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Report of an Australian Parliamentary Delegation to the Republic of Korea and United States of America

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Delegation membership

Senator David Johnston (Leader)

Senator for Western Australia

Liberal Party of Australia

Senator Mark Bishop

Senator for Western Australia

Australian Labor Party

Senator Steve Hutchins (United States of America only)

Senator for New South Wales

Australian Labor Party

The delegation was accompanied by:

Ms Lisa Fenn

Secretary to the Delegation

Department of the Senate

Briefings and assistance

The delegation appreciated the assistance of Mr Martin Quinn, Counsellor Political, who accompanied the delegation in the Republic of Korea, and Mr Jim Gledhill, Defence Materiel Attache, and LCDR Peter Mingay, Specialist Marine Engineer, who accompanied the delegation in the USA. The delegation also thanks Mr Tom Corcoran for his administrative assistance with the USA visit and Mr Phillip Minos, Deputy Consul-General, for his assistance with the delegation's transit through Los Angeles.

The delegation acknowledges DFAT officers Mr Peter Baxter, First Assistant Secretary, North Asia Division and Ms Jeannie Henderson, Director, US Political and Strategic Section, for their informative briefing prior to departure.

The delegation also thanks Mr Paul Jeanroy and the staff of the Parliamentary Relations Office for their invaluable administrative support and assistance, and Ms Kylie Clynk at Carlson Wagonlit Travel for assistance with travel arrangements.

Chapter 1

Introduction

Background

1.1 On 10 November 2005, the Senate referred the matter of Australia's naval shipbuilding and repair industry to the Senate Standing Committee on Foreign Affairs, Defence and Trade (FADT Committee) for inquiry and report by the last sitting day of 2006.

1.2 The terms of reference asked the FADT Committee to inquire into and report upon the scope and opportunity for naval shipbuilding in Australia and in particular:

> (a) the capacity of the Australian industrial base to construct large Naval vessels over the long term and on a sustainable basis;
>
> (b) the comparative economic productivity of the Australian shipbuilding industrial base and associated activity with other shipbuilding nations;
>
> (c) the comparative economic costs of maintaining, repairing and refitting large naval vessels throughout their useful lives when constructed in Australia vice overseas;
>
> (d) the broader economic development and associated benefits accrued from undertaking the construction of large naval vessels.

1.3 In the course of its inquiry the FADT Committee visited a number of Australian shipbuilding sites: Henderson in Western Australia, Osborne in South Australia, Williamstown in Victoria, the Incat yard in Tasmania and the Australian Defence Industries (ADI) facility at Garden Island in Sydney.

1.4 These site visits greatly assisted the committee, giving insight into how the Australian industry operates, the challenges it faces and the solutions used to improve efficiency and competitiveness. The committee was particularly interested to understand the rapid advances in technology in shipbuilding and industry's response to these changes.

1.5 Given the influence that global trends and international partnerships have on Australian shipbuilding and the specific international component of the inquiry terms of reference, on 13 June 2006 the FADT Committee wrote to the Minister for Defence, the Hon. Dr Brendan Nelson, seeking his support for the committee to go on an extra parliamentary delegation. The committee sought to study first hand the developments in shipbuilding taking place internationally.

1.6 The Hon. Dr Nelson responded favourably to the committee's request, writing to the Prime Minister endorsing the committee's proposal to undertake international

site visits. The committee wrote to the Prime Minister seeking approval for an extra parliamentary delegation to visit naval shipyards in the Republic of Korea and the United States of America and the Prime Minister responded on 4 August 2006 granting approval for the delegation.

Aims and objectives

1.7 The aim of the delegation's visit was to contribute to the FADT Committee's understanding of the capacity and sustainability of the Australian shipbuilding and repair industry and, in particular, to assist in understanding the comparative economic productivity of the Australian shipbuilding industrial base with regard to other shipbuilding nations.

1.8 The visit aimed to give insight in the following areas:

- the issues that shape the naval shipbuilding industries in the Republic of Korea and the USA;
- technological developments in naval shipbuilding in the Republic of Korea and the USA and their impact on industry; and
- the economic underpinnings of shipbuilding in the Republic of Korea and the USA.

The delegation's visit

1.9 The delegation visited the Republic of Korea over the period 13 September to 15 September 2006 and the United States of America from 15 September to 22 September 2006.

The report

1.10 In this report the delegation provides details of its meetings and site visits. The report will in turn contribute to the Senate Standing Committee on Foreign Affairs, Defence and Trade report on Australia's naval shipbuilding and repair industry.

Acknowledgement

1.11 The delegation records its appreciation to the Hon. Dr Brendan Nelson, Minister for Defence, for supporting the proposed visits and to the Prime Minister, the Hon. John Howard, for endorsing and approving the additional delegation.

Chapter 2

The visit to the Republic of Korea

The Republic of Korea – overview

Capital: Seoul

Head of Government: President Roh Moo-hyan

Surface area: 98,480 km^2

Population: 48.5 million (2005)

GDP: US$793.1 billion (2005 estimate)

GDP growth rate: 4 per cent (2005)

Exchange rate: A$1=715 won (July 2006)

Naval shipbuilding in the Republic of Korea

2.1 Economic progress in the Republic of Korea has been remarkable over the last half-century. Following Japanese occupation during World War II, the South Korean economy was impoverished and rurally-based. The Korean War (1950–1953) had an enormous cost, both in human life and destruction of the country's infrastructure. As a result, by 1960 South Korea's per capita GDP lagged behind that of Zambia and Bangladesh. However, sustained high economic growth has seen the Republic of Korea transform into a highly industrialised and internationally competitive economy. In 2005, it was estimated that the Republic of Korea had the 10th largest economy in the world.[1] Exports have been critical to the Republic of Korea's impressive economic growth, with finished products such as electronics, automobiles, machinery and equipment, ships, steel and textiles forming some of its most important exports.

2.2 The Republic of Korea is now the world's largest shipbuilding nation. In 2003 the output of the Republic of Korea's shipbuilding industry was estimated at 7.2 million compensated gross tons (cgt), ahead of Japan (6.9 million cgt) and China (2.6 million cgt).[2] In comparison, Australia's shipbuilding output for the same year was estimated at 48 000 cgt. The Republic of Korea provides excellent examples of large scale, mass production shipbuilding.

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1 As measured by GDP. Australia ranked 15th by the same measure.

2 Department of Industry, Tourism and Resources, *Submission 38* to the Senate Foreign Affairs, Defence and Trade Inquiry into Naval Shipbuilding in Australia, p. 9. Compensated Gross Tons takes into account the complexity of the vessels produced as well as their size. DITR note that the available statistics provide imperfect measures of output.

2.3 While naval shipbuilding forms a relatively small component of the Republic of Korea's shipbuilding output, demand has increased and diversified in line with the Republic of Korea Navy's aim of becoming a substantial blue-water navy.[3]

The delegation's program

2.4 The delegation visited the Republic of Korea on Thursday 14 and Friday 15 September 2006. This section of the report details the site visits and meetings held.

Daewoo Shipping and Marine Engineering (DSME)

2.5 The delegation was pleased to visit DSME's shipbuilding site at Okpo Bay, Geoje Island on the southeastern tip of the Korean Peninsula. Transport to the site was provided in DSME's helicopter, affording a good view of Okpo bay and the scale of DSME's shipping operation.

2.6 The delegation was pleased to meet with DSME officials Rear Admiral (Retd) Pyong Koo An, Vice President Special Ship Division, Mr Hyon-Seok Kim, Senior Manager Special Ship Project Team, Mr Yeong-Ho Choi, Team Leader, Special Projects Team and Mr Tae-Hyun Kim, Manager Special Marketing Team. Discussions were interesting and informative and delegation members appreciated the generous hospitality and time spent answering their many questions.

Members of the delegation were transported to DSME by helicopter

2.7 DSME supplies a world-wide market with a range of commercial vessels and offshore plant including passenger ferries, tankers, LNG and LPG carriers, container ships, bulk carriers, fixed platforms and offshore drilling rigs. Naval shipbuilding comprises only a small component (around five per cent) of DSME's production. Naval vessels constructed at DSME include submarines, destroyers, frigates, corvettes and patrol boats.

3 A blue-water navy is a naval force which has deep ocean power projection capabilities. Such a navy can operate effectively beyond its national shores for extended periods of time.

2.8 DSME first entered the naval shipbuilding market in 1989 when it designed and built a 4000 ton destroyer. Following construction of two more vessels in this class (KDX-I), DSME won the contract for a 5000 ton class destroyer and delivered three vessels in that class (KDX-II). DSME has also built a variety of 1000 to 3000 ton warships and exported a 2300 ton frigate to the Bangladesh navy in 2001. DSME has built nine Changbogo submarines and is currently providing an overhaul to two German 209 submarines for the Indonesian navy. DSME is interested in exploring further naval export opportunities.

2.9 DSME employs more than 15 000 skilled workers, with approximately 1500 employed in design and research and development fields. The Okpo shipyard was constructed in the early 1970s and currently has production capacity of around 40 commercial vessels, 10 speciality vessels and 20–30 units of off-shore and on-shore plant per year. Up to two 7000 ton destroyers and two 3000 ton submarines can be built annually. In addition, DSME has significant ship repair and refurbishment capacity.

2.10 DSME's Okpo yard has two dry docks, three floating docks and a 3600 ton capacity floating crane. Dry Dock No. 1 is described as the largest in the world. The dock is 500m long by 131m wide, with one million dead weight ton (dwt) capacity. The yard's largest crane, the 900 tonne Goliath crane, services Dry Dock No. 1. Final assembly of destroyers and frigates occurs using the 20 000 dwt capacity floating dock. Submarines are assembled in an indoor temperature and humidity controlled workshop.

2.11 DSME has a strong research and development arm, with research centres for basic technology, design and production technology. Some of DSME's specialist research and development fields include welding technology (technology and technique development, heat treatment, and stress release technology), precision measurement technology, hydrodynamics (manoeuvrability, heat transfer analysis, propulsion performance analysis and propeller design), automation and production robotics (mechanization and automation of industrial facilities, production facilities, welding and painting).

2.12 This investment in research and development has greatly contributed to DSME's automation of many aspects of shipbuilding, for example, welding robots for superstructure block fabrication, robotic systems for painting and automated, computer controlled welding equipment.

2.13 Delegation members asked DSME representatives about the differences between the company's commercial and naval production. Naval construction requires longer lead times and testing than commercial production, with typical naval ship test and evaluation procedures taking around one year. Overall, representatives said that commercial ship construction averages around six to eight weeks (up to two years for the biggest projects) compared with four years for a submarine build.

2.14 While naval construction comprises a small proportion of DSME's production, Rear Admiral An commented that the technology gain and prestige associated with naval construction are key drivers for DSME's naval building program. Representatives noted that it is the profit from commercial building which makes naval building viable, although the Republic of Korea Government does make downpayments for naval acquisitions.

2.15 The Republic of Korea's naval shipbuilding industry is structured around three major primes. DSME and Hyundai Heavy Industries (HHI) are the principal suppliers of frigates and destroyers, while Samsung Heavy Industries also supplies landing craft. DSME's majority shareholder is the Republic of Korea Government, while Hyundai is completely privately owned.

2.16 The procurement process for naval vessels in the Republic of Korea is tender based with competition for each order. Both DSME and HHI use the same ship designs. Two competitive tenders were conducted for the KDX II and III class program: the first, for the design, was awarded to HHI and the later contract, for the build, was awarded to DSME. DSME officials noted that the Republic of Korea Government has an interest in maintaining competition and contracts are often awarded alternately to DSME and Hyundai. In terms of planning and scheduling, the Republic of Korea Government produces a Defence White Paper which includes details of intended submarine and frigate acquisitions.

2.17 Over lunch Rear Admiral An expanded on the culture and work ethic promoted at DSME, encouraging delegation members to embrace the South Korean spirit of 'Bali Bali' ('Hurry Hurry'). Rear Admiral An emphasised that on-time production is guaranteed at DSME.

Site tour

2.18 The delegation was very pleased to be given a guided bus tour of sections DSME's 4 million m^2 site. The delegation was able to gain a good appreciation of DSME's use of modularisation techniques. It viewed the steel arrival area, steel cutting workshop (steel cutting is largely automated at DSME), steel stacking palettes and steel assembly areas, where small pieces are welded, followed by assembly of large structures (blocks) and then superblocks (up to 800 tons). Superblocks are lifted by crane for final assembly. Completing block assembly and fit out on land reduces the production time required in the facilites' dry docks, thus maximising use of the available infrastructure.

2.19 The delegation members viewed DSME's No. 1 Dry Dock. Officials explained that it takes eight hours for the four installed pumps to empty the dock for ship launches. At the time of the delegation's visit a 300 000 ton, 300 metre Very Large Crude Oil Carrier was under construction in the dock.

2.20 Delegation members alighted for a walking tour of the Pressure Hull Production workshop. The workshop has capacity to hold three submarines and is accompanied by an over water testing shed. During the delegation's visit, the

production shed contained a German 209 submarine under conversion for the Indonesian navy. The delegation leader, Senator Johnston, inspected some of the welding work undertaken on the pressure hull, which had been cut to enable an engine to be removed for maintenance.

2.21 Delegation members also toured a KDX II class destroyer. The ship is being built by DSME using a Hyundai Heavy Industries design. The delegation viewed the crew's mess and the command and control centre, where Thales and DSME staff were observed conducting harbour testing. DSME officials explained that the combat system for the KDX is similar to Aegis but smaller. The ship has a 31 knot maximum speed.

2.22 During the site tour officials reiterated DSME's emphasis on maintaining a clean, neat and beautiful shipyard. Delegation members were impressed by DSME's success in reforesting the hills surrounding the shipyard.

Visit to the Historic Park of Geoje POW Camp

2.23 Mr Tae-Hyun Kim, DSME Manager Special Marketing Team, accompanied the delegation on an informative and moving visit to the Historic Park of Geoje Prisoner of War Camp. Over 170 000 POWs were held at the camp during the Korean War; a war in which 17 000 Australians served as part of the United Nations multinational force.

Hyundai Shipyard

2.24 The delegation was interested to visit Hyundai Heavy Industries' shipyard at Ulsan and was pleased to meet with Rear Admiral (Retd) Ban-Woong Lim, Director and Mr Herman Kwon, Manager, Special and Naval Shipbuilding Division.

Members of the delegation with Hyundai Heavy Industries representatives

2.25 Hyundai Heavy Industries Co Ltd (HHI) operates various business lines including shipbuilding, engine and machinery, electric systems, industrial plant,

offshore engineering and construction equipment. HHI has around 16 per cent share of the global new shipbuilding market. Products include crude oil tankers, chemical tankers, LNG and LPG carriers, bulk carriers, cargo ships, container ships, car carriers, ore and bulk oil carriers, passenger ships, fast ferries and barges.

2.26 HHI has a workforce of around 26 000 and employs around 10 800 workers in shipbuilding; some 8500 technical and skilled workers and 2300 office workers. Hyundai's shipyard has nine dry docks of various capacities, ranging from 15 000 to one million DWT. The largest dock enables simultaneous construction of a range of vessels. Dry docks 9 and 10 each have a 900 tonne Goliath crane and are specially designed for Very Large Crude Oil Carrier production. Dry dock 1 is allocated for LNG carrier construction. HHI has recently purchased a 1500 tonne capacity crane for its offshore plant construction. The yard also has a 3000 tonne capacity ship lift.

2.27 Naval shipbuilding forms a small component of HHI's construction work and representatives confirmed a preference for commercial work The naval vessels produced by HHI include submarines, destroyers, frigates, corvettes, patrol vessels, fast attack craft and logistic support vessels. HHI is developing a 10 000 tonne Aegis destroyer (HDD-10000) and a 16 000 tonne Landing Platform Dock.

2.28 HHI principally supplies the Republic of Korea Navy and has a small export market involving Venezuela, New Zealand and Bangladesh. HHI has supplied these navies with auxiliary ships and replenishment ships, including a 10 000 tonne auxiliary oiler, based on Korean designs.

2.29 HHI's submarine program centres on the 214 class submarine, which is based on the 212 class operated by the German and Italian navies. The submarine is a 1800 tonne, 65 metre vessel with a crew of 40. It uses an Air Independent Propulsion system. Rear Admiral Lim noted that the Government's Defense Acquisition Program Administration (DAPA) provided the design package and some materials for the Republic of Korea Navy submarines. Rear Admiral Lim also explained that 10 per cent of the materials used for the submarines were required to be supplied locally. Atlas (a subsidiary of Blohm and Voss) is providing HHI with technical systems and systems integration assistance and has stationed engineers at the Hyundai shipyard site for this work.

2.30 Given relatively small overall demand from the Republic of Korea Navy (two to three ships per year), demand for naval shipbuilding at HHI is not consistent. HHI uses its commercial program to help smooth demand peaks and troughs. For example, tradespeople may be moved into commercial building, or small-scale fabrication projects may be taken on, to fill lows in naval demand. However the skill sets of some sectors of the workforce, such as naval ship designers, do not transfer easily into other work. Mr Lim noted that the cost associated with retaining these workers contributes to the underlying costs of maintaining a naval shipbuilding program.

2.31 Tensions between competition and industry rationalisation were apparent. HHI officials indicated that while DAPA releases five year acquisition plans, the

Republic of Korea Government's orders for naval vessels are insufficient for three companies. Rear Admiral Lim considered that while competition is a good thing, one or two naval shipbuilders would be more viable in a market the size of the Republic of Korea's. According to HHI officials, from the Government's perspective it is important to grow a naval industry capability and therefore the government has an interest in keeping three shipyards viable. However, tensions arise between keeping the yards viable and attaining the cheapest price for each build program.

Site tour

2.32 Hyundai's outfitting quay covers 7.2 million m^2. Delegation members toured the facility by bus, viewing the steel cutting workshops, block construction shops, the outfitting shops and dry docks 1 and 2, each of which contained four vessels under construction. Officials explained that the smooth flow of transportation around the site is critical. No cars are allowed on site, with staff using bicycles and scooters. HHI also employs its own traffic police to maintain the site's 30 km speed limit.

2.33 Delegation members walked through the engine manufacturing division and observed staff conducting propeller testing. The delegation was then transported to the Naval Division of the shipyard and observed an Aegis destroyer under construction in dry dock number 6, scheduled for prototype delivery in late 2006. Representatives explained that a tight development schedule of 49 months was required for the Aegis ships, to meet the Republic of Korea Navy's needs. The delegation was also provided with a brief view of one of HHI's 214 class submarines, which was launched in June 2006 and is scheduled for delivery in 2007.

Members of the delegation touring HHI's engine manufacturing plant. An engine block hangs from the hall roof behind the delegation.

Poongsan Munitions

2.34 The delegation was officially welcomed and hosted to lunch by Poongsan Corporation's President, Mr Moon-won Lee, and Plant Manager, Mr Sang-young Choi. Along with a range of munitions, Poongsan is a major producer of copper coin blanks. The delegation viewed a short promotional movie providing an overview of Poongsan Corporation and its products and staff gave a guided tour of Poongsan's showcases, providing details about the munitions, propellants and coins displayed.

Concluding comments

2.35 The delegation was most interested to visit both the DSME and HHI shipyards and gained a stronger appreciation of the scale of production achieved by these yards. Discussions with officials confirmed the delegation's impression that the viability of these yards derives principally from commercial building. DSME and HHI's naval building programs are largely underpinned by less commercial drivers, such as technology transfer, prestige and national duty. The delegation observed that it is difficult for shipbuilders to successfully undertake both diversified commercial and naval shipbuilding on large scales. It was apparent that the Republic of Korea Government provides some support for these companies' naval shipbuilding programs, for example through the allocation of contracts.

2.36 During its inquiry into naval shipbuilding in Australia, the FADT Committee received evidence about the efficiencies of Common User Facilities, which enable infrastructure investment returns across different sectors of heavy engineering industry. Members of the delegation were interested to observe that, due to the scale of their production and diversified commercial product base, both DSME and HHI are each able, in effect, to operate Common User Facilities within one company. The efficiencies derived from economies of scale, automation and modular construction were clear.

2.37 Delegation members benefited greatly from the opportunity to tour facilities and closely inspect some work. However delegation members were also aware of the inevitable limitations to overseeing access and scrutinising standards that can arise when naval construction is outsourced to distant locations.

2.38 In Australia there have been calls for a rationalisation of the naval shipbuilding industry. The delegation was interested to note that in the Republic of Korea, where yards are able to offset their naval building by the scale and efficiency of their commercial building, industry players still called for a rationalisation of the industry to only one or two builders.

Acknowledgement

2.39 The delegation expresses its thanks and appreciation to officials of DSME, HHI and Poongsan Munitions for their gracious hospitality, informative meetings and interesting site tours. Delegation members appreciated the responsiveness of officials in addressing their many questions and the generous time spent hosting the visits.

Chapter 3

The visit to the United States of America

The United States of America – overview

Capital: Washington D.C.

Head of State and Head of Government: President The Hon. George W. Bush

Surface area: 9,364,000 sq km

Population: 296.4 million (2005)

GDP: US$13.469 trillion (October 2006 forecast)[1]

GDP growth rate: 3.4 per cent (2006 forecast)

Exchange rate: A$1=US$0.7491 (January 2006)

Naval shipbuilding in the United States of America

3.1 The United States of America is a world leader in defence technology development and application. Its major shipbuilders, together with technology and systems specialists, produce some of the most technically advanced and capable warships in the world.

3.2 On a dollar basis, the USA has the highest Defence expenditure in the world, more than double that of the next five highest countries' expenditure combined.[2] Defence spending comprises around 4% of the USA's GDP.[3] The USA *Department of Defense Appropriations Act 2007* appropriated US$10.6 billion for naval shipbuilding and conversion projects, to remain available until 2011.[4] The scale of this demand is evident in comparison with Australia's naval construction and upgrade projects, which total approximately A$16.5 billion to 2025.[5]

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1 The Financial Forecast Center, www.neatideas.com/index.htm, accessed 30 October 2006.

2 Central Intelligence Agency, 2006, *The World Factbook,* www.cia.gov/cia/publications/factbook/rankorder/2034rank.html, accessed 19 October 2006.

3 Central Intelligence Agency, 2006, *The World Factbook,* www.cia.gov/cia/publications/factbook/rankorder/2034rank.html, accessed 19 October 2006.

4 Bill no. H.R. 5631, *Department of Defense Appropriations Act, 2007* (Enrolled as Agreed to or Passed by Both House and Senate).

5 Department of Defence, *Submission 20A* to the Foreign Affairs, Defence and Trade Committee Inquiry into Naval Shipbuilding in Australia, p. 1. Includes projects already approved and projects detailed in the *Defence Capability Plan 2006 – 2016*, plus anticipated future frigate and submarine construction.

3.3 While sheer demand provides a level of certainty for the US naval shipbuilding industry, the legislative environment also guarantees protection. Overarching legislative protection is provided by the Title 10 United States Code, which specifies that other than by Presidential waiver, no vessel and no major component of the hull or superstructure of any vessel may be constructed for any of the USA armed forces in a foreign shipyard.[6] The above mentioned Defense Appropriations Act specifies that none of the funds provided for shall be used for the construction of naval vessels in foreign shipyards, or for the construction of major components of the vessels in foreign yards. Further protections are afforded by various Defense Federal Acquisition Regulations that restrict the use of foreign shipyards for overhaul, repair and maintenance and the foreign supply of speciality metals and components.

3.4 As an important Australian ally, interoperability with US forces is a key criterion for Australia's own naval fleet. The US is a major supplier for Australia's naval capability; for example, the Aegis weapon system for Australia's upcoming Air Warfare Destroyer project is being purchased from the US Government. Given the already important relationships between Australian and US naval shipbuilding industries, the scale of demand for US naval ships and the legislative context affording protection to the US industry, the delegation was particularly interested to see first hand some of the developments currently taking place in naval shipbuilding in the USA.

The delegation's program

3.5 The delegation visited the United States of America from Saturday 16 September to Friday 22 September 2006. This section of the report details the site visits and meetings held.

Northrop Grumman Ship Systems Ingalls Operations, Pascagoula, Mississippi

3.6 Northrop Grumman Ship Systems (NGSS) is a subsidiary of Northrop Grumman Corporation. Its headquarters and Ingalls operations are located in Pascagoula, Mississippi, on the Pascagoula River giving easy access to the Gulf of Mexico. NGSS Avondale operations are located at New Orleans and NGSS also has operations at Gulfport Mississippi and Tallulah Louisiana. NGSS is the largest manufacturing employer in Mississippi-Louisiana, with around 17 700 employees.

3.7 The delegation was pleased to meet with Mr Philip Teel, President NGSS, along with Mr Bob Merchent, Mr George Yount, Mr Kevin Jarvis, Mr Rocco Tomanelli, Mr Paul Robinson and Mr Robert Howell. The delegation was given an informative briefing and discussed with NGSS officials a range of issues, including

6 Title 10 United States Code, Section 7309, Construction of vessels in foreign shipyards: prohibition.

US naval acquisition processes, NGSS' operations and in particular the DDG 51 program and the DDG 1000 program.

Meeting with representatives of NGSS Ingalls Operations

3.8 NGSS has a diverse naval ship product base and constructs multiple classes of ships concurrently. NGSS is currently producing four classes of naval ships, the DDG 51 class destroyers, LPD 17 class amphibious ships, LHD 8 class amphibious ships and the USCG National Security Cutter. A fifth class, the DDG 1000 destroyer is under development. NGSS engages in little commercial building, which representatives commented has not been very successful. Representatives noted that there is enough diversity and challenge in producing a range of classes of naval vessels.

3.9 NGSS is an exporter of ships, having supplied three SA'AR 5 class Corvettes to the Israeli Navy. Other ships supplied internationally include a 62 metre Multimission Missile Boat, a 62 metre Customs Patrol Ship, an 85 metre Corvette, a 128 metre Frigate and a 150 metre Multipurpose Amphibious Ship. NGSS also delivered a major surface combatant modernisation program for two LUPO class frigates for the Venezuelan Navy and has prepared two US Navy frigates for transfer to international fleets.

3.10 NGSS's focus has been to use the ship upgrade process to build up a successful yard capable of building multiple types of ships. Mr Teel summarised the main characteristics of NGSS as: the use of short production runs; construction of multiple classes of ships; and investment in commonality across shipyards. With regard to the last characteristic, it is important to note that NGSS Ingalls Operations were heavily affected by Hurricane Katrina in 2005, when the entire facility was under

water. Twelve months later the site was back at 40 per cent of production capacity. NGSS is using the rebuilding process as an opportunity to implement many of the recommendations of an international benchmarking study of US shipyards.[7] NGSS is also looking for commonality in building techniques with other yards, in order to maximise return on its rebuilding investment.

3.11 Delegation members discussed with NGSS representatives naval ship acquisition processes in the USA. Representatives commented that at a policy level there is commitment to stability in demand from the US Government, with a 30 year ship acquisition plan. Representatives considered that while the 30 year time frame is probably unrealistic, the first ten years of the plan are critical. Mr Teel commented that demand planning is critical not only for shipbuilders, but also for companies in the supply chain. This is particularly true in what is a difficult time in the region following the impact of Hurricane Katrina.

3.12 NGSS officials indicated that for the US Government there is a national strategic imperative for naval shipbuilding, with investment in the industry considered critical for guaranteed supply. The representatives commented that industry does apply pressure to Congress, both for more stable shipbuilding plans and larger demand, and noted the importance of good relationships with local congressmen across a number of states.

3.13 While proposed US naval acquisitions are approved on a program by program basis, the budget is approved on an annual basis. For example, NGSS representatives explained that for the DDG 1000 program the first appropriation is for a dual lead build of one ship at Bath Iron Works and one ship at NGSS. A second appropriation for further ships is scheduled for 2009. Representatives expressed some frustration with this process, and would prefer to see appropriations approved for a whole ship program, with budgets guaranteed unless contract violations occur.

3.14 Delegation members raised with NGSS officials the issue of demand peaks and troughs. Mr Teel considered that managing fluctuating demand was nothing exceptional and should be considered part of the job of running a naval shipbuilding program. Mr Teel noted that managing workforce volatility remained an issue regardless of the shipbuilding schedule, as the build process for each ship itself has workload peaks and troughs.

The DDG 51 and DDG 1000 programs

3.15 Delegation members were interested to discuss with the NGSS representatives the teaming arrangements used for the DDG 51 and DDG 1000 programs. NGSS representatives considered that the US Government, by employing teaming arrangements, had adopted a managed approach to competition, noting that under a 'winner takes all' approach they would stand to lose some yards.

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7 Office of the Deputy Under Secretary of Defense, *Global Shipbuilding Industrial Base Benchmarking Study*, May 2005.

3.16 The DDG 51 is a Government design, with the Navy design team including representatives of Gibbs and Cox, Northrop Grumman and Bath Iron Works. The DDG 51 program is a 62 ship program, with construction of 28 ships awarded to NGSS and 34 ships awarded to Bath Iron Works. Each shipyard employs different techniques in building the DDG 51. While the US Navy, as customer, has gained detailed knowledge of each builder's processes and financial details, NGSS representatives were confident that such information had not been disclosed to other yards within the team. The Aegis system for the DDG 51s is purchased as government furnished equipment, with around 30–40 Lockheed Martin staff working on site at NGSS Ingalls operations for installation and testing.

3.17 At NGSS Ingalls operations the average construction time for the DDG 51 has been 163 weeks from start of fabrication to delivery. Overall, there has been a 19 week reduction in construction time since construction of the lead ship. Officials noted that the main time variable has been related to combat system testing following each system upgrade.

3.18 For the DDG 1000 program, NGSS and Bath Iron Works have each been awarded 50 per cent of the build work, under separate contracts. Some classes of equipment will be built by one yard for the other. For example, all the kitchens (galleys) may be built at one location. Under this arrangement, integration will be a key factor for the program's success. Representatives explained that each yard has different methods for producing the same items. Where it is necessary to designate processes, arbitration will be based on assessing the best technical approach.

3.19 There has been significant sharing between the two prime yards in relation to design and build processes for the DDG 1000 platform. NGSS officials indicated that intellectual property issues have not arisen and that these generally relate more to the ship's systems and subsystems than the structure.

3.20 While discussing the DDG 1000, Mr Teel stressed the importance of the shipbuilder being involved in the initial design process, noting that the program would be 'a disaster without it'. It is important for the shipbuilder to be involved at an early stage to assess costs and the implications of design changes, so that informed decisions can be made about cost and capability trade-offs. Mr Teel considered that involvement of the shipbuilder in the design process was critical regardless of the level of complexity of the ship.

Site tour

3.21 The delegation was given a bus tour of NGSS Ingalls Operations, viewing the steel cutting workshop, fabrication workshop, aluminium workshop, module construction workshops, ship slipway and dry dock. Delegation members were interested in the recovery made at the yard since Hurricane Katrina and wished representatives well in the remaining rebuilding process.

3.22 Delegation members also undertook comprehensive guided tours of a DDG 51 Class Surface Combatant and LPD 17 Class Amphibious Ship, both under

construction. Officials advised that around 1200 tradespeople were working on the construction of these ships.

3.23 The DDG 51 is 509 ft vessel, displacing 9300 tons with a maximum speed over 30 knots. It accommodates 383 crew and its capabilities include 2 Seahawk Undersea Warfare Helicopters, 2 MK 41 Vertical Launching Systems, a 5-Inch Rapid Fire Gun Mount and 2 Triple Barrel Torpedo Mounts. The DDG 51 uses multiple electronic warfare systems and was described as similar to, although larger than, what Australia's AWDs will be. Delegation members viewed the crew's quarters, captain's quarters, mess, galley, command and control centre and the bridge.

3.24 The LPD 17 is a 684 ft vessel, displacing 25 000 tons at full load. It has a sustained speed of 22 knots, crew size of 361 and capacity for a 720 troop landing force. The ship's vehicle storage capacity is 25 000ft^2 and cargo volume is 30 000 ft^3. Delegation members were interested in the amphibious ship's well deck, vehicle decks and ramps and flight deck. The well deck is coated in composite materials to prevent degradation from sea water.

Austal, Mobile, Alabama

3.25 Austal is an Australian company with shipyards located at Henderson in Western Australia and Mobile, Alabama. The USA yard opened in 2001. Since then Austal USA has built and delivered eight ships in the yard, including a 192ft high-speed vehicle-passenger ferry, two 150ft fast crew/supply monohulls, an 86ft high-speed passenger catamaran, a 111ft dinner cruise catamaran, a 135ft dinner cruise monohull, a 143ft high-speed passenger/excursion catamaran and a 102ft surface-effect ship. Austal is currently constructing the largest aluminium catamaran in the US, a 107m high-speed cargo/passenger ferry for Hawaii Superferry. In terms of naval vessels, Austal as the designer and builder of the Littoral Combat Ship (LCS) platform, is part of the General Dynamics team offering a unique trimaran solution for the US Navy.

3.26 Having visited Austal's facilities at Henderson in Western Australia as part of the FADT Committee's inquiry into naval shipbuilding, delegation members were keen to visit Austal USA. The delegation was pleased to meet with Mr Greg Metcalf, CEO, Mr Bill Pfister, Mr John Caccivio, Mr Richard Liley and Mr Dan Spiegel.

3.27 Austal's US shipyard occupies around 14 acres on the Mobile River, around 20 miles from the Gulf of Mexico. The site includes a 90ft by 360ft construction bay plus an expansion of two large (134ft by 400ft) construction buildings. The original construction bay has a 380ft wharf, while the expansion facilities have added additional wharves totalling 750ft. Austal has plans for further expansion at the site, including new construction sheds and expansion of the front wharf. Austal is also looking to develop another site for module construction, retaining the consolidation and launch sheds at the current site.

The delegation with Austal representatives, Mobile, Alabama

3.28 Delegation members asked about the choice of location for Austal's US facilities. Officials advised that, in addition to the practical environment for building purposes, the state provided tax incentives for Austal to locate there. Significant government investment assisted Austal's start in Alabama, with US$5 million provided by the state, $2.5 million by the county and $2.5 million by the city. Representatives noted that Austal effectively had to provide the 600 jobs to get started. Mr Metcalf described the company's expansion, from 300 to 750 staff in 12 months, and commented that Austal USA would take 100 more workers if they were available.

3.29 Austal has faced some challenges securing the labour it requires to expand its business in the USA. Aluminium welders are rare in the US and officials commented that the economy is service focussed rather than trades focussed. This creates difficulties attracting apprentices out of high school, as the majority of school leavers go on to colleges and there is a stigma associated with working for a shipyard.

3.30 Austal's aluminium shipbuilding is a different business to steel construction. In terms of labour transferability, Austal representatives advised that steel welders can be retrained in aluminium welding in around six weeks, however retraining is harder for those workers who have been steel welders long term. Around half of Austal's workforce are aluminium welders and fabricators. It is a non-unionised workforce and the average age of the workforce is 34 years.

3.31 Delegation members asked about the movement of staff between Austal's commercial and naval operations. Austal will move workers from commercial building into its naval program, but this requires some further training and certification to ensure that naval standards are met.

3.32 Delegation members discussed with Austal representatives the Littoral Combat Ship (LCS) program. The LCS is intended to operate in coastal areas globally, be highly maneuverable and configurable to support mine-warfare, anti-submarine and surface ship warfare. Austal's LCS is based on its trimaran underwater hull design, which offers superior seakeeping and speed, along with the capacity to configure a range of weapons packages. It is a 127 metre long craft, with maximum hull draft of 4.5 metres and speed over 40 knots. The mission bay comprises 1000 m^3 and the ship has aviation capacity for one H-53 or two H-60 helicopters. Mission specific system modules, such as submarine seeking or minehunting modules, can be added to the generic vessel (the 'sea frame') to tailor the ship's specific capabilities. Open architecture systems are therefore critical. If the program proceeds as planned the US Navy may require up to 60 LCSs.

Austal designed US Navy Littoral Combat Ship

3.33 General Dynamics Advanced Integration (GDAI) is undertaking the Mission Systems Integration role for the LCS. The bridge system is being built by GDAI offsite in modules. Austal stressed the importance of the builder and designer working with the systems integrator, as what may be perceived as small system changes can have a major impact on building specifications. Austal staff gave the example of the type of twist locks used throughout the vessel. While changing the lock type may appear to be a small change, the resulting overall weight gain could exceed specifications. Austal has representatives on the Mission System Integration Team to address these kinds of issues.

3.34 The LCS is being built using the principle of 'cost as an independent variable' (CAIV). Austal offers capability options within its capped price of $220 million. Where further specification changes are required the resulting cost and capability outcomes are assessed.

3.35 Delegation members spent some time discussing Austal's experiences and frustration in relation to specification changes. Austal's aluminium building provides a new, innovative and efficient approach to naval shipbuilding. Austal staff are experiencing frustration obtaining consistent and timely interpretations of naval shipping standards, which have historically been interpreted in relation to steel building. Comparisons were made between Austal's naval building experience and its commercial experience. Whereas specifications are agreed at the outset of the build process for a commercial build, for the LCS a complete set of specifications has not yet been agreed on twelve months into the two year project.

3.36 Austal's LCS ship has a scheduled production time frame of two years, compared with around four years for a regular combat ship. Representatives pointed to the advantages of Austal undertaking both the design and the build of the ship. Usually, when a design is handed over to a shipbuilder there are many consequent design modifications to enable the ship's construction to fit with the shipyard's build processes. In Austal's case, design and build issues are being resolved concurrently.

Site tour

3.37 The delegation undertook a guided tour of Austal's southern shed where the Hawaii Super Ferry was under construction, and the northern shed where the Littoral Combat Ship was under construction. Both projects were well underway and delegation members were able to gain a sound appreciation of the scale and structure of the vessels and the launching procedures. As Austal's ships are constructed under cover, the vessels are launched by rolling them out of the construction buildings on a removable track system onto a floating dry dock. The dock is subsequently flooded for ship launch.

Lockheed Martin, Moorestown, New Jersey

3.38 Lockheed Martin is principally engaged in the research, design, development, manufacture, integration and sustainment of advanced technology systems, products and services. Its core markets are Defence and Intelligence, Homeland Security and Systems and Information Technology. Lockheed Martin typically accounts for about 19 per cent of global defence exports and about 40 per cent of all US defence exports.[8] The delegation was particularly pleased to meet with Lockheed Martin as the supplier of the Aegis weapon system that is to be used in Australia's AWD program.

3.39 Lockheed Martin is structured around five core areas: Space Systems, Aeronautics, Electronic Systems, Information and Technology Services and Integrated

8 http://www.lockheedmartin.com/data/assets/969.pdf

Systems and Solutions. The delegation met with Mr Orlando Carvalho, Mr Jeff Napoliello, Mr Thomas James, Mr Timothy Broderick, Mr Timothy Fuhr, Mr Chris Meyers and Mr Ken Webb from the Maritime Systems and Sensors area, a part of the Electronic Systems division.

3.40 The delegation was also introduced to Mr Robert Coutts, Executive President Electronic Systems and Mr Fred Moosally, President Maritime Systems and Sensors, who welcomed the delegation members and thanked them for the visit. Mr Coutts expressed great pleasure at receiving representatives of a long-standing US ally and affirmed Lockheed Martin's commitment to the Aegis system and the Australian AWD project. Delegation members were also pleased and greatly honoured to be invited to meet with Mr Bob Stephens, Lockheed Martin President, CEO and Chairman of the Board.

3.41 Delegation members were interested to discuss the Aegis combat system with Lockheed Martin representatives. The Aegis system has evolved significantly overtime, with seven major upgrades. However costs have remained relatively stable. The Aegis system which will be used in Australia's AWDs is the latest upgrade (Baseline 7 Phase 1) and will also use the latest radar system (to be used on the US Navy's upcoming DDG 112).

3.42 Significantly, Aegis has moved to an open architecture approach. Put simply, this approach allows the system to be modularised, with common reusable components and platform specific components. Open architecture separates out the hardware, operating systems, middleware and software applications of a system. This enables efficient integration of Aegis with other systems and reduces IP issues, as other systems including commercial mainstream products are able to be 'plugged into' packaged Aegis modules. Also, by splitting software into components, certain parts can be upgraded independent of other parts of the system. Lockheed Martin described some of the advantages of open architecture as 'the ability to reuse applications across platforms' and 'facilitate international participation'. The ability to reuse applications across platforms can create efficiencies; for example, the same operator consols can be used on different ships and the same training provided for operators.

3.43 The increased opportunity for using commercial off the shelf (COTS) systems created by open architecture has resulted in different lifetime support issues. As commercial companies may go out of business, customers need to look well ahead in considering through-life support requirements. Lockheed Martin officials noted that while capability used to be the dominant factor when assessing technology, selection is now weighted more towards through-life support abilities.

3.44 The Lockheed Martin representatives stressed that systems integration is the major area of risk for naval shipbuilding programs. While advanced technology exists and its performance is proven, the business models underpinning projects can be the most difficult factor to manage. Lockheed Martin representatives stressed the company's proven record in managing close partnerships with a range of navies and industries over many years. Officials cited the example of a recent F310 Frigate for

the Norwegian navy, which was a major multi-national integration project. The vessel included weapons and systems built in Italy, France, Norway and Germany and the ship was built in Spain.

3.45 In relation to Australia's AWD project, officials commented on the need to build the anti-air warfare system, the combat system and the ship as a single entity, noting that the integrated Aegis system provides the basis for the ship design. Lockheed Martin representatives commented that Australia is 'buying an Aegis ship, not buying a ship and putting Aegis on it'. Lockheed Martin saw a need for up-front, clear definition of roles, responsibility and scope within the AWD alliance, with 'all players at the table'. Lockheed Martin emphasised that the relationships within the alliance would be critical to the program's success.

3.46 Lockheed Martin representatives outlined the business relationships that underpin the United States Navy Aegis ship projects. As customer, the Navy Program Office through the Program Executive Office, Integrated Warfare Systems (PEO IWS) has responsibilities in the area of systems engineering, direction, review and acceptance of the ship. Lockheed Martin as the Combat Systems Engineering Agent has responsibilities in the areas of design, engineering, production, ship integration, systems integration, land based testing and ship testing. As the shipbuilders, General Dynamics (at Bath) and Northrop Grumman (at Pascagoula) have responsibilities in the areas of design, engineering, construction, installation, testing and ship trials. Lockheed Martin noted that authority and responsibility for the success of the projects lies with the group, not one company.

3.47 The relationships underpinning the Australian AWD program have two further components. First, Raytheon Australia has been contracted as the combat systems engineer and will perform some of the roles undertaken by PEO IWS in the US model. Second, the Aegis system for the AWDs is to be purchased as government furnished equipment, bringing the US Government into the model as system supplier. Lockheed Martin emphasised that different business models are needed for different programs, with the model designed to fit both the program and the customer's resources.

The delegation being welcomed at Lockheed Martin

3.48 Delegation members participated in an interesting guided tour of some of Lockheed Martin's Moorestown facilities, including a demonstration in the Theater Network Integration Centre, and visits to the Production Test Centre in the Maritime Systems Engineering Centre, and the Combat System Engineering Development Site.

Raytheon Integrated Defense Systems, Tewksbury, Massachusetts

3.49 Raytheon Company is an industry leader in defence and government electronics, space, information technology, technical services, and business aviation and special mission aircraft. Raytheon is structured around the following major business arms: Integrated Defense Systems, Intelligence and Information Systems, Missile Systems, Network Centric Systems, Raytheon Aircraft, Raytheon Technical Services Company and Space and Airborne Systems.

3.50 Raytheon Australia, a fully owned subsidiary of Raytheon Company, has been awarded the contract as combat systems engineer for Australia's AWD program. Raytheon Australia considers that a key to its 'success and growth in Australia has been the ability and willingness of our parent company to strengthen the capability of its local subsidiary by transferring technology, knowledge, skills, and processes'.[9] The delegation was therefore keen to meet with representatives of Raytheon Company in the USA.

3.51 Raytheon's Integrated Defense Systems (IDS) business is headquartered at Tewksbury, Massachusetts. It has over 13 300 employees, customers in 34 countries and in 2005 recorded US$3.8 billion in revenue. The IDS focus is Joint Battlespace

9 Raytheon Australia, *Submission 35* to the Foreign Affairs, Defence and Trade Committee Inquiry into Naval Shipbuilding in Australia, p. 2.

Integration. Some of its products and programs include the Ballistic Missile Early Warning System, Patriot Missile System, Cobra Dane Radar System, Sea-Based X-Band Radar and Early Warning Radar.

3.52 Delegation members were pleased to meet with Mr Skip Garrett, Mr Tony Smith, Mr Bill Kicsuk, Mr Denis Donohue, Mr Tony Marinelli, Mr Myron Liszniansky, Mr Mark Russell, Ms Jane Wentworth and Mr Mike Boots, representatives of Raytheon IDS, and Mr Terry Stevenson, representative of Raytheon Australia. Mr Skip Garrett warmly welcomed the delegation on behalf of Mr Dan Smith, Raytheon Integrated Defense Systems President, noting and affirming Australia and the USA's strong bilateral relationship.

The delegation with representatives of Raytheon

3.53 Raytheon representatives provided an overview of the evolving security environment, noting that the proliferation of ballistic missiles and continuing nuclear programs mean that missile defence is rapidly becoming a core military competency. Representatives briefed the delegation on the capabilities of Raytheon's missile technology, which provides interception defence at all ranges, from boost through the midcourse to terminal stages of missile flight. Counter-measures are a critical challenge for missile defence and Raytheon has developed the Center for Discrimination Algorithms to make advancements in this area. This is a highly specialised area employing around 150 engineers.

3.54 The delegation found Raytheon's briefing and discussions on 'reachback'[10] and open architecture particularly fruitful in the context of the FADT Committee's inquiry into naval shipbuilding in Australia, and consideration of the costs and benefits of on-shore and off-shore builds. Representatives emphasised the importance of rigorous thinking and decision making to the success of naval shipbuilding programs. Mr Skip Garrett memorably commented, 'You can outsource the building, but you can't outsource the thinking'.

3.55 Raytheon representatives emphasised how important it is for customers to provide specifications for the outcomes they want, not the technology they want. This includes analysing not only desired strategic defence requirements, but also the broader aims that may be important to a customer of defence acquisitions, such as skilling the local workforce.

3.56 Mr Mark Russell, head of Raytheon IDS Engineering, commented on the relationship between systems engineering, integration and platform construction, noting that system engineers need enough shipbuilding knowledge to know what is feasible for both systems and platforms. In the Australian context, it is important for DMO and the Navy to have enough internal technical skill and ability to define needs and for these to be consistently understood throughout the entire chain of command. Raytheon representatives stressed that incremental disclosure must be avoided. Up front discussions which realistically look at all the positives and negatives of available options and are willing to address hard decisions, including trade-offs between scope, capability and cost are critical to a project's success. Mr Russell commented on the need to train engineers not only technically, but in a rational, business thinking approach. He also noted the importance of documenting all architectural decisions. For example, the through-life support needs of the AWDs will reflect the original design decisions made, including whether systems are designed for in-service support or for home-port support.

3.57 In Raytheon's experience, sourcing cutting edge technology is no longer the major issue for major naval ship projects. Execution within time and budget are the key issues, requiring disciplined thinking and processes. Raytheon representatives suggested that sourcing technology is no longer a difficulty; program success depends on how relationships between the primes and with suppliers are managed.

3.58 Delegation members asked about Raytheon's approach to finding and retaining skilled engineering staff. Raytheon has an active program targeting undergraduate engineers and also a middle school program encouraging students to undertake mathematics and science subjects. Raytheon makes a significant training and development investment in its staff. Mr Russell commented that challenging, interesting work is the key to retention. He noted that for his engineers, enjoying the

10 'Reachback' is a term used by Raytheon to describe the process by which its subsidiaries are able to strengthen their capabilities through technology, knowledge and skills transfer from the parent company.

work that they do and working in a good team was often more of an incentive than monetary considerations. Mr Russell also commented that a culture of interesting, challenging work in a stimulating team environment will need to be cultivated for the AWD project in order to retain skilled staff.

3.59 Consistent with the briefings and discussions at Lockheed Martin, Raytheon representatives also explained the technological advances being made through the use of open architecture systems. They commented that open architecture provides greater functionality and better capability for a given cost. The use of software protocols and hardware and software standards should also enable a broad supplier base and reduce system integration risks. Again Raytheon representatives emphasised that defence customers need to have sufficient technical knowledge about what they are buying, particularly if they want to change or adapt systems over time. This is relevant to Australia given the requirement for defence technology that is adaptable to Australia's specific strategic needs and operating environment.

3.60 In an open architecture environment, the interface to other systems is important. How modularised a system is and how much of the system lies within packaged architecture will strongly influence through-life support requirements and the ability of the customer to change the system over time. While the aim is to make open architecture systems as open and extendable as possible, eventually as technology continues to evolve, the capability of open architecture systems will be limited by its interface to other systems.

3.61 Because open architecture design allows different vendors to 'plug' systems into modularised components, management of commercial relations is important. Processes need to be in place allowing suppliers to sell systems without divulging the detail of how they work. Raytheon considered that where such business models are well set up and managed, they operate more efficiently than the commercial negotiations that are required for full system information exchange.

3.62 Raytheon representatives provided an overview of the DDG 1000 program, for which it is the systems integrator. As both of the DDG 1000 primary builders (NGSS Ingalls Operations and General Dynamics Bath Iron Works) were included in the delegation's program, members were interested to also gain a systems integration perspective of this major acquisition program. Raytheon has overall detailed design and integration responsibility for the program and will work with the shipyards as they prepare for the build. Lockheed Martin and BAE Systems are major subcontractors. The DDG 1000 will employ an open architecture total ship computing approach. Representatives provided an overview of the DDG 1000 critical technologies, including guns, missiles, decoys and sensors. Of the Total Ship Computing Environment, three software releases have been coded, tested and authorised. Two million lines of code have been written, with around four million remaining.

Demonstrations

3.63 The delegation viewed a demonstration of the DDG 1000 combat system operation console. Mr Dave Butter demonstrated the engagement sequence for two scenarios, one in which an incoming enemy aircraft was detected and the DDG 1000 responded, and the other in which a land-based vertical lift enemy was elsewhere detected and the DDG 1000 engaged to respond.

3.64 Representatives also demonstrated Raytheon's mission experimentation process. Raytheon describes a mission as 'a focussed application of organisations, people and systems to achieve a set of objectives'. Technology is only ever considered as a part of a mission. The delegation was shown a generic maritime threat simulation, including the algorithms behind the simulation. The simulation addressed all aspects of the mission, including technical capacity, crew abilities, fuel availability etc. to assess whether a desired outcome could be accomplished.

DDG 1000 system demonstration

Bath Iron Works, Bath, Maine

3.65 Bath Iron Works (BIW) has a long and proud shipbuilding history, beginning in 1884 with the construction of the passenger steamer the *Cottage City*. Since then BIW has been awarded more than 425 shipbuilding contracts, including 245 military ships, mostly destroyers and frigates for the US Navy. BIW has been sold three times, each following the award of major contracts. It became a wholly-owned subsidiary of General Dynamics in 1995.

3.66 In terms of modern naval shipbuilding, BIW was the lead ship builder for the FFG 7 Oliver Hazard Perry Class of guided missile frigates, delivering 24 of these

surface combatants in the 1970s and 1980s. BIW delivered eight of the CG 47 Ticonderoga Class Aegis guided missile cruisers in the 1980s and early 1990s. In 1985 BIW won contracts for detailed design and construction of DDG 51 Arleigh Burke guided missile destroyers. The last of these ships is expected to be delivered in 2010.

3.67 Bath Iron Works is currently the prime contractor for the General Dynamics Littoral Combat Ship (LCS) program. As described previously, Austal is undertaking the design and platform construction for the program. The US Navy ultimately contemplates a fleet of 30 to 60 LCSs.

3.68 The delegation met with Mr Dugan Shipway, President, Mr Tom Bowler, Vice President and Mr Alan Doughty and was very interested in their views of the US naval shipbuilding industry. Bath Iron Works is a small yard focussing on one or two main products. As a small builder, BIW is working hard to reconfigure itself and promote efficiency in order to remain viable with low rate production.

3.69 BIW currently has 5600 staff of whom 4260 are unionised. Officials noted that BIW places a particular focus on occupational health and safety and good workplace relations. Peak staffing of around 12 000 occurred at BIW during the high production years of World War II. Major capital investment was made in the early 1970s and BIW reached almost peak employment again in 1990. BIW is now aiming to reduce its staffing levels to around 3000 to 4000, in order to be efficient and viable for the future.

3.70 Major efficiency gains have been made at BIW as a result of investment in a new Land Level Transfer Facility (LLTF) in 2001–2002. Combined with improving modularisation, the LLTF has enabled increased proportions of the ship build process and fit out to occur on land, reducing water based construction and testing time. For the last ship produced at BIW using inclined slipways, 64 per cent of assembly occurred on land. Using the new LLTF, 85 per cent of assembly occurs on land. BIW representatives emphasised that the more modules that can be constructed onshore, the cheaper it is to produce ships.

3.71 BIW has significantly enhanced its use of modular technology. The advent of mega units (larger modules, weighing up to 1400 tons) has enabled ships to be built in 21 separate units. Previously 25 units, each weighing up to 480 tons, were required. A key advantage of the larger mega units is that a greater proportion of ship fit-out can be undertaken prior to the ship's final assembly.

3.72 Like Northrop Grumman, BIW also participated in the US Department of Defence's International Benchmarking study and has been able to use the experience to improve its efficiencies. In 2000 BIW rated below both the average US shipyards and international yards on a range of productivity criteria. By 2005 BIW was well above US averages and slightly above international averages.

3.73 The benefits of building multiple ships in a class were clearly demonstrated at BIW. For the DDG 51 program, the first ship took nearly 6000 hours to complete,

while ship seven took around 4500 hours. This reduction was the result of both improvements in modular processes and progress against the learning curve.

3.74 As emphasised in discussions at other yards, BIW representatives also stressed the importance of the shipbuilder and designer working closely together. Officials commented that BIW needs to be involved in the DDG 1000 design, so that the ship design will align with BIW's new efficient production processes. Officials also commented on the new business approach being used for the DDG 1000, with both BIW and NGSS designing parts of the ship and the build program being split between the two yards. This relationship means that long standing competitors are required to work together collaboratively.

3.75 In the view of BIW representatives, the US Navy has more to gain from collaboration than competition at this stage of the DDG 1000 project, but this will change in the future when the focus moves from development to quantity delivery. Representatives explained the competitive processes that had been used for the DDG 51 program. Initially, NGSS Ingalls Operations and BIW competed for batches of five ships. The winning tenderer was awarded a contract for three ships and the other builder two ships, reflecting government interest in sustaining both yards. As orders dwindled, three ship contracts were awarded to each yard. Both yards still competed on price, with the winning tenderer awarded a higher profit rate. BIW representatives considered that this process provided shipbuilders with security, while maintaining a competition driven price incentive.

3.76 BIW representatives considered that naval orders will be insufficient to sustain the yard into the future and that diversifying the product base, including moving into some commercial building may be required. BIW's intended approach is to commence with a small commercial project and on that basis consider whether further commercial operations are viable. Mr Shipway outlined three criteria for assessing the worth of commercial building: it must have no impact on naval builds, which are to remain BIW's primary focus; it must be affordable for the customer; and it must return profits to General Dynamics' shareholders. Mr Shipway did not consider incorporation of a commercial program to be an insurmountable challenge, noting that BIW is well placed to look at the lessons learned by other shipyards. Mr Shipway also noted that embracing challenges is essential for the future of the yard.

3.77 Delegation members discussed with BIW representatives the nature of government support for the naval shipbuilding industry in the USA. BIW has received government concessions in the form of business equipment tax relief for its major infrastructure investments, such as the Land Level Facility. However, such concessions do not apply to the investment made in equipment to facilitate modular construction.

3.78 Representatives also noted that, given congressional influence over naval acquisitions, industry is interested in having programs as broadly distributed as possible to shore up congressional support for a program. As an example, the

production and supply chain for the DDG 51 program included contributions from companies in 48 states.

3.79 BIW officials provided an overview of the international programs of General Dynamics, NASSCO and Electric Boat and outlined Bath Iron Works' international partnering experience. Of particular current interest, BIW provided support to ASC for Australia's AWD program. This support included a review of ASC's capability and capability gaps prior to the program tender. BIW was invited by ASC to be a capability partner to fill identified gaps. BIW also supported ASC during the request for proposal and proposal evaluation and negotiation process. BIW currently has seven employees in the AWD systems centre in Adelaide and anticipates this will increase to 20–25 employees during the construction period.

3.80 Delegation members discussed with BIW representatives issues related to offshore platform construction. BIW officials considered that offshore construction can be undertaken effectively if managed carefully. For example, the DDG 1000 program will involve ship parts being barged from NGSS Ingalls operations to BIW and vice versa. However, the representatives also noted that while Australia may be able to buy completed ships from BIW at a lower cost than building them in Australia, other issues, such as the Australian workforce and skills base and indigenous production capability need to be considered.

The delegation at Bath Iron Works, Maine

BIW site tour and tour of DDG 101

3.81 The delegation was able to get a very good understanding of BIW's modular construction processes during a site tour, which included walking through the module construction workshops and construction halls. The mega unit workshop showcased the innovative advances in the use of modularisation technology that have been made at BIW. For example, the delegation viewed a short video showing the transport of a 1300 ton mega block to the dry dock using a rolling tray borrowed from Electric Boat.

3.82 The original workshop floor used at BIW was not strong enough to carry the weight of outfitted mega blocks, so a rail system had been installed to distribute weight. Given the anticipated increase in use of mega blocks, BIW is planning to expand the workshop, building a specially designed 'ultra hall' which will be double the height of the existing workshop. This facility will be used from 2008 for the DDG 1000 program.

3.83 The delegation's tour of DDG 101 was particularly informative, in light of the earlier tour of the DDG 51 class vessel at NGSS. The BIW ship was at a more advanced stage of construction than the NGSS ship, so delegation members were able to gain a clearer understanding of the ships' fit out and finishes.

3.84 The delegation viewed the mess, galley, command and control centre and bridge. All finished equipment and systems were well covered and protected. Officials commented on BIW's proud reputation and record for care of delivered systems and equipment. BIW's emphasis on occupational health and safety was also apparent to delegation members as they toured the shipyard.

3.85 Delegation members observed that BIW's construction approach is quite different to many other yards, with smaller cranes used and effective land based movement of modules through the yard. Delegation members were interested to understand the drivers behind BIW's construction methods. Officials explained that in the 1980s and 1990s, the US government removed many subsidies for the commercial shipbuilding industry and at the same time made investments in major naval acquisitions. BIW therefore took the opportunity in the early 1990s to assess ship production techniques internationally and made a concerted effort to adopt some of the best techniques available. Government investment, combined with BIW's effective networking with other shipyards, drove BIW's production innovation and efficiency.

Concluding comments

3.86 The delegation's visit affirmed positive relationships with Lockheed Martin and Raytheon, two companies important to Australia's upcoming AWD program. The delegation was also pleased to see at both NGSS Ingalls Operations and at Bath Iron Works the successful production of Aegis ships.

3.87 It was a pleasure for the delegation to meet with Austal representatives at Mobile Alabama and to understand more fully the innovative capabilities being

developed by Austal. The delegation records its support for the progress that this Australian company is making in the US commercial and naval markets.

3.88 The delegation's visits in the USA clearly demonstrated the technological advances being made in naval shipbuilding. Modularisation techniques now apply both in platform construction and systems design. In relation to platforms, larger modules are being produced allowing more fit-out and testing to occur on land earlier in the build process. The delegation notes that international benchmarking studies have assisted US shipbuilders to improve their efficiency and production processes. In relation to systems, open architecture is enabling system components to be packaged and configured to specific requirements and combined with commercial off the shelf products.

3.89 Each of the companies visited by the delegation emphasised the importance of ship designers and builders working together in the production of naval vessels. Similarly, companies stressed the importance of systems developers and integrators working with ship designers and builders. The delegation was given the clear message that naval ship production is an integrated process and that platform design and production and systems design and production cannot be considered in isolation.

3.90 Both Lockheed Martin and Raytheon presented the view that in the current era of advanced technology shipbuilding, appropriate business models and management of client relationships are integral to successful project delivery. The delegation was cognisant that in the Australian context, the Defence Materiel Organisation has a critical role in managing complex contracts and complex alliance relationships in order to successfully deliver upcoming programs.

3.91 It was apparent that naval shipbuilding in the USA occurs within a highly supportive legislative and political context. Tendering processes, such as the allocation of build contracts between yards and use of cost plus contracts, also sustain the indigenous industry. Capability advancement is a key consideration for the USA industry and it was apparent that the government has invested heavily in retaining and developing this capability edge.

Acknowledgements

3.92 The delegation was very pleased to visit Northrop Grumman Ship Systems, Austal, Lockheed Martin, Raytheon and Bath Iron Works. The program provided useful insights into a range of aspects of naval shipbuilding in the USA, including platform construction and systems development and integration.

3.93 The delegation thanks the officials of each of the above companies for their official hospitality, informative meetings, site tours and demonstrations. The delegation is particularly grateful as a number of the visits were arranged within a relatively short timeframe.

Senator David Johnston
Delegation Leader