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OPERATIONAL DEVELOPMENT OF THE CCG VOYAGEUR ACV

VOLUME 1

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OPERATIONAL DEVELOPMENT OF THE CCG VOYAGEUR ACV

VOLUME 1

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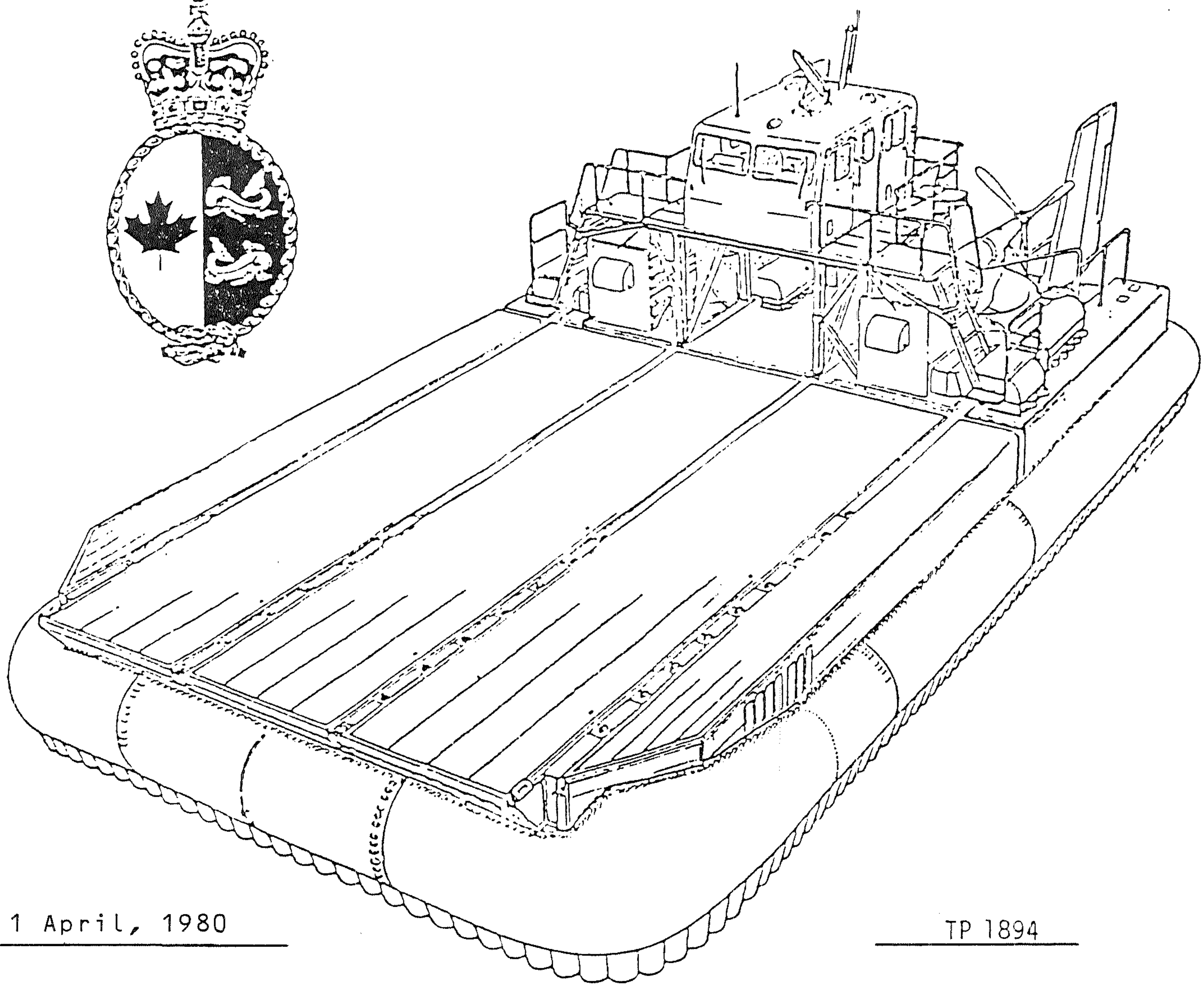
VOLUME I

OPERATIONAL DEVELOPMENT OF THE CCG VOYAGEUR ACV



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TP 1894

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Summary

Purpose

This document consolidates information recorded in various other reports regarding the Operational Development of the Voyageur ACV in the Canadian Coast Guard, to focus attention on the capabilities and the potential of this vehicle in Coast Guard roles.

The information was compiled during five distinct periods (not consecutive) of the vehicle's development between September 1972 and August 1979. The vehicle was evaluated and developed in the following roles: Aids to Navigation; Construction Support; Search and Rescue; Pollution Control; Icebreaking; Lighthouse Supply and Logistics; Fire Fighting; Skin Diver Support; Cable Laying; and Ability to Navigate the St. Lawrence Seaway System.

Aids to Navigation

The vehicle proved itself to be extremely capable of carrying out all aids work and was restricted only in the buoy handling role where the maximum size buoy handled was the 1.4m electric type. This restriction was due solely to the inadequate lifting capacity of the HIAB crane installed. A higher capacity crane has since been installed capable of handling 1.8m buoys.

Construction Support

The vehicle was well suited to construction support work. On at least five occasions it demonstrated its capability by transporting material, equipment and personnel to sites that would be extremely difficult, if not dangerous, for other types of vehicles used for this work.

Search and Rescue

Apart from two or three incidents, the vehicle has only been evaluated in simulated search and rescue operations. The results were encouraging and showed that the vehicle has significant potential in this role. The capability of the ACV in this role is exemplified by the Hovercraft Unit on the West Coast.

Pollution Control

The vehicle was evaluated in this role by the Marine Emergencies Branch of the Laurentian Region. The vehicle carried all types of pollution equipment; laid, anchored, towed and maneuvered over oil booms, dispersed and recovered simulated oil (oil blotter); operated as an oil deflector; and acted as a communications centre. These trials were an unqualified success proving the vehicle to be an extremely potent resource in this very important field.

Icebreaking and Ice Management

An operational and technical evaluation was carried out in February 1974 to explore the feasibility of using the vehicle for low-speed icebreaking and to further investigate the mechanism of ACV icebreaking. At that time the high-speed method of icebreaking was discovered. In subsequent seasons the vehicle was used to further develop ACV icebreaking and carried out operational assignments, such as assisting ships in and out of ice-infested berths; clearing ice jams; clearing ice to relieve potential floods; clearing and maintaining open channels; freeing merchant ships from batture ice; clearing heavy batture ice; and servicing fixed or floating aids in ice-covered waters.

The success of the Voyageur as an icebreaker is well documented and its capability in this role is beyond question.

Lighthouse Supply

It has been demonstrated that the vehicle is a stable and controllable platform for lighthouse supply and logistics, in good and adverse weather. It has allowed light-keeper exchange to take place in weather that would have made it impossible by conventional means.

In September 1972, successful trials were conducted in Lakes Ontario and Erie to assess the ability of the vehicle to land at light stations to discharge supplies.

During the months of April and May 1979, the vehicle demonstrated its capability to supply light stations in the St. Lawrence River. Fuel, water and freight were delivered to eight light stations whose accessibility is normally difficult. All of these stations were previously supplied by a combination of ships, barges and helicopters.

Additional Operational Capabilities

Fire Fighting

A fire fighting trial was inconclusive, but it was determined that jet reaction from fire fighting equipment was minimal. Additional trials are required to determine the capability of the vehicle in this role.

Skin Diver Support

The vehicle was evaluated in the skin-diver support role and proved excellent as a diving platform, recovery vehicle and high-speed transport to and from diving sites.

Cable Laying

On two occasions the vehicle assisted in laying cable to connect beacons to shore power. In both cases the work was carried out successfully and easily. These operations can be very difficult and time consuming when carried out by conventional means.

Seaway Transit

On several occasions the vehicle transited the Seaway system in both directions, negotiating the locks without disrupting other traffic.

Roles Not Exploited by CCG

Although not pursued by CCG it has been demonstrated by the U.S. Army in 1972 and by Transport Development Centre in 1975 that the Voyageur air cushion vehicle is an excellent resource for transporting cargo from ship-to-shore (lightering), and that it can be integrated into an existing marine transportation system improving its ability to deliver cargo.

Another field in which Voyageur's potential has not been exploited is hydrographic survey. Successful trials have been carried out starting as early as 1968, using SK5, SR.N5 and SR.N6 ACVs, to develop sounding equipment specifically for use in air cushion vehicles.

Contents

List of Figures

List of Tables

Preface

What does the air cushion vehicle have to offer the Canadian Coast Guard? The CCG already operates icebreakers, weather ships, buoy tenders, cutters, lifeboats, a cable layer and many other miscellaneous types of vessels.

The first point that must be made before this question can be properly answered is that the ACV is not the be-all and end-all for any marine organization. Nevertheless, the ACV does have a great deal to offer any forward looking organization that has the desire to do things better, faster, easier and, most importantly, more economically.

There is no question that the ACV is a resource that can help an organization realize these goals. It can do some things better and easier, and in most cases, faster and more economically.

The ACV is not limited to one role, nor to one season of the year. It is a multi-role vehicle that can be used throughout the year, and it can operate in places that are out of the question for conventional vessels.

This report clearly defines the extremely wide ranges of applications ACVs have in CCG roles, and their capability to carry out these roles extremely well under trying and adverse conditions, not the least of which is the resistance of people (generally based on fear, or ignorance, or both) who are unable to grasp the importance and the potential of the relatively new technology.

I

INTRODUCTION

I

Introduction

On 29 August, 1972, Transport Development Agency (now TDC) accepted delivery of the Voyageur air cushion vehicle (ACV), model 7380, serial number 002.

The Voyageur was developed by Bell Aerospace Canada (BAC) in a program jointly funded by that company and the Department of Industry, Trade & Commerce (DOITC).

The vehicle is the second of two prototypes and is a general purpose, amphibious flatbed ACV with a main cargo deck area of 118.9 sq m, a cargo capacity up to 26,760 kg, a speed of 50 knots and is powered by two Pratt & Whitney Canada Ltd. Twin-Pac ST6-T75 turbo shaft engines each capable of delivering 1,270 KW.

From June 1972 until September 1973, TDC contracted Northern Transportation Co. Ltd. (NTCL) to evaluate the vehicle in both government and commercial roles.

During these trials the Canadian Coast Guard (CCG) was allotted two periods for evaluation in Coast Guard roles. The first period was September 1972 to December 1972 inclusive in the St. Lawrence River and the Great Lakes, and the second was June and July 1973 on the Mackenzie River, N.W.T.

In the 1972 evaluation, the vehicle demonstrated that it could do all of the tasks attempted, except tow a full-sized buoy tender.

During the 1973 trials, the vehicle underwent major modifications to correct shortcomings in the design, a not unusual situation when introducing prototypes of any kind. Once the modifications had been carried out, the vehicle demonstrated its capability by successfully lifting and laying buoys in currents as fast as 11.3 kph. ? acceleration !!

In January 1973, between the two evaluation periods, the vehicle was dismantled at Trenton, Ontario, and airlifted to Tuktoyaktuk, N.W.T., in five Hercules C-130 loads that included spares and support equipment.

From January 1973, through April 1973, the vehicle was subjected to cold weather evaluation at Tuktoyaktuk, Inuvik, Norman Wells and Wrigley.

On completion of the 1973 CCG trials, the vehicle proceeded from Norman Wells to Hay River. The buoy handling package which was specifically designed and installed for lifting Mackenzie River buoys, was removed and the vehicle was prepared for environmental trials.

During August 1973, a series of tests was conducted to assess the impact of multiple passes of the vehicle on the terrain, vegetation, and avifauna under low Arctic conditions. The results of these tests are tabulated in a three-volume report by the Environmental Protection Service of Environment Canada.

At the completion of the environmental trials in August 1973, the vehicle proceeded to Hay River where noise measurements and VIP demonstrations were carried out. Between August 6 and 14 the vehicle was dismantled, loaded onto six trailers and shipped to Bell Aerospace at Grand Bend, Ontario, where inspection, refurbishment and modifications were carried out by the manufacturer under DSS contract.

The vehicle was accepted by the newly formed CCG Evaluation & Development Unit on 26 January, 1974, and on 30 January, 1974, it proceeded from Grand Bend to Parry Sound under the control of a CCG crew. While at this location, the Unit was brought up to strength and the vehicle was evaluated in the icebreaking role.

In December 1974, the Unit moved to a new base at Montreal where, until the present, it has been extensively involved in aids to navigation; construction support; search and rescue; pollution control; icebreaking; lighthouse supply; skin diver support; and cable laying.

Leading Particulars
of
CCG Voyageur
Operational Development

1. General

	Name	- Voyageur 7380
	Type	- Amphibious, flatbed, cargo transport vehicle
A.	Principal material of construction	- 6000 series aluminum alloy
B.	Crew	- 3: 1 operator; 1 radar navigator; 1 crewman mechanic
C.	Additional seating (cab)	- 3 people
D.	Dimensions	
	i) length	- 19.75M
	ii) width	- 11.19M
	iii) height (on cushion)	- 6.70M
	iv) height (off cushion)	- 5.73M
	v) skirt height	- 1.21M
	vi) usable deck space	- 12.2 x 7.6M
E.	Weight	
	i) empty	- 19,934 kg
	ii) maximum	- 47,628 kg
F.	C.G. Limits	
	i) longitudinal	- st 360 to st 395
	ii) lateral	- vehicle centre line
	iii) vertical	- 1.6M above buoyancy box bottom

Table 1

2. <u>Fuel System</u>

A. Types of fuel - (Jet A), (Jet B), (Arctic Diesel)

B. Capacity

i)	main	- 7,494L	7,077 kg
ii)	trim (normal)	- 2,498L	2,359 kg
iii)	trim (overload)	- 4,996L	4,718 kg
*iv)	maximum total	-12,490L	11,795 kg
v)	maximum usable	-11,733L	11,080 kg

* included 757L (715 kg) of residual fuel. (Not available for use).

C. Consumption - 549L (518 kg) per hour.

3. <u>Propulsion</u>

A. Engines - 2: ST6-T75 Twin Pac turbo shaft

B. Transmission - 2: Speco gearboxes and shafting

C. Propellers - 2: Hamilton Standard 43-D-50 three bladed variable pitch of 2.7M diameter

4. <u>Lift</u> - 2: BHC 2.1M diameter, 12 bladed fixed pitch centrifugal fans

5. <u>Electrical System</u>

A. Type - 28 volt direct current

B. Generators - 4: 28 volt Lear Seigler 200 Amp starter/generators

C. Batteries - 4: 28 volt 40 amp/hour, nickel cadmium batteries

Table 1 (cont'd)

6. Performance

   A. Seakeeping

      i) Operation is permitted at an all-up-weight of 47,628 kg provided the conditions do not exceed 0.5M significant wave height.

      ii) Operation is permitted at an all-up-weight of 40,144 kg provided the conditions do not exceed 2.0M significant wave height.

      iii) Voyageur can operate at higher sea states with reduced all-up-weight and speed at the discretion of the vehicle commander.

   B. Speed

i)	Over water	-60 kts degrading to 28 kts in 0.5M significant wave heights
ii)	Over solid surface	-15 kts
iii)	Transition water/ice	-20 kts

7. Equipment

   A. Crane - Hiab 1165A/10 - 6,586 kg @ 1.7m

   B. Winches

i)	Hydraulic Gearmatic(2)	- 3,629 kg pull each
ii)	Warn Winch (2)	- 3,629 kg pull each

   C. Crew module - Accommodation 7 seated - sleep 4

   D. Tool module - Tools and spares for running maintenance

8. Communications Equipment

- VHF-FM	Marine
- VHF-AM	Aircraft
- HF	Single Side Band

9. Navigation Equipment

   A. Radar - Decca 514

   B. ADF - Collins

   C. Compass

i)	Magnetic (Standby)	- Bendix
ii)	Gyresyn	- Sperry - C4
iii)	Magnesyn	- Air Corporation

Table 1 (cont'd)

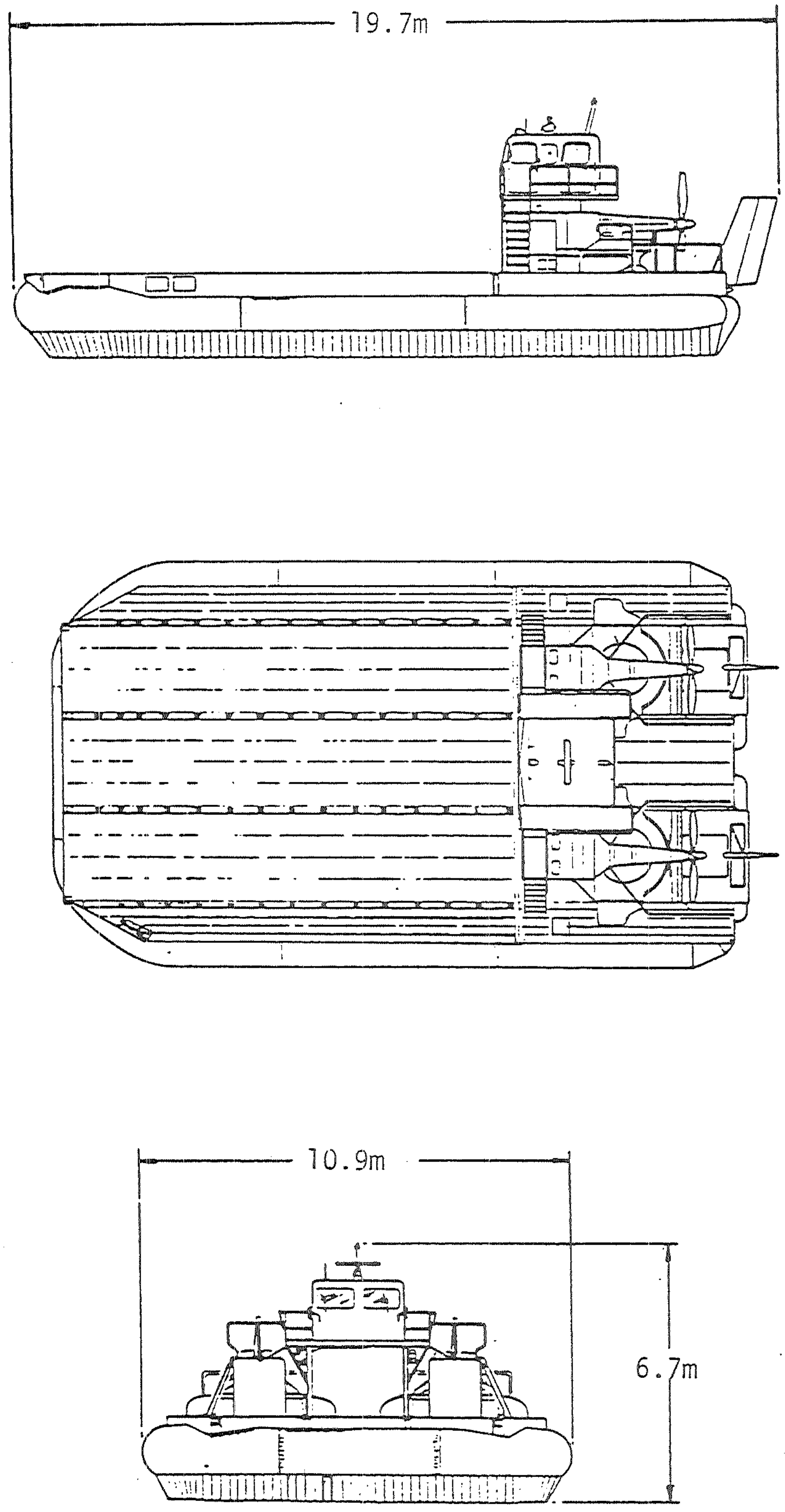


Figure 1 - VOYAGEUR GENERAL DIMENSIONS

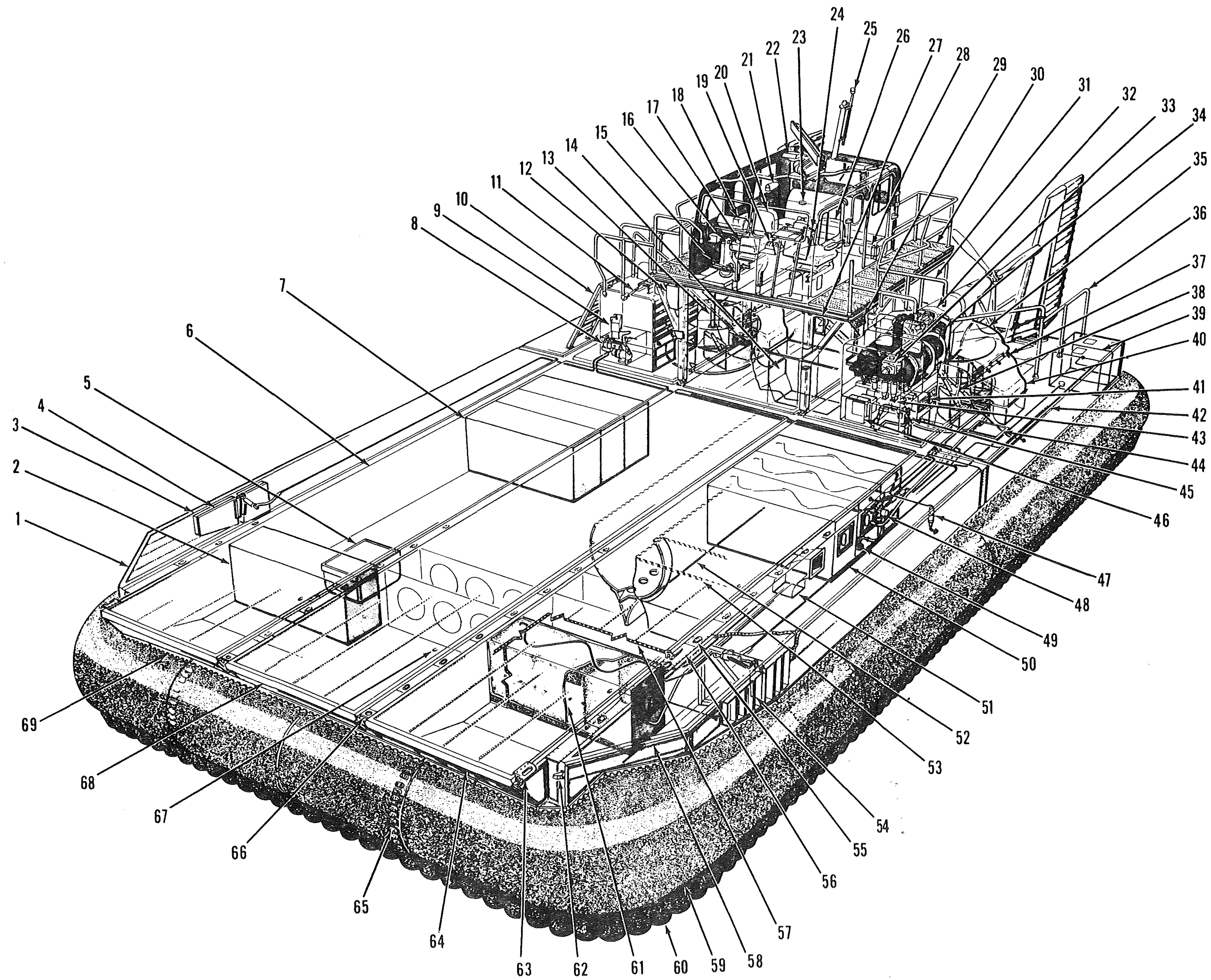
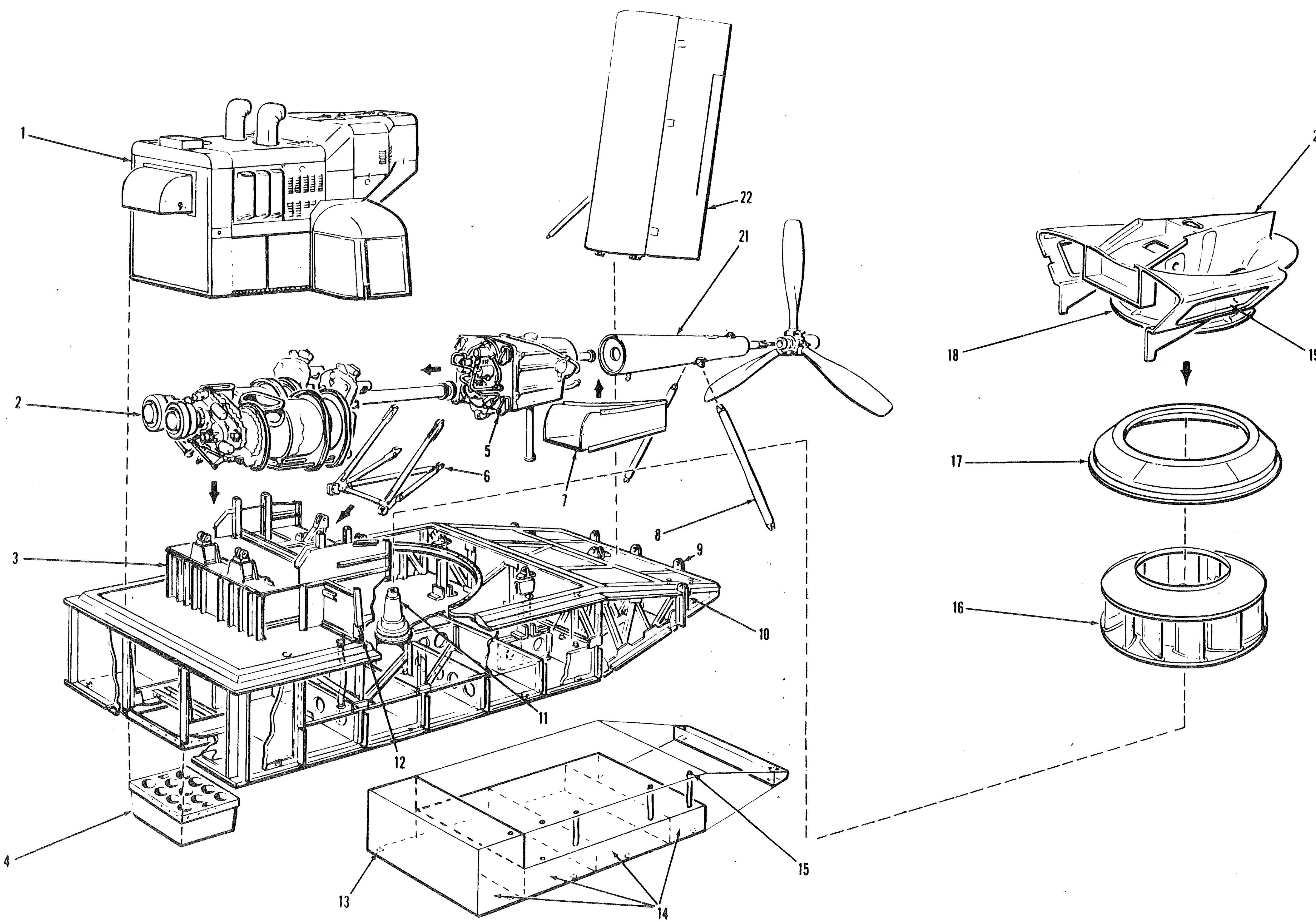


Figure 2 - VOYAGEUR GENERAL ARRANGEMENT

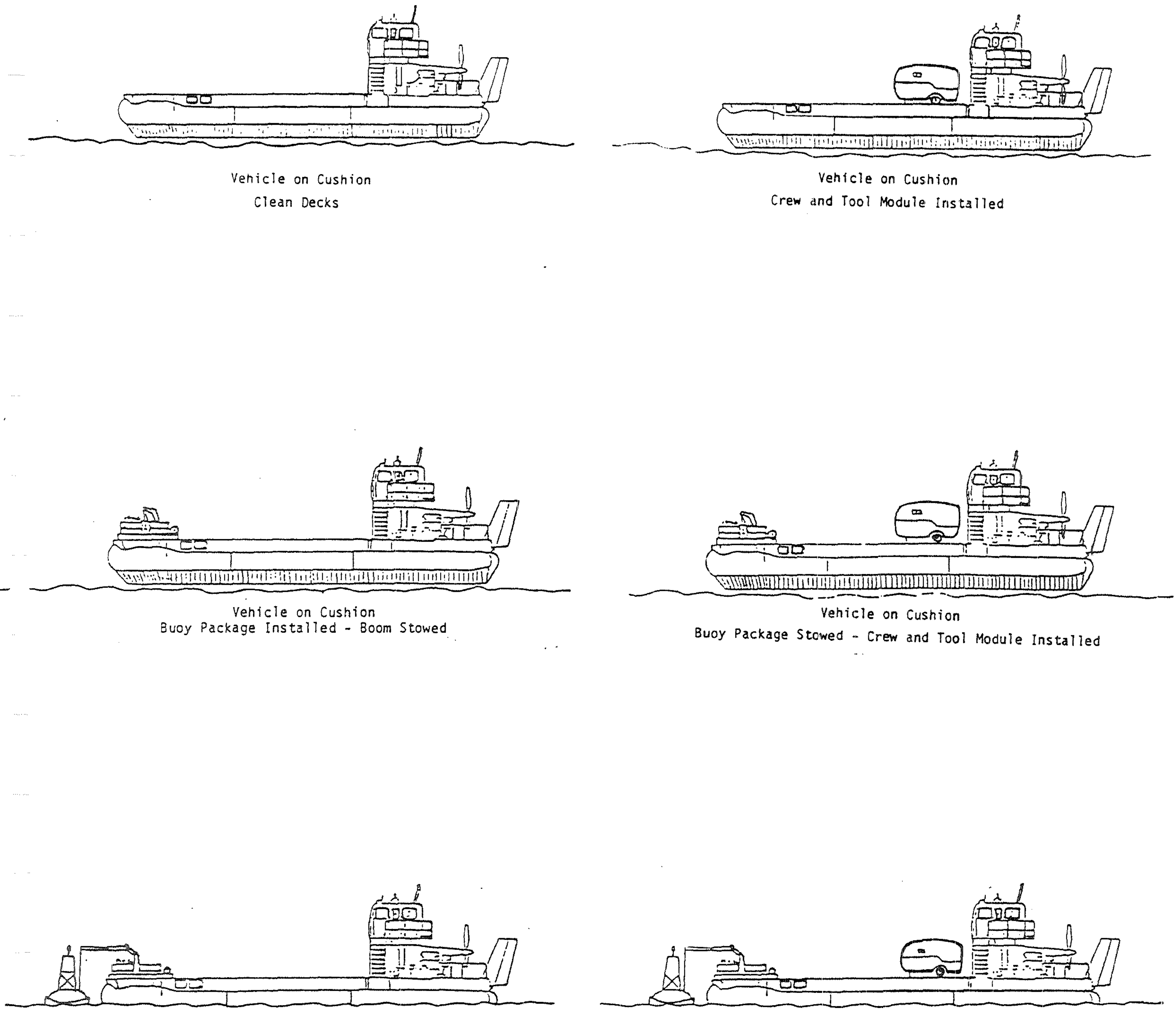
ITEM	INDEX
44	ACCESS HATCH
12	AIR INTAKE FOR CABIN HEATING
39	BALLAST TANK, AFT PORT
2	BALLAST TANK, FORWARD STARBOARD
61	BALLAST TANK BLADDER, FORWARD PORT
46	BATTERY COMPARTMENT, PORT
14	BIFURCATED CENTRE PLENUM DUCT
67	BILGE ACCESS OPENING, TYPICAL
21	BOW NAVIGATION LIGHT
12	CABIN HEATING AIR INTAKE
29	CABLE DUCT
17	CENTRE CONSOLE, CABIN
23	CABIN LIGHT OVERHEAD
22	CABIN VENTILATOR, STARBOARD
37	ENGINE - AIR INTAKE FILTER, PORT OUTBOARD
40	ENGINE - AIR INTAKE PLENUM BLEED AIR DUCT, PORT OUTBOARD
37	FILTER, ENGINE AIR INTAKE, PORT OUTBOARD
47	FILTER, FUEL CELL CAVITY VENT, PORT
60	FINGERS
43	FIRE EXTINGUISHING BOTTLES
6	FLOTATION BOX, FORWARD STARBOARD
64	FLOATATION BOX, FORWARD PORT
68	FLOATATION BOX, FORWARD CENTRE
38	FUEL FILLER PIPE, PORT
45	FUEL BAY, PORT
48	FUEL BOOSTER PUMP, PORT
49	FUEL STRAINER, PORT
50	FUEL TANK, PORT
7	FUEL TANK, STARBOARD
36	GUARD RAIL
31	HAND RAIL
69	HINGES, TRUNK
57	HOLLOW CORE PANEL, TYPICAL
8	HYDRAULIC COMPARTMENT
9	HYDRAULIC TANK
18	INSTRUMENT PANEL
52	KEEL TRUNK
10	LADDER (REMOVABLE) STARBOARD
5	LANDING PAD
13	LIFT - FAN ASSEMBLY, STARBOARD
35	LIFT - FAN AIR INTAKE DUCT, PORT
	LIGHTS - SEE BOW, PORT, AND STERN NAVIGATION LIGHTS, AND CABIN LIGHTS

ITEM	INDEX
27	LOUD HAILER
25	MAST, ROTATING BEACON, AND STERN LIGHT
65	MECHANICAL FASTENERS
26	NAVIGATOR'S SEAT
	NAVIGATION LIGHTS - SEE BOW, PORT AND STERN
23	OVERHEAD LIGHT, CABIN
33	OIL TANK
41	OIL - COOLER BAY, PORT OUTBOARD
59	PERIPHERAL TRUNK
20	PILOT'S SEAT
51	PLENUM - AIR DUCT TO STABILITY TRUNK, PORT
14	PLENUM DUCT, BIFURCATED CENTRE
40	PLENUM BLEED - AIR ENGINE - AIR INTAKE DUCT, PORT OUTBOARD
28	PNEUMATIC RESERVOIR
62	PORT NAVIGATION LIGHT
16	PROPELLER PITCH CONTROL
3	PUFF PORT STARBOARD
4	PUFF PORT DOOR
54	PUFF PORT VANES, PORT
24	RADAR
25	ROTATING BEACON, STERN LIGHTS, AND MAST
15	RUDDER BAR
20	SEAT, PILOT'S
26	SEAT, NAVIGATOR'S
1	SIDE DECK, FORWARD STARBOARD
11	SIDE BRACE, STARBOARD
42	SIDE DECK, AFT PORT
58	SIDE DECK, FORWARD PORT
56	SPLICE PLATE, TYPICAL
53	STABILITY TRUNK, PORT
25	STERN NAVIGATION LIGHT
19	THROTTLE CONTROL
55	TIE - DOWN FITTING, TYPICAL
63	TOW FITTING, OUTBOARD, TYPICAL
66	TOW FITTING, INBOARD, TYPICAL
32	TRANSMISSION GEARBOX
34	TURBOSHAFT ENGINE, TWIN-PAC ST6T-75, PORT
22	VENTILATOR, CABIN, STARBOARD
30	WALKWAY, PORT



1 ENGINE COWL
2 TWIN POWER SECTION TURBOSHAFT ENGINE
3 ENGINE PEDESTAL
4 LANDING PAD
5 TRANSMISSION GEARBOX
6 GEARBOX SUPPORT TUBES
7 NACELLE FAIRING
8 NACELLE SUPPORT STRUT
9 FIN BRACE FITTING (TYP)
10 REAR MODULE LIFTING FITTING
11 LIFT FAN PINTLE
12 FORWARD MODULE LIFTING FITTING
13 DRAIN COMPARTMENT PLUG (TYP)
14 BUOYANCY COMPARTMENTS
15 COMPARTMENT BILGE ACCESS PLUG (TYP)
16 LIFT FAN
17 LIFT-FAN INTAKE BELLMOUTH SUPPORT
18 LIFT-FAN INTAKE BELLMOUTH
19 ENGINE AIR INLET DUCT (TYP)
20 BIFURATED DUCT
21 PROP SHAFT NACELLE
22 FIN-RUDDER-TAB ASSEMBLY

Figure 3 - POWER MODULE BREAKDOWN



Vehicle on Cushion
Clean Decks

Vehicle on Cushion
Crew and Tool Module Installed

Vehicle on Cushion
Buoy Package Installed - Boom Stowed

Vehicle on Cushion
Buoy Package Stowed - Crew and Tool Module Installed

Vehicle in Displacement
Buoy Package Installed - Boom Cable Secured to Buoy

Vehicle in Displacement
Buoy Package Installed - Boom Cable Secured to Buoy
Crew and Tool Module Installed

Figure 4 - Vehicle Configurations

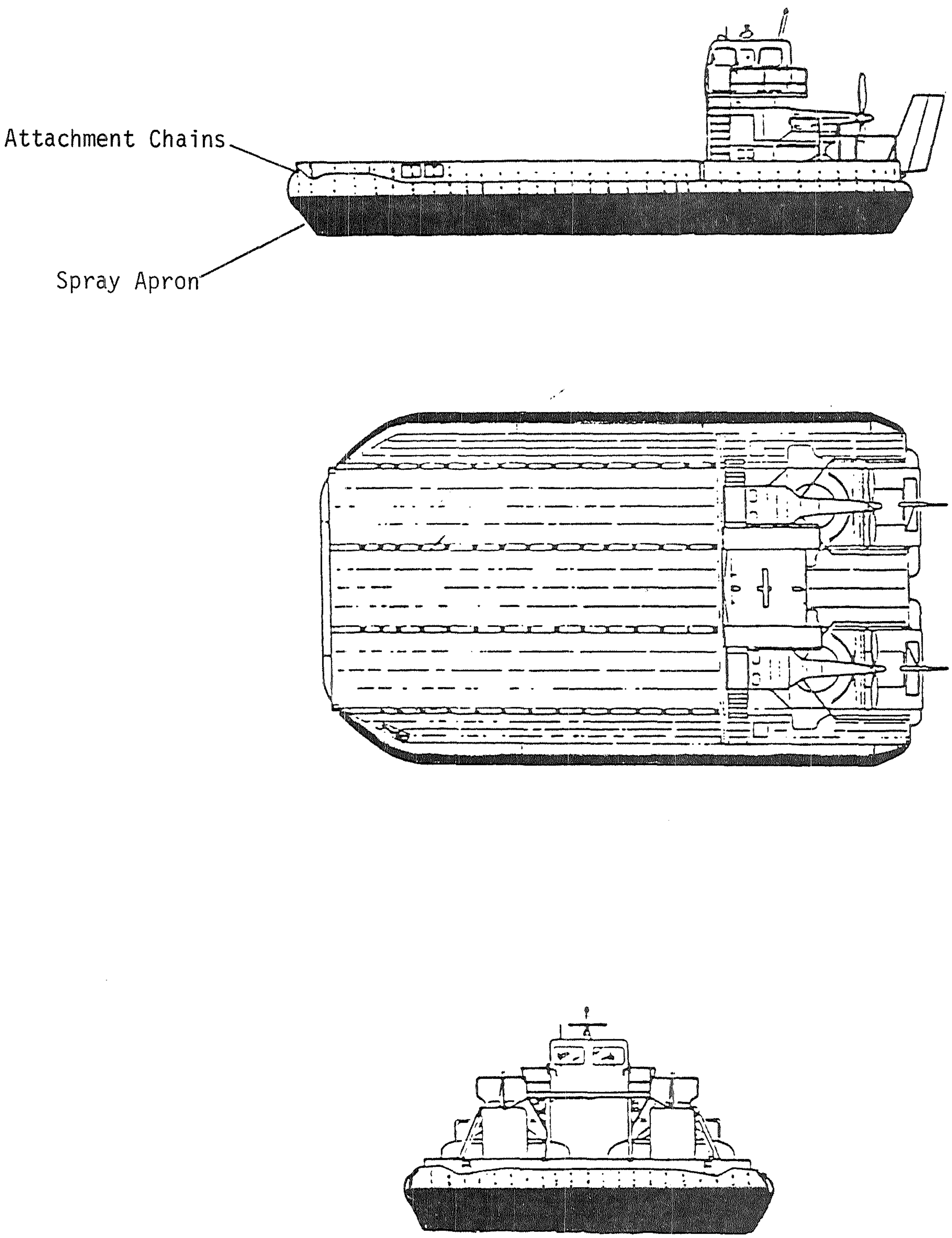


Figure 5 - Spray Suppression Apron Installed

II

AIDS TO NAVIGATION

II

SUMMARY OF AIDS TO NAVIGATION

The variety of aid work carried out by the Voyageur, as well as the different locations in which it was carried out, permitted a very good evaluation of its capabilities and potential in this field.

This work was carried out during five distinct periods between September 1972 and August 1979:

1. Sept. 1972 - Dec 1972, St. Lawrence River and Great Lakes
2. June 1973 - July 1973, Mackenzie River and Great Bear Lake
3. May 1975 - Sept. 1975, St. Lawrence River, Lac St. Pierre and Lac St. Louis
4. July 1977 St. Lawrence River System
5. March 1978 - Dec 1978, St. Lawrence River System
6. March 1979 - Aug 1979, St. Lawrence River System

From September to December 1972, the vehicle's capabilities were evaluated in various roles.

The roles evaluated were loading and unloading various types of buoys and equipment; laying and picking up 1.4m electric buoys, 61 cm winter spars, Ottawa River spars and boat type buoys; transporting equipment and technicians and servicing river lights; replacing lanterns and batteries.

From time to time, minor problems occurred but nothing that prevented completion of the work. Inexperienced personnel and a lack of suitably designed equipment for handling buoys were the main causes of the problems. Nevertheless, the vehicle carried out in hours some jobs that require several days to complete using conventional means.

The vehicle's speed and maneuverability, when servicing light towers such as those at Squirrel Island, proved to be a distinct advantage over the conventional method which is carried out with much difficulty. It was shown that the vehicle, under actual working conditions, is particularly suited to servicing unwatched aids with considerable saving in time and, therefore, costs.

Much of the work performed during this period was carried out in sub-freezing temperatures, with a low wind chill factor and icy deck, making the job difficult.

From June to July 1973 the vehicle operated on the Mackenzie River and Great Bear Lake so that its capability could be evaluated in the buoy tending role in this area.

Operations were carried out in the San Sault Rapids. Buoy positions were checked; Swift Current buoys were picked up from caches and transported for laying; Mississippi buoys were transported to several locations; partially submerged buoys were recovered; range building work was carried out.

The evaluation period allotted to the CCG was drastically reduced due to the vehicle being taken out of service for major modifications and repairs.

For approximately half the time available, the crew was in the learning process, developing and establishing new operational methods peculiar to the vehicle. In the latter half of the period, the potential of the vehicle in the Aids Tender role was demonstrated, when the vehicle successfully lifted and laid buoys in currents as swift as 9 knots.

From May to September 1975, the vehicle operated on the Ottawa River, Lac St. Pierre, Lac St. Louis and down river as far as Sorel.

During this period, shore beacons were serviced on the Ottawa River; shore beacons and day marks were serviced on Lac St. Pierre and Lac St. Louis; rapid response was provided to investigate and repair aids reported out, as far afield as Sorel; aids servicing was carried out in the vicinity of Trois Rivières.

The vehicle proved to be extremely capable in servicing beacons in the locations mentioned; its capability for rapid response in investigating and repairing aids reported extinguished is extremely important for the safety of shipping.

During the month of July 1977, personnel and equipment were transported to service the Caughnawaga, Dixie and Dorval range lights. Part way through this operation the vehicle suffered mechanical difficulties with its propeller system.

From March to December 1978, a great deal of work was carried out in the St. Lawrence River System.

The Dorval, Châteauguay and Lac St. Louis range lights were serviced; 157 buoys were checked and 98 buoys re-checked for the Laurentian Region; a buoy-laying exercise was carried out for the "Task Force for the Extension of the St. Lawrence Seaway Season"; a day mark painting program was carried out; five spar buoys weighing 8,165 kg, for use by CCGS TRACY were transported from Sorel to St. Angele-de-Laval; a buoy-recovery operation was carried out in Lac St. Pierre; six barrel buoys were picked up in Lac St. Louis where the water was too shallow for the District vessels.

From March to August 1979, the vehicle was employed on various tasks in the Laurentian Region.

Survey technicians were transported to survey the Lavaltrie range lights; twenty range lights were serviced in the Ottawa River; a day mark painting program was carried out for the Quebec District; buoy positions were checked in the St. Lawrence River; the vehicle demonstrated aids work to the Planning Co-ordination Division of Coast Guard (CGMS); 181 Gannett buoys were checked in the Ottawa River.

These buoy checking and laying exercises show beyond doubt that the Voyageur is an excellent resource for navigation aids work; it was restricted to handling buoys up to 1.4m only because of the limited capacity of the crane used. A crane of higher capacity has since been installed with the capability of handling 1.8m buoys.

AIDS TO NAVIGATION

Sept 1972	-	At Prescott, Ontario, various types of buoys were loaded aboard the craft, including one 1.8m fibre-glass, one 61 cm spar, 6 boat type and 6 Mississippi.
Nov 1972	-	Technicians and equipment were landed during the servicing of sixteen St. Clair River lights. Two technicians were used on this task. Having landed a technician at one tower, the vehicle proceeded to the tower on the opposite side of the river and landed the second technician, by which time the first was ready for pick-up.
Nov 1972	-	To service the Squirrel Island back range light, the vehicle traversed about 0.8 km of 1.5m high swamp grass and was placed against the light towers. The speed and maneuverability of the vehicle proved to be a distinct advantage over conventional methods which encounter extreme difficulty.
Dec 1972	-	At Trenton, Ontario, buoys, stores and mooring were loaded and discharged a number of times.
Dec 1972	-	At Bay of Quinte, Ottawa River spars were laid and picked up many times. The average times required to lay and pick up buoys were 8 and 6 minutes, respectively.
Dec 1972	-	Boat type buoys were laid in 13 minutes and picked up in 15 minutes.
Dec 1972	-	Electric buoys up to 1.4m were laid and picked up many times with average times required to lay and pick up being 12 and 18 minutes, respectively.

Dec 1972 - Simulated replacement of a 1.4m electric buoy with a 61cm dia Winter Steel Spar was effected in 15 minutes.

Dec 1972 - Simulated replacement of a lantern on a 1.4m buoy was effected in 8 minutes and battery replacement in 10 minutes.

Dec 1972 - During buoy pick-ups, the vehicle was able to proceed on cushion at 15 knots as soon as the stone was clear of the water, and while the stone was being lifted on deck.

Dec 1972 - The work above was carried out in sub-freezing temperatures with the wind chill factor and icy deck making the job difficult.

Dec 1972 - The vehicle demonstrated its controllability and capability in performing the buoy tending role with buoys as large as the 1.4m electric types.

June 1973 - The vehicle operated at San Sault Rapids at Kilometer 956 on the Mackenzie River, where it checked buoy positions, picked up Swift Current buoys from caches at Kilometer 1,014, removed debris from buoys, lifted and re-positioned buoys in fast waters. The time required to raise anchors was 5 to 15 minutes.

June 1973 - On several occasions, the vehicle proceeded to other buoy caches and loaded as many as twenty-four mixed Mississippi and Swift Current buoys, which were transported to Norman Wells for scraping and painting.

June 1973 - The vehicle ranged, during this month, from Kilometer 666, where the furthest upstream buoys are in its designated area, to Fort Good Hope at Kilometer 1,094. During these missions the vehicle was engaged in checking, re-positioning, and recovering partially submerged buoys and range building work.

July 1973 - The vehicle made a trip from Norman Wells into Great Bear Lake carrying eight drums of turbo fuel for caching at Fort Franklin, for the Agency helicopter. The light on Whiskey Jack Point was also inspected at this time.

May 1975 - Technicians were transported up the Ottawa River, 107 nautical miles from Montreal, to service shore beacons. Many of these beacons are on beaches, others have to be approached from high steep banks. In all cases the technicians were delivered right up to the beacons.

May 1975 - Technicians were transported to Lac St. Pierre to service shore beacons and day marks.

May 1975 - The vehicle was demonstrated for the Sorel Aids Manager. The on-board crane was used to lift and place the Ottawa River buoy which was easily handled without incident.

June 1975 - Channel beacons and day marks were tended on Lac St. Pierre and Lac St. Louis. All beacons were located in deep water with a strong current. No difficulty was experienced maneuvering into the current and equipment was easily passed up to the platform.

June 1975 - The vehicle provided rapid response to investigate and repair buoys reported extinguished in the area serviced by Sorel. It was able to maintain its position in currents as swift as six knots providing a stable dry platform for technicians working on the lights. Proceeding from base, picking up technicians, proceeding to the reported lights and repairing them took approximately 7 hours, and at times much less.

June	1975	-	The vehicle carried out Navaids servicing in the vicinity of Trois Rivières.
July	1975	-	Technicians were transported up the Ottawa River to service shore beacons.
July	1975	-	The vehicle was employed tending beacons on Lac St. Pierre.
Sept	1975	-	Technicians were transported to the Sorel area to investigate and repair buoys reported extinguished.
July	1977	-	Personnel and equipment were transported to the Caughnawaga, Dixie and Dorval range lights. The vehicle provided a platform from which material was lifted onto the beacons by the onboard Hiab crane. The Caughnawaga front and back range light was serviced after which the vehicle experienced mechanical problems.
March	1978	-	Technicians boarded the vehicle in Châteauguay and were transported to service the Dorval and Châteauguay range lights, which took 4½ hours.
April	1978	-	Technicians were transported to service lights in Lac St. Louis. Total craft operating time was 3.2 hours. The technicians estimated that it would have taken 2 days to do the job using conventional equipment.
June/ July	1978	-	A buoy checking program was carried out for the Laurentian Region during June and July (Table 2). All floating aids to navigation in the main ship channel of Lac St. Louis, Montreal Harbour and the St. Lawrence River downstream as far as Sorel were checked.

June/ July 1978 - (cont'd) During this program 157 buoys were checked for position and operation in ten and one-half working days. Bulbs, batteries, lanterns, connections and sun switches were replaced on some of the buoys.

Difficulties encountered, such as rusted battery compartment cover nuts and batteries jammed in their compartments, were easily overcome.

The vehicle was held steady at all of the buoys, using propeller thrust to maintain position. The displacement mode was used to check most of the buoys but some were checked while on partial cushion.

Where the buoys were close together, such as in Montreal Harbour, the time required to move from one buoy to another was minimal, varying from 2-7 minutes. Where the buoys were farther apart, craft speeds of 35 to 40 knots were achieved between buoys without difficulty.

July 1978 - At this time Montreal District personnel suggested that the accuracy of the checking carried out was in doubt. Two Regional surveyors joined the crew to take sextant angles and to assist in identifying sighting marks.

During this period 98 buoys were re-checked at the request of the Montreal District. The re-checking operation confirmed the original positions recorded by the vehicle were correct.

Both surveyors, who are experienced in laying and checking buoy positions from ships, expressed the opinion that the Voyageur is <u>at least as accurate</u> as a ship in checking buoy positions.

July 1978 - Buoy checking completed, the vehicle was placed on standby for aids outages in Lac St. Louis to replace Barge 99 which was checking buoys in the Ottawa River.

Aug 1978 - The vehicle was on standby for outages in Lac St. Louis. It was called out for outages in the small boat channel and to check for debris reported floating downstream.

Aug 1978 - Buoy checking was carried out during this month.

Aug 1978 - The vehicle was used in a daymark painting program, to provide data for the Laurentian Region assessment of the vehicle, transporting painters and their equipment to selected ranges.

The program consisted of scraping, painting and varnishing both daymarks of five ranges and the front daymark of one range between Montreal and Sorel. Three of the ranges were in the small boat channel and three were in the main ship channel of the St. Lawrence River.

The program was completed in nine days. All of the marks were situated on islands or surrounded by swamp. If a boat had been used, the workmen would have had to wade through 1.8m high brush, weeds and bullrushes, carrying their equipment. The vehicle was able to carry the workmen and their equipment to within 15.2m of the marks in the worst case, and right up to the mark in the swampy areas where it was used as a work platform. The task was made easier for the painters, and the craft speed reduced the time required to do the job.

Sept 1978 - The vehicle was dispatched to check the position of a freighter aground in Montreal Harbour. The positions of three buoys were also checked.

Sept	1978	-	The vehicle was on standby for Montreal District to check outage reports.
Sept	1978	-	The vehicle was used to check outages reported in Lac St. Louis. This took 1.5 hours.
Sept	1978	-	While enroute to Portneuf, on request the vehicle checked two buoys after which it continued to its destination, having added only one hour to its transit time.
Sept	1978	-	The vehicle travelled to Portneuf, servicing one buoy and checking two others enroute. The servicing involved replacing batteries.
Sept	1978	-	A radar reflector was installed on one buoy and outages were checked at the request of the Quebec District.
Nov	1978	-	The VTM Radar Site at Ile Grossbois was reported to be inoperative due to generator problems. The vehicle transported a 726 kg diesel generator from base to Ile Grossbois and later transported a similar generator from Ile Grossbois to Boucherville on the South Shore.
Nov	1978	-	An exercise was carried out for the "Task Force for the Extension of the St. Lawrence Seaway Season" to demonstrate the capability of the vehicle to lay and lift buoys.

The vehicle transported, laid and lifted back on board a standard 1.4m electric buoy weighing 1,504 kg, 34.8m of 1.9cm chain and a 1,814 kg serrated-edge cast iron anchor. The ACV personnel, most of whom had never handled buoys, were able to lay the buoy in six minutes and recover it in eleven.

Nov 1978	-	Five ice spars for use by CCGS TRACY, weighing 8,165 kg, were loaded aboard the vehicle at Sorel and transported 51.5 km to St. Angele-de-Laval in 1.13 hours at an average speed of 28 kts. The spars were unloaded by dockside crane after which the vehicle returned to Montreal. The round trip distance of 235 km was completed at an average speed of 31.5 kts.
Nov 1978	-	A buoy recovery operation was carried out in Lac St. Pierre. The twelve buoys retrieved and transported to Sorel were 0.762m diameter lighted and can spar buoys from the St. François and Du-Loup River entrance channel.
Dec 1978	-	In response to a request from Sorel, six barrel buoys were picked up at Pt. Hebert in Lac St. Louis where the water was too shallow for any of the District vessels.
Dec 1978	-	Two technicians were transported from Montreal to Yamachiche in Lac St. Pierre to service beacons.
Mar 1979	-	Two technicians were transported to Lac St. Louis to turn on all fixed lights. The vehicle departed base at 10:55 hrs and arrived back at 16:00 hrs.
Mar 1979	-	The vehicle departed Pierreville to pick up survey technicians at Contrecoeur Iron Ore Wharf and transported them to various islands from which Lavaltrie range lights could be surveyed.
May 1979	-	Twenty range lights were serviced on the Ottawa River.
May 1979	-	Range light batteries were changed on Lac St. Pierre and one light was serviced at Way Channel in the Ottawa River.

May/ June 1979 - The vehicle was deployed to Quebec District to transport personnel and equipment to paint buoy positioning triangulation marks. Many of these marks are inaccessible by land. Maintenance consisting of scraping, painting and repairing is normally accomplished by personnel transported to the site by boat or helicopter.

The program commenced at Portneuf and thirteen beacons were completed. The sites chosen as operating bases were Portneuf, Ile d'Orleans, Quebec City and Baie St. Paul. The vehicle was refuelled and parked overnight at these bases.

June 1979 - At 09:45 hours while at Batiscan, the vehicle was ordered to check buoys located between Trois Rivières and Portneuf. Checking commenced at buoy 64½Q, ten miles from Batiscan, and proceeded to buoy 51Q. Thirteen buoys were checked in two hours and twenty minutes, after which the vehicle was placed on standby.

July/ August 1979 - During buoy checking duties on the Ottawa River, the Voyageur demonstrated its capabilities in this role to the staff of Coast Guard Planning-Coordination Division (CGMS).

The 0.9m Gannett buoys used in the Ottawa River are manufactured from fibreglass and weigh approximately 181 kg. The moorings, comprising nylon, chain and anchor, weigh approximately 227 kg.

During the demonstration one buoy was lifted, its batteries replaced, and re-positioned. Voltage, bulbs and bulb changers, on fifteen other buoys, were checked with an average time for one buoy of 10 minutes.

The total number of buoys checked during the five day operation was 181.

Buoy Checking Data

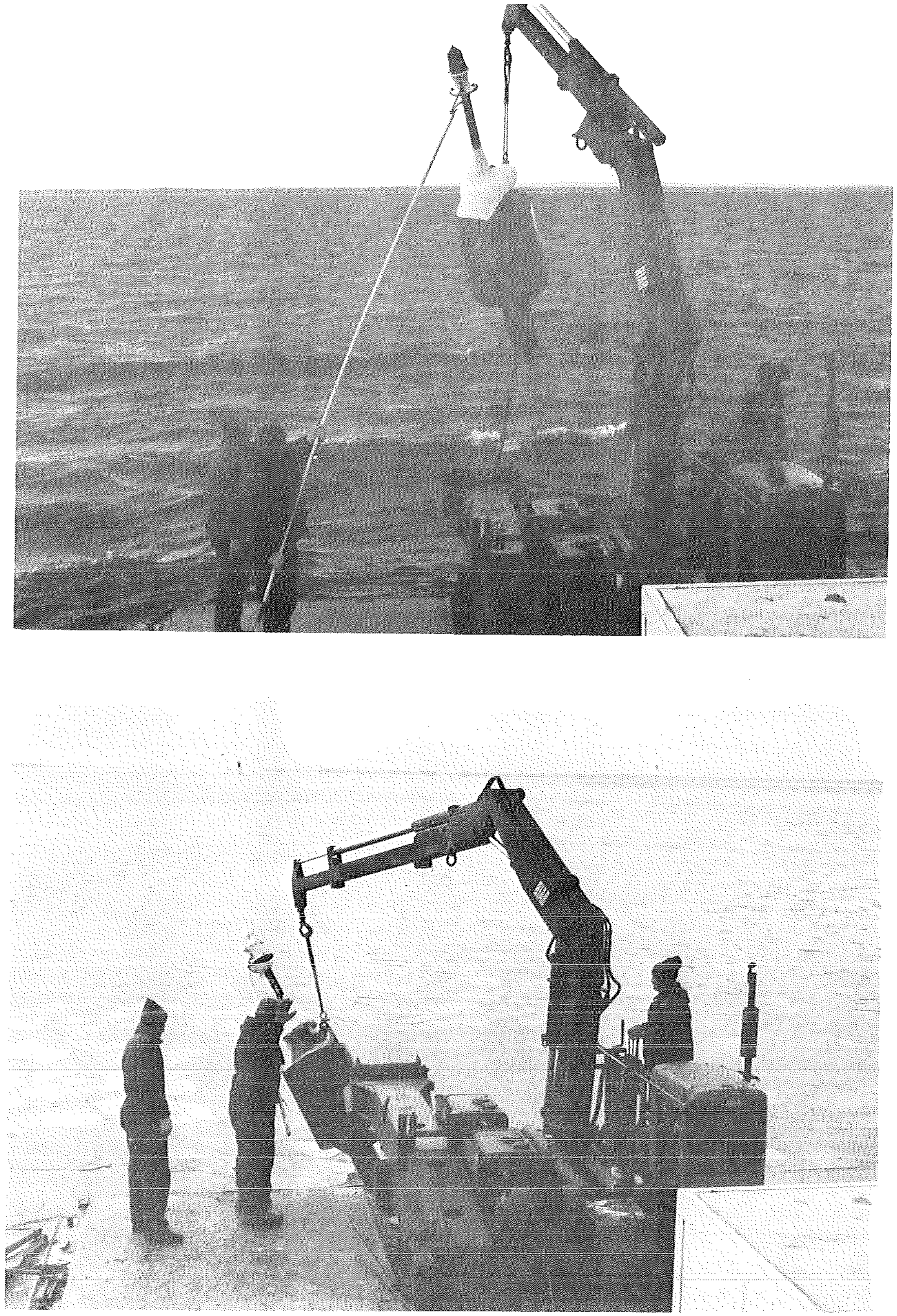
June - July 1978

Buoys checked	157
Bulbs changed	8
Batteries changed	9
Lanterns changed	2
Connectors changed	1
Sunswitch changed	1
Average time on task per buoy checked	14.2 min
Average time in transit per buoy checked	4.8 min
Average total time per buoy checked	19.0 min
Time on task all buoys checked	37.3 hrs
Time in transit all buoys checked	12.7 hrs
Total time on task and in transit	50.0 hrs
Transit distance for buoys checked	680 km

Rechecking Buoys

Buoys checked	98
Average time on task per buoy checked	5.4 min
Average time in transit per buoy checked	3.7 min
Average total time per buoys checked	9.1 min
Time on task all buoys checked	8.8 hrs
Time in transit all buoys checked	6.1 hrs
Total time on task and in transit	14.9 hrs
Transit distance for buoys checked	298 km

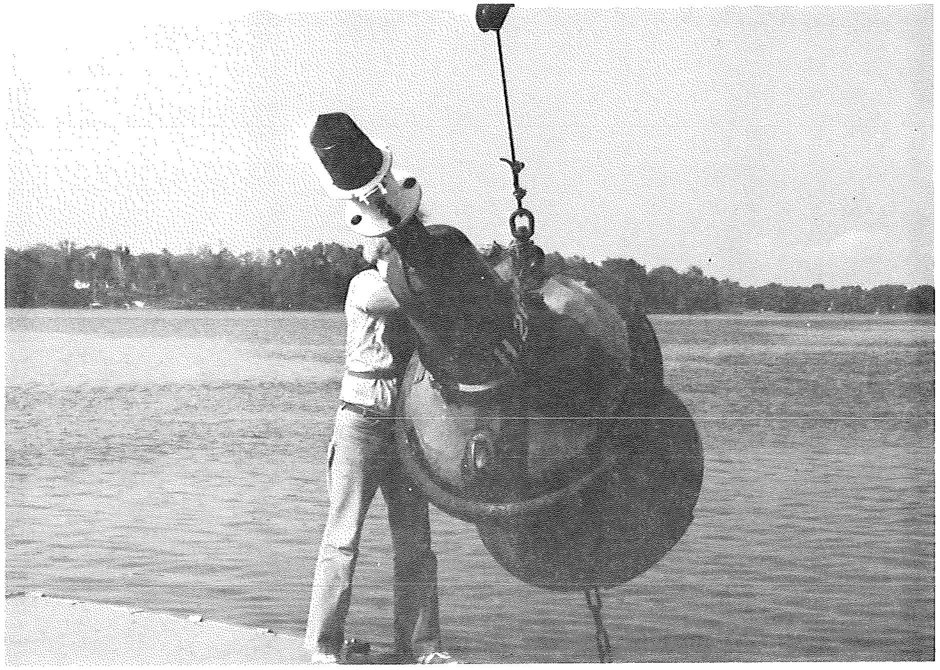
Table 2

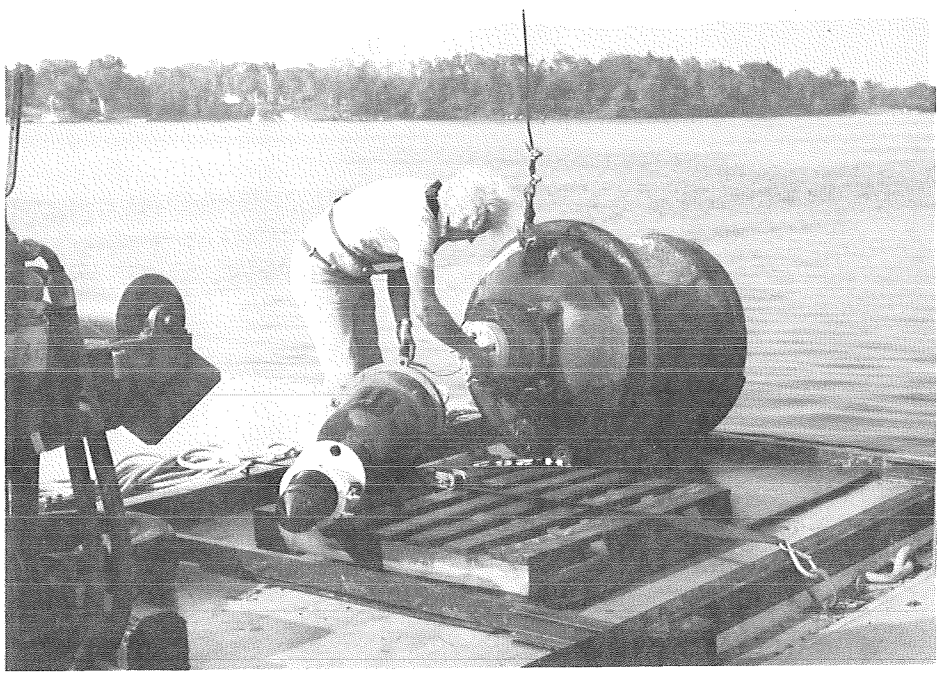


Handling 76 cm Electric Spar Buoys

Figure 6

Laying, Lifting and Transporting 0.9m x 1.5m Coastal Type Buoys





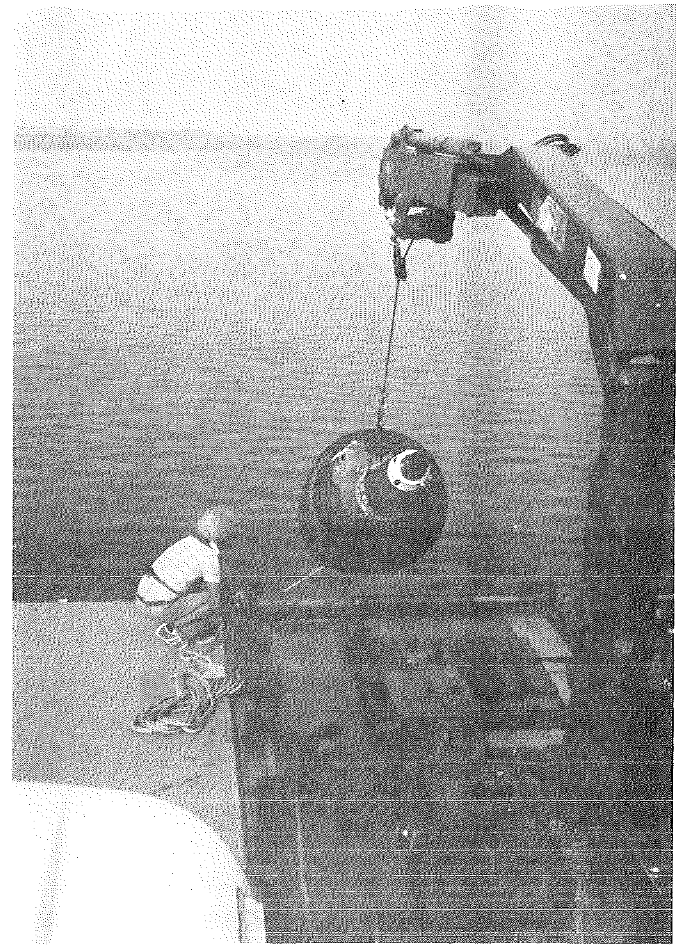


Figure 7 - Checking 0.9m Gannett Buoys
in the Ottawa River

Figure 8 - Transporting Diesel Generator
to VTM Station at Ile Grossbois

III

CONSTRUCTION SUPPORT

III

SUMMARY OF CONSTRUCTION SUPPORT

On at least five occasions the vehicle proved that it was well suited to working in support of construction.

The vehicle assisted in construction at Grondines. Although it is true that a tracked vehicle can be used here at low tide, and a motorized barge at high tide, the ACV can be used at high, low and partial tides, when the site is not accessible to the other types of vehicles and the danger exists of tractors being submerged and barges grounded.

Assistance was given at Ile Lozeau where beacon construction was carried out. Without this assistance, the tower that was erected would have had to be transported by road as an extra wide load.

At Anse des Mêres the vehicle gave valuable assistance in the construction of a tower. Without the assistance of the ACV, the equipment would have had to be trucked in on a very rough cleared track. The water at this location is too shallow for vessels and only limited clear space is available for the utilization of a helicopter.

The vehicle assisted the Quebec District in erecting a generating station on Ile Richelieu light tower. The task consisted of loading, transporting and unloading equipment, material, fuel and personnel as well as acting as a safety vehicle in case of injury to personnel working on the tower. The project was completed successfully and, due to the excellent cooperation of all concerned, in minimum time.

At the request of Sorel the vehicle assisted in the construction of a light tower near Pointe-du-Lac in Lac St. Pierre. The questionable integrity of the ice that was in place at this time made the use of vehicles such as ski-doos impractical.

The vehicle was successful in completing all of the tasks allotted to it and was able to carry them out faster and much more easily than the conventional equipment normally used for this type of work.

CONSTRUCTION SUPPORT

June 1975 - Beacon construction was carried out at Grondines where cement and equipment were used. The vehicle was required to transport 40,824 kg of cement bags and various types of construction equipment over 2.7 km of tidal rock beach.

During partial tides, the site is not accessible to either land vehicle or motorized barge, as at this time there is a danger of submerging the tractor or grounding the barge. Five trips were made in all.

June 1975 - Beacon construction was carried out at Ile Lozeau where the vehicle was required to transport five 4,536 kg loads of steel frame and wood from Sorel to Ile Lozeau, a distance of 40.2 km. The cargo was unloaded by a shore crane.

No difficulty was experienced in getting over hump or in controlling with a 20 knot head wind.

June 1975 - At Anse des Mêres, the craft transported 16,390 kg of equipment, consisting of a tower, wooden frame and cement, from Sorel to Anse des Mêres on Lac St. Pierre, a distance of 19.3 km. Two miles of the trip was across swampy grass. Without the ACV, the equipment would have had to be trucked in on a very rough cleared track. The water was too shallow for vessels and there was very little clear space to permit the utilization of a helicopter.

The craft was able to transport the material in two loads with no problem. Unloading was done with a shore crane.

Winds were very strong during transit but no difficulty was experienced in maneuvering.

Sept/
Oct 1978 - The vehicle was assigned to assist the Quebec District in erecting a generating station on Ile Richelieu light tower, and to assess the capability of the vehicle in performing various tasks involved in such a project.

The task consisted of loading, transporting and unloading equipment, material, fuel and personnel as well as acting as a safety vehicle in case of injury to personnel working on the tower.

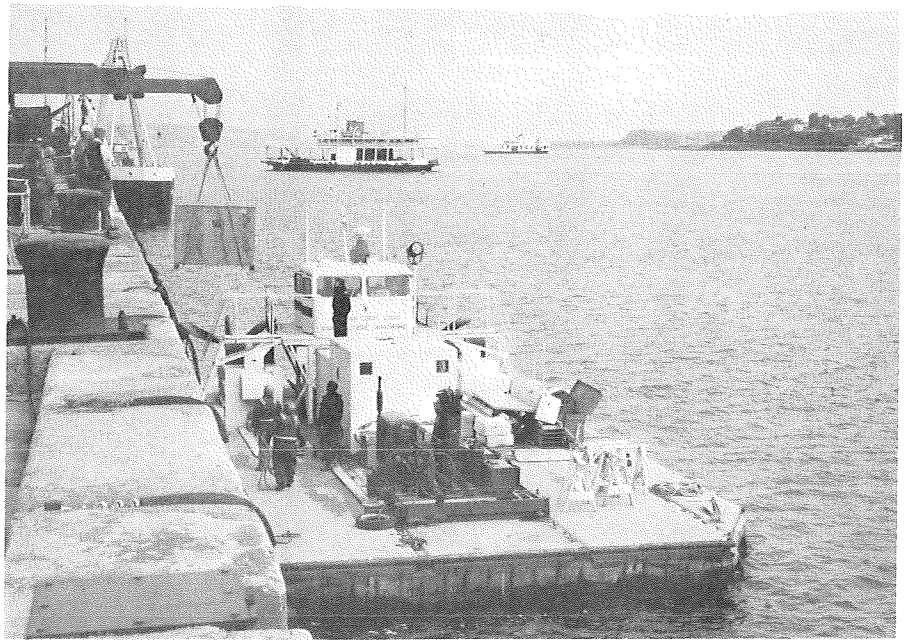
The vehicle transported all the equipment and material required to build the generating station.

The equipment transported included tools, building supplies, two diesel generators of 5,443 kg each, four fuel tanks made from 0.6 cm steel plate 1.8m x 0.9m x 3.6m weighing 1,134 kg, a 7,570 litres fibreglass fuel tank for transporting fuel to the site and a diesel powered pump used to pump the fuel from the vehicle to the tower.

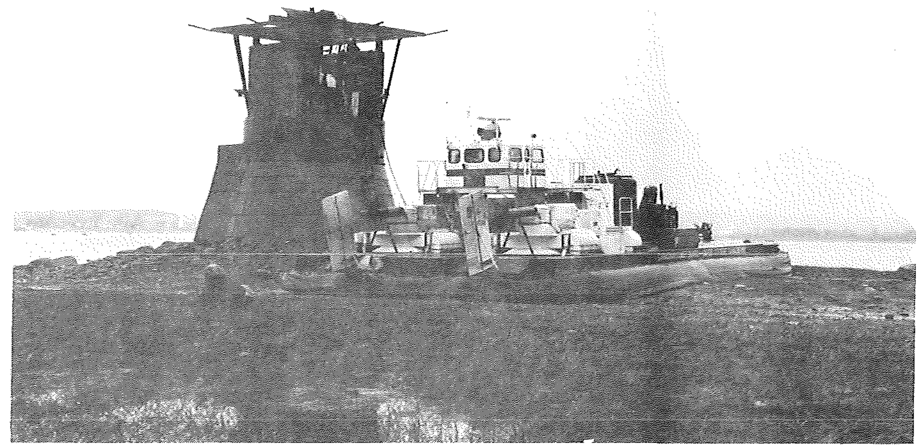
Construction workers were transported from Portneuf to Ile Richelieu every morning, returned ashore at midday, transported to the site again in the afternoon and back ashore at the end of the workday. A one-way trip took an average of seven minutes to complete. An average of eight passengers were carried with the maximum being fifteen.

The crew lifted all the equipment onto the tower using the crane and winches carried on board. After the first fuel tank had been hoisted into place on the tower, it was discovered to be too large. It had to be removed from the tower and along with the other ones, transported to Quebec City for modifications; after this they were once again transported to Ile Richelieu and hoisted into position.

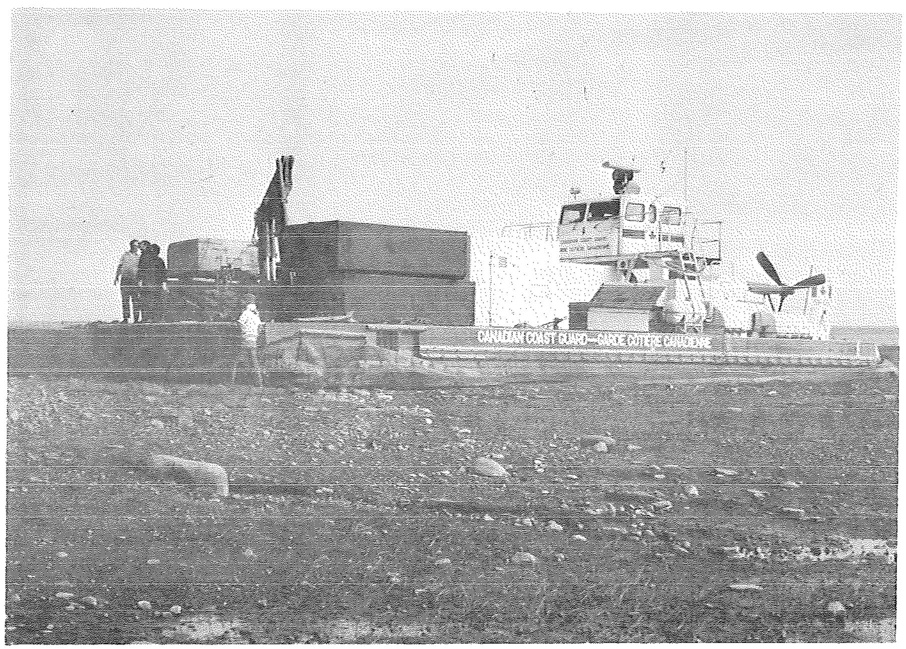
Jan 1979 - At the request of Sorel, the vehicle assisted in repairing a light tower near Pointe-du-Lac in Lac St. Pierre. A welding machine and two personnel were transported to the site. The welding machine was hoisted onto the leading light of the range. While the welding was being carried out, the vehicle remained on site to transport the workers to and from the tower. The tower was situated near the ice edge where, because the integrity of this ice was questionable, the use of other types of vehicle such as the ski-doo was not practical.



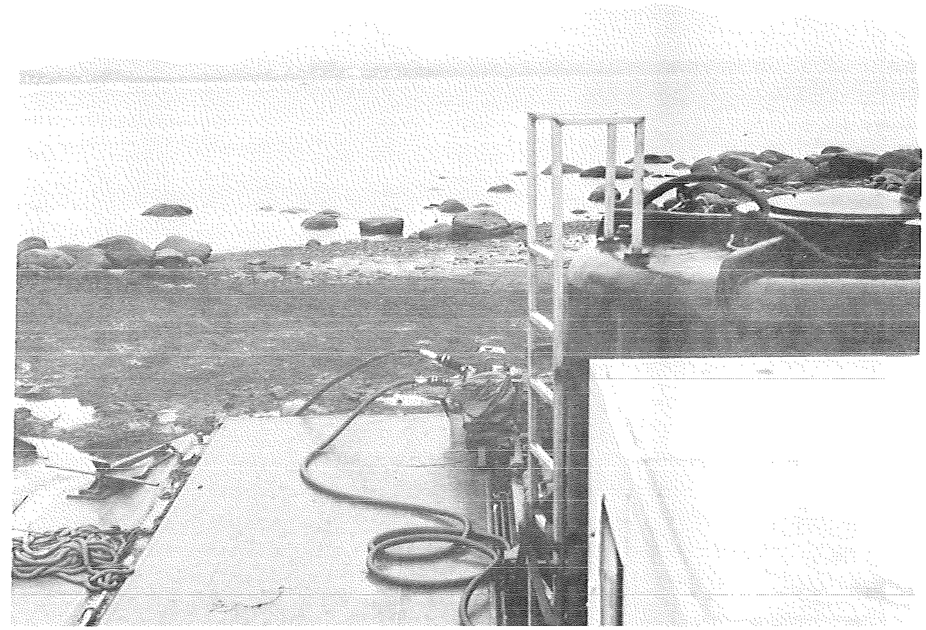
Loading Building Supplies, Diesel Generator and Fuel Tank for Construction on Ile Richelieu Light Tower



Fueling Ile Richelieu Light Tower After Construction

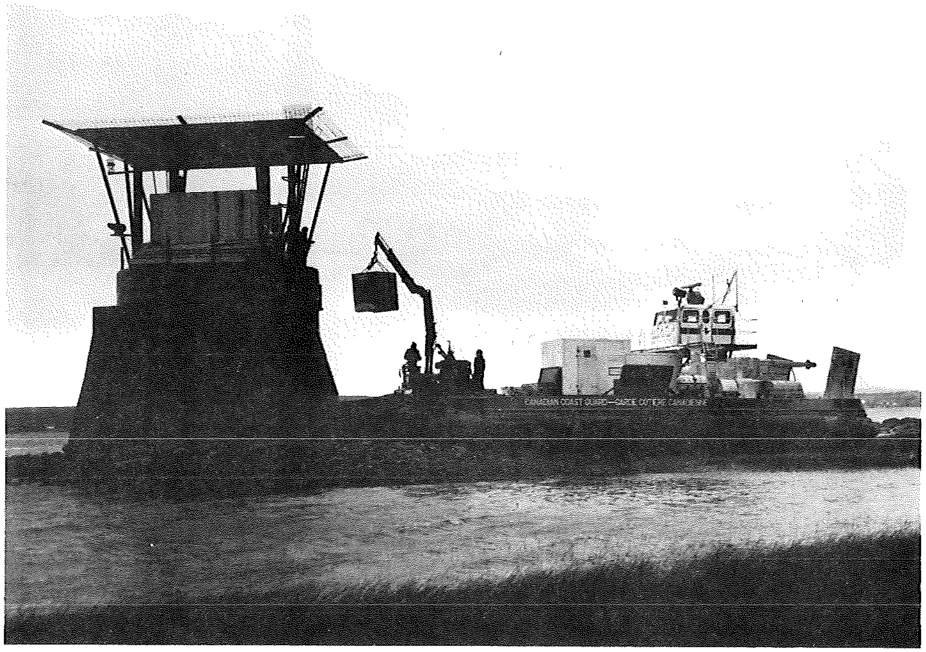


Delivering Building Supplies, Diesel Generator and Fuel Tanks for Construction on Ile Richelieu Light Tower



Fueling Ile Richelieu Light Tower After Construction

Figure 9



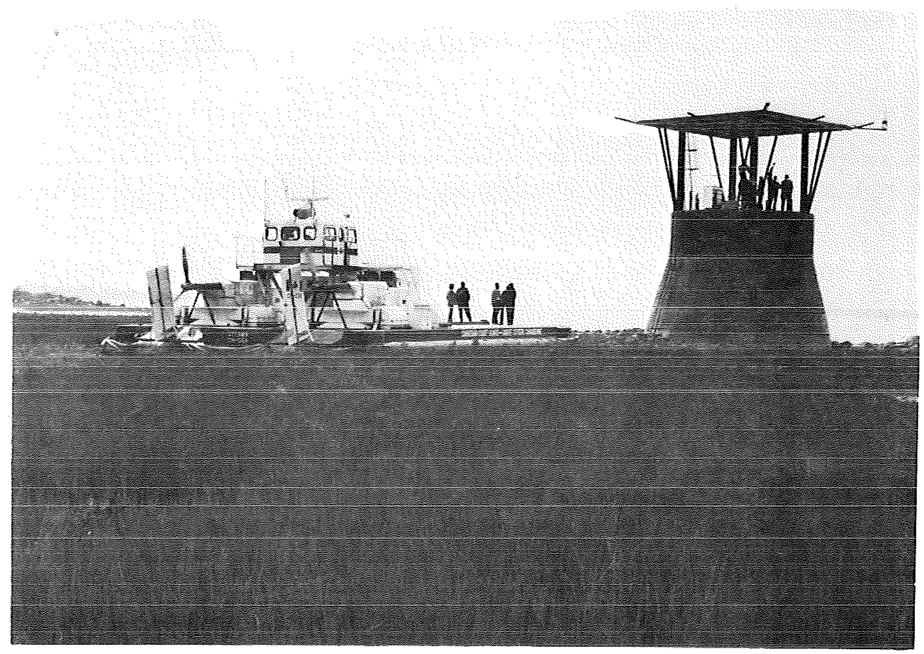
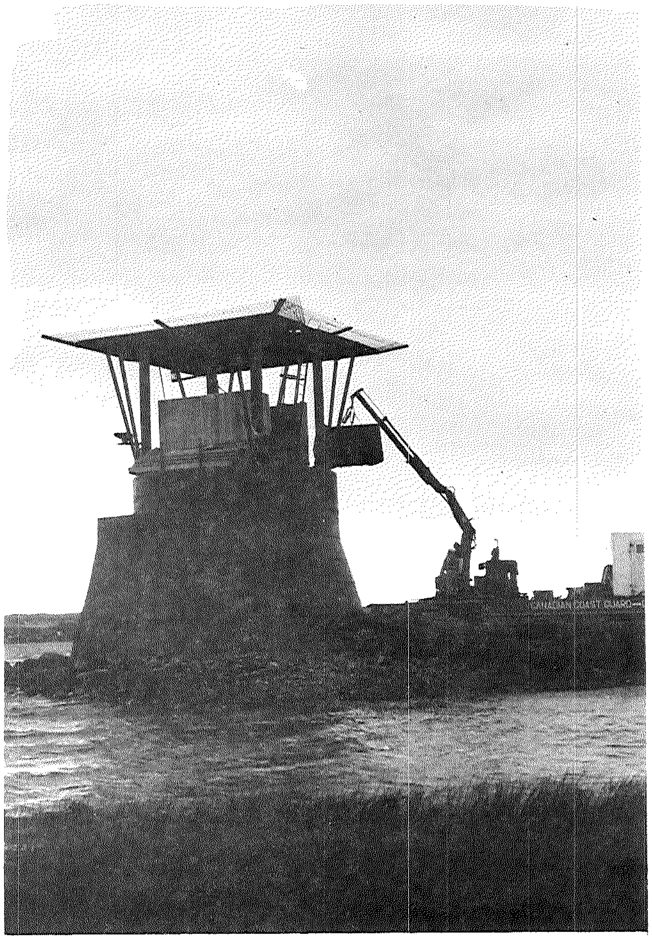


Figure 10 - Assisting Construction on
Ile Richelieu Light Tower



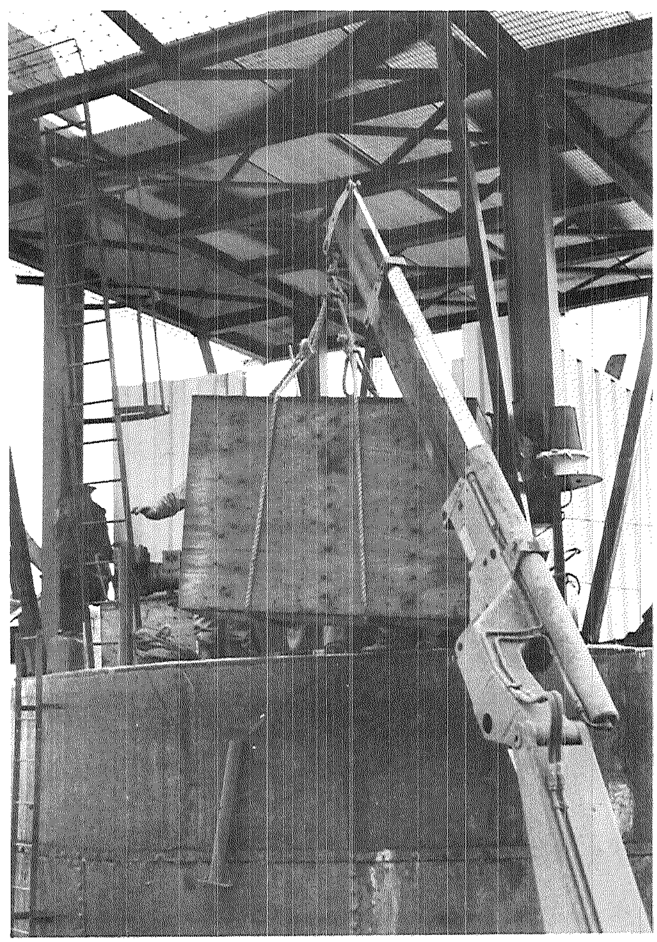


Figure 11 - Assisting Construction on
Ile Richelieu Light Tower

IV

SEARCH AND RESCUE

IV

SUMMARY OF SEARCH AND RESCUE

The vehicle has been successfully evaluated as a shoreline search vehicle; an open water search vehicle; in picking up survivors from swamped pleasure craft; in picking up survivors from the water; transferring survivors to and from larger vessels; and in towing vessels up to 21.3m in length.

Although the vehicle has not been involved in many search and rescue operations, the evaluation trials, as well as the two real incidents in which it was used, prove that it is well suited as a search and rescue vehicle.

The speed of deployment of the vehicle is exceptional in calm conditions, and good in conditions that are less than calm. Frequently transits between Montreal and Sorel are completed in one hour, at an average speed of 40 knots. On one occasion, an open stretch of the St. Lawrence River was covered at a speed of 60 knots.

The capability of the vehicle to carry out searches in extremely poor conditions, including zero visibility, is beyond question. The record of the SR.N5 and SR.N6 on the West Coast is proof enough of the ACV's capability in this area. As the Voyageur is a larger craft of more rugged construction, with four engines instead of one, two propellers instead of one and a cabin with a much greater height of eye, it must obviously be at least as capable as the aforementioned vehicles.

SEARCH AND RESCUE

Sept 1972 - The vehicle was evaluated in a simulated shoreline search for a missing person in a known area. The vehicle was dispatched and then requested to search approximately 32.2 km of shoreline in the Presqu'île Provincial Park and Bay area. It proceeded to the area at maximum speed and searched the entire shoreline in one and a half hours. The search was conducted 22.9m offshore at speeds up to 25 knots in 0.4km visibility. The vehicle demonstrated that it was effective in this task. The cabin height of eye (5.5m) offered good visibility for a detailed scrutiny of the shoreline and adjacent water.

Sept 1972 - The vehicle was evaluated in a simulated pick-up of survivors from a swamped pleasure craft and the pick-up of a survivor from the water.

The exercise was successfully carried out in winds of 15 knots and 0.6-0.9m seas. At the end of the exercise, the pleasure boat was hoisted by hand onto the deck of the vehicle, demonstrating that the ACV can lift and carry boats quite easily rather than having to tow.

It was demonstrated that the best method of recovering people from a boat on the water is from the stbd side using scrambling nets, while the vehicle is in the displacement mode.

Sept 1972 - The vehicle was evaluated as to its capability in picking up survivors, including stretcher cases, from larger vessels, and transferring them to a parent vessel. Trials were carried out with a 12m cutter and with CCGS SIMCOE.

Sept 1972 - (cont'd)
The trials with the cutter were carried out in calm weather. The vehicle approached the cutter in the displacement mode and laid alongside to transfer a stretcher case which was done several times without incident.

The trials with CCGS SIMCOE were carried out in 24 kph winds but in calm water, with the vehicle approaching the lee side of the ship, on cushion. This task was performed several times with both units proceeding at varying speeds. Survivors, including a stretcher case, were transferred back and forth without incident.

These demonstrations leave no doubt whatsoever that the ACV is admirably suited to this role.

Sept 1972 - The vehicle was evaluated as an open water search craft.

Search pattern trials were carried out at an average speed of 26 knots. This speed greatly reduces the time required to search an area. The cabin height of eye (5.5m) and the all-round visibility allowed for detailed searching.

The trials established that the Voyageur can be effectively used in this role and a trial with a helicopter demonstrated that this combination in a search role is extremely effective.

The only shortcomings apparent during these trials involved equipment, i.e. speed indicating and navigation equipment and the cabin layout. These are purely technical and can be resolved.

Sept 1972 - The vehicle was evaluated in the towing role in conjunction with a 12m cutter, CCGS SPINDRIFT and CCGS SIMCOE.

The 12m cutter was towed in winds of 8 kph and calm seas. This tow was successfully carried out at a speed of 10-12 knots and at all angles to the wind.

The CCGS SPINDRIFT (21.3m) was towed in 24 kph winds and seas of 0.6-0.9m. This tow was successfully carried out at 8 knots and at all angles to the wind. The vehicle was able to tow the CCGS SIMCOE (54.6m) at approximately 2 knots but, due to wind conditions, was unable to maintain effective steering control.

It was demonstrated that the Voyageur is capable of towing vessels up to 21.3m in length and that this capability can probably be extended to vessels up to 30.5m in length. It was also demonstrated that it would be possible to prevent larger disabled vessels from drifting.

Sept 1972 - The vehicle was contacted by Port Hope Police and requested to search for two men and a 4m boat which sank 2.4m from Wesleyville while they were retrieving a weather balloon for Ontario Hydro.

A police officer was taken aboard and the search commenced using Trenton Armed Forces Base as a communications link. The two men were located in the water and taken aboard. The survivors were put in the cabin to keep them warm while being transported to shore where a waiting ambulance took them to Port Hope hospital.

Sept 1972 - (cont'd)

Both men were suffering from exposure; one was also suffering from shock and was detained in hospital.

May/June 1975 - On two occasions the vehicle was dispatched on search and rescue missions. On both occasions the weather was clear with a 15 knot wind and the sea was calm.

May 1975 - The vehicle was locking down in the St. Ours lock when the lock master advised that a swimmer had been washed down the sluice-way a few minutes before. The lock gates were opened, the vehicle exited from the lock and commenced searching directly below the sluice gate. The strong current in this area created great turmoil. The search continued downstream at slow speed, and a river bank search was carried out until the vehicle was well out of the search area without the swimmer being found.

It was amply demonstrated that the Voyageur is capable of maneuvering freely in restricted areas with strong currents. Below the control dam at St. Ours the vehicle searched an area 183m x 183m several times with great ease and control.

April 1978 - While breaking ice on the Bécancour River, the vehicle intercepted a radio transmission from CCGS TRACY to CCGS MCLEAN. CCGS TRACY signalled that it was steaming at best speed to Trois Rivières with a member of the crew who had severed a finger.

After the vehicle offered assistance which was accepted, it departed Bécancour River at 15:04 hours, travelling 18 km to rendezvous with CCGS TRACY. The injured man was taken aboard and transported to Pointes des Ormes Pilot Station, 6.5 km away, where he was disembarked to a waiting taxi at 15:32 hours. Total elapsed time was 28 minutes. This is an excellent example of the speed capability of the Voyageur in an emergency situation.

Jan 1979 - Sorel requested that the vehicle transport personnel to the scene of a ski-doo accident. Three people were embarked at Sorel and transported to the scene of the accident, a patch of open water over the stone weir at Ile-de-Grace. The ski-doo and sleigh had gone into the area with the result that two of the four occupants were drowned. After the site had been examined for approximately one hour, the passengers were returned to Sorel where the vehicle remained overnight.

Jan 1979 - (cont'd)

The following day the vehicle transported four passengers, one of whom was a scuba diver, to the scene of the accident where an attempt to locate the ski-doo and sleigh, and possibly the bodies, proved futile. The four personnel were returned to Sorel.

June 1979 - While employed by the Quebec District, in transporting painters to sextant marks, the vehicle was assigned to search for a 12.2m cruiser, which had not been heard from since reporting that she was anchored in fog near Pillar Rock.

The search commenced at Ile Madame and continued down the south channel in 1.2m to 1.5m seas. The vehicle checked the harbours at Montmagny, Ile-aux-Grues, St. Jean-Port-Joli and L'Islet as well as Pillar Rock and Ile-Loup-Marin, before proceeding to Cap ã l'Aigle, the boat's destination. The boat had arrived at Cap ã l'Aigle approximately ten minutes before the Voyageur. A total distance of 112.6 km was covered in 2.8 hours.

June 1979 - A CSI inspector, along with two salvage and insurance inspectors, were transported to a grounded grain ship and later returned to shore. The vehicle remained on standby until the following morning.

Aug 1979 - The vehicle was requested by RCC Quebec to carry out a medivac mission. The light keeper at Ile Rouge was sick, requiring immediate medical attention. Visibility was zero with rain and fog ruling out the use of a helicopter.

The vehicle departed its temporary base at Rivière du Loup, approximately 13 nautical miles from Ile Rouge, at 1637 hours and had completed the evacuation by 1741 hours, an elapsed time of one hour, four minutes.

V

OIL POLLUTION CONTROL

V

SUMMARY
OF
OIL POLLUTION CONTROL

The best defence against an oil spill is rapid assessment of the situation and rapid deployment of oil booms. Voyageur's speed and carrying capacity can be used most effectively as a means of controlling oil spills.

Trials in 1972 showed that the vehicle had great potential as an oil pollution prevention resource by loading a section of PVC oil boom onboard and deploying it with relative ease.

In September 1978, while investigating the source of an oil spill off Pointe aux Trembles, a trial was carried out, in the presence of officials from DOT, NHB, and DFE, to determine the effect of the vehicle on oil spills when proceeding through or over them. It was determined that the effect was slight and in fact that the vehicle could be used to move the oil in a pre-determined direction.

In November 1978, trials were carried out under the direction of the Marine Emergencies Branch of the Laurentian Region. The vehicle carried pumps, skimmers, decantation tanks, booms and other equipment. Booms were laid, anchored and towed, and oil blotter was dispersed to simulate pollutants. The vehicle manoeuvered over booms, came alongside other vessels, recovered simulated oil using onboard Transvac Pumps and Mantaray Head Skimmers, acted as an oil deflector and operated as a communications centre. The trials were an unqualified success.

OIL POLLUTION CONTROL

Nov 1972 - The vehicle was evaluated to establish if it could be used effectively in the oil pollution control role. A section of PVC oil boom was loaded aboard at the DFE facility at Burlington. The section was then deployed from a finger pier to the main wharf, with minimum effort.

The vehicle made several passes over the boom on full cushion while being observed by DFE personnel. The boom was seen to depress slightly but, with the vehicle's speed, very little oil would have escaped.

The 610m of PVC oil boom on the wharf was not loaded aboard but it was obvious that the vehicle could have carried it with space and payload to spare.

The vehicle excels in the rapid deployment of equipment and personnel and it was demonstrated that it is relatively easy to stream PVC oil boom from the deck.

The payload and deck space available on the Voyageur would allow the transportation of a minimum of 610m of booms, drums of dispersant and other oil pollution equipment.

Oct 1975 - The vehicle was dispatched to attend to the grounded tanker FRANK D. MOORE, which had suffered an electrical failure and was totally "dead ship."

The task was to reach the tanker at top speed, supply radio communications and advise the main radio station as to the possibility of damage and spilling.

Oct 1975 - (cont'd)
The vehicle reached the ship 1.2 hours after receiving the call from Montreal Channel (this time included a 5-minute stop to pick up three steamship inspectors).

There was no evidence of oil spilling but, had there been, the Voyageur would have been the fastest resource available to perform boom laying.

Aug 1977 - Temporary modifications were made to the vehicle for preliminary studies to determine whether air cushion vehicles could be considered as potential oil spill dispersant spraying platforms.

Trials were carried out on the Lac St. Pierre area of the St. Lawrence River. The vehicle operated at speeds between 20 and 30 knots on a variety of courses relative to a 15 knot cross wind.

It was determined that air turbulence resulting from underskirt escapage, propeller wash and forward velocity does not present any obstacle to the use of these vehicles as dispersant spraying platforms.

Sept 1978 - While in transit to Sorel an oil slick was sighted off Pointe aux Trembles. The sighting was reported to Montreal VTM who requested the vehicle to determine the source of the slick. It was determined that the source was the Imperial Oil Refinery and VTM was advised of this. Three pollution officers (Messrs. Duchesneau (DOT), Nicholson (NHB) and Rivet (DFE)), were embarked in Bikerdike Basin. They were taken to the spill site, disembarked to investigate the source, and re-embarked to observe the effect of the craft on the spill.

Sept 1978 - (cont'd)

It was determined that the oil was a middle distillate and the following observations were made:

a) When the vehicle moved over the slick on full cushion at slow speed, air escaping from under the skirt blew aside the oil to approximately 0.6-0.9m from the vehicle. The remainder of the oil was emulsified with the water under the craft. A small amount of oil was detected in the air circulating at cab level.

b) When the vehicle was in the boating mode or on reduced cushion (moving at approximately 5 knots), the skirt seal prevented air from escaping and the oil was pushed aside approximately 0.3-0.6m from the vehicle. It was also observed that by placing the vehicle at an angle to the current, it could be effectively used to deflect the oil slick.

Mr. Rivet of DFE is in full agreement with these observations and is of the opinion that the action of the air cushion on oil slicks would not prevent recovery operations being conducted from the vehicle.

Nov 1978 - The vehicle was evaluated by the Marine Emergencies Branch of the Laurentian Region, in the oil pollution prevention and clean-up role and as a primary resource for marine contingencies.

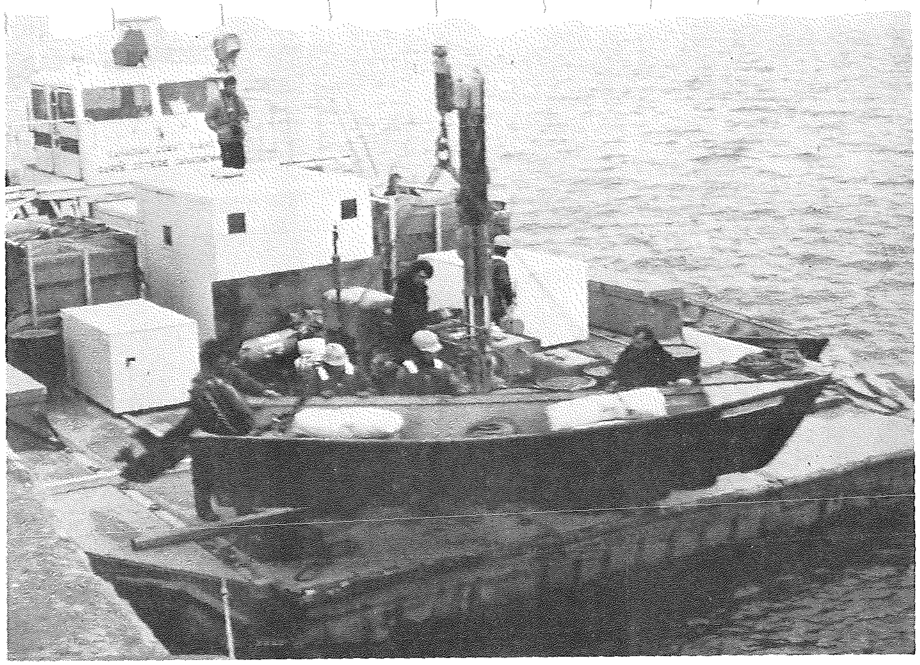
The exercise included loading and unloading the vehicle with various combinations of all the available equipment in the Region. This was followed by practical exercises in conducting oil pollution operations using the vehicle as a transport and work platform.

Nov 1978 - (cont'd)

The following equipment was carried and used:

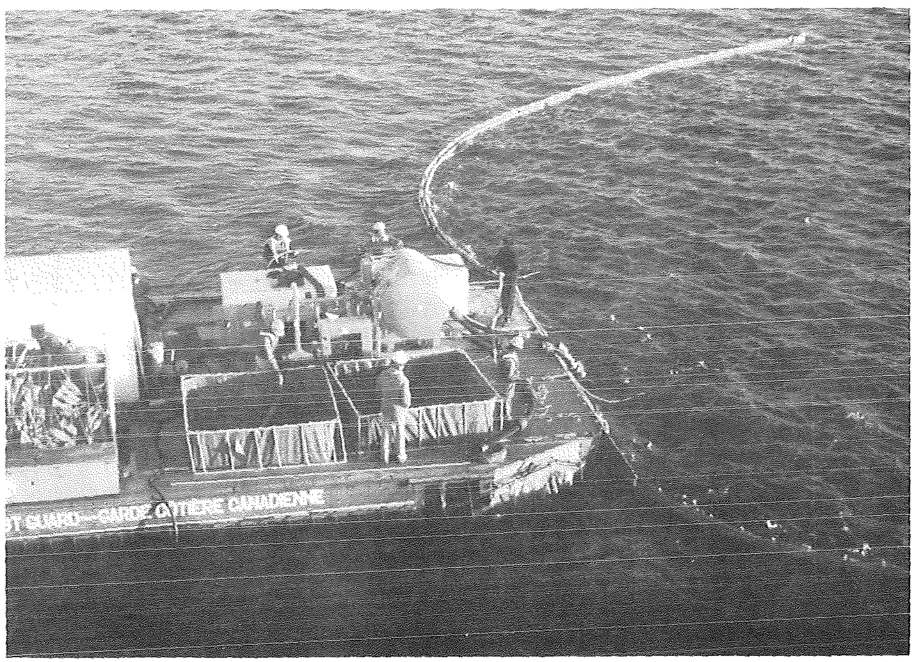
a) Framo pump (diesel engine, hydraulic pump, TK4 suction head);
b) Transvac pump (two diesels , vacuum pump, transfer pump, 1,892.5L vacuum tank);
c) Minikomara surface skimmer;
d) Decantation tanks;
e) Mantaray head surface skimmer.

Activities included laying and anchoring oil booms in position from the deck of the vehicle, simulating pollutants by dispersing oil blotter on the surface inside the deployed boom, towing booms, maneuvering over booms, coming alongside other vessels to place transfer pumps, recovering booms and anchors and acting as an oil deflector and as a communication centre.

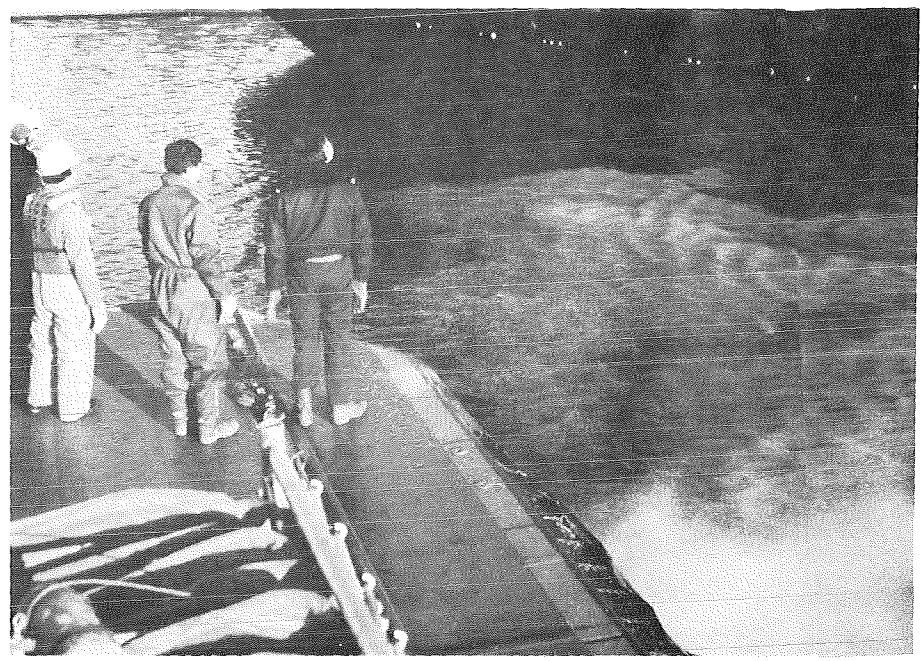


Lowering Verchères into Water

Oil Recovery Exercise

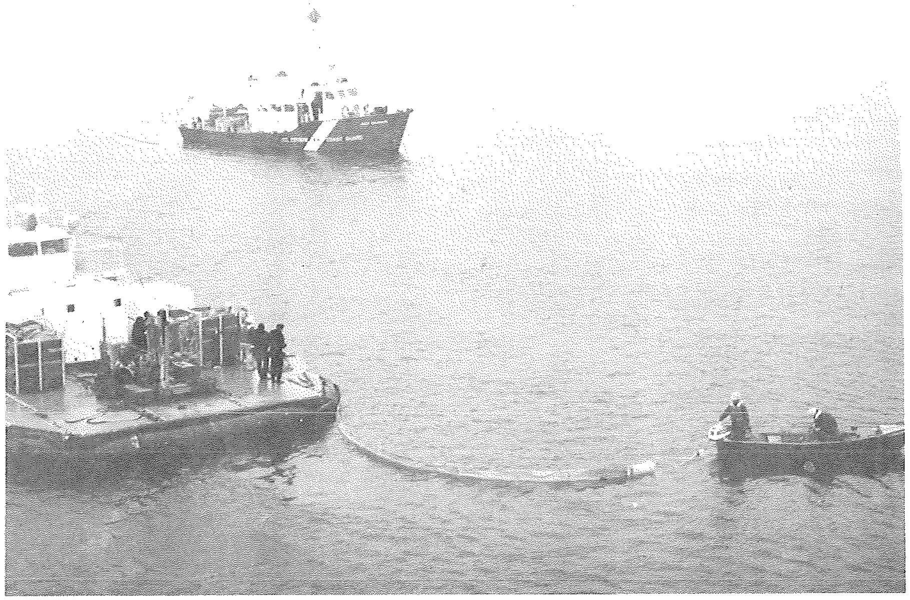


Recovery with Transvac Pump

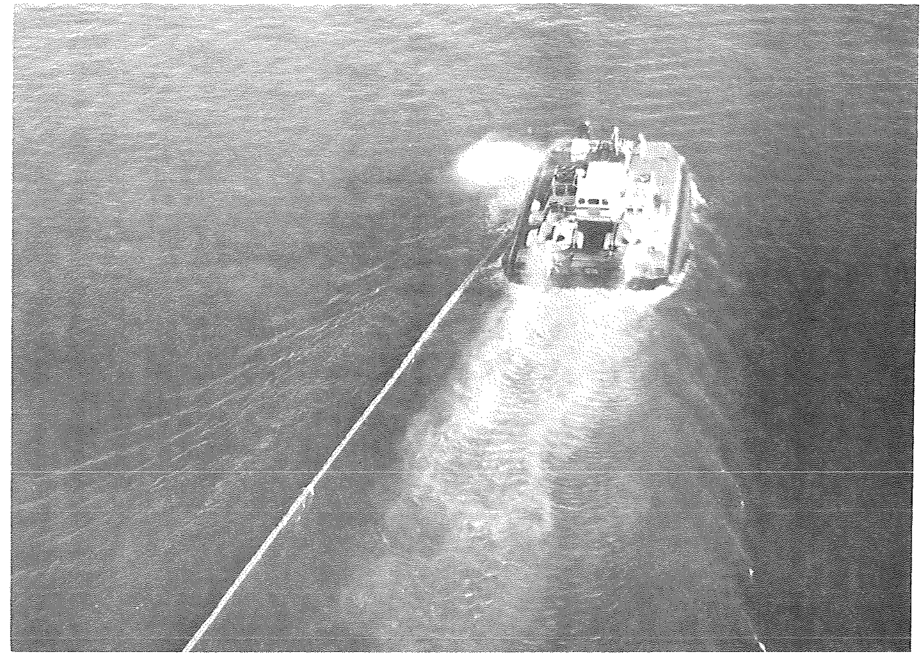


Dispersing Oil Blotter

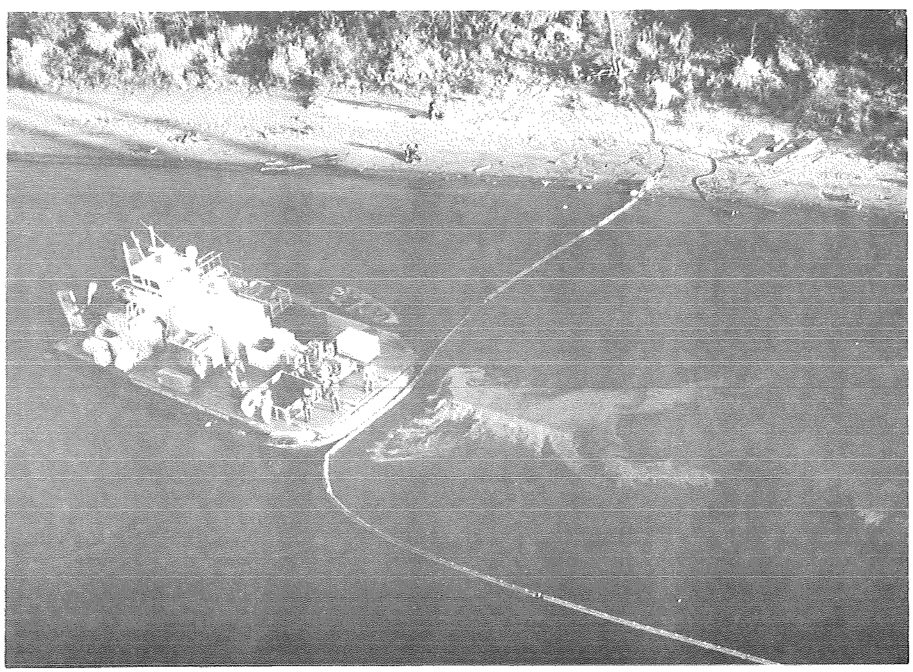
Figure 12 - Oil Pollution Exercise



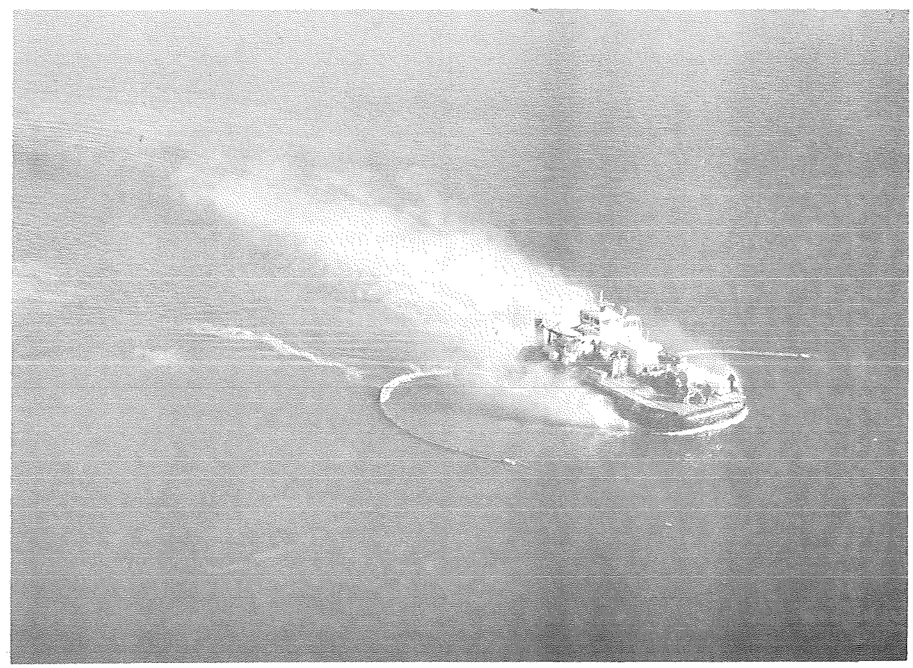
Boom being deployed using the Verchères



Towing boom from dock to M/V Prince Edward Island



Oil Recovery Exercise



Passing over 18" Flexy Boom

Figure 13 - Oil Pollution Exercise

VI

HIGH-SPEED ICEBREAKING AND ICE MANAGEMENT

VI

SUMMARY OF HIGH-SPEED ICEBREAKING AND ICE MANAGEMENT

Icebreaker support of commercial shipping is a vital annual task of CCG in the St. Lawrence upstream to Montreal. It requires several ships to maintain the main channel and also to clear the upstream exit from Montreal in preparation for the Seaway opening in the Spring.

An ACV can rapidly break significant thicknesses of ice at speeds up to 45 knots, without regard to water depth; trials at Parry Sound, Ontario, in 1974, showed the potential of Voyageur in this role, and operating techniques were developed in the winter of 1974-75 at Montreal.

In January 1975, Voyageur cleared an ice jam creating a potential flooding situation in Rivière des Prairies, at the request of the local Emergency Measures Organization. This set a precedent for Voyageur to be requested on numerous occasions to clear ice jams in rivers outside CCG mandate. Failure to respond to emergency situations would be irresponsible, and each succeeding year Voyageur has relieved floods on eight or nine tributaries of the St. Lawrence east of Montreal.

In the 1975-76 winter season, techniques were further developed for high-speed icebreaking, and with river current assist, up to 15 sq km per hr of ice up to 1m thick were cleared.

During the 1977-78 and 1978-79 winter seasons, Voyageur was placed under the operational control of the icebreaker captain in charge of local operations. In addition to clearing ice in Lac St. Louis and river jams, the vehicle operated extensively in Lac St. Pierre in support of channel clearance, being able to operate in shallow water either side of the channel to manage and control ice clearance more effectively than ships such as CCGS ROGERS and CCGS RADISSON.

It is significant that Voyageur has year-round access to Lac St. Louis, being able to negotiate the Lachine Rapids with ease. Because the South Shore Canal is closed to shipping in the winter, special arrangements have to be made for the passage of icebreakers to and from Lac St. Louis. The free access allows Voyageur to fail and clear ice as required, and also to transport personnel and supplies for Navaid maintenance at will. All range lights were re-activated in Lac St. Louis, using Voyageur for transport on March 13 and 14, 1979.

Demonstrations of icebreaking capabilities have been given to representatives from authorities of Sweden, Finland, USA and USSR governments.

HIGH-SPEED ICEBREAKING AND ICE MANAGEMENT

Feb 1974 - Parry Sound

The vehicle was evaluated in icebreaking following previous low-speed icebreaking tests with air cushion platforms. Results were as expected, with Voyageur failing ice 20 cm thick at 7-8 knots. High-speed operation, however, revealed a previously unknown natural phenomenon: a powerful stern wave developing in the ice sheet, at speeds in the 12-15 knot range, which failed ice up to 45 cm thick. Operations were limited due to shortage of personnel and funds for Voyageur, which was a new CCG resource just becoming established at that time.

Jan/Apr 1975 - Montreal area

The vehicle was operated to develop optimum icebreaking techniques over intact ice sheets in Lac St. Louis. Ice up to 71 cm thick was broken and cleared at an average rate of 2.5 sq km per hour, with a track width of 120m.

Operations were carried out at the request of Emergency Measures officials to clear an ice jam in Rivière des Prairies; a 4.8 km length of ice and frazil up to 6m thick required development of further techniques, which were successfully applied.

A similar operation clearing 2 km of ice in the Châteauguay River was also successful.

Evaluation of ice clearance in confined areas was conducted successfully and two ships were assisted out of ice-infested berths in Montreal Harbour.

The vehicle's speed and amphibious capability enabled it to operate at will in Lac St. Louis, via the Lachine Rapids at times when the Canal was closed, and to make rapid transits over shallow water or ice of any thickness to reach an operational area.

Jan/ Apr 1976 - Further development of operational techniques, coordinated with SLSA.

Ice up to 1.05m thick broken and cleared at speeds up to 25 knots.

Ice cleared in unrestricted areas at the rate of 15 sq km per hour.

MVs MAURICE DESGAGNES and FORT RAMSAY freed from ice near Ile St. Thérèse.

Range lights in Lac St. Louis activated to allow night icebreaking to proceed.

Assisted CCGS NORMAN MCLEOD ROGERS in clearing Lac St. Louis.

Cleared 14.5km of Richelieu River in full flood and prevented serious flooding.

Cleared 11.5km of St. François River.

Cleared 3km of Rivière des Prairies.

Cleared 4km of Nicolet River.

Cleared 4km of Bécancour River.

Cleared two large jams 1.5km long in Lac St. Pierre shipping channel.

Cleared 11 km long jam in St. Lawrence at Varennes.

SLSA requested Voyageur to be operational status for 1977 and future seasons.

Citations and requests for assistance from:

- Regional Director (Québec) Emergency Planning Canada
- Town of Bécancour
- St. Lawrence River Pilot of MV MAURICE DESGAGNES
- Captain, CCGS NORMAN MCLEOD ROGERS
- Town of Pincourt
- Town of Châteauguay
- Quebec Ministry of Natural Resources.

River ice cleared - 31 kms in 43 hrs on-site operation.

Jan/ 1977 - Apr	Operational unit tasked by CCGS NORMAN MCLEOD ROGERS. Maintained open channel in Lac St. Pierre. Maximum sheet ice thickness broken - 1.6m. Assisted CCGS N.M. ROGERS in Lac St. Louis. Cleared ice from Bécancour, Nicolet, Châteauguay, Richelieu, St. François and Yamachiche Rivers. 125 hours of icebreaking during 182 hours total operation over 77 days; just over 1,609 km travelled. Citations and requests for assistance from: - SLSA - Town of Notre Dame de Pierreville - Town of Nicolet.
Dec 1977 - Apr 1978	Icebreaking was carried out on an operational basis over a 160km stretch of the St. Lawrence between Ste-Anne-de-Bellevue in the West, to the Bécancour River in the East, including seven tributaries. Heavy batture ice was successfully cleared in Lac St. Pierre; on one occasion, an area 4 km x 1.25 km was cleared in one hour. Flood control operations occupied almost 150 hours onsite, during which jams were cleared from the following rivers: - Mille Iles - Rivière des Prairies - Châteauguay - Nicolet - Bécancour - Yamaska - St. François Ship channel icebreaking operations were integrated with those of CCGS N.B. MCLEAN in Lac St. Pierre, and with CCGS N.M. ROGERS in Lac St. Louis.

Jan 1979 - While under the operational control of the Captain of CCGS PIERRE RADISSON the vehicle was ordered to assist in breaking a large amount of batture ice that had broken adrift in Lac St. Pierre. The vehicle departed base at 13:00 hours on 4 January and arrived on task in Lac St. Pierre at 15:00 hours.

The remainder of this day, and the following day until 14:05 hours, was spent breaking the batture ice to prevent it from jamming as it entered the river. The ice was 15.3 cm to 30.5 cm thick and there was no difficulty breaking it.

Feb 1979 - The Captain of CCGS NORMAN MACLEOD ROGERS ordered the vehicle to commence breaking the ice out of the Châteauguay River on 19 February. All the ice in the river (30.5 to 45.7 cm thick) up to the first bridge was broken in 4.1 hours.

Feb 1979 - On 27 February, icebreaking commenced 4.8 km downstream from the mouth of the Rivière des Prairies, in order to create an exit path for the ice coming out of the river. Ice was broken for a distance of 4.8 km, and a channel was cleared up to the bridge by 29 February when the vehicle was placed on standby.

Mar 1979 - On 6 March the vehicle commenced breaking batture ice at the eastern end of Lac St. Pierre on the south side of the channel. The ice surface was quite rough, with many pieces on edge, and the thickness varied up to 1.0m.

The ice was broken quite easily but having to dodge pinnacles slowed down the rate of breaking. One very large piece of batture ice came down the lake, which took considerable time to break-up before it passed into the narrow channel at the end of the lake.

Mar 1979 - On 7 March, the vehicle broke out the entrance channel to the Nicolet River, and then proceeded to the Montreal area where it broke out the small boat channel on the south side of the Boucherville islands.

Mar 1979 - On 8 March icebreaking was carried out in the Boucherville channel until noon when the vehicle proceeded to the Nicolet River and commenced icebreaking.

The vehicle cleared the Nicolet River of ice up to the highway bridge by noon on 10 March, and then proceeded to Lac St. Pierre to break the batture ice on the north side of the channel. The ice which was 45.7 cm thick, was easily broken at speeds up to 45 kts.

Mar 1979 - The vehicle returned to the Boucherville channel on 11 March to complete icebreaking in the area.

Mar 1979 - From 15 to 19 March the vehicle broke ice in Lac St. Louis along with CCGS PIERRE RADISSON.

Mar 1979 - From 20 to 22 March the vehicle was employed breaking ice in the Bécancour River. The water level in the river was low, the channel was only 30m wide and the ice was 0.76m thick. The remainder of the river ice up to the first highway bridge was broken quite easily despite the low water level.

Mar 1979 - A piece of loose batture ice, 5.6 km by 2.4 km and 45.7 cm thick, was broken in Lac St. Pierre on 21 March in only 50 minutes.

Mar 1979 - On 22 and 24 March icebreaking was carried out at the mouth of the Yamaska River. The ice in the river was completely broken, right up to the bridge at the Village of Yamaska, by 16:00 hours on 24 March.

Mar 1979 - Icebreaking commenced in the St. François River on the morning of 25 March and, by the afternoon, the water level at Notre-Dame-de-Pierreville had gone down 61 cm. The following day, the river was cleared up to Pierreville by 11:30 hours and the water level at the town had gone down 1.5m.

Mar 1979 - Icebreaking was carried out in Lac St. Louis from 28 to 31 March, ending with clearing of Anse-au-Sables at 11:30 hours.

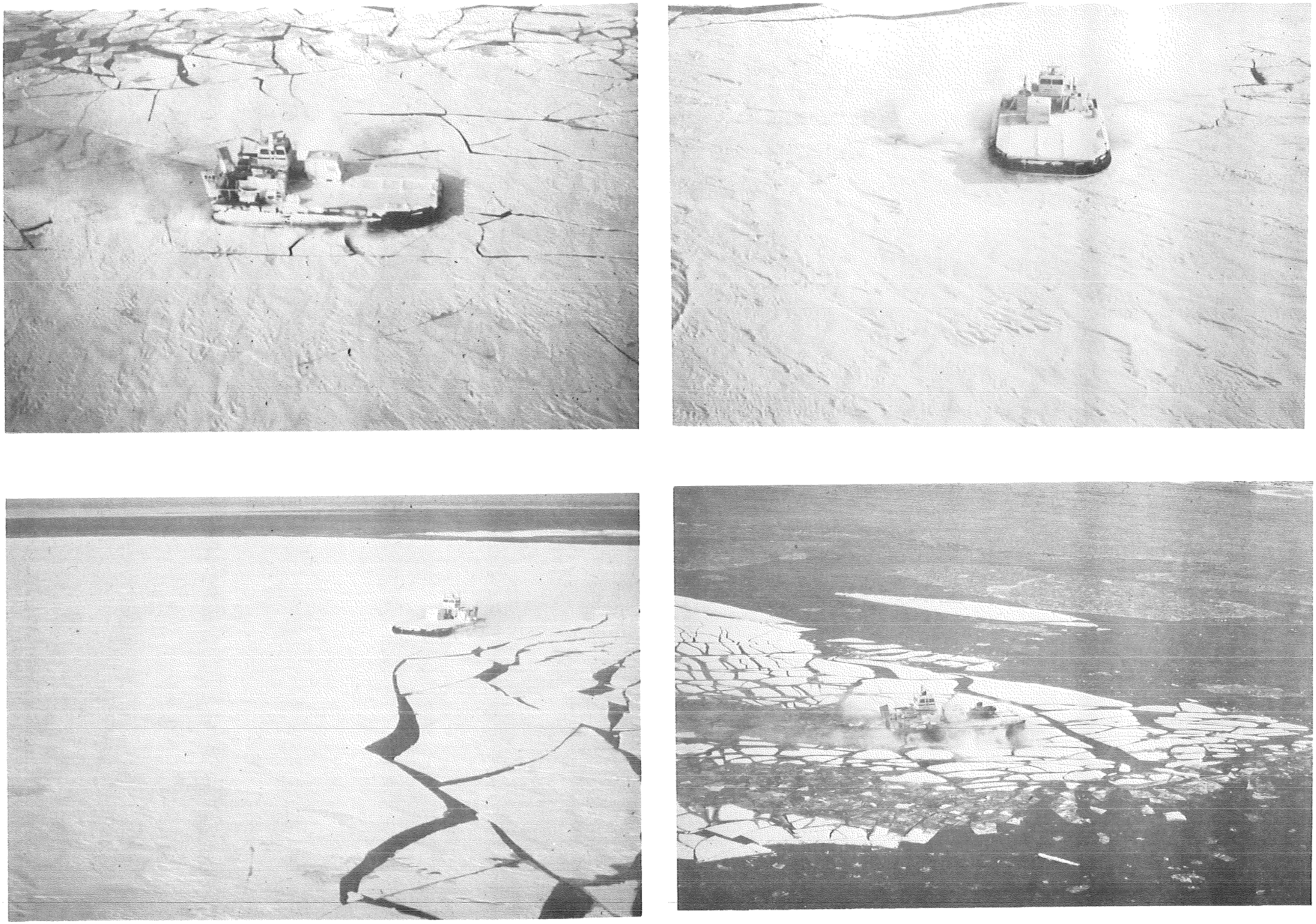


Figure 14 - Voyageur Icebreaking

VII

LIGHTHOUSE SUPPLY

VII

SUMMARY OF LIGHTHOUSE SUPPLY

Trials conducted in September 1972 demonstrated that in good and adverse weather conditions the vehicle could provide a more stable and controllable platform than the small boats and barges presently used for supply work and lightkeeper exchange. It is a fact that the lightkeeper exchange carried out at Southern Shoal would not have been possible in the prevailing weather conditions by any other means.

During April and May 1979, under the control of the Quebec District, eight light stations were re-supplied. In total 86,071 lit of fuel, 45,450 lit of water, and 2,087 kg of other freight were delivered during the 92.7 hours spent on the task. The operation began at Ile Richelieu and continued downstream to Ile Bicquette.

LIGHTHOUSE SUPPLY

Sept 1972 - Trials were conducted to assess the ability of the vehicle to land at light stations to discharge supplies and personnel. Approaches and landings were attempted at the following light stations and beacons:

Lake Ontario: Peter Rock, Scotch Bonnet, Pointe Petrie, False Duck Is., Main Duck Is., Presqu'île, Proctor Point.

Lake Erie : Long Point, Southeast Shoal, Colchester Reef, Middle Sister, Pelee Passage.

The weather conditions ranged from calm to 64.3 kph winds with 1.8 - 2.4m seas.
At all of the light stations visited, the vehicle was able to make controlled approaches and landings. It provided a stable platform for discharging supplies, equipment and personnel.
The vehicle was able to get close enough to storage areas at all light stations visited so that the handling of supplies could be kept to a minimum.
At Main Duck Isle, the vehicle approached the light itself and demonstrated that it could be held against a low sea wall to discharge cargo.

Nov 1972 - At Southeast Shoal, an exchange of lightkeepers and their belongings was carried out in 40-48 kph winds and seas of 0.9 - 1.2m.

Apr/May 1979 - The vehicle was assigned to the Quebec District from 23 April to 6 May to demonstrate its suitability as a supply vehicle and to determine the type of equipment most suitable for use onboard the vehicle.

Apr/ May 1979 - (cont'd)

The light stations to be supplied are in the St. Lawrence River with difficult accessibility.

Supplies were delivered to eight light stations: Ile Richelieu, Banc Brulé West, Banc Brulé East, Cap Gribane, Prince Shoal, Ile Rouge, Ile Blanche, and Ile Bicquette. All of these light stations have previously been supplied by ships, barges and helicopters.

All eight of these stations were supplied with diesel fuel, while Prince Shoal and Ile Rouge also received fresh water. Two diesel generators, an aluminium hatch cover and oxyacetylene welding equipment were delivered to Prince Shoal.

Initially the fuel was carried in one 7,570 lit fibreglass tank but, after the third station had been fuelled, a 11,355 lit rubberized fabric tank was used. The rubberized tank proved to be superior for the job.

Water was carried in four 1,892 lit collapsible tanks manufactured from rubberized fabric and neoprene coated fabric. Although neither of the two types of tanks was considered suitable, the rubberized fabric tanks were the better. It is recommended that in future operations, the same type of tanks be used for water as for fuel.

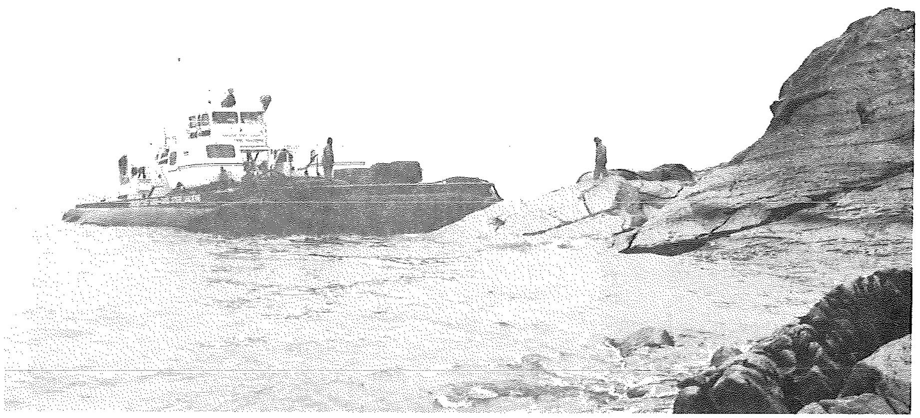
The operation began at Ile Richelieu and continued downstream to Ile Bicquette. The total hours spent on the task were 92.7, 86,071 lit of fuel and 45,420 lit of water were delivered.

OPERATIONAL STATISTICS AND CARGO DELIVERED

Total days away from base	14
Transit time from/to base and operating area	6.5 hrs
Transit distance from/to base and operating area	388 km
Average transit speed	37 kts
Total days in operating area	12.5
Days lost due to weather	.5
Days lost on secondary tasks	.5
Days lost due to craft unserviceabilities	nil
Days lost due to other circumstances	1.5
Days on primary task	10
Total craft time on primary task	88.7 hrs
Total craft time on secondary task	4.0 hrs
Average craft time on primary task per day	8.87 hrs
Total craft engine time on primary task	67.6 hrs
Average craft engine time on primary task per day	6.76 hrs

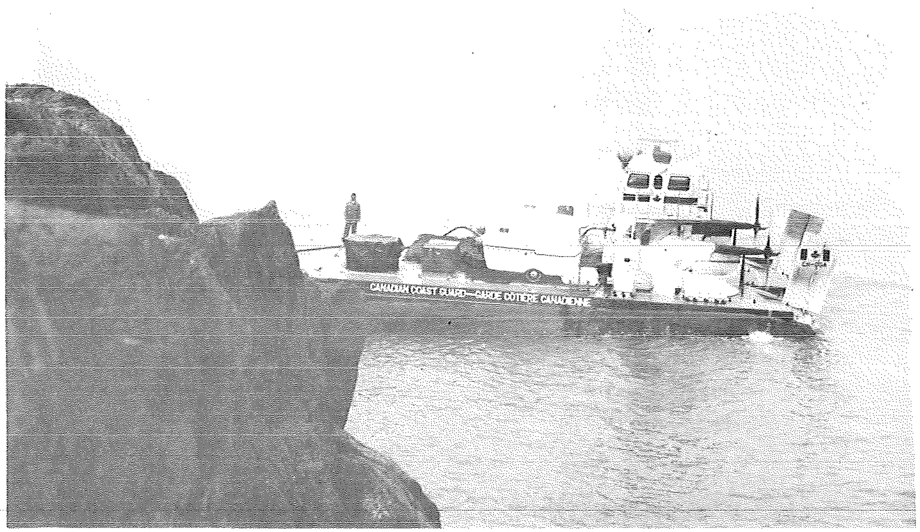
Light Station	Fuel Supplied	Water Supplied	Other Supplies
Ile Richelieu	16,427 L		
Banc Brulé West	7,570 L		
Banc Brulé East	6,813 L		
Cap Gribane	15,140 L		
Ile Blanche	9,462 L		
Prince Shoal	17,032 L	22,710 L	2 diesel generators 1,633 kg 1 hatch cover 454 kg 3 acetylene tanks 2 oxygen tanks
Ile Rouge		22,710 L	
Ile Bicquette	13,626 L		
Total:	86,071 L	45,420 L	2,087 kg

Table 3



Delivering Fuel and Water to
Ile Bicquette

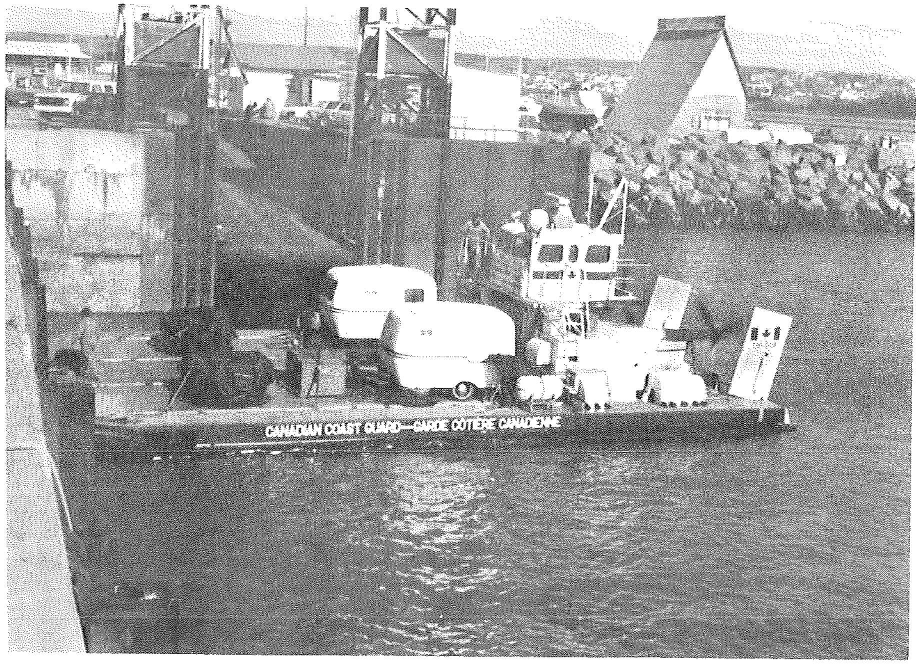
Carrying Collapsible Water Tanks



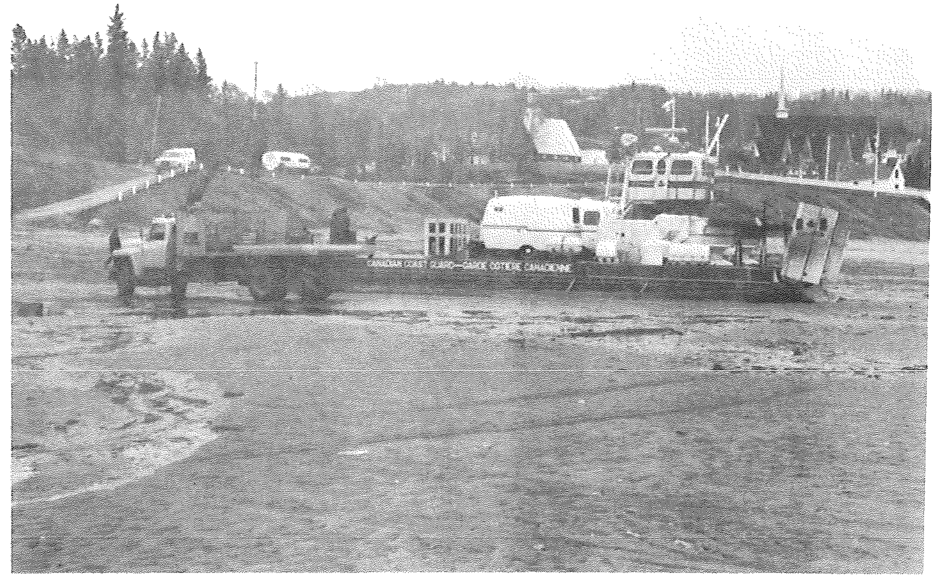
Delivering Fuel and Water to Ile Bicquette

Delivering Fuel and Water to Ile Bicquette

Figure 15

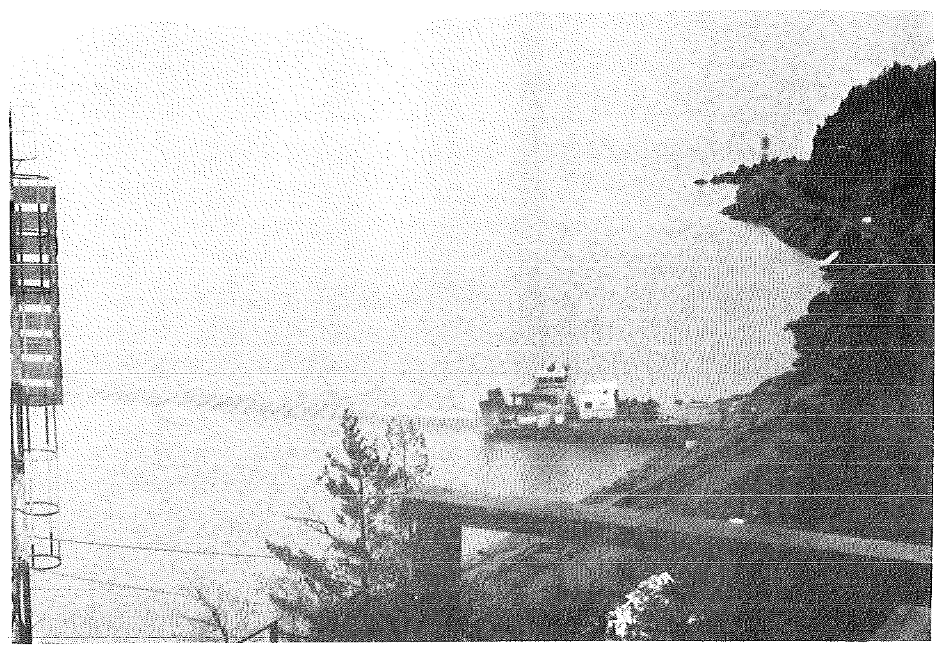


Vehicle at Ferry Wharf Rivière du Loup
Taking on Water



Loading Generators at Tadoussac
for Prince Shoal

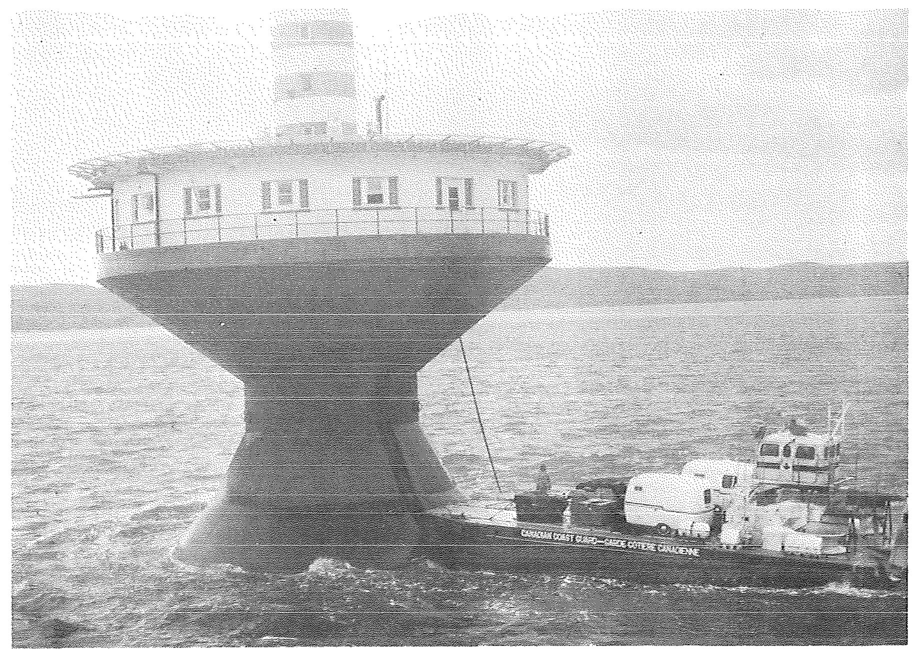
Vehicle on Cushion Against Rock - Cap Gribane



Vehicle Refuelling Cap Gribane

Figure 16

Vehicle on Beach at Ile Rouge



Vehicle Alongside Prince Shoal Light

Figure 17

VIII

ADDITIONAL OPERATIONAL CAPABILITY

VIII

SUMMARY OF ADDITIONAL OPERATIONAL CAPABILITY

Fire Fighting

The fire fighting evaluation was inconclusive, due entirely to the shortcomings of the equipment supplied. The trial indicated, nevertheless, that the effect of jet reaction on vehicle control would be minimal, and could be compensated for easily.

Additional trials are necessary to determine the validity of these findings.

Skin-Diver Support

The deck of the Voyageur is spacious, providing a stable platform for skin-diver support. The 46 cm free board, with engines shut down, is excellent for divers entering and leaving the water. Should a diver get into trouble and drift away from the vehicle, the engine can be started and the diver retrieved in minutes.

These operations leave no doubt that the Voyageur is excellent for skin-diver support, and its high-speed capability will allow it to travel to and from diving sites with a minimum loss of time on diving days.

Seaway Transit

The vehicle has transited the Seaway system in both directions on several occasions. Any doubts that the authorities may have harboured about its disrupting other traffic were quickly dispelled by the practical demonstration of its capability to negotiate the locks.

Cable Laying

The vehicle was used on two separate occasions to assist in laying and burying cable: once was to connect the beacons at Ile aux Basques and Ile du Moine to shore power at Canal du Moine, and the other was to bury approximately 1.6 km of cable in shallow water and marsh at Longue Pointe in Lac St. Pierre.

In both cases the work was carried out successfully, and what can be a very difficult operation when done by conventional means was quite easy when using an ACV.

ADDITIONAL OPERATIONAL CAPABILITY

Fire Fighting

Nov 1972 - An evaluation was carried out to determine the effect water jet reaction from fire pumps would have on vehicle control.

A WAJAX portable fire pump of 690 kPa capacity was loaded on board and positioned as far forward as possible of the vehicle's centre of gravity. The vehicle was tested for water jet reaction both in the displacement mode and on full cushion.

No reaction to the water jet was noticeable and counter control was not required.

The trial was inconclusive due to the smallness of the pump and its inclination to lose suction as the vehicle rose on cushion, even though the suction hose remained submerged.

Skin-Diver Support

May 1975 - On two separate occasions the vehicle was used for skin-diver support in the vicinity of the Ice Control Structure at Nuns' Island.

On the first occasion the divers were employed checking the ground tackle used to secure the floating vans.

On the second occasion the divers were employed checking the ground tackle for ice boom buoys and anchors.

In both of these operations the vehicle was used as a floating work platform, with engines shut-down. The divers were able to change and to prepare their equipment in the small trailer on deck. Access to and from the water was via a specially designed boarding ladder, which extended 1.2m into the water providing good footing for the divers.

These two operations were successful. The vehicle proved to be an excellent platform for diving support, which coupled with its high-speed capability makes it a very good resource for diving operations support.

Operation Through the St. Lawrence Seaway

Nov 1972 - Trials had been planned to evaluate the vehicle's ability to negotiate locks. They became unnecessary, however, when the vehicle was seconded to the Sub-Agency at Amherstburg and transited the Welland Canal in both directions.
On the reaches between the locks, the vehicle attained speeds of 30 knots. Its maneuverability and stopping capability were recognized by the Seaway Authority and it was allowed to overtake other vessels.
The vehicle demonstrated that it can be safely operated through the canal and locking system.

Dec 1974 - The vehicle successfully transited the Seaway Locks when the Unit was transferred from Parry Sound to Montreal.

Dec 1976 - The vehicle successfully transited the Seaway Locks on completion of the modification program while enroute from Grand Bend to Montreal.

Cable Laying

July 1975 - Cable was laid and buried to connect the beacons at Ile des Barque and Ile du Moine to shore power at Canal du Moine, a distance of 4,130m.

The terrain consisted of two islands separated by two channels, 366m and 183m wide.
The land was relatively flat grassland with occasional water-filled ditches, 2.4m deep and 30m wide, containing tall reeds and clumps of willow bush.
The cable laying and burying was carried out in two separate operations.

Aug 1977 - The Sorel Agency requested the use of the vehicle in laying about 1.6 km of electrical cable in shallow water and marsh at Longue Pointe in Lac St. Pierre.
Equipment transported included a 4.9m boat, winch and other heavy equipment, which was loaded by the onboard Hiab crane.
Approximately 1.6 km of cable was pulled ashore from reels located on a barge, through shallow water and marsh with no difficulty.
The vehicle assisted in burying 80% of the cable in two days.

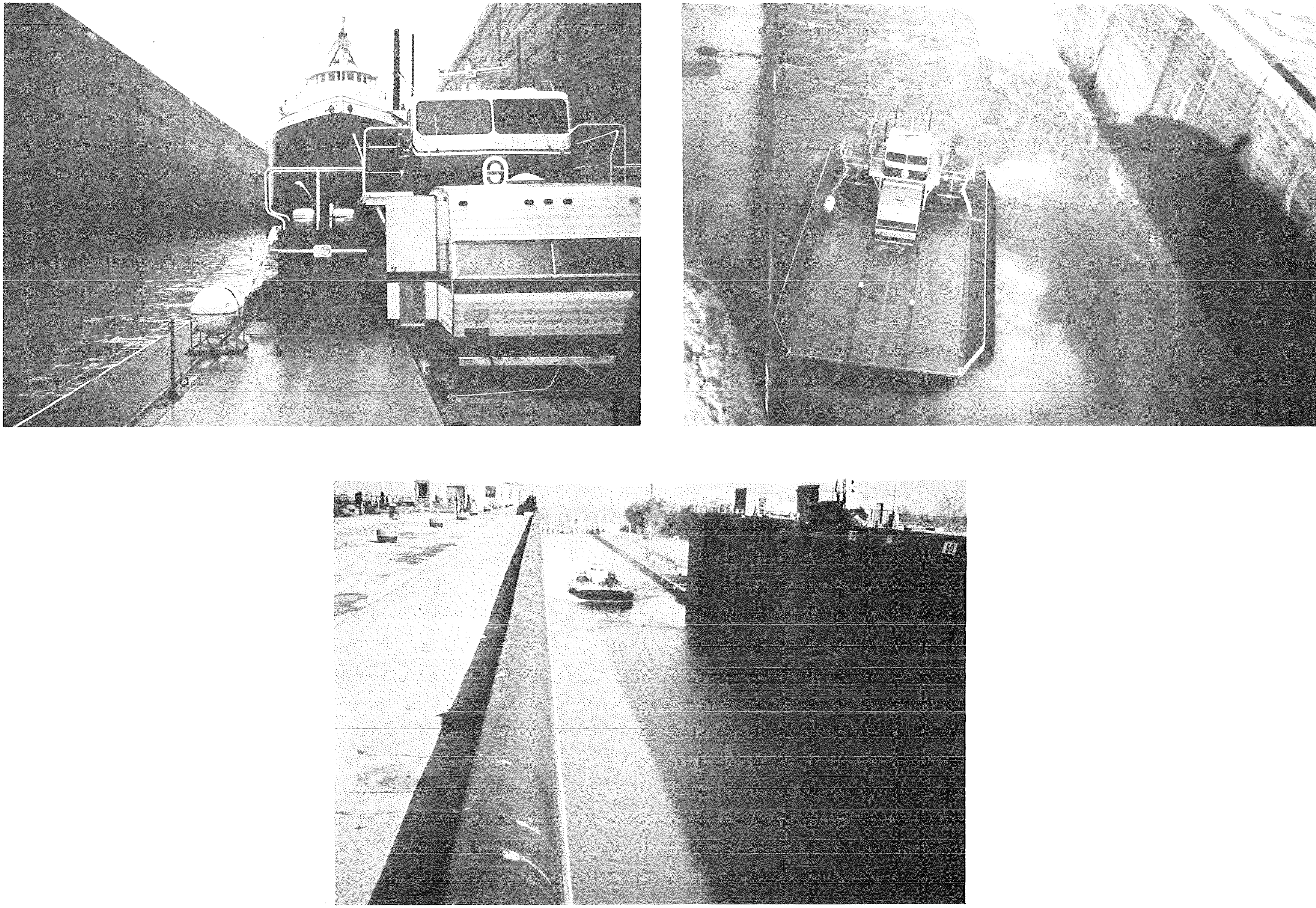


Figure 18 - Voyageur Transiting Seaway

IX

AREAS OF HIGH POTENTIAL NOT EXPLOITED BY COAST GUARD

IX

AREAS OF HIGH POTENTIAL NOT EXPLOITED BY COAST GUARD

Two very important areas in which the CCG has failed to take advantage of the potential of Voyageur are Hydrographic Sounding and Lightering.

Hydrographic Survey

Since its inception in 1954, the Polar Continental Shelf Project (PCSP) Survey Unit has been working to develop technology for hydrographic and bathymetric surveys.

From as early as 1962, several towed-body systems have been developed and tested using various types of tow vehicles (including helicopters), however, these vehicles have definite limitations.

The PCSP has carried out evaluations of the air cushion vehicle as a potential Arctic hydrographic survey vehicle since 1963.

In 1968/69 the Hydrographic Section held several trials on Lake Erie using a Bell SK-5 air cushion vehicle. In these trials two cable-towed bodies were used but neither was too successful, due mainly to the cable-towed-body system. As a result the National Research Council (NRC) designed and built a prototype of an entirely new system based on a retractable fixed strut. This system was installed on a SK-5 ACV with very encouraging results at speeds up to 29 knots.

As a result of these tests a successful survey was carried out in the summer of 1969 using an SR.N6 ACV. This survey produced useful charting of the Herschel Island area in a season when ice conditions were such that very little surveying was possible by regular hydrographic ships in the Western Arctic. A second operational survey, using the same equipment, was successfully carried out in Franklin Bay east of the Mackenzie River Delta in 1970.

In 1972, field trials and evaluation of a redesigned Hydrographic Depth Sounding System for air cushion vehicles were carried out using the CCG SR.N5 in the area west of Sturgeon Bank, Straits of Georgia, near Vancouver, B.C.

It was determined from these trials that the Fixed Strut System was successful. The average recorded speed was 20 knots, the maximum 24.5 knots. At high-speed (over 22 knots) with a depth of 90 fathoms, the sounding graph blanked out. The reason for this blanking of the graph was that the hollow interior of the towed-body was not packed with styrofoam material, as is usually the case, to displace the water from the interior. The styrofoam was not installed for these particular trials for technical reasons.

The average speed was only 20 knots due to the fact that the area of operations did not allow the vehicle to run on an extended straight course without reducing speed, therefore, it was not possible to develop full speed. The blanking out of the graph and the precautions taken against damage to the fixed strut from drifting logs also resulted in speed reduction.

Lightering - U.S. Army

During the month of October 1972, the Voyageur prototype 001 participated in the US Army exercise 'Offshore Discharge of Containers II' (OSDOC II) at Fort Story, Virginia. Operations involved principally haulage of 6.1m MILVAN containers from ship to shore and inland. A typical load consisted of two MILVANs with a maximum payload hauled of 17,237 kg. Sea State 2 conditions with plunging/spilling surf of 0.9 to 1.2m were experienced.

These trials demonstrated that ACVs can operate effectively in lighterage missions. Their fully amphibious/zero draft characteristics make them independent of tidal conditions and also offer the possibility of direct inland penetrations.

Even with the short off-shore distance (approximately 2.4 km) involved, cyclic times were much lower than those achieved with alternate surface systems. This advantage increases with greater off-shore distances, where the proportions of high speed cruise to total cycle time would be greater.

The trials showed that the Voyageur, with its wide cargo flat-deck discrete from the aft machinery and control cabin, offered safe and rapid container handling. Voyageur 001 performed satisfactorily with payloads as high as 17,237 kg. Voyageur 002 (CCG) and subsequent vehicles, with their higher powered Twin-Pacs, offer a similar performance standard with payloads as high as 26,760 kg.

Vehicle operation at sea did not at any time present problems and it is reasonable to expect that operations could have continued in conditions up to, at least, Sea State 3.

Methods of coming alongside ship, tying up and transferring containers were developed early in the trials. These proved so successful that they were used in all subsequent alongside ship operations.

The vehicle was able to cross the surf zone in either direction with no difficulty, negotiating 0.9-to-1.2m plunging spilling surf. The vehicle's heading relative to the surf line did not appear to be critical during inward and outward transitions.

Maximum payload during the trials was 17,237 kg (two 6.1m containers), which was hauled at 30 knots when the prevailing wind speed was 20-25 knots. Loading and unloading the vehicle proved to be simple and fast. On land and alongside the ship in Sea State 2, the vehicle's crew could easily and rapidly position containers within acceptable centre of gravity limits.

Lightering - Canadian

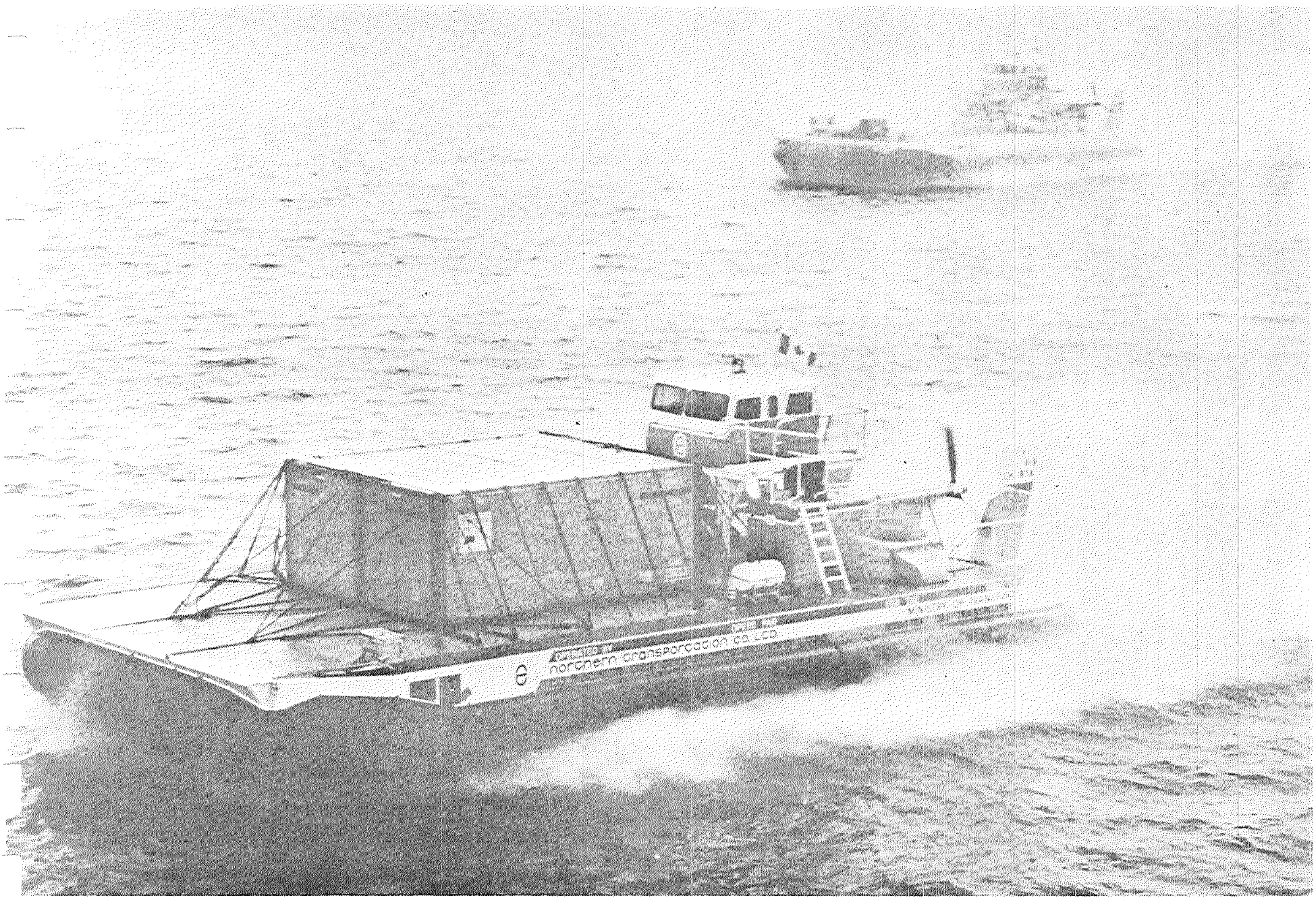
A program funded jointly by the Transport Development Centre, Quebec Government, Agence Maritime Inc., and Bell Aerospace Canada was carried out during the first three months of 1975. It was to demonstrate the feasibility of an air cushion vehicle freight transportation service for the communities along the lower North Shore of the St. Lawrence River, a 660 km stretch of coast extending from Sept-Iles to Blanc-Sablon in the Province of Quebec.

The program was carried out in three phases with part of phase 3 concerned with ship-to-shore delivery (lighterage) using a Voyageur ACV. The lightering exercise, and other cargo distribution activities undertaken in conjunction with a ship, effectively demonstrated the versatility of the vehicle in transporting goods to ice-bound ports normally inaccessible except with icebreaker assistance, or to points ashore, where shallow water or rocky terrain make normal navigation impossible or hazardous.

The program also demonstrated the potential of this vehicle for special assignments in handling specialized cargo under rigorous climatic and regional conditions. When delivering cargo to remote communities the vehicle showed that its productivity (kgs/day) and cost effectiveness ($ kgs) were most favourable when it delivered cargo directly from ship to shore.

It was shown that the vehicle could operate at a number of types of landing sites in harsh environments and carry many different types and sizes of cargo, thereby indicating its suitability for use in other remote areas.

It was concluded that the air cushion vehicle could be integrated into an existing marine transportation system and improve the ability of such a system to deliver cargo.



Voyageur 002
Trials on Lake Ontario

Figure 19

Voyageur 001
US Army Exercise (OSDOC II)

Figure 20

X

CONCLUSIONS AND RECOMMENDATIONS

X

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

From the information compiled in this document it can only be concluded that the Voyageur air cushion vehicle is an extremely useful, all climate, all terrain, multi-role resource. It has been successful in every role in which CCG has tasked it, as well as in roles in which CCG has not tasked it, such as sounding and lightering.

It is most important to remember that, in all of the tasks the vehicle carried out, the crew were not trained in, or dedicated to, the role in which it was employed. It must be obvious to even the casual observer that, if the vehicle was dedicated to these roles, the success already enjoyed would increase immeasurably, because of familiarity, repetition and improvements in equipment and methods.

To date there has been a complete lack of real operational comparison between Voyageur and other CCG resources.

Recommendations

Air cushion vehicles should be seriously considered for inclusion in the inventories of all CCG regions as operational units, and should be tasked in all the roles in which the CCG Voyageur has been evaluated.

In addition to the roles above, serious consideration should be given to employing these units in roles successfully carried out by other air cushion vehicles, i.e. lightering (particularly Arctic supply), and hydrographic survey.

All comparisons with regard to capabilities, effectiveness and cost effectiveness should be based on real evaluation, using the same criteria as those used for the resource with which the air cushion vehicle is being compared.

APPENDIX

APPENDIX A

F				C
	ENGLISH-TIMES-FACTOR = METRIC			
	METRIC-DIVIDE-FACTOR = ENGLISH			
-40	ENGLISH	factor	METRIC	-40
0	**LENGTH**			-20
	inch	2.54	centimeters	
	foot	.3048	meters	
32	yard	.9144	meters	0
	mile	1.609	kilometers	
	AREA			20
	sq. inch	6.452	sq. cm	
80	sq. foot	.0929	sq. meters	
	sq. yards	.8361	sq. meters	
	acre	4047	sq. meters	
	sq. mile	2.59	sq. km.	
98.6				37
	VOLUME			
	cubic in.	16.39	cubic cm.	
	cubic ft.	.02832	cubic meter	
	cubic yd.	.7646	cubic meter	60
160	**WEIGHT**			
	ounce	28.35	grams	
	pound	1.2	pound troy	
	pound	.4536	kilograms	80
	LIQUID			
212	ounce	29.57	m-liter	100
	quart	.9463	liter	
	gallon	3.785	liter	

Conversion Table

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