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Inc.



# Design, Construction, and In-service Performance of an Ice-Capable Pilot Boat

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# THE STORY OF A VERY SPECIAL BOAT...

## ■ *M/V Taुकामािम*

- Lengkeek Vessel Engineering was lead designer; HydroComp assisted with propeller and powering



# INTRODUCTION

- Pilotage station at Les Escoumins, QC
- First-year ice of brackish water, 10/10, snow-covered, no leads, with ridges



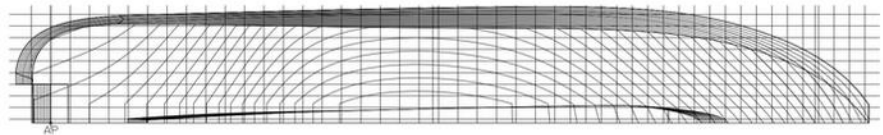
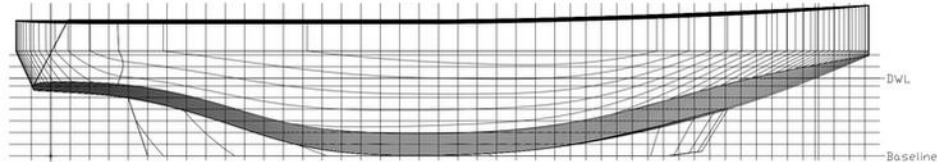
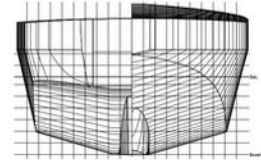
# DESIGN MANDATE

- A pilot boat derived from the LVE-designed 20m high-speed “ice-strengthened” boat for LPA
  - Maneuvering in ice was of greater design priority than open-water performance
  - Needs low freeboard for boarding of multiple vessel types (including tug/barge combos)



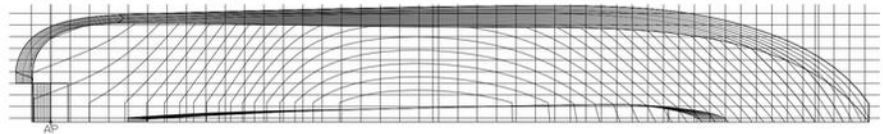
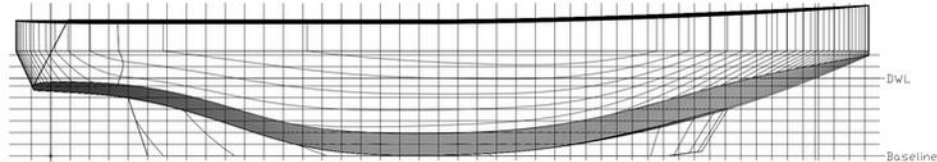
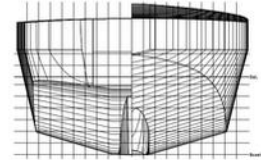
# HULL FORM DESIGN

- Designed in consultation with John Carter
  - “A lovely swept hull form” inspired by R-class form
  - Addition of hard chines now the “Terry Fox” form
- Ice clearing by flow
  - Stern wave system helps to lift and break ice



# HULL FORM DESIGN

- Ice clearing by shape
  - <25 deg profile angle; low deadrise; pushes ice down and out
  - Beam carried forward; allows thinner plating aft
- Propeller concerns
  - Large tip clearance (25%D) for ice passage



# STRUCTURAL FEATURES

- Classed to LR Notation: ✠100A1 SSC Pilot Mono, Ice Class 1D, G2, Near Coastal Voyage, Class 2
  - Structure made heavier by direct calcs (Timoshenko); referenced study of ice properties for crushing strength
- Framing oriented to loads
  - Transverse framing except in bow
  - Longitudinal framing narrows span where ice is pushed

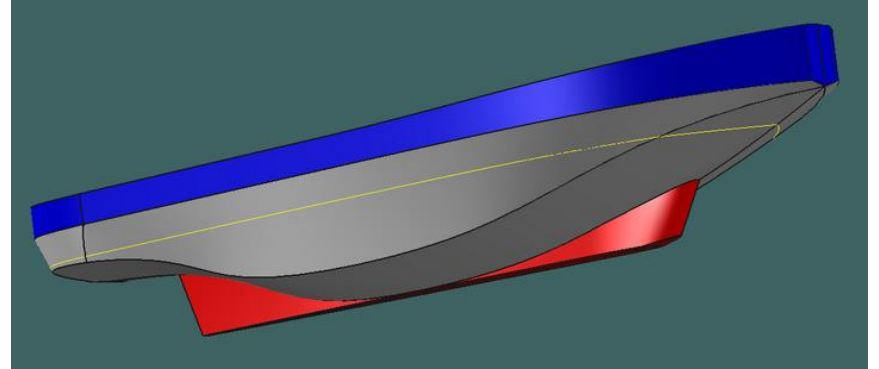
# SELECTED MACHINERY

- Engines
  - CAT C32 950 HP (same as LPA's other boat)
- Miscellaneous
  - Lo-Rez vibration coupling and torque limiter
  - Fernstrum box coolers
  - Deck heating by rectangular steel tubing
  - Handrail heating!



# POWERING CALCULATIONS

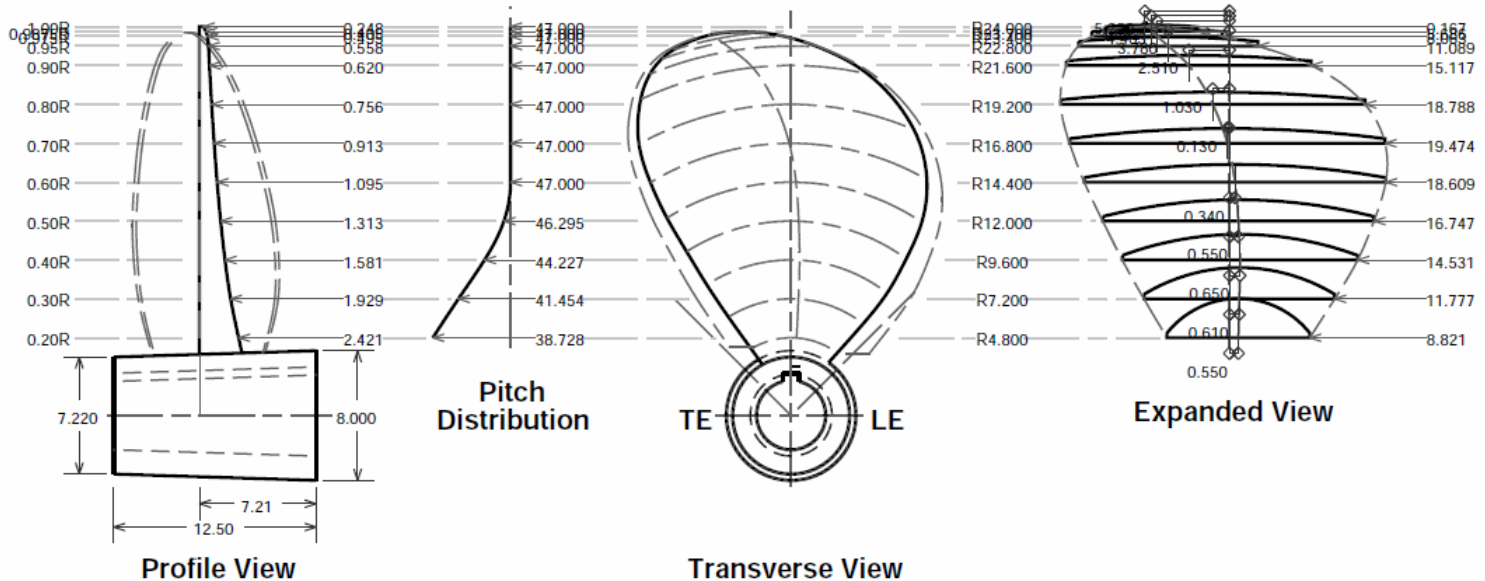
- Design conditions
  - 5 knots in 400 mm ice with 300 mm snow cover
  - 13 knots top speed in open water (85% MCR)
- Resistance predictions
  - Hull form varies from methods: be conservative!
  - Validation study of similar vessel benchmark



# PROPELLER SPECIFICATION

- Multi-objective design points
  - Top speed + towpull + “ice milling” added torque
  - BAR sized for 11-12 knots; accept cavitation at 13 knots
  - Deeper gear ratio option selected for higher pitch; greater clearance between blades
  - Flat-faced segmental design with heavy edges for ease of inspection, repair; beneficial for reversing!
  - Thickness per LR Ice Class 1D/1E; heavier edges

## ■ Custom geometry for manufacture

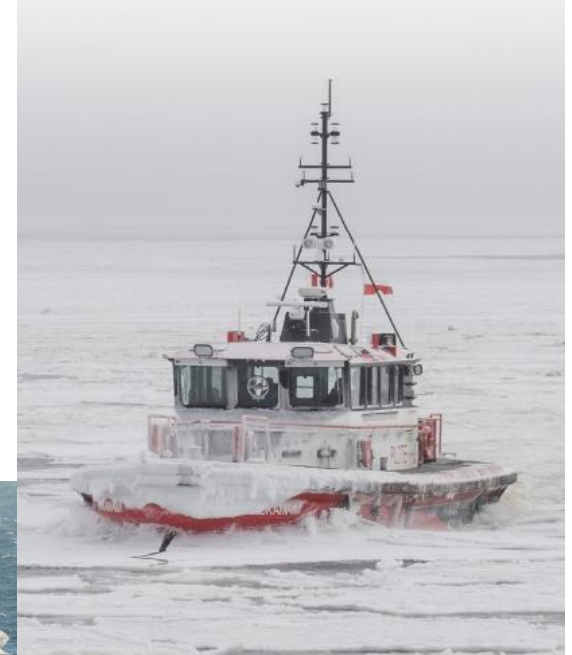


# IN-SERVICE PERFORMANCE

- Successfully met objectives
- Performance in ice
  - Maximum conditions; 600+ mm ice
  - Never stuck; no damage; completed all assignments!
- Open-water
  - Achieved 13 knots at 80% engine load (well matched)
  - Some vibration at 13 knots (expected)

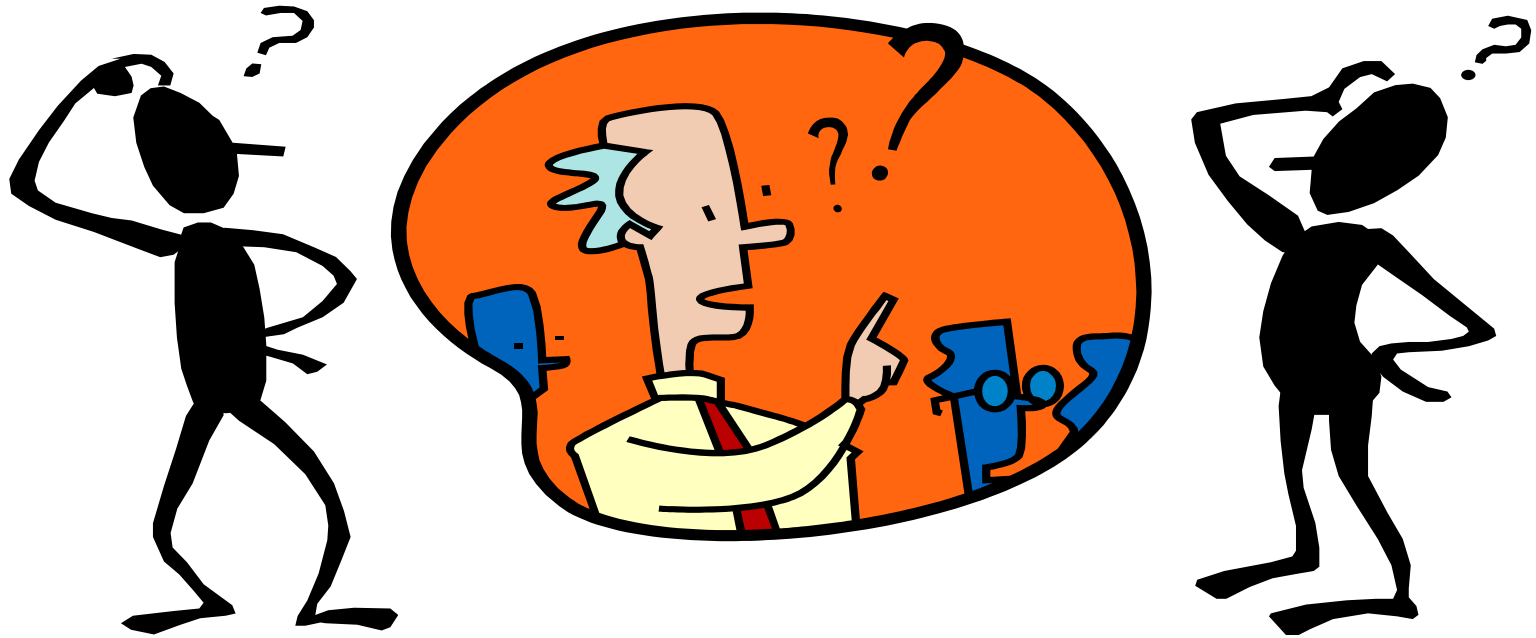
# CONCLUSIONS AND LESSONS LEARNED

- Improvements to consider
  - Bow great for ice; not so much for open-water
  - Increase freeboard if possible
  - Add bulwarks fwd to reduce wetness
  - Add spray rails





THANKS! QUESTIONS?



# REFERENCES

- Lengkeek Vessel Engineering
  - rory@lengkeek.ca
  - [www.lengkeek.ca](http://www.lengkeek.ca)
  
- HydroComp, Inc.
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