A3-77	Drummond	5	Fatal. Aircraft crashed at sea — suspect pilot incapacitation
1 Sep 67	76 SQN	A3-43	Karpys	5	Fatal. Aircraft crashed during low level aerobatic display practice
25 Sep 67	3 SQN	A3-52	Susans	5	Ejected. Engine flamed out in cruise, inadequate spline lubrication.
30 Oct 68	3 SQN	A3-70	Roberts	5	Ejected. during air-to-ground gunnery, ricochet went down intake.
18 Mar 69	75 SQN	A3-67	Myers	5	Fatal. Aircraft crashed into sea on night low level intercept mission.
6 Oct 71	2 OCU	A3-109	Dale	5	Fatal. Aircraft crashed into sea on a local training mission.
27 Apr 72	77 SQN	A3-74	Perry	5	Ejected. Birdstrike — engine failure.

DATE	UNIT	AIRCRAFT	PILOT	CAT	SUMMARY
4 May 72	3 SQN	A3–85	Smith	5	Fatal. Aircraft impacted ridge on a night radar navigation sortie.
6 Jul 72	3SQN	A3-98	Kindler	5	Ejected. Engine fire during low level strike mission.
17 Jul 72	75SQN	A3-63	Allen	5	Engine explosion and fire on engine run-up prior to take-off.
3 Aug 72	ARDU	A3-4	Richardson	5	Ejected. Afterburner fire light followed by engine flame-out.
3 Apr 73	77SQN	A3-79	Groom	5	Fatal. Engine vibrations on a low level training flight.
1 Apr 74	75SQN	A3-18	Boyd	5	Ejected. Engine compressor stall — power loss.
24 Oct 74	ARDU	A3-16	Ford	5	Wheels up landing
16 Mar 76	77SQN	A3-14	Kubank	5	Ejected. Engine compressor stall during low level formation practice.
6 Apr 76	77SQN	A3-41	Wilkie	5	Engine bay fire due hot air leak. Aircraft landed.
8 Jun 76	75SQN	A3-67	Hurman	5	Ejected. Engine compressor stall on base finals.
24 Jun 76	77SQN	A3-61	Vandenburg	5	Fatal. Disorientation during night formation — flew into water
~~6 Jul 77~~ 6 JUL 76	75SQN	A3-64 A3-26	Kaye Kelly		Fatal — Kelly A mirage landed on top of another lined up on the runway.
10 Aug 76	2OCU	A3-114	Wood/ Shepherd	5	Both ejected. Left main undercarriage failed to lock in lateral position.

DATE	UNIT	AIRCRAFT	PILOT	CAT	SUMMARY
2 Feb 77	2OCU	A3-50	Friedrichs	5	Fatal. Crashed during low level aerobatics display practice.
29 Nov 77	75SQN	A3-57	Wilkie	4	Starter turbine disintegrated during start.
5 Dec 77	3SQN	A3-94	Crowhurst	5	Ejected. Engine bearing failure and thrust loss at night
17 Feb 78	77SQN	A3-8	Watson	5	Tyre failed at 150 kias on take-off — aircraft burnt.
7 Aug 79	2OCU	A3-47	Lee	5	Ejected. Undercarriage failed to lock in lateral position.
18 Feb 80	77SQN	A3-75	Carr	5	Ejected. Snakeye MK 82 partially slick, prob frag damage to engine.
2 May 80	77SQN	A3-58	Butterworth	5	Ejected. Undercarriage failed to lock in lateral position.
2 Apr 81	3SQN	A3-88	Hiser	4	Tyre blew at high speed on take-off.
9 Sep 81	77SQN	A3-80	Alexander	5	Ejected. Undercarriage failed to lock in lateral position.
29 Oct 81	75SQN	A3-32	Simmonds	5	Fatal. Aircraft crashed into sea during night sortie.
30 Mar 83	75SQN	A3-69	O'Halloran	5	Ejected. Mid-air collision with RSAF A4 on finals.
2 Aug 83	77SQN	A3-82	Kindler	5	Ejected. Engine thrust loss — aircraft crashed into sea.
6 Mar 84	3SQN	A3-97	McCormick	4	Crash landed. Engine surge on finals.
9 Apr 84	77SQN	A3-29 A3-30	Wylie Rim	5 5	Both fatal. Mid-air collision during low level combat profile mission

DATE	UNIT	AIRCRAFT	PILOT	CAT	SUMMARY
26 Apr 84	2OCU	A3-105	Barden/ Conlan	5	Both ejected. Undercarriage malfunction lateral jack failed to lock.
3 May 84	ARDU	A3-76	McCormick	5	Ejected.
27 May 85	75SQN	A3-36	Quaife	5	Ejected. Engine compressor stall at base turn.
21 Jun 85	75SQN	A3-89	Davidson	5	Fatal. Aircraft lost in sea at night on low level intercept mission.
24 Jun 85	77SQN	A3-12	Pierson	4	Aircraft overstress ^{g}9.5 to -4.5 during low level tac ints.
2 May 86	77SQN	A3-40	Macklemann	5	Fatal. Aircraft impacted water during an air-to-air gunnery mission.
16 Mar 87	77SQN	A3-95	Batten	5	Ejected. Fire warning/engine stall.
27 Jan 88	79SQN	A3-56	Todd	4	Birdstrike.

Annex D

MAJOR ACCIDENTS (CAT 4 and 5)

MIRAGE IIIO, IIID

BREAKDOWN BY CATEGORY

CATEGORY	TYPE	AIRCRAFT LOST	REMARKS
Material	Engine/fire	16	11 ejections, 1 fatal
	undercarriage	6	8 ejections
	type failure	2	Both on take-off
		24	51% of total losses
Human Factors	Ground/water impact	5	5 fatal, all at night
	sus. incapacitation	3	3 fatal
	low level aero prac.	3	2 fatal, 1 ejection
	mid-air collision	3	2 fatal, 1 ejection
	collision on ldg.	2	1 fatal
	wheels up landing	1	
	overstress	1	
	spin	1	1 ejection
	fragmentation	1	1 ejection
		20	42% of total losses
Operational Hazard	ricochet	1	1 ejection
	birdstrike	2	1 ejection
		3	7% of total losses
	TOTAL	47	25 ejections, 14 fatalities
			DAFS — AUG 88

Annex A

RAAF MIRAGE DISPOSITION AS AT JUL 88

TAIL No	CONDITION	AIRFRAME HOURS	LAST FLOWN	LOCATION	LAST UNIT	WITHDRAWL DATE	REMARKS
A3-1	Category 5	—	07 Dec 64	—	ARDU	—	Dassault built. Crashed Avalon
2	In service	1957	—	Edinburgh	ARDU	Late 88	Pattern aircraft built by Dassault
3	Static display	—	—	Williamtown	77 SQN	31 Mar 87	First Australian built Mirage
4	Category 5	—	03 Aug 72	—	ARDU	—	Crashed Avalon.
5	Storage	3693	27 Nov 87	Woomera	77 SQN	Nov 87	Pending disposal.
6	Storage	3701	—	Woomera	75 SQN	Sep 88	
7	Reduced to spares	*	01 Sep 86	Darwin	75 SQN	22 Aug 86	For disposal Dec 88
8	Category 5	—	17 Feb 78	—	77 SQN	—	Damaged East Sale, destroyed by fire enroute to Edinburgh.
9	Storage	3445	27 Jun 88	Woomera	75 SQN	Jun 88	Pending disposal.
10	Storage	3982	—	Woomera	75 SQN	Sep 88	
11	Storage	3789*	27 Nov 87	Woomera	77 SQN	Nov 87	Pending disposal.
12	In service	4214	—	Edinburgh	ARDU	Late 88	
13	Static display	3760	03 Jul 87	Point Cook	77 SQN	—	Airlifted by Chinook to RAAF Museum.
14	Category 5	—	16 Mar 76	—	77 SQN	—	Crashed Williamtown.
15	Storage	4223	—	Woomera	75 SQN	Sep 88	
16	Category 5	—	24 Oct 74	—	ARDU	—	Damaged, Tullamarine
17	Storage	4554*	27 Nov 87	Woomera	77 SQN	Nov 87	Pending disposal.
18	Category 5	—	01 Apr 74	—	75 SQN	—	Crashed Butterworth
19	Storage	3426	06 May 88	Woomera	79 SQN	May 88	Pending disposal.
20	Training aid	*	13 Nov 86	Kingswood	77 SQN	07 Nov 86	Airlifted by Chinook to 1CAMD

TAIL No	CONDITION	AIRFRAME HOURS	LAST FLOWN	LOCATION	LAST UNIT	WITHDRAWL DATE	REMARKS
21	Storage	3887	—	Woomera	75 SQN	Sep 88	
22	Storage	4011*	27 Nov 87	Woomera	77 SQN	Nov 87	Pending disposal.
23	Storage	4210	—	Woomera	75 SQN	Sep 88	
24	Storage	4277	—	Woomera	75 SQN	Sep 88	
25	Storage	4429	06 May 88	Woomera	79 SQN	May 88	Pending disposal.
26	Category 5	—	06 Jul 76	—	3 SQN	—	Written off, Butterworth.
27	Storage	4435	27 Jun 88	Woomera	75 SQN	Jun 88	Pending disposal.
28	Category 5	—	29 Jul 66	—	75 SQN	—	Crashed Queanbeyan.
29	Category 5	—	09 Apr 84	—	77 SQN	—	Crashed near Townsville.
30	Category 5	—	09 Apr 84	—	77 SQN	—	Crashed near Townsville.
31	Storage	4090	27 Nov 87	Woomera	77 SQN	Nov 87	Pending disposal.
32	Category 5	—	29 Oct 81	—	75 SQN	—	Crashed Penang.
33	Storage	3222	—	Woomera	75 SQN	Sep 88	
34	Storage	3828	06 May 88	Woomera	79 SQN	May 88	Pending disposal.
35	Storage	4197	27 Jun 88	Woomera	75 SQN	Jun 88	Pending disposal.
36	Category 5	—	27 May 85	Dubbo	75 SQN	—	Crashed Darwin.
37	Category 5	—	18 Mar 69	—	75 SQN	—	Crashed Butterworth.
38	Storage	4438	27 Jun 88	Woomera	75 SQN	Jun 88	Pending disposal.
39	Storage	4213	27 Nov 87	Woomera	77 SQN	Nov 87	Pending disposal.
40	Category 5	—	—	—	77 SQN	—	Crashed at sea off Williamtown.
41	Category 5	—	06 Apr 76	Wagga	77 SQN	—	Fire damage near Nowra, RAAFSTT training aid.
42	Training aid	4015*	15 Oct 87	Wagga	77 SQN	—	RAAFSTT Airframe Flight.
43	Category 5	—	01 Sep 67	—	76 SQN	—	Crashed Williamtown.
44	Training aid	4201*	—	Kingswood	77 SQN	28 May 87	Training aid.
45	Static display	—	Sep 86	GAF, Melb.	77 SQN	—	To GAF for display.

TAIL No	CONDITION	AIRFRAME HOURS	LAST FLOWN	LOCATION	LAST UNIT	WITHDRAWL DATE	REMARKS
46	Category 5	—	03 Apr 67	—	76 SQN	—	Crashed Darwin.
47	Category 5	—	07 Aug 79	—	2 OCU	—	Crashed Williamtown.
48	Reduced to spares	—	—	Butterworth	79 SQN	31 May 87	For disposal Jul 88.
49	Storage	—	27 Nov 87	Woomera	77 SQN	Nov 87	Pending disposal.
50	Category 5	—	02 Feb 77	—	2 OCU	—	Crashed near Williamtown.
51	Training aid	4176*	23 Jul 87	Wagga	77 SQN	—	RAAFSTT Airframe Flight.
52	Category 5	—	25 Sep 67	—	3 SQN	—	Crashed Gloucester, NSW.
53	In service	3895	—	Edinburgh	ARDU	Sep 88	
54	Storage	4199	06 May 88	Woomera	79 SQN	May 88	Pending disposal.
55	Training aid	*	Apr 87	Amberley	77 SQN	—	Security & Fire Training School.
56	Storage	3530	06 May 87	Woomera	79 SQN	May 88	Pending disposal.
57	Reduced to spares	*	01 Oct 86	Kingswood	77 SQN	14 Oct 86	Fuselage 1CAMB training aid.
58	Category 5	—	02 May 80	—	77 SQN	—	Crashed at Tanilba Bay, NSW.
59	Static display	*	01 Dec 85	Butterworth	3 SQN	13 Dec 85	Handover to RMAF, Jul 88.
60	Storage	3414	27 Jun 88	Woomera	75 SQN	Jun 88	Pending disposal.
61	Category 5	—	24 Jun 76	—	77 SQN	—	Crashed Williamtown.
62	Storage	4234	06 May 88	Woomera	79 SQN	May 88	Pending disposal.
63	Category 5	—	17 Jul 72	—	75 SQN	—	Damaged Butterworth.
64	Category 5	—	06 Jul 76	—	75 SQN	—	Crashed on landing Butterworth.
65	Storage	4119	03 Feb 87	Woomera	77 SQN	Feb 87	For component recovery as required.
66	Reduced to spares	*	01 Sept 86	Dubbo	77 SQN	—	For disposal as scrap metal.
67	Category 5	—	08 Jun 76	—	75 SQN	—	Crashed Butterworth.
68	Storage	4157	07 May 88	Woomera	79 SQN	May 88	Pending disposal.
69	Category 5	—	30 Mar 83	—	75 SQN	—	Crashed Singapore
70	Category 5	—	30 Oct 68	—	3 SQN	—	Crashed near Williamtown.

TAIL No	CONDITION	AIRFRAME HOURS	LAST FLOWN	LOCATION	LAST UNIT	WITHDRAWL DATE	REMARKS
71	Storage	4499	27 Nov 87	Woomera	77 SQN	Nov 87	Pending disposal.
72	Training aid	3850*	22 May 87	Wagga	77 SQN	22 May 87	RAAFSTT Airframe Flight.
73	Storage	3963	27 Jun 88	Woomera	75 SQN	Jun 88	Pending disposal.
74	Category 5	—	27 Apr 72	—	77 SQN	—	Crashed Darwin.
75	Category 5	—	18 Feb 80	—	77 SQN	—	Crashed at Sale, Vic.
76	Cateogry 5	—	03 May 84	—	ARDU	—	Crashed near Adelaide.
77	Category 5	—	17 May 67	—	2 OCU	—	Crashed near Newcastle.
78	Reduced to spares	*	01 Apr 87	—	77 SQN	13 Apr 87	For disposal as scrap metal.
79	Category 5	—	03 Apr 73	—	77 SQN	—	Crashed Gloucester, NSW.
80	Cateogry 5	—	09 Sep 81	—	77 SQN	—	Crashed near Williamtown.
81	Storage	3896	06 May 88	Woomera	79 SQN	May 88	Pending disposal.
82	Category 5	—	02 Aug 83	—	77 SQN	—	Crashed near Nowra.
83	Storage	4216	03 Feb 87	Woomera	77 SQN	Feb 87	Pending disposal.
84	Static display	4394	28 May 87	Point Cook	77 SQN	—	Airlifted by Chinook to RAAF Museum.
85	Category 5	—	04 May 72	—	3 SQN	—	Crashed near Butterworth.
86	Storage	4196	03 Feb 87	Woomera	77 SQN	Feb 87	Pending disposal.
87	Storage	4215	—	Woomera	75 SQN	Sep 88	
88	Storage	3802	27 Nov 87	Woomera	77 SQN	Dec 86	Pending disposal.
89	Category 5	—	21 Jun 85	—	75 SQN	—	Crashed near Darwin.
90	Reduced to spares	*	01 Apr 86	Williamtown	77 SQN	Jul 86	For disposal as scrap metal.
91	Reduced to spares	*	01 Nov 86	Kingswood	77 SQN	Nov 86	Fuselage 1CAMD training aid.
92	Training aid	4037*	22 May 87	Wagga	77 SQN	May 87	RAAFSTT Airframe Flight.
93	Storage	4094*	27 Nov 87	Woomea	77 SQN	Nov 87	Pending disposal.
94	Category 5	—	05 Dec 77	—	3 SQN	—	Crashed Butterworth.
95	Category 5	—	16 Mar 87	—	77 SQN	—	Crashed at sea near Williamtown.

TAIL No	CONDITION	AIRFRAME HOURS	LAST FLOWN	LOCATION	LAST UNIT	WITHDRAWL DATE	REMARKS
96	Storage	3517	27 Jun 88	Woomera	75 SQN	Jun 88	Pending disposal.
97	Training aid	—	06 Mar 84	Williamtown	3 SQN	—	Sustained Cat 4 damage at Butterworth, Aircrew training aid.
98	Category 5	—	06 Jul 72	—	3 SQN	—	Crashed Johore, Malaysia.
99	Storage	3918	07 May 88	Woomera	79 SQN	May 86	Pending disposal.
100	Static display	*	01 Mar 86	Darwin	75 SQN	Nov 86	
101	In service	3445	—	Edinburgh	ARDU	Late 88	
102	Static display	—	—	Williamtown	77 SQN	Dec 86	Fighter Display Centre.
103	Storage	3343*	27 Nov 87	Woomera	77 SQN	Nov 87	Pending disposal.
104	Storage	3348	—	Woomera	75 SQN	Late 88	
105	Category 5	—	26 Apr 84	—	2 OCU	—	Crashed near Darwin.
106	Reduced to spares	—	13 Mar 74	Dubbo	2 OCU	Jan 86	Disposal as scrap.
107	Reduced to spares	—	01 Feb 79	Edinburgh	3 SQN	Jul 81	Unrepairable due extensive corrosion.
108	Storage	3610	27 Jun 88	Woomera	75 SQN	Jun 88	Pending disposal.
109	Category 5	—	06 Oct 71	—	2 OCU	—	Crashed at sea near Williamtown.
110	Storage	2744	06 May 88	Woomera	79 SQN	May 88	Pending disposal.
111	Storage	2025	—	Woomera	75 SQN	Sep 88	
112	In service	2350	—	Edinburgh	ARDU	Late 88	
113	Storage	2283	—	Woomera	75 SQN	Sep 88	
114	Category 5	—	10 Aug 76	—	2 OCU	—	Crashed Williamtown.
115	Reduced to spares	2032	08 Dec 86	Edinburgh	77 SQN	Dec 86	Transferred to DSTO.
116	Reduced to spares	*	01 Mar 86	Dubbo	77 SQN	Mar 86	For disposal as scrap.

Notes: * — Airframe reached the limit of its RAAF-determined fatigue life.

2 — A3-1 to A3-48, designated IIIO(F), primarily all-weather interceptor/fighter (were all converted to ground attack role, commencing late 1969).

3 — A3-49 to A3-100, designated IIIO(A), primarily ground attack and close-support aircraft.

4 — A3-101 to A3-116 designated IIID, 2 seater trainers.

RAAF Standard Prices: Aircraft $1,665,000
Power Unit $216,300
After Burner $116,300

GLOSSARY OF TERMS

ARL	Aeronautical Research Laboratories
AB	Afterburner
ARDU	Aircraft Research & Development Unit
ADEX	Air Defence Exericse
AFC	Air Force Cross
AMTS	Air Member Technical Services
ASR	Air Staff Requirement
AVM	Air Vice Marshal
AH	Artificial Horizon
A SEC F	Assistant Secretary Finance
BEZU	Attitude Indicator
AMSER	Australian Multiple Store Ejector Rack
CFS	Central Flying School
CEAM	Centre d'Experiences Ariennes Militaires
CAS	Chief of the Air Staff
CBE	Commander of the Order of the British Empire
CO	Commanding Officer
CAC	Commonwealth Aircraft Corporation
CB	Companion of the Order of Bath
DEFAIR	Department of Defence (Air Force)
DGP	Director General of Plans
DCAS	Deputy Chief of the Air Staff
DQA	Directorate of Quality Assurance
DGOR	Director General Operational Requirements
DSC	Distinguished Service Cross
DSO	Distinguished Service Order
ENG	Engineer Aeronautical
ARM	Engineer Armanent
INST	Engineer Instrument/Electrical
EXO	Executive Officer
FSR	Field Service Representatives
'G'	Force of Gravity
FOD	Foreign Object Damage
SNECMA	French Aircraft Manufacturer
FAF	French Air Force
GD	General Duties
GAF	Government Aircraft Factories
GD	General Duties
GAF	Government Aircraft Factories
GCA	Ground Control Approach
GCI	Ground Control Intercept
FCI	Graduate of Fighter Combat Instructor Course
QFI	Graduate of Flying Instructors Course
JSSC	Graduate of Joint Services Staff College Or US Armed Forces Staff College

H de H	Hawker De Havilland
HQBUT	Headquarters, Butterworth, Malaysia
HQOC	Headquarters Operational Command
HCSC	Headquarters Support Command
HQWLM	Headquarters, Williamtown
IFF	Identification Friend or Foe
IAS	Indicated Air Speed
IADS	Integrated Air Defence System
ILM	Intermediate Level Maintenance
KBE	Knight Commander of the Order of the British Empire
KTS	Knots
KIAS	Knots indicated Air Speed
LOTEX	Life of Type Extension
MSI	Maintenance Supply Item
AM	Member of the Order of Australia
MET	Meteorological
MCRU	Mobile Control and Reporting Unit
NIC	National Instrument Company
NM	Nautical Miles
NAVO	Navigation Officer
NCO	Non Commissioned Officer
NATO	North Atlantic Treaty Organisation
OC	Officer Commanding
AO	Officer of Order of Australia
MMSO BGY TAST	Old Fighter Pilot Course
OCU	Operational Conversion Unit
OR	Operational Requirements
OBE	Order of the British Empire
PMG	Post Master General's Department (Australia Post)
QANTAS	Queensland and Northern Territory Aerial Services
RAC	RAAF Assessment Code
ROC	Rate of Climb
RESENG	Resident Engineer
RPM	Revolutions Per Minute
RAF	Royal Air Force
RAAF	Royal Australian Air Force
RAN	Royal Australian Navy
RCDS	Royal College of Defence Studies
RMAF	Royal Malayasian Air Force
RSAF	Republic of Singapore Air Force
SASO	Senior Air Staff Officer
SEATO	South East Asia Treaty Organisation
MACH	Speed in relation to speed of sound
SO	Staff Officer
TACAN	Tactical Air Navigation
TACPR	Tactical Photographic Reconnaissance
TMP	Technical Maintenance Plan
TMC	Technical Management Code

UHF	Ultra High Frequency
UAE	Unit Aircraft Establishment
UK	United Kingdom
USAF	United States Air Force
US	United States of America

The RAAF Mirage Story is a compilation of personal accounts by those who acquired, built, maintained and operated the RAAF Mirage. It is not an official history, but a story as recalled by those who took part – Ron Susans, Fred Barnes, Jim Flemming and many others. The foreword is provided by a former Chief of The Air Staff and Mirage pilot – Air Marshal Jake Newham.

The story starts in Paris in 1961 and ends 28 years later in a storage hangar in Woomera. In between are the trials and tribulations, the joys and sorrows, the failures and successes of the RAAF Mirage era. It is a story of evolution in the RAAF Fighter Force and the Australian aircraft industry. Above all, though, it is a story of respect and affection for an imperfect, yet highly-regarded fighter aircraft.

Wing Commander Martin Susans joined the RAAF as a trainee pilot in 1964. His flying experience has been mainly on fighter and strike aircraft including Sabre, Mirage, F4E and F111C.

Wing Commander Susans has logged over 1600 hours on the Mirage 1110, much of that during two tours with No 3 Squadron at Air Base Butterworth, Malaysia.

His association with RAAF Mirage project started in 1961, when as a high school student he accompanied his parents to Paris. His father, Air Vice Marshal Ron Susans, was the RAAF's first Air Attache in Paris and as such was responsibile for setting up the office which acquired the RAAF Mirage.

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