June 28, 2024

The Polar Icebreaker Project: 2024 Update

OFFICE OF THE PARLIAMENTARY BUDGET OFFICER
BUREAU DU DIRECTEUR PARLEMENTAIRE DU BUDGET

The Parliamentary Budget Officer (PBO) supports Parliament by providing economic and financial analysis for the purposes of raising the quality of parliamentary debate and promoting greater budget transparency and accountability.

This report provides an updated independent cost estimate of the Development and Acquisition phases of the Polar Icebreaker Project.

Lead analysts:

Mark Creighton, Analyst
Albert Kho, Analyst

Prepared under the direction of:

Christopher E. Penney, Acting Director of Policy (Costing)

Nathalie Desmarais, Marie-Eve Hamel Laberge, Martine Perreault and Rémy Vanherweghem assisted with the preparation of the report for publication.

For further information, please contact the Office of the Parliamentary Budget Officer.

Yves Giroux
Parliamentary Budget Officer

Table of Contents

Highlights

The acquisition of 2 Polar Icebreakers is estimated to cost $8.5 billion. This cost includes all relevant components of the Development and Acquisition phases of the project.

The first Polar Icebreaker is expected to be delivered in 2030-2031, and the second in 2032-2033. This represents a 1 and 2 year delay for the first and second vessels, respectively, relative to prior PBO work on this Project in 2021.

A one-year delay to both vessels is estimated to cost an additional $260 million while a two-year delay is estimated to cost an additional $530 million.

Summary

The Polar Icebreaker Project was launched by the Government of Canada in 2008 to replace the Canadian Coast Guard's (CCG) fleet of heavy icebreakers with a new class of heavy icebreakers built to modern specifications. The Polar Icebreaker project calls for the acquisition of two vessels, with one being constructed at Vancouver Shipyards (VSY) in British Columbia, and another at Chantier Davie Canada Incorporated (CDCI) in Québec.

This report is an update to prior PBO work from 2021 on the Polar Icebreaker Project.[1] It is an independent cost estimate of the Development and Acquisition phases of the Project with a sensitivity analysis for a one-year and two-year delay to the start of construction for both vessels. We used a set of analogue approaches based on four procurement programs to estimate the cost of these activities.

Based on information provided by the Department of Fisheries and Oceans (DFO), PBO anticipates that the construction process will span seven years. Construction on the first vessel from VSY begins in 2024-2025 and finishes with delivery in 2030-2031.

The Government of Canada is currently in negotiations with CDCI to establish timelines for the Project's second vessel. We assume that construction on the second vessel will begin two years after VSY in 2026-2027 and delivery will be in 2032-2033.

Table 1 presents a summary of the fiscal results of the analysis. We estimate the total project cost to be $8.5 billion, inclusive of project management costs of $420 million, design costs of $960 million, and acquisition costs of $7.1 billion. This represents a $1.3 billion increase over the prior PBO estimate. Delays of one or two years are expected to increase project costs by $260 million or $530 million, respectively.

Polar Icebreaker Cost

The total project cost is estimated to be $8.5 billion, representing a $1.3 billion increase over the prior PBO estimate.

Table 1

Activity costs, millions of dollars

Activity	Estimate	One Year Delay	Two Year Delay
Project Management	420	460	490
Design	960	970	980
Acquisition	7,130	7,350	7,580
Total	8,520	8,780	9,050

Source:

Office of the Parliamentary Budget Officer calculations.

Note:

Figures are in nominal dollars. All costs are exclusive of any applicable taxes. Numbers may not add due to rounding.

Introduction

The Polar Icebreaker Project was launched by the Government of Canada in 2008 to replace the Canadian Coast Guard's current fleet of heavy icebreakers with a new class of heavy Icebreakers built to modern specifications. The project was originally intended to construct a single new polar icebreaker with an estimated cost of 720 million that would achieve operational status in 2017.[2] The delivery date was subsequently delayed to allow Vancouver Shipyards (VSY) to finish its work on the Royal Canadian Navy's Joint Support Ship (JSS) Program. Delays surrounding the Joint Support Ship program prompted additional delays to the Polar Icebreaker Project, requiring that the current existing heavy icebreaker, the Canada Coast Guard Service (CCGS) Louis S. St-Laurent, undergo a life extension program.[3]

The Polar Icebreaker Project calls for the acquisition of two new vessels, with one being constructed at VSY in British Columbia and another at Chantier Davie Canada Incorporated (CDCI) in Québec. The Government of Canada is currently in negotiations with CDCI regarding the vessel that they will construct.[4]

We anticipate that the construction process will span seven years, with construction on the Vancouver Shipyard vessel beginning in 2024-2025 and being delivered in 2030-2031. The Government of Canada is currently in negotiations with Chantier Davie Canada Incorporated to establish timelines for the second vessel. PBO assumes that construction will begin two years after VSY in 2026-2027 and that the second vessel from CDCI will be delivered in 2032-2033.

This report provides an updated cost estimate of the Polar Icebreaker Project, following prior PBO work in 2021 on this subject. We incorporate all applicable costs associated with the Development and Acquisition phases for the program. We estimate each of the following categories:

- Government project management costs for the Development and Acquisition phases;
- Design costs;
- Studies, analysis, and engineering support costs;
- Acquisition costs including the cost of initial spares; and,
- System test, trials, and evaluation costs.

We estimated each of these cost categories using analogue approaches based on historical and contemporary experiences of other procurement programs. These programs include the Arctic and Offshore Patrol Ship (AOPS) program, the Joint Support Ship (JSS), the Offshore Oceanographic Science Vessel (OOSV), and the United States Navy's Lewis and Clark-class Support Ship (T-AKE) program. The results of these analogues were combined to produce the final cost of the Polar Icebreaker Project.

Table 2
Polar Icebreaker Characteristics

Characteristic	Value
Weight, Full Load	26,000 metric tonnes
Length	158 m
Beam	28 m
Max Speed	Top speed - 20 knots Ice breaking speed – 4.7 knots in 2.2 m of first-year ice with 30 cm snow cover
Crew	100
Propulsion	Diesel electric
Ice Class	Polar Class 2 "Icebreaker +"
Helicopter Capacity	2

Source:

Department of Fisheries and Oceans.

Aker Arctic (Updated Ship design)

Seaspan (Ship construction)

Note:

A knot is a nautical unit of speed equal to one nautical mile per hour, or 1.852 kilometres per hour.

Polar Class is the classification assigned to ships based on their operational capabilities through polar waters developed by the International Association of Classification Societies.

The "Icebreaker +" notation refers to a vessel that has undergone a rigorous assessment to determine if its operations require any additional strength above the "Icebreaker" requirements. The Icebreaker + notation ensures that a vessel is structurally sound to withstand forces it will encounter in its operational environment.

Estimates

The estimates made in this section are derived from specifications provided to the PBO by the Department of Fisheries and Oceans (DFO) and are current as of May 2024. The Polar Icebreaker Project is currently in the Acquisition phase, which is inclusive of all construction activities, as well as outlays associated with initial studies, analysis, and engineering support, the acquisition of initial spares, and system test, trials, and evaluation. Construction activities for the first vessel are expected to begin in 2024-2025. The Government of Canada is currently in negotiations with CDCI for the second vessel to determine its construction timeline.

Compared to other naval vessels, estimating costs for large polar icebreakers present an additional challenge as there are not many existing vessels of similar specifications and capacities. Using historical and contemporaneous procurement programs for vessels that have either a "right size, wrong mission" or "right mission, wrong size" specification profile as a basis of cost estimation addresses this challenge to get an appropriate cost for the project.[5]

Data and Methodology

The methodology used to estimate the costs for the Polar Icebreaker Project is based on the analogue approach used in the 2021 PBO report on the Project. The costs for the Polar Icebreaker Project are divided into two categories: ancillary project costs and acquisition costs. These are estimated separately.

Ancillary costs include all program costs that do not directly relate to construction activities. These include project management costs during the Development and Acquisition phases, and design costs.[6] The estimate of the Government's project management cost is estimated using project management expenditures associated with the AOPS program, adjusting for the inclusion of an additional shipyard. Design costs were estimated using the relationship between the AOPS design cost and lightship weight.

Acquisition costs include all construction activities as well as expenditures on initial studies, analysis, engineering support, initial spares, trials, and evaluation. Our estimate of Acquisition costs for the Polar Icebreaker Project are based on four analogue procurement programs: the Royal Canadian Navy's AOPS and JSS Programs, the CCG's

OOSV program, and the United States Navy's T-AKE program. To estimate the Acquisition cost for the Polar Icebreaker Project, we normalize the first ship costs from each of the four analogue programs to a common base year, then scale them to account for the difference in lightship weight between the different vessels and the Polar Icebreakers, with a non-linear relationship applied between weight and ship cost. Additional adjustments were made for the Lewis and Clark-class vessels to account for differences in labour productivity and costs, and exchange rates between the United States and Canada.

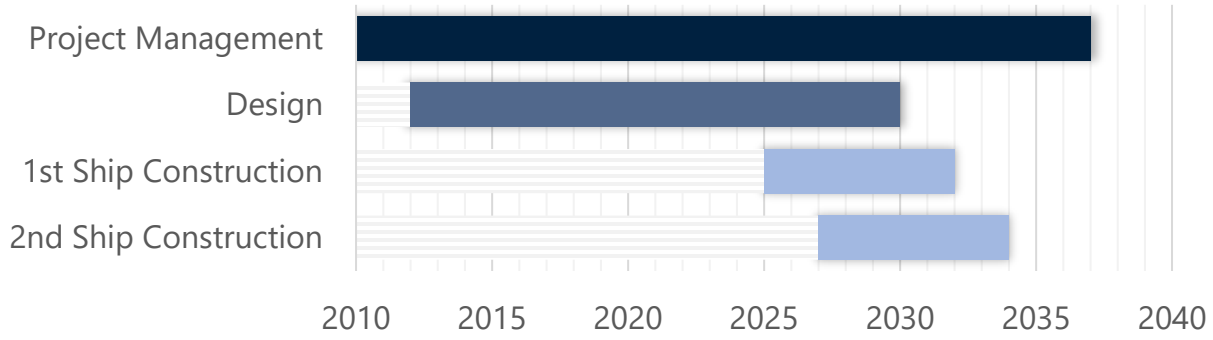
Assumed Project Timelines

Figure 1 presents the estimated timelines for the progression of the Polar Icebreaker Project based on PBO calculations and inputs provided by DFO, accounting for prior experience with the project so far.

Project management started to incur costs in fiscal year 2009-2010 and it is assumed that these costs will continue until 2035-2036. Design activities are assumed to have begun shortly after the program began and are expected to be complete by 2028-2029. Construction of the first ship at VSY is scheduled to begin in 2024-2025. The Government of Canada is currently in negotiations with CDCI to determine the production timelines of the second vessel. PBO currently assumes construction of this vessel will begin in 2026-2027, two years after construction begins on the first ship at VSY. The two vessels are expected to be delivered in 2030-2031 and 2032-2033, respectively.

Costs pertaining to each category are not distributed uniformly over these periods. We distribute the estimated real costs over the assumed timelines according to the experience and projected expenditure profiles of the JSS program; these real costs are then adjusted for inflation and, where necessary, shipbuilding-specific inflation to produce the final cost estimate of the Program.

Figure 1
Polar Icebreaker Timelines



Textual description:

Activity	Fiscal Year Started	Fiscal Year Completed
Project Management	2009-2010	2035-2036
Design	2011-2012	2028-2029
1st Ship Construction	2024-2025	2030-2031
2nd Ship Construction	2026-2027	2032-2033

Source:
Office of the Parliamentary Budget Officer.

Department of Fisheries and Oceans.

Note:
The listed timelines for the second vessel represent PBO estimates as the Government of Canada is currently in negotiations with partner shipyard CDCI.

Total Project Costs

We estimate the Polar Icebreaker Project will cost a total of $8.5 billion dollars. Table 3 presents a breakdown of the constituent elements of these costs. PBO estimates project management expenditures for the Development and Acquisition phases of the Project to be $420 million, Design costs to be $960 million, and Acquisition costs including all those associated with construction to be $7.1 billion.

Table 3
Activity costs, millions of dollars

Activity	Estimate
Project Management	420
Design	960
Acquisition	7,130
Total	8,520

Source:
Office of the Parliamentary Budget Officer calculations.

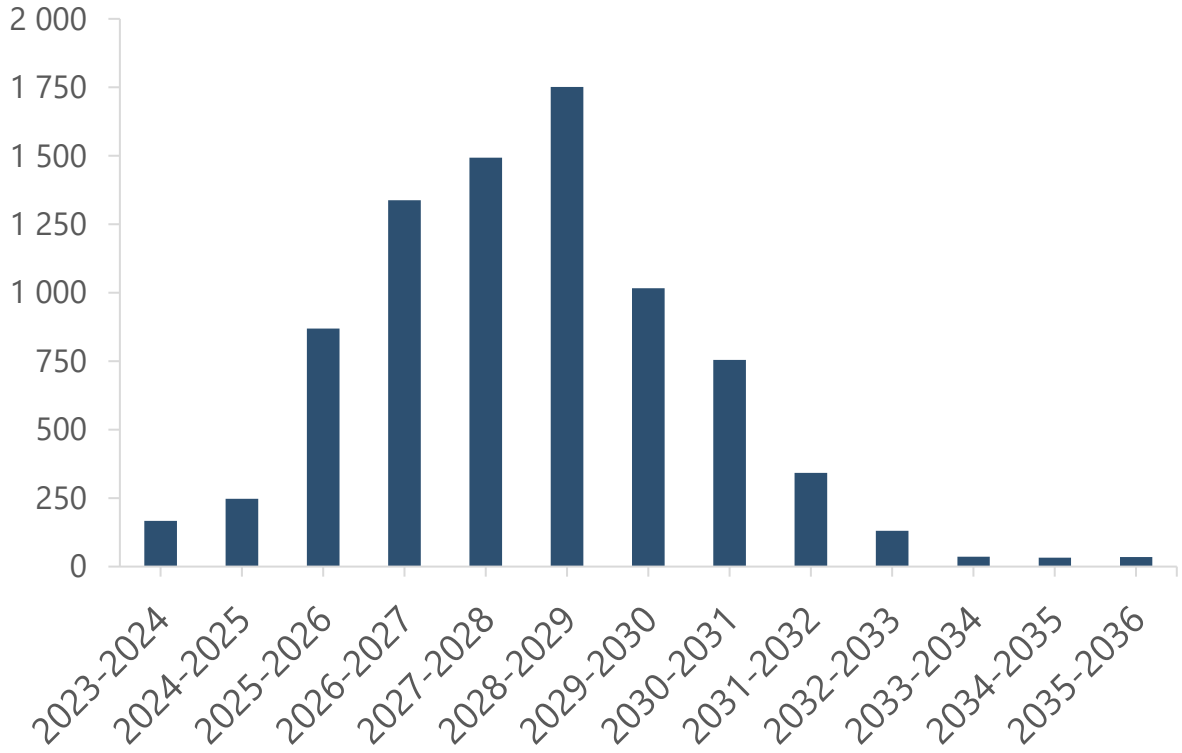
Note:
Values are in nominal dollars.

These costs represent an increase of about $1,270 million over the estimate in the 2021 PBO report on this project. There are several factors that contributed to this increase. The first was an increase in the overall tonnage of the vessel, from a full load weight of 23,500 metric tonnes as reported in 2021 by PBO to 26,000 metric tonnes. Second, the previous report did not account for higher-than-expected inflation in the intervening years.[7] Third, continued delays to the program which resulted in a longer Development phase, and a subsequent decrease in purchasing power in the Acquisition phase due to inflation.

Figure 2 depicts the expenditure profile of the Polar Icebreaker project over its duration. Expenditures increase rapidly in 2025-2026 as construction activities increase, peaking in 2028-2029. Expenditures then decline near the end of the construction period, with the delivery of the second vessel expected in 2032-2033. This expenditure profile is reported on a cash basis, and subsequently will differ from what will appear in the Government's financial statements that are presented on an accrual accounting basis.

Figure 2

Polar Icebreaker Project Expenditures 2023-2024 to 2035-2036, millions of dollars



Textual description:

Fiscal year	Expenditure
2023-2024	170
2024-2025	250
2025-2026	870
2026-2027	1,340
2027-2028	1,490
2028-2029	1,750
2029-2030	1,020
2030-2031	760
2031-2032	340
2032-2033	130
2033-2034	40
2034-2035	30
2035-2036	30

Source:
Office of the Parliamentary Budget Officer.

Note:
Expenditures are shown on a cash basis. Expenditures from prior years are excluded. Totals may not add due to rounding. The sum of the listed expenditures will not total the estimate of the program as expenditures from prior years are excluded.

Sensitivity Analysis

A sensitivity analysis was carried out to determine the fiscal impact of a one-year and two-year delay to the start of construction for both vessels at each shipyard. Concurrent design costs would be similarly delayed. Project management costs are assumed to increase due to the Polar Icebreaker Project being subsequently delayed. Table 4 displays the results of the sensitivity analysis. A one-year delay results in an increase of $260 million, and a two-year delay increases expenditures by $530 million.

Table 4
Activity costs, millions of dollars

Activity	Estimate	One Year Delay	Two Year Delay
Project Management	420	460	490
Design	960	970	980
Acquisition	7,130	7,350	7,580
Total	8,520	8,780	9,050

Source:
Office of the Parliamentary Budget Officer calculations.

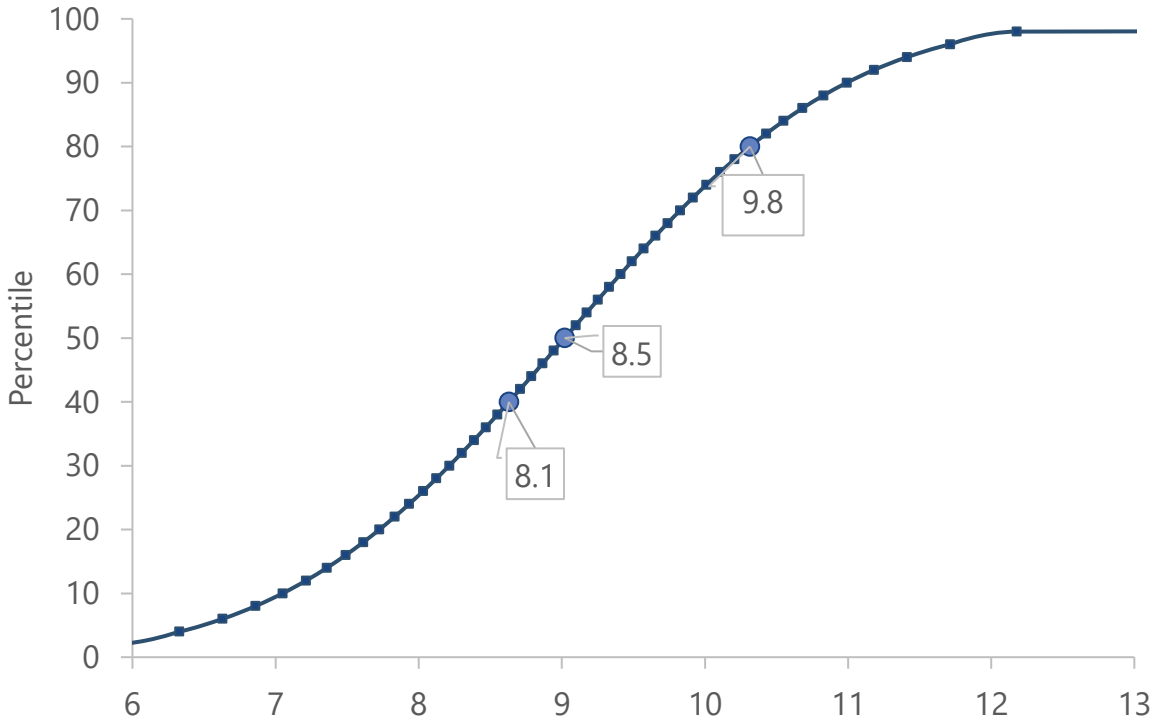
Note:
Values are in nominal dollars.

Modelling Uncertainty

Acquisition costs are the largest category of the total cost estimate. These were calculated using four analogues. Three of these are existing Canadian procurement programs, and one is a historical US Navy procurement. The averages of these different approaches were used to create an estimate of total acquisition costs. The variance of the constituent estimates was calculated to model the inherent uncertainty in this approach.

Figure 3 displays the results of this calculation. The 50th percentile of $8.5 billion represents the "most likely" price tag of the project and is the total cost estimate discussed in prior sections. We also estimate a low-end cost, evaluated at the 40th percentile of the total project cost distribution of $8.1 billion, and a high-end cost, evaluated at the 80th percentile of $9.8 billion. Consequently, modelling imprecision may result in a decrease in expenditures of $0.4 billion, or an increase of $1.3 billion when compared to the point estimate of $8.5 billion.

Figure 3
Cumulative distribution of project costs, billions of dollars



Textual description:

Percentile	Expenditure
10	6.5
20	7.2
30	7.7
40	8.1
50	8.5
60	8.9
70	9.3
80	9.8
90	10.5

Source:
Office of the Parliamentary Budget Officer.

Note:
40th, 50th, and 80th percentiles are highlighted.

Appendix A: Modelling Acquisition Costs

Acquisition costs are inclusive of all construction activities as well as expenditures associated with initial studies, analysis, and engineering support, initial spares, and systems. We use an analogue approach to estimate these costs. This method is the principle one employed by the United States Congressional Budget Office in Estimating ship costs.[8] It involves identifying a historical procurement program or a ship class similar to the one to be produced and for which costs are fully known. The cost per metric tonne is then calculated and adjusted for differences in weight, labour cost, productivity, and other characteristics and capabilities. This is then used to estimate the cost of the icebreaker.

Due to a lack of comparable analogue vessels, several historical and contemporaneous procurement programs were used to inform our cost estimates. Our approach was based on a mix of vessels that were "right size, wrong mission," or "right mission, wrong size." These analogues were the Royal Canadian Navy's AOPS and JSS Programs, the Department of Fisheries and Oceans' OOSV program, and the US Navy's Lewis and Clark-class underway replenishment vessel.

Arctic and Offshore Patrol Ship

The AOPS is a class of armed patrol ships capable of conducting armed presence and surveillance throughout Canadian waters, including the arctic. This class of vessel is smaller than the Polar Icebreakers and has a different mission profile that is aimed at conducting support, patrol, and sovereignty missions. It is similar to the Polar Icebreakers in its ability to operate in icy condition, with a reported Polar Class of 5.

Table 5
AOPS Characteristics

Characteristic	Value
In-Service	4 vessels currently in service
Weight, Full Load	6,660 metric tonnes
Length	103 m
Beam	19 m
Max Speed	Top speed - 17 knots Ice breaking speed - 3 knots in 1 m of ice
Crew	85
Propulsion	Diesel electric
Ice Class	Polar Class 5
Helicopter Capacity	1

Source:
Department of National Defence.
VARD.

Joint Support Ship

The Joint Support Ships are multi-role vessels capable of supporting the Royal Canadian Navy's warships at sea, including the underway replenishment of fuel, munitions, and stores. The ships are equally capable of providing support to forces ashore through its sealift capabilities. While its mission set differs from the polar icebreaker, it is of comparable size and can operate in minimal ice conditions. Once operational, the JSS will possess a Polar Code certification to operate in Arctic waters above 60 degrees latitude.

Table 6
JSS Characteristics

Characteristic	Value
In-Service	2 under construction
Weight, Full Load	21,597 metric tonnes
Length	174 m
Beam	24 m
Max Speed	Top speed - 20 knots
Crew	239 crew and personnel
Propulsion	Diesel electric
Ice Class	Polar Class anticipated
Helicopter Capacity	2

Source:
Office of the Parliamentary Budget Officer.

Department of National Defence.

Note:
The JSS is expected to receive a Polar Class rating following the completion of the construction process.

Offshore Oceanographic Science Vessel

The OOSV is a CCG research vessel intended to support research missions, such as oceanographic, geological, and hydrographic surveys. It is also capable of supporting CCG operations that include search and rescue, and environmental response. It is similar to the Polar Icebreakers in that it will have a Polar Class rating as well as it being constructed at VSY.

Table 7
OOSV Characteristics

Characteristic	Value
In-Service	1 under construction
Weight, Full Load	5,200 metric tonnes
Length	88 m
Beam	18 m
Max Speed	13 knots
Crew	60 crew and personnel
Propulsion	Diesel electric
Ice Class	Polar Class 6
Helicopter Capacity	0

Source:
Department of National Defence.

Lewis and Clarke-class Underway Replenishment Vessel

The Lewis and Clark-class cargo ship is a replenishment vessel with a mission profile similar to that of the JSS. Built in the United States, the vessel operates globally, supporting US military operations in theatre and at sea. Compared to the polar icebreaker, it is significantly heavier.

Table 8

T-AKE Characteristics

Characteristic	Value
In-Service	14 ships of class in service
Weight, Full Load	41,700 metric tonnes
Length	210 m
Beam	32 m
Max Speed	20 knots
Crew	135 crew and personnel
Propulsion	Diesel electric
Ice Class	N/A
Helicopter Capacity	2

Source:
United States Congressional Budget Office.

Notes

[1] See The Polar Icebreaker Project: A Fiscal Analysis.

[2] Nunatsiaq New, "Feds to replace old icebreaker".

[3] Public Services and Procurement Canada, Government of Canada awards contract for refit work on Canada's largest icebreaker.

[4] Public Services and Procurement Canada, Polar Icebreakers.

[5] This methodology follows the approach of NATO studies on cost estimation for shipbuilding procurement.

[6] See The Polar Icebreaker Project: A Fiscal Analysis for further details.

[7] The PBO forecast of inflation found in our March 2024 Economic and Fiscal Outlook was used when creating this report.

[8] Congressional Budget Office, How the CBO Estimates the Cost of New Ships.

RP-2425-010-C_e
T_RP_3.1.0e