Department of the
Parliamentary Library

INFORMATION AND RESEARCH SERVICES

Research Paper
No. 4 2001–02

Procuring Change: How Kockums was Selected for the Collins Class Submarine

ISSN 1328-7478

Published by the Department of the Parliamentary Library, 2001

Information and Research Services

Research Paper
No. 4 2001–02

Procuring Change: How Kockums was Selected for the Collins Class Submarine

Derek Woolner
Foreign Affairs, Defence and Trade Group
18 September 2001

Enquiries

Information and Research Services publications are available on the ParlInfo database.
On the Internet the Department of the Parliamentary Library can be found at: http://www.aph.gov.au/library/

IRS Publications Office
Telephone: (02) 6277 2778

Contents

Abbreviations

ASC	Australian Submarine Corporation
CDS	Combat data system
CNR	Cantieri Navali Riuniti
DTCN	Directions Techniques Des Constructions Naval
FRGN	Federal German Navy
HDW	Howaltsweke-Deutsch Werft
IKL	Ingenieur Kontor Lubeck
IT	Information Technology
kts	Knots (international nautical miles per hour)
nm	Nautical miles
RAAF	Royal Australian Air Force
RAN	Royal Australian Navy
RDM	De Rotterdamsche Droogdok Maatschappij
RFT	Request for Tender
RN	Royal Navy
RNN	Royal Netherlands Navy
SSN	Nuclear powered attack submarine
TNSW	Thyssen Nordseewerke
USN	United States Navy

Major Issues

The program to design and build the Collins class submarines has been one of the most controversial Defence procurement programs in history. It has been likened to the F-111 bomber of the early 1960s for problems of technical difficulties and delayed introduction to service. Even in its earliest days, the project generated controversy as it attempted objectives not previously achieved in Australia and opted for solutions which were outside those normal for the time.

This early controversy was later to become a problem for policy makers, confounding discussion of the issues and confusing analysis of the problems which later affected the submarines. Knowing that there is evidence sufficient to explain the events in the early development of the new submarine program allows us to analyse current problems of the program without such distractions. Those problems are discussed in 'Getting in Early: Lessons of the Collins Submarine Program for Improved Oversight of Defence Procurement', *Research Paper*, no 3 2001–02 of the Australian Parliament's Information and Research Services.

Such was the perception of changed practice in the early development of the submarine project that it confounded many in political, naval and public spheres. This was especially the case with the selection of Kockums, a Swedish submarine design and construction company, to build Australia's new submarines. Swedish defence materiel suppliers had been held in bad odour in Defence circles since the Vietnam War, when Sweden banned the supply of ammunition for equipment operated by the Australian Army. Furthermore, Kockums had built only small submarines, suited to the Baltic Sea and not the deep ocean deployments intended for the Royal Australian Navy's (RAN) submarines.

To some, the only explanation for such a decision lay in reasons outside the quality of the company's offering. Rumours of corruption, political influence and mistaken judgment came to be heard. Indeed, allegations of improper conduct were investigated. These produced no evidence to substantiate claims that they might have had an effect on the selection of Kockums. In the future, when the relevant documents become public, the clams of 'irregular' practice can be more fully evaluated. In the meantime there is evidence enough to suggest that the influences behind the decisions in the project lay elsewhere.

The 1980s were no less a period of rapid change than the present. Political, economic and technological forces caused objectives to be reformed and forced a search for alternative ways of avoiding the type of economic, industrial and technological problems that had become manifest in the recession of 1983.

From the beginning, the objectives set by the new submarine Project Office forced changes in many areas. An early, central decision was to base the program on building the submarines in Australia, thus demanding a new level of sophistication and significant advances in technology. Despite the extent of this challenge, the objective of local construction was seized by both the Coalition (from first approval in the 1981–82 Budget) and the (post-March 1983) Labor Governments.

During the first half of the 1980s, when the most important decisions regarding the future of the program were made, Information Technology (IT) was spreading rapidly out of the realms of data processing. For the new submarine project, utilising this capacity was important not just for the rapidly evolving areas of combat related systems but for functions ranging from automating the normal running of the boats through to their design and development, and the management of their production.

In addition, Navy's concept of its new submarines was sufficiently advanced that no existing design could meet the specifications it generated. In parallel but separately, it was seeking to develop a combat data system (CDS) of a type no one had built before. The recognition of these factors marked the most important turning point of the program for, after Navy's position was endorsed by a Department of Defence review in early 1985, the program became one involving very high levels of risk. As discussed in *Getting in Early*, it was deficiencies in the management approach to controlling these risk factors that was to be the origin of the subsequent problems of the Collins submarines.

In the final analysis, Navy appears to have recognised the extent of the challenges that faced it, if not precisely the best way of managing them. Navy chose, as the two companies to develop final options for the program, those which appeared to have the most innovative approaches to the range of naval, technological and industrial changes which the program would encounter. One of these two companies was better able than the other to adapt these approaches to meet the needs of the naval environment in which they would be used. For the CDS, Navy chose a company which was already working on a conceptually similar system for new naval helicopters. This company was never able to develop the CDS to the level required.

Many of the design features which Kockums brought to the new submarine have since been demonstrated successfully in the Collins program. Automated ship control, high manoeuvrability, low noise signature at patrol speed, and computer assisted design and computer assisted manufacturing processes have all been factors in those areas of the Collins program which have succeeded. There were other areas where the submarines have not performed so well and the reasons for these are discussed in *Getting in Early*.

Undoubtedly, there will continue to be debate as to whether Defence should have endorsed Navy's high risk approach or returned the project to the original objective of selecting a tried and proven design. The decision being made, however, there is sufficient evidence to indicate that Navy approached the development of the submarine program with diligence and a great deal of ingenuity. That many aspects of the program did not develop as expected says more about the procurement strategy adopted for managing the program than the quality of Navy's tender evaluation process.

Introduction

This paper discusses the early phases of the Collins submarine program, from its initiation in the 1981–82 Budget until the selection of Kockums as the designer and leader of the building consortium in 1987. It is a companion piece to 'Getting in Early: Lessons of the Collins Submarine Program for Improved Oversight of Defence Procurement', *Research Paper*, no. 3, 2001-02 of the Australian Parliament's Information and Research Services. *Procuring Change* is intended to provide additional detail to the judgments about the sources of problems in the Collins class program made in *Getting in Early* and to provide an insight into the nature of the challenges faced in the early-to-mid 1980s when the project was developed.

The paper is based on published, or publicly available sources only, and many of these reflect the vested interests of those involved in some way in the program. Attempts can be made to adjust for possible distortions by cross-referencing sources where possible but a fully verifiable history of the Collins submarine program will be possible only after the release of classified information, sometime in the future.

Genesis of the Collins Submarines

Early in the 1980s the RAN began planing the replacement of the *Oberons*, then expected to begin leaving service in the early 1990s. Among the objectives that Navy envisaged for its new submarines was a range of over 10 000 nautical miles (nm), and endurance which would allowed it to remain submerged for 10 weeks or more. Whilst these criteria were little different in performance from those of the Oberons, the Navy envisaged a far superior indiscretion rate and submerged performance, achieved in part by reducing crew to around 41.[1] In naval parlance the frequency with which a conventional submarine must approach the surface to recharge its batteries is known as its 'indiscretion rate'. This determines the time a submarine can hunt for targets before retreating to safer waters to recharge its batteries.

Equally significantly, the new submarine was expected to transit at twice the speed of the Oberons and to be able to submerge for up to three times as long as their predecessors[2] although, later, the objective for improvement in transit speed was reduced to a more realistic 25 per cent, together with an expected improvement of 30 per cent in maximum speed.[3]

Early Objectives for the Combat System

Most importantly, the Navy wanted a combat data system (CDS) that would allow it more often to use the submarines' weapons out to their maximum range of around 60 nm and to improve on the Oberons' ability to attack only two targets simultaneously.[4] To achieve this involved the integration of a large range of sensors feeding data into a computerised system capable of filtering the faint signs of distant vessels from the ambient noise of the ocean environment. The input from several types of sonar systems, as well as electronic warfare sensors, radar, infra-red detectors (and the more traditional periscope) and sophisticated navigation systems, would have to be handled simultaneously by this data system. To be useful, the CDS then would have to be capable of identifying possible targets (frequently checking against its library of pre-recorded ship noises), of determining relative positions and of tracking dozens of them simultaneously. All this data would have to be presented so that quick and effective command decisions could be made.

To achieve this performance and especially to facilitate decision making during operations, it was decided to abandon the centralised computer which, at that time, was the basis of naval combat data systems. Instead, a philosophy of 'distributed processing' was adopted whereby any of a number of crew stations could acquire and process the information from the relevant sensors, to allow command decisions to be made and the consequent actions to be controlled. It was hoped this would not only improve operational effectiveness but also reduce the boats' lifetime maintenance costs. The latter would be achieved by eliminating the need to cut open the hull to remove a bulky mainframe during modernisation programs, allowing the system to be upgraded instead by converting to new software.[5]

The new submarines' availability for operations was expected to improve by up to 30 per cent and the cost of operating them throughout their lifetime was to be reduced considerably. It was expected that boats designed with new technology would be able to refit every six years, compared with the Oberons five. Further, the refit of a boat of the new generation should require only 150 000 to 250 000 labour hours to complete compared with the 1.25 million required by the Oberons.[6]

An Australian Submarine Industry

This approach was to have significant bearing on the subsequent history of the Collins class submarines but it was a decision to build the boats in Australia that has dominated their subsequent history. From early in its gestation, there was political support to maximise participation in the project by Australian industry.[7] During early development of the Collins project three factors influenced the consideration of whether to buy completed boats from a foreign yard or to build them, to a greater or lesser degree, in Australia.

One of these was the great cost of maintaining submarines throughout their operational lives. This had been realised very early in the career of the Oberons when the first refit of

HMAS *Oxley* cost, at $7 million, 76 per cent of the $9.2 million price of the boat on commissioning in 1967.[8] By the time that the Oberons' successors were being planned, it had been realised that supporting submarine operations would cost 250 per cent of their purchase price over the 25-year service life of the boats. Containing this cost, especially toward the end of the boats' operational lives, would be assisted by close access to the building yard and its technical data, which also would reduce the RAN's dependence on overseas suppliers. Furthermore, the ability of the Navy to support the submarines through their operational lives was a major element of the Service's ability to maintain a deterrent capability in undersea warfare. It seemed that the companies best placed to provide this support should be those involved in building the submarines.[9]

Supporting this consideration was the high proportion of the initial capital costs of the procurement program that were allocated to integrated logistics support. This latter area consists of items such as test equipment, training, facilities, documentation and transport, and associated labour costs. In general, integrated logistics support consists of items necessary to bring the equipment into useful military service. By its nature, integrated logistics support has a high proportion of components best produced in the purchasing country. In the case of the project for the new submarine, it had been estimated that integrated support would constitute about 25 to 30 per cent of the total capital costs,[10] which constituted a good base on which to build further Australian participation in the project.

Finally, of the issues to be considered, was transfer of technology.[11] The obvious aspect of this consideration was the prospect of the project channelling new technologies into Australian industry that could, in turn, be called on to support future naval or general defence requirements. Such technologies included the more obvious naval architectural and underwater design techniques, electronic systems and software development. However, they might also include advances in specialised steels and alloys, electrical and mechanical engineering, hydrographic technologies and many forms of associated research. Furthermore, with these technologies might come advances in techniques, such as welding, in management procedures, such as computer integrated production planning, and in production techniques, such as modularised construction.

The Period of Project Development

Government approval for Phase 1 (Project Definition) of the acquisition of the new class of submarines was given in the context of the 1981–82 Budget and, in January 1982, the project began to take shape with the assembly of a four-man project team.[12]

Initially, it was thought that the project might call for as many as 10 boats, each thought likely to cost over $100 million.[13] By early 1983, when the project cost was estimated at $1.5 billion, the program was considered more likely to cover four to eight boats.[14]

A planning objective was that the new submarines should be available to replace the Oberons from 1991–92 as the latter were decommissioned. At this stage of planning, it was thought this objective would be obtained by building the first boat overseas. Building was scheduled to commence in 1986 and was expected to take four years. The rest of the boats would be built in Australia, starting in 1988.[15]

It was easy to contact possible contenders for supply of the design, as only nine companies, all bar one located in Europe, built diesel electric submarines. Those not approached were the Russians and the Japanese, both builders of comparatively large boats. Of the Europeans, only the (then) West German company Thyssen and the Dutch firm Rotterdam Dockyard CK were building submarines large enough to meet the RAN's requirements, the rest offering designs still under development.

However, whichever design was chosen, the project team had decided already that the boats' CDS would be supplied to a separate RAN specification.[16] Expected to comprise about 30 to 35 per cent of the submarine unit cost,[17] this system would be fitted whether the boats were built overseas or in Australia. By the end of 1982, the RAN had made the decision that the project would feature a fully integrated CDS. The first step to involve suppliers in the development of the new submarine was the taking of advertisements, in January 1983, calling for registration of interest from suppliers of 'modern integrated combat system(s)'.[18] Fourteen suppliers of combat data systems had been considered potential contractors and the advertisement drew a response of eight proposals later in the year.[19]

The RAN was encouraged in this approach by Australian industry. An integrated architecture was seen as easier to manage than the process under which previous combat systems had been delivered, almost as an afterthought once the structural areas of building had been completed. Developing a software based CDS was also seen to be an advantage given the reputation Australian industry was building at the time for high productivity and reliability in software writing. Indeed one industry representative was hopeful that 60 per cent by value of the system could be produced in Australia.[20]

As yet, no firm decision had been made about where the new submarines would be built. Steps towards such a decision were taken on 1 March 1983, with the briefing of personnel from more than 100 Australian companies on possible Australian industry participation in the submarine project. At this early stage it was already hoped that more than 50 per cent of the project would be supplied by Australian industry.[21] This was a daunting objective at a time when it took energetic management of Australian Industry Participation clauses (conditions stipulating work for Australian industry) in defence procurement contracts if local industry was to supply only 30 per cent of an equipment project.

In May 1983 the project began to move towards shipbuilding, with the issuing of a Request for Tender (RFT). This document invited the seven European submarine builders to undertake project definition studies and to provide proposals for the design and production of the new submarine.[22] The building companies were expected to liaise with the potential suppliers of combat systems in preparing their designs; however, Navy would select the combat system separately. From the proposals of the seven companies, two would be chosen in about May 1986[23] for further evaluation and eventual selection as the provider of the RAN's new submarines, which were expected to be manufactured between 1987 and 1998.[24]

Rewriting the Plot—the Evaluation of the Contenders

All seven companies responded to the RFT by the end of 1983.[25] It soon became apparent that one of the objectives of the procurement strategy could not be met. The tender had stipulated that the selected design should be one already in naval service or intended to be in service by 1986. This allowed project risk to be minimised through evaluation of the sea trials of the chosen design. Further, as a minimum, the design should be a derivative of a submarine already proven by its performance in service. Any modifications to meet unique RAN requirements were to be of low risk and cost.[26] It was also hoped that the more competitive companies would have had experience in constructing submarines in other than their home nation. However, to meet the RAN's specifications, all the submarine builders had to offer either new designs or designs modified to a greater or lesser extent.[27]

All seven of the European companies responded to the RFT: resulting in two German proposals and Dutch, Swedish, British, French and Italian proposals. All respondents had an established history of building conventional submarines but some had no modern design to offer whilst some with modern designs were not building them for the home navy. The seven companies responding to the RFT are discussed below.

Directions Techniques Des Constructions Naval

The French company Directions Techniques Des Constructions Naval (DTCN), had experience of constructing its designs overseas, having cooperated with Spanish yards to build there its Agosta submarine design and one of an earlier generation. However, it had no contemporary diesel electric design to offer, since the French navy had decided years before to concentrate on nuclear powered attack submarines (SSN). Consequently, DTCN was reported initially to have responded to the RFT with an updated version of the Agosta which, being little more modern than the Oberon, was not encouraged.[28]

As a result, DTCN placed its efforts behind a conventionally powered version of its *Rubis* SSN. Previous SSNs had been much too large to provide the basis for a conventionally powered submarine but the *Rubis* was something of a breakthrough, displacing only some 17 per cent more than the Oberons. The existence of the nuclear powered alternative was to become something of a distraction, however, as it became the focus for a campaign arguing that the RAN should adopt nuclear propulsion.

Ingenieur Kontor Lubeck

Ingenieur Kontor Lubeck (IKL) was a German design office which teamed with builder Howaltswerke–Deutsche Werft (HDW) to successfully export submarines worldwide. Its IKL2000 was some 500 tonnes heavier than the design, for the Indian navy, on which it was based. IKL, together with its construction partner had designed and managed the construction of several classes of small submarine for foreign navies, among them Turkey, Greece, Argentina, Chile and Indonesia. The production of the Turkish boats had involved construction in that country. IKL/HDW were accepted as the world's largest exporter of conventional submarines[29] and in the previous decade had built over half of the (then) non-communist world's conventional boats.[30] The first-of-class of the Indian submarines was not due to be proven till 1986.

Thyssen Nordseewerke

Another German design, the Thyssen Nordseewerke (TNSW) type TR1700A had a redesigned pressure hull, six metres longer and half a metre wider than the TR1700, two of which were then being produced for Argentina. However, it was an export product and not intended for the Federal German Navy. Nevertheless, the first of the Argentinian boats was already at sea by early 1984. TNSW had assisted in the construction of the Argentinian yard where a further four of the boats were to be produced and were promising in their RAN proposal the inclusion of a 10 year logistics support package. The company was also claiming outstanding performance for its design, especially submerged speed, where a 'burst' (in fact sustainable for only minutes before exhaustion of the batteries) of 25 kts was claimed. Crew numbers were also said to be unusually low at around 30 personnel.[31]

Cantieri Navali Riuniti

The bid of the Italian company, Cantieri Navali Riuniti (CNR) was perhaps the least well founded, as their design was based on the *Sauro,* CNR's design of the early 1970s. There was no existing contract from any other client to build the design, which was 25 per cent larger than the original and the company had no experience of managing the overseas construction of submarines.

United Shipbuilder Bureaux and de Rotterdamsche Droogdok Maatschappij

United Shipbuilder Bureaux and de Rotterdamsche Droogdok Maatschappij (RDM) were a well established and highly regarded Dutch team which had pioneered the adaptation to conventional submarines of the so-called 'tear-drop' hull shape of SSNs. In 1984, RDM was building the *Walrus,* the first of a new class of submarine for the Royal Netherlands Navy (RNN).

Of the designs submitted, RDM's was the least changed to meet the RAN specification probably because, at 2350 tons, it was the largest. However, in its RNN version it required 52 crew, almost 29 per cent more than the RAN specification. Although the first of class had not yet been completed, it was an iteration of the partnership's earlier Zwaardvis class, a version of which had recently been ordered by Taiwan. However, at the time, RDM employed traditional shipbuilding techniques in its submarine yard and its man-hour costs were reported to be comparatively high.[32]

Kockums

The Swedish company, Kockums, was a long established submarine builder for the Royal Swedish Navy, having produced its first submarine in 1914. In the twenty years leading up to the selection of the Collins class design, Kockums had designed and produced five generations of submarine,[33] a higher rate of activity than any of its competitors except, perhaps, HDW. It was also established as a company that produced innovative designs and was known to be experimenting with alternative forms of conventional submarine propulsion. Its designs were amongst the first to be extensively automated and use remote control of machinery. As a result, they required small crews for the time (typically around 27).[34] Swedish boats were, however, optimised for operations in the Baltic Sea. Consequently, the Vastergotland class, then the latest Kockums design, displaced two-thirds as much as the Oberons and its offering for the RFT, the 1900 ton[35] Type 471 had to be considered as a new design.

The company had exported no boats, partly because of Sweden's policies on its neutrality in international disputes, which had made it appear to be an 'unreliable supplier' in some quarters. By the early 1980s the Swedish Government was actively seeking to overcome this image, driven by the need to export defence materiel to support the local defence industry, upon the survival of which the Swedish defence policy of neutrality and full independence had been predicated. Kockums had developed designs for export markets and had been a finalist in the Indian navy evaluations (eventually won by IKL) with a 1600 ton design which had a range of 10 000 nm and required a crew of 33.[36]

Kockums was particularly well regarded for its advanced production management practice.[37] The US company Newport News had recently bought Kockums' computer-based design and management system to control the building of the latter of the Nimitz class of nuclear powered aircraft carriers. Using the system it was able to reduce production costs by 25 per cent.[38]

Vickers Shipbuilding & Engineering Ltd

Vickers was a long established naval engineering company that had built many classes of nuclear powered submarines for the Royal Navy (RN) before being rationalised into the conglomerate, British Shipbuilders. However, by the early 1980s it had been nearly a quarter of a century since Britain had designed a diesel electric submarine and the Type 2400 remained a design, with the RN not having placed a contract at the time of the RFT. This order was placed in November 1983 but it eventually became apparent that the RN boat could not meet Australian requirements, and indeed was thought to have endurance insufficient to meet all the mission profiles of the British Service.[39] Vickers was reported to have offered the RAN a modified design, the Type 2400A. This had displacement increased by almost 20 per cent, to nearly 3000 tons, in order to accommodate the fuel, batteries and weapons reloads specified by the RAN. This version was reported to interest the RN for the remainder of what was thought likely to be a 10 boat program, but was said to be considerably more expensive than the Type 2400.[40]

Vickers had no experience of managing construction programs overseas but had established a subsidiary in Australia, which, as the manager of Vickers Cockatoo Island Dockyard, was responsible for the refit of the Oberons. However, VSEL appeared less interested in Australian production than in preparing an 'assembly' package.[41] They were later described by a member of the selection team as the 'least enthusiastic' about building the boats in Australia.[42] In any case, Vicker's ability to successfully transfer submarine building technology to Australia may have been regarded with some scepticism because of its traditional, labour intensive construction techniques.[43]

Growing Pains

It appears that none of the above respondents could meet the Navy's specifications and it was reported that this deficiency was viewed as being sufficiently significant to delay the project for a year or so.[44] Only two of the designs submitted, the *Walrus* and the Type 2400A, were based on a class of boat eventually intended to serve with the navy of the designing country. Of the specific design shortcomings, it was reported that the original Type 2400 was too small (by about 500 tons) to accommodate the CDS, one of the German designs was too narrow to accommodate it, whilst the other could accommodate only four torpedo tubes (instead of the six required). The French conventional boat was said to be too noisy, the Walrus class to be too expensive and the Kokums design no more than that. The Italians were said to have withdrawn.

With the benefit of hindsight, the most ominous of the problems being encountered in the development of the project was with the CDS, for which five would-be producers had expressed interest. These were a consortium led by the American firm Rockwell, Plessy (UK), HSA (Holland), Sintra Alcatel (France) and Krupp/Ferranti (Germany and UK).[45] A favoured model, said to be based on that of a RN nuclear powered boat, was reported to be far more expensive than estimated; likely to consume 60 per cent of the total project cost, rather than the 40 per cent it had been allocated.[46]

The credence of such claims was supported by further reports on the growing cost of the project and by rumours of increasing bureaucratic turmoil in its decision making processes. Before the end of 1984 there was speculation that the estimated cost of the project had increased by between 25 and 100 per cent to $1.9 or $3 billion.[47] Further, it was now being reported that the two designs being favoured by the Navy project team were the IKL 2000 and the Kockums 47/1,[48] both having no role in the navies of the country in which they originated.

The likely cost increase and the growing risk, associated with including no design already proven by overseas naval service, reportedly prompted resistance to the project within the decision making committees of the Department of Defence. Civilian officers of the Department, in particular, argued for the program to refocus on seeking smaller, cheaper designs.[49] The incoming Defence Minister, Kim Beazley, ordered the Department to examine the option of procuring boats of around 1500 tonnes.[50] It recommended against such a course, reportedly on the grounds that the smaller boat's shorter range offset any advantage of cost.[51] This conclusion is also consistent with the history of submarine campaigns. The most successful of these, such as the U boat offensives in the Atlantic in both World Wars and the USN submarine offensive against the Japanese, have been strategic campaigns conducted in the enemy's focal areas at long range from home base. Tactical defensive campaigns, such as those which were operational dogma for the Soviet and Italian submarine forces in World War Two, were not attended by success.

The Paper Boats Surface: Selection of the Final Short List

In May 1985, three months later than projected, IKL/HDW and Kockums were selected as the two contractors for the $26 million funded development study phase of the project. In addition, the Government decided that two groups, rather than the one recommended by Defence,[52] should be selected as the 'finalists' for the CDS. These were the Rockwell consortium and the Dutch company HSA.[53]

The likely cost of the project was now confirmed as having risen to $2.6 billion and Cabinet also had made a decision that all six boats should be built in Australia. It had considered that the additional cost to the project of $30 to $40 million, incurred by not building the first of class in the designer's yard, was outweighed by opportunities to increase Australian involvement in equipment supply and in project management.[54] The design parameters still indicated that the new submarines would displace around 2200 tons, have a range better than 10 000 nm and an endurance of around 90 days. There was increasing evidence that evaluation of the industrial package offered by the two contenders would play an important part in the final selection of the new submarine.[55]

From the beginning, the decision was extremely controversial. The choice annoyed traditionalists, Anglophiles, communist conspiricists and the other competitors. It marked the end of the RAN's procurement of Royal Navy combat vessels as the Oberons were the last combat type of British design in RAN service.[56] The selection represented the rejection of traditionally strong naval builders in favour of companies perceived as minor constructors. It was the first time that Australia had opted for combat platforms developed other than in Britain, the US or France. These factors provided sufficient hurt to tradition and vested interest to ensure a protracted public campaign against the selection.[57]

Among the distractions promoted were claims that neither the USA or British governments would permit their naval technology to be incorporated in the submarine if the RAN persisted with the German and Swedish companies.[58] Of more seriousness were charges of bias in the selection procedures, based on the supply of information to the IKL team about questions it was to be asked by a Labor Caucus committee. Although the Commonwealth Ombudsman subsequently found that information had been leaked (from an unknown source),[59] he found no credible evidence of malpractice. In any case, the backbenchers' committee was irrelevant to the submarine selection procedures. The Minister had given them a brief only to inquire into the Australian industrial aspects of the project and, in any event, the committee meeting occurred after the selection of the two companies.[60] This had involved the vetting of the submarine team's decision by no less than five Defence committees, involving over 300 personnel, before the submission was referred to Cabinet.[61]

The Importance of Industrial Factors in the Selection

In retrospect, the identity of the two companies selected should have come as no surprise, for both had strong technical recommendations. What the critics had failed to recognise was the extent of the determination for change in Australian defence procurement practices. The Defence White Paper *Australian Defence*, of 1976, had developed a theme of increasing self-reliance in defence policy. The Coalition Government of the day had sought to promote relevant Australian industrial capacities as a way of applying the policy. They had built a fleet support tanker of French design, HMAS *Success*, in the ailing Vickers Cockatoo Dockyard in Sydney, had approved construction of a fleet of mine hunters of uniquely Australian design and had approved in principle the construction of two US designed FFG-7 frigates in the largely under-used naval dockyard at Williamstown. In other areas, the Coalition Government approved the design and construction of the Wamira as the RAAF's next training aircraft.

However, the development of the mine hunter soon became problematic and building of *Success* had been a disaster. By the time it was commissioned, the vessel was three years late and had cost three times the amount quoted to build in a French yard.[62] The future for the FFG-7 project looked little better and was subject to studies of the future efficiency of the dockyard. By 1983, the Wamira project was in difficulties and was to be cancelled by the mid-1980s. Nevertheless, the Labor Government elected in 1983 followed its predecessor's lead with increased vigour, because it had been elected during a severe recession. However, they did so within the constraints of a more rigorous economic policy which carried an increased market orientation. The Government showed that defence construction projects would no longer be used for job creation when it resisted union demands to build a second tanker at Cockatoo Island, ultimately condemning the yard to extinction.

Commodore Oscar Hughes, when appointed to lead the new submarine project in 1987, said of the process to select the eventual winner that it would be based on juggling into the best combination three variables of 'capability, industrial involvement and cost'.[63] It appears that the Navy was very serious in its belief that a sustainable submarine deterrent required it to seek self reliance in the maintenance of its submarine fleet and that this, in turn, was best achieved if the boats were built in Australia. The evaluation of the new submarine project was revolutionary in that it required those companies bidding for the RFT to provide detailed information on their plans to involve Australian industry in the production of the boats. Previously, the question of how to build defence equipment in Australia had been decided in the final selection processes, by use of an arbitrary Australian Industry Participation target or by placing the contract with a government-owned facility. The new submarine project was the first to differ and consider the issue of Australian production from the initial stages of the evaluation process, as Minister Viner's involvement at the beginning of the project testifies.

In this environment, the credibility of the contenders' proposals for building the boats in Australia was important. Those bidders who thought that selection would be determined by the traditional measure of equipment performance, perhaps balanced by any significant differences in price, were to be proved wrong. Efficient construction processes for the type 2000 of IKL were reported to give it an advantage over the VSEL 2400. [64] The IKL/HDW design was estimated to take only one million labour hours to build. Labour hours for some of the other designs were up to four times greater which, in the comparatively high labour cost environment of Australian industry at the time, was in itself an insurmountable handicap.

An insight into the type of thinking which may have borne on the selection of the contenders can be found in a report to the (then) Department of Defence Support from the South Australian submarine task force.[65] It argued that Kockums' modular construction techniques were five years ahead of the other European builders and 'several' years ahead of the American Newport News Company,[66] principally because of Kockums' integrated use of CAD/CAM (computerised design) techniques in project management of modular construction techniques. The South Australians found reason to be less-than-convinced about the credentials of the other companies, noting that none were, at the time, fully operational in modular construction techniques.[67]

Where the future of the project depended on Defence convincing government that the new submarine would not go the way of previous shipbuilding disasters, the traditional submarine yards were at a disadvantage. DTCN were probably handicapped because of the history of HMAS *Success*. When the South Australian's commented that transfer of technology to Australia from Germany or Sweden should be successful because of the strong use of English in those countries, they were indicating a weakness of the French bid. Inadequate documentation, resulting from problems in translation, had been held to be a cause of the difficulties in building *Success*.

RDM and VSEL adhered to traditional building methods, with modular construction capability still on the drawing board. In the media, 'concerns' were expressed that VSEL's production techniques would bedevil the building of its submarine in Australia.[68] The submarine project team could well have concluded that, to minimise risk in the construction phase, these three bidders could best be excluded. With government expressing a strong desire for Australian construction of the boats, risk in the industrial phase also equated to risk to the final cost. VSEL's price was reported as being high, and its delivery schedules as doubtful, given the problems it was then experiencing with the Type 2400 program for the RN.[69] On two of Commodore Hughes' criteria, cost and the industrial program, DTCN, RDM and VSEL were probably early casualties when the final decision was made.

Strengths of the Shortlisted Companies

On the criteria of performance, as well, the traditional yards may not have fared as expected. The Type 2400 was subject to an unfortunately timed broadside by a former RN officer who remarked on the slowness and conservatism of British submarine design. He went on to indicate that the Type 2400 would have taken more than 18 years to evolve by the time it entered service and had doubled in cost. He assessed the version offered to Australia as being underpowered.[70] Subsequently, the Collins has been claimed to have better endurance, range, battery capacity, weapons capacity speed, diving depth and manoeuvrability than the Type 2400.[71] In contrast, the *Walrus* is generally accepted as a well performing design. However, against one crucial specification it was deficient. As stated above, its complement was too high and there was no demand from the RNN to promote a change in boat management philosophy leading to a reduction in crew numbers, which have remained at 52 in all the RNN boats.

In terms of designing submarines with small crews, the German and Swedish companies were less of a risk. HDW submarines in the West German navy operated with 22 crew. These were, admittedly, tiny submarines but HDW had built a design for Greece over 2.5 times larger but with an increase in complement of only nine. Kockums designs were even more parsimonious and its Nacken class, then in service since the late 1970s, required only 27 crew. The Vastergotland class, which Kockums was then building, had the automated ship control systems that the RAN had specified as the means of reducing crew numbers.

As far as the technological basis of their designs was concerned, both of the selected companies drew on considerable experience. The IKL design bureaux could draw a direct line to the revolutionary Types XXI and XXIII, fast U boats of the last months of the Second World War—of which the design of the Oberons had been an extrapolation. The Type 2000 design incorporated the newly developed 'Permasyn' electric motor, said to deliver the power of a motor twice its size.[72]

Kockums' designs reflected the experience of the attempts of the Swedish navy over three decades to counter the incursions of Soviet underwater forces into Swedish waters in the

Baltic Sea, acknowledged as a demanding area for underwater operations[73]and reckoned to have the highest density of underwater craft in the world.[74] Its adoption of American research into rudder and hydroplane performance, indicating that X-shaped control surfaces on the stern were superior, gave it a boat reputedly able to out-turn most surface vessels and submarines.[75] This claim has been vindicated subsequently by the exceptional manoeuvrability of the Collins class.

Finally, both companies were amongst the leaders in technological innovation. Both companies were developing 'air independent propulsion' systems, which promised to revolutionise the operation of conventional submarines. Although not a criteria in the selection process, such evidence of innovation indicates that the RAN had grounds of possible future technological advances on which to favour these bidders over their more traditional rivals.

The Selection of Kockums

The Kockums Type 471 submarine design, with a combat system from a consortium headed by Rockwell International, was announced on 18 May 1987 as the winner of the evaluation for the RAN's new submarine. The boats were to be produced at a new site at Outer Harbour in South Australia, by the Australian Submarine Corporation (ASC), a joint venture company composed of Kockums, the Australian Industry Development Corporation, Wormalds International and Chicago Bridge and Iron Australia. The CWDS was to be supplied under sub-contract to ASC by Rockwell, whose consortium included Singer Librascope, Thompson-Sintra, Computer Sciences of Australia and Scientific Management. The contract covered 95 per cent of the project by value on a fixed price basis, with allowance for inflation and valuation effects on the dollar.

The selection of the winning submarine design proved to be as controversial as the earlier short listing. So far had the project come from its beginnings that the program the Minister announced would:

- cost $3.9 million in June 1986 prices, with
  - $2.8 billion being for the building of the six submarines, and
  - $1.1 billion for logistic support, management and other Defence costs,[76] and
- 'be the largest, longest ranging and most lethal conventional submarines in the western world'.[77]

In a comment that only hinted at the process by which the RAN had secured its ideal design, the Minister said the selection had resulted in 'a submarine design ideally suited to the *unique* and demanding requirements of Royal Australian Navy submarine operations'[78] (emphasis added). The combat system, which was to be more advanced than any ever installed in a conventional submarine, was calculated to represent about a third of total construction costs. Construction work was to begin in 1987–88, initially with the building of the assembly plant at Port Adelaide and with:

- assembly of the first vessel beginning in 1989 for
- launching in 1993–94, followed by
- commissioning into service in mid-1995.[79]

Why Kockums Won

Unlike the selection of the short-list, there was no mystery about the selection of the Type 471. In another example of the indiscipline which has continued to mark the conduct of some of the personnel involved,[80] details of the selection process were leaked. Indeed, before the Minister had made his announcement, the media had revealed that the RAN was dissatisfied with the German design. A document signed by the then Chief of Naval Staff, Vice Admiral Mike Hudson, not only explicated the shortcomings of the IKL/HDW design but postulated a reason for them.[81] The IKL design team, the memo stated, had not paid sufficient attention to the RAN's requirements due, it was suggested, to the less demanding nature of the non-NATO customers with whom, of late, it had associated:

> This may be due to the fact that they have not designed a submarine for the FRGN (the Federal German Navy) since the early 1970s and their experience with less competent submarine forces which do not maintain the same rigorous operational standards as the RAN, but it has resulted in a design which has failed to realise the potential which Navy expected of it.[82]

In contrast to HDW/IKL, Kockums had the support of Swedish naval personnel in Australia throughout the selection process. Hence it is not surprising that the naval memo saw the Type 471 as:

> clearly the product of designers who are well versed in satisfying the current practices of a parent navy which has to work in a complex and demanding operational environment. Their experience should flow on to the benefit of the RAN.[83]

The Revised Performance Controversy

The leaks underscored not only the determination of Navy to secure their custom designed base line submarine performance specifications but a determination to dictate how a designer should meet them. In evaluating the designs, the 280 staff of the new submarine project team[84] revised the contenders' claims for the predicted performance of their boats. This is part of the normal tender evaluation process but, in this case, they invariably reduced the claimed performance of the IKL design and increased that of the Type 471. In several cases these revisions were marked. The covert transit range at ten kts was assessed by Kockums as 9300 nm and by the RAN at 10 440 nm.[85] The days on station claimed for the Type 2000 were reduced by 36 per cent; in contrast, the battery endurance estimated by Kockums was increased by 15 per cent.[86]

The technical consequences of this situation were that the Type 2000 was adjudged either not to meet RAN requirements or to be inferior to the Type 471 when it did. Fuel stowage and battery volume of the Type 2000 were said to be inadequate, perhaps related to the RAN's insistence on full-time air conditioning and the German's apparent reluctance to provide it. Rectification was estimated to cost $60 million. The weapons handling and discharge system of the Type 2000 did not meet RAN specification and was estimated to cost $188 million to rectify. The Navy's evaluation team rated the Kockum's design superior on the basis of:

- covert transit range
- days on station
- battery endurance
- indiscretion rate on station
- acoustic characteristics
- shock attenuation, and
- the location of some structural elements.[87]

It was claimed that the good narrow band noise (largely, noise generated on board) characteristics of the Type 471 were verified by the USN who were interested in its performance in this area as a suitable platform to conduct covert surveillance on Soviet and Vietnamese naval facilities in the North Pacific.[88]

Overlaying Manufactures Claims with Operational Reality

At the time, these revelations served to renew the controversy surrounding the submarine program. However, hypotheses about deliberate corruption or political interference were difficult to substantiate because of the elaborate mechanisms of the Defence selection process. The 280 staff of the evaluation office were divided into five teams which reported separately on specific aspects of the project. The decision of the project team was then reviewed at different stages by 5 higher level Defence committees.

Notwithstanding the attractiveness of conspiracy theories, there is a more likely explanation for the radical downgrading of the performance claimed for the IKL design. As with most military equipment, the theoretical performance of any submarine design is not the performance it will deliver in operations. Indeed, conventionally used figures may be irrelevant to the operational procedures actually used when the boats are deployed.

Thus, while it is convenient to talk of a submarine's range, operational deployments of these craft are seldom planned in such terms. Rather, submarines *transit* to an area of operations and patrol this at a *patrol speed* and in a mode of operation which will be markedly different to that of the transit journey. The period on patrol should ideally be longer than the transit time as, usually, the patrol area is where the submarine can be expected to achieve its mission objectives. Yet the mode of operation in the patrol area (generally, creeping around at four or so knots) is such that energy consumption may be less than during transit.

Further, whilst transit may be considered dead time in terms of mission objectives, it is by no means a period of ease. The submarine may be observed whilst underway (particularly when snorting – running its engines whilst submerged, by use of a snorkel) and may be shadowed into the patrol area, by anti-submarine forces, possibly another submarine, positioned along the most likely approach to the patrol area. Since patrolling unannounced (or possibly being in any of a number of patrol areas unbeknown to an enemy) is one of the greatest assets to the strategic conduct of submarine operations, disguising the transit route is usually important. This can involve not simply the obvious procedure of regularly changing course and speed but transiting along a course chosen after extensive hydrographic survey for properties favourable to submarine operations.

Despite the image of submarines being isolated from the elements, performance of conventional submarines during transit is also effected by the weather. Snorkels may produce a wake during moderate conditions and can be affected by waves in heavy seas. Because of these factors submarines never achieve the performance for which they were designed whilst on operations.

In general terms, operational performance is usually considered to be significantly below the optimum. Moreover, the extent of such deviations from theoretical performance can be expected to vary with the prevailing characteristics of particular operational scenarios.[89] It is likely that the evaluation of the performance data provided by the two contending manufacturers for the new submarine was performed against the known characteristics of a number of operational scenarios considered to be representative. Thus, it could have been the case that the project team, in evaluating the bits of the two shortlisted companies, found reasons to disagree with the interpretation that both companies had made of the operational scenarios for which they were designing their bids.

Were the Swedes Simply Smarter?

It is also likely that the Swedish effort was more carefully targeted. It was supported more obviously throughout by serving naval personnel than was the German proposal. Kockums appeared to be more aware and accommodating of the effects of RAN operational profiles on base line design performance.

This thesis is supported by the explanation by the (then) Minister (Kim Beazley) of the RAN's preference for the Kockums design. Keeping to a theme, he generally explained the alteration of the contending design teams' performance figures as due to their reduction to a common base line.[90]

Conclusions

The development of the Collins submarine program marks a significant change in the history of Australian defence procurement. Australia had built its own naval vessels before but usually to foreign, partially modified or less sophisticated, design. With the new submarine program, Navy proposed the building of a unique design that was at the leading edge of technology. It had embarked on a program that carried high levels of risk in almost all its components.

Undoubtedly, there will continue to be debate as to whether Defence should have endorsed this approach or returned the project to the original objective of selecting a tried and proven design. The decision being made, however, there is sufficient evidence to indicate that Navy approached the development of the submarine program with diligence and a great deal of ingenuity. That many aspects of the program did not develop as expected says more about the procurement strategy adopted for managing the program than the quality of Navy's tender evaluation process.

Endnotes

1. Graham White, Captain RAN, 'Our Submarine Arm and the Future', *Fleet Maintenance Bulletin*, Issue 18, 1984, p. 7.
2. 'Writing on wall for Oberon subs', *Navy News*, 11 March 1983, pp. 6–7; Tom Ballantyne, 'Navy pushes Aust Share in submarine project', *Sydney Morning Herald*, 1 March 1983.
3. 'Smaller crews, better habitability, higher speeds', *Defence Industry*, 10 October 1984, p. 2.
4. Paul Dibb and Commodore Terry Roach, 'Collins: the submarine we had to have', *Financial Review*, 17 February 1999.
5. Graham White, Captain RAN, 'Our Submarine Arm and the Future', op. cit., p. 8.
6. 'New boats will require shorter refits', *Defence Industry*, 10 October 1984, p. 2.
7. 'Government to call tenders for new submarines', *Canberra Times*, 26 January 1983 and, The Hon. Ian Viner, MP, Minister for Defence Support, *Speech for Opening of Australian Industry Briefing, New Construction Submarine Project*, HMAS *Watson*, 3 March 1983.

8. '$9.2 million submarine costs $7m to refit', *Sydney Morning Herald*, 8 February 1973; Frank Cranston, 'Submarine refit slow and costly', *Canberra Times*, 9 February 1973.
9. G. D. White, Captain RAN, 'Submarine Project Overview', *An Approach to Carrying Out Major Projects in Australia*, The Institute of Engineers Australia, Canberra, September 1984, pp. 59–60; *Defence Industry*, 16 February 1983, p. 4.
10. G. D. White, 'Submarine Project Overview', op. cit., p. 57.
11. ibid., p. 58.
12. 'Writing on wall for Oberon subs', *Navy News*, 11 March 1983, pp. 6–7; 'New submarines for the RAN', *Navy News*, July 1983, p. 9.
13. Tom Ballantyne, 'The shape of subs to come', *Sydney Morning Herald*, 3 November 1982.
14. 'Writing on wall for Oberon subs', *Navy News*, 11 March 1983, pp. 6–7; 'Submarine Project', *Canberra Times*, 1 March 1983.
15. 'Writing on wall for Oberon subs', *Navy News*, op. cit.
16. ibid.
17. Graham White, 'Our Submarine Arm and the Future', op. cit., p. 8.
18. 'Government to call tenders for new submarines', *Canberra Times*, 26 January 1983, 'New submarines for the RAN', *Navy News*, op. cit.
19. The Hon. Kim Beazley, MP, Minister for Defence, 'Swedish-designed submarine chosen for the RAN', *News Release* No. 67/87, 18 May 1987, p. 5.
20. Andrew Johnson, 'Viability of Combat System Development in Australia', *An Approach to Carrying out Major Projects in Australia with Reference to the New Construction Submarine Project*, The Institution of Engineers Australia, September 1984, p. 68.
21. 'Submarine Project', *Canberra Times*, op. cit.; Tom Ballantyne, 'Navy pushes Aust Share in submarine project', *Sydney Morning Herald*, 1 March 1983.
22. Department of Defence, 'Request for tender for RAN submarine project', *Defence Press Release*, No. 79/83, 20 May 1983.
23. 'New submarines for the RAN', *Navy News*, op. cit.
24. The Hon. Brian Howe, MP, Minister for Defence Support, 'Tenders received for new submarine project', *News Release 50/83*, 16 December 1983.
25. Department of Defence, 'Request for tender for RAN submarine project', *Defence Press Release*, No. 79/83, 20 May 1983, 'New submarines for the RAN', *Navy News*, op. cit.
26. Letter from W. L. Owen, Capt, RAN (ret.) quoting *verbatim* clause 2.23.4.1.3 of the tender, cited in P. Lewis Young, 'The Australian new submarine selection', *Asian Defence Journal*, December 1987, p. 30.
27. A. W. Grazebrook, 'New subs must be built here', *Pacific Defence Reporter*, February 1984, pp. 42–43. Unless otherwise stated, the data regarding the various contenders in the section immediately following is drawn from this source.

28. P. Lewis Young, 'The Royal Australian Navy's New Submarine Selection', *Asian Defence Journal*, August 1984, p. 51.
29. 'West German consortium have large export sales', *Defence Industry*, 10 October 1984, p. 3.
30. Hugh White, 'Two chosen to design submarine', *Sydney Morning Herald*, 22 May 1985.
31. P. Lewis Young, 'The Royal Australian Navy's Submarine Force—now and looking to the future', *Asian Defence Journal*, July 1984, p. 23
32. Kenneth Davidson, 'Navy determined to build submarines in Australia', *The Age*, 17 January 1985.
33. P. Lewis Young, 'The Australian new submarine selection', *Asian Defence Journal*, December 1987, p. 32.
34. 'Kockums hoping for first export', *Defence Attache*, No. 6/1985, p. 31.
35. P. Lewis Young, 'The Royal Australian Navy's New Submarine Selection' *Asian Defence Journal*, August 1984, p. 52.
36. ibid.
37. Davidson, 'Navy determined to build submarines in Australia', op cit.
38. 'Several Australian partnership options open to Kockums', *Defence Industry*, 5 June 1985, p. 3.
39. Nick Childs, 'RN submarine endurance improvements suggested', *Jane's Defence Weekly*, 8 September, 1984, p. 378.
40. ibid.
41. P. Lewis Young, 'The Royal Australian Navy's Submarine Force—now and looking to the future', op. cit., p. 22.
42. Andy Millar, Commander RAN, 'The Collins is a first-rate sub', *Canberra Times*, 7 June 1999.
43. P. Lewis Young, 'The Royal Australian Navy's Submarine Force—now and looking to the future', op. cit., p. 22.
44. Frank Cranston, 'Delay likely on submarines', *Canberra Times*, 7 August 1984.
45. 'Multi-national combat system package in front?', *Defence Industry*, 7 November, 1984, pp. 1–2.
46. ibid.
47. Louise Boylen, 'New submarines may be delayed by "one man" hold-up', *Australian*, 17 December 1984; Geoff Kitney, 'Off to sea in a paper boat', *National Times*, 21–27 December 1984.
48. Kitney, ibid.

49. An insider of those times has published a critique of the decision making processes involved in the early stages of the new submarine project. Mike Gilligan, 'What the sub report did not say', *Canberra Times*, 30 July 1999.
50. Ian Davis, 'Government moving closer to crucial submarine decision', *Age*, 13 May 1985; Kenneth Davidson, 'A most intelligent approach', *Age*, 23 May 1985.
51. Hugh White, 'Two chosen to design submarine', *Sydney Morning Herald*, 22 May 1985.
52. Andy Millar, Commander RAN, 'The Collins is a first-rate sub', op. cit.
53. Deborah Snow, 'Submarine fleet of six will be built locally', *Financial Review*, 22 May 1985.
54. Frank Cranston and John Jesser, 'Companies chosen to design submarine', *Canberra Times*, 22 May 1985.
55. Frank Cranston, 'Australia's submarine program, *Jane's Defence Weekly*, 24 August 1985, p. 365.
56. This comment excludes the Fremantle Class patrol boats, based on the design of a British company. At the time, confused Defence planning processes would have led some to contend that the Fremantles had a combat role but clearer strategic analysis and more disciplined force structure planning procedures, introduced since, have identified the patrol boats as having no combat role. See, Department of Defence, *Australia's Strategic Policy*, December 1997, p. 62.
57. Gay Davidson, 'Debate over submarines goes on but misses the real issue', *Canberra Times*, 13 June 1985.
58. John Stackhouse, 'UK, US to shut gate on secret sub technology', *The Bulletin*, 26 November 1985, p. 55–56.
59. Fia Cumming, 'Ombudsman finds leak in submarine tender', *The Age,* 2 November 1985.
60. 'Claim of bias on submarine deal rejected', *Sydney Morning Herald*, 3 December 1985.
61. 'New submarine project' *The Navy*, July 1985, p. 9, and Andy Millar, 'Time for sub's critics to let the truth surface', *Sydney Morning Herald*, 31 May 1999. Miller is an RAN officer who has been involved in the New Submarine Project from 1982.
62. Frank Cranston, 'Australia's submarine program, *Jane's Defence Weekly*, 24 August 1985, p. 365.
63. Deborah Snow, 'Two contenders in submarine project still operational', *Financial Review,* 25 September 1985.
64. P. Lewis Young, 'Australia's new submarine project: will ASEAN navies opt for the same?', *Asian Defence Journal*, 9/86, p. 12.
65. South Australian Submarine Contract Task Force, *RAN new construction submarine project. South Australian delegation visit to submarine builders*, submission to the Department of Defence Support, 12 September 1984, p. 9ff.
66. ibid., p. 2.
67. ibid., p. 6ff.

68. Frank Cranston, 'Australia's submarine program, *Jane's Defence Weekly*, 24 August 1985, p. 365. See also, 'VSEL's Australian and UK submarine programs', *Jane's Defence Weekly*, 26 October 1985, p. 948.
69. ibid., and Andy Millar, 'Time for sub's critics to let the truth surface', op. cit. Miller confirms that the cost of a Type 2400 as offered for the project in 1983 was more expensive than the Swedish bid.
70. P Lewis Young, 'Australia's new submarine project: will ASEAN navies opt for the same?' p. 10.
71. Andy Millar, 'Time for sub's critics to let the truth surface', op. cit.
72. 'Type 2000 a leader in technology', *The Australian*, 19 November 1986.
73. A. W. Grazebrook, 'Submarines, defence and politics', *Pacific Defence Reporter*, February 1987, p. 19.
74. Patrick Walters, 'How Sweden could torpedo its rival for Aust contract', *Sydney Morning Herald*, 1 February 1987. This experience should have applied to HDW as well, but it had not built submarines for the Federal German navy since the early 1970s.
75. P. Lewis Young, 'The Australian new submarine selection', *Asian Defence Journal,* 12/87, p. 35.
76. 'Submarine' contract signed, *News from Defence*, 3 June 1987, p. 1.
77. The Hon. Kim Beazley, MP, Minister for Defence, 'Swedish-designed submarine chosen for the RAN', *News Release* No67/87, 18 May 1987, p. 1.
78. ibid.
79. ibid, p.6.
80. Malcolm McIntosh and John Prescott, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, Canberra, 20 June 1999, p. 7. The authors note that they are 'astonished and appalled' by the extent of information about the Collins submarines which has been leaked. Several people, both civilians and officers, were involved in the leaks which, together with security breaches concerning the East Timor situation, led to the creation, in May 2000, of the Security Investigation Unit, a new unit in Defence. Lincoln Wright, 'Leakers allowed to leave Defence', *Canberra Times*, 16 May 2001.
81. Amanda Buckley, 'German submarine unacceptable: Navy', *Financial Review*, 18 May 1987.
82. quoted in P. Lewis Young, 'The Australian new submarine selection', *Asian Defence Journal*, December 1987, p. 32.
83. quoted in Amanda Buckley, 'German submarine unacceptable: Navy', op. cit.
84. A. W. Grazebrook, 'Submarines, defence and politics', op. cit., p. 19.
85. P. Lewis Young, 'The Australian new submarine selection', op. cit., p. 38.
86. ibid., p. 32.
87. ibid.

88. A claim made by journalist Brian Toohey, who alleged that the size and consequently, some $500 million to $1000 million of the cost of the submarines was due to the desire of the USN (which has no quiet conventional submarines) to have Australia continue to perform this role. Quoted in P. Lewis Young, 'The Australian new submarine selection', op. cit., p. 38.
89. For a discussion of these and other aspects of submarine operations see: Norman Friedman, *Submarine Design and Development*, London, 1984.
90. *Defence Industry*, 2 December 1987, pp. 2–3.