WORKING PAPER NO. 57

A NEW AIRCRAFT CARRIER FOR THE ROYAL AUSTRALIAN NAVY?

by

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As with all its monographs, the Strategic and Defence Studies Centre presents this paper without either endorsement or critical comment. It is a serious contribution by two professional analysts on a subject of great national inportance. The authors are responsible both for their analysis and their conclusions.

A second working paper assessing from a different viewpoint Australia's need for a fleet air arm will be published shortly.

Editor.

A B S T R A C T

The Australian Government's decision to acquire a new aircraft carrier is critically analysed in strategic, operational and financial terms. The paper concludes that the strategic justification offered is "not proven", that the operational characteristics of available contenders do not satisfy assessed requirements and that the Australian defence budget cannot support both planned outlays and carrier-associated costs. A comprehensive re-assessment of naval force structure is recommended.

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SUMMARY OF MAIN POINTS

The paper addresses strategic, operational and financial points in that order.

Strategically, we find that no internally consistent case has yet been made by Navy, the Defence Department or Government. Clear shifts in their stated position are apparent and several contradictions in their argument are pointed out.

The claimed strategic requirement for an aircraft carrier varies from protection of our sea lines of communication (SLOC) at some times, to antisubmarine warfare (ASW) in focal areas off major ports, to a deterrent role. No consistency can be found in these shifts.

Moreover, we find that the claimed requirements are either of dubious validity or could well be met by options other than an aircraft carrier.

Operationally, we point out that relatively large platforms such as the major contenders for a Melbourne replacement are increasingly vulnerable to current and projected antishipping missiles from submarines, aircraft and surface combatants. Not only is there a significant threat to the survivability of the carrier, there is an even greater threat to its operability, even if it is not sunk outright.

We point out that, even were a carrier theoretically capable of all that is demanded of it, a single carrier is in practice not adequate. Ideally, three carriers would be required.

We show that the possible fixed-wing aircraft complement of any likely Australian carrier is too small to confer adequate operational capabilities for many of the roles claimed by advocates of the acquisition.

The use of the carrier as a platform for ASW helicopters appears of doubtful utility. Current developments in the field of ASW point to an ASW carrier being amongst the least efficient responses to any submarine threat against Australia. Moreover, we find that technological advances in detection and weaponry are likely to give an inherent advantage to the submarine in a contest with a small carrier task force such as that Australia proposes to operate.

We find that the value of Harrier-type STOVL aircraft in the strike role, against both land and sea targets, is necessarily limited. The capabilities conferred do not meet either the requirements stated by Navy (which have not always been consistent) or our assessed national security needs. Despite some recent kudos gained by the aircraft in the fighter role, inherent limitations in the number and balance of types of aircraft which can be carried by a V/STOL carrier mean their ability to protect a small force from aerial attack is severely limited.

Financially, our analysis indicates that the Five Year Defence Program (FYDP) cannot support the acquisition of a carrier, its helicopters and (later) its STOVL aircraft without either a substantial injection of funds or the indefinite deferral of other, more essential, defence equipment programs.

We conclude that the advocates of an aircraft carrier acquisition have not established their case well enough to justify the acquisition beyond reasonable doubt. We suggest that the reasons for this can be found in inadequate overall policy and in a failure to apply consistent and objective criteria to the selection of major defence equipments.

We suggest, in the Preface, that none of the presently apparent "carrier options" offer acceptable solutions to our national security requirements, and that the non-availability of HMS Invincible is an excellent opportunity for a re-assessment of the future structure of the Defence Force in general and Navy in particular.

LIST OF ABBREVIATIONS

ACTU:	Australian Council of Trade Unions
ADAWS:	Action Data Automatic Weapons System
AEW:	Airborne Early Warning
AIO:	Action Information Organization
ASM:	Air-to-Surface Missile
ASW:	Anti-Submarine Warfare
AWACS:	Airborne Warning and Control System
C^3:	Command, Control and Communications
CASS:	Command Activated Sonobuoy System
CDFS:	Chief of the Defence Force Staff (Australia)
CIWS:	Close-In Weapons System
CEP:	Circular Error Probable
DISCON:	Defence Integrated Secure Communications Network
DoD:	Department of Defence (Aust) or Defense (US)
ECM:	Electronic Counter-Measures
FAE:	Fuel-Air Explosives
FC:	Fire Control
FLIR:	Forward-Looking Infra-Red
FMS:	Foreign Military Sales (US)
FOD:	Follow-On Destroyer
FY:	Fiscal Year (US)
FYDP:	Five Year Defence Program
GDP:	Gross Domestic Product
GIUK:	Greenland-Iceland-United Kingdom (gap)
HE:	High Explosive
helo:	Helicopter
IFF:	Identification-Friend-or-Foe
IRI:	Invitation to Register Interest (in the carrier project)
LAMPS:	Light Airborne Multi-Purpose System
LAPADS:	Lightweight Acoustic Processing and Display System
LRMP:	Long Range Maritime Patrol
NCBW:	Nuclear, Chemical and Biological Warfare
NCDS:	Naval Combat Data System
nm:	Nautical Mile
PAYE:	Pay As You Earn

PGM:	Precision Guided Munition(s)
RAN:	Royal Australian Navy
RN:	Royal Navy
SAM:	Surface-to-Air Missile
SCOT:	Satellite Communications Terminal
SLOC:	Sea Lanes of Communication
SOSUS:	Sound Surveillance Under Sea
SSM:	Surface-to-Surface Missile
STOVL:	Short Take-Off, Vertical Landing
SURTASS:	Surveillance Towed Array Sonar System
SWUP:	Submarine Weapons Update Program (Aust)
TACTASS:	Tactical Towed Array Sonar System
TFF:	Tactical Fighter Force (Aust)
USMC:	United States Marine Corps
USN:	United States Navy
V/STOL:	Vertical/Short Take-Off and Landing

PREFACE

Perhaps the major problem facing those wishing to write about Australia's decision to acquire an aircraft carrier to replace HMAS Melbourne has been the pace at which events have moved since the then Minister for Defence announced the Government's decision to purchase HMS Invincible in February 1982. The Anglo-Argentine conflict in the South Atlantic in particular has had consequences unthought-of when first we undertook this project.

As a consequence, this paper has dated somewhat despite our best efforts to keep it abreast of developments. Some revisions have been possible, but the careful reader will readily discern some allusions, and even some argument, which specifically related to the Invincible decision. Nevertheless, we consider that the central arguments of this work remain sound and applicable to any carrier acquisition option now available, and not just to Invincible.

Indeed, certain of the points made have been reinforced by the recent decision of the British Government to retain HMS Invincible in Royal Navy service. While it is not presently possible to go into detail about the position now confronting Australia's defence decisionmakers, clearly the loss to Australia of Invincible has thrown the entire "carrier question" open once more, and it is not inconceivable that the Government will move to initiate fresh studies of the available options.

As we see it, there are seven options which might be studied. Some of them have been studied previously, others arise out of changed circumstances and one - the last we list below - we would suggest has never received the detailed and systemic scrutiny it deserves. The options we see are:

(a) accept the British offer of HMS Hermes - a carrier laid down in 1944 but not commissioned until 1959 - as a stopgap measure, and postpone a decision on a new aircraft carrier until the end of the decade. Hermes of

course saw service with Invincible in the recent South Atlantic conflict.

(b) place an immediate order with the British for a new Invincible-class platform, with expedited construction (as far as possible) and a possible delivery date of 1988-89. In the meantime, Australia could either recommission Melbourne, lease Hermes or go without an aircraft carrier until delivery.

(c) revive the option of modifying the US Iwo Jima class LPH, the option we believe was the leading contender in the selection process until the British offered Invincible to Australia in September 1981.

(d) revive the possibility of acquiring an Italian Garibaldi class ship.

(e) lease or buy a "second-hand" carrier, not as a stopgap but as a longterm addition to the fleet. A vessel mentioned in this context is the USS Oriskany, in mothballs at present, and at 40,000 tons full load, significantly larger than anything previously considered.

(f) recommission Melbourne for as long as she will last, with a full scale refit to bring her up-to-date and restore her ability to embark fixed-wing aircraft.

(g) abandon altogether the idea of maintaining a seagoing aircraft platform in the RAN and embark on the development of new operational and force structure concepts.

All of these options involve problems - operational, financial, with the force structure, political.

It is not possible at this stage to enter into a full analysis of these options. In one sense, we have done so for all of them in the body of the paper: a perusal of our conclusions will leave the reader in no doubt as to which of the seven we would advocate. We would, however, add these brief comments.

The acquisition of USS Oriskany does not seem financially feasible, quite aside from the fact that she is designed to operate more and larger aircraft than the RAN has ever flown from its earlier carriers. Jane's Fighting Ships 1981-82 states that to bring Oriskany out and get her in shape to steam would, by itself, cost some $US170 million (p.638). To this would have to be added the actual acquisition or leasing costs, the costs of modifications needed for Australian purposes (likely to be extensive), aircraft costs - this would depend on the choice of aircraft - and manpower costs, none of which would be modest.

To recommission Melbourne is undoubtedly possible. However, as we have observed in our conclusions, to do so will achieve nothing more than postpone the day when an Australian Government is going to have to face up to the hard decisions about seaborne air power. This option we rate as little more than cosmetic and, like most cosmetics, relatively expensive with little to show for them in the long run.

Much the same can be said of the Hermes option. This vessel is undeniably antique and could not serve very much longer than Melbourne.

The modified-LPH and Garibaldi options have already been studied and rejected by Navy. Recent events have done nothing which could substantially vary the reasons for those rejections, be they operational or financial.

The possibility of acquiring a freshly built vessel of the Invincible class offers some superficial benefits. It would be possible to incorporate a ski jump of a better angle, to fit a

Phalanx CIWS in construction (rather than the more costly retrofitting originally contemplated), to improve air conditioning and, perhaps, to do something about the somewhat troublesome vibration problem which plagues Invincible herself. No major design changes could be contemplated without substantial additional costs and inflation alone would push the vessel's cost up well beyond anything contemplated when the original Invincible deal was made. We have looked in some detail at Invincible in the body of the paper.

Moreover, we do not see how any option which is likely to involve the expenditure of significant sums in the period beyond 1985-6 can be supported without the allocation of very large additional sums into the FYDP.

While the situation at present remains fluid, we believe that it is fortunate for Australia that an opportunity has appeared for us to re-think the entire question of the suitability of an aircraft carrier-type vessel for the RAN. In our view, the essential arguments we present herein and the conclusions we have drawn from them remain as valid now as they were when the only option under consideration was the acquisition of HMS Invincible herself.

Canberra,
28 July 1982

A NEW AIRCRAFT CARRIER FOR THE ROYAL AUSTRALIAN NAVY?

A Strategic, Operational and Financial Analysis

Gary Brown and Derek Woolner*

1. Introduction

Ever since HMAS Sydney entered RAN service in 1948, the Australian Defence Force has operated one, and sometimes two, seagoing platforms for fixed and rotary wing aircraft. The advancing age of the Navy's present carrier, HMAS Melbourne, and the Government's eventual decision to acquire HMS Invincible from the United Kingdom led to a spirited debate as to the wisdom of maintaining an aircraft carrier - whether with antisubmarine helicopters or Harrier-type fixed wing aircraft - as part of Navy's order of battle. The recent British decision to retain Invincible, with its consequent decisionmaking problems for Australia, has changed the direction but not the intensity of that debate.

In this paper we propose to examine in some detail the case which has been made by the Navy, the Department of Defence (DoD) and the Government supporting the decision to acquire a new carrier, and specifically to examine the capabilities of HMS Invincible. Thus, we will be considering the strategic situation and the relevance to it of an aircraft carrier; operational factors, including the survivability and operability of a carrier into the next century, the value of helicopters and fixed wing aircraft; and financial considerations which bear directly on the viability of the Five Year Defence Program (FYDP).

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* The authors are on the staff of the Defence Research Group in the Legislative Research Service of the Commonwealth Parliamentary Library, Canberra. The views expressed in this paper are entirely their own and should not be taken as representing those of the Commonwealth Parliamentary Library. The authors wish to thank the management of the Library for the assistance afforded them during the preparation of this paper, and Ann Pooi for super-human efforts at the word processor.

2. Background to the Carrier Decision

Australia's present flagship, HMAS Melbourne, is approaching the end of her economic service life. Originally a British Majestic class carrier, she was laid down in 1943, launched two years later and entered RAN service in 1956. In 1959, the Menzies Government decided to phase out the Fleet Air Arm by using only existing aircraft on Melbourne until 1963, when her theoretical useful life would be at an end. In announcing this decision, the then Defence Minister (Mr. Athol Townley) said:

> A replacement carrier of a more modern type, that would be suitable to our requirements and within our Budget, is not available from any likely sources. The construction of a new carrier... could not be seriously considered; the cost would be completely prohibitive, and the time required for new construction would not meet our needs. In any case, the position is that naval aviation is now a complex and costly enterprise, both in respect of carrier and aircraft. It is therefore extremely doubtful if it is possible for a small navy such as the Royal Australian Navy to keep pace with modern developments in this field, without unduly prejudicing other defence activities, not only from the joint service aspect, but within the Navy itself.1

In 1960, however, the Government decided to retain Melbourne in the role of an anti-submarine warfare (ASW) helicopter carrier, and twelve Wessex helicopters were acquired to this end. By 1963, the phase-out plans announced in 1959 had been substantially dropped, and a decision taken that the carrier would continue to operate fixed-wing aircraft until 1967. In that year, the phase-out was formally abandoned, Melbourne underwent a major refit and new fixed-wing aircraft - the first batch of Skyhawks - procured. The Wessex helicopters (helos) were also modernised. A further extensive refit was completed in 1976 and new ASW helicopters - Sea Kings - replaced the Wessex 31B machines.

Funds were allocated in the 1981-82 Budget for a further refit of Melbourne to allow her to operate into the mid-eighties. With the likelihood of acquiring Invincible, however, it was

decided to suspend this refit, and when the decision to buy the British vessel was made, Melbourne's refit was cancelled.

Successive Governments have faced the problem of what to do when Melbourne leaves service. With the exception of the 1959 decision to disband the Fleet Air Arm, all Governments have postponed any definite resolution by further extending the carrier's service life: this option has been adjudged no longer available. In 1977, therefore, the Government decided to initiate preliminary investigations of options which might satisfy our requirements after Melbourne's departure. An Invitation to Register Interest (IRI) was issued in September 1977, asking companies around the world to submit proposals on a "no obligation will be entered into" basis.[2] By February 1978, some sixteen companies from five different countries had submitted responses to the IRI.[3] In August 1979, the Minister (Mr. Killen) told Parliament that investigation had been narrowed down to three companies:

- Empresa Nacional, Bazan, Spain: a variant of the US Sea Control Ship;

- Italcantieri, Monfalcone, Italy: the Garibaldi class; and

- Litton-Ingalls, Pascagoula, USA: the LPH Iwo Jima class.[4]

All this was of course still in the context of an investigation, rather than an assessment of contenders to fill a specified requirement: the Government had made no official announcement of a decision to acquire a new carrier. Nevertheless, it was clear that significant pressures in favor of acquisition were building up led, not surprisingly, by the Navy itself. For example, Navy officers interviewed on the media later in 1979 made no bones about their view, as these remarks

made by Commodore Robertson, RAN, on the ABC TV program Nationwide indicate:

> ... I believe that if we don't acquire a carrier we will have told the world that we are no longer interested in securing the use of the sea beyond the range of land-based air and that is very limited indeed, particularly for fixed-wing fighters.5

Indeed, official Navy evidence to the Sub-Committee on Defence Matters of the Joint Standing Committee on Foreign Affairs and Defence (the Katter Committee) strongly argued for a carrier some months before the Government had made its decision:

> It is Navy's strongly held professional view that the absence of integral seaborne air would seriously jeopardise our capability to conduct effective maritime operations in our areas of interest and significantly reduce the options open to Government.6

In the event, it was not until 9 September 1980 that the Government finally announced its commitment to a new carrier. The Minister told Parliament:

> The Government has decided to replace HMAS Melbourne with a purpose-designed ship to be equipped with helicopters for anti-submarine warfare, but with a potential for operating also short take-off and vertical landing - STOVL - aircraft. The Government will not make a decision on the actual acquisition of STOVL aircraft until 1983. I should emphasise that at this stage there is no commitment to acquire STOVL aircraft. The period between now and 1983 will provide valuable time for the Government to assess the advantages, availability, suitability and cost of STOVL aircraft in the light of further development of this particular type of aircraft. Further definition of the carrier details will now be undertaken and be completed in the next financial year.7

Despite the Minister's announcement in August 1979 that the three ships previously mentioned comprised the list of contenders, developments in the United Kingdom in mid-1981 led to media speculation that a British carrier of the Invincible class was also under consideration. Budgetary cutbacks in the UK led the Government there to decide to retain only two of the three

Invincibles it possessed, the third of which, Ark Royal, had been launched in 1981. However, the media also reported that senior Australian Defence sources were denying this speculation. An article in the Sydney Morning Herald on 24 June 1981 by Peter Hastings said:

> Senior defence sources in Canberra emphatically denied yesterday that Australia was looking to buy "cast off" Royal Navy ships at bargain prices....
>
> "You can forget about Hermes [an old UK carrier]", said one senior defence official. "She's out of date. We were offered an Invincible-class ship several years ago and knocked it back".8

An article in an Australian defence journal in June 1980 had also reported that the Invincible class had been rejected in the initial RAN analysis (presumably the analysis of the sixteen initial respondents to the IRI).[9]

On 1 September 1981, however, the Financial Review reported that "a British Government sales team will arrive in Australia next week in a determined bid to sell... one of the new Invincible class light carriers now declared surplus to British needs".[10] It was as a result of this visit that Mr. Killen issued a Press Release on 24 September 1981, which announced that:

> The British Invincible class aircraft carrier design is to be evaluated, along with other designs already under study, as a possible replacement for the aircraft carrier HMAS Melbourne.
>
> The Minister for Defence, Mr. D.J. Killen, said today this had been decided following discussions with officials of the British Defence Ministry in Canberra.
>
> Likely cost and the ready availability of a ship from Britain had been important factors influencing the decision, he said.
>
> ... the Invincible class design would be evaluated in competition with other designs at present under study. These included a modified version of the US Iwo Jima class landing platform-helicopter (LPH), and a variant of the US Sea Control Ship Design.

> As a result of earlier investigations, the Department of Defence already had considerable information available on the Invincible class.11

This statement was of major significance. Firstly, it overturned the "emphatic denials" of senior Defence Department sources reported by the Sydney Morning Herald in June, and added the Invincible class to the list of contenders. Secondly, it acknowledged that the Defence Department had much data on this class as a result of earlier investigations, thus adding credence to the claim that the Invincible class had been evaluated and rejected by Defence in its analysis of the sixteen IRI responses (see p.5, above). Thirdly, it was unusual in that the Minister chose to make this particular announcement via a press release on a day when both Houses of Parliament were in session, when most other major statements were made in Parliament. Finally, by failing to mention the Italian Garibaldi class with the LPH and the Spanish Sea Control Ship, it gave a strong signal (though not a definite statement) that the Italian carrier had fallen out of contention.

That this was indeed the case was finally established on 25 February 1982 when the Minister told Parliament that:

> ...the Government has decided that Australia is to purchase the aircraft carrier HMS Invincible from the United Kingdom to replace HMAS Melbourne. The plan is to take delivery of the ship in late 1983 .... The purchase price of the Invincible is £175m sterling, which at the August 1981 exchange rate was $285m. This was quoted as a firm price not subject to escalation. The total project costs, including provision for spares, test and training equipment, necessary modifications and other support, but excluding missiles, is estimated at $478m at August 1981 prices and exchange rate.12

The Minister also said that Invincible had initially been eliminated from contention because of cost, but that following the mid-1981 British defence cutbacks, she had been offered to Australia at a "lower and more than competitive price". He also stated that, while Invincible is capable of operating short

takeoff/vertical landing (STOVL)* aircraft of the Harrier type, it was intended at present to embark only - "I repeat, only" - ASW helicopters. The possibility of subsequent STOVL acquisition (which, it will be recalled, was originally intended for decision in 1983, as announced by the Minister in September 1980) was also downplayed by the Prime Minister (Mr Fraser) the day after the Invincible decision was announced:

> It will be used as a helicopter carrier and there shouldn't be any expectations in present circumstances that we'd go beyond that .... We bought the carrier for its contribution to anti-submarine warfare, not for its capacity to have short takeoff and landing aircraft.13

The English-Argentinian dispute over the Falkland Islands, wherein Invincible played an important role, has led to suggestions in the UK that the decision to sell was perhaps hasty. The statement by Prime Minister Fraser in May, to the effect that the British could keep Invincible and their acceptance of this offer, has thrown the entire carrier debate back into the melting pot.

The announcement of the Invincible buy shifted the "carrier debate" from a general discussion of the issues to a close examination of what Invincible can offer the Defence Force, but her non-availability has again widened the debate. Thus, more general considerations, particularly of a strategic nature, remain of relevance when assessing the carrier question, and it is to these that we now address ourselves.

3. The Strategic Requirement for a Carrier

Few would take issue with the view of the Katter Committee, expressed in its November 1979 report on Australian Defence Procurement, that:

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* The most recent change in the jargon is to refer to the Sea Harrier as a "Short Take-Off and Vertical Landing" aircraft to more accurately describe the operational procedure now almost always used with these aircraft. The "vertical" reference (V/STOL = Vertical or Short Take-Off and Landing) is seldom relevant today because of the restricted payload

> A nation's strategic environment is the prime determinant of its defence objectives, strategies and doctrines and of the defence forces it maintains. Thus it is a prime determinant of its defence procurement policy.14

In other words, any significant defence equipment program must be based on requirements which can be derived validly from an assessment of the nation's strategic environment. This is not to suggest, of course, that it is necessary to develop specific forward projections or scenarios to support the acquisition of any given major equipment - indeed, for a nation like Australia where no single threat is readily identifiable, such an exercise is likely to be futile more often than not - but simply to say that if an equipment program is clearly at variance with the assessed strategic environment, then its validity must be open to serious question. For example, it would be most difficult to support the acquisition of, say, a further two hundred Leopard 1 tanks in terms of a requirement credibly derived from an analysis of our strategic situation in the foreseeable future. In the case of the aircraft carrier, then, its advocates have been at some pains to try to show that our strategic situation does in fact generate a requirement (or a spectrum of requirements) which the proposed acquisition would meet more cost-effectively than either no acquisition at all or the acquisition of some other weapons platform or platforms.

A major statement in favor of a new carrier appeared in the Defence Force Journal in late 1977. Written by Captain I.H. Richards, RAN, at that time Director of the Carrier Project, this article argued in essence that the RAN cannot afford to lose the capability to project air power beyond the range of land-based aircraft and that there is a requirement for air power as an integral part of RAN capabilities against both surface shipping and submarines. The article stated:

> There are three fundamental properties of carrier based air power which combine to give it a unique quality not otherwise available.... These properties are base mobility, proximity and the organic nature of the air power.15

By "proximity", Richards meant that the carrier in its role as a mobile air base can be close to its targets, with all the advantages that this involves. The "organic nature" of air power he explained as:

> ...its close integration into the tactical organisation of the force with which it operates. It is an integral part of the total force... [the prime benefit of which] is rapid reaction. The high speed of modern aircraft and missiles, coupled with the difficulty in achieving long range detection, can result in a very short period between initial detection and missile delivery/impact. Swift reaction is thus crucial to success... this swift reaction can only be achieved if the aircraft are provided as an integral element of the force.16

Richards very correctly pointed out, some two years prior to the Katter Committee, that all the operational advantages claimed for carriers may be valid and yet leave questions as to the strategic requirement for such a platform. He therefore addressed the strategic need for a carrier:

> Not only geography, but our reliance upon seaborne trade, dictates a maritime strategy. Virtually all our overseas trade and much of our interstate trade is carried in ships. Significant interference with our overseas and coastal trade could call into question the ability of many segments of our defence force to continue operating. Even in the event of war, Australia would be dependent on trade for its continuing existence.... Short of nuclear "blackmail" disruption of our sea lines of communication may well be the only form of serious threat which Australia alone might face from a regional power in the long term....
>
> The linch-pin of the argument for carrier borne air power is that it would be valuable in <u>any</u> situation in which Australia were required to display or use military force.17

Defending Sea Lanes of Communication

This emphasis on protection of Australia's sea lanes of communication (SLOC) can also be found in other arguments which have been advanced for acquisition of a new carrier. Vice-Admiral (Ret) Sir Richard Peek (a former Chief of the Naval

Staff) giving evidence to the Katter Committee in July 1980 for the Australian Navy League, stated bluntly that:

> Without one or more seaborne aircraft platforms, armed with anti-submarine helicopters and vertical or short takeoff aircraft of the Harrier type, we just will not have a blue water navy any more.... Even to suggest that we can protect our trade and our resources within the short range for which shore based aircraft can provide cover is almost irresponsible.18

Mr. A.W. Grazebrook of the Navy League has argued along similar lines as long ago as September 1976.[19] Thus, both the Director of the Carrier Project Office and a significant body of outside opinion considered the protection of Australia's SLOC to be a prime determinant of the requirement for a carrier or carriers.

The likelihood of a SLOC protection requirement merits investigation: Under what circumstances could Australia's SLOC come under serious threat? Discussions of Australia's strategic situation frequently categorise three levels of contingency which might arise - low level, medium level and high level. These are defined in terms of their probability, the degree of military action likely to be involved in each case and the amount of warning which can reasonably be expected.20 Thus, low level contingencies (minor raids and incursions) could arise at very short notice, while a high level problem, such as a set-piece assault on continental Australia, could only occur in the context of great international tension, if not global conflict, which could take many years to develop. The table below sets this out in a convenient form. Significant threats to our SLOC might fall into a medium or high level situation: however, it is necessary to consider just what such threats would imply in terms of international politics and the military capacity to operate against Australia.

LEVELS OF THREAT TO AUSTRALIA'S SECURITY

Level	Example	Relative Probability	Relative Warning Time
HIGH	attempted long-term lodgements, invasion	relatively low	long
MEDIUM	major raids, attacks on outlying possessions (Cocos, Xmas Islands)	midrange	midrange-short
LOW	sabotage raids, EEZ incursions, manufactured incidents, air or sea harassment	relatively high	short-almost nil

It would be no simple matter to embark on a campaign against Australian SLOC. To mount a serious threat would require the stationing of warships - probably submarines - astride key routes or near focal areas where sea lanes converge near ports, while maintaining such a threat over a long period would imply rotating submarines on station. A substantial submarine force would thus be required for any power wishing to interfere with Australia's SLOC. While the Soviet Union possesses this capability, it is not easy to develop a scenario short of war between the superpowers in which the Soviets would exercise it; while in a global war, the bulk of the Soviet submarine fleet would most likely be occupied elsewhere.[21] In any event, it would seem that a serious threat could only develop as part of a high level, low probability situation.

This conclusion is heavily reinforced by the nature of our seaborne trade. Very little of Australia's overseas trade is carried in Australian bottoms: in the nine months ending March 1980, for instance, only 6.4% of Australian overseas trade was carried in Australian flag vessels.[22] To make any significant impact on Australian maritime commerce, a foreign power would be obliged to credibly threaten acts of war against ships of non-

Australian registry - in many cases, of Japanese, US, British or even Soviet bloc origin: this would severely test the resolution of a country hostile to Australia. Thus, a serious threat to Australian SLOC short of general war must be deemed improbable while our trade is carried in foreign bottoms.

Indeed, for some considerable time, Navy itself moved away from the concept of defending Australia's SLOC as a major factor in the carrier debate. In March 1981 the Chief of Defence Force Staff* (Admiral Sir Anthony Synnot) gave evidence to the Katter Committee in which he said:

> We do not see Australia being capable of escorting all merchant ships across the oceans but we do see us firstly trying to keep our ports open and what we call "focal areas" - that is where all the trade routes come together - because that is where a [hostile] submarine would go to find its target. Over the wide oceans you can spread your merchant ships out and submarines have great difficulty finding their targets and so they come in closer to your focal areas.23

The SLOC argument - in the sense of defending very long lines by projection of sea power - was again effectively refuted by a Navy Press Briefing held on 1 July 1981. This stated, inter alia:

> Much of our overseas trade could be re-routed away from a known threat area and in any case, disruption of Australia's trade must involve third-party nations - either the flag nations of the foreign vessels carrying 98% of our peacetime overseas trade or the nations with whom Australia is trading. Widespread measures for the protection of maritime commerce would likely be required only in a situation which was tantamount to global war.24

It is difficult to take issue with the view of the Chief of the Defence Force Staff (CDFS) at the Katter Committee or indeed with that expressed by Navy in the press briefing paper just cited. However, neither sits well with the case made by Captain (now Admiral) Richards in his earlier Defence Force

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* Throughout this paper, "CDFS" refers to Admiral Synnot unless specifically indicated otherwise.

Journal contribution (see p.9 above). More recently, the suggestion has been advanced that a requirement may exist at some future time for escort not of the bulk of our trade but of an individual vessel, or perhaps two or three vessels, carrying a cargo of great economic or defence significance. While it is certainly possible to posit such a scenario, it is perhaps of dubious utility in assessing the real requirement for an aircraft carrier. Several points can be made in this regard:

(a) many such cargoes could, if desperately needed, be carried by air. Even large and weighty cargoes can be accommodated in an aircraft like the Lockheed C-5A - for example, two M-60 tanks (98,000kg), or 16 3/4 ton lorries; or one M-60 and two Bell Iriquois helicopters, 5 M-113 personnel carriers, one M-59 21/2 ton truck and an M-151 1/4 ton truck; or 10 Pershing missiles with tow and launch vehicles. Its gross load capacity is about 100,000 kilograms.[25] While the C-5A is not in the Australian inventory, if the need were genuinely desperate it is difficult to imagine our US allies refusing us the use of one or two from their inventory of seventy, which the US Defense Department currently proposes to increase to 120 by FY 87.

(b) the escort of a ship carrying a crucial cargo by the carrier (plus, presumably, its own escort of three or four destroyers or frigates) would be an extremely difficult exercise to conceal. An enemy would find such a grouping a conspicuous and tempting target. A naval battle of some intensity could be anticipated if the enemy was able to deploy submarines and/or surface vessels, or (at some point) even land-based air against this convoy. While the outcome cannot of course be predicted definitely, this prospect must at least bring into question the wisdom of committing so much of RAN's strength to the escort even of a critical shipment. Analogous objections might also apply to the C-5A operation suggested in (a), but in that case transit time is substantially less and even the loss of a C-5A and its escorting aircraft would not do as much damage as that of the carrier or, indeed, of part of its escort. One might ask who would (or could) attack US transport aircraft flying to Australia over the Pacific, and under what circumstances.

(c) alternatively, it would be possible to conceal such a cargo quite effectively by making it merely one of a large number of cargoes in transit. To guarantee interception, an enemy would be obliged to stop all shipping on the route, thus requiring the deployment of substantial forces over a long period. This would present even a large naval power with a difficult operational problem.

(d) the entire "crucial shipment" scenario assumes that Australia is involved in hostilities of some magnitude: that an enemy is prepared to attack such shipments (even if carried in foreign bottoms) and that the conflict has gone on long enough for Australia to be in desperate need of the cargo. Such a scenario in fact assumes conditions approaching global war if one agrees with the Navy assessment of the chances of interference with our SLOC quoted at page 12 above. In fact, global war conditions are likely to mean that most hostile submarines have higher priority tasks than threatening Australia's SLOC.

(e) furthermore, little has been said about the possibilities of avoiding the necessity for such shipments by prudent stockpiling of essential materials. It is difficult, because of the justified secrecy surrounding our defence-oriented stockpiling, to be categorical about this matter, other to say that careful stockpiling would clearly be good policy.

(f) it has been suggested that Australia may require the carrier and its escort to protect a critical shipment leaving Australia. This could involve not only goods but perhaps a military force. Michael MccGwire discussed this at the first Australian Naval Institute National Seminar in 1979:

> Australia might consider it essential to intervene in Papua New Guinea, if the government offered an unfriendly major power extensive rights and facilities within its borders ... an Australian military takeover could be mounted without much difficulty. This could rely primarily on airborne assault, with merchant ships [and, one can now add, HMAS Tobruk] providing the lift for succeeding echelons. While participation by carrier-borne fixed wing aircraft would be useful, comparable support can be provided by other means.26

MccGwire's conclusion can of course be disputed in scenarios where the destination is more remote than Papua New Guinea. However, such would imply that Australia acting alone will require the capability to land forces in "forward defence" operations areas. This suggests a radical departure from the accepted "defence of Australia" policy and, moreover, that a sufficiently serious situation had arisen overseas which was nevertheless within our capability to contain by projected power. The policy change is, per se, feasible (though in our view unwise), the situation much less so.

The defence of Australia's SLOC over their entire length is a clear impossibility for a nation with the limited maritime capabilities of Australia, and this will remain so whether or not the RAN possesses a carrier. While it is possible to postulate scenarios where a one-off shipment of critical importance needs escort, the assumptions implicit in such scenarios either favor stockpiling in advance, the air transport option or suggest that the entire convoy, even with a carrier and its escort, would have to fight its way through whatever an enemy could throw at it with no guarantee of survival. (The seriousness of such scenarios also implies that the enemy would throw quite a lot). Moreover, the same assumptions necessarily imply that the one-off exercise is of small probability. To suggest that this kind of exercise can contribute significantly to a case for an aircraft carrier is to rely too heavily on relatively remote possibilities.

Carriers for ASW

The preceding analysis suggests, in short, that the defence of Australia's SLOC does not per se support a requirement for an aircraft carrier. Indeed, the evidence clearly indicates that Navy itself de-emphasised SLOC defence in the period between the publication of Captain Richards' article in late 1977, the evidence given to the Katter Committee by the CDFS in March 1981 and, finally, the briefing given to the media in July 1981. However, one aspect of SLOC defence was specifically exempted from this de-emphasis by CDFS in his Katter Committee evidence, namely the defence of focal areas where sealanes converge off the

coast near major ports (see p.12 above). In this context, it has been strongly argued that a requirement does exist.

There can be no doubt that credible scenarios exist for a submarine threat to Australian SLOC in focal areas. At present, we can be said to have two or three major focal areas: off the southwest coast and on the east coast off Sydney and Melbourne. Smaller concentrations of marine traffic also exist (and may increase as resource exploitation expands) in the northern sector near the northwest shelf gas fields and at export points for other minerals in the Darwin-Weipa-Gove area. It is quite possible for hostile submarines to be placed on station near such concentrations with a view to interdicting or at least substantially disrupting Australian overseas trade at the source. At the same time, the substantial constraints on hostile operations of this type (already mentioned) need to be borne in mind: the consequences of interfering with ships flying the flags of nations other than Australia, and the operational implications involved in maintaining conventional submarines on station so as to apply the interdiction effectively.

Accepting that a potential enemy possesses the necessary submarine force and is prepared to commit it to this type of operation, there would be a clear ASW requirement for the Australian Defence Force. Australia could not permit an interdiction operation of this type to proceed unhindered: at the same time, the defeat of this operation would force an enemy to drastically re-cast his strategy, given the great difficulties and larger forces involved in attacking Australia's SLOC away from focal areas.

CDFS has argued that a helicopter carrier can provide the most cost-effective ASW operation for focal area ASW:

> The helicopter carrier does give you this other dimension in anti-submarine matters that you would otherwise not have. You can, to some extent, put those helicopters into smaller ships.... But it is not a very economical way of doing it. You really need six of these large helicopters and the maximum you can carry on one of these small ships is two. It is really much more

> economical to carry them in a big ship where you have better workshops to repair them. It is not so rough because the bigger the ship, the less you notice the rough weather. You can operate them in rougher seas; you can repair them in rougher seas and that sort of thing.27

Given that the acquisition at a later stage of STOVL aircraft for an Australian carrier is still problematical - indeed, the Prime Minister's statement reported in the Canberra Times (see p.7 above) has been interpreted as reducing still further the chances of STOVL acquisition - it is certainly true that the carrier's only capability, apart from task force command and secondary sealift aspects, is in the operation of ASW helicopters. Thus the requirement for this capability has become an essential element - and, with taskforce command, almost the essential elements - of the case for acquisition.

Alternatives for Focal Area ASW

Given that a credible threat to Australian SLOC focal areas can be posited, it is clearly important to develop solutions which provide the most cost-effective means of denying hostiles access to the areas in question or of destroying them in the event of penetration. That the ASW helicopter carrier possesses a capability in this mission is beyond dispute: however, there is very little on the official public record to indicate that other solutions, especially solutions based on relatively new technologies, have received serious investigation.

The problem of successfully defending focal areas against hostile submarines breaks down into three elements: detection, vectoring of forces to the vicinity and destruction. A solution based on the ASW carrier relies on conventional means of accomplishing each phase. Patrol aircraft will detect the presence of a submarine; ASW helos will establish the intruder's position and either attack themselves or direct surface vessels and/or friendly submarines to the area to attack. This solution, while tried and true traditional ASW, is by no means the only one available.

Of great potential usefulness in focal area defence would be fixed-array sonars. These consist of a pattern of underwater microphones (hydrophones) so arranged as to be able to hear intruding craft and provide data as to their location. A well-known fixed array ASW system is the United States' SOSUS (Sound Surveillance Under Sea) family, which includes subsystems such as CAESAR, COLOSSUS, BARRIER and SEA SPIDER. SEA SPIDER has been installed in waters off the Hawaiian islands and consists of bottom-mounted hydrophones interconnected by cable and thence to onshore data-processing and display systems.[28] Though the hydrophones are bottom-moored, it is believed that they are strung vertically at various depths to provide enough data to generate a three-dimensional "picture" of detected targets, thus yielding data on range, azimuth and depth. It is difficult to ascertain the cost of this type of three-dimensional fixed array system: however in the last three US Fiscal Years, $US 128m (FY 80), $106.8m (FY 81) and $124.3m (FY 82) were spent on procurement for CAESAR. However, one of the reasons for this continued high level of funding is that it is undergoing a constant program of upgrading. This includes the installation of a number of proven low-cost sensors (which will reduce the manpower requirement) and of certain classified equipments, as well as the removal or refurbishment of certain portions of CAESAR, because newer equipment with greater detection ranges was available.[29] Moreover, CAESAR is installed in a large number of locations on both the Pacific and Atlantic coasts of the US, thus pushing up the overall cost.

On the face of it, there seem to be valid grounds for a detailed investigation of the potential applicability of fixed-array sonar systems - if not on the lavish scale of CAESAR - to the antisubmarine defence of Australian SLOC focal areas. Of course, even if such an investigation did show that the concept is applicable, this would by no means represent the entire solution to the defensive task. However, CAESAR-principle installations might well form a valuable component of an effective focal area defensive system functioning without any

requirement for the capabilities of an ASW carrier. In broad outline, the components of such a system could be:

(a) a CAESAR-principle fixed-array three dimensional sonar system covering the approaches of our SLOC focal areas to provide initial warning and general location data. Data from this system would go to a shore station.

(b) land based fixed-wing ASW aircraft operating sonobuoy sensors to investigate detections by the fixed-array system, verify them and localise the contact with sonar and, finally, magnetic anomaly detectors. (Rotary-wing aircraft could also be deployed for this task if the detection was close enough to the shore station to restrict transit time and allow adequate loiter time).

(c) ASW forces, including fixed and/or rotary-wing aircraft, which may often be those in (b) above, plus surface vessels in some instances, to be vectored to the localised detection for attack;

(d) the shore station would receive input from the fixed-array system and act as operational control for mobile detection/attack units.

Such a system would not require the capabilities of an ASW helicopter carrier to function effectively. The range of CAESAR-type systems is classified, but is nevertheless believed to be great enough to cover focal areas without difficulty, while P-3 aircraft (already in the inventory) or a machine like the S-3 Viking ASW aircraft would be capable of both detection and attack missions.* Because the SLOC focal areas are relatively close to

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* The system's performance in the GIUK gap is said to be outstanding (Four Corners, 18 Feb 1978).

the coast, there seems to be ample justification for consideration of land-based systems operating in tandem with fixed-array sonar as a potential solution to the ASW problem. Should such a solution be found to be viable, the claim that an aircraft carrier is required for the SLOC focal area ASW mission necessarily loses much of its force.

Another possibility, particularly if Australia strengthens her submarine force, would be to station submarines off enemy ports or at key choke points to attack hostile submarines before they became a threat in our focal areas.

Whether or not these concepts are valid is, in one sense, not as important as whether or not they received serious attention before an in-principle decision to acquire a new carrier was made. In this context, the views of the Katter Committee in its 1979 report on defence procurement are worthy of mention:

> The Committee reiterates its view that strategic circumstances are subject to change and that as a consequence of this and changes from other sources, Australia's Defence Force requirements are also subject to change. It is therefore of primary importance that the impending obsolescence of a weapon system or platform not be taken as a cue to initiate processes leading automatically to the acquisition of a system or platform of the same type ... there is a responsibility at such times to commence the procurement process from its initial phases ...30

There is little evidence to support suggestions that alternative ASW options such as that sketched above did receive serious consideration.

The Carrier as a Deterrent : Strike Capability

One of the major criticisms which levelled at the Invincible decision was that Australia would have acquired an aircraft carrier with no aircraft. Certainly the Minister (Mr Killen) was at some pains in his statement announcing the

decision to emphasise the ASW helicopter carrier role over the strike role:

> Further, the ship is capable of operating short take-off and vertical landing aircraft of the Harrier type, although at present it is intended only, I repeat only, to embark ASW helicopters.31

Indeed, as already noted (see p.7 above), remarks attributed to the Prime Minister emphasised the point, already stressed by Mr Killen in his Parliamentary statement. Certainly, the state of the FYDP (Five Year Defence Program) into the foreseeable future indicates that acquisition of STOVL aircraft will be no easy matter. (Financial aspects of the carrier decision are dealt with in detail in a subsequent section of this paper - see p.113ff).

Nevertheless, even if the importance of fixed-wing aircraft operations from a carrier apparently declined in the Government's thinking, the potential of the platform to operate STOVL aircraft is worthy of consideration. While later parts of this paper will deal with strictly operational aspects of STOVL aircraft and the Invincible class, we will address in this section the strategic requirement for this capability and offer an evaluation of its validity. Because an integral element of a strike capability is its potential deterrent effect, it is appropriate to consider this aspect immediately.

It is important to understand clearly the difference between a defence force and a deterrent force if one is to attempt to assess Australia's requirement for the latter. In their work on nuclear strategies, Albert Legault and George Lindsay discuss this difference:

> It is hard to overemphasize the psychological aspect of deterrence. J.D. Singer and the American behaviorist school define the perception of a threat as the product of the estimated capability of the opponent's forces multiplied by the estimated probability that he will use them .... the policy of deterrence consists in not engaging in warfare, but preventing it, by threatening

any attacker with reprisals which would cost him more in damages than he would gain by his resort to force.32

In a specifically Australian context, the Katter Committee's 1979 procurement report outlined an approach to the defence of Australia which it called the "high cost of entry approach":

> The basis of this concept would be to develop and maintain a military capability which would raise the cost and risk of any military activity which a potential enemy should contemplate to a degree unacceptable to that enemy. The deterrent capability developed should be relevant to all levels of potential enemy activity.
>
> Capabilities acquired should [relate to both our environment and to enemy vulnerabilities] ... They should seek to exploit those factors which would produce a multiplier effect; they should seek to compound an enemy's problems by forcing the enemy to combat a range of threats; they should seek to ensure that the capabilities required by the enemy to combat those threats would be specialised, expensive in cost and manpower, and long-lead items.33

Thus the deterrent requirement is not necessarily for forces designed to defeat a specific threat assessed as more likely than others: it can be for forces capable of inflicting on the enemy levels of damage, to his defence and/or economic infrastructure for example, which are unacceptable to him. (This we call "offensive deterrence", in contradistinction to "defensive deterrence" which is predicated on possessing the visible capability to inflict unacceptable damage on any hostile force unwise enough to venture within our reach). In this knowledge, the potential enemy should not proceed with his intended military adventures against Australia. Either deterrent effect is, moreover, significantly enhanced if it can generate an enemy requirement for what the Katter Committee called a "multiplier effect", otherwise known as a disproportionate response: in other words, forcing the enemy to add new weapons and platforms to his own equipment inventories at a higher relative cost than that incurred by Australia in acquiring its deterrent force in the first place. If successfully carried off, the disproportionate response strategy is one in which the potential

enemy cannot win without incurring far greater defence costs than Australia.

It would be readily agreed by defence observers that Australia has a requirement to be able to handle alone both low and medium-level contingencies. Even now Australia's Defence Force has on strength elements with considerable deterrent value, and a STOVL equipped carrier would add further deterrent capability to the force.

The questions which need to be answered with respect to the carrier's value as a deterrent include the following:

(a) is additional deterrent capability required?

(b) can the carrier fulfil the strike role sufficiently well to provide any necessary increment to our deterrent capabilities?

(c) would a carrier, in adding to our deterrent capabilities, add disproportionately to the requirements of potential enemies - or, put another way, will she hurt them more than she hurts us?

The last question is by no means flippant. It is always necessary to consider the "hurt" - the entire cost, cash and other - inflicted by an acquisition on the purchaser in relation to the potential that acquisition has to achieve stated objectives. In Australia's case, the primary objective is ASW.* This has been discussed in other sections of the present paper. A major secondary objective (assuming the STOVL acquisition goes ahead) will be deterrence. The second question really divides into two: can a carrier in the attack role add to our capability sufficiently to help justify her acquisition; and, would its presence impose on potential enemies a requirement to respond

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* We will discuss subsequently the matter of the carrier's capability as a C^3 centre.

It is against these parameters that the potential value of the STOVL carrier should be assessed.

That the risk of misperception, with potentially unfavorable consequences to future regional stability, is real enough should not be doubted. The Katter Committee's procurement report discussed an approach to Australian defence which it termed the "major deterrence approach" and commented:

> It could be misrepresented as a belligerent approach causing our neighbours to believe that Australia was developing a hostile intent, and possibly provoking them into higher levels of defence preparedness and to seek major power supporters, to the detriment of regional stability.36

Alluding specifically to the prospect of Invincible operating Harrier STOVL aircraft, an ABC television interviewer addressed a question most relevant to this point to Rear Admiral Stevens, retiring RAN Fleet Commander:

> Q: With "Sea Harriers" on board it's rather more of an offensive ship than a defensive one. Will this worry any other countries in the region?
>
> A: Well I hope they won't sort of look at it that way. I think that the "Harriers" are really - would provide - the area in which "Invincible" is operating, and I would expect that to be in the area where our own shipping is operating, with some form of local air defence, and I think that's the role I see for the "Harrier".37

Clearly the Admiral felt it necessary to "talk down" suggestions that Invincible with STOVL could be seen in the region as adding an aggressive capability to the RAN.

An element frequently important in the successful maintenance of a deterrent strategy is the requirement for a capacity to react on short notice. While there is of course always warning time for medium level contingencies, the time available for response to a particular act of aggression, even if some act is expected, may be quite short. In this type of situation a STOVL equipped carrier would be useful only if it

were within reasonable distance of the potential target. While it can be argued that a prudent Government advised by competent defence planners would see to it that the carrier was favourably placed, it needs to be recalled that the carrier may well be required elsewhere for its primary mission as seen by Navy, focal area ASW. (Certainly an intelligent and capable foe would be looking to posing some such threat for diversionary purposes, given a sufficiently serious scenario). In any event, there can be small doubt that the reaction time of land-based aircraft for a strike mission will be shorter in all cases save where the carrier is stationed ready for a strike mission; and in such a case it can be assumed that the enemy will have taken measures to counter the threat it poses.

This leads to the next major question about the value of a carrier in the deterrent role: does it force the potential enemy to take measures which amount to a disproportionate response to deal with the carrier and its attendant vessels? The answer to this question would appear to be in the negative for a number of reasons. In brief, it is possible to pose a serious threat to the operational capability of a carrier task force with forces of significantly lower cost and complexity. This is, in fact, the essential consequence of developments in military technology over the last ten to fifteen years. As Dr Robert O'Neill of the ANU Strategic and Defence Studies Centre wrote in 1976:

> The development of a range of precision guided munitions (PGMs), including laser-guided "smart" bombs, terminally guided artillery and rocketry, will confer enormous increases in accuracy.... Some of these PGMs are relatively cheap to produce and it now becomes feasible to plan confidently in terms of firings of single missiles costing tens of thousands of dollars each, destroying targets worth tens of millions of dollars each.38

Of course, while PGM can pose a dire threat to large platforms like a carrier, it is still necessary to place oneself in a position to launch against the target: PGM require platforms themselves. Nevertheless, it remains true that a relatively

simple platform equipped with PGM - even if destroyed in the process - has a chance to destroy or cripple a far more elaborate and complex platform such as an aircraft carrier. This subject will be dealt with in more detail in the section on survivability (see p.39ff): the relevant point at present is simply that the advent of effective PGM makes it increasingly difficult to evoke a disproportionate response from potential enemies through the deployment of large platforms like the carrier (see also pp.87-88).

How Many Carriers?

The discussion to this point has been in the general context of one aircraft carrier: little mention has been made either of the necessary escort vessels or of whether a single carrier would (assuming that a case can be made) be adequate to our needs. The latter point is of particular significance.

Navy statements cited previously indicate that the primary and initial role of the carrier will be in ASW, particularly in SLOC focal areas, with the possibility of subsequent embarkation of STOVL aircraft and the adoption of a strike role as well. Clearly Invincible could not be in two places at once and, moreover, would periodically be out of service for refit - according to a recent RAN presentation, once every four and a half years.[39] (This represents a longer than usual delay between refits: in its 1977 IRI, Navy specified a three-year refit cycle with docking eighteen monthly.)[40] Invincible is scheduled to undergo a short refit - about four months - in the United Kingdom towards the end of 1983, and would then not require further refit for some two years.[41] As she was commissioned in June 1980, the four month refit scheduled for late 1983 (though this would have involved some modifications for Australian purposes) was most likely a scheduled short refit, and that due in early 1986 will be her first major overhaul. It can be anticipated that as the vessel ages - which would occur more rapidly than planned by the British if she is used extensively in the warmer waters frequented by the RAN - refits would have been required more frequently. CDFS told the Katter Committee that in

peacetime the carrier would "be brought in once every two years or once every three years for a relatively long period ... Even with a major refit we can put a ship together quite quickly - usually in three or four days".[42] No explanation of how Invincible was to operate on a refit cycle one-third as long again as that originally envisaged was ever given by RAN. Moreover, it is difficult to see how a vessel could be "put together" in only three or four days after a major refit. In the course of such a refit a vessel will have its paint stripped, its electronics upgraded, its weapons fit updated, its hull and power plant overhauled and so on, and it takes a very considerable time to complete all this work. Even then, radars and her other electronics gear will require calibration and testing. It seems likely that to get a carrier battleworthy in the middle of such a refit would take weeks (perhaps up to six weeks in the worst case) rather than the few days suggested.* It is, of course, possible when pressing needs arise to neglect a scheduled refit, although to do so too often would result in a growing degradation of the vessel's performance.

Nevertheless, it is clear from the case presented by Navy that a single carrier, even if it had one hundred per cent availability, would not be capable of meeting all stated requirements. For example, the large distances between the southeast and southwest SLOC focal areas mean that an ASW carrier could be deployed in one area only should a simultaneous threat arise to both. Again, should it eventually receive STOVL aircraft, she will not be able to operate in both the focal area ASW role and the strike role simultaneously unless an enemy were so foolish as to use submarines and surface units against a focal area. It can be confidently anticipated that an enemy planning maritime operations against Australia would pay great attention to the operational status of our carrier - whether she was in refit or due for refit, and particularly where she was at any given time.

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* Only the fact that she is powered by gas turbines makes a major refit possible in so short a time. Steam driven vessels take much longer to refit fully.

It is a truism that Australia's geography favours a two-ocean maritime force. In this strategic context, the acquisition of a single major unit like an aircraft carrier introduces an operational imbalance in the RAN which cannot be corrected without the acquisition of additional platforms. This is presumably the background to the Minister's remark in the House when announcing the Invincible acquisition:

> Later options for expansion would not be confined to the acquisition of purpose-designed carriers, but could include the conversion of merchant ships for limited roles. This was done with good results in World War II.43

Whether or not the acquisition of converted merchantmen as a supplement to the carrier would be sound policy is a question beyond the scope of the present paper, except that it is doubtful, given the state of the defence budget, that such a project will attain any priority for many years. In the meantime, it is difficult to escape the conclusion voiced by Captain John Moore, RN, in his foreword to the 1980-81 edition of Jane's Fighting Ships:

> ... the acceptance of the basic fact that at least three ships are needed to ensure the timely arrival of one around Australia's vast coastline is still apparently far away.44

Moreover, Admiral Synnot in an address to the National Press Club on 12 May 1982 - just after his retirement as CDFS - has stated that in his opinion two carriers are required.

This being so, it would appear that both Navy and the Government have taken the view that one-third - or, in Admiral Synnot's case, one-third now and another third at some later stage - of a loaf is better than no loaf at all, and that one carrier alone represents a sound investment. This is a view we find hard to accept. Even granting that Invincible represented the best solution to focal area ASW and, when Harrier-equipped, to certain strike missions and air defence of fleet units, the fact remains that one vessel alone cannot carry out these

missions with a high degree of availability and reliability. While she would doubtless be able to demonstrate each capability, it is simply not possible to suggest that she can fulfill the stated roles operationally in circumstances where more than one requirement exists in different locations. True, her capability to carry out one mission frees forces which might otherwise be doing that job, but this does not amount to a justification of her purchase. The position seems more likely to be that, if we are really determined to proceed with the acquisition of ASW and light strike carrier capabilities, then we must bite the bullet and eschew half (or, in this instance, one-third) measures. However, as has already been discussed, doubts of some substance as to her suitability for the ASW mission can be raised. Moreover, the acquisition of three carriers, plus their helicopter and STOVL fits, and with the escort requirement thereby generated, is clearly beyond our resources. It seems that, even if the validity of the requirement is admitted, it is not possible for Australia to meet it. Under such circumstances, other resource allocations would seem to be more profitable.

The Strategic Issues in Summary

The strategic debate over the carrier acquisition has been characterised by a kind of dialectic process, with advocates putting a case, opponents replying to it and the advocates modifying the case to deal with criticisms advanced. After the announcement of the Invincible acquisition, however, there was a tendency for Navy and the Government to return to positions which were originally espoused and then abandoned in the face of criticism.

Nowhere was this process more pronounced than on the subject of SLOC defence. In the early phases of the debate, Navy made a strong case for a carrier on the grounds that it was essential for the effective protection of Australian SLOC (see p.9 above). However, it was pointed out that, with so much of our overseas trade being carried in foreign bottoms, the probability of a potential enemy being prepared to commit or threaten acts of war against third, fourth, fifth or nth parties

was very low in all cases outside general war. Thereupon (with some delay) Navy shifted its ground somewhat, arguing that it was not intended to defend SLOC over their entire length, but only in key focal areas where both trade and would-be predators concentrate. An additional argument, the so-called "one-off vital cargo" scenario was also advanced by some supporters of the carrier purchase. What happened to the SLOC argument, in other words, is that it was gradually watered-down in the face of objections, some of which Navy itself accepted.[45]

In assessing the merit of arguments supporting any major equipment procurement, it is important to remember where the onus-of-proof lies. Because any major procurement has a deep and extended impact, not only on the defence budget, but on force structure and capabilities and, in the final analysis, on our capacity to preserve vital national security interests, it is important that decisions be made wholly on the merits of the matter. It is necessary then for those advocating a major purchase to establish their case, if we may express it as a legalism, beyond reasonable doubt.

The modified SLOC argument is as difficult to sustain under this test as was the more sweeping original partly abandoned by Navy. While it appears, for the moment at least, as if the Government's primary interest is in an ASW helicopter carrier for focal area ASW, no justification of its greater utility in this role vis-a-vis various alternatives (some of which we have outlined above) has yet been forthcoming. And, even if such justification had been presented her value in this role is in any event seriously vitiated by the fact that she can be in one place only. In fact, this implies that ASW for all focal areas will necessarily have to be provided by other means, because it cannot be guaranteed that the carrier will be available in any of them at the critical time, and failure to do so could leave them inadequately defended.

There has, however, been some late reversion to arguments resembling the original SLOC case since the acquisition

of Invincible was announced. A recent issue of the newspaper Navy News presented a question-and-answer feature on Invincible:

> Q: You claim INVINCIBLE is required for ASW support of convoys and further that one of the difficulties of an enemy is finding the ship. I suggest the convoy system is outmoded and that with modern surveillance systems, such as satellites, the ship's position will always be known.
>
> A: Satellites and other modern surveillance systems... have limitations. Emission control policies and deceptive tactics can be used to make the enemy's surveillance problem more difficult, particularly with regard to identification. Nevertheless, a submarine with good intelligence could inflict heavy losses on unprotected mid-ocean shipping. Extensive studies and exercise experience continue to demonstrate that the convoy system, with a mix of ASW assets for defence in depth, offers the best protection in most circumstances.46

The argument is here presented in truncated form, and Navy's earlier assertion that serious threats to our seaborne trade would arise only in circumstances "tantamount to global war" (see p.12 above) has apparently been abandoned. The day before the Navy News piece, the Minister representing the Minister for Defence (Senator Durack) defended the carrier purchase on behalf of the Government during a debate in the Senate, and said:

> On an average day there are about 195 merchant ships in our ports and about 175 in transit to and from Australia. In fact, I am told that today there are 294 merchant ships in our ports...the passage of these ships to and from Australia is, of course, of vital importance to us as is the passage of vessels on our coastal trade. There is some view that our trade routes need only be protected off our ports as this will be where enemy submarines will be concentrated. In the early stages of conflict the enemy may be expected to concentrate its efforts there. But defences close to Australia should drive the submarines further away and protection will be required at greater distances. With the development of ocean surveillance systems, the submarine's problems of intercepting mid-ocean shipping have eased. If we were involved in a conflict we would have to provide protection, probably, for convoys coming to our shores.47

This view of the ASW requirement does not sit well with that given to the Katter Committee by CDFS just on a year previously. It is worth quoting again:

> We do not see Australia being capable of escorting all merchant ships across the oceans but we do see us firstly trying to keep our ports open and what we call "focal areas" ...because that is where a submarine would go to find its target. Over the wide oceans you can spread your merchant ships out and submarines have great difficulty finding their targets and so they come in closer to their focal areas.48

Here there are three direct contradictions. Firstly, the CDFS does not see Australia operating frequent escorts on the open ocean; the Minister representing the Minister for Defence, speaking in the Parliament on behalf of the Government, states the contrary. Secondly, CDFS advised the Katter Committee that submarines have great difficulty finding targets on the wide oceans; the Minister told Parliament that the detection problem has eased. Thirdly, while the Minister stated that ocean surveillance systems have eased the submarine's problems in intercepting mid-ocean shipping, Navy News of the next day was pointing out the limitations of such systems and suggesting that emission control measures and the like could still make detection difficult.

Quite recently, there has been a further variation in the Defence Department's stated attitude to the usefulness of a carrier in the ASW role. The Secretary of DoD, Mr W.B. Pritchett, made a prepared statement to the Katter Committee on 24 May 1982. This statement tended to lay more emphasis on the carrier's usefulness for ASW on overseas shipping routes, with the provision of protection for both naval and merchant shipping. This is consistent with the shift in emphasis in official statements on SLOC defence since the carrier purchase was announced. However it effectively negates the statements of Admiral Synnot, while CDFS, about the usefulness of a carrier in SLOC focal area ASW. It does so in these words:

> In some circumstances, use of the carrier could be contemplated for other ASW tasks [i.e., other than on shipping routes], such as focal area surveillance and offensive operations against submarines but in general other types of ASW platforms and systems would be more suitable.[49]

This statement is difficult to square with that of Admiral Synnot as CDFS in his March 1981 Katter Committee evidence, that the main ASW task lay in the focal areas and that the helicopter carrier "does give you this other dimension in anti-submarine matters that you would otherwise not have" (see note 23). Exactly where this leaves the ASW case for acquisition of a carrier is not easy to determine. At some times and in some places, authoritative DoD statements suggest that the key mission is defence of SLOC; at other times, that it is in focal area ASW; and at other times again, that systems and platforms other than an aircraft carrier are most useful in the latter role.

When faced with contradictions from such authoritative sources, it is difficult to avoid the conclusion that arguments have been tailored to suit audiences. There is no reason to doubt that CDFS answered questions put to him by the Katter Committee in good faith; nor can it be suggested that the Defence Minister's representative in the Senate was doing more than using a brief supplied to him for the purposes of a debate, as is normal practice in the Parliament when a "representing" Minister is called on to handle an issue of substance for a Minister who is a member of the other House. This being so, it seems as if the argument put in the Senate was put as it was because, having announced the acquisition a month earlier, it was perceived that there was need to offer the broadest possible justification for it. The Katter Committee, however, would have been most unlikely to have accepted without query the argument put to the Senate in March this year, and CDFS of course put his case in a much tighter and better argued form.

Whatever the reasons for such obvious contradictions as these, the fact of the contradictions remains. Similarly, the Navy News item cited above represents a reversion to the "oceanic

SLOC" case (as against the "focal SLOC" case). With so great a degree of variation in the arguments put on the subject, the observer trying to penetrate the fog can only conclude that the case put forward is riddled with inconsistencies and contradictions. The kindest assessment one can make on evidence of this nature is that those arguing the case are very confused. Certainly, it is not possible to say that any case has been definitively established when sources which should be authoritative change their positions in this way.

The "vital cargo" scenario posited by some carrier supporters has few feathers to fly with. Prudent stockpiling should reduce the list of critical materials; a carrier task force escort for one or two vital ships would present a tempting target to hostile forces, thus placing a substantial proportion of the RAN at risk in locations not of its choosing; such cargoes can be concealed in routine shipping; many heavy and bulky commodities can be airlifted; and, in any event, the scenario assumes that an enemy has credibly threatened to cut off the bulk of our overseas trade: in other words, this is a low-probability high-level scenario.

The requirement for additional deterrent forces, and the suitability of an aircraft carrier (if ever equipped with STOVL aircraft) for that task is a much more complex issue. Nevertheless, the utility of deterrent forces can be assessed on three basic criteria: operational effectiveness; creation of a disproportionate response requirement for would-be enemies and avoiding the creation of an apparently belligerent stance because of the strength of the deterrent force. In Australia's case, it is suggested that our existing and pending deterrent forces - the Oberons, F111s, the F/A18 and the P3s - represent a deterrent capability of some magnitude. Moreover, it is contended that the carrier does not force an enemy into a disproportionate response, because of the relative simplicity and cheapness of systems capable of posing credible threats to so large a platform. It is also contended that in any event the operational effectiveness of the small carriers possibly available to Australia in the strike role is relatively low (see p.98ff, below). Finally, it is

contended that in Australia's situation the possession of what regional powers may see as excessive offensive capability is unlikely to serve the long-term goal of regional stability.

The most recent statements of DoD officialdom on the carrier project have been made since the retirement of Admiral Synnot as CDFS and the appointment of Air Marshal McNamara. The paper presented to the Katter Committee* on 24 May (cited above) was noticeably cooler in its assessment of what the carrier can do and less sanguine about its survivability under some circumstances. Nevertheless, it also tended to re-emphasise the "oceanic SLOC" argument:

> ...while no threat offers at present of submarine attack, should such threat be contemplated possession of a helicopter carrier in the Australian inventory makes the task of attack more complicated and dangerous. This is particularly relevant for a nation like Australia surrounded by seas and oceans and heavily engaged in international trade.50

However, the statement was significantly less enthusiastic about the contribution a carrier might make in several roles: "an aircraft carrier could have relevance" for support of allied interests; "a helicopter carrier with STOVL potential offers prospect of a range of capabilities and has strategic relevance...albeit limited in comparison with other systems" in the context of providing a basis for core-force expansion; its ASW capabilities are seen "as supplementing" other ASW assets on inventory.[51] While it would be untrue to say that there has been a major change of heart since the departure of Admiral Synnot, it does appear from the Pritchett paper that DoD is now less willing to make far-reaching claims about the effectiveness of small carriers.

Certainly there are experienced naval personnel who have fundamental doubts about small carriers. Admiral Thomas H.

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* The Katter Committee is inquiring specifically into the carrier decision, pursuant to a reference from the Senate, and is expected to report in the 1982 Budget Session of Parliament.

Moorer, USN (Ret) recently wrote to the Wall Street Journal about the qualitative difference between small carriers (like all of those on Australia's possible shopping list) and large, Nimitz-type vessels:

> ...the loss of the destroyer Sheffield proves to be the best justification I can think of for the large aircraft carrier... Had a carrier of the Nimitz class complete with airborne radar and airborne counter-measures been defending the Sheffield, the Argentine aircraft which released the Exocet missile would have been destroyed long before the Sheffield was detected by the attacking aircraft.
>
> While it is attractive to suggest...that seaborne airpower should be dispersed in small ships, the problem with this concept is that seaborne airpower in small ships is simply incapable of performing well in today's technological environment, as HMS Invincible and HMS Hermes have so clearly demonstrated.52

In a specifically Australian context, Moorer's remarks strongly indicate the inadvisability of proceeding with the acquisition of a carrier, given that a Nimitz-type is clearly beyond our resources. Our carrier debate has proceeded with the implicit (and entirely justified) assumption that what is under discussion is a small carrier, not the kind of vessel which forms the heart of US naval force structure.

At the heart of the Australian carrier debate, as indeed for many other defence acquisitions, lies the so-called "core force" concept. It is not possible in the present paper to subject this concept, which has been actively promoted by both DoD and Government, to detailed analysis. Others - notably writers from the ANU's Strategic and Defence Studies Centre and also the Katter Committee's procurement report - have done so, raising fundamental questions about the "core force" which have yet to be answered. Suffice it to say at this point that the concept, although nebulous and difficult to pin down, remains a driving force behind DoD procurement policy and practice, and that we share many of the doubts expressed by those who have written extensively on the subject. The role of the concept in the carrier acquisition debate has been to intellectualise the Navy's desire to preserve its existing force structure. By

talking in terms of a "naval air capability" which must be preserved if expansion at some future date, as envisaged by the "core force" concept is to be possible, the RAN can attempt to broaden the national defence relevance of its conviction that it should continue to operate an aircraft carrier. This was, perhaps, almost inevitable given that the "core force" concept tends to support the inclusion of long lead major equipments in the FYDP as a hedge against unforeseen strategic developments. However, such an emphasis tends to downgrade strategic analysis as a determinant of acquisition policy, and certainly makes it difficult to adhere to the principle - spelt out by the Katter Committee (see p.8, above) - that a nation's strategic environment is a prime determinant of the kind of defence force it maintains. In the present case, as we have tried to show, strategic considerations are by no means wholly supportive of acquiring a STOVL-capable ASW helicopter carrier.

The strategic issues surrounding the carrier are easily clouded by irrelevancies, but the bottom line of the argument remains the same. Only if it can be shown that the acquisition of Invincible or any other possible platform will add to the Defence Force a credible capability which is required against a range of contingencies assessed as being sufficiently probable to fall within the scope of long range planning, and only when that capability can be shown to be both reliable and adequately available can the acquisition be justified strategically. To date no case meeting these criteria has been made by Navy, DoD or Government. To revert to a legal term once more, at best the case presented by Navy and the Government would attract the Scots' verdict: "not proven".

4. Survivability and Operability: The Threat to Large Platforms

Essential aspects of the whole carrier debate, even if one accepts that a strategic case has been made for acquisition, are survivability and operability. Ever since the Israeli destroyer Eilat was sunk by an early Soviet PGM during the Six Day War of 1967, commentators have been drawing attention to the threat posed by new-technology weaponry to large platforms, and

particularly large sea-going platforms where concealment is relatively difficult. In the period since the sinking of Eilat, the PGM revolution has proceeded apace, and there are now available, for deployment on quite small platforms, weapons with accuracies and striking power unthought of when the aircraft carrier came into its own during World War II. In his recent work on Australian defence, Dr Ross Babbage lists a number of consequences flowing from the advent and proliferation of PGM and other technologies. These include:

- the increasing vulnerability of large and obvious weapons platforms and the degradation of their cost-effectiveness;
- the increasing utility of small units;
- the increasing importance of remaining untargeted;
- the rising costs of many military systems; and
- the accelerating pace of tactical war.[53]

Unless effective countermeasures are employed, such developments clearly militate against the continuing effectiveness of a platform such as Invincible.

There is ample evidence that the designers of modern platforms are concerned by the PGM threat and that countermeasures have been sought. The Garibaldi class (one of the earlier unsuccessful contenders for the Australian carrier), for example, is fitted with not one but two independent anti-missile systems in an effort to boost her survivability: Dardo, a system with the same role as the US Phalanx CIWS,* and Albatros, a gun-and-missile system for defence against aircraft and antiship missiles, especially those which, like Harpoon, fly at low altitude or have high diving angles.[54] Invincible herself suffers from a design problem - cross-ducting of air intake

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* CIWS: Close-In Weapons System.

shafts for her gas turbines - which may significantly increase her vulnerability to missile hits. (This is discussed further at pp.60-1 below). Australia had been moving to fit Phalanx to Invincible to provide some last-ditch anti-missile defence for the carrier.

A recent incident in the United States, involving one of the more sophisticated PGM - the Harpoon now entering Australian service - highlights the potential deadliness of the threat. USS Coontz, a guided missile destroyer, accidently fired a Harpoon during exercises in the Caribbean Sea, and the weapon headed for a resort town in the Virgin Islands. Two F-14 aircraft scrambled to intercept and destroy the missile were unable to detect it, but fortunately it fell into the sea short of its gratuitous target. Certainly we would not disagree with the Australian Defence Department's assessment of Harpoon as highly accurate and "very difficult to detect or shoot down."[55] Such an assessment, with relatively little modification, applies to most sea skimming current generation PGM and will apply to many more as time passes.

A look at two other antiship missiles in use in the region to the north of Australia will indicate the extent to which PGM have proliferated even among relatively minor military powers in recent times.

The French Exocet is in service in both the Indonesian and Malaysian armed forces (as well as those of Argentina - now well known as a successful user - Belgium, Brazil, Brunei, Chile, Ecuador, France, Germany (FRG), Greece, Morocco, Oman, Peru and the United Kingdom.) It has a range of between 42 and 70+km, depending on which of three versions is considered, relies on inertial guidance plus built-in terminal homing, and delivers a warhead of 165kg of high explosive. Either impact or proximity detonation can be selected, the latter posing a significant threat to deck fittings, antennae and so on.[56] Ten years ago, the manufacturers estimated that it would cost about $US 1m to fit four Exocet to a destroyer sized platform; more recently, the West German Navy spent $Aust 10.4m in January 1976 prices for 150 of the original MM38 Exocet - a unit cost of about $70,000.[57] A

rough conversion to current $A would yield a unit cost of about twice that - say, $150,000.

Singapore operates the Israeli Gabriel SSM from 6 fast attack craft.[58] This SSM is also believed to be in service with Thailand, South Africa, Taiwan, and Kenya as well as with Israel herself. There are two variants in current service, Mks I and II. The Mk II has a range of about 36km, almost twice that of the Mk I, and Mk I's semi-active homing system has been improved by the addition of home-on-jam and anti-radar capabilities, facilitating operations in heavy electronic countermeasure (ECM) conditions. The system can be fitted on craft down to about 50 tons displacement.[59] In development at present is the Mk III, which can operate in any of three modes, depending on requirements and the hostility of the environment: fire-and-forget, fire-and-update and fire-and-control. Fire-and-update uses a search radar, a command datalink between ship and missile and an automatic tracking computer for track-while-scan capability; fire-and-control uses an additional fire control (FC) radar, and targets detected by search radar are passed to the FC radar which then takes control of the missile. The missile's seeker is not activated in this mode until the "range gate" (the area illuminated by the seeker radar) equals the size of the target.[60] The cost of Gabriel is thought to be in the vicinity of $US300,000 for Mks I and II and $350,000 for Mk III (1979 figures).[61]

It is well to note that some PGM can already be launched from submerged submarines - Australia's Oberon class boats will be able to launch Harpoon in this way after the necessary modifications are completed. In this context, the most recent DoD statement on the carrier's vulnerability is worthy of notice:

> In ASW operations there is a risk of the loss of the carrier to submarine attack. If the carrier is one of many heavy ships in the main body of a task force or convoy, the risk of its loss is assessed to be fairly low. However in cases where the carrier is one of a small number of heavy ships in a force, the risk of loss to determined submarine attack would be higher.[62]

This statement represents the first real admission from official sources that the carrier is potentially vulnerable. It will be recalled that Minister Killen, in his statement announcing Invincible said: "Vulnerability is an oft quoted concern of many. I reject this." (Hansard, 25 February 1982, p.631). While it would be incorrect to claim that the carrier is totally vulnerable, it is equally incorrect to reject out of hand suggestions that vulnerability is a matter for concern. The threat to Invincible's survivability or operability posed by sub-launched PGM is, as the DoD statement quoted above indicates, one to be taken seriously. Indeed, the high likelihood of fitting Phalanx to the carrier, noted previously, is testimony to the reality of the threat.

Exocet and Gabriel are by no means atypical of current PGM, and the proliferation of weapons of this type poses a growing threat to the survivability and operability of relatively large platforms such as carriers. Indeed, it is important to note that it is not necessary to sink a platform to put it out of action, destruction of radar and command, control and communications (C^3) antennas will suffice. A modern warship stripped of its radar and communications capability would be almost helpless: unable to detect threats, unable to control its missiles or aircraft and unable to call for asistance beyond visual range. The sinking of a vessel in such shape, if it remained in the combat zone, could be left to the leisure of the enemy.

This threat is particularly real in cases where C^3 is an important aspect of a warship's function. Navy has argued most cogently that it is necessary to consider a carrier task force as an organic whole, that its strength is greater than the sum of its parts:

> ...in general the concept of naval operations is to bring ships together to enhance each other's capabilities, so that the total unit which is together will be far stronger than just an addition of the capabilities of those four, five or six ships. So we would not really envisage one of our ships operating singly unless circumstances forced it to do so.63

However, this gain in capability of the task force vis-a-vis its individual members is dependent on rapid exchange of information via data links and on inputs of data from the total sensor fit of the participating vessels. One vessel, (Australia had intended Invincible for this purpose) will act as a central processing, coordinating and directing unit. The "nerves" and "eyes" of this complex naval organism are its electronics links and sensors, and it is these which face perhaps the greatest threat from modern PGM. This threat is likely to increase further in the event of fuel-air explosive (FAE) warheads appearing on PGM.

The principle of FAE is the timed detonation of an aerosol cloud of some volatile fuel, yielding very high blast overpressures. Some idea of the potential power of FAE can be gained from an answer recently given by the Minister for Defence in response to an Australian Democrat Senator's Question on Notice, whence the following table is derived:[64]

OVERPRESSURE YIELDS FOR 30kg FAE AND 130kg HE CHARGE
(overpressure in kilo Pascals/p.s.i.)

Distance (m)	30kg FAE	130kg HE
0	2,000/290	>100,000/14,500
7	700-900/102-131	700/102
35	20/2.9	18/2.6

The significant thing about these results is the rate at which overpressure drops off away from the centrepoint of the detonation: a 130kg high explosive (HE) charge yields far higher overpressure at the centre than does an FAE, but at only seven metres distance, the 30 kg FAE charge will produce an overpressure equal to or greater than that of a HE charge over four times as massive. In other words, a near miss with an FAE warhead is more dangerous to non-hardened targets than one with a

conventional HE warhead of equal size. This threat was well outlined by Desmond Ball and Steven Rosen in April 1977:

> With present FAE technology, a 1,100lb [500kg] methane charge will cause moderate damage to a ship at a distance of some 600 feet from the blast boundary and badly damage or sink all types of ships at distances of about 330-430 feet. New FAEs under development promise to increase the radius for moderate damage to 800 ft. and that for serious damage and sinking to 500 ft. from the edge of the blast. Even moderate damage, defined as the destruction of radar antennas, direction finding and other navigation equipment, radars, on-deck helicopter hangars, ECM horns, and other external fittings, piping and machinery fixtures, etc., which are vulnerable to shock waves, can have disastrous results for surface combatants. FAEs can be detonated at a sufficient distance to render close-in defence systems inoperable, leaving the ship vulnerable to closer FAE detonation or even to conventional TNT missiles and torpedos. The CEPs of most ship-to-ship missiles are much less than the "lethal envelopes" described above.65

Thus, the threat posed to large seagoing platforms is likely to grow as FAE warheads are deployed; even with HE warheads it is far from negligible. In the case of Invincible, it would be possible to negate much of her capability with one or two near misses: sinking her would not be necessary. The real threat to a carrier with a major C^3 role is to her electronics and data acquisition/transmission capacity, which is seen by Navy and the Government as one of her central functions:

> But if you want a ship which will last you a long time, do the job properly and probably be required to do command and control - a little like a task force headquarters or a field headquarters the Army has - you do need something more than obtain just a merchant ship. You have to exchange data with other ships. It requires quite compliicated communications equipment with good radars. (CDFS March 1981)66
>
> HMS INVINCIBLE has a modern and comprehensive operations room complex, with facilities which enable the ship to:
>
> a. co-ordinate anti-air warfare, including control of RAAF and friendly force fighters, and AEW aircraft operating in support of the force;
> b. co-ordinate the anti-submarine warfare and surface warfare activities of the force in co-operation with land based long range maritime patrol and strike aircraft;

c. control her own weapons systems including ASW helicopters, surface-to-air guided weapon missile system, electronic warfare systems, reconnaissance, and strike aircraft (STOVL); and
d. act as area air warfare commander and area anti-submarine warfare commander simultaneously.

The ship has adequate communications for the command and control task including a tactical data link which is interoperable with USN ships, our DDGs, P3C aircraft and later on the FFGs. (The Navy's February 1982 Presentation).67

...examinations have shown it is more cost-effective to group a number of helicopters together in a larger ship with centralised command and control, maintenance and support facilities.
...there is a need for a ship capable of planning, commanding and co-ordinating operations by a group of ships and aircraft. (The Minister for Defence).68

With so much importance attached to the carrier's C^3 capabilities, it is difficult not to take the threat to these capabilities posed by PGM near misses very seriously indeed. This is a problem which has been very little addressed in official statements made thus far about the carrier: for the most part, officialdom has been more concerned with refuting suggestions that the vessel might be sunk by new technology weapons. We suggest, however, that the true criterion is not simple survivability - the capacity to stay afloat after one or two hits or near misses - but operability. A carrier with her sensors and C^3 gear knocked out by near misses would be unable to fulfill her stated role in the task group, which would become, as it were, headless:

As when death smites the swollen brooding thing that inhabits their crawling hill and holds them all in sway, ants will wander witless and purposeless and then feebly die, so the creatures of Sauron...ran hither and thither mindless; and some slew themselves, or cast themselves in pits, or fled wailing back to hide in holes and dark lightless places far from hope.69

Tolkien's words are poetic: no close analogy applies, but they highlight the central point. A very real threat to the carrier's utility does exist, and little has been said about it by advocates of the acquisition. And this threat, it needs to be

noted, is of significantly greater probability than the not inconsiderable chance that the carrier could be sunk outright by these weapons. Clearly it would be very dependent for its continued usefulness in battle on protection afforded by other units. Despite suggestions from Navy that destroyer or frigate escort for the carrier is not primarily for its protection,[70] Navy's observation (made at the same forum) that "we would not really envisage one of our ships operating singly unless circumstances forced it to do so" is really much more to the point.[71]

We consider, then, that modern weapons technology poses two immediate threats to the carrier. Firstly, to its survivability under attack and, secondly (and more importantly), to its operability. In the event that FAE warheads begin to appear on PGM as time passes, both of these threats will grow. And it needs to be remembered that PGM can be launched from a wide variety of platforms and in diverse environments: from aircraft, large and small naval surface combatants and from submerged submarines. Thus they can generate requirements - for anti-aircraft, ASW and antishipping capabilities, as well as specifically antimissile systems - amounting to a disproportionate response for the defending force. It is for those who consider the carrier operable in hostile environments to show how the HE and FAE PGM threats can feasibly be countered without such degradation. Our conclusion at this juncture is that its operability is likely to be short lived in the face of many current PGM and their successors.*

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* The fate of the British Type 42 destroyer HMS Sheffield bears out the thrust of this analysis. At the time of writing, we do not have full details of the engagement in which this ship was hit, but the following points appear in such accounts as are available.

1. Sheffield was hit by one AM39 Exocet launched from an Argentine Super Etendard strike aircraft, probably land-based. The hit was at the centre of her radar reflection: aft of and below the bridge, at the operations room.
2. Two missiles were launched by the aircraft, but the British claim to have defeated one with countermeasures (probably chaff). (cont. p.48)

5. Operational Characteristics of the Platform

In an operational deployment the effectiveness of an air capable vessel will depend largely upon the type of aircraft which it carries. Given the restricted range of aircraft types available to any of the vessels considered as a Melbourne replacement, their effectiveness in any particular role would be of much the same order. However some qualifications of this generalisation are necessary. These relate mostly to factors

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(cont. from p.47)

3. The damage caused by the hit was sufficient to take the ship out of action immediately. The Captain was reported as saying that the whole working area was a mass of flame and that one could see right down into the engine room.
4. The fires were extremely intense and uncontrollable. This indicates that temperatures were so high at impact and detonation that the steel of the vessel was ignited. Vessels with aluminium superstructures would not last as long as Sheffield did.
5. It is possible that, as well as the 165kg warhead, the missile's destructive power was enhanced by the rapid combustion of unexpended propellant.
6. The missiles were apparently launched from 30 miles, and the attacking aircraft escaped unscathed, though one report has it that the aircraft were sighted by radar from Invincible at 60 miles.

The loss of HMS Sheffield was followed by a spate of press reports stating that RN personnel were amazed or astonished at the destructive capability of a single missile. We find this hard to credit. Tests of antiship PGM against obsolete vessels have resulted on occasion in even more spectacular damage, some targets being broken in two and sinking almost immediately. What the loss of this ship does emphasize is that those who have discounted the PGM menace with talk about the enhanced capabilities of a carrier task force must now think again. Australia could ill afford the loss of a DDG or FFG in similar circumstances involving a carrier, let alone the loss of the carrier itself. Those who have argued with Roy Corlett (United Service, April 1977) that "the ghost of the Eilat incident in 1967 be exorcised, because it has been allowed to have too profound an effect on subsequent thinking", have been given additional reasons to reconsider their attitudes. While Sheffield's fate is of course not an omen of certain doom for other major surface combatants, it is a strong signal to those in Australia who have not paid sufficient attention to the threat posed by modern PGM, many of whom seem to have been influential in the decision to acquire another aircraft carrier.

which would restrict the mode of employment of the vessel's aircraft in practice or, in some cases, determine whether they could be deployed at all.

An effective constraint on the flexibility of any naval vessel is its unrefuelled range. In the case of an air capable ship such as Invincible, this limitation affects not only the distances over which she herself might operate, but in general the range of her group as a whole. Whilst in ideal circumstances any group centered around a carrier would include an underway replenishment ship (AOE) this may not always be possible.

The adequacy of Invincible's operational range for the Australian environment was a subject of controversy during the period when its purchase was being considered. The Navy's IRI stated that the cruising range of any Melbourne replacement was "to be about 10,000 nautical miles" at a speed of "about 18 knots",[72] although the financial aspects of varying these parameters might be studied. On the basis of published data many lay commentators assumed that Invincible would be rejected as unable to meet this requirement, since the most respected publicly available source (Jane's Fighting Ships) gave her range as 6,000 miles (4,350 n.m.) at 18 knots.[73] In announcing the Government's decision to purchase Invincible the Minister did not allude directly to the question of the range performance of the vessel, but did remark, in talking of proposed modifications of the design for RAN service, that "These will include adding 450 tonnes of fuel to increase the ship's operating range to meet our basic requirement".[74]

However, this "basic" requirement was not the 10,000 n.m. sought by the RAN in 1977. Rather, it was 8,000 n.m., an increase of 1,000 n.m. over the range which the RAN stated Invincible was already capable of achieving.[75] In the text of its February 1982 presentation made to members of the Government's back-bench committee on Defence, the RAN presented figures relating to Invincible together with data on the modified-LPH design and HMAS Melbourne. They showed that the RAN could have achieved its objectives with the LPH, which has an

estimated design range of 11,400 n.m. at 18 knots, but also that Invincible, once modified, would have had a better performance than Melbourne, stated to have a 7,000 n.m. range at 18 knots.

This contradicted the data on Invincible as given by Jane's Fighting Ships and which had been taken (as mentioned above) to show that the ship was not suitable for Australian service. Furthermore the Navy presentation seemed to indicate another discrepancy with Jane's Fighting Ships, this time with the data on the range performance of Melbourne. Jane's does not present figures for the cruising range of Melbourne at 18 knots but recorded her performance as 12,000 miles (10,400 n.m. approx.) at 14 knots and 6,200 miles (5,400 n.m.) at 23 knots (which is almost maximum speed). As fuel consumption rises dramatically as a vessel approaches maximum speed one would expect the cruising range at 18 knots to be greater than the median of the two distances (7,900 n.m.) that is, practically identical with the RAN's figures for Invincible after modification.

What could not then be known, in the absence of more detailed information, were the operational specifications in accord with which these estimations were derived. There are many ways of stating a military requirement and an apparent disagreement may merely reflect differences in the operational procedures of the Defence Force of two nations. These are usually not stated, let alone defined, and it is always difficult for the outside observer to know if he is receiving enough information, presented with sufficient precision, to properly evaluate the statements of any defence organization.

More specific information now available[76] provides at least part of the answer to the conundrum which misled most commentators. An apparently alternative framing of the IRI defined the endurance required by the RAN as 5,000 n.m. at 18 knots with 30 per cent fuel remaining and an allowance of 550 tonnes for transfer to escorts. Melbourne's range was less than 5,000 n.m. with reserves but without the escort allowance, whilst Invincible's was about 4,000 n.m. with both considerations

applied.[77] This is close to the 4,350 n.m. given by Jane's Fighting Ships as the range of the ship at 18 knots. The addition of an extra 450 tonnes of fuel as mentioned above would have brought Invincible's cruising range to the 5,000 n.m. required by the RAN under this formulation. This would have improved the Navy's situation by giving it a ship better able to support its task force group and keep the whole unit at sea for longer. Nevertheless the long range endurance of an Invincible class vessel represents a compromise compared to the purpose-designed LPH modification. This can display a 50 per cent better cruising range, and will now be competitively priced with a newly constructed Invincible class ship.

In retrospect it is indeed fortunate that an allowance of fuel for transfer to escorts was specified for the replacement of Melbourne. One of the consequences of the decision to purchase Invincible was a severe cash-flow problem which prompted a reorganization of several equipment programs. One outcome of this is that the RAN may well be less able to guarantee afloat support to its carrier group for the forseeable future than had been planned. The RAN has a new AOE, HMAS Success, under construction and a second of this type was approved in early 1980. However, building of Success has been so protracted that contracts for the second of the type had not been let at the time when the Minister announced that acquisition would not proceed "at this stage."[78] This means that the RAN will have only one AOE for the immediate future and whilst one might expect that vessel to accompany a carrier and her escorts on any mission thought to warrant it, this may not always be possible.

Thus the carrier herself may have to be the source of fuel replenishment for her surface escorts. The refuelling of escorting destroyers from a carrier is not an unusual practice but it is one which, as shown above, reduces the range of the carrier. Obviously, if the presence of an AOE meant that, for instance, Invincible could draw upon her 550 tonne allowance herself, the range of the squadron would increase considerably. Just how great the extent of that increase can be is shown by RAN data giving the range of a carrier group, which combines a DDG

and two FFG-7s with Invincible and an AOE, as 14,400 n.m. at 18 knots.[79] If operational range is to be an important factor in assuring the operational utility of an RAN carrier, the benefits of a balanced force structure to support it are thus apparent. It is ironic, therefore, that the financial consequences of the method originally adopted to provide a new RAN carrier, have most probably delayed the development of this important support element.

Systems and Communications

Although the Melbourne replacement as originally envisaged by the RAN was to be lightly armed, its sensor and communications fit was seen as an important factor governing the effectiveness with which it could make use of its aircraft. Since no existing fixed-wing V/STOL aircraft or helicopter has a radar possessing a good range for the task of aircraft detection, any carrier in RAN service will be dependent mainly upon its own surveillance systems for early warning of aircraft attack and on its communications systems for command and control of any ensuing anti-aircraft operations. In ASW actions the vessels now to be reassessed are reliant upon sensors in other platforms but the importance of co-ordinating sensor data and the resultant action would, if anything, be even more important.

It was precisely the need for such command, control and communications facilities which was used by Admiral Synnot as CDFS to justify the procurement of a purpose-designed ship to replace Melbourne instead of taking a more innovative approach,[80] and which was emphasised subsequently to justify the purchase of Invincible (see pp.45-6). The RAN's resultant enthusiasm for Invincible owed much to the sensors and C^3 features of the ship. The Invincible class possess a fully automated combat information and control system, the ADAWS 6 (Action Data Automation Weapons System). This provides an automatic, up-to-date picture of the tactical situation using information provided by the vessel's own sensors and those of other platforms. In RN service it also provides fire control instructions to the Sea Dart missile system but, although the RAN had not announced officially whether it

would retain this system or remove it before the offer to cancel the sale was accepted, it appears that this system would have been replaced by a CIWS. Contrary to earlier reports[81] the C^3 systems already aboard the vessel include a data link compatable with NATO equipment such as the LINK 11 on board the RAN's DDGs and the RAAF's P3C Orion patrol aircraft.[82]

The Invincible class are equipped with the RN's Type - 1022 aerial surveillance radar which is also mounted by later versions of the Type 42 destroyer. The range of the Type 1022 is classified but it is known that this radar is a hybrid, with the major equipment being that of the Dutch Hollandse Signaal-apparaten LW08 married to a new antenna produced by Marconi of the U.K.[83] The range of the Type 1022 under standard conditions would depend upon its installed power and this is a function of the Dutch equipment. The only different feature of the RN system, the aerial, appears on sight to be designed to maximise the detail in return emissions, not to enhance illumination at range. (This is to be expected in a naval radar required to distinguish small, low-flying targets amongst the clutter of emission returns from the wave tops). It can be assumed, then, that the range of the Type 1022 is close to that of the LW08: 145 n.m. against a $2m^2$ airborne target.[84]

This detection range is not exceptionally great and is, for instance, less than that of the AN/SPS-49 on the FFG-7, which is up to 175 n.m.[85] It seems that this will be the radar which the RAN would mount on the modified-LPH if that design eventually proceeds (see below p.54). The difference in detection ranges has consequences which go beyond the question of the distance at which a carrier can expect warning of possible attack. Some of these issues affect the efficiency with which STOVL fighters can be controlled and this issue and its consequences is discussed in the section on the operation of such aircraft from small V/STOL carriers.

However, the theoretical maximum range of a ship board radar is seldom the relevant issue. As with the accuracy of figures issued about the cruising range of Invincible, publicly

available figures on radar performance are seldom useful unless qualified by data about prevailing conditions, the size and height of the target, the use or otherwise of countermeasures and so on. Often, published figures represent nothing more than the 50 per cent probability of detection of a certain target under "standard" conditions. An example of just how different radar performance can be under operational conditions was given by the sinking of HMS Sheffield in the Falklands conflict. The incident serves to illustrate just how little warning of attack may be provided when only ship-board radar surveillance is available. According to reports from correspondents with the British fleet the first warning of the attack came when two aircraft closing from the South West were detected at only 52 n.m. (60 miles)[86] from Invincible. Shortly afterward Sheffield was reported hit and was said to be "some 15 to 20 miles to the South West",[87] - that is, in the direction from which the attack came. This means that at the time Invincible's radar detected the approaching Super Etendards they were already within 39 to 35 n.m. of Sheffield. As the range of the AM 39 air-launched version of Exocet varies with conditions between 39 and 27 n.m.,[88] it is probable that the attacking Argentinian aircraft were already within range when they were spotted. Indeed, it is possible that what Invincible's radar detected was the aircraft breaking-off and climbing for home after the missiles had been launched. That this may have been so, and that the Sheffield, equipped with the earlier Type 965 surveillance radar, may never have detected the attack is borne out by the fact that Sheffield's crew was not at battle stations and that she had no warning, implying that there had not been time for Invincible to signal. As the ship's commander said: "We had only time to say 'take cover'. Three or four seconds later the missile hit".[89] It is clearly dangerous to assume that maximum quoted performance will be achieved by any military system under operational conditions.

Apart from the surveillance radar the only deficiency in the electronics of the Invincible class would appear to be in air traffic control, as the IFF (Identification Friend or Foe) interrogation and the TACAN aircraft navigation homing aid from Melbourne were stripped from that vessel for fitment to

Invincible.[90] However this probably had more to do with different operating procedures in either Navy than it did with any serious deficiency in the outfitting of the Invincible class, and this should not be a problem in a new vessel of this type should one be built for the RAN, nor in any of the other designs being considered by the Service.

There is some evidence that the RAN was actually gaining more in the C^3 systems of Invincible than it ever hoped for with its specially designed alternatives. The table of ship characteristics accompanying the Navy Office presentation to the Government Defence Committee shows under the head of "Command and Control" that the combat data system intended for the modified-LPH was the NCDS (Naval Combat Data System).[91] This is the U.S. Navy system which has been standardized in RAN surface combatants since the introduction of the Charles F. Adams class DDG's in the 1960s. It will be fitted to in the four FFG-7 frigates now entering service and has been progressively developed by the RAN using a land based system located at Fyshwick, A.C.T. This confirms the impression, created by Australian dealings with the U.S. Government, that the RAN would have been prepared to accept basically this existing system as the nerve centre for its proposed flagship. Early in 1981 the US Defence Department notified Congress of a letter of offer to Australia for the sale of technical assistance for the design and construction of an air-capable ship. This proposal was to cover the redesign of the LPH, then the RAN's leading contender, a major part of which was the addition of combat systems compatible with those of the FFG-7.[92] The objective here was probably to reap the benefits of logistic commonality, proven reliability and reduced development costs - all of them important - but it does imply that RAN was at that stage prepared to accept as its flagship a vessel whose command and control systems and sensors were little different to (or maybe practically the same as) those of lesser elements in the fleet.

At a later date, after the RAN had recommended that Invincible be the vessel to be purchased, the C^3 functions appear to have been raised in importance to become a major justification

for the RAN requiring this type of ship. In fact, in the Navy Office presentation the role of "task force command ship" rates first in the enumeration of Invincible's capabilities, before even its ASW helicopter role, ostensibly the strategically justified reason for purchasing it.[93] The Minister also stated that there was "a need for a ship capable of planning, commanding and co-ordinating operations by a group of ships and aircraft", a task which he said was now beyond Melbourne.[94] Perhaps the importance then seen for the C^3 role was a compensation for the Government's apparent desire to down-play the importance of embarking STOVL aircraft, but it is likely that it also reflects the RAN's pleasure at the capability it was so unexpectedly about to acquire. Once the existence of a compatible data link on-board Invincible was verified, it appeared that the ship's C^3 facilities were more than adequate and indeed they could introduce the RAN to satellite relayed communications, if the dual SCOT (Satellite Communications Terminal) terminals are fitted to any RAN ship of the class. The existence of such a developed series of equipments, already integrated and without requiring from the RAN the development and testing usually inevitable with the first of a class of vessel, was probably amongst the factors which made Invincible appear a bargain at the proffered price. Whether the RAN will consider them so when paying the full commercial price for a vessel of the class remains to be seen.

Part of the review now instituted to assess the consequences of Invincible being no longer available is to consider the problem of providing command-ship facilities. However it is important to recognize that, whereas in situ the C^3 capabilities of Invincible would have added considerably to the RAN's capabilities, these are not sufficient by themselves to support the purchase of any of the newly-contending designs. The Navy appears to having been willing to accept less capable C^3 facilities at an earlier stage of the project and currently recognizes that "supporting command functions" can be carried out in frigates. However, it maintains that these and slightly larger destroyer-sized ships are inadequate for the command role because they lack the space for "staff" and the necessary

"hardware".[95] Presumably by "hardware" Navy means the variety of communications and other electronic systems required for task force command, their operating consoles and the power and environmental systems needed to sustain them. Perhaps this would be true of a vessel of, say, DDG or FFG dimensions *if* they were also to retain their full combat capabilities. However, there is no inherent reason why one of these vessels could not be modified as a task force command ship, with the loss of some combat capability, were a vessel such as *Invincible* unavailable. In fact the physical demands of the command ship role are not overly challenging, consisting as they do of "living and working space" for "about 25 personnel" and extra communications and dedicated command displays.[96] Further, the displays of the DDGs and FFG-7 are already able to handle information relating to the *Standard* SAM, a task not required of *Invincible's* systems were it intended to remove the Sea Dart system, as seemed likely.

As an example of possible innovative solutions to a command ship problem, some years ago the Royal Navy built a series of comparatively lightly armed, smallish (2,170 tons standard) *Salisbury* class aircraft direction frigates to act as anti-air warfare radar pickets and command ships. This was in the late 1950s, a period of bulky, unreliable analogue systems with over-hot vacuum tubes producing excessive air conditioning demands, thus presenting a much more difficult "packaging" problem than would be the case today. An alternative route to force level C^3 could have been that of the US Marine Corps which uses headquarters ships of the *Blue Ridge* class, which are specialized for that role and have no offensive combat functions but are large and expensive vessels as might be thought necessary for a service the size of the US Marine Corps. Of course, these alternatives are unnecessary if adequate C^3 facilities attached to the topsides of a far more versatile ship can be secured at a bargain price. The point must be reiterated, however, that these facilities of themselves do not justify the purchase of a carrier: that should lie with her usefulness seen against the strategic requirements outlined in Section Three.

As mentioned above the ADAWS 6 system of the Invincible class performs not only the AIO (Action Information Organization) function but also controls the vessels' only hull mounted weapons system, the Sea Dart missile. However, if the Navy did intend to remove the Sea Dart launcher and systems, two of the most prominent features on the ship would have disappeared along with it. These are the two domes, one on the front and the other on the rear of the island, which contain the Type 909 tracker/ illumination radars which guide Sea Dart missiles in flight. These would have no sufficient function to justify retention after the missile system was abandoned. A consequence of this move would be to remove a large portion of the role of ADAWS 6. Whether the resulting spare computer capacity could be utilized economically by a vessel built specifically for the RAN can only be speculation, but the prospect of one of the contenders for the role of the Navy's flagship being able to dispense with some of her analytical power does tend to weaken, if only anecdotally, the claimed need for such a vessel to perform the role of task-force leader.

Propulsion and Construction

The Invincible class are powered by 4 Rolls-Royce Olympus TM3B gas turbines each producing 20,880 k.w. The turbines are grouped in pairs driving a fixed-pitch propeller via a triple-reduction reversing gearbox. It is the use of fixed-pitch propellers (each 5.2m in diameter) which gives the type a greater draught than Melbourne (8.8m and 7.6m respectively, at extreme draught) as such devices are larger than the currently more fashionable constant pitch propeller. The latter are, however, more complex, more expensive and create more underwater noise, which is best avoided if capable enemy submarines are in the area. The Invincible's propellers were also the first cause of concern about the design as the first set trialled were found to be unsuitable.[97]

This problem has now been eliminated with the fitting of more suitable propellers but an associated propulsion problem, although ameliorated, has not been entirely eradicated. This is

a vibration problem which affects the ship in two speed "bands" and was sufficiently severe to require concerted action to overcome. The ship now vibrates noticeably at a speed of about 20 knots and again, more markedly, at maximum speed, but Navy considers the degree of this problem as "not operationally significant"[98] although vibration at maximum speed is apparently such that it is extremely difficult to read data displays on the bridge. At this stage we have no data to indicate whether other vessels of the class suffer the same problems.

It should be noted that Invincible's maximum speed of about 31 knots[99] was significantly more than the 24 knots which the Service requested and some 7 knots greater than either Melbourne or the modified-LPH. This points to another area where the RAN would have achieved more than it sought in the purchase of Invincible. The massive power output of the marine Olympus is sufficient to accelerate the class across certain speed bands at a rate faster than that of an RN Type 42 destroyer, or to enable it to make way on a single engine at 16 knots. The ship's hull shape is apparently well refined, compared to that of the LPH design, as the RAN claims that the higher fuel consumption per unit output of the Olympus when compared with that of a more recent power unit (such as the LM 2500 aboard the LPH) is offset by the inherent efficiency of Invincible's hull. Both designs are estimated to generate similar demands for fuel in the course of a typical year.[100]

Gas turbines bring other advantages to modern warships as well as providing for a spectacular progress. They have a better power-to-weight ratio than other conventional power plants, are more flexible and capable of faster response from cold, and being modular in installation are capable of easy removal and replacement. In total these features lead to a much greater proportion of operational service during the lifetime of the vessel. Gas turbines do, however, extract some penalties. Simply because they are comparatively light the use of gas turbines results in a higher centre of gravity than would otherwise be the case and this can result in stability problems unless weight distribution is carefully studied.

Potentially more serious in its consequences are the demands of these power units for large volumes of air. The intakes for Invincible's turbines are four elongated rectangular slots of considerable size arranged in two sets of pairs on each side of the vessel's hull. These feed ducts of 2 metres diameter and it would seem that these could provide a passage by which internal damage might be sustained in the event of a missile strike. Certainly this threat has been responded to in the design of the Invincible class as the engines are cross ducted to ensure that one engine would be available to each shaft should the ship be heavily damaged on one side.[101] The process is followed with the exhaust ducts, leading to four sets of 2 metre ducting crossing the vessel in the midships area. The consequences of this are twofold: firstly, the duct structures protrude into the space at the sides of the hangar deck, producing a hangar that has been described as "dumb-bell" shaped; secondly, it makes lateral compartmentalization of the hull impossible over much of its depth.

The first of these is more of a nuisance than a danger. The hangar was designed when the role of the ships was purely that of ASW cruiser and the neck of the "dumb-bell" was sized to allow large helicopters to be moved past each other. When accommodating STOVL aircraft the hangar becomes a problem because the wing-span of the Harrier is sufficient to prevent aircraft passing each other in the narrow section of the hangar. Whilst this can apparently be done by some clever juggling of aircraft in the two large end sections, this shortcoming might cause problems where one of the elevators was damaged or faulty and aircraft had to be shuffled on to the other elevator from the opposite end of the hangar deck.

The second consequence of the cross ducting of the engine-air supply is potentially more serious and was demonstrated by the fate of HMS Sheffield. Whilst press reports following the destruction of this ship purport to convey the surprise of naval personnel at the destructiveness of a single missile and particularly the intensity of the fire it caused, the incendiary effect of surface-skimming PGM has been known for some

time. Naval architects have been aware of the consequences of an SSM hitting its target with a large proportion of its fuel unused and adding a powerful incendiary effect to that of its warhead.[102] As these are often sufficiently powerful to breach several bulkheads with their detonation there is always a possibility of a widespread, intense fire following a hit from a surface-skimmer. This appears to have been the case in the attack upon Sheffield and, whilst a single instance can not establish the generality of a problem, it does at least show that its possible occurrence can not be ignored. The peculiar problem arising from the cross-ducting of intake and exhaust ducts in the Invincible class is that, whilst they are intended to isolate the effects of battle damage to the side which was struck, they may provide a pathway by which fire might reach the vital internals of the vessel, should she be struck in the vicinity of the ducts by a surface skimmer. In the absence of lateral compartmentalization (which the cross-ducting prevents) there may be more than a possibility that an uncontainable fire will spread across the ship after a PGM hit, and thus undo the original intention of the cross-ducted design.

(Matters associated with maintenance and running are discussed in Section 7, below, in the course of analysis of support costs).

Aircraft Complement

The final, though obviously most important factor, governing the operational effectiveness of the type of ship procured to replace HMAS Melbourne is its aircraft carrying capacity and aircraft handling arrangements. Although the aircraft complement of a ship is limited primarily by its size other factors, such as poor design or the requirement to incorporate other equipment, may influence the efficiency with which hangar space aboard ship is provided.

This factor can be illustrated by a comparison of the hangar capacity of Invincible, the ship it was to have replaced and one of its competitors, the modified-LPH. Despite the

handicap of its "dumb-bell" shaped hangar, Invincible can accommodate three more aircraft below decks than could HMAS Melbourne which, despite being marginally larger at 20,265 tonnes, could hangar only 13 aircraft. The 21,400 tonne modified-LPH, however, has a greater than proportional increase in hangar capacity compared with either, and has room for 22 aircraft. This may well result as much from the use of American-style aircraft elevators mounted on the side of the hull as from superior naval architecture. However the traditional British location for the elevator, on the centre-line of the deck, does allow better sealing of the hangar, which not only benefits the air conditioning of this area but provides better NCBW (Nuclear, Chemical and Biological Warfare) protection.

A limited number of additional aircraft can be parked on the deck of aircraft carriers in most weather conditions without inhibiting air operations. Surprisingly the capacity claimed by the RAN[103] for each of the three vessels indicates that the larger modified-LPH has the smallest deck park and this evens the size of the total air wing which it is possible to carry. The total complement is 22, 20 and 26 aircraft, for Invincible, Melbourne, and the modified-LPH, respectively. However, with the Government's announcement of 29 April that "planned expenditure for additional ASW helicopters has been deferred",[104] and its previous admonitions against the prospects for procurement of STOVL aircraft, the maximum aircraft capacity of a carrier is unlikely to be the cause of any crushing problems for quite some time.

Nonetheless, in assessing the worth of a carrier to the nation's security some assessment of their effectiveness when properly equipped should be made. This must include an assessment of their capacity to operate STOVL aircraft even though the Government has denied that an ASW role calls for such equipment. In RN service the Invincible's standard air wing comprises 9 Sea King helicopters and 5 Sea Harrier STOVL aircraft. An assessment of the adequacy of aircraft in these numbers for various roles is made in the relevant sections below, but here it should simply be noted that this is an extremely

limited complement for many roles outside the RN's specialised ASW tasks in the North Sea.

In the context of some of the claims made for an "aircraft carrier" by protagonists of Australian-naval air power, one clearly important consideration is the flexibility of the air wing. The most important governor of this flexibility is the number of fixed wing STOVL aircraft which can be carried at any one time, since these aircraft are required to perform air-to-air fighter, wide area ocean surveillance and anti-shipping strike duties. Whilst ASW helicopters can double in other roles, and are the only means of performing their primary ASW duties and vertical assault missions from V/STOL carriers, their performance overly restricts them in any of the roles dedicated to the fixed-wing aircraft, if indeed they are capable of performing them at all. Nevertheless the number of ASW helicopters cannot be arbitrarily reduced, since their role is vital to the survival of the ship itself in conditions where any level of submarine threat is expected. Indeed, as is discussed in the section on ASW below, on occasions where a high-level submarine threat is apparent the number of ASW helicopters may need to be increased, even at the expense of STOVL aircraft and, hence, the operational flexibility of the ship. Obviously more STOVL fighters can be embarked than is normal in R.N. service and indeed Invincible departed for the Falkland Islands with 8 to 10 Sea Harriers aboard as well as the normal helicopter wing.[105]

The only surprising aspect of this was that the number of STOVL aircraft was so small, given that the British force was heading for combat in an area over half of which it was known that the Argentinians would have numerical air superiority. This might have reflected a priority to maintain the size of the helicopter flight, reflecting perhaps some concern about the threat posed by the two Argentinian Type 209/1 submarines, and the need for the helicopters' secondary use in vertical assault should a landing become possible. Alternatively, the RN may have felt that the notoriously turbulent seas of the South Atlantic would make the parking of aircraft on the deck too risky. However, it may simply be the case that the 20 Sea Harriers which

sailed with the task force (the remainder in the larger HMS Hermes) were all that the RN had at readiness, since production of the order for 34 operational aircraft (plus 4 trainers) is not yet complete.

The fact that there were, in the event, too few STOVL aircraft with the British fleet in the Falklands soon became apparent and was exacerbated by the early loss of three of them. In the initial stages of the engagement 10 additional Harriers were despatched in the requistioned container ship Atlantic Conveyor[106] but the loss of aircraft with the task force, and the success of the air attack on HMS Sheffield appears to have further emphasised the urgency of the situation; to sufficient an extent that an additional 20 Harriers were fitted with air-refuelling probes and despatched to the task force via Ascension Island with mid-air refuelling en-route.[107] Because of the limitations of the RN's inventory of Sea Harriers the additional aircraft which were despatched to the Falklands were mainly Harrier GR Mk3s of the RAF. While it is clear that the additional aircraft were of considerable benefit to UK forces in the combat zone, they were unable to prevent the loss of three more British surface combatants: Antelope, Ardent and another Type 42, Coventry.

The point of this digression into Britain's Falkland experience is that it illustrates the degree of air power which is needed by a naval force attempting to attack any reasonably well-prepared adversary near its own territory. In the opinion of the leading proponent of RAN maritime air power, Sir Anthony Synnot, the British had too few aircraft with the task force to allow them to perform both the air superiority and the strike roles. Thus, when Sheffield came under attack, no Sea Harriers were present because they were away on a ground attack mission.[108] Whatever the situation when Sheffield was attacked, the event indicates the nub of the difficulties in projecting a flexible response to a changing Australian strategic or tactical situation from a platform such as Invincible: the comparatively small size of the ship and the consequent limitation of her air wing make it very difficult to assemble a convincing level of

force in many roles whilst at the same time maintaining sufficient residual capability in the other roles needed just to safeguard the ship.

As Vice Admiral Hayward was to write:[109]

> The battle in the South Atlantic has shown conclusively the inherent shortcomings of the small carrier with an air capability severely limited by such aircraft as the Harrier. Having had to operate Air Groups from our large ships I can state that aircraft of that limitation have little real use in such a situation.

This is not a problem which would be new to the RAN, however, for HMAS Melbourne suffered from the same restrictions of size; but the problem which Navy will face, at least for the foreseeable future, with a V/STOL carrier is that they are inherently more limited in aircraft choice than Melbourne. Being a conventional carrier, equipped with steam catapults, arrestor wires and angled flight deck, Melbourne had the potential to operate many of a range of small fixed-wing naval aircraft. Lacking these facilities, V/STOL carriers cannot. At the moment, and probably till well into her declining years, the only fixed wing aircraft that could be flown from such a ship would be variants of the Harrier. The attributes of this aircraft are discussed below, but whatever its virtues, it is not a fixed wing ASW aircraft such as the Grumman S2 Tracker formerly operated from Melbourne, nor is it an AWACS (Airborne Warning and Control System) aircraft. Fixed wing ASW aircraft are a powerful component in any balanced operation against submarines and one which has always been included in the air wing of conventional carriers. The importance of AWACS aircraft is a lesson which is emerging strongly in a number of contexts (see below p.106). It is significant that after their first serious loss to Argentinian aerial attack the British were forced to use the RAF Nimrod ASW aircraft as a stop-gap AWACS system, even though this entailed a 6,000 n.m. round trip from Ascension Island.[110] Thus, even if adequate numbers of aircraft could be purchased and operated by the RAN, there would still persist a number of serious qualitative restrictions on the projection of force by an RAN

carrier group for as long as that "carrier" is a V/STOL ship and the present level of V/STOL technology enjoys only incremental improvements.

The Consequences of the Reduced Australian Aircraft Complement

Whatever the eventual composition of the air wing to be carried by a carrier in RAN service it is apparent that if it does enter service its aircraft complement will be too small to perform more than a minimum of roles. Far from worrying about the adequacy of the maximum aircraft capacity of their new carrier, the RAN is going to have the problem of developing adequate expertise and operational doctrine with a bare 8 helicopters. These Sea Kings consist of the 6 survivors of 10 Mk50s originally approved in 1972 and a further 2 approved in February 1980 as part of the Government's response to Russia's actions in Afghanistan. Following the Ministerial Statement of 29 April it is now apparent that this is all that the RAN can look forward to for quite some years. Worse still, unless the attrition rate of the Sea King can be better controlled than in the past, the Navy could quite soon have even fewer assets with which to work.

Since the first of them entered service in 1975[111] 4 of the original order have been lost, at a rate of almost one every 18 months. It was apparently thought that this was a situation serious enough to warrant correction in the aftermath of Afghanistan and that there were "particular advantages in proceeding with the acquisition of two additional Sea King helicopters to replace recent losses".[112] Yet if the past average is maintained it is a situation which will reassert itself within 3 years.

It is obvious that the air complement which was proposed for Invincible was limited simply if it is compared to the 9 helicopters which are normally embarked in RN service, but the problem is worse than this since the total which would be on board the carrier at any one time would be much less than the Service inventory. Helicopters require a comparatively busy

maintenance schedule and on average two of the RAN's Sea Kings would be out of service for major overhaul at any one time. It would not be atypical for at least one of the remainder to be inoperable because of minor maintenance or breakdown. If another aircraft was required for pilot conversion, or similar shore-based tasks not connected with operational flying, and this could often be the case, Invincible would have found herself at sea in her initial years with no more than 4 operational helicopters. This clearly would have been inadequate, even on the RAN's estimates. In talking about the role of ASW helicopters Admiral Synnot has stated that "you really need six of these large helicopters".[113] Although the subsequent unavailability of Invincible will lead to some short term re-organization of Defence finances, the fact that any alternative will be at least twice as expensive will restrict even further the Government's ability to fund procurement of new ASW helicopters.

Opinion is developing overseas that modern submarines can be hunted successfully by ASW helicopters only if the latter work in co-ordinated groups of preferably 4 helicopters each.[114] The complement which was proposed to equip Invincible would have been adequate for only one such hunter group. Whilst there may have been times when Melbourne put to sea with as few Sea Kings the situation then would not have been so critical. The effectiveness of Melbourne in the ASW role was enhanced by her ability to use as many of the operational S2E and S2G Trackers as were felt necessary. The latter of these two variants was quite sophisticated, having been developed for the US Navy as a bridging system following delays in the introduction of the S-3 Viking. The S2G carried many of the electronic systems intended for the S-3 with passive and active sonobuoy systems including CASS (Command Activated Sonobuoy System).[115] These systems are not available to the Sea King Mk 50,[116] and the RAN will lose the capabilities of passive air-dropped sonar detection with the sale of its Trackers. There is no prospect of any STOVL successor to the Tracker becoming available overseas before the mid-1990s, if then, with a further delay before entry to Australian service. Even the prospect of this happening is beyond Australia's control and depends upon a change of the hitherto less-than-enthusiastic

attitude of the US Navy. So the RAN's self-selected major role of ASW will be performed in the near-to-medium term future by a reduced range of technologies (and, it will be argued in the next section, by a range of inferior technologies) mounted within a reduced number of airframes, whatever vessel might be chosen to take them to sea.

Some idea of the degree of constraint this will enforce upon the RAN can be gained by contrasting the 8 helicopters it will have for the foreseeable future, with the number it would prefer to have. Just what would constitute an adequate contingent of ASW helicopters for the RAN's purposes was revealed when DoD made requests to industry for information leading to the procurement of various helicopters. This was in early 1981 when several long-standing RAAF and RAN requirements for helicopters were combined into a total project designed to produce the greatest degree of commonality possible in the next generation. At that time the entire project, which included helicopters for the FFG-7 frigates, fleet utility helicopters and utility troop-lift helicopters, amongst others, was valued at in excess of $1,000m. It is these programs which were "reduced" as one of the expenditure savings announced in the Minister's 29 April statement.[117] Nonetheless, in headier times the project included a requirement for "Fleet ASW helicopters". According to industry sources this called for 18 aircraft with an additional 4 following as an allowance for attrition. The project, still in the early planning stages and subject to change of priorities, did not then envisage these helicopters being in service till 1990. This, however was before the RAN was offered Invincible and when planning was concentrated on having a modified-LPH enter service in 1986 or later and the 18 aircraft can be regarded as the number the RAN considered necessary to maintain a carrier based ASW capability.[118]

In its response to questioning of the value to national security of a single V/STOL carrier the RAN has tended to downplay the question of operational viability during hostilities and instead point to peace-time conditions, saying "One carrier will allow skills to be maintained and will provide for use in

response to an emergency contingency".[119] Given the small number of helicopters available for practising ASW techniques now and for the foreseeable future, not to mention recently imposed constraints on activity, the RAN will be performing valiantly indeed if it manages to train more than a few future naval aviators.

More obvious is the fact that the Navy is unlikely to maintain the skills it possesses in fixed-wing naval aviation. If, as often has been claimed,[120] the carrier was necessary to retain skills which were expensive to recreate once lost, this economy now will not be realised because of the Government's intention to purchase Invincible without STOVL aircraft, and the subsequent disappearance of that option.

That economic penalty will begin to accrue in the near future, as the Navy's fixed-wing aircraft are to be "paid off as soon as practicable"[121] to provide funds towards the rescheduling of Defence expenditure which, ironically, had been caused by the purchase of the ship upon which the RAN's aviation future was supposed to rest but which is now not available. Given the current commitment to expenditure on defence equipment programs and the problems which it implies (dealt with in the final section of this paper) the previous Minister's admonition, not to expect anything more to be made of Invincible than a helicopter carrier, may stand for even longer than expected since any alternative carrier will be considerably more expensive than Invincible. It is now probable whatever decision the Government makes that the RAN will suffer a reduction of capability till after the end of the decade.

The Importance of the "Ski Jump"

In the light of present Government uncertainty about the purchasing of STOVL aircraft for the RAN, the discussion of improvement in the performance of fixed-wing aircraft from V/STOL carriers is academic. However, much of the debate about the procurement of a carrier has centred around "options" and

"possibilities" and from this point of view the RAN has avoided some problems with the withdrawal of the offer to sell Invincible.

A great deal of research in the United Kingdom has proven the advantages of a device known as the "ski jump" in improving the operational capabilities of shipborne STOVL aircraft. The ski jump is little more than a curved ramp mounted at the end of the flight deck, usually over the bows but, in the case of Invincible, behind the forecastle. In practice a STOVL aircraft of the Harrier-type (since the concept has been proven only with the Harrier which is unique in vectoring all its engine thrust) takes off by accelerating along the flight deck and up the ramp, the top of which it leaves in a ballistic trajectory which carries the aircraft to a height of some 60 metres above sea level. From here it has sufficient forward speed for its wings to begin to contribute progressively more lift.[122] The purpose of this technique is that it allows the aircraft to take-off at speeds lower than that normally required for any given weight. In shipboard operations, where speed cannot be built-up over an inordinately long take-off run, the use of a ski jump means that either the aircraft can become airborne within a shorter distance or can take-off carrying a heavier payload.

This was vital for the use of the Sea Harrier in the STOVL mode from Invincible. To perform three of its major missions to the specification of the RN the Sea Harrier would have needed to use the full length of Invincible's flight deck (167.8 metres) and an engine with water injection to increase thrust.[123] This would have involved an expensive modification program and been inherently dangerous because the failure of the injection system during take-off would usually have meant the loss of the aircraft. In practice it has been found that a 15 degree ski jump allows the aircraft to become airborne in either one-third of the normal deck run or with an increase in its fuel or weapons load of up to 30 per cent. The method is also inherently safer since there is no injection system to fail and the launch trajectory allows the pilot time for either correction or escape, in the event of an accident.[124]

Of the designs originally studied only one featured a ski jump. This was Invincible, but the ski jump of this particular vessel is less than optimum. The first two vessels of the class suffer from the fact that their design commenced when the ships were intended to operate only with helicopters and before the ski jump was proven to be of such benefit. It was not therefore an original feature of Invincible and her sister ship Illustrious. When it was decided to fit them with the ski jump it was found that any construction giving an angle of exit greater than 7 degrees interfered with the arc of fire of the Sea Dart SAMs. Therefore both Invincible and Illustrious have ski jumps limited to 7 degrees and only the third of the class, HMS Ark Royal, has a ski jump which, at 15 degrees, is close to the theoretical optimum of a 20 degree exit angle.[125] Thus the performance gain which the Invincible would be able to bestow upon STOVL aircraft is somewhat restricted. In Australia's area of operation this might have been an awkward limitation since it has been suggested that water injection, with all its costs and risks, may be required to allow the Sea Harrier to operate at higher weights and temperatures.[126] The ski-jump could be rebuilt at a later stage of the vessel's RAN service, but only with weight and financial penalties since the increased angle of Ark Royal's ski-jump is achieved by increasing the length of the structure to some 45 metres. This weight would be counterbalanced however, if the RAN decides to remove the Sea Dart launcher and magazine from its location on the forecastle immediately adjacent to the ski-jump. The other designs now being considered will also undoubtedly benefit from the opportunity to incorporate a ski jump into the design.

6. The Carrier for Anti-submarine Warfare: How Effective?

As has been previously discussed (see pp.32-35), the major thrust of the RAN's argument in favour of replacing the Melbourne for some time shifted from defence of SLOC to an almost total concentration on focal area ASW. This paper has already dealt with the claimed strategic justification for procurement of a carrier in terms of its effectiveness for protecting merchant shipping in areas where shipping routes converge. It was noted

then that CDFS in his March 1981 evidence to the Katter Committee had emphasised this role. In view of the suggestion that alternative methods of prosecuting ASW should be investigated it is interesting to note that Admiral Synnot presented his argument largely in management terms. Responding to an argument that basically it was pointless having a vessel to carry only ASW helicopters since they, unlike fixed-wing aircraft, could be operated from a large number of alternative platforms, the Admiral replied "when this was looked at it was seen that there was a need for an anti-submarine helicopter".[127] He then went on to talk about the performance and method of deployment of ASW helicopters, using this to imply that since they provided a unique capability they were something one could not really be without. Stating that six such helicopters were needed for effective ASW and that these could be operated more economically from a single large ship than from several smaller ones, he implied that this justified the procurement of a helicopter carrier for ASW operations.[128]

Unfortunately, the CDFS did not attempt to explain the factors that created the "need" for ASW helicopters nor was he asked whether the "economy" of the helicopter carrier was sufficient reason by itself to purchase such a vessel. It is true (in the context of financial criteria) that concentrating maritime aircraft on a single ship is a more effective and efficient method of operating naval air power. The RAN estimates this effectiveness at a ratio of 4:3[129] - that is four helicopters operating from small vessels are required to perform the same duties as three from a carrier. The more significant fact is that, in the context of current policy, this efficiency would not have been realized by Invincible in RAN service. With an operational contingent of only four helicopters the effective potential of Invincible was less than that of three FFG-7 frigates had they been equipped to carry such helicopters. Although it is possible that a RAN carrier often would be escorted by this number (the RAN hopes to have 6 in inventory by 1990) they are not at present equipped with helicopters, and this program was one of the casualties of the 29 April "reorganization".

It is not RAN policy to base ASW helicopters on the FFGs and Sea Kings are too large to operate from them but more modern helicopter designs are available to perform this task. It would be interesting to know if DoD had acknowledged that their budget could not finance both Invincible and adequate numbers of helicopters before it recommended the ship's purchase to Cabinet and, if so, whether it had undertaken cost/benefit comparisons of the value of an under-equipped ASW helicopter carrier with the option of purchasing the helicopters for which the FFG-7 frigates were designed.

ASW helicopters, whatever the platform on which they are based, are able to hover and thus to use a larger active sonar, and thus have capabilities which other ASW aircraft lack. What is also true, however, is that helicopters are comparatively small and slow aircraft which nonetheless can become extremely expensive to buy and operate as modern ASW technology struggles to overcome the inherent advantages of submarines and the complexities of the medium in which they operate.

Inherent Difficulty of ASW

The sea is a most complex medium and sound waves are still the only means offering reasonable prospects of submarine detection, despite the large amount of research devoted to once promising new technologies. Although sound travels vast distances under water and generally at four times its velocity in air, the nature of its propagation varies greatly depending on factors such as water temperature, depth, salinity and the composition and topography of the ocean floor. Significant variations in temperature produce layers of water in which the velocity and propagation characteristics of the sound differ from those above or below it. These layers are known as thermoclines and constitute one of the major problems in ASW. The first of these thermoclines, lying on the surface and often referred to as the "surface duct", has characteristics such that sound propagated within it, say from an active sonar transmission, tends to be reflected back towards the surface by the colder, more dense water immediately below it. (Systems which emit a

pulse and listen for a reflected return are known as "active" sonars, in contradistinction to "passive" sonars which merely listen for target-generated noise).

As a consequence, a submarine can "hide" under the first thermocline and not be detected by sonar on the surface only 20-30 metres above it.[130] To overcome this problem, sonars with variable depth can be used: one example of this is the "dunking" sonar of the ASW helicopter, which is lowered whilst the helicopter hovers, and can be used at various depths. Unfortunately, the energy of sound in the dense medium of the ocean is soon spent, and therefore the detection range of active sonar is decidedly small. For instance, the enormous AN/SQS-53 sonar, which is fitted to the USN's Spruance class destroyers, and represents the latest in active sonar technology, has a range of only some 8 nm.[131] The maximum range for the much smaller dunking sonar of an ASW helicopter is, by contrast, only of the order of 3.8 nm under ideal conditions.[132] At a time when even conventional submarines are capable of bursts of up to 20 knots, such short ranges imply a low detection probability at the best of times. Such marginal performance has led the West German Navy, for one, to conclude that location and attack of a modern submarine by a single helicopter is not feasible, even with such a sophisticated machine as the USN's forthcoming LAMPS-III,[133] which abandons dunking sonar in favour of sonobuoy technology. In fact, many navies already have adopted the tactic of hunting submarines in groups and in future it may be impossible to track and successfully attack a modern submarine unless a group of helicopters with some form of data link operate together.[134] In Australia's case, these problems are compounded by much of the ASW carrier's time being spent in tropical or sub-tropical waters, where the distortions and vagaries of sound propagation are greater than in the colder oceans for which ships like Invincible and their systems were originally designed.

Movements Towards Passive ASW Detection Systems

It is for reasons such as these that most nations operating large ASW helicopters appear to be moving to the

extensive use from them of sonobuoys. As mentioned earlier, sound can travel for enormous distances under the sea and, theoretically at least, the noise emitted by a submarine can be detected by a listening hydrophone at ranges much greater than those at which the sound emitted by an active sonar would be returned to the receiver. Moreover, a passive sonar, making no noise of its own, reduces the chances of the listening platform prematurely giving itself away to the target submarine. Until now the problem has been that all noise has been so well propagated under water that detection of a submarine amongst the clutter of background noise has been possible only at quite short ranges. However, the increasing power of computers now enables processing devices to screen out all non-mechanical noise and thus allow the detection of mechanical sound, such as submarines, at considerable ranges. When packaged into sonobuoys and used by aircraft equipped with a sonics processor, such as the RAAF's Orions, this technology provides a much better method of hunting modern submarines than the dunking sonar. Modern sonobuoys, such as the Australian Barra, are also able to give bearings on the target noise when deployed in "patterns", thus speeding localisation and attack. Spread in a geometrical pattern, "barriers" of sonobuoys are able to cover a much wider area than even a team of helicopters using active dunking sonar. In addition, passive sonobuoys will provide classification of the target by analysis of its acoustic properties, and the Barra system is even capable of identifying an individual class of submarine.[135] In the attack phase, the constant stream of data from a well laid sonobuoy pattern, at this juncture including active sonobuoys, enables tracking of the target up to weapons release, whereas a helicopter working with dunking sonar has to continually break contact, retrieve the sonar transducer and fly to the next predicted intercept point. It thus risks losing the quarry before it closes to attack.[136]

It appears that the use of sonobuoys by helicopters has been considered by the RAN as the 1976 Defence White Paper declared that "studies are being undertaken into the possibility of increasing the capability of Sea King helicopters in the 1980s by fitting of processing equipment for use with Barra and other

sonobuoy systems".[137] Although nothing tangible has arisen from these studies, the Royal Navy has proceeded with the development of a sonobuoy processor for its Sea King helicopters. This is the Marconi LAPADS (Light-weight Acoustic Processing and Display System) which is basically a reduced version of the AQS-901 system used by the RAF on its Nimrod Mk2s and the RAAF on its P3C Orions. The LAMPS-III under development for the USN features a similar development but in its case a data link between the aircraft and ship allows all processing to be done on board the parent craft. This doctrine allows much greater computer power to be applied to the ASW problem and obviously the rate of flow and quantity of data which could be accepted under this system would be much greater than that of the traditional dunking sonar equipped helicopter.

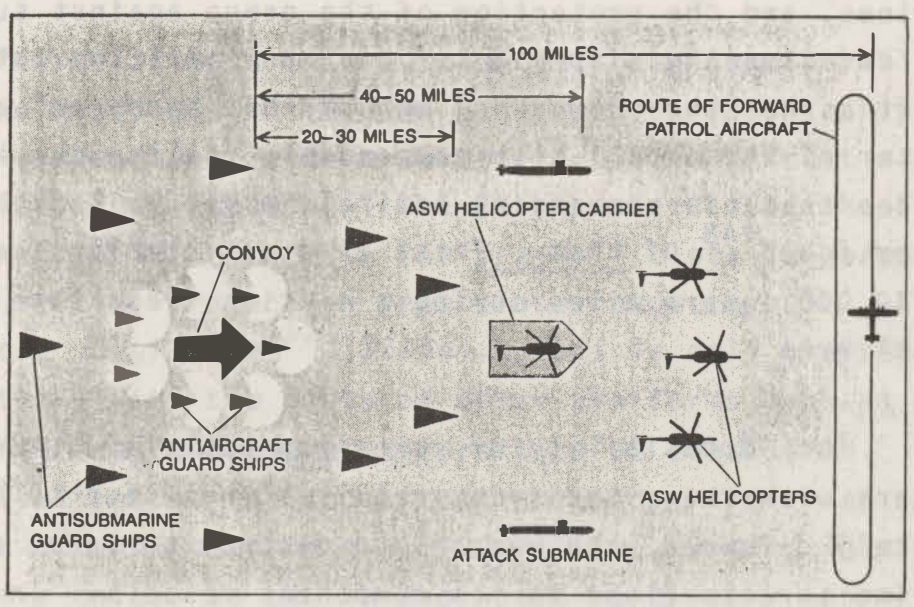
Although the use of sonobuoys undoubtedly expands the capabilities of ASW helicopters, its practical benefits are somewhat qualified because of the size and payload capacity of these basically inefficient flying machines. The LAPADS system in Royal Naval service can handle the data of only four sonobuoys simultaneously,[138] whilst the AQS-901 onboard the P3C can process that from 16 simultaneously.[139] The most sophisticated of ASW helicopters, the yet-to-be-deployed LAMPS-III, can carry only 25 sonobuoys[140] compared to the 84 which can be carried by the RAAF's P3C Orion.[141] This low payload, typical of the helicopter, is compounded by its lower operational performance. With a cruising speed at sea level of 112 knots and a cruising radius with maximum standard fuel of 332 nm, it is obvious that the Sea King will take longer to cover a smaller area than a P3C cruising at 206 knots with a maximum mission radius of over 2,000 nm.

Practical Difficulties of ASW

The practical difficulties of conducting successful ASW operations with equipment as essentially limited as ASW helicopters can be illustrated from a study of the requirements for protection of a USN carrier group, written by a USN ASW specialist. The study found that to protect an area of radius

100 nm around the carrier, assuming total coverage was necessary and a median detection range per buoy of 5 miles was likely, approximately 300 sonobuoys would be required.[142] The author concludes (and, it must be remembered, in the context of the resources available to a superpower) that this is "an unrealistic and unworkable approach".[143] Even abandoning the area coverage scheme and constructing a single-line barrier around the friendly ships would require 50-60 sonobuoys. This field would require two P3Cs simply to replace the sonobuoys at the rate required to cover the speed of advance of the ship. Even if the distance of the barrier were reduced to 70 miles, it would require four P3Cs to monitor and lay a single sonobuoy barrier.[144]

If this situation is considered impractical by a nation with all the assets available to a carrier task group, it is easy to see why the RAN abandoned the idea of protection of shipping along Australia's SLOC, whatever the strength of their subsequent equivocations. The following diagram illustrates a US conception of a typical ASW helo carrier task force protecting a convoy:



(Source: Scientific American, February 1981, p.40)

In contrast with the American situation, the RAN is apparently proposing to conduct maritime air ASW operations with a minimum

of six helicopters.[145] In other navies such as that of France, whose Super Frelons operate in groups of three or four,[146] this number would produce, at most, two potential groups. This would not even allow for maintenance requirements and systems failures, which are notoriously prevalent amongst helicopters.

As "unworkable" as this US example is considered by its presenter, developments in submarine technology mean that even worse situations might have to be faced in a major war scenario. An example of one such has been given by a recent Assistant Chief of Naval Staff (Operations) of the Royal Navy.[147] This is particularly relevant in that it outlines the role of the Invincible class ships. Writing in the context of a task-force group escorting some maritime item of "paramount" importance, the author states that the "immediate" sea area of operations covers some 300,000 square miles. This corresponds to a radius of operations around the centre of the group of almost 270 nm, some two-and-a-half times greater than the problem considered in the USN context. This is a high threat scenario and envisages combined actions from enemy aircraft and ships, as well as submarines, and the protection of the group against submarine attack requires the dispersal of "as many maritime patrol aircraft as he [the commander] can lay his hands on" at the perimeter of the area. With commendable realism the writer concludes that the commanding Admiral "might be lucky and get three or four"[148] of them. These aircraft combined would patrol about 40,000 square miles during a mission, less than 13% of the "threat" area.

The impossibility of screening out all would-be attackers with these resources requires the group to be adequately defended with weapons to destroy surface, air and submarine threats close to its component vessels. In this circle, some 10 miles in radius, the ASW helicopter is one of the weapons deployed. However an enormous area lies between the forward surveillance of the maritime aircraft and the defensive circle of the ASW helicopters and shipboard weapons. From within this area the task force is vulnerable to attack from missile firing nuclear and conventional submarines whose weapons make the

ASW problem an anti-aircraft problem as well: to a major maritime power planning for such a contingency the answer is the nuclear attack submarine positioned some 100 miles out from the group and using passive towed array sonar to detect enemy submarines and surface ships.[149] This solution is not available to the RAN.

In this classic exposition of "defence in depth" the role of Invincible, besides operating helicopters, is to co-ordinate the widely differing platforms and capabilities available for the defence of the group, to ensure that data flows as required to and from all of its elements and that the most effective use of weapons systems is made when deployment of force is necessary.[150] This concept is similar to the "force multiplier" argument used by protagonists of a RAN carrier, both to argue for its survivability and to maintain that ships accompanying it should not be thought of as "escorts" tasked only with safeguarding the carrier. The writer of this British high level scenario study concludes that the task force group "may well prevail".

Prevail though it may, the costs are considerable. To protect the group against medium range air threats a ship like the Type 42 destroyer, with a current replacement cost of £stg. 180m[151] ($300m) is required. The RN then developed the Type 22 ASW destroyer also armed with the Sea Wolf close-in-weapons system to provide protection from close range threats. These vessels cost £stg. 125m[152] ($215m). This is only the beginning of the outlay, with the costs of other platforms such as nuclear attack submarines and patrol aircraft to be considered. One writer has estimated that each task group represents an investment of well over £stg. 1,000m[153] ($1,700m). This is by no means a levy unique to the RN and would be closely approximated in RAN service whenever a task group of 4 FFG-7 frigates was assembled around the Invincible. It is however, a cost that the UK Government was not prepared to carry till after the events in the Falklands. In announcing the decision to retain only two of the Invincible class in service, and thus beginning the process leading to the offer of Invincible to Australia, the British

Secretary of State for Defence left no doubt that this was largely due to "their heavy demands on supporting anti-submarine and air defence escorts".[154]

Of more importance in the general context of the feasibility of defence against submarines in a high threat scenario is the fact that the British Government is not as certain of the chances of survival against modern nuclear attack submarines as are its naval leaders. The Secretary of State for Defence described the USSR's newly deployed Oscar class submarine, equipped with a 250 mile (217 n.m.) range underwater-launched anti-shipping missile, as a "breakthrough in technology". Using the example of this threat to defend the decision to operate only two Invincible class ships, Mr Nott emphasised the consequences of this "breakthrough" by saying "I do not believe that we would order them [the Invincible class] if we were making the decision today. Times have changed."[155] This attitude corresponds with reports that the scientific advisors to the British Secretary for Defence hold the view that surface warships can no longer be defended adequately.[156]

Impressive though the long-range striking power of the Soviet Oscar class undoubtedly is, it is a strength which can only be optimised as part of a combined force needing data from other Soviet fleet elements to provide range and bearing. It is a capability requiring developed C^3 and the survival of a sufficient number of other units in the force for success; the answer of a superpower to a high level defence crisis. However it is not simply the Soviet's integration of high level force elements into a long range system which represents the extent of the submarine threat to surface shipping. If anything the threat from both nuclear and conventionally powered submarines operating alone in their traditional role of covert intrusion has increased in proportion.

As in the use of active sonar the inherent advantage lies with the submarine, so the development of passive sonar has given the submarine another powerful counter to surface units. Since they operate wholly immersed beneath the sea, submarines

avoid generating the turbulence and concomitant noise that is created by a ship moving across the surface. A great deal of effort has gone into silencing submarines and in the case of diesel-electric submarines they can, for short periods, become almost noiseless. Submarines are as capable of using passive sonar to listen for surface ships as are aircraft in listening for the submarine. Using the same technology as used by surface ships equipped with TACTASS (see below p.85) the well equipped submarine can gain both range and bearing co-ordinates without having to close to visual range. In hostile waters where any surface ship is open to attack, the day of the periscope is over: the submariner can now target his quarry by running passive acoustic data through his fire control computer whilst the unsuspecting surface ship is perhaps 100 n.m. away.[157] Such distances are usually theoretical optima, but covert detection at ranges in excess of ship-borne active sonar is the norm. In the early period of the Falklands conflict the only pressure which the British could place on Argentina was the threat of its nuclear attack submarines and much was made of their capability to passively identify and target shipping at ranges in excess of 30 n.m.[158]

This distance is still adequate to outrange the inner ring of ASW defence depending upon helicopters and surface ships. With adequate weapons the submarine can attack and retire with impunity, as indeed happened when the Argentinian cruiser General Belgrano was sunk. At the high level of conflict there are at least two Soviet sub-surface launched anti-shipping missiles with a more than adequate range, but for nations involved in lower-level conflicts there are also modern torpedos whose performance allows them to be fired beyond a 20 mile defensive helicopter screen. Of the Soviet missiles, the SS-N-7 is reported to have a range of up to 30 miles whilst the SS-N-9, apparently the weapon deployed by the USSR's Charlie class submarines, has a range reported to be about 50 miles. The powerful American Mk 48 torpedo, now entering service with the RAN itself, has a maximum range of 28.5 miles, whilst should this weapon prove too expensive for a potential purchaser, the British Tiger Fish, has a range in excess of 20 miles and perhaps the equal of that of

the Mk 48.[159] Both torpedos have dual command guidance/ autonomous guidance homing systems. Thus, it would appear that the apparently low productivity of conventional ASW operations in terms of the enormous investment demanded is compounded by the extreme vulnerability of the platform itself, at least while current equipment and operational doctrines are used.

Improved Methods of Protecting Australian Shipping

Of course it can be argued that the rather remote prospect of high technology submarine warfare in the circumstances of a major level conflict is not the criteria against which the prospects of success of RAN ASW operations involving a carrier should be evaluated. The rather nervous RAN flirtation with defence of SLOC (see pp.32-36) would tend to deny this argument for, as we have stated above, this type of action implies the development of a major-level defence threat and that the adversary would most likely be the Soviet submarine fleet. Indeed the ex-Minister recently went so far as to denote the submarines held by the Soviet Pacific fleet as the "threat" to Australia.[160] This does not represent the official views of his advisors, for as the then CDFS, Admiral Synnot, told the Katter Committee without, he assured them, any sarcasm, "I still think, that for Australia to think of taking on a super-power single-handedly is not possible on the defence budget that your parliament votes us".[161] Should thoughts of Australia independently defending SLOC continue to be advanced to justify the purchase of a carrier, one could well expect a major increase in the defence budget to provide the increase in naval power necessary to allow the ship to survive combat with the nuclear attack submarine.

However, if Navy firmly eschews the defence of SLOC as a major role for a carrier and firmly espouses its efficacy for focal-area ASW, it could argue that the context is one of medium level hostilities and the enemy is the conventional diesel-electric submarine. ASW in this context it can be argued is a greatly different operation. This is undoubtedly so, but the conventional submarine is not without its strengths when compared

with the nuclear submarine, especially with its extreme quiteness.[162]

Admittedly, when operating within enemy focal areas a conventional submarine is relatively slow and lacking in mobility, but this is their traditional role: "a lone and stealthy one conducted in waters controlled by the enemy. Success in this role depends on the submarine's ability to penetrate hostile water and lurk there undetected until a target appears, to destroy the target as quickly and completely as possible, and then to withdraw in the reactive melee to penetrate another day and repeat the process".[163] And, it should be added, to this tactic of stealth has now been added the intelligence of passive sonar, computerised fire control systems and the power of long range torpedoes and sub-surface launched anti-shipping missiles which are available to conventional, as well as nuclear propelled, submarines. Such is the technology of submarine systems that in focal area ASW operations although the submarine may use different tactics he is no less dangerous, and the ASW platform not inherently safer, than in ASW engagements between the superpowers.

However, closer to friendly territory, different tactics are open to the defender of focal areas and different platforms can be used for ASW operations. These systems can be compared for cost/effectiveness against ASW helicopters and the choice of a superior system made. The evidence is that ASW helicopters would be no more efficient at providing protection for shipping within the focal areas for maritime trade around Australia's coast than along the SLOC. The inherently poor endurance of helicopters limits them to comparatively short-ranged operations, if they are to stay on station searching for submarines for any length of time and carry a worthwhile weapons load.

In Australia's case, it appears that the operational procedure is to deploy ASW helicopters not more than 20 miles (17.4 nm) from the carrier.[164] USN practice is to station its helicopters at 40 nm from the carrier and the USN maintains that it needs expensive new technology, in the form of the LAMPS-III,

to be able to extend this defensive perimeter to 100 nm.[165] Endurance in the search operation at this distance is not known but in Royal Navy service it appears that the average mission time of an ASW helicopter is slightly more than 3 hours.[166] In contrast, at a distance of 435 nm from its deployment airfield a P3C can remain on station for about 8 hours.[167] This time on station does not include the 2 hours taken flying to and from the patrol area whereas transit time is included in the example given of Royal Navy Sea King operations. During its 8 hours on station the P3C would be vastly more productive than the slower moving and less capable helicopter. In covering this area the P3C can sweep the dangerous zone from which attack by sub-surface launched surface-skimming missile or long range torpedo can be launched, which a helicopter stationed at only 17 nm cannot.

In an area as localised and close to shore as the focal areas off Australia's coast, there are several more effective and efficient methods of conducting anti-submarine warfare. The superior performance of fixed-wing Long Range Maritime Patrol (LRMP) aircraft and their greater computer capacity has already been outlined above. Other modern technological solutions for the ASW problem, when used together with such LRMP aircraft, would appear to offer a more effective answer than traditional Naval strategies. Not only would the fixed-sea bed systems mentioned above (see p.18) appear to offer prospects for successful surveillance of the approaches to Australia's ports, but the same technology is usable as a means of localising, identifying and attacking enemy submarines when incorporated into systems on smaller naval vessels than an ASW carrier.

The increased use of computer interpretation of sonic data has made possible the detection of enemy submarines by surface vessels at ranges greater than that which currently is possible with a helicopter's detection equipment. In recent years the USN has developed a variety of towed array sonar systems, the latest of which, the AN/SQS-19, is to be deployed from the majority of its destroyers and frigates. These systems, known as TACTASS (in the case of the SQS-19) or SURTASS (in the case of a long-range deep ocean surveillance version of the

system), are basically extremely long cables which have hydrophones affixed at pre-determined intervals. Using the passive sonar technology discussed above and powerful computers to analyse the data, it is possible to not only detect a submarine but to estimate its heading and speed as well. The range at which this can be done remains classified, but various reports indicate it varies from 30 n.m.[168] to beyond 50 n.m.[169] The significant improvement which this performance represents is obvious, especially when teamed with an aircraft such as the P3C, which is capable of a dash speed of 411 knots, almost three times that of which the Sea King is capable.

A less obvious, but no less important, advantage of these systems is that they can be operated from small and comparatively cheap vessels. The traditional naval destroyer sonar of the past has been bulky and required high power outputs, thus restricting its use to vessels of 2,000 tonnes upwards. The towed array is neither bulky nor heavy and, for instance, the SURTASS will be deployed by ships which are basically redesigned ocean-going tug boats. The RAN is not unfamiliar with this form of technology, and under operation Flowerless has experimented with trailing such sonar arrays behind an Attack class patrol boat. The main requirement for operating these systems is extensive computer power, but even this can be economised upon. For instance, in the case of SURTASS most of the data is analysed in real time at facilities in the United States, using satellites to relay the information.

It is not inconceivable that a system similar to that of the US in technology, involving west and east coast analysis centres and using, perhaps, space on the Australian domestic communications satellite, could be constructed if it were felt necessary. This may not be required, however, as it would appear that for the limited objective of protecting Australia's shipping focal areas all that would be necessary would be for the Australian Government to press its American counterpart to allow the fitting of TACTASS to Australia's FFG-7 frigates. This is a course which it does not yet appear to have pursued, despite the

fact that TACTASS is standard equipment for similar vessels in USN service.

There are other technical and operational procedures which could be used to improve Australia's protection of the focal areas of its maritime trade without recourse to the expenses involved in a new ASW helicopter carrier. These would include more extensive use of Australia's submarine fleet and its possible supplementation, not primarily to disrupt the operations of enemy submarines against merchant shipping approaching Australia's ports, but for the strategic alternative of placing similar pressure upon the military and/or civilian sea traffic of the hostile nation: in other words, for a deterrent strategy.

To quote the 1976 White Paper "the effectiveness of submarines, and the complexities of the medium in which they operation pose very difficult problems for the defender and impose a disproportionately high strain on his resources".[170] This has been aptly demonstrated in the Falklands conflict by both sides. The British diverted the Argentine navy by advertising the presence of the attack submarine Superb in Argentinian waters when other units of the RN were a week's steaming away. The fact that Superb was subsequently found to have never left home waters in no way diminished the restrictions her phantom "presence" imposed on the Argentine navy. Similarly, the British task force expended considerable resources in attempting to find the two modern conventional Argentine Salta class submarines which remained a threat simply because they remained hidden. As with Superb, their mere existence was sufficient to tie up scarce assets and distort enemy strategy.

It would seem that, in many instances, it would make greater strategic sense for Australia to impose a similar "disproportionate strain" upon an opponent's naval resources instead of simply attempting to absorb his threats by the approach of increasing Australia's ASW forces (see also pp.28-29). There would appear to be considerable evidence to suggest that to attempt to defeat the tactical submarine threat (that is, the non-SLBM submarine) by moving consistently to counter every

advance in conventional submarine design and systems is ultimately futile. In other words, the submarine is likely to stay "one jump ahead" for the foreseeable future.

Although it appears from some sources that it may be possible to defeat the strategic submarine threat by the application of high technology such as the American SOSUS system,[171] the problem of countering the tactical submarine especially where it is conventionally powered is, as outlined above, a completely different problem. There is much to suggest that national defence would be better served by developing the potential to mount a submarine offensive equal to that of a potential adversary. The finance which will otherwise be spent on a carrier and its ASW helicopters might be better devoted to the development of a submarine force which by astute use of modern technology such as already demonstrated in the Oberon SWUP (Submarine Weapons Update Program) currently underway, should act as an effective deterrent to a potential aggressor and thus obviate the need for the RAN to be involved in a real life ASW campaign.

This certainly was the sort of conclusion about his own nation's security drawn by Admiral Gorshkov, a favourite prophet of former Defence Minister Killen. Nowhere, he claimed, could one find the disproportionate effort required to counter a threat so much as against the German U-boat in the Second World War. For every U-boat there were 25 British and US surface ships and 100 aircraft; chasing every German submariner at sea there were 100 Allied seamen.[172] Yet despite this effort, and despite a technological balance then more favourable to ASW forces, the German submarine threat was never defeated "'The submarine war' was concluded only after German territory was taken by the anti-Hitler coalition."[173]

Whatever the validity of this contention it is undeniable that, with few resources, the German U-boat effort in the Atlantic in World War II forced the Allies to make a hugely disproportionate response. It should be noted that Gorshkov can measure this disproportion quite specifically. As we have

explained, the doctrine of deterrence is one with a definite logic and one that is quantifiable in application. At a late stage in the debate there was a tendency to shift the justification for the purchase of Invincible from its ASW role to that of a STOVL fighter-armed deterrent. This probably does not imply any loss of faith in Invincible's ASW role by her champions, but rather their attempts to persuade the Government to purchase STOVL aircraft for use from it. In this context it would be interesting to see the calculations of disproportionate response which a fighter-aircraft armed carrier would evoke from potentially hostile opponents. On the available evidence it would not prove as cost/effective as an enhanced Australian submarine deterrent and, certainly, would not evoke from a potential enemy a disproportionate response as costly to them as Australia's response to the submarine has so far proved.

7. The Importance and Limitations of Carrier-Borne Fixed-Wing Aircraft

Almost as soon as the Government announced its approval of the purchase of HMS Invincible the voices of recently retired senior naval personnel were raised in support of the RAN acquiring STOVL aircraft to operate from her. The early remarks of the retiring Flag Officer Commanding Her Majesty's Australian Fleet, Rear Admiral John Stevens, were noted in Section Three of this paper. But where the Rear Admiral was rather modest in his expectations of the role of STOVL aircraft in the RAN and realistic in assessing the chances of their procurement, other naval men have been both more forthright and more sanguine.[174]

Rear Admiral Stevens stressed the role of STOVL aircraft in providing local air defence for the ship and "not projecting power overseas"[175] and acknowledged that finance prevented the purchase of Invincible and Sea Harrier aircraft simultaneously.[176] In contrast the Rear Admiral's superior, Admiral Synnot, stated immediately upon his retirement as CDFS, not only that Invincible would lack a vital capability if not equipped with STOVL aircraft but that the Navy should aim to acquire them in the next two or three years.[177] He subsequently

extended the force of this opinion when he told the Katter Committee that the value of a properly equipped Invincible was that it helped Australia in displaying a deterrent power within the region.[178] This was a theme extended by another former naval officer shortly afterwards, Rear-Admiral Guy Griffiths, who retired in 1980 as Flag Officer Naval Support Command. Griffiths contended that the Navy should be expanded, with (amongst other things), two carriers like Invincible equipped with STOVL aircraft and a change in defence policy to "use a strong 'blue water' naval force to fly the diplomatic flag amongst your neighbours and trading partners, acting simultaneously as a deterrent to potential agressors".[179]

There can be no doubt, therefore, that professional naval opinion insisted that Invincible should be expeditiously equipped with STOVL aircraft, even though, officially, serving RAN officers acknowledge the Government's position.[180] Thus, the problem that should be assessed is the consequences of the Government's apparent intention to operate a carrier with only helicopters, assessing not only the loss in capabilities resulting from the lack of fixed wing aircraft, but restrictions imposed upon the chosen ASW role because of their absence.

Deficiencies of Helicopters in Offensive Roles

It is immediately obvious that a carrier proposed for RAN service as was Invincible would lack all anti-aircraft capability, other than the close range defensive powers of whatever anti-aircraft system is fitted aboard ship. This means the absence not only of the capacity to destroy aircraft attacking the carrier, but of the ability to deter or destroy reconnaissance aircraft which might target it, and to disable enemy aircraft on the ground before they could strike. The obvious consequence of this is a level of impotence against modern air-attack systems which must severely limit the possible area of deployment of the carrier whenever a hostile air threat exists. On the basis of aircraft performance this would most likely prevent operations in the islands to the north-west of Australia and off South East Asia in circumstances of medium- to

high-level threat. This is where the range of land-based aircraft is sufficient to allow air attack on the carrier in the event of some possible, though improbable, conflict with a nation in that region. Operations in the South West Pacific seem much less likely to be affected within the conceivable future. The "emptiness" of the Indian Ocean should allow relatively safe operation of an ASW carrier group, but it is possible that a capacity to operate maritime patrol aircraft equipped with ASMs could be developed by some of the littoral states. This could well be sufficient to restrict operations to the south east of that Ocean.

However, anti-air warfare is not the only responsibility of ship based aircraft. They can also be tasked with attacks on land targets (other than aircraft), strikes against enemy surface shipping, and reconnaissance of both land and sea. A helicopter such as the Sea King has a dangerously limited capability in reconnaissance or offensive on land but can perform both roles in the maritime environment.

Their effectiveness is, however, restricted by the inherently less efficient aerodynamics of rotary-winged aircraft. This is apparent in all aspects of performance and in a helicopter such as the Sea King a maximum sea level cruising speed of 112 kts restricts both the area which can be reconnoitred and the speed of response to any threat which may emerge. Helicopters are notoriously prone to loss of lifting performance in hot temperatures such as habitually encountered in Australia's north, a factor which led the RAN to seek engines of increased power in the Sea King Mk 50 which it ordered in 1972. Helicopters have higher demands for maintenance, are more frequently unserviceable than fixed wing aircraft and are more frequently restricted by poor weather. There is some indication that Sea Kings have proved less reliable than expected in the Falklands and that the weather conditions restricted their operations more severely than predicted.[181]

Even in the most recently projected Sea King variant, the HAS Mk5 for the RN, the normal useful operational load is

only some 16% of the airframe empty weight and is little more than one tonne.[182] Although Westland has developed the installation for mounting an armament of 2 AM 39 Exocet ASMs on the Sea King and sold helicopters with this equipment to at least one customer,[183] two such heavy weapons could only be lifted at the expense of considerable fuel and therefore of the radius of operation of the helicopter. Westland claims that the weapons carriers developed for the Exocet installation have sufficient capacity to carry Harpoon ASMs, which are becoming Australia's standard anti-shipping weapon. Unfortunately this weapons fit has not been certified and were the RAN to mount Harpoon on its Sea Kings Australia would be expected to fund the necessary development and trials program, including test firings. Given the current state of financial stringency affecting the Defence budget, and the fact that the Australian Services have so far fired only two of the $A950,000 missiles, such a program does not appear likely.

The weakness of the Sea King's detection systems, however, would probably make such a program unrewarding. The crucial aspect of warfare with surface-skimming missiles is targeting and attacking an opponent before he does the same to you. Although better than any ship, the Sea King is by no means as useful as a fixed-wing aircraft for this role. Not only is its speed-of-advance comparatively slow but the ARI 5955 surveillance radar which equips the Mk 50 has a very limited performance. The maximum range of this equipment is 50 n.m.[184] This is a maximum, not an optimum range, and the difference is important.

Little other than gross data is usually available for military systems but the extent of radar surveillance degradation can be shown by reference to a (superior) civil system. The Litton AN/APS-504 radar, which is fitted to the GAF Nomad Search Master L operated by the Australian Bureau of Customs, is capable of detecting a vessel with a radar image of some 1,000m^2 at a range of approximately 100 n.m. This is the target represented by a large sized destroyer but against a smaller vessel, say a large missile-armed patrol boat (return of typically 150m^2)

detection range drops to a little over 50 n.m. Smaller craft, such as might be used to carry commandos or other infiltrators might be detected at only something like 35 n.m.[185] Further, radar performance in this role is affected by the state of the sea; the rougher the weather the more the wave tops tend to "mask" the presence of surface vessels, especially smaller ones. Other factors such as atmospheric conditions, operator efficiency and so on, often conspire to further reduce radar search range. Thus it would seem that a threatening patrol boat might usually be discovered at ranges of about 25 n.m. from a Sea King, which would allow precious little time to mount a missile strike by helicopters on-board the carrier before the boat launched its own weapon.

In attempting to debunk claims that an aircraft carrier could be vulnerable to patrol boats armed with surface-skimming missiles, the Navy has argued that a carrier would usually not venture near the islands and straits around which such craft might lurk. Rather, the carrier would stand out of range and destroy with her aircraft any patrol boat which might venture out to the open sea.[186] This is not a salvation available to a carrier in RAN service equipped as was proposed with Invincible. Nor is it true that a carrier operating in the ASW role, would be able to avoid dangerous, confined waterways. There are many areas where at some time in the future anti-submarine precautions may be deemed necessary, but where the environment is suitable for the effective operation of patrol boats. An example is the area extending from the western end of Torres Strait up into the Gulf of Siam. Given the short range from the carrier at which ASW helicopters operate it would be impossible for a carrier to operate against submarines in this area without being continuously within range of hostile patrol boats which might be deployed should a sufficient deterioration of relations with a regional nation occur. This, coinciding with the restricted performance of helicopters in strike roles, does much to negate the RAN's sanguine view of carrier operations.

In contrast to the Sea King Mk50, LRMP aircraft, such as the P3 Orion, typically have maximum radar detection ranges of

the order of 150 n.m. and correspondingly greater operational detection ranges against smaller targets. Armed with Harpoon ASMs and with a superior performance, the RAAF's P3Cs would seem better suited to provide a carrier with protection from missile-armed patrol boats in this type of scenario. As was suggested earlier, in discussing the protection of shipping focal areas against submarine attack, it would appear that here is another operational task where the comparatively restricted performance of helicopters makes them less cost/efficient than LRMP aircraft. Whether or not this claim would be supported by a technical study, it is probable that the RAN recognises that its force of 8 ASW helicopters is so small that none of them could be diverted from that role to surface strike missions. For this reason, let alone any consideration of cost, a carrier would be dependent upon shore based aircraft for her protection until such time as she embarks her own STOVL aircraft and, consequently, limited in the type, place and timing of her operations - whether ASW or of other nature.

Choice of Aircraft

At present there is only one western naval aircraft which fulfils the requirements for a STOVL aircraft for use from vessels other than the traditional aircraft carrier. This is the British Aerospace (BAe) Sea Harrier FRS Mk1. The Harrier was developed as a strike fighter for short-range deployment from close to the land battle front but was subsequently redesigned to provide some level of protection for what were then simply the through-deck ASW command cruisers of the Invincible class. The design was "marineised" (by detail design changes such as the deletion of magnesium components) and rendered more useful for air-to-air combat primarily by the design of a new nose section with a raised cockpit canopy and a dual purpose radar. However engine power and general performance remained much the same as that of the ground strike variants and RAN opinion seems to have been that this was inadequate.

When he appeared before the Katter Committee in March 1981 the then CDFS answered an inquiry about why the question of

STOVL aircraft for whatever ship might succeed Melbourne had been deferred till 1983, by saying that the selection of this equipment could wait because of its shorter lead-time and because of "doubt" concerning developments in Britain and the USA. When this was settled there would be a better chance of evaluating the available aircraft.[187] This "doubt" centred around the future of an American derivative of the Harrier, the AV-8B and whether or not the UK would elect to become partners in this project or proceed with their own development, known coloquially as the "big wing" Harrier. Throughout the period up to the selection of the Invincible and the realisation that they would get no fixed wing aircraft at all, it remained clear that the RAN was hoping to be able to procure the AV-8B. Indeed there have been some reports that the British Government included an offer of sale of Sea Harriers in its original approaches to sell Invincible only to have these quickly rejected, even before the Australian Cabinet had considered the purchase of the ship. Feelers for the lease, rather than purchase, of Sea Harriers have also been reported, but the result was equally negative.[188]

The attraction of the AV-8B lies in its superior payload/range performance, improved maintenance requirements and state-of-the art cockpit ergonomics. Whilst retaining the same power plant and basic fuselage, BAe's American partner, McDonnell Douglas, has developed a completely new wing, nose section and electronics for the aircraft. The wing is made of carbon fibre composites and has a "supercritical" section to improve its lift/drag ratio. Although larger, it is lighter than the earlier wing and considerably more so than a comparable metal wing. These features almost double the weapons load it can carry over a set distance (or vice-versa) when compared with the Harrier. Detail design changes to the fuselage and engine air intakes improve airfield performance, whilst LERX (Leading Edge Root Extensions) - added at British insistence - improve combat manouvreability.

Data is as yet sketchy but some sources quote a HI-LO-HI mission radius of 600 n.m. with a 1500 kg war load,[189] much better than that quoted for the GR MK.3 Harrier at 350 n.m. with

a unspecified but (since the mission requires the carriage of drop tanks on the wing main hard points) obviously much lighter weapons load.[190] However, the wing and intake modifications developed for the AV-8B generate more drag than the original and the AV-8B is somewhat slower than the earlier British versions of the aircraft. The YAV-8B development aircraft has reached a maximum speed of M=0.91[191] compared with M=0.95 for the standard RAF Harrier.[192] The improvement in combat manoeuvreability has also been compromised in favour of weapons carrying performance in the strike role because the original LERX proved destabilising in one of the US Marine Corps weapons configurations.[193] New smaller surfaces of reduced effectiveness are currently being designed.

The problem that the RAN would face with the AV-8B or its British counterpart, the Harrier GR Mk.5, is that they are specialised ground-attack aircraft. Their avionics are developed for precision release of free fall weapons, assisted by navigational systems and cockpit displays intended for use over land. For the more important of the roles of carrier based aircraft the AV-8B would appear to have less capability than the Sea Harrier. These are the roles of air-to-air combat against enemy reconnaissance aircraft or fighters, high speed medium range reconnaissance and strike missions against enemy surface units. To perform these roles the only aircraft with a basic capability is the BAe Sea Harrier. The reason is simply that, at present and for the foreseeable future, the Sea Harrier is the only STOVL aircraft equipped with radar. The McDonnell Douglas AV-8B as described above, can fairly be labeled as a "bomb truck", that is, an aircraft designed to cart a heavy load of ordnance and dump it on a relatively ill-defended land target. As it is designed specifically for strike missions the AV-8B is not equipped with radar. Thus it would not be able to reconnoitre effectively for hostile surface vessels and would be forced to make visual contact and identification before attacking any target which might be discovered. This could be somewhat risky should the "target" be equipped with an area-defence SAM system. Although the AV-8B will carry the latest AIM-7L version of the Sidewinder AAM when it enters service with the US Marine

Corps, the full potential of this weapon can not be exploited without a radar in the aircraft's nav/attack system.

The "L" variant of the Sidewinder has a new guidance system with a far more sensitive infra-red (IR) target seeker which is capable of homing from directly ahead instead of "up the tailpipe", as has usually been the case with IR missiles. However, to fully exploit the range of the missile and simply to be aware of the imminence of a head-on attack (the combined closing speed of two aircraft would often be in excess of 1200 kts) an aircraft carrying the AIM-7L would need radar early warning and firing bearings.[194] Thus in the air combat role, even were this to involve no more than simply chasing off reconnaissance aircraft, the Sea Harrier would be a more effective aircraft than the AV-8B.

To overcome these restrictions there has been for some time a proposal to develop a version of the AV-8B, known as the AV-8B+, which would be equipped with a radar and air-to-air attack systems, most likely those of the F-18. However, over the years of the Carter Administration, when the US Marine Corps was fighting to retrieve the AV-8B from the cancellation orders of the Secretary of Defense, the USN gave no assistance, displaying little interest in the AV-8B+. The change of defence policy under the Reagan administration has now assured the future of the Marine Corps' aircraft and the USN has been displaying a little more interest in the AV-8B+, but the current US FY82 defence budget contained no funding for the program. Although the US Senate Armed Services Committee added $US10m to the 1982 Authorisation Bill for development of the avionics system of the AV-8B+ its House of Representatives counterpart took no such action,[195] thus killing the appropriation.

The history of the less than enthusiastic support of the USN for V/STOL developments does not auger well for the prompt development of the AV-8B+. Currently it does not plan for the introduction of an anti-air V/STOL aircraft before 1994.[196] In fact it has been suggested that decisions in this area may be delayed until the late 1990s.[197] In any event, the first of the

AV-8Bs for export, those for the RAF, will not be delivered until mid-1986[198] and it is unlikely that any of this variant, let alone the AV-8B+, would be available for delivery to the RAN for some time afterwards. Thus while the AV-8B could be available for deployment aboard a newly constructed V/STOL carrier delivered about 1990, any interim vessel would serve its entire commission without such aircraft.

The schedule for the protracted development program of the AV-8B has been known for some time. Even when the CDFS addressed the Katter Committee it was apparent that Australia could not take delivery of any such equipment till at least two years after the then projected retirement date for Melbourne. The planned purchase of Invincible advanced that retirement by two years, and the Government decided to sell the Fleet Air Arm's fixed-wing aircraft as soon as possible. In fact the gap in the RAN's experience with the operation of high performance aircraft from carriers may now span almost the decade of the 1980s. Because of equipment failures aboard Melbourne, Skyhawks have not operated from the ship since late 1980. These defects were to have been made good during Melbourne's refit, scheduled to commence in December 1981[199] but delayed, and finally cancelled, because of the selection of Invincible. A newly constructed Invincible class ship will not be available till 1989, according to the Minister,[200] whilst one of his naval advisors has been quoted as saying that the modified-LPH would take as long to procure.[201] The only apparent methods of resuming FAA carrier borne aviation in the near future, the purchase or hire of HMS Hermes or the recommissioning of Melbourne, have both been discounted by the Minister who stated "I would not prefer that option" when referring to the recommissioning of Melbourne.[202]

Unless the hiatus in RAN fixed-wing flying is shorter than expected, delays will also be encountered at the further end of the period. This will depend upon the number of pilots available with experience of high performance ship-borne fixed-wing flying at whatever time the Navy might obtain STOVL aircraft. Training of Sea Harrier pilots from scratch for the RN involves pilot and operational training over 462 flying hours and

requires 141 weeks to complete.[203] Thus, should the Government suddenly decide its ASW carrier really does need STOVL aircraft after all, it will find that the concept of "lead-time" applies to personnel, as well as equipment.

It is ironic that if, as many naval officers have claimed, the purchase of Invincible was necessary to maintain the RAN's expertise in naval aviation, the accelerated purchase of that vessel then should lead directly to the Service's first hiatus in fixed-wing seaborne flying by prompting the early paying off of Melbourne. It was in response to this situation that Sir Anthony Synnot urged the acceleration of procurement of STOVL aircraft shortly before the purchase of the ship was foregone. In a retirement-eve interview the CDFS was reported as saying that they should be acquired in the next "two or three years" because he would "be sorry to see the Fleet Air Arm down because of lost experience in this field. Once you lose this capability it takes very much more to get it back."[204] It may be, therefore, that Sir Anthony has changed his ideas on the selection of STOVL aircraft, for the only such equipment available in 2 or 3 years is the Sea Harrier. Whether or not this parting advice from the former CDFS is ever to again be relevant, the aviation skills of the Fleet Air Arm are becoming visibly rigid. Given likely developments, the argument that STOVL aircraft should be purchased to avoid a costly loss of experience is not just out-of-date, but stone dead.

STOVL Aircraft for Use Against Land Targets

Throughout most of the period that it was developing its program to select a replacement for Melbourne the RAN appears to have downgraded long-range strike compared with other potential missions of its future carrier. As Admiral Synnot when CDFS said "but you would not use a carrier of that size in a strike unless you knew the enemy did not have a lot of aircraft against you. You do not misuse a carrier. If you wanted to strike something your F111s would probably be what you would use".[205] However, a little later in his testimony Admiral Synnot was more equivocal when he said "so you would probably be looking at strike aircraft

in the F111 sense if it was within range and the carrier would only really be providing land strike outside the range of the F111."[206] This was basically a technical observation with no comment about the type of action this might entail or the circumstances in which it might take place. Subsequently, more emphasis appears to have been placed on the land strike role of aircraft deployed from Invincible as ex-RAN officers have publicly argued for the purchase of STOVL aircraft, as a means of developing the Invincible into a credible deterrent.[207] For Invincible to adopt this role implies in part an ability for her to threaten an opponent's military and/or economic power, especially on his own territory.

As shown above, the generalised payload/range statistics for the Sea Harrier do not make it a particularly punishing aircraft in the strike role. Its effectiveness is further restricted by the fact that it still appears to be limited to the use of free fall bombs, clearance for use of which was the extent of the RN's original weapon's development program.[208] The daily press reports of two or three Sea Harriers flying off with 3 x 454 kg bombs to strike targets at Stanley or Goose Green were familiar copy from the Falklands conflict. The first carrier launched assault on the Falklands provided a useful indication of the Sea Harrier's practical capabilities in a genuine combat situation, as distinct from the "brochure" figures of manufacturers. At a time when uncertainty of the success of the Vulcan strike on Stanley airport would have dictated caution in British tactics, it is significant that the carriers closed to within 78 n.m. of Stanley to launch the first strike, presumably to allow the Sea Harriers sufficient fuel to strike at Goose Green some 43 n.m. further west. If indeed a tactical radius of some 120 n.m. with 3 x 454 kg bombs represents an optimum strike mission for the Sea Harrier in those operational conditions, even with the advantages of the ski-jump, the limitations of the Invincible as a "deterrent" are patently obvious.

Launching an attack against a probably disabled airfield when the enemy's mainland bases are more than 350 n.m. away is easy enough; having to bring the carrier to within 120 n.m. of a

mainland enemy target, which may of necessity be a military airfield, is a far more dangerous manoeuvre. As the long range strike potential of the Super Etendard of the Argentinian naval air arm has shown, it certainly does not correspond with the argument advanced in Navy News that carriers can reduce the risk to themselves by standing out of range of enemy defences and allowing their aircraft to do the fighting.

Again, in the light of the Falklands experience one can doubt that the strike missions possible with a limited number of Sea Harriers can be militarily significant. After persistent attacks on both Stanley and and Goose Green, the Argentinians were still able to deploy helicopters and Pucara aircraft against the British land forces. The Pucara is a light turbo-prop powered strike aircraft, designed for counter-insurgency operations and does not require elaborate airfield facilities. They were probably dispersed under camouflage around the airfields' perimeters to avoid attack. Nonetheless, from the apparent nature of the terrain and vegetation around both airfields, there was little scope for successful subterfuge. The failure of the Sea Harriers to locate these targets would seem to indicate deficiencies in the number available to prosecute attacks and in their ability to locate targets, without the addition of specialized targeting systems such as FLIR (Forward Looking Infra-Red) pods.

In the light of this experience a proponent of alternative methods of creating an Australian defence deterrent might argue that the most important single action of the entire campaign was the low level dawn strike by the RAF Vulcan on Stanley airfield. The fact that this aircraft was able to fly a round-trip mission of some 6,000 n.m. and accurately deposit 21 x 454 kg bombs in a single low level pass[209] was sufficient to deprive the Argentinians of any local tactical air cover. Noting the use of aerial refuelling to accomplish this mission, it might be argued that the purchase of aerial tankers to increase the effectiveness of the RAAF's F111C and F-18A aircraft should be given more priority than procurement of STOVL aircraft for use from a carrier.

Nevertheless, the AV-8B offers appreciably better performance in the strike role and might prove more efficacious in destroying enemy land facilities. However its handicaps in the other roles required of a carrier-borne aircraft would limit its flexibility, and as this is often advanced as a principle objective for the force structure of Australia's Services in the context of the "core force" concept, it is questionable whether it should be procured for this role alone. Whatever the performance of any "brand" of STOVL aircraft, the real problem preventing the development of a deterrent with carrier-borne STOVL aircraft remains insoluble: the small number which could be carried on any ship like Invincible is insufficient to allow an effective campaign to be sustained. This problem was discussed at length in the section on aircraft complement and is particularly critical in this role because of the need to bring both intense and sustained fire power to bear upon targets important enough to have the threat of their destruction deter a potential adversary.

This ability could be required to present an effective deterrent to any nation within Australia's region, not just an economically developed, militarily powerful opponent. It should not be forgotten that a greater tonnage of bombs was dropped on Indo-China by the USA and her allies during the Vietnam campaign than that dropped on Nazi Germany. Not all of this effort was aimed at churning-up jungle in the hope of interdicting well disguised supply lines. The effort involved in, and the cost of, destroying specific tactical targets in that war is unimaginable for a country with the defence resources of Australia. One of the most spectacular examples of this was the Thanh Hoa Bridge which cost the Americans 50 tactical bombers and in excess of $US1 billion before it was eventually destroyed by the use of PGMs.[210]

Indeed it has been frequently argued that many of the operations described as "strategic" bombing in past wars (but in many ways similiar to modern interdiction raids against specific targets) have been generally ineffective and may have often cost the attacking force more in the value of bombers and aircrew than

it did the opponent in lost military strength.[211] (Certainly Nazi Germany was able to increase its output of most weaponry and components right through the crescendo of "strategic" bombing up to November 1944). Nor would the development of PGMs by themselves have altered this situation in general. Although they have undoubtedly been effective where one side has introduced them unexpectedly, the use of PGM in the anti-aircraft role has also grown significantly and even hand held infantry SAM pose a threat to tactical aircraft.

Indeed this problem of numbers has been acknowledged by some of the proponents of a carrier-based "deterrent". Speaking to the Katter Committee after his retirement as CDFS, Sir Anthony Synnot commented that the British had expected "too much" from their total of "22" aircraft.[212] With reference to the sinking of Sheffield he was reported as saying that "The number of Harriers was not adequate for both air superiority and strike. When the Sheffield was hit it seems the Harriers were away on a strike mission."[213] This observation on the number of aircraft deployed by the British at that time, was corroborated by reports from the UK which quoted "Royal Navy sources" as supposing that this attack had reduced the task force's operational flexibility by forcing the Sea Harriers to spend more time on anti-aircraft duties.[214] The problem of the small number of aircraft deployable has apparently been such as to prompt both Sir Anthony[215] and Rear-Admiral Guy Griffiths[216] to call for the inclusion of two STOVL carriers in the RAN fleet.

Whether the Australian Navy could do better than its British senior is a moot, and irrelevant, point. In view of the experience of previous sustained air offensives against land targets, the exposure usually likely to be forced upon a STOVL carrier in this role, the diversion of the aircraft from other essential fleet roles and, above all, the disproportionately small number of Fleet Air Arm aircraft Australia is ever likely to possess, it is doubtful whether a carrier equipped with STOVL fighters would deter more than the most minor military power in our region if they had otherwise sufficient cause to become hostile towards us. The sometimes postulated seizure of

territory such as Cocos Island might provide a supposedly carrier-biased scenario but it is one which analysis of the capabilities of land based aircraft may well debunk and one infinitely more remote than the historically embedded dispute over the Falklands. The presence of a mini-carrier in the South West Pacific might comfort a few of its island states. In the context of Australia's defence structure, however, equipping a carrier with STOVL aircraft simply for these faint possibilities and minor benefits must be considered both grossly uneconomic and still unjustified.

The Uses and Limits of STOVL Aircraft in the Fighter Role

When talking of the benefits of an ASW carrier to the Katter Committee, Admiral Synnot went on to state "it is very helpful to have about four fighters so as you can strike enemy reconnaissance aircraft".[217] In this the Admiral was probably alluding most particularly to the practice which the USSR has been developing over the last twenty years of using long-range, shore based aircraft in support of their naval vessels. At present this takes the form of the shadowing of allied fleet units by reconnaissance versions of the Tu-16 Badger or Tu-95 Bear. During hostilities however, these aircraft would be passing data to Soviet submarines or providing mid-course guidance to anti-shipping missiles launched by other Soviet units - from beyond the range of the SAMs of allied vessels.

In many cases the Sea Harrier could be a useful response to this threat in the (highly unlikely) circumstance that it would be posed to Australian forces unsupported by major allies. When attacking a comparatively slow moving aircraft (such as the Tu-95 which normally cruises at between 300 and 400 kts), the Sea Harrier,[218] which can be airborne within two minutes of the alarm and can accelerate rapidly to 600 kts,[219] has a useful margin of performance. Armed with two 30 mm Aden cannon and two AIM-9 Sidewinder AAMs the Sea Harrier would be capable of destroying the target but obviously the outcome would depend upon the circumstances of the engagement.

For instance it has been stated that even if the target aircraft were capable of the comparatively modest velocity of M = 0.8[+] then it would be doubtful if even a supersonic interceptor would be able to engage it.[220] In a "tail chase" such as this the Sea Harrier is further handicapped by the fact that its Ferranti Blue Fox radar does not provide the continuous wave illumination needed to control a medium-range AAM such as the AIM-7E Sparrow[221] and although the development of such a capability has been said to be underway[222] there appears to be no official requirement for this capability and no progress in fulfilling it. This factor at present limits the Sea Harrier to the use of the Sidewinder, which has a maximum range of only 9.7 n.m., considerably less than that of the 27 nm of the AIM-7E.[223]

This example presumes that aircraft would be "scrambled" from the deck upon command, but even were the Sea Harrier airborne on station, there are still practical restraints on its performance. Endurance of the Sea Harrier on station is 90 minutes at 100 nm which implies that many sorties will have to be flown per aircraft to keep only one aloft. Two NATO exercises in August and September provided a well publicised example of the deployment of Sea Harriers in defence of the carrier. During a period of intensive operations an aircraft was aloft at all times during a 90 hour period with another on the deck ready to launch.[224] Assuming that each aircraft was able to use its maximum endurance and stay on station for 90 minutes, some 60 sorties would have bbeen flown to achieve this result. Mathematically this would have required each aircraft to fly 12 sorties with a 6 hour break between flights. However, although a period of unusually intense activity for Invincible, in the context of the exercise as a whole the Sea Harrier's air defence role was minor, since the aircraft operated mainly in conjunction with those of the USN based aboard USS Eisenhower.[225] In the high level engagements contemplated by NATO the brunt of the air-to-air fighting would be taken by the USN's F-14 Tomcats and the Sea Harriers would benefit from the American's use of long range

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[+] i.e. 0.8 Mach, or eight-tenths of the speed of sound.

AAMs and from the early warning provided by USN E-2C Hawkeyes and other NATO AWACS aircraft.

Without this support the Sea Harrier would usually operate singly, positioned out in the quadrant from which a threat was most likely to materialise[226] and in danger of being "wrong footed" should an enemy be able to employ alternative tactics. Apart from the publicised period of intense operations the utilization of the Sea Harrier during the NATO exercises was comparatively low. During the three week period in which Operations "Magic Sword North and South" and "Ocean Safari" were held, the aircraft flew 170 sorties totalling over 200 hrs of flying.[227] This means that, on average, for more than half of the period there was no fighter from Invincible aloft. Each aircraft would have flown an average of 34 sorties and spent some 40 hours in the air. This is only some 8% of the total time covered by the period of the operations. On the credit side, however, these NATO deployments were the first trials for both ship and aircraft and the unit was at sea for 6 weeks before its first failure to carry out a planned mission.[228] However the experience of this generally exploratory "shake down" period serves to emphasise the importance of the essential point of this section of our paper, that the usefulness of a weapons system available in the comparatively small numbers aboard a V/STOL carrier will be limited and highly dependent upon the circumstances of the engagement, regardless of the performance characteristics of the aircraft involved.

This supposition is supported by the results of a three month trial exercise involving some twenty USMC AV-8As aboard the 40,000 tonne LHA, USS Nassau. The report concluded that "airborne intercept is marginal with the AV-8A and that a fully operational strike center is required on board the V/STOL carrier".[229] Although it can be argued that tests involving the AV-8A are not representative of the BAe Sea Harrier the systems of this aircraft suffer from inherent limitations such as not to affect significantly the relevance of the American findings. No official data about the performance of the Blue Fox radar appears to have been published, and whilst the performance of the radar

is claimed to be exceptional for its type[230] it is nonetheless a small, lightweight unit with "very strict size, time and cost limits imposed by the use of an existing V/STOL airframe".[231] Given these constraints it is unlikely that the detection range of Blue Fox is even as great as that in the General Dynamics F-16, which is only 38 n.m.[232] Even were Blue Fox to approach this level of performance it would remain a clearly inadequate instrument with which to perform independent air search and aircraft intercept operations in defence of the fleet. This conclusion appears to be strengthened by the reports that following the sinking of HMS Sheffield, additional Nimrod maritime patrol aircraft were dispatched to the South Atlantic to act as early air warning pickets.

Where that cannot be done, any detachment of Sea Harrier aircraft embarked upon a RAN carrier will be dependent upon that ship for radar search, vectoring and combat air control. This again emphasises the problems inherent in the selection of an Invincible class ship to fill the role, as the probable range of their air surveillance radar (deduced above, p.53), is critically short in some circumstances. Even where performance is at a maximum the control of STOVL aircraft from the carrier is complicated by the fact that the Sea Harrier is not equipped with data link,[233] which limits the volume of information which can be transferred, slows its transmission, and leaves it less secure from countermeasures. It was probably these reasons which led the US Navy, in the report cited above, to conclude in evaluating the AV-8A interception exercises "that an airborne early warning aircraft with the capability of the Grumman E-2C is required for anti-air warfare operations".[234] Of course this aircraft is of a type singularly lacking in Australia's defence inventory and one which it is impossible to operate from a V/STOL carrier.

The airborne warning and control deficiency again reemphasises the problem which lies at the centre of the debatable operational efficacy of the V/STOL carrier. Simply because the airwing of such a vessel is comparatively small, capabilities in one combat role must be traded continually against another. As a result effectiveness in one particular

mission may result in a dangerously low level of performance against any other threat which might be posed during the course of the mission. The four-aircraft flight which Admiral Synnot told the Katter Committee would be "very helpful" for use against reconnaissance aircraft would appear to be inadequate to do more than drive away reconnaissance aircraft through the symbolic act of taking-off from the carrier's deck.

With a time-on-station of only 90 minutes, it appears difficult to maintain more than one aircraft on station for more than a limited period and, as has been shown above, one aircraft on station does not represent a strong probability of a successful intercept unless the enemy is restricted to a defined approach path. It has been reported that the Royal Navy believes it is sufficient to chase off the interloping reconnaissance aircraft[235] but against aircraft like the 3450 nm ranged Tu-16 or 6775 nm ranged Tu-95 there is a clear danger of the enemy returning to probe the defences, or of his remaining sufficiently close to still pass useful information to other enemy units in the vicinity.

The problem of insufficient numbers and no AWACS facility similarly limits the effectiveness of fixed wing aircraft performing other traditional fighter missions from a V/STOL carrier. Despite its subsonic maximum speed and, until the Sea Harrier, relatively unsophisticated systems, the Harrier has won a reputation as a very effective air-to-air fighter, with the USMC claiming the Harrier had a "better manoeuvrability for lower fuel consumption than any comparable conventional fighter".[236] In level flight it can accelerate faster than an F-4 Phantom up to its maximum speed of M = 0.94 and in "dog fighting" USMC Harriers have outfought F-14 Tomcats in one-to-one combat below 20,000 feet. This expectation would appear to have been borne out in air-to-air combat over the Falklands where the Sea Harrier scored several victories. However even the British pilots acknowledge that in this conflict the odds were heavily on their side. As the pilot who shot down the first Argentinian aircraft said, "We have everything on our side in terms of range, operating base and radar information. They are often 300 to 350

miles from home and are desperately short of fuel. They can not afford to mix it".[237]

Later experience when the Argentinian Mirages and Skyhawks were able to press home continual attacks against the British fleet in Falkland Sound suggests that any forward defence provided by the Sea Harriers was swamped. This would seem to further indicate that, against a defence directed by a land based air combat control system or against a squadron strength attack by fighters with long-range radar and PGM, the small number of STOVL aircraft carried by a V/STOL carrier would represent only a token commitment and would be clearly insufficient to win, let alone hold, air superiority. This may well be the reason that in his March 1981 testimony Admiral Synnot was careful to de-emphasise the use of aircraft from a V/STOL carrier as a means of striking at land targets and the Secretary DoD subsequently stated that "it is not realistic to expect a high air defence effectiveness from a small number of subsonic or transonic STOVL aircraft against a sizeable raid of modern strike aircraft."[238]

Defence Against Attack by Air Launched Missile

In the mid-60s the threat which preoccupied the RAN was the Tu-16s equipped with Kennel ASMs which the Russians had supplied to Indonesia. It is improbable but not entirely inconceivable that a regional threat of this nature could again materialise, but nowadays the weapon would more likely be the AS-5 Kelt, a weapon which was used by the Egyptians against Israel in the 1973 Yom Kippur War (although to little effect). This missile is usually launched at an altitude of 30,000 feet and cruises at a speed of M = 1.2 at altitude, or M = 0.9 at low level. Its range has been quoted as being up to 173 n.m.,[239] although other sources have stated it to be as low as 130 miles.[240] Only in the latter case would the launch aircraft have to enter the normal detection range of the V/STOL carrier's air search radar allowing some chance of the missile launch being detected. Even in this case, although the Harrier is capable of climbing to 40,000 feet from a vertical takeoff in 2 minutes 23 seconds,[241] any attack on the missile in flight would be hampered

by the Sea Harrier's inability to use radar directed missiles. Unless the latest "L" model of the AIM-9 Sidewinder were in RAN service an attack could only be made from the rear hemisphere of the ASM, a matter of no fine judgement when the target's speed is noticeably greater than that of the Sea Harrier. If indeed the Kelt could be launched beyond the range of ship board detection interception by aircraft would be infinitely more difficult.

In any attack of this nature the tolerances are fine, especially in the case of a concerted attack from several aircraft. This can be shown by the fact that at its cruise speed a Kelt would take only some 16-18 minutes to reach the target from maximum range. The standard airwing of five Sea Harriers in RN service aboard the Invincible are likely to be swamped by such an attack and once the ASM's have passed the aircraft the carrier would be heavily dependent upon the Standard SAMs of the FFG-7 frigates or DDGs which would have to accompany the carrier to meet just such a danger.

There are other ASMs in the Soviet armament with even more daunting performance, such as the AS-6 Kingfish with a speed of M = 3.0 or the 350 n.m. ranged AS-3 Kangaroo. As yet deployment of these weapons has been restricted to Soviet forces and it is unreasonable to expect them to be used against an RAN carrier group, except in the remote case of a global war. However there are several missiles of Western origin which are equally deadly, readily available, and some of which are already operational with the armed forces in our region. Amongst this type of missile are the Franco-Italian Otomat and the American Harpoon in their air launched forms, both of which have a range of around 100 n.m. Furthermore, these surface skimming missiles are even more difficult to intercept than their Soviet counterparts which cruise at altitude and can be attacked by SAMs such as Standard. It is unlikely that the small scanner of the Blue Fox radar would have the resolution needed to discriminate surface skimming targets from background sea clutter at ranges of any magnitude.

The Maritime Strike Role

A variation of the problem created by ASMs is the threat posed to all large vessels by surface-to-surface missiles (SSMs). These present a defence problem very similar to that created by ASMs and are often the same missile launched from a different platform. SSMs missiles differ widely in performance and flight profile, including range capabilities of 60 nm for the Harpoon in SSM form to up to 300 nm for the Russian SS-N-3 Shaddock. Because of these comparatively long ranges the essential problem for both attack and defence where SSMs are concerned is one of reconnaissance - even at 20 n.m. the attacker and defender are both operating beyond their normal radar horizon. Solving this problem is one of the principal roles of the Soviet's Tu-16s and Tu-95s and their ability to pass position fixes to missile-armed vessels beyond the search range of the carrier would be the principal reason for seeking to destroy them in time of hostilities.

The defender's task in this form of engagement is far more difficult than the attacker's: hostile reconnaissance aircraft could be signalling to any point of the ocean within missile range and the carrier's defence must independently attempt to fix the position of the attacking vessels. With a sea-skimmer such as Harpoon the aircraft of the STOVL carrier are useful only if the enemy vessel can be attacked before it launches its weapons, since most SSMs cruise at a speed near to or greater than that of the Sea Harrier itself, which is also limited in attack by the performance of its radar and its lack of a radar guided air-to-air missile. The task of finding an enemy missile armed craft is also daunting, as the range of a weapon such as Harpoon enables it to attack from anywhere within a circle around the carrier of an area of over 11,300 square miles of sea.

The performance of Sea Harrier in the reconnaissance role where it can survey approximately 20,000 square miles of sea[242] in a single mission is certainly a better counter to this threat than a helicopter. Selectable frequency control enables

the Blue Fox radar to search for surface targets[243] but the resolution of the radar in this role is not known and it cannot be said with certainty that the aircraft would detect small missile armed patrol boats in anything but calm sea states. The Sea Harrier should have no difficultly in destroying the target once detected since it is capable of carrying a pair of Harpoon or similar missiles over a radius of action of 280 n.m.[244] which, with the Harpoon's range of up to 100 nm in the air launch mode, gives the Sea Harrier a reach against enemy ships of almost 400 n.m. This is very much a theoretical capability, however, for at these ranges targeting is a problem, since Blue Fox certainly could not discover and classify any nautical target at so great a distance.

Of greater difficulty would be the problem of detection and attack in the case where an enemy operating a long-range missile (such as the SS-N-9) was in the area, a situation which would probably be beyond the Sea Harrier's capabilities. In this case the 150 nm range of the missile places the carrier within an area of possible danger covering some 70,900 square miles of sea, when a reconnaissance aircraft is available for mid-course guidance. Coverage of such an area would require the simultaneous operation of four Sea Harriers, which is clearly beyond the capabilities of a V/STOL carrier to sustain with an airwing of the standard in the RN and still impractical to sustain when a maximum contingent of STOVL aircraft is embarked. In operating under such a threat, the carrier group would be forced to depend upon the support of long-range, land based aircraft, most likely P3C Orions. However this dependence would limit carrier operations to a range no greater than that of land based aircraft and would render the carrier's role in anti-surface warfare irrelevant. Australia's P3Cs are themselves equipped with Harpoons and quite capable of destroying enemy surface vessels without the assistance of STOVL aircraft based on an RAN vessel.

Conclusion - the Limited Effectiveness of STOVL Aircraft

It is apparent from the above discussion that there are some advantages in operating fixed wing STOVL aircraft from any V/STOL carrier. It is also apparent that there are many roles which such aircraft cannot perform satisfactorily. It seems that the roles perceived by the RAN for such aircraft - interception of reconnaissance aircraft and maritime anti-shipping strike[245] could be successfully prosecuted only against a weak opponent, one so weak as to be susceptible to other deterrents. The indications of this study are that should an enemy make a concerted attack, with either air or sea launched missiles, a single V/STOL carrier in any likely RAN deployment would be most difficult to defend. The probability is that if an enemy were driven to the extreme of risking an attack upon a major vessel of the RAN there would be little reason for it to avoid using the maximum necessary force. A scenario such as appears to be postulated by CDFS in his Katter Committee evidence (where there would be a need to use STOVL aircraft operating from a carrier, yet in which and at the same time, the situation was not already so desperate as to largely preclude the chances of survival for such a ship) would seem to be of low probability. This being so, to acquire a carrier against such scenarios in preference to expenditure on other equipments does not appear to be cost-effective.

In the 1976 White Paper the Department of Defence declared that submarines provided "the only means of sustained interdiction in areas where local air superiority cannot be established".[246] The conclusion of this study is that there is no adequate reason to believe that any small carrier equipped with STOVL aircraft is a sufficient means of establishing that superiority. And it should further be remembered that in this era of the cruise missile much of naval warfare is becoming a question of anti-air warfare. For Australia, then, it would seem more appropriate to establish air superiority around the continental approaches (and especially at SLOC focal areas) using land-based aircraft, and beyond the approaches to use an expanded

submarine force to challenge a potential enemy's attempts to gain control of the sea.

8. Program Costs and Financial Consequences

Project Costs

This section has been amended slightly to record changes which have occurred since June when this section was written. However in some important areas the data to allow a reassessment of the financial consequences of not proceeding with the purchase of Invincible as planned are not yet available. The main difficulty facing the Government will be to again reorganize the Defence equipment program to allow the approximately $400m it had planned to spend on Invincible in the financial years 1982-84 to be spent on other equipment programs. It is not clear how, or to what extent this will be done, but as later parts of this section demonstrate, there is no shortage of equipment programs which could be funded. In fact, as will be seen in the later sections, the demand for funds is so great that whatever the Government does with short term rearrangement of programs, it will merely be transferring the recent cash flow crisis for the next two financial years to a period later in the decade. Since the Minister expects the cost of any new vessel to be about $1000m,[247] more than twice the project cost of Invincible, this cash flow crisis will be even more intense. Indeed, because the unavailability of Invincible compounds the problem of financing the Defence equipment program should any other carrier be purchased, the following section remains highly relevant.

The project cost for the purchase of Invincible and her introduction to RAN service was estimated at $477.8m.[248] This price includes the cost of the vessel herself and the equipment and training to introduce her to RAN service, but not the costs of aircraft or weapons. The British Government had quoted a fixed price of £stg 175m for Invincible which was to remain the same regardless of inflation. At the rate of exchange existing in August 1981 this equated to $285m, although exchange rate variations would have been borne by the Australian Government.[249]

The $193m of project costs in addition to those of the vessel were required just to ready her for operation with the RAN and establish the initial support structure needed for her to continue to operate with that Service. It represented 40% of the total project cost - not an unusually high amount for a project of this nature. However part of the support costs did represent a penalty for buying a "second hand" vessel as Navy required Invincible to undergo a refit before accepting her, and the cost of this, together with on-board spares and subsequent proving trials represented, at $43.9m, approximately 23% of the total support costs. In compensation, the cost of special modifications to meet RAN requirements (which included the extra bunkering) had been held to only $5m, which represented an unusually low proportion for an Australian military procurement program.

Most of the cost of the 1983 refit would have been spent in the U.K. where it will be undertaken, as would much of the $12.2m which was to have been spent on training and travel associated with the project. In addition $8m was to have been spent on training equipment and it seems likely that most of this would have come from Britain. Thus something in excess of $350m in foreign exchange would have gone overseas leaving only $128m or 26.8% of the total project cost to benefit the Australian economy. In partial compensation the U.K. had "given an offset undertaking amounting"[250] to £stg 17.5m or $28.5m at the August 1981 exchange rate. Presumably this meant that, as normally happens, the British would have offered defence oriented contracts for which Australian industry could have made bids; award being on the normal competitive commercial criteria. The offer amounted to 10% of ship cost, significantly less than the 30% of the cost of equipment which is sought as offset work under current Government policy, but in the circumstances must be considered as having been generous.

Operating Costs

Once procured, all defence equipment must be armed, maintained and eventually, modified to keep it up-to-date. The

Navy has estimated that it would cost approximately the same to run Invincible every year as it did to run Melbourne. At $32.1m per annum this is $6.2m more than the estimates for the modified LPH, but on the basis of Invincible's low capital cost the RAN calculated that through-life costs will still be lower for the latter. Unfortunately the length of service that the RAN assumed in this calculation is not known, nor is the date at which values for the costings were fixed. Manpower costs comprised 32% of the annual running costs of Invincible and Service salaries were increased by ranges between 16.5% and 30% in February of this year. Running costs may have increased before Invincible became unavailable, if the estimates were based on price levels of the same period as those of the capital costs (i.e. August, 1981). This would not effect the comparisons between the Invincible class and the modified-LPH, as these ships are manned to approximately the same levels. However, it would improve the comparison with Melbourne which, with air group embarked, requires some 360 more crew than Invincible.[251] At the levels of pay pertaining before the recent Services' salary increases the average annual cost of employing a serviceman was $19,792 for the ranks and $36,421 for an officer.[252] The savings from the more efficient manpower requirements of Invincible would have been therefore something of the order of $8m per annum in 1981 and perhaps closer to $10m p.a. at present.

Yet, if the Navy can say that average annual operating costs for Invincible were the same as for her predecessor, despite the considerable savings in manpower costs, it is obvious that other running costs must have been considerably higher. Indeed even if the manpower saving is calculated at the lowest level, $8m, this implies that, manpower apart, Melbourne would be some $2m p.a. cheaper to run than the modified-LPH, since this is only $6.2m p.a. cheaper to run than Invincible. This is an extremely unusual situation when dealing with an old piece of military equipment, whose servicing costs usually rise markedly with age. No data exists to compare this aspect of Invincible's operation with that of Melbourne but a clue can be obtained from a comparison with those of the modified-LPH which accompanied the RAN briefing of Government backbenchers. These show the

estimates of the direct operating costs (mainly fuel and manpower) of both vessels to be almost identical, but the indirect costs to be considerably different. In this area only the largest item of cost ($5.4m for refit and docking) is the same, with other items being from almost two to more than five times as great for Invincible. The most costly of these items is an estimate of $4m p.a. for repair and maintenance of Invincible, some three times greater than that estimated for the modified-LPH.

It would not be surprising if these cost differentials prove broadly similar should comparison be made with Melbourne. It is, in fact, what would be expected with a vessel unique in RAN service. When preparing its specifications for the modified-LPH, Navy undoubtedly hoped to benefit from the reduced running costs which commonality with FFG-7 systems would give. As mentioned above, modifications intended for the original LPH design included re-engining with LM-2500 gas turbines and the fitting of the FFG-7 sensor suite, and it was probably intended to maintain these in the FFG-7 facility recently opened at Garden Island, Sydney - the home port for the RAN's carrier. The items which would incur cost penalties if an Invincible class carrier is chosen for the RAN include the power plants, the electronics and systems software, whilst the benefits of commonality become relevant again in reconsidering the benefits of the modified-LPH and the Italian Garibaldi class.

Should the Government decide to procure an Invincible class vessel the RAN should have little trouble in maintaining its Olympus gas turbines although it may have to go a little afield and the cost will undoubtedly be higher than with the LM-2500 powerplants in the alternative American and Italian designs. There are presently 21 Olympus in service at 13 locations around Australia, mainly in pipeline pump houses. The Commonwealth Aircraft Corporation can already do some work on the Olympus at its Fisherman's Bend, Melbourne plant but will probably need to increase its investment to maintain the engines.

Unfortunately almost no data has been made public concerning the consequences of introducing to the RAN the new sensors and electronic systems aboard the Invincible class. It is obvious, however, that much software development would be necessary to ensure interoperability of the RN ADAWS 6 system with the NCDS already installed in RAN destroyers. For a newly constructed vessel this would be accounted as part of the purchase price but as the program was previously developed the several years required to fully integrate Invincible's systems with existing RAN equipments would have become part of support costs in much the same way as the NCDS developmental system which is maintained at Fyshwick, A.C.T.

Future Equipment Costs

From the announcement of the decision to purchase Invincible a Departmental study was pending on whether the ship's Sea Dart SAM system would be retained for RAN service. No official report of this study was made but it might be expected that, as a result of combat experience in the Falklands, rather more weight would have been placed on close-in defence against surface-skimmers than on the area anti-aircraft capabilities represented by Sea Dart. If so, part of the 1983 pre-delivery refit would have included the removal of the Sea Dart launcher, magazine and controlling radars and the fitting of a CIWS. Before cancellation the Navy had foreshadowed the fitting of CIWS to Invincible at some later time[253] and RAN estimates give the cost of fitting 2 Phalanx CIWS at $12-15m.[254]

A much greater outlay to improve the combat readiness of Invincible than this would have been needed, however, if the Government had had the opportunity to purchase STOVL aircraft. This is a decision it will still face should it decide to purchase a carrier. The cost of such a move would depend upon the type and number of aircraft procured, and this depends not only upon technical evaluation of the contending designs but also on factors such as estimated attrition rates and the production future of the aircraft. When the Fleet Air Arm received its 1967 stay-of-execution, ten Douglas A-4 Skyhawks were procured to

continue advanced fixed-wing maritime operations but these proved too few and in his March 1970 Statement, the then Defence Minister, Malcolm Fraser, announced the decision to purchase another ten Skyhawks. In the time since then ten aircraft have been lost in accidents. In the British case 38 Sea Harriers (four of them two seat conversion trainers) were ordered for the three ships of the Invincible class but this was reckoned to be sufficient for only a Headquarters Squadron of 7 aircraft, two operational units of 5 aircraft each and attrition reserves till 1990.[255]

The RN will undoubtedly be reassessing its Sea Harrier requirements after the losses of the Falklands campaign but it seems fair to comment that attrition was to be expected without any combat involvement. (Indeed, one aircraft was lost to an accident before the crisis developed).[256] Naval aviation is inherently more dangerous than land based military aviation even though its proponents claim that ski-jump take-offs and the Harrier's vertical landing makes it safer to use than any carrier-borne aircraft before it.[257] True though this may be, it is nevertheless equally true that minor miscalculations cannot be retrieved from the ocean in the same way that they can from an airfield verge. US Navy statistics show that accident rates run from two to four times higher for conventional ship board compared with land based operations.[258] And it is also true that the Harrier is a demanding aircraft to fly and loss rates in operating it have been high.

The US Marine Corps procured 110 AV-8A Harrier's and TAV-8A trainers between 1970 and 1977, with the first squadron forming in April 1971. At present it has left only 61 operational AV-8As, having suffered over 40 major accidents.[259] This almost 40% attrition rate over some 10 years was briefly checked by tougher criteria for pilot selection, but 1981 the AV-8A suffered an accident rate of 55.94/100,000 flying hours, the highest of any US military aircraft, and more than five times that of the USMCs A-4 Skyhawks which had an accident rate of 10/100,000 hours.[260] The use of tighter pilot selection procedures is a difficult option for the RAN, which is likely to

have few pilots of any experience by the time that STOVL aircraft enter its service. The reintroduction of fixed-wing flying to the RAN may have to be made, therefore, with RAAF personnel and although this might hold down the loss rate in the initial stages it will probably increase as new naval trainees join the squadrons. The only correctives for this tricky problem would be to have some RAAF personnel transfer permanently to the RAN or to give responsibility for naval fixed-wing flying to the RAAF; neither of these is likely.

It thus seems improbable that the RAN could look forward to an attrition rate of STOVL aircraft any lower than that achieved by the USMC, or indeed by themselves when operating Skyhawks. The requirement for STOVL aircraft, were it decided to equip a carrier with these, would therefore seem to have to be for the same 20 aircraft which were required previously. On this basis the cost of STOVL aircraft would vary considerably, depending upon whether the Sea Harrier or the AV-8B were selected. During 1979 a BAe spokesman estimated the flyaway cost of the Sea Harrier at £stg 5.5m to £stg 6m, depending on avionics fit.[261] Assuming that the support costs of a STOVL aircraft program represented 50% of the flyaway cost[262] the total program costs would be between $A280m and $A310m at the rates of exchange existing in June 1982. These prices are at 1979 levels and given the rate of inflation in the U.K. over the past two years could be anything from 20% to 30% higher, which would give project costs ranging from a lowest estimate of approximately $A340m to $A400m at the other extreme. For a program based on the AV-8B the cost would be about twice that of the Sea Harrier alternative. Using the March 1982 US SAR (Selected Acquisition Review) and the latest program objective to produce 342 AV-8Bs to give an estimated project unit cost of $US31m, and the same assumptions for project costing as for the Sea Harrier, the cost of a RAN program would be $A900m at rates of exchange pertaining in June 1982.

It now appears, however, that the Government had been considering procuring only 12 aircraft in its studies of fixed wing capabilities for Invincible.[263] A program on this scale

would give only the equivalent of the RN's 7 aircraft Headquarters squadron and one 5 aircraft operational deployment. Considering that it would not be unusual to have up to 40% of the aircraft out of service at any one time for modification programs, major overhaul and minor repairs, this small a purchase could leave the base squadron with only 2 or 3 serviceable aircraft whenever the 5 aircraft airwing was deployed. This in turn would complicate the programs of advanced, conversion, refresher and weapons training for which the base squadron would be responsible. Halts and delays would have their consequences in lower operational readiness, lowered morale and increased costs. There is no allowance for attrition and the loss of an aircraft would compound this situation. In the event of a sudden crisis, such a small procurement would mean that 7 or 8 aircraft would be all that the RAN could be certain of deploying and that the development of naval fixed wing pilots would cease for the duration of the crisis. With only 8 aircraft aboard, the carrier's commander would be far more constrained than the British in the Falklands, restricted in his actions by an imperative to conserve both his aircraft and his pilots.

In his prepared statement (May 1982) to the Katter Committee the Secretary of DoD gave the estimated cost of a 12 unit STOVL aircraft purchase as $350m to $400m.[264] This is the clearest indication so far that the RAN's studies of STOVL aircraft continue to be based upon the purchase of the AV-8B. The discrepancy between the latest estimates of the cost of the Sea Harrier and the figures quoted by the Secretary DoD are too great (in all cases greater than unity) to refer to estimates based upon this aircraft. The upper limit of DoD's project cost is some $140m below a costing based on the AV-8B according to the criteria on p.119. This may be accounted for as being based on earlier (August 1981) U.S. cost assessments, a different rate of exchange and/or more sanguine estimates of support costs. The significant factor is that RAN thinking still clearly favours the AV-8B despite its significant shortcomings in the major roles for which Navy says that it requires STOVL aircraft. These roles are fully explained and their priority weighted in the Secretary's paper, and the strike mission against land targets is clearly the

least important of the roles discussed.[265] It is indeed surprising that in an age where discussion of defence equipment inevitably involves evaluation of electronics, the Navy is apparently happy to revert to the Eyeball Mk1.

The delivery date for a newly constructed carrier of 1989, will ease the pressure to supplement the number of ASW helicopters which would have been expected to serve on Invincible had she been purchased. However, if the Government opts to provide the RAN with an interim carrier, expenditure will be required sooner, rather than later, to provide an adequate operational contingent of ASW helicopters. If for no other reason than the high probability of losing one or two Sea Kings over the next few years, the RAN will find it difficult to keep an interim carrier operational in even the limited role foreseen for it by the Government. As the section on aircraft complement explained, there are strong reasons to believe that 8 ASW helicopters are inadequate to maintain this capability in the first place. There have been some reports that the RAN had formulated a submission for a further 8 Sea Kings to establish a second squadron.[266] It appears that Navy had managed to convince the Government of the need for at least something extra, for Senator Durack, in a speech that appeared to rely heavily up Cabinet briefing papers, told the Senate that an order for another Sea King was planned.[267] Little more than one month later the Minister for Defence announced that this expenditure had been deferred along with reductions in expenditure on other Service helicopters[268] as part of the general rescheduling of defence expenditure, ironically, caused by the proposed early purchase of Invincible.

Additional Sea King Mk50 helicopters would probably cost around $7m each at present. The latest estimate of the cost of the 2 Sea Kings announced by the Prime Minister in February 1980 is $12.7m[269] and inflation in the subsequent years would have increased costs by upwards of 20%. The RAN might choose instead, to procure the new HAS Mk5 variant of the helicopter which recently entered service with the RN. The cost of this aircraft does not appear to have been released but is undoubtedly more

expensive than the Mk50 because of its improved sonic processing equipment and radar.

Should the Government decide to procure a new carrier more definite action will be required in the longer term to establish a credible ASW capability. In discussing the topic of aircraft complement we mentioned that the RAN had already initiated steps in this direction as part of a general program to modernize Australia's military helicopter inventories (p.68) and that it sought - at that time without formal approval - 22 helicopters for the fleet ASW role. This objective has undoubtedly been denied as a result of reductions announced on 29 April 1982, and the increased cost of any other carrier could well see this reduction compounded.

One of the helicopters known to have been under study by the RAN is the USN's LAMPS III. Although primarily designed for use from smaller vessels, such as the FFG-7, the LAMPS III helicopter appears to be a far better ASW platform than the Sea King and the RAN might opt for it on the grounds of commonality, operating a single type from the carrier and escort vessels. The LAMPS III is in the same weight category as the Sea King but with technology representative of the 1980s. The March 1982 SAR placed the price of these helicopters at $US32m. This was the "flyaway" cost; that is, without any allowance for spares, support and so on. When these are added, the twenty-two helicopters which the RAN was seeking would have cost $A1024m at exchange rates in June 1982.

This, of course is the main problem with the LAMPS III, one which has accompanied the system since its inception and drawn upon it unremitting US Congressional criticism. It appears that realization of this factor may now be dawning upon the RAN. Upon his retirement Admiral Synnot noted that, as far as equipping the FFG-7s is concerned the "LAMPS III helicopter ... is now going to be so expensive that we may have to go for some other solution."[270] If the LAMPS III were not procured for the FFG-7s there would then be no reason to procure it for the fleet ASW role in order to maintain commonality of equipment.

The navy's choice of replacement would then rest with several other designs, the most likely of which would be a lower priced fleet ASW version of the LAMPS III and the EH-101, a British and Italian joint venture which is due for deployment in 1988. The latter of these appears to be engaging official attention at the moment, for in the Secretary, DoD's submission to the Katter Committee it was said that helicopters to follow the Sea King would "not be available towards the end of the decade".[271] Of the possible replacement for the Sea King this best fits the EH-101. As yet no reliable cost data are available but as the EH-101 is to be a large, three-engined aircraft with state-of-the-art electronics it is certain to be expensive. At this time, however, it seems apparent that the Government has little enthusiasm for pursuing the question of the next generation of ASW helicopters.[272]

Budgetary Problems and their Consequences for the Defence Force

The proposed purchase of Invincible has already affected the future structure of the Australian Defence Force. When, on 29 April 1982, the Minister for Defence addressed the House of Representatives, it was to announce a major restructuring of present and planned defence expenditures. The requirement to pay for Invincible at an earlier date than had been planned for the Melbourne replacement, a similar acceleration of a $280m program for 10 P3C Orion aircraft, and increases in Service pay rates had forced the Government to postpone, reschedule or reduce other equipment programs. Of these, the payments for Invincible would have required the highest immediate expenditures after the pay rises. Although there was no specific allocation for the carrier replacement in the 1981-82 Appropriations, $81.6m was introduced in the equipment Division of the Additional Appropriations for initial payments on Invincible.[273] The total amount which the Government decided to outlay on Invincible in 1981-82 was reported as $98.6m,[274] the additional $17m presumably being spent on items other than the prime cost. The nature of this additional expenditure is impossible to guess, for there are no other entries in the Additional Estimates notifying Parliament of the intention to spend more than $81.6m on Invincible in 1981-82.

Of course, with the Invincible remaining in the Falklands and the issue of her purchase unresolved till after the conclusion of the Financial Year, none of this was spent. Had the original arrangements been adhered to, that is transfer of the ship to the RAN in the U.K. in late 1983 with payments divided before and after delivery, this would have required the expenditure of some $240m in each of the Financial Years 1982-83 and 1983-84. The average annual expenditure which would have been required over the next two financial years if Invincible had been purchased, represents some 34% of the estimated expenditure on new equipment provided in the 1981-82 Budget, 40% of the downgraded allocation remaining after the Government's restrictions on expenditure earlier this year, and a higher proportion, probably 47%, of the expenditure actually achieved after action to purchase Invincible was suspended.

The cash flow management problems of such a position were sure to result in dislocation of the funding program for new defence equipment, and the consequences, when announced by the Minister on 29 April, were indeed far reaching. Projects to provide an additional 5 Fremantle class patrol boats, a second AOE, photographic survey aircraft to replace the Canberras of the RAAF, and additional ASW helicopters have been deferred. The follow-on-destroyer project, to build two FFG-7 frigates, has been delayed. The DISCON communications project, RAN and RAAF helicopter projects and the Mirage refurbishment program have all been reduced. General Service activity was restricted and the construction of many defence facilities delayed.[275] In addition, nothing further has been heard of equipment projects mentioned in Ministerial statements as being planned for the near future. No indication has been given of when, if ever, deferred projects will be reinstated. Now that Invincible will not be purchased after all, a further reorganization of the equipment program will be necessary. However given the tight Defence budgetary future outlined below it is no means certain that these restrictions will be removed.

The task of reorganizing equipment programs has not been assisted by the reduction of the equipment vote forced upon DoD

as part of the Government's campaign of budgetary restraint earlier this year. This resulted in $101m of the $658m allocated to finance new equipment for the Services being "cut".[276] The extent of dislocation to equipment programs was greater than this, however, being masked by the $81m included for Invincible. A total of $172m[277] was cut from approved equipment programs, and the majority of this will have to be paid in immediate future years, only a small proportion of it being expenditure on projects then deferred. Some of the "cut" appears to be the result of negotiating deferment of payments to the USA, for equipment bought under FMS (Foreign Military Sales) procedures, which may have resulted in a moratorium of two or three years on these programs. Strangely, however, the Minister did not seem to know the financial implications of the agreement he had reached with the Americans at the time he addressed Parliament.[278] What is certain, however, is that at the end of the moratorium these FMS payments will fall due and have to be made over a shortened period.[279] In addition these later payments will have to be made at the values then in force, as most FMS agreements include inflation clauses requiring the purchaser to meet agreed increases in labour and material costs. For this reason, and because if the Government were to decide to purchase a new carrier its demands for funding would conflict with the amended FMS repayments, it is probable that the Government will not take full value of this rescheduling and instead use the greater part of the finances earlier intended for Invincible to pay for American equipment already ordered. To do otherwise would be to create an almost insoluble cash flow problem towards the end of the decade.

The Defence Department has implied, if not directly claimed, that the developments of 29 April represented nothing more than a rearrangement of payment schedules with some consequent inconvenience. On the other hand, we would argue that the Defence Program is already in a deal of trouble and that the Government will not be able to fund the programs it has already committed for procurement, let alone those other equipment items which it should commence, for one reason or another, before the end of the decade.

In the aftermath of the actions of the USSR in Afghanistan, the Government announced a new defence program which was to see $17,600m (at August, 1979 price levels) spent on Defence in the financial years from 1980-81 up to and including 1984-85. This FYDP was based on a general calculation that raising the Defence budget by 7% p.a. in real terms would reach the expenditure target over the 5 year period, at the end of which annual Defence spending should be approximately 3% of Gross Domestic Product (GDP). In addition it was planned that expenditure on new equipment should rise as a proportion of the total Defence budget till it reached 25% in 1984-85. This was to be done by controlling recurrent costs, particularly manpower costs, and was to ensure that the large amounts needed to finance the re-equipment of the Services were available.

The 1980-85 FYDP followed another such program, the 1976-81 FYDP, well publicised in the White Paper of November 1976, Australian Defence. This had similar objectives and aimed to achieve a similar distribution of defence resources as the 1980-85 FYDP (except, of course, with the monetary quantities being smaller) but was based on a real annual growth rate of 5%. The widespread judgement of this program is that its objective were not achieved, with real growth failing to reach the target and the structure of the budget not sufficiently altered. On the Minister's admission, real growth through the period was around 3% p.a.[280] and in 1980-81, the last year of the FYDP the proportion of Defence Expenditure devoted to capital equipment was only 16.1%.[281] In a sense, then, the FYDP announced in February 1980 represented an attempt to recapture lost ground. The financing of the program started slowly, with a real increase of 5.6% in 1980-81[282] and a slight fall on the previous budget in the proportion of total Expenditure devoted to new equipment (16.4% to 16.1%),[283] but the 1981-82 Financial Year was to have seen a major increase in the real growth of the Defence Budget. At one stage, with a projected Outlay of $4211m, the 1981-82 Defence Budget represented an increase of 19% over the previous year at current (uninflated) values but in the event Outlay reached only $4116m.[284] This is an increase of only 16.4% in current value terms and, unless the rate of inflation fell

markedly during the last quarter of 1981-82, would represent a constant price (real) increase of only about 5%. Moreover this growth is mainly the result of increased manpower costs, of Service and civilian wage increases having added an additional $284m to the August, 1981 Estimates and resulting in a total increase to the Budgetary estimate of Defence Outlay of $99m.[285] The $101m sliced off the new equipment appropriation resulted in its comprising only 13.7% of the total Expenditure[286] then estimated, the lowest proportion since 1978-79, but the subsequent inability to spend the allocation for Invincible has probably reduced Outlay on equipment to around 12% of the total, lower than in any year since the 1976 FYDP was formulated.

This situation arises after, and further compounds, problems which have been developing in the equipment component of the Defence budget over the past two financial years. Instead of a gradual rise of expenditure on new equipment towards 25% of total expenditure, the last two budgets have seen a slow down of the rate of monetary increase; a significant underspend of the appropriation; a decline in the proportion of the budget spent on new equipment; and a decline in the real value of expenditure on new equipment for the Services, now exceeding 10% over the period of the 1980-85 FYDP compared with the last year of its predecessor. This does not provide a good base upon which to implement an historically unprecedented equipment program. Only if the Government can increase its spending dramatically will it be able to avoid further dislocation of scheduled Defence equipment programs; and this option would appear to be closed off by the overall Government policy of expenditure restraint.

The Government's policy remains one of allocating 25% of Defence expenditure to capital equipment by 1984-85.[287] If the real total Defence Outlay is increased at 7% p.a. from the 1981-82 Outlay of $4116m, it will reach $5040m (at end 1981-82 cost levels) by 1984-85. To spend 25% of this on new equipment would require an outlay of $1260m, which represents a 31% real increase in each of the next three financial years. When likely rates of inflation, presumed to be slightly greater than 10% p.a. for the period are considered, the money increase that would be required

for each of these years would be in excess of 40%. This rate of increase has been exceeded only once under the present Government, in 1976-77, when the Outlay on new equipment increased by more than 84% compared with the previous financial year. Only once since then has the rate of increase at current prices been greater than 20% - in 1978-79 when an increase of 31.4% was achieved. Clearly then, the Government is going to have considerably less than 25% of the Defence budget to spend on new equipment by 1984-85 unless it is able to increase the Defence budget to an extent unprecedented in peace for each of the next three financial years, and do this in a time of severe economic recession. As far as the equipment component of the 1980-85 FYDP is concerned, it is clear that, by responding to the priority of national economic policy, the Government has been handicapped in exactly the same way as it was in the 1976-81 FYDP.

Just how much the Government will be able to allocate to procurement over the remainder of the FYDP depends not only upon its own willingness to increase the size of the Defence budget but upon factors beyond its own control. One of these is the continuing effects of the pay rises. The Government will have to increase the Defence budget by considerably more than its own objective of 7% p.a. over each of the next three financial years for these to be negated. The only acknowledgement that the distribution of finances within the FYDP would continue to be a problem rather than an aberration confined to the 1981-82 Financial Year came when the Minister told the Parliament, with respect to the levels of wage increases:

> "The effect in this year has been to divert investment expenditures provided for in the Budget away from real growth towards meeting higher wages and other costs. There will be flow-on effects in later years of the defence program".288

The reason for this is that the Service pay rises, dramatic as their effects were on the 1981-82 budget were paid for only two-thirds of the financial year. Whereas Service pay rises added $171m[289] to Defence costs in 1981-82, they were

estimated to add $260m in a full year.[290] Thus approximately another $90m will have to be added to the Defence budget for 1982-83 to pay for the full effects of the Service pay rises. A similar, though much less serious "full-year" effect exists with civil salaries and this, together with other wages related costs, will force up the manpower bill in 1982-83 by a further $32m, increasing the total manpower "bill", at constant prices, by $122m over that of 1981-82. Moreover, additional increases in Service and DoD civilian pay scales over the ensuing FYDP period must be expected. Whether the Government can contain these to manageable levels is, of course, an imponderable; nevertheless it must be conceded that Service pay, at least, will not be allowed to fall too far behind community standards, while the recent affiliation of several major Public Service unions to the ACTU will not weaken their bargaining position.

Overall wages pressure on the defence vote is thus likely to remain a serious constraint for the foreseeable future. Inflation and an increased income from PAYE (Pay-As-You-Earn) taxation returns will present an opportunity for the Government to increase the Defence budget in real terms and absorb some of the effects of the manpower commitment. However, countervailing pressures on what will be vital budgets in the Government's pre-election strategy will probably limit the extent to which this opportunity can be grasped as will have the recent tax concessions to industry. Further, as already noted, it is unlikely that manpower costs will remain static after the recent increases; whilst manpower costs will not increase by the 27.6% of 1981-82 there is no reason to believe that they will increase by much less than the 11.7% average annual increase of the period from 1976-77 to 1980-81.[291]

Even should the Defence budget increase during 1982-83 by the 19% at one stage projected for 1981-82, and manpower cost increases be restrained to only 10%, the amount freed for expenditure on new equipment - presuming that expenditure in other areas, such as facilities, defence science and so on, are not cut - would be only an additional $50m or thereabouts.

In fact, the appropriation for new equipment will probably increase by more than this in 1982-83 because of the reductions in Service training and excercising which were announced on 29 April.[292] However, the Government decided after the USSR's action in Afghanistan that the readiness of the Australian Defence Force should be increased and that proportionately higher funding should be devoted to Service operations.[293] Judging by the Minister's sombre strategic analysis in his Statement on 29 April, the Government's view about the situation requiring this increase in operational expenditure has not changed. It would be surprising, therefore, if the Services do not strongly advocate the restoration of funding for training, exercising and other operational expenses at an early date. Thus, even with the strongest of intentions it is unlikely that the Government will be able to free funds from the area of general running costs to finance a significant proportion of the new equipment programs.

The consequence of these restrictions on the Government's options in defence budgeting is to reinforce the conclusion reached earlier (p.128) that only by massive increases in the Defence budget can it meet the objectives of its equipment program. Yet should it attempt to do this the very effort will make it vulnerable to the pressure of bureaucratic and political oponents of increased Defence expenditure. Another increase in the Defence budget of about the 19% which the Government had hoped to reach in 1981-82, in the current circumstances of a declining GDP will see expenditure at a level which may well exceed 3% of GDP, fully two years earlier than scheduled. In these circumstances, and with an election pending, the pressure for allowing only a marginal increase in future Defence budgets is likely to become intense. The problem for the Government will be that although it would have reached with alacrity two of its objectives for the 1980-85 FYDP it will be left with the problem that its (probably major) objective, financing new equipment programs for the Defence Force, will be little closer to realisation than before.

The fact that the Government's problems with its equipment program are immense can be see from the extent to which it has already obligated the nation to pay for new equipment projects. As a proof of the Government's achievement in Defence policy the Prime Minister has cited the fact that in some 18 months the Government had "more than doubled our commitment to future defence purchases to almost six billion dollars".[294] The increase of the debt incurred for defence equipment which is yet to be delivered has been marked over the past three financial years. At the end of 1979-80, $1731m of outstanding obligations for equipment orders placed, but not as then paid for, was carried into 1980-81 and subsequent years.[295] By March 1981 the Katter Committee was provided data which showed that the "forward commitment" on new capital equipment at that time was $1990m.[296] However, by the end of the financial year the carry-over of financial obligations to subsequent years had risen to $2236m.[297] It was estimated at that stage that outstanding obligations to be carried over one year later, into 1982-83 would be some $2578m but that decisions likely to be made during 1981-82 could increase these "by some $2800 million".[298] In the event some five project approvals during the year have increased the forward commitments by $3436m[299] raising the total obligations to $6014m.

The unavailability of Invincible will have reduced the obligation, but with any newly constructed carrier to cost about $1000m a decision by the Government to replace Melbourne with a new vessel would raise the total of outstanding obligations to over $6500m. Should the Government yield to pressure and procure STOVL aircraft to be available when the new carrier is delivered in 1989, it would have to find an extra $350m-$400m (even for the modest program outlined by Secretary DoD to the Katter committee - p.119 above) although we have argued that a more realistic program based on the AV-8B would cost almost $1 billion. If an interim vessel is to be hired these costs would be a further addition to the program whilst at least four attrition helicopters would be required to maintain the current inventory till the end of the decade. These would cost about $30m for the outdated Sea King Mk50 which may no longer be in production toward the end of the decade. The cuts in the 1981-82

equipment programs will transfer a further $170m to these outstanding obligations resulting in some $7100m becoming the liability for defence equipment at the end of 1981-82. Even if the Government decides not to procure STOVL aircraft till the next decade, the obligation still amounts to $6700m.

There is nothing inherently wrong with increasing the commitment to spend money in the future to equip the Services. Indeed, given the lead times for procuring modern military systems it is unavoidable. The problem occurs when the rate at which expenditure is increased fails to match the growth in commitments. It is seldom possible to spend anything of significance on a program in the year it is announced, but if the way is to remain clear for accepting further obligations, the rate of expenditure must increase within a few budgets. Instead, as we have seen, (p.127) in the period since the February 1980 commitment to increase the equipment and readiness of the Defence Force, there has been a comparative decline in procurement for the Services. As a result, either the rescheduling of the programs which comprise the Government's $6700m obligation with a carrier, or the paying for them within the pre-April 1982 schedule, will be daunting. The last of these equipment projects due for completion will be the Tactical Fighter Force and the carrier which are planned to conclude in 1988-89. Along with the remainder of the current equipment program they will have to be paid for in 7 financial years according to current planning.[300] This is an average in excess of $950m per annum at current prices.

In addition to this obligation are the costs of several other projects which, whilst they have not proceeded as far as to have gained Cabinet approval for specific items of equipment, have been given public Government approval. Of these the most important is the Follow-on Destroyer (FOD) project to provide new destroyers to replace the River class Destroyer Escorts.[301] It is difficult to define the status of this project because the Government still has not decided whether to build locally or overseas and no estimate of cost or formal approval to begin fabrication has been given, but on balance it appears that the

FOD's costs will represent a substantial addition to future new equipment funding obligations.[302] If the RAN still adheres to its earlier convictions, it will be pressing the Government for substantial outlays for a building program as the first of its DEs will need replacing in 1987.[303] As all of its 6 DEs and 3 DDGs will be retired between 1987 and 1996 the Navy is concerned at the effects of any delay in commencing the replacement process.[304]

We would contend that this objective is now highly doubtful as a direct result of the 29 April modifications of the FYDP consequent, in large part, on the then proposed purchase of Invincible. Although it might be thought possible to return the FOD program to its original schedule now that large outlays will not be required in 1982-83 and the following year to purchase Invincible we do not think this likely. The Minister's 29 April statement imposed a hiatus of 5 years upon the FOD indicating that something more than simply the immediate demands of Invincible's procurement was amiss with the FYDP. More significantly a decision to purchase a new carrier would see its construction proceeding concurrently with that of the first FOD, and at a price more than twice that of Invincible the demand for funds appears to be far too great. However since the present analysis is aimed at unearthing all major consequences of buying a carrier, the costs of the FOD project are here treated as an addition to the Prime Minister's $6,000m of forward obligations and falling due for payment within the same time scale from the present up to 1988-89. To meet these objectives it is difficult to see less than some $400m[305] being required in the period up to and including 1988-89. Since the RAN's objective is a program, expenditure on successive vessels would be required before the first was completed. The amount involved to phase-in a continuous program is impossible to estimate, but its non-inclusion in our calculations will more than compensate for any over-estimate of the project costs of the first of the FOD vessels.

Two other projects may well contribute to the Government's future funding problems as they also have in-

principle approval without, it would appear, specific Cabinet approval and a firm costing basis. In October 1981 the Minister stated that two Hunt class minesweepers, like Invincible ex-RN, were being considered for procurement with an option for a third.[306] Press reports indicate that this project would cost $200m[307] with payment falling squarely within the period under consideration. The Minister's comments on Project Raven place this Army communications project in the same category.[308] Production is due to commence in 1985 and could well be worth $120m at current prices.[309] A related Army communications program, Project Parakeet will impinge on the later part of the 1982-89 time scale,[310] but estimates of cost are not yet readily available.

Nonetheless it can be seen that if the Government is to adhere to its program of re-equipping the Forces, and if the cost of the carrier is to do no more than cause a re-arrangement of the phasing of different projects within that program, considerable expansion of the Defence budget is required. If we add the cost of these projects (which we might define as having a firm commitment rather than a stated obligation) to the $6,700m of obligations, it can be argued that, to maintain its objectives in providing Defence equipment, the Government will be required to spend some $7,400m over the next seven financial years; that is, over a billion dollars a year for the next seven years - clearly the largest armaments program in Australia's history, even without allowing for procurement of adequate STOVL aircraft and helicopters to equip any carrier the RAN might procure.

Whilst it might be argued that inflation over the next seven years will enable the Government to outlay this amount or more towards the end of the period the fact is that almost all defence equipment is purchased under conditions which pass inflation directly to the purchaser. Indeed the Prime Minister's $6000m of outstanding obligations is already undervalued as a year's inflation will have to be added to the uncompleted projects amongst those of the $2288m worth of obligations carried into 1981-82. Furthermore the future budgetary problem is compounded by the consistent pattern of costs for defence

equipment rising faster than the general rate of inflation. In the experience of Great Britain, inflation of defence equipment costs has been running at some 5-6 percent above general inflationary trends,[311] whilst in the USA the experience appears to have been the same.[312]

Although inflation may continue to fall in the USA, where the bulk of the Australia's defence equipment will be procured, as the recession deepens the consequence, for so long as inflation in Australia remains higher, is merely to increase the value of the American Dollar against Australia's. Indeed, the Australian dollar fell by 9.1% against its US counterpart in the three months to June 1982 to be at its lowest value against the $US for 5 years.[313] Whilst future devaluations against the $US are unlikely to be quite as dramatic, their effects can be discomforting. For instance, this de-facto devaluation would have increased the official estimate of the cost of the TFF project by somewhat in excess of $200m. Ironically, the high annual expenditure required to fund existing obligations for new equipment could possibly compound any existing exchange rate problems. Much of the required billion dollars will be paid directly overseas and may worsen balance of payments problems should the current record rates of capital inflow slacken. The Government's task in re-equiping the Services will be difficult indeed.

There is strong circumstantial evidence to show that even Defence officials recognize that the funding program for new defence equipment is already overstretched and that the situation is sufficiently critical to interfere with the orderly development and implementation of Defence policy. Before the British accepted the opportunity to withdraw its offer the Senate was told by the Minister Representing the Defence Minister that Invincible could be procured within the bounds of the Defence program which the Government had provided for. The more significant fact, however, was that he admitted that any alternative means of replacing Melbourne would have meant "a very considerable addition"[314] to the planned Defence program. Yet ever since the Government announced its approval for the

replacement of Melbourne in September 1980 the costs of this vessel have been (one would expect) in the FYDP. Either the initial estimates were astonishingly low or the subsequent demands made upon the FYDP have left it unable to meet the objectives for which it was devised. And now that a new carrier can be provided for the RAN only at a price at least twice that which the Minister said was within the bounds of the program it is obvious that the Government will have to make the "very considerable addition" to its FYDP planning he referred to if it intends to replace Melbourne. Despite the extolling of Invincible's role in providing what was really minimal ASW protection, it is clear that it was actually financial constraints which would have limited her to this task. The fact that opponents of RAN airpower were able to use financial arguments to veto the purchase of STOVL aircraft at the same time as Invincible seems apparent from Admiral Synnot's statement to the Katter Committee that "As soon as there was a bit of a budget problem people were up in arms over long-term items like STOVL aircraft.[315]

While the Admiral's displeasure at this situation is easy to appreciate, it is not unique to himself or to naval officers. A glance through Chapter 4 of the 1976 White Paper Australian Defence will renew memories of many equipment projects it was said would commence during the 1976-81 FYDP and for which no program has yet been announced. The feelings of naval officers concerning the prospect of an indefinite delay in the provision of aircraft for any RAN carrier are probably no different from those of Army officers with no immediate prospects of securing Anti-Tank Guided Weapons[316] or CMF artillery men who know they are not to receive their British 105mm light guns until into the next decade. The RAAF is sufficiently concerned about the balance of its equipment program to have stated "In total, as well as in elements, the airspace control/air defence infrastructure of the country is poor and serves little purpose as it exists in support of national defence objectives".[317]

The relevance of other shortcomings in the force structure of the Services to the issue of the purchase of a

carrier is simply that all are competitors for what is a very restricted budget for new equipment. The situation is indeed severe when it is not possible to equip a cut-price carrier, not just to protect herself with fixed-wing aircraft, but to have an effective operational capacity in her only remaining role, that of ASW. The situation is worse when the likely annual outlay required to pay for equipment already ordered is so great that all analysis suggests that many programs will have to be delayed or reduced because they cannot be funded within existing schedules. It is worse still when the value of forward commitments already made is so much greater than current and likely rates of expenditure that it will be some time before the Government will be able to initiate new major programs. This includes not just items like STOVL aircraft but major new capabilities such as aerial tankers and AWACS aircraft which are arguably more useful in securing the nation than any single aircraft carrier. The situation is further compounded because re-equipment of the Defence Force is a dynamic process. A reduction in any particular annual appropriation for new equipment is not a painless saving that can be "picked-up" at some later date. The delay will merely postpone payment till a time when some other item is in need of replacement and simply guarantees another budgetary crisis in the near future.

So it is that the proposed procurement of Invincible further delayed the follow-on-destroyer project (to replace the RAN's ageing River class destroyer escorts) and set the stage for construction of surface vessels to be competing for funds with the replacement of submarines over the second-half of this decade. If, as Admiral Synnot and Rear-Admiral Griffiths contend, Australia needs two carriers to realise the capabilities of naval air power (pp.31 and 89 above) then on financial grounds alone the procurement process for a carrier should be halted now because, clearly, in its present circumstance Australia can not conceivably provide two carriers - especially when there is no longer a "cut price special" up for sale.

9. Conclusions: The Consequences of Inadequate Policy

At this point it is appropriate to take stock of the issues surrounding the decisions, firstly, to acquire Invincible and, secondly, to acquire a carrier in general. Many of the carrier's proponents have contended that it is a reasonably cheap exercise compared to, say, the $2430m F-18 program, or that its utility will be maintained (albeit in a very limited role) by confining its operational environment to the relatively secure task of coastal ASW.

Our analysis of the state of the Australian defence budget now and into the future shows, however, that there is no such thing as a "cheap option"; that the acquisitions of major equipments for the Defence Force cannot be based on the security of the forces chosen to perform a task; and that the proper criteria for such decisions are derivable from coherent strategic and operational analysis. In the final analysis, the problem is not one of arguing the ancillary benefits of an additional capability which might be proposed, so much as one of first selecting the basic capabilities required to enable the Defence Force to fulfill its primary mission of safeguarding vital national security interests. Peripheral considerations, such as showing the flag, or keeping unlikely options open, are relevant if and only if the primary criteria are satisfied.

The established concept for Australia's Defence Force is the so-called "core force". This has proved a most elusive and slippery beast when subjected to study, even though DoD has given more than one extensive and well-presented outline of it. In essence, the core force concept is predicated on the maintenance of a "force-in-being" capable of dealing with all likely short lead time contingencies, and capable of timely expansion to meet unforeseen, but longer lead time, threats which may arise. In this context then, the proposed acquisition of Invincible would have been seen as an addition to the force-in-being, while the absence of STOVL aircraft at the time did not mean that this capability could not have been acquired at a later time should a requirement have been perceived. (How this could be done with

any future carrier, given the state of the FYDP, is, however, a question with no real answer).

Yet the core-force concept does not stand up well under close analysis. The Katter Committee's 1979 procurement report expressed serious reservations about its adequacy. Other published studies have cast doubts on the ability of the Defence Force to expand at an adequate rate should some emergency arise.[318] Official DoD testimony (again before the Katter Committee, whose contribution to the informed study of defence-related matters in Australia over recent years has been outstanding) has shown that the Department has put minimal effort into studies of how best to mobilise the national resources for defence if required.[319] Criticisms of the core force concept have been dismissed with what amount to reiterations of its rationale which take no regard of the substance of the criticisms. A great many questions have been raised, but very few meaningful answers given.

In any event, the essential vacuity of the core force concept has led with awesome inevitability to the crisis of financial management described above. Nor is this the most fundamental adverse consequence of established policy. Currently, the force structure of a capital-intensive and technologically oriented Service like the RAN is determined, so far as one can ascertain, more by the equipments it has operated in the past than by the conclusions of broad-ranging studies of the nation's essential priorities in securing itself from military threats. There is nothing on record to convince us that such studies have been undertaken with vigour and systematic purpose. While any number of isolated, "one-off" studies related to specific matters have of course been carried out, what seems to be missing is that systemic approach which characterises sound analysis in any field. A fair comment would be that ad hoc-ery as modified by intra-DoD and inter-Service bureaucratic politics (frequently driven by the so-called "replacement syndrome"), and the occasional intervention of Governments concerned to appear active and decisive in an important field, are too characteristic of Australian defence policy and practice for comfort. In this

context, the tergiversations of Navy over the carrier's role in defending Australia's SLOC - outlined at some length in section 3 of this paper - are perhaps more understandable than otherwise.

Had the RAN taken the benefit of proper analysis, it would not now be in the situation of seeing the replacement of its surface fleet jeopardised by financial dictates. The postponement of the FOD project is but the first tangible effect of the attempts to purchase a carrier. A purchase of this nature, at a time when competition for resources is so intense, is symptomatic of the lack of unified and coherent guidance in the selection of equipment for the Defence Force as a whole; apart, that is, from the pervasive, and so far unchallenged dictatorship of finance. "Growth of air-defence system components has been piecemeal, with new equipment requirements being related more to existing equipment capabilities rather than to guidelines emanating from a basic total-system concept" the new CDFS has written about the RAAF.[320] He might have been writing about the Defence Force as a whole, for the impression is the same.

We would contend that whether Australia has a submarine fleet, or tactical aircraft refuelled in the air and directed by AWACS aircraft, or a fully developed surface fleet including an adequately equipped aircraft carrier should be decided by careful analysis developed into a cohesive policy. The nation's security should not be left, should a crisis appear, to a poorly developed air defence structure, an ill equipped carrier with no aircraft and perhaps a submarine fleet largely decommissioned because of age or shortage of crews because of inadequate conditions, simply because financial stringencies have been allowed to become, de facto, the touchstone for future defence planning. And perhaps, should a cohesive plan arise and priorities be identified, it might be found that some existing Defence Force capabilities were no longer crucial, and could be dispensed with, thus reducing the tyranny of finance.

It should be remembered that with the impact that modern technology has made upon the battle-field, the balance of

equipment is only a beginning in the development of force structure. With the cost of modern PGM rising to upwards of a million dollars, the costs of their procurement and especially the development of expertise in their use (which must include firings) is also a major competitor for defence equipment finance. In the UK the restructuring of their forces, particularly the Navy, was largely argued in terms of altering the balance between "platforms" and "weapons".[321] The balance struck by the British Government was hotly debated but the essential truth of the argument has now been demonstrated by the defeat of Argentinian forces which, while comparatively well endowed in "platforms" were hopelessly underequipped with "weapons". The Argentines' successful use of Exocet is the only exception. Although the numbers of Harpoons, Standards, Mk48 torpedoes and other advanced weaponry provided for the Services are (quite properly) classified, analysis of the financial data suggests that Australia's balance of "platforms" and "weapons" is rather too close to Argentinian ratios for comfort. This would be especially so if one were to develop a scenario of the recently retired CDFS which sees the Defence Force left to fend for itself after the Northern hemisphere was devastated by nuclear war.[322]

One does not have to adopt this viewpoint to argue that the balance between weapons, platforms, and the development of skill in their use in Australia's Defence Force has not been sufficiently studied. Certainly no cohesive policy has been enunciated. Overseas, the influence of PGM, ECM, C^3 and the other acronyms of modern defence jargon upon the force structure, operational doctrines, and manpower policies of national defence forces is hotly argued: in Australia, for all that has been said at senior Service or political levels, one might not know that the debate even existed. Indeed, it was less than four years ago that a senior DoD officer, subsequently again promoted, put in writing in an official submission to the Katter Committee the truly astonishing assertion that "the changes in technology applicable to military operations are relatively slow". DoD went so far as to attempt to defend this view in subsequent hearings.[323] This statement runs so contrary to well-founded

opinion all over the world that, were it not in Hansard, one would question the accuracy of the reporting.

The proponents of the procurement of Invincible have said much about the incremental benefits of maintaining various capabilities in the fleet; they have not been able to draw upon any policy which would show which, if any, of those capabilities has priority in ensuring the nation's security. Aircraft carrier advocates have said much about the need to maintain capacities to take certain actions and operate in certain areas; they have not been able to show that Invincible or any other V/STOL carrier could achieve those objectives, nor that there is any bureaucratic or political agreement that those objectives need to be achieved. The proponents have argued for a carrier as a means of "keeping open" the defence options of future governments; they have not explained how the financial consequences of maintaining those options can be prevented from closing others. Nor has there been any credible analysis made to show that the options opened by a carrier will serve Australia's long-term national security interests better than those which have been closed off. In short, the proposed procurement of Invincible and the continuing efforts to gain Government approval of an alternative have been the result of decision making founded on an underlying policy lacking in clarity and internal consistency.

As the policy concerning a carrier now stands, it may be purchased to allow the RAN to operate sea-based ASW helicopters. The main argument in favour of this action is that a single large ship is the most efficient way of deploying these aircraft. As we have shown, the priority given to the ASW role is doubtful. The force of the argument for efficiency is destroyed, firstly, where the purchase of the vessel is not matched by the purchase of adequate aircraft, and, secondly, by the admission - not made until the decision to buy was taken - that one carrier is really not enough. The diversion of finance for such a currently limited military capability, and one still subject to important operational restraints even when fully equipped, is very difficult to justify where there are so many other potential defence capabilities competing for severely restricted finance.

Finally, it is difficult to escape the conclusion that the words of Minister for Defence Townley in 1959 remain valid in every respect today:

> A replacement carrier of a more modern type, that would be suitable to our requirements and within our Budget, is not available from any likely sources. The construction of a new carrier...could not be seriously considered; the cost would be completely prohibitive, and the time required for new construction would not meet our needs. In any case, the position is that naval aviation is now a complex and costly enterprise, both in respect of carrier and aircraft. It is therefore extremely doubtful if it possible for a small navy such as the Royal Australian Navy to keep pace with modern developments in this field, without unduly prejudicing other defence activities, not only from the joint service aspect, but within the Navy itself.324

Indeed, Townley's words operate today with added force. It would, in theory, be possible even now to put HMAS Melbourne back together and operate her as an aircraft carrier for the few years she has left. To do so, however, would merely postpone once more the day when it has to be recognised that the strategic, operational and financial case which has been made for a new aircraft carrier does not stand up under analysis.

FOOTNOTES

1. Hansard (Representatives), 26 November 1959, p.3184. (Emphasis added).

2. "Invitation to Register Interest in Assisting in Project Investigation of Possible Aircraft Carriers for the Royal Australian Navy", Department of Defence (Navy Office), 23 September 1977. (Hereafter abbreviated as "IRI").

3. Defence Press Release 26/78, 22 February 1978.

4. Hansard (Reps), 23 August 1979, p.549.

5. Nationwide, 3 December 1979, Parliamentary Library transcript.

6. Joint Committee on Foreign Affairs and Defence, Sub-Committee on Defence Matters, Hansard, 2 May 1980, p.219. (Hereafter cited as Katter Committee Hansard).

7. Hansard (Reps), 9 September 1980, p.996.

8. "No Australian Home for 'cast-off' Flotilla", Sydney Morning Herald, 24 June 1981.

9. Roy Braybrook, "The Great Carrier Debate", Australian Aviation and Defence Review, June 1980, p.30. The list of respondents to the IRI has not been made public.

10. "Britain Seeks to Sell Australia an Aircraft Carrier", Financial Review, 1 September 1981.

11. Defence Press Release No. 200/81, 24 September 1981.

12. Hansard (Reps), 25 February 1982, pp.629-30.

13. "PM Outlines Invincible's Functions", Canberra Times, 27 February 1982.

14. Joint Committee on Foreign Affairs and Defence, Sub-Committee on Defence Matters, Report on Australian Defence Procurement, Parliamentary Paper 260/1979, p.5. (Hereafter cited as Katter Procurement Report).

15. I.H. Richards, "An Aircraft Carrier for the Royal Australian Navy", Defence Force Journal (DFJ), November/December 1977, p.47.

16. ibid., p.48.

17. ibid., pp.46 and 48. (Emphasis in original).

18. Katter Committee Hansard, 28 July 1980, p.367.

19. A.W. Grazebrook, "Sea Control and Maritime Airpower: An Australian View", Pacific Defence Reporter, September 1976, p.20.

20. See, for example, pp.5-10 of the Report of the Joint Foreign Affairs and Defence Committee on Industrial Support for Defence Needs and Allied Matters, (Parliamentary Paper 225/1977).

21. See the evidence of Mr. G. Jukes to the Senate Standing Committee on Foreign Affairs and Defence, Indian Ocean Hearings, Hansard, 10 August 1976, p.673.

22. Hansard (Reps), 5 March 1981, Answer to Question No. 252, p.547. (This figure was calculated in terms of a standard unit, "revenue tonnes").

23. Katter Committee Hansard, 18 March 1981, p.1728.

24. Navy Press Briefing Paper, 1 July 1981, para. 9 (p.3). Emphasis added.

25. Janes All the World's Aircraft 1975-6, pp.378-9.

26. M. MccGwire, "Australia as a Regional Seapower - An External View", Seapower '79: Australia and Seapower, Australian Naval Institute, First National Seminar, 2-3 February 1979, Seminar Papers, p.29.

27. Katter Committee Hansard, 18 March 1981, pp.1726-7.

28. DMS Market Intelligence Reports, Electronic Systems, "CAESAR (General)", November 1981, p.1.

29. DMS, op. cit., "CAESAR (Data)", p.1.

30. Katter Procurement Report, p.35 (Emphasis added).

31. Hansard (Reps), 25 February 1982, p.630 (Emphasis added).

32. A. Legault and G. Lindsay, The Dynamics of the Nuclear Balance, Cornell University Press 1974, pp.140-1.

33. Katter Procurement Report, op. cit., p.19.

34. Katter Committee Hansard, 2 May 1980, p.223.

35. ibid., p.263.

36. Katter Procurement Report, op. cit., p.19.

37. ABC TV 7pm News (ex ABC 3 Canberra), 14 March 1982, Parliamentary Library transcript.

38. R. O'Neill, "A Need for New Ideas, Smart Weapons", Sydney Morning Herald, 20 February 1976.

39. Department of Defence (Navy Office), Aircraft Carrier Project Presentation, February 1982, p.9.

40. IRI, op. cit., p.B-1.

41. "Why a Carrier?", Navy News, 26 March 1982, p.6.

42. Katter Committee Hansard, 18 March 1981, p.1735.

43. Hansard (Reps), 25 February 1982, p.630.

44. Jane's Fighting Ships 1980-81, p.133.

45. As, for instance, with the suggestion that a general threat to our SLOC could arise only in a situation tantamount to global war (See note 24).

46. "Why a Carrier?", Navy News, 26 March 1982, p.6 (Emphasis added).

47. Hansard (Senate), 25 March 1982, pp.1235-6.

48. See note 23 above.

49. W.B. Pritchett, Statement to Katter Committee, 24 May 1982, p.7.

50. Pritchett, op. cit., pp.2-3.

51. Pritchett, op. cit., pp.3, 3, 4 and 4 (respectively).

52. Vice-Admiral J.H. Moorer, USN (Ret), Letters to the Editor, Wall Street Journal, 16 June 1982, p.27.

53. Ross Babbage, Rethinking Australia's Defence, University of Queensland Press 1980, pp.26-42.

54. Jane's Weapon Systems 1970-80, p.244 and 246.

55. "Red Faced Coontz", Flight International, 25 July 1981, p.211. Defence News Release No. 41/82, 1 April 1982.

56. Jane's Weapon Systems 1980-81, pp.56-7; The Military Balance 1981-82, pp.81 and 84. DMS Market Intelligence Reports: Europe: Missiles and Satellites, "Exocet, General", June 1981, p.1.

57. DMS, op. cit., "Exocet, Data", June 1981, p.2.

58. The Military Balance 1981-82, p.87.

59. DMS, op. cit., "Gabriel, Data", p.2 and "general" p.1 (both Feb. 81).

60. "Israeli Combat Experience Incorporated in Latest Anti-Ship Missile", Flight International, 26 December 1981, p.1886.

61. DMS, op. cit., "Gabriel, Data", p.1.

62. Pritchett, op. cit., p.6.

63. Katter Committee Hansard, 2 May 1980, p.236.

64. Hansard (Senate), 17 March 1982, p.916. (Answer to Question No. 1757 in the name of Senator Siddons).

65. Desmond Ball and Steven Rosen, "Fuel-Air Explosives for Medium Powers", Pacific Defence Reporter, April 1977, pp.17-18. (Emphasis in original).

66. Katter Committee Hansard, 18 March 1981, p.1734.

67. Department of Defence (Navy Office), Aircraft Carrier Project Presentation, February 1982, pp.4-5.

68. Hansard (Reps), 25 February 1982, p.630.

69. J.R.R. Tolkien, The Lord of the Rings, Vol. III: The Return of the King, George Allen and Unwin, London, 2nd Ed. 1973, p.227.

70. "Destroyers are not necessarily there to protect the aircraft carrier. That is certainly part of their role but you do not have to have them there just because you have an aircraft carrier ..." Evidence of Rear-Admiral Loosli, Katter Committee Hansard, 2 May 1980, p.241.

71. ibid., p.236.

72. IRI, "Ship Requirements - General", para. 2, p.C1.

73. Jane's Fighting Ships 1980-81, p.555.

74. Hansard (Reps), 25 February 1982, p.631.

75. Department of Defence (Navy Office), Aircraft Carrier Project Presentation, February 1982, Attachment A, p.A-1.

76. Vice Admiral Sir James Willis, "The Navy's New Aircraft Carrier", Journal of the Australian Naval Institute, February 1982, p.19ff.

77. ibid, p.24.

78. Ministerial Defence Statement, Hansard (Reps), 29 April 1982, p.2072.

79. DoD (Navy Office) Aircraft Carrier Project Presentation, February 1982, Vuegraph "Ship Characteristics".

80. Katter Committee, Hansard, 18 March 1981, p.1734.

81. Desmond Wettern, "Putting a Price on Invincible - No. 2 : A Portrait of the Ship", Pacific Defence Reporter, November 1981, p.26.

82. DoD (Navy Office), op. cit., p.5.

83. R.B. Pengelley, "The Royal Navy's Invincible-class cruisers", International Defence Review, 8/1979, p.1338.

84. Jane's Weapon Systems 1980-81, "Naval Radar", p.499.

85. I.F. Holmes, Capt. RN (FFG Project Director), The RAN Guided Missile Frigate (FFG) Project, 4 April 1979, p.3.

86. John Witherow (on board Invincible) "Smoke from Sea to Clouds", The Times, 6 May 1982.

87. loc. cit.

88. Mark Hewish, "Tactical-missile survey - Part 3: ship targets", International Defense Review, 3/1981, p.275.

89. "What it's like to be hit by a missile", Sydney Morning Herald, 7 May 1982.

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91. DoD (Navy Office) op. cit., Attachment A, p.A.1.

92. "Aid to Australia Proposed for Carrier", Aviation Week and Space Technology, 15 June 1981, p.107.

93. DoD (Navy Office) op. cit., p.2.

94. Hansard (Reps), 25 February 1982, p.630.

95. DoD (Navy Office), op. cit., p.3.

96. Hansard (Reps), 25 February 1982, p.630.

97. Desmond Wettern, op. cit., p.26.

98. DoD (Navy Office) op. cit., p.10.

99. Willis, op. cit., p.24.

100. Navy News, op. cit., p.7.

101. R.B. Pengelley, op. cit., p.1337.

102. See for instance, Capt William J. Ruhe, USN (Ret.) "A Note on Anti-Ship Missiles and Future Ship Design", Naval Engineers Journal, August 1980, p.85.

103. DoD (Navy Office) op. cit., Attachment A, p.A-1.

104. The Hon. D.J. Killen, "Ministerial Statement on Defence", Hansard (Reps), 29 April 1982, p.2073.

105. Reports on the number of Sea Harriers which sailed for the Falklands have been garbled and contradictory, and have ranged between 16 and 22. The favourite has been 20. One report ("Cheers" The Herald 5 April 1982) stated that 8 aircraft had embarked on each of the Hermes and the Invincible.

106. "Lost jets a blow for fleet", Sydney Morning Herald, 8 May 1982.

107. Peter Smark, "Britain denies claims of Invasion", The Age, 10 May 1982.

108. William Pinwill, "Admiral wants Harrier fighters on the Invincible, Australian, 11 May 1982.

109. Wall Street Journal, 16 June 1982, p.27.

110. Drew Middleton, "Shortage of aircraft hurts UK strategy", Sydney Morning Herald, 8 May 1982.

111. Defence Report 1975, p.23.

112. Ministerial Defence Statement, Hansard (Reps), 25 March 1980, p.1139.

113. Katter Committee Hansard, 18 March 1981, p.1729.

114. "European Helicopter Requirements", "French Navy", International Defense Review, 4/1979, p.566.

115. Hansard (Reps) Answer to Question on Notice No. 861, 18 August 1977, pp.483-485.

116. In the 1976 White Paper Australian Defence it was noted that the possibility of fitting processors for the Australian designed BARRA passive sonobuoy system to the RAN's Sea Kings was being studied (p.21 para. 57). Unfortunately no further public statement about this idea has been issued in the subsequent 6 years and the initiative appears to be dead.

117. Hansard (Reps), 29 April 1982, p.2073.

118. This would not necessarily have been the number agreed to by DoD or ultimately the Government, as being required. Service "requirements" are often argued down to conform with financial imperatives during their progress from "planning objective" to "approved program".

119. Navy News, op. cit., p.6.

120. Richards, op. cit., Defence Force Journal, p.48.

121. Hansard (Reps) 29 April 1982, p.2071.

122. J.W. Fozard, Ski Jump a Great Leap for Technical Air Power, British Aerospace, 1979, p.16.

123. Roy Braybrook, "Sea Harrier Fully Operational", International Defence Review, Vol. 15, No. 1/1982, p.50.

124. loc. cit.

125. J.W. Fozard, op. cit., p.16.

126. Roy Braybrook, op. cit., p.50.

127. Katter Committee Hansard, 18 March 1981, p.1727.

128. ibid., pp.1728-1729.

129. Navy News, op. cit., p.6.

130. Gowri S. Sundaran, "ASW the Key to Sea Control", International Defence Review, 3/1980, p.369. For a general discussion of the characteristics of oceans and the methods of detecting submarines within them, see this paper pp.368-370.

131. John P. Wilson, "When Silence is Golden", Defence, September 1979, p.654.

132. Ronald T. Pretty, ed., Jane's Weapon Systems 1980-81, "Sonar and Underwater Detection", "PMS 26 and PMS 27 Surface Ship Sonars" and "Type-195 Helicopter Sonar", p.671. Figures for helicopter dipping sonar are not available, but the Type-195 and Types PMS 26 and PMS 27 are British sonars which differ only in that they latter two are designed for fitting in surface ships. The range performance given is that for the surface ship version which may in fact be greater than that of the helicopter sonar because of the larger power source available when installed aboard ship.

133. "European Naval Helicopter Requirements", "German Navy", International Defence Review, 4/1979, p.567.

134. "European Naval Helicopter Requirements", "Some Current Solutions", International Defence Review, 4/1979, p.562.

135. Vince Donovan, "The Limiting Factor", Triad, No. 22 April 1982, p.17.

136. International Defence Review, 4/1979, p.562.

137. Australian Defence, p.21.

138. "Sub-hunting on a Small Budget", Flight International, 18 March 1978, p.754.

139. Jane's Weapon Systems 1980-81, "Sonar and Underwater Detection", "AQS-901 Acoustic Data Processing and Display System", p.669.

140. "Sikorsky SH-60B: The US Navy's LAMPS Mk III", Flight International, 25 February 1978, p.511.

141. Tony Self, "In Active Service - Part 2: Maritime Surveillance", Australian Aviation and Defence Review, September 1980, p.84.

142. P. Taylor Lonsdale, Commander USN, "ASW's Passive Trap", USNI Proceedings, July 1979, p.36.

143. loc. cit.

144. ibid., p.37.

145. Katter Committee Hansard, 18 March 1981, p.1729.

146. "European Naval Helicopter Requirements", "French Navy", International Defence Review, 4/1979, p.566.

147. Rear Admiral M. Lat. Wemyss, CB "Submarine and Anti-submarine Operations for the Uninitiated", Royal United Service Institute Journal, September 1981, p.22ff.

148. ibid., p.26.

149. loc. cit.

150. See especially pp.18-20 for a discussion on the advantages of more closely integrated use of submarines and maritime patrol aircraft.

151. "War costs rise, but who cares?" Sydney Morning Herald, 7 May 1982.

152. Mr John Nott, Secretary of State for Defence, Hansard (House of Commons), 25 June 1981, p.390.

153. Brian Longworth, (Naval Advisor to British Aerospace Dynamics), "The Decline of the Surface Fleet", Defence, January/February 1982, p.70.

154. Mr John Nott, loc. cit.

155. Mr John Nott, Hansard (House of Commons), 19 May 1981, p.166.

156. Longworth, op. cit., p.71.

157. Norman Friedman, "Is the Nuclear Submarine Really Vulnerable?" Defence, January/February 1982, p.8. Wemyss, op. cit., p.24.

158. "For HMS Superb's victims there can be no hiding place", Australian, 12 April 1982.

159. ibid.

160. D.J. Killen, Hansard (Reps), 4 May 1982, p.2188.

161. Katter Committee Hansard, 18 March 1981, p.1699.

162. Friedman, op. cit., pp.11-12.

163. Wemyss, op. cit., pp.22-23.

164. Katter Committee Hansard, 18 March 1981, p.1728.

165. Clarence A. Robinson Jr., "Maritime Superiority Goal Keyed to 600 Ship Fleet", Aviation Week and Space Technology, August 31, 1981, p.38 and "Soviet Weapons Technology Advancing", ibid., caption to photograph p.49.

166. Desmond Wettern, op.cit., p.26 - this figure is calculated from the fact that during NATO exercises "Magic Sword North and South" and "Ocean Safari" held in August and September 1981, the Sea Kings of HMS Invincible flew 140 sorties totalling some 450 hours flying time.

167. Australian Defence, p.17.

168. Gowri S. Sunduran, op. cit., p.375, states that TACTASS can operate out to the first convergence zone. In general this is usually about 30 nm from the ship.

169. "Panel Cautious on new Navy Technology", Congressional Quarterly Weekly Report, vol. 36, no. 23, 10 June 1978, p.1474.

170. Australian Defence, p.20.

171. DMS, Electronic Systems, "ASW", February 1980.

172. Admiral of the Fleet of the Soviet Union S.G. Gorshkov, Navies in War and Peace reprinted in US Naval Institute Proceedings, September 1974, p.59.

173. loc. cit.

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175. Rear Admiral John Stevens, Interview, News Voice ABC radio, 15 March 1982, Department of Parliamentary Library transcript.

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177. Patrick Walters, "Retiring admiral differs with P.M. over carrier: Jump jets vital says Synnot", Sydney Morning Herald, 21 April 1982.

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179. Robert Drewe, "Canberra's naval chiefs re-draft plans", The Bulletin, 18 May 1982, p.28.

180. William Pinwill, "No Aircraft in Sight for Invincible", Australian, 25 March, 1982.

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182. "Omnifarious Sea King", Air International, May 1981, p.218.

183. ibid., p.251.

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191. Roy Braybrook, "AV-8B Harrier II", Air International, February 1982, p.68.

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193. Roy Braybrook, Air International, February 1982, p.68.

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248. DoD (Navy Office), op. cit., Appendix, vugraph "HMS Invincible Estimated Project Cost". Unless otherwise indicated all the cost data which follows is from vugraphs accompanying this publication.

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252. Katter Committee Hansard, 18 March 1981, p.1803. This answer was returned on 13 May, 1981, following undertakings given at the hearings.

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259. Ray Braybrook, Air International, February 1982, p.64 and "Accidents Cut Marine AV-8As from 110 to 68", Aviation Week and Space Technology, 22 March 1981, p.75.

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261. Allen Greenwood quoted in "Scuttlebut", Pacific Defence Reporter, December 1979, p.46.

262. This is the same proportion as the support costs for the F-18 program.

263. Pritchett, op. cit., Attachment "Effect of the Purchase of an Aircraft Carrier on the Future Defence Procurement" (sic) p.2.

264. loc. cit.

265. Pritchett, op. cit., pp.8-12.

266. "Airscene", Air International June 1982, p.262.

267. Hansard (Senate), 25 March 1982, p.1236.

268. Hansard (Reps), 29 April 1982, p.2072.

269. During 1980-81 $3.34m was spent (Auditor-General's Report 1980-81, Part 1, p.75) and $9.31m remained unspent (Department of Defence, Explanatory, Notes 1981-82 Estimates p.160).

270. Frank Cranston, "Threats unlikely while guard maintained" (Interview with Admiral Synnot), Canberra Times, 21 April 1982.

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272. loc. cit.

273. DoD "Estimates of Expenditure 1981-82", Appropriation Bill No. 3, Explanatory Notes, April 1982, p.71A.

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275. D.J. Killen, Hansard (Reps), 29 April 1982, p.2072-2073.

276. DoD "Estimates of Expenditure 1981-82", Appropriation Bill No. 3, p.3.

277. Department of Finance, "Statement of Savings Expected in Annual Appropriations made by, Act No. 164 of 1981 - Appropriation Act (No. 1) 1981-82; Act No. 165 of 1981 - Appropriation Act (No. 2) 1981-82, 24 March 1982, p.13 and DoD, "Estimates of Expenditure 1981-82", Appropriation Bill No. 3, p.71A.
The first reference shows that reductions of $62.7m were made in the appropriation for "Aircraft and associated equipment and stores" and $73.3m in that for "Other equipment and stores" in the 1981-82 Defence budget. Together with a small reduction concerning the RAAF's 707s, this gave a total reduction of $136.2m for the Defence Force's equipment vote. This was offset by an increase of $35.1m in the appropriation for "Naval construction" giving a budgetary shortfall of $101m. However the increase in the appropriation for "Naval construction" resulted from the addition of $81m for Invincible and some other adjustments, and a total of $35.8m was cut from the expenditure estimated for other ship building projects as in the Budget presented in August 1981. Thus program reductions of $172m were made in projects funded in the 1981-82 Budget.

278. D.J. Killen, Hansard (Reps), 29 April 1982, p.2071.

279. There has been no announcement of programs to provide equipment under FMS arrangements being slowed, and it must be assumed that they still have the same completion dates.

280. Hansard (Reps), 20 October 1981, p.2202.

281. Defence Report 1981, AGPS, Canberra 1981, Table: "Expenditure on Defence Function 1976-77 to 1981-82 : Major Categories as Percentages of Total", p.59.

282. Hansard (Reps), 20 October 1981, p.2202.

283. Defence Report 1981, loc. cit.

284. Treasurer and Minister for Finance, "Commonwealth Budget Outcome 1981-82", Press Release, 8 July 1982.

285. DoD, "Estimates of Expenditure 1981-82", Appropriation Bill No. 3, pp.4-5. The effects of the manpower cost increases on total Outlay was reduced by the inclusion of $100m in the Budget specifically to meet possible salary increases.

286. Senator Durack, Answer to question without notice, Hansard (Senate), 5 May 1982, pp.1826-1827.

287. loc. cit.

288. Hansard (Reps), 29 April 1982, p.2070 (Emphasis added).

289. loc. cit.

290. DoD, "Service Pay Increases", Defence News Release No. 252/81, 15 December, 1981, p.2.

291. DoD, Defence Report 1981, Calculations based on Table "Expenditure Defence Function 1976-77 to 1981-82 : Major Categories", p.58.

292. Hansard (Reps), 29 April 1982, p.2073.

293. Hansard (Reps), 14 February 1980, pp.25-26.

294. Malcolm Fraser, Electorate Talk, Transcript, Prime Minister's Press Office, 2 May 1982, p.2.

295. Budget Speech 1980-81 "Budget Statement No. 3 - Estimates of Outlays, 1980-81 : Defence", p.70.

296. Katter Committee Hansard, 18 March 1981, pp.1651-1652.

297. Budget Statements 1981-82, "1981-82 Budget Paper No. 1", "Statement No. 3 - Estimate of Outlays, 1981-82: 1. Defence", p.67.

298. loc. cit.

299. These programs are the Tactical Fighter Force ($2430m); HMS Invincible ($478m); 10 P3C Orion LRMP aircraft ($280m); the 105m.m. light gun ($93m); Australian Trainer Aircraft ($155m).

300. The only exception is the 105m.m. light gun project some elements of which will continue in the 1990's.

301. The Minister announced that this program would be based on two (initially) vessels of FFG-7 design to be built, if possible, at Williamstown in Victoria. The purchase of long lead items was approved. Hansard (Reps), 9 September 1980, pp.996-997.

302. In April 1981 the Minister announced that the Government was investigating the procurement of equipment for the FOD project with its US counterpart and that a decision to purchase would probably be made later in the year (Defence Press Release, No. 77/81, 5 April 1981). No announcement was made and subsequently the project was downgraded with little expenditure to be expected in the 1982-87 FYDP Hansard (Reps), 29 April 1982, pp.2072-2073). It thus appears that, although the general outline of the project has been approved, no definite program with detailed cost estimates has been approved by Cabinet and that the FOD project was not amongst the $6,000m committed by the Government for new equipment as mentioned by the Prime Minister.

303. DoD (Navy Office), "The Combat Capabilities of the Royal Australian Navy", Katter Committee Hansard, 2 May 1980, p.222.

304. loc. cit.

305. This estimate is based on the FY82 cost estimate for the FFG-7 built in US yards at $US324m (DMS Market Intelligence Reports "Ships Vehicles and Ordnance : FFG-7 Class" DMS, Greenwich, Connecticut, October 1981, p.2.) together with an estimated 40% loading for support costs, which is the same level that applied to the 4th FFG for the RAN. Converted at the rates of exchange of June 1982, this gives a project cost of $A434m. However there will be a cost penalty for building such a vessel in Australian yards and this is assumed to be 23%, the proportion indicated by LH Barnard when, as Minister for Defence, he gave reasons for building the initial FFGs in US yards. On this basis the project cost of the 1st FOD would be $513m. It is assumed that $400m of this would be spent by June 1989.

306. Hansard (Reps), 20 October 1981, p.2200.

307. Simon Balderstone, "Australia set to buy $200m mine vessels", The Age, 7 April 1982.

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309. Defence Press Release, No. 196/80, 16 October 1980. This valued the project at $100m and the cost would most probably have increased by 20% since then.

310. Defence Press Release, No. 168/81, 13 August 1981.

311. Brian Longworth, op. cit, p.69.

312. William J. Perry (Undersecretary of Defence for Research and Development) quoted in Congressional Quarterly, Weekly Reports, 18 April 1981, p.683 stated that "Costs for defence systems have increased in the last year at a rate higher than the [Consumer Price Index] (14.3 percent) and may approach the 20 percent level".

313. Edna Carew, "Flight into US dollar gathers strength", Australian Financial Review, 15 June 1982.

314. Hansard (Senate), 25 March 1982, p.1235.

315. William Pinwill, op. cit., The Australian, 11 May 1982.

316. Before the reorganization of the equipment program a small quantity of these weapons was to be ordered in mid-1982 for 1984 delivery. The numbers will be sufficient to provide the Operational Deployment Force only with merely training quantities of ATGW. Hansard (Senate), Answer to Question No. 1750, 16 March 1982, p.841.

317. Quoted from a report said to be signed by the then Chief of Air Staff (now CDFS) Air Marshall Sir Neville McNamara in, William Pinwill, "RAAF worried over ability to defend nation", The Australian, 27 March 1982.

318. For example, D. Ball and J. Langtry, Problems of Mobilisation in Defence of Australia, Phoenix Defence Publications, Manuka, ACT, 1980.

319. Katter Committee Hansard, 18 March 1981, pp.1790-1792.

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323. Katter Committee Hansard, 9 November 1978, p.1046; 29 November 1978, pp.1492-6 and 25 July 1979, pp.2326. (Evidence of Mr G. Cawsey (written, 9 November; oral, 29 November; and of CDFS (Admiral Synnot) 25 July 1979).

324. See note 1.

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