

## Is There a 'Made in Canada' Premium for Building Warships?

Dr. Eric Lerhe

There is probably no aspect of the National Shipbuilding Strategy (NSS) more contentious than the premium Canadian taxpayers pay for constructing warships in Canada. It has been argued that Canada will pay five times what the Koreans might charge for the supply ships and seven times what a Polish-built Arctic patrol ship would cost.<sup>1</sup> Yet in 1999, DND's audit office, the Chief of Review Services (CRS), compared the cost of the Canadian Patrol Frigate (CPF) with the costs of other Western-built warships and found that "the production cost for the last ship is reasonably competitive with other nations."<sup>2</sup>

There was no way to corroborate or update the CRS findings until the publication of the 2014 RAND report "Australia's Naval Shipbuilding Enterprise."<sup>3</sup> I will be making the case that this study provides lessons in cost premiums and shipbuilding efficiency for the NSS and particularly the Canadian Surface Combatant (CSC).

### CRS Cost and Capability Comparison 1999

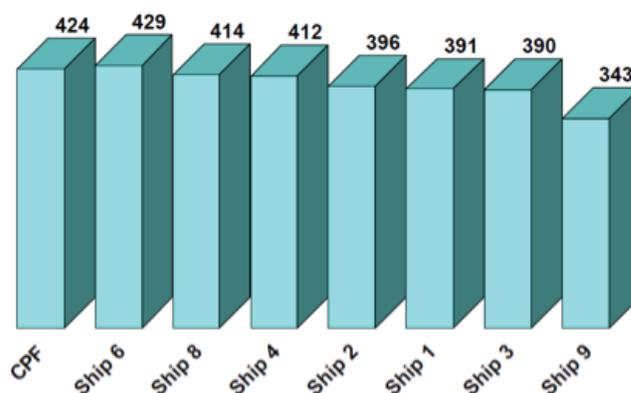
The CRS report compared the costs and capabilities of the CPF with seven to 11 other Western frigates. The centrepiece of its comparison was the CPF "Sailaway Cost Comparison" graph and the assertion that the cost of the last Canadian frigate built was 'reasonably competitive' with its Western counterparts.

Figure 1 makes clear that the CPF costs were within 7% of the average cost of the counterpart ships. As you can see from the figure, only seven ships of the 11 ships could be compared for sail-away cost because of incompatible or missing data.<sup>4</sup>

The CRS study also compared the fighting capability of the CPF with its Western equivalents. The study concluded that the CPF was the combat superior to all of the ships under consideration except for one which was its apparent equal.<sup>5</sup> An annex provided the warship details to allow a ship-to-ship measuring of the actual capability differences. In more subjective areas like systems integration the CRS report relied on outside assessors, such as the US-based group Forecast International or major international journals to make the case. An article in the journal *Naval Forces*, for example, described the CPF's successful and fully distributed command system as a world "first."<sup>6</sup>

The CRS report hinted at problems other ships had in the command system category. Ship 1 was the British Type 23, which an article in the respected journal *SIGNAL* described as a "worst-case scenario" of combat system "disintegration," noting "[t]he first seven ships, F230 to F236, were at sea for more than 10 years without any combat display system at all."<sup>7</sup> Ship 2 was the USS *Oliver Hazard Perry*-class frigate (FFG-7), and the first of these was delivered without a naval tactical data system or towed array. Ship 4 was the French *Lafayette*-class, which the CRS report notes lacked a sonar, towed array and anti-submarine torpedo tubes. Moreover, the detailed capability annex to the CRS report show its anti-surface and anti-air weapons were inferior to the CPF. Regrettably, the CRS report

Figure 1. CPF Sailaway Cost Comparison with Frigates from 7 States (\$M)



Note: Design, facility, depot spares, PMO, documentation and training costs are not included in NATO sailaway costs.

Source: DND, Chief Review Services, "Report on Canadian Patrol Frigate Cost and Capability Comparison," Figure 4, p. 10.

did not relate ship combat capability to ship cost. There are now, however, studies that partially resolve this.

In 2014 the RAND Corporation was engaged by the Australian Department of Defence to examine Australia's shipbuilding industry, suggest alternate approaches, and gauge the 'made in Australia' premium for warships. Given that the Australian experience is also one of 'boom and bust' offset by a navy that needed advanced warships, there are obvious parallels to Canada.

The Australian study too had difficulty extracting national ship cost data and, like the DND CRS study, relied on a modified form of sailaway cost it termed the 'unit procurement' cost or 'purchase price' that also excluded design costs. However, in a partial effort to include capability within its costing comparisons it used cost per ton (CPT) data rather than simple cost as it compared the *Anzac* frigate to a range of foreign warships including, thankfully, the USN FFG-7 that was also measured in the 1999 Canadian study. In fact, throughout the RAND study, US equipment and costs were the baseline against which Australia was measured. This allows one to input Canadian CPF data into the same calculations and the results are shown in Table 1.

This table shows that the Australian *Anzac* frigate had a cost per ton that was some 42% higher than the USN FFG-7 baseline (the number was obtained by adding 1.36 and 1.48, and dividing by 2). The CPF cost per ton range averages out to only 4.5% higher. This comparison certainly shows that Canada should not be expecting a significant 'made in Canada' premium based on CPT data.

The RAND report also partially offsets the problematic warship costing data by examining a spread of inputs that include shipyard labour rates, broad industry construction costs and



productivity instead of relying on costing data alone. Many of these input data sources are available on the internet and are pulled from credible sources – like the US Bureau of Labor Statistics. The logic underpinning the RAND analysis is that labour costs and yard productivity have a direct bearing on warship costs (representing up to 40% of their value) because the remaining material costs are likely to be equal given that much of the combat systems and ship machinery is purchased on the international market.<sup>8</sup> An Industry Canada analysis of warships and patrol vessels came to the same conclusion.<sup>9</sup>

RAND begins the labour and productivity comparison by comparing shipbuilding wages in Australia with those of other states baselined against the United States. I have added the 2013 Canadian data from Industry Canada which uses the same index as RAND’s US source and I have done the currency conversion.

While the Australian shipyard rates were 39% higher than the US baseline rates in 2013, Canadian rates were 17% less. This indicates significantly lower actual labour costs combined with a cost-favourable currency exchange rate with regard to the United States.

A similar effort was made to compare hourly compensation costs which add sick pay, vacation, health insurance, unemployment insurance and payroll taxes to the basic national manufacturing labour cost. The same US Bureau of Labor Statistics “International Comparisons” source used by the RAND report shows Canada’s rate as 4% higher than the US baseline rate while Australia’s is 34% higher.

The RAND report then compares construction costs using Compass International data on the oil and gas industry as the

shipbuilding industry employs many of the same trades and contractors.<sup>10</sup> This combined labour, equipment and construction costs, and I used the same source and ratios to derive like Canadian oil and gas costs. The results show Canada’s Gas Plant Construction costs as 20% higher than the US costs, in part reflecting Compass International assigning a 1.15 labour productivity index to Canadian industrial labour overall. RAND calculated the same percentile for the Australian gas plant costs.

RAND then used First Marine International (FMI) shipyard productivity data to assess relative Australian construction costs. These costs were assessed as 45% higher than the US baseline relying primarily on the problematic Australian Air Warfare Destroyer (AWD) program.<sup>11</sup> While the RAND report based its relative construction costs on a ‘compensated gross tonnage’ system that included no Canadian data, the report notes that those results are “consistent with the view of that program’s [the AWD] performance.” That and the extensive use of FMI standards by both Australia and Canada allow a credible comparison with current Canadian productivity within the NSS.

The Australian approach to building the AWD relied on a distributed construction approach whereby three different yards built large modules which were transported for assembly in the Australian Submarine Corporation (ASC) yard near Adelaide. However very early it was discovered that the contributing BAE yard in Williamstown had one of its blocks “out of dimensional tolerance” and “distorted” according to the Australian National Audit Office (ANAO).<sup>12</sup> The remaining module work assigned to BAE then had to be transferred to Navantia’s Spanish and British yards.

**Table 1. Unit Procurement Cost and Relative Index Cost Data, Frigates**

| Ship                           | Country       | Relative CPT Index <sup>a</sup> |             |
|--------------------------------|---------------|---------------------------------|-------------|
|                                |               | Low                             | High        |
| F590 FREMM                     | Italy         | 0.95                            | 1.00        |
| D650 FREMM                     | France        | 1.18                            | 1.24        |
| De Zeven Provinciën LCF        | Netherlands   | 1.00                            | 1.07        |
| Iver Huitfeldt                 | Denmark       | 0.56                            | 0.62        |
| Anzac                          | Australia     | 1.36                            | 1.48        |
| Incheon                        | Korea         | 0.65                            | 0.75        |
| Oliver Hazard Perry FFG-7      | United States | 0.93                            | 1.07        |
| Littoral Combat Ship           | United States | 1.42                            | 1.44        |
| <b>Canadian Patrol Frigate</b> | <b>Canada</b> | <b>0.83</b>                     | <b>1.26</b> |

**Notes:** (a) *Oliver Hazard Perry*-class FFG-7 is set to 1.0; (b) because the authors did not have costs split by variants, they reported an average cost instead. Also, these costs do not include mission module costs.

Source: With the exception of the Canadian data, this data is taken from Table 5.9 of RAND, “Australia’s Naval shipbuilding Enterprise,” 2015.

Sources for Canadian data: The average cost per ton ratio between the CPF and FFG-7 was 104%. The CPF data shown comes from CRS, “Report on Canadian Patrol Frigate Cost and Capability Comparison,” the combined DND/PWGSC report, and interview data then converted to cost per ton. This is then baselined to the FFG-7. The latter is 1150 tons less than the CPF’s 5235 tons. For FFG-7 costs I used the NAVSEA 017 Ship Acquisition Database data quoted in Robert Francis Dudolevitch, “A Cost Comparison between Active and Naval Reserve Force FFG Seven Class Ships,” Thesis, Naval Postgraduate School, Monterey, California, 1993, p. 7. I also used Forecast International, “FFG-7 Oliver Hazard Perry Class (archived),” August 2002, p. 4.

**Table 2. Direct Hourly Wage Rates for Boat and Ship Building**

| Country       | Direct Pay per Hour <sup>a</sup> | Converted Direct Pay (AUD per hour) | Relative Pay (USA = 1.0) | Source  |
|---------------|----------------------------------|-------------------------------------|--------------------------|---|
| Australia     | AUD 38.80                        | 38.80                               | 139%                     | Australian Bureau of Statistics, "Employee Earnings and Hours, Australia," May 2013   |
| USA           | USD 24.50                        | 27.84                               | 100%                     | US Bureau of Labor Statistics, "National Industry-Specific Occupational Employment and Wage Estimates: NAICS 336600 – Ship and Boat Building," May 2013 |
| UK            | £ 16.35                          | 29.75                               | 107%                     | UK Office for National Statistics, "Weekly Pay – Gross (£) – for Full-Time Employee Jobs: United Kingdom, SIC2007, Table 16.1a," 2013                   |
| <b>Canada</b> | <b>CAD 23.00</b>                 | <b>23.23</b>                        | <b>83%</b>               | <b>Industry Canada, "Ship and Boat Building: Salaries and Wages," NAICS 3366, 2013</b>  |

**Notes:** Values are reported on a fixed 2013 basis; (a) value has been escalated from 2012 to 2013 to be on a comparable basis.

Source: With the exception of the Canadian data, this table came from RAND, "Australia's Naval Shipbuilding Enterprise," Table 5.1. The Canadian data was obtained from Industry Canada, as noted in the source column.

FMI, a recognized assessor of shipyard productivity, was brought in to advise the government at construction start. It reported to the government, and its role towards the shipyards was one of suggestion and focused on productivity improvements. Three years later, however, FMI claimed that only 5% of the issues it had raised with the shipyards had been "resolved," with another 24% partially resolved. And 68% were "issues where little effective action had been taken," or new issues.<sup>13</sup> Moreover, the project's program manager reported that the "call for improvement has not been consistently accepted by the shipbuilder."<sup>14</sup> Unsurprisingly, the program was late and over budget.

The situation in Canada under the NSS is quite different, especially in the more powerful role played by FMI as the productivity monitor. In Canada's case, FMI was brought in as a third-party assessor by the government five years before construction began. It assessed which two of the five competing Canadian shipyards were likely to be able to meet international standards for efficiency and it outlined to the winning yards precisely what productivity investments were needed. It will assess whether the Halifax and Vancouver yards have met the 'target state' production efficiency that will place them in the top quartile of shipyard productivity in the world. Undoubtedly, once reached, one can expect ongoing measurement to ensure efficiency is maintained and improved. Moreover, follow-on shipbuilding contracts are understood to be conditional on them maintaining 'top quartile' standards.<sup>15</sup> There have been public reports that they are meeting those goals and the two yards openly supported the FMI process.<sup>16</sup> They are specifically not resorting to the distributed construction approach used in the Australian AWD. The Irving yard will also have its CSC workforce prepared by five years work on the Arctic Offshore Patrol Ship. All of this suggests that Canadian productivity is likely to be within the top quartile of efficiency demanded by the contracts. This should, as a result, mean relative costs will be in a 25% band centred on the US baseline.

Table 3 shows the Canadian data from the previous tables, save for 'parametric' data, 'Destroyer costs' and 'Amphibious ship

costs.' There is no matching recent Canadian data on the latter two, and the parametric process used within the RAND report is not accessible. Where RAND argued the Australian premium was in the 30-40% range, my data suggest that the 'made in Canada' premium for warships lies in a band -17 to +26% centred on 4%, a result not far from the 1999 CRS result. I fully admit that I should be ready to have other researchers expand that band. But what is absolutely clear is that no foreign yard offers the possibility of warships five to seven times cheaper.

### Conclusion

The RAND report argued that it could reduce the 'made in Australia' shipbuilding premium from 30-40% to 20% if the government moved to a continuous shipbuilding strategy and introduced a form of continuous improvement, much like that within the Canadian NSS process. It also argued that the long-term allocation of government warship work would encourage the needed investments in shipyards and worker upgrading also seen in Canada.

A year later, the Australian government followed that recommendation and assigned frigate and patrol shipbuilding contracts worth (AUD)\$40 billion to ensure a continuous series of work would follow the AWD project. As the Canadian NSS process had started that same path six years earlier, it seems difficult to believe that Canada's building premium could exceed Australia's targeted 20% rating.

These two studies demonstrate that a country will only be able to maintain low national premiums for shipbuilding if it learns certain lessons, including:

- Shipyards building government vessels will only invest in modern facilities and trained workers if there is predictable long-term government work. The NSS needs to maintain its 30-year outlook.
- Within that long-term outlook governments also have a responsibility to ensure their ship needs do not arrive in a boom-and-bust cycle. Load leveling is needed, otherwise shipyards face gaps and difficulty retaining skilled workers.



**Table 3. Summary Metrics for Australian and Canadian Shipbuilding Costs Relative to a US Basis**

| Method      | Metric   | Approximate Australian Premium Relative to a US Basis (%) | Approximate Canadian Premium Relative to a US Basis (%) |
|-------------|--|---|---|
| Input       | • Direct shipbuilding labor wages                              | 40  | -17   |
|             | • Manufacturing labor costs                                    | 35  | 04  |
|             | • Oil and gas industry construction                            | 20  | 20  |
|             | • Construction costs adjusted to FMI shipbuilding productivity | 45  | -12.5 to +12.5  |
| Comparative | • Frigate costs  | 40  | -17 to +26  |
|             | • Destroyer costs  | 30  | N/A   |
|             | • Amphibious ship costs  | 12  | N/A   |
| Parametric  |  | 35  | N/A   |

Source: The Australian data is from RAND, *Australia’s Naval Shipbuilding Enterprise*, 2015, Table 5.13. The Canadian data is a summary of Canadian data presented in previous tables here.

- Shipyards, in return, must continue the drive for efficiency and the government has every right to monitor this via mechanisms such as FMI assessments.
- Governments have recognized and must continue to recognize that there is no point allowing new, and especially unreformed, shipyards into this mix.
- All the ships of one class must be built in one yard and not distributed to provide short-term regional benefits. This can reduce the learning curve and lead to greater efficiency. 🍷

11. *Ibid.*
12. Australia, National Audit Office, “Audit Report No. 22 2013–14 - Performance Audit Air Warfare Destroyer Program,” Canberra, March 2014, p. 223.
13. *Ibid.*, p. 255. The missing 3% is not explained.
14. *Ibid.*, p. 257.
15. Tom Ring, “The National Shipbuilding Procurement Strategy: How Did We Get to Where We are Now?” Canadian Global Affairs Institute Policy Update, March 2016, pp. 4, 9.
16. *Ibid.*, pp. 4, 5.

**Notes**

1. Terry Milewski, “Canada’s Vast Shipbuilding Plan Still at Starting Line,” *CBC News*, 4 May 2015.
2. Department of National Defence (DND), Chief Review Services (CRS), “Report on Canadian Patrol Frigate Cost and Capability Comparison,” 7050-11-11 (CRS), 26 March 1999.
3. John Birkler, et al, *Australia’s Naval Shipbuilding Enterprise: Preparing for the 21<sup>st</sup> Century* (Santa Monica, CA: RAND Corp. 2015).
4. The CRS study found that four of the ships had sailaway costs that were greater than acquisition costs. Some elements of this comparison were criticized, with one reviewer pointing out the report’s elimination of design costs potentially skewed the cost calculations in favour of the 12 ship CPF program (and other smaller ship runs). The CRS report was justified in so doing given the lack of such data from most of the other ships, coupled to the fact that during the FFG-7 project (one of the ships compared with the CPF), the Congressional Budget Office reported that the US Navy did not pay for detailed design work with production funds. There were other complications, including the Canadian government’s insistence that the salaries and benefits of the 300 personnel in project management be included in the project’s costs as well as a decision to provide the CPF with 15 times the spares of comparable US or NATO ships.
5. CRS, “Report on Canadian Patrol Frigate Cost and Capability Comparison,” p. 10/13. From Annex A it is also relatively easy to identify Ship 1 as UK Type 23, Ship 2 as USS *Oliver Hazard Perry*-class frigate, Ship 4 as French *Lafayette*-class, and Ship 7 as Australian *Anzac*-class. I am not certain of the identity of the others due to their lack of distinctive features.
6. Anthony Reston, “Seeing the Big Picture,” *Naval Forces*, November 1994, Volume XV.
7. James C. Bussert “Foreign Navies Combat System Dis-Integration,” *SIGNAL*, March 2003, p. 1.
8. RAND, *Australia’s Naval Shipbuilding Enterprise*, p. 104 and p. 108, footnote 14.
9. Mott MacDonald, “Economic Analysis of National Shipbuilding Procurement Practices: International Comparison of Ship Construction Costs – Deliverable C,” report prepared for Industry Canada, May 2009, Report has been redacted, p. 3-1.
10. RAND, *Australia’s Naval Shipbuilding Enterprise*; and Compass International, *2014 Global Construction Costs Yearbook* (Morrisville: Compass International, 2014).

*Dr. Eric Lerhe retired from the Canadian navy at the rank of Commodore. He received his PhD from Dalhousie University and is currently a Senior Research Fellow at the Centre for Foreign Policy Studies at Dalhousie.*