#24

COMMERCIAL CRAFT APPLICATIONS

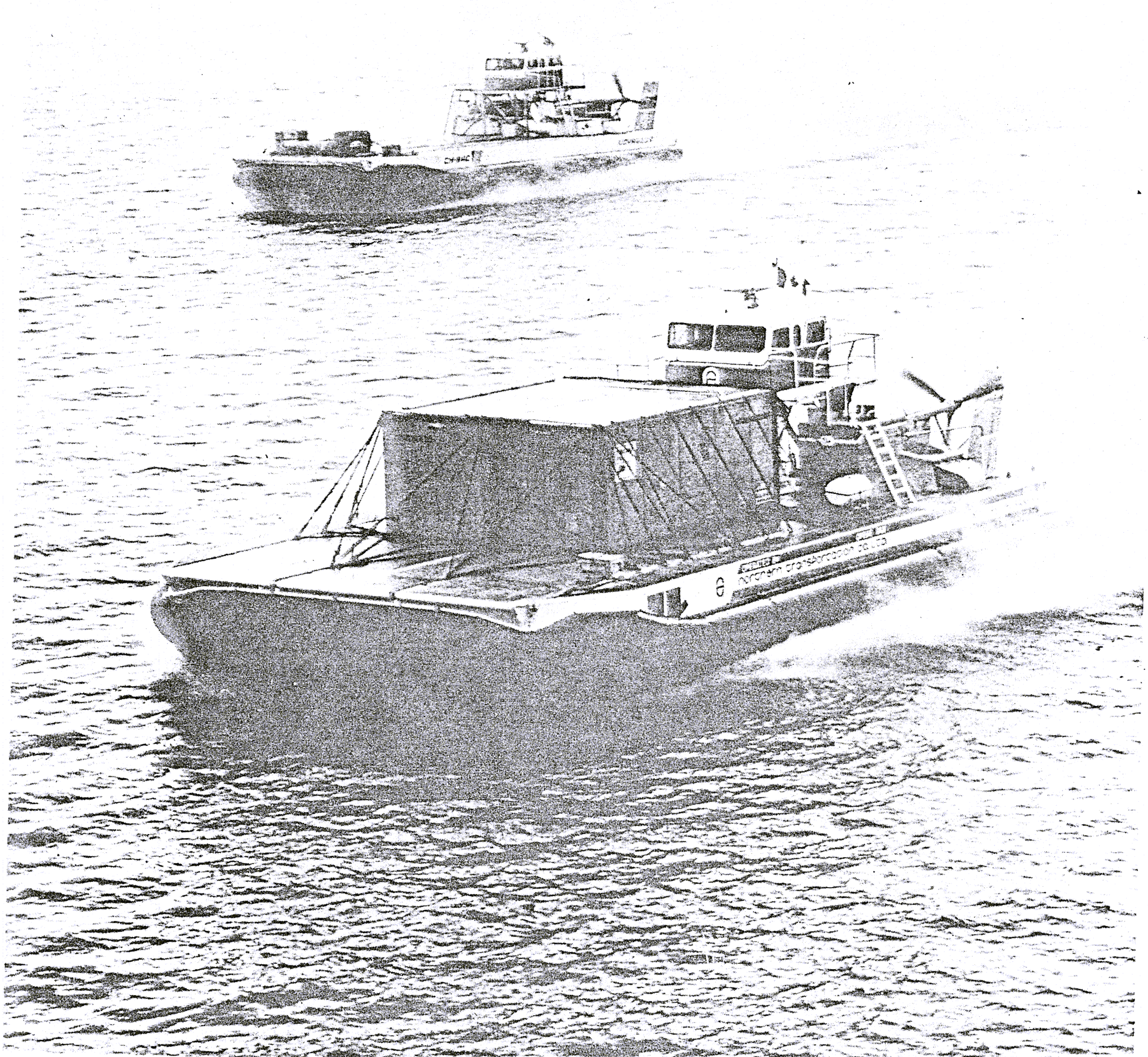
J. B. CHAPLIN

ADVANCED MARINE VEHICLES

C. S. DRAPER LABORATORY, M.I.T.

JULY 7-11, 1975

VOYAGEUR AIR CUSHION VEHICLE



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INTRODUCTION

Recognizing the potential for a Canadian Air Cushion industry, Bell Aerosystems Canada (now Bell Aerospace Canada) was formed in October 1962. Initial efforts were devoted to developing the Company's knowledge of Canadian and international market needs in the field. These efforts were aided by its close association with the Bell Aerospace Company in the United States and by its Sales Agency link with the British Hovercraft Corporation. With this extensive background of experience involving practical assessments of Canadian air cushion vehicle operations by U.S. and British-built craft, Bell Aerospace Canada was expanded in 1970 to include full air cushion vehicle engineering, manufacturing, development, and customer support capabilities with the Voyageur vehicle as its key project.

This wholly owned Division of Textron Canada, Ltd. has its main plant located at Grand Bend, Ontario. The facilities at Grand Bend Airport include two main buildings with 38,000 square feet (3530 sq.m) of floor space on a 32-acre tract of land giving adequate room for plant expansion as the program progresses.

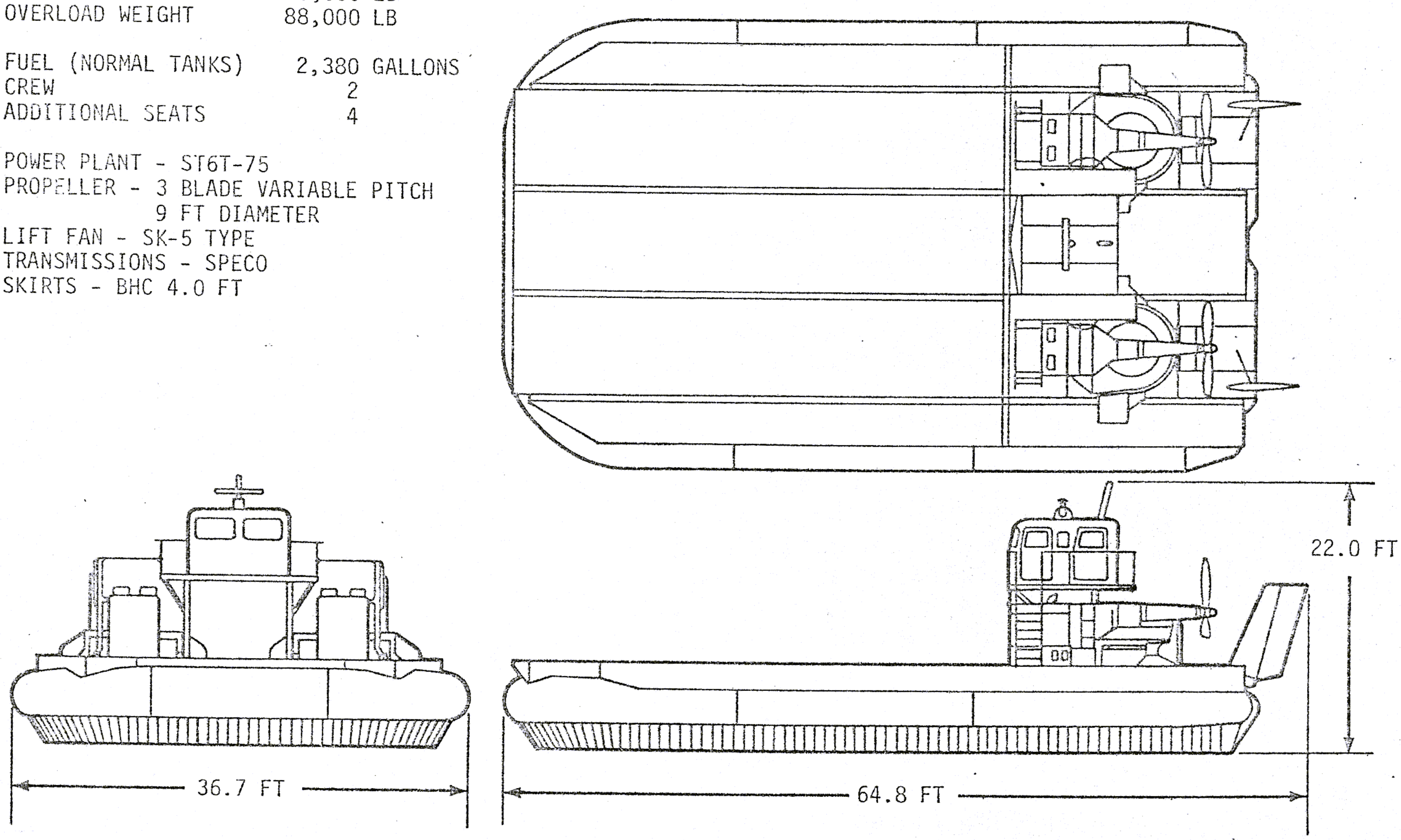
There is direct access to a wide variety of test environments including sheltered and open water (Lake Huron), flat ground (Grand Bend Airport), and marshland. Seasonal conditions range from 95°F (35°C) in summer to -20°F (-28.9°C) with deep snow and lake-ice conditions in winter.

The Bell Aerospace Canada Model 7380 Voyageur, developed in association with the Department of Industry, Trade and Commerce of the Government of Canada, was evolved as a direct result of rigorous in-depth assessments of worldwide potential ACV requirements. These studies indicated firm needs for a fully amphibious craft in the 15- to 25-ton payload category. However, this demand pattern proved to be complex and diverse in nature, emphasizing a requirement for a basic craft design which is not committed to specific missions and/or functions. Potential applications vary widely from Coast Guard duties to freight haulage in remote areas to passenger service in mass transit environments as as well as military logistics operations.

WEIGHT EMPTY 35,360 LB
DESIGN WEIGHT 78,000 LB
OVERLOAD WEIGHT 88,000 LB

FUEL (NORMAL TANKS) 2,380 GALLONS
CREW 2
ADDITIONAL SEATS 4

POWER PLANT - ST6T-75
PROPELLER - 3 BLADE VARIABLE PITCH
9 FT DIAMETER
LIFT FAN - SK-5 TYPE
TRANSMISSIONS - SPECO
SKIRTS - BHC 4.0 FT



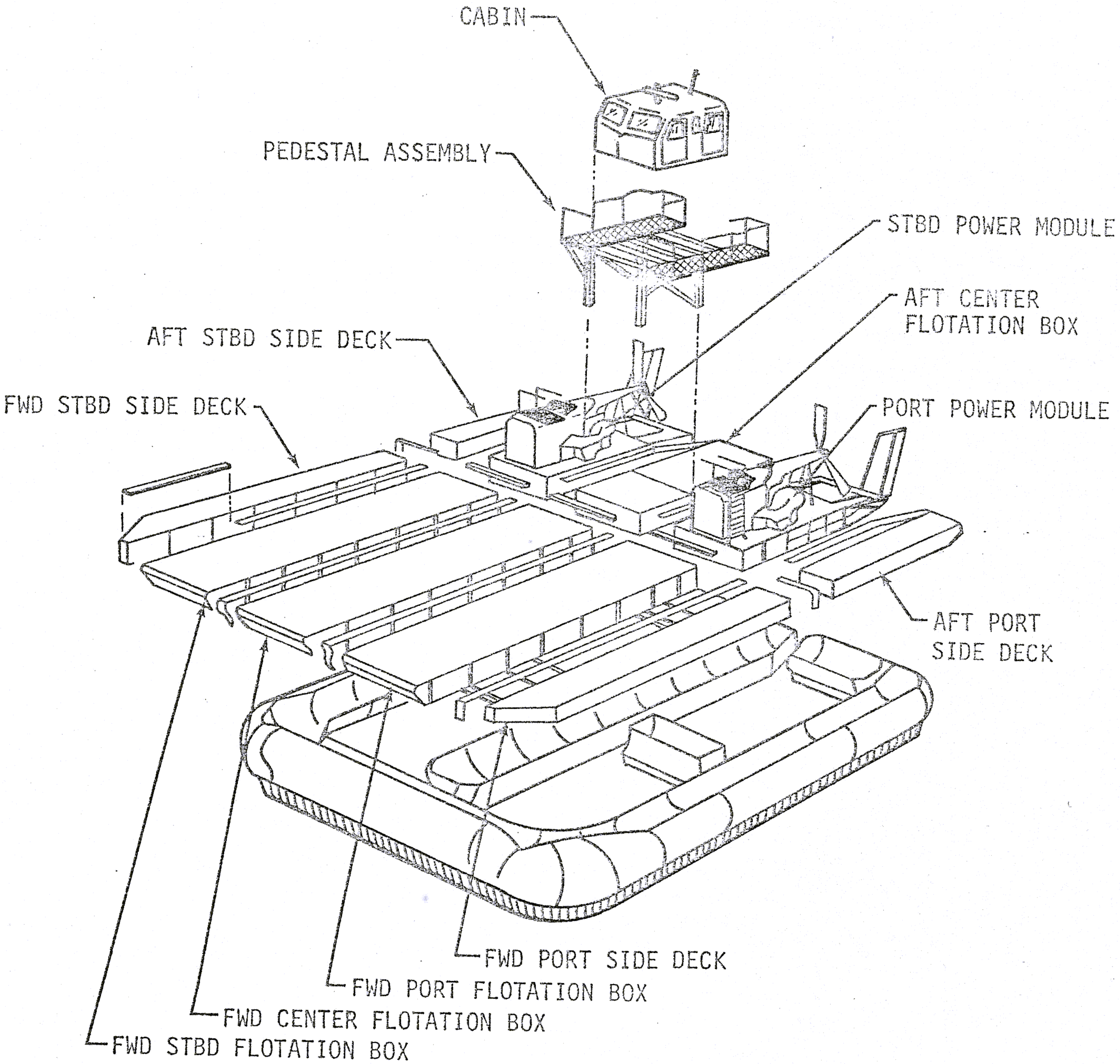
VOYAGEUR CONFIGURATION

The Voyageur is a rugged all-metal craft constructed of corrosion resistant 6000 series aluminum. The design of the modular structure incorporates hollow-core, thin-walled aluminum extrusions similar to those used in military and commercial ships. Use of this material, together with extruded corners for constructing the joints, produces a structural box of great stiffness. Flat surfaces are used wherever possible, thus eliminating the need for formed parts, simplifying repair. The structural modules are welded using the gas shielded metal arc and the gas shielded tungsten arc process. The craft is powered by two Pratt and Whitney/United Aircraft of Canada Ltd. "Twin Pac" power plants. Each engine drives a propulsion air propeller and a centrifugal lift fan. The twin engine/propeller layout gives reliability in combination with greatly improved control. Pitch of both propellers is fully reversible. Fins mounted aft of the propellers give increased directional stability and control. The lift fans are mounted forward of and below the propellers. Air is drawn by the fan through the large annular intake and directed through plenum chambers into the peripheral trunks. From the trunks, the air is directed inboard beneath the craft to provide the air cushion.

The control cabin is supported by a simple truss structure and located toward the rear of the craft. The cabin provides efficient and comfortable seating for the vehicle operator and for an assistant operator/navigator. Instruments, communications, controls and radar systems are carefully sited for accessibility and reduction of operator fatigue. Large windows assure an excellent 360-degree field of view.

The main deck is designed to accept loadings of up to 1000 pounds/square foot (4882 kg/sq.m). Cargo tiedown rings and craft handling gear are provided. When the vehicle is off-cushion, the cargo deck is low enough to permit rapid loading and unloading from fork lifts or trucks. Access to the control cabin is provided by ladders and walkways.

VOYAGEUR MODULAR COMPONENTS

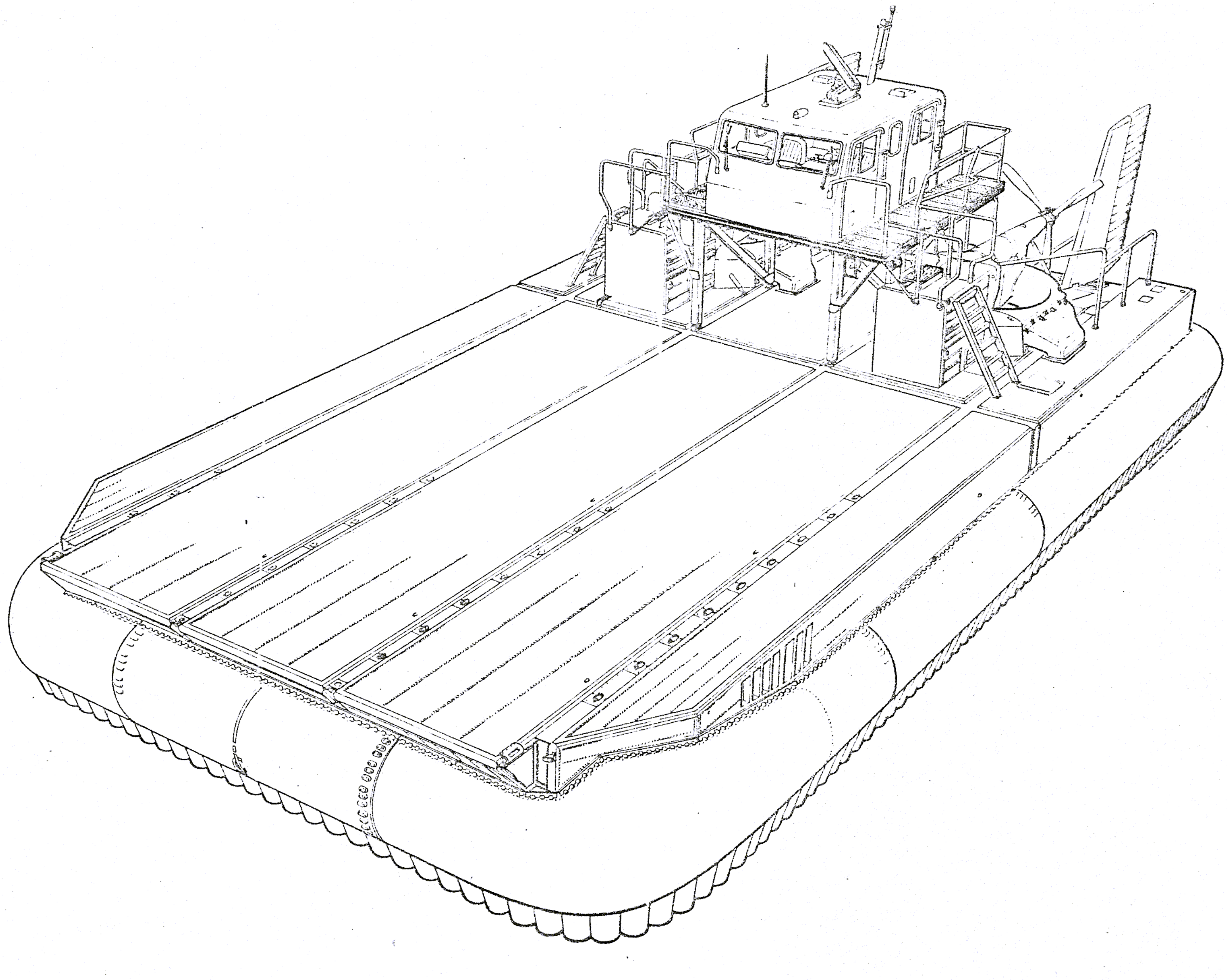


MODULAR CONSTRUCTION

The Voyageur is constructed in modular form to meet the requirements of rapid deployment whether by sea, air or land. (This also permits "in the field" repair of major damage by module replacement.) The figure on facing page gives details of the individual module elements into which the craft may be broken down for shipment and reassembly on site.

This system has been well proven with routine deployment by Hercules C-130 and by truck to remote locations. Using this technique, a Voyageur can be transported as follows:

Air - One C5A load
Three C141 loads
Five C130 loads
Road - Five 40 ft low-loaders
Rail - Four 60 ft open-top or flatbed cars.



STRUCTURE

The Voyageur is an extremely rugged all-metal craft, constructed essentially of corrosion-resistant 5000 and 6000 series marine aluminum alloys. Welded modular structure incorporating hollow-core aluminum extrusion with extruded corners for constructing the edge joints produces double-wall structural boxes with great stiffness and strength. These boxes create the load-bearing members and the buoyancy tanks. Each box is a waterjet compartment and is further subdivided into smaller compartments. There are a total of 39 watertight compartments provid-169% reserve buoyancy.

The craft (see figure on facing page) consists of three forward and one aft center flotation box, port and starboard side decks, two power modules, a cabin support pedestal, and control cabin. The three forward boxes are similar and nominally measure 40 ft long, 8 ft wide, and 37-1/2 in. deep. The difference in these boxes is that the port and starboard boxes each contain a main fuel tank of three interconnected cells, a forward reserve fuel tank, a landing pad support structure, and an air duct to supply the stability trunk. The aft-center box is of similar construction to the forward boxes, but is only 24 ft long. Indentations are formed in each side to permit airflow around the perimeter of the lift fan. Also contained is ducting for air to the longitudinal keel trunk and an aft reserve fuel tank.

The power modules are of similar construction and also contain truss structure adjacent to the fan to permit free passage of air into the side deck plenum and thence into the skirt system. The fins and fan mounts are part of the power module. The individual hull box modules are joined together with bolted horizontal and vertical splice plates.

Cargo tie-down fittings are provided in a pattern of four rows spaced 102 in. apart with the fittings located every 33 in. along the row. These tie-down fittings have an ultimate load capacity of 15,000 lb and are also used in combination with appropriate slings for hoisting the craft. Two additional hoist points are provided in the aft center box splices to the power modules.

Four bow towing eyes are located at the forward end of each of the upper longitudinal splice plates. Two stern towing eyes are provided at the corners of the aft center box. Four 10-in. high landing pads support the vehicle on land and also prevent damage to the underside of the buoyancy boxes and prevent trapping the skirts.

PROPULSION/LIFT SYSTEM SCHEMATIC

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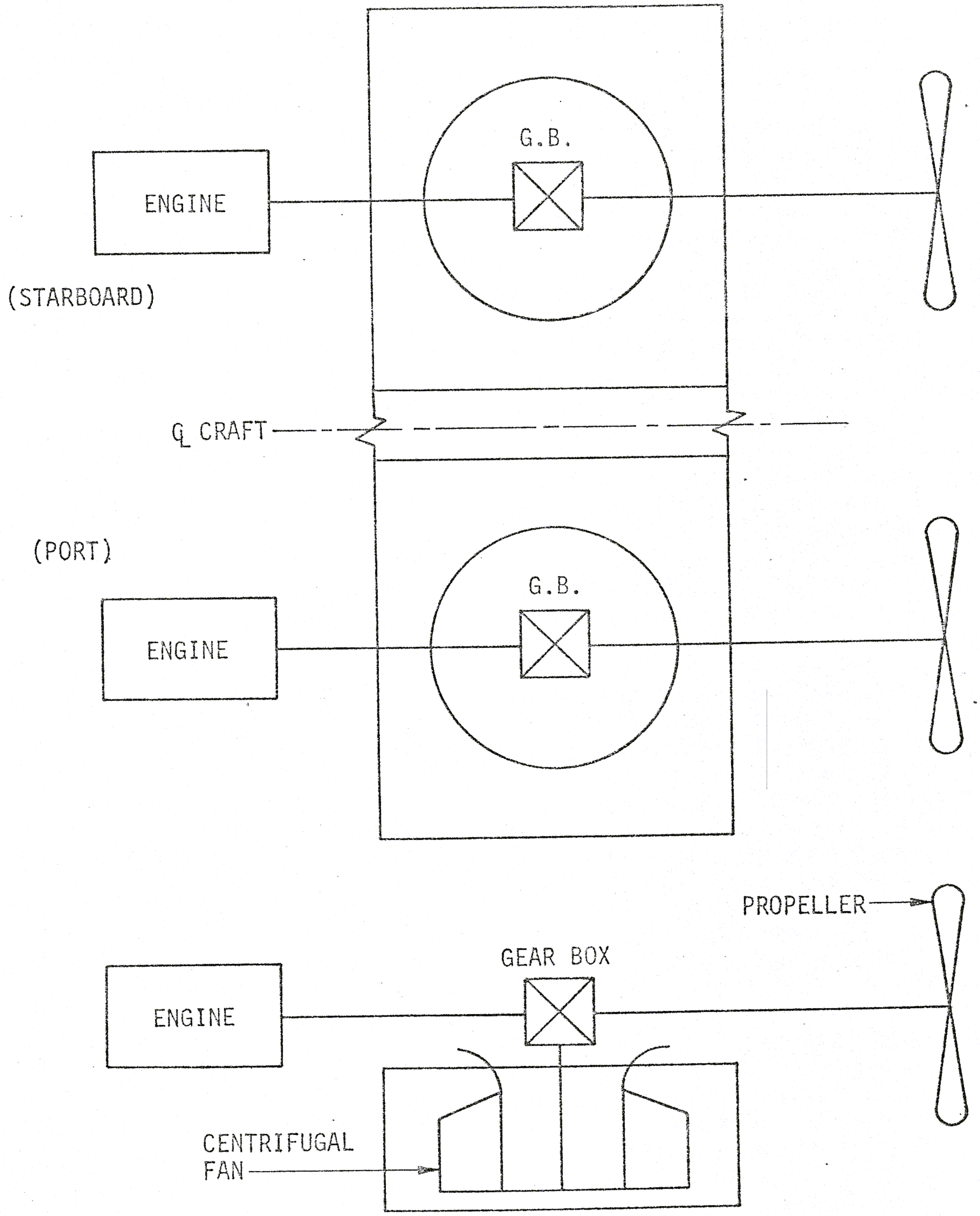

POWER UNITS AND TRANSMISSION

Voyageur is powered by two United Aircraft of Canada Limited "Twin Pac" ST6T-75 marine gas turbine engines. These engines have two separate turboshaft power sections coupled into a combining gearbox with a single output shaft. Normal rating of the ST6T-75 is 1300 shp at 6600 rpm. The arrangement provides four-engine reliability and permits Voyageur to continue operation (at reduced speed) in the event of single-engine failure.

The combining gearbox reduces the 33,000 rpm full-speed output of the gas generators to a single output speed of 6600 rpm through a pair of overrunning clutches and a 5:1 reduction ratio. The gearbox contains a torquemeter for each engine and independent oil systems.

The gear ratios between the engine, lift fan, and propeller are fixed; the power distribution can be altered by varying the propeller pitch. This action changes the speed of the system and alters the power absorbed by the fixed geometry centrifugal lift fan. The power absorbed by the fan can be altered from minimum (vehicle floating off-cushion with idle power) to the maximum permitted by engine and propeller speed limitations. This arrangement is termed integrated lift/propulsion.

The main gearbox contains a single stage reduction gear and a spiral bevel reduction gear to drive the lift fan. Auxiliary gear trains drive hydraulic pumps which provide pressure for both the propeller pitch controls and the lubrication system.

Both engine installations are supplied with air from the cushion plenum. The air supplied to the compressor inlet is obtained through two plenum intake ducts on each engine located on the inboard and outboard side of each lift fan. The velocity vector of the fan airflow provides an initial separation of dirt particles from the air, with further cleansing effected by inertial separators and a water separator located upstream of the compressor inlet.

The engine bay is subdivided into two fire zones by firewall bulkheads. The zones are protected by a common extinguishing system which is actuated by a switch located on the operator's panel. The extinguishing agent (bromochlorodifluoromethane, $CBrClF_2$) is stored in a pressurized container located outside the fire zones and distributed by spray tubes located in each fire zone. An infrared flame detector system will activate a warning light at the operator's station to indicate the presence of flame in the engine bay.

AIR DISTRIBUTION SCHEMATIC

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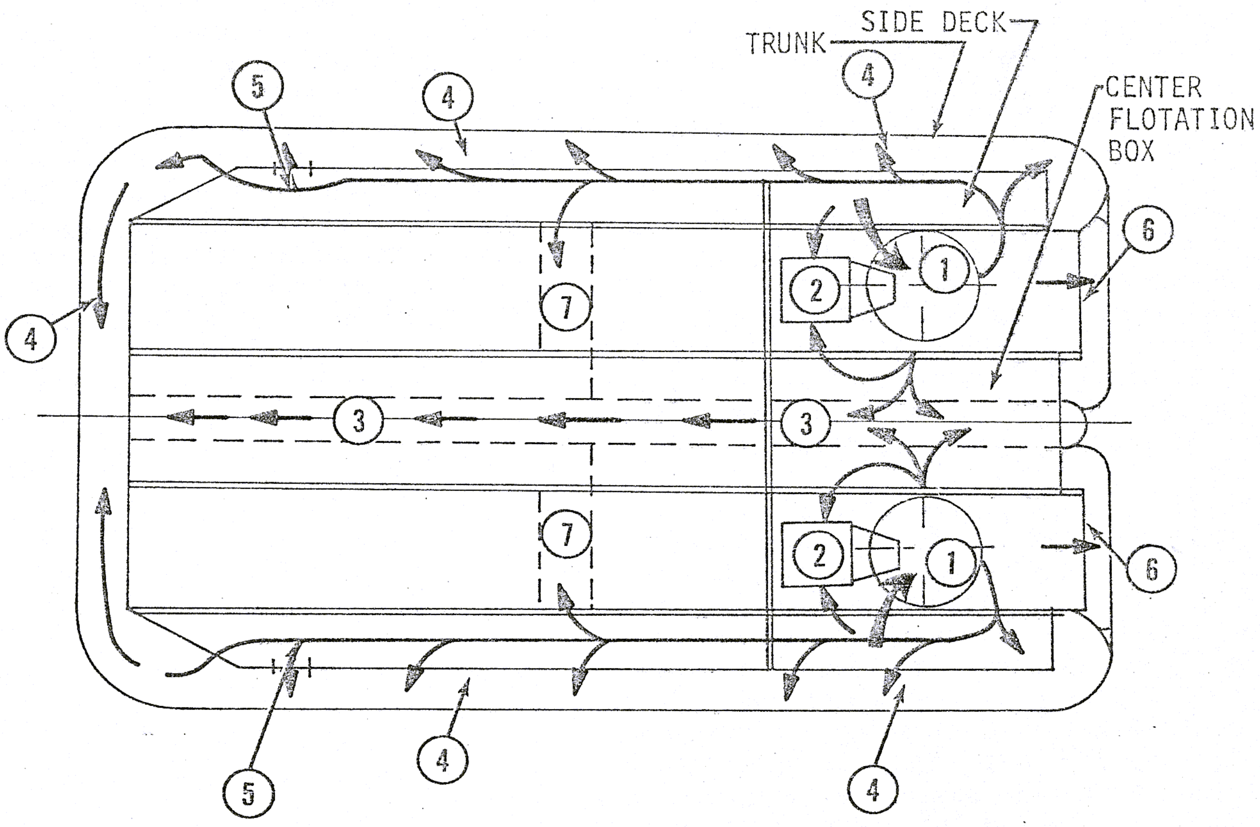


(1) INLET AIR FROM ATMOSPHERE THRU FAN TO PLENUM

(2) PLENUM AIR FROM SIDE DECK AND POWER MODULE TO ENGINE INLET AND COOLING

(3) PLENUM AIR FROM BOTH POWER MODULES TO CENTER KEEL

(4) PLENUM AIR FROM POWER MODULE TO SIDE DECK, AND PERIPHERAL TRUNK

(5) PLENUM AIR FROM SIDE DECK TO PUFF PORT

(6) PLENUM AIR FROM POWER MODULE TO STERN SEALS

(7) PLENUM AIR FROM EACH SIDE DECK TO STABILITY TRUNK

The power units for the Voyageur craft are located at either side of the aft section of the craft. The fan impellers are located in the plenum chamber directly underneath the fan inlet. The fan impeller is a backward slope airfoil, 50° blade angle centrifugal fan impeller with outside diameter of 7 ft. The ratio of the blade height at the outside diameter of the impeller to the impeller diameter is 0.233. Airflow in the Voyageur craft is as follows (see figure on facing page):

a. Air is taken from above deck and goes into the fan through the inlet at the deck level and is pressurized by the impeller.

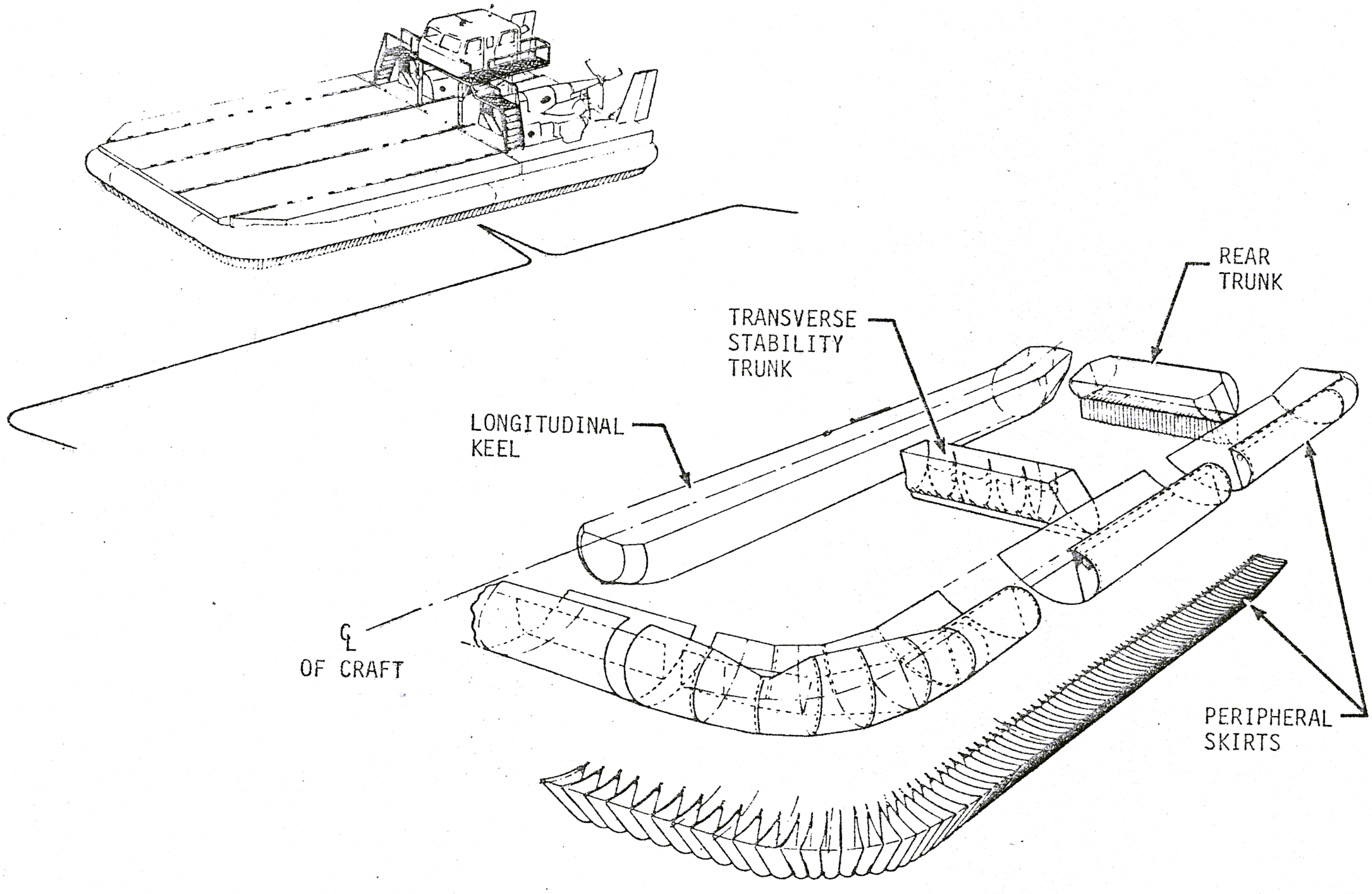
b. Pressurized air is discharged from the impeller into the fan plenum chamber.

c. Pressurized air from each plenum chamber feeds the engine, half of the stern trunk, half of the side trunk, and the center keel which is located on the centerline of the craft.

d. The transverse stability keel is fed from an opening in the side deck situated in mid section of the craft.

The main flow of each of the fan impellers is divided as follows:

a. 60% of the flow goes to the side trunk.
b. 20% of the flow goes to the engine.
c. 20% of the flow goes to the stern trunk.

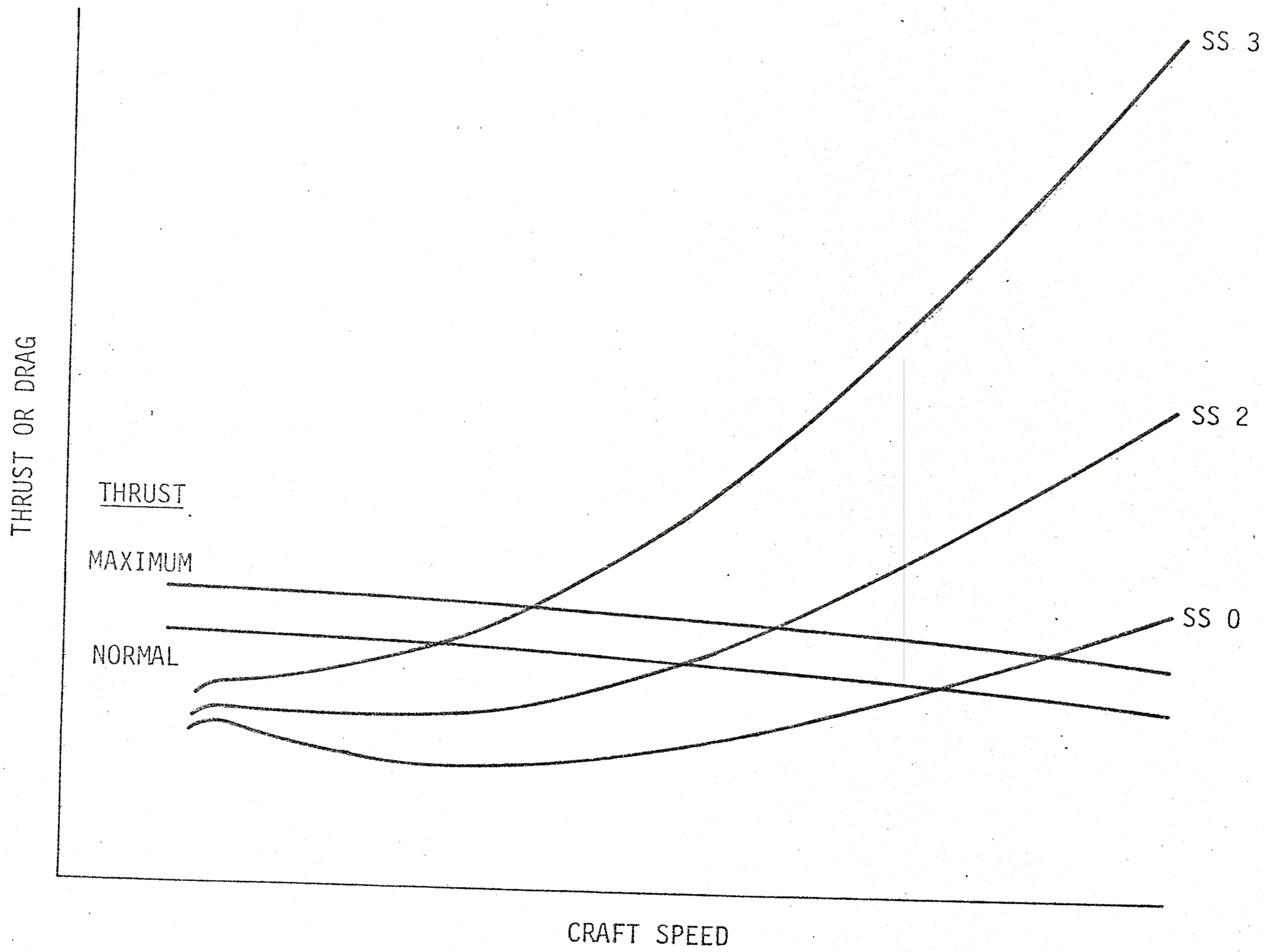

REAR
TRUNK
TRANSVERSE
STABILITY
TRUNK
LONGITUDINAL
KEEL
℄
OF CRAFT
PERIPHERAL
SKIRTS

VOYAGEUR SKIRT CONFIGURATION

The skirt system shown on the facing page is an adaptation of the well-proven BHC SR.N6 design, using 50 percent fingers. The skirts around the bow section make a transition to a higher outer attachment hinge line across the bow which maximizes the over-water plow-in resistance of the craft. The skirt system is fabricated of neoprene-coated, single-ply nylon material.

The air cushion is subdivided into four compartments to provide stability. This subdivision is accomplished by the longitudinal keel trunk and the transverse stability trunks. At the stern, the cushion is contained by the rear trunks. Fingers are hung from the bottom of the peripheral trunks. Cones are used beneath the transverse stability slot and the rear trunks.

An anti-plow-in bag is incorporated into the bow area of the skirt. The skirt system is fabricated of neoprene-coated, single-ply nylon material. Material weights varying from 40 to 85 ounces per square yard (95 to 2,020 gms/sq.m) are utilized in different portions of the skirt system.


SS 3
SS 2
SS 0
THRUST OR DRAG
THRUST
MAXIMUM
NORMAL
CRAFT SPEED

The figure on the facing page presents a typical relationship of thrust and drag for the Voyageur at gross weight of 78,000 lb in sea states 0, 2, and 3.

Maximum speed in calm water at this weight with a 10 ton payload is 63 miles per hour. With maximum fuel, an endurance of ten to twelve hours can be obtained. A continuous gradient capability up to 8% is available. The Voyageur can clear a vertical obstacle of 3.5 ft and traverse a 10 ft wide ditch.

VIKING GENERAL ARRANGEMENT

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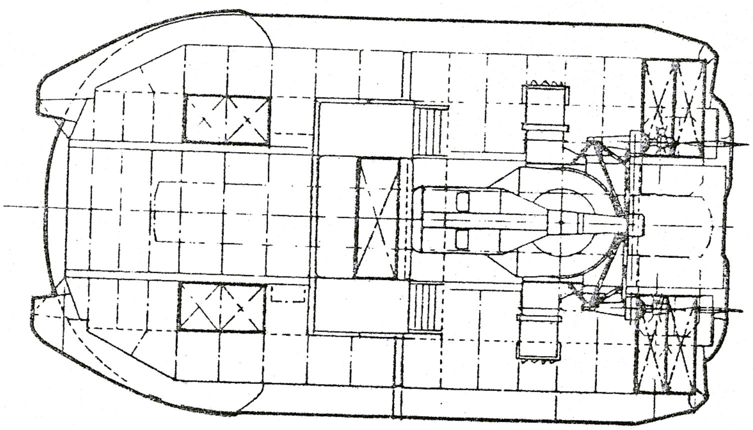

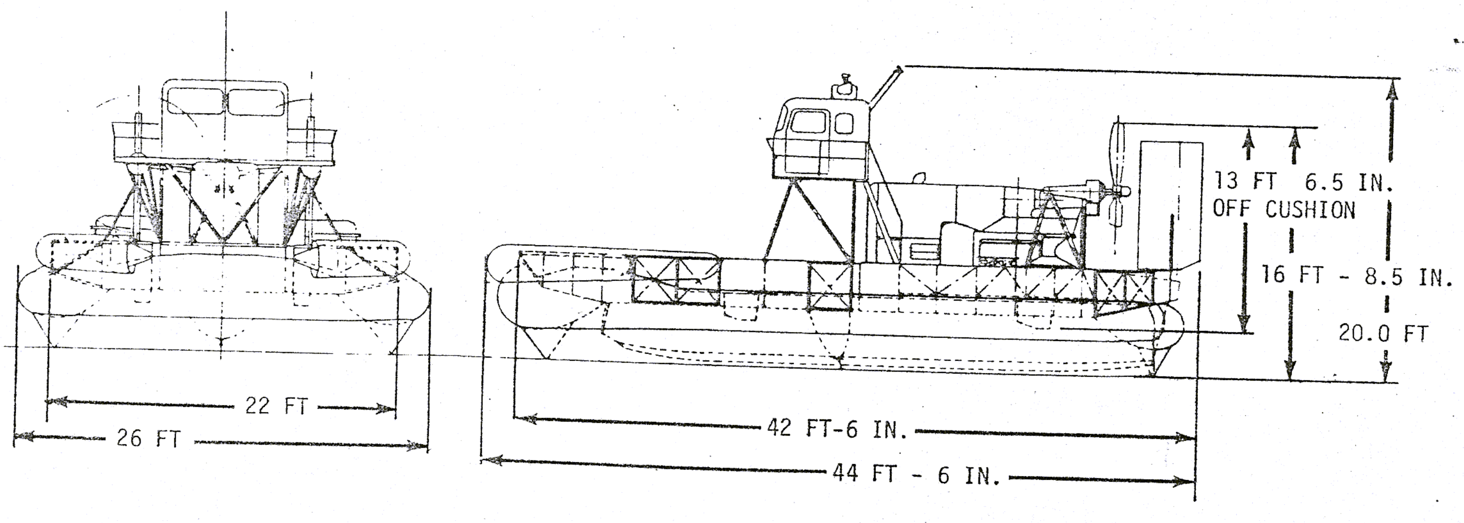

VIKING AIR CUSHION VEHICLE

The Viking is a direct derivative of the Bell Aerospace Canada Model 7380 Voyageur developed in association with the Department of Industry, Trade and Commerce of the government of Canada. The craft is powered by one Pratt and Whitney/United Aircraft of Canada, Ltd. "Twin Pac" power plant which features turbine speed governing. The engine drives two propulsion air propellers and a centrifugal lift fan. The twin propeller design gives excellent control. The pitch of both propellers is fully reversible. Fins mounted aft of the propellers give additional directional stability and control. The lift fan is mounted forward of and below the propellers. Air is drawn by the fan through the intake and directed through plenum chambers into the peripheral seals. From the seals, the air is directed inboard beneath the craft to provide the air cushion.

The general arrangement of the basic Viking craft is shown on the facing page. The design meets or exceeds the Air Cushion Vehicle Regulations and Certification Requirements of the Canadian Ministry of Transport.

Principal characteristics are as follows:

Weight Empty	20,685 Lb
Gross Weight	32,500 Lb
Payload up to	11,000 Lb
Max. Cushion Pressure	39.6 Lb/Sq Ft
Cargo Area	820 Sq Ft
Tie-Downs	4 Rows of 8 Ft
Individual Tie-Down Capacity:	
Inner Rows	10,000 Lb
Outer Rows	5,000 Lb

VIKING MODULAR COMPONENTS

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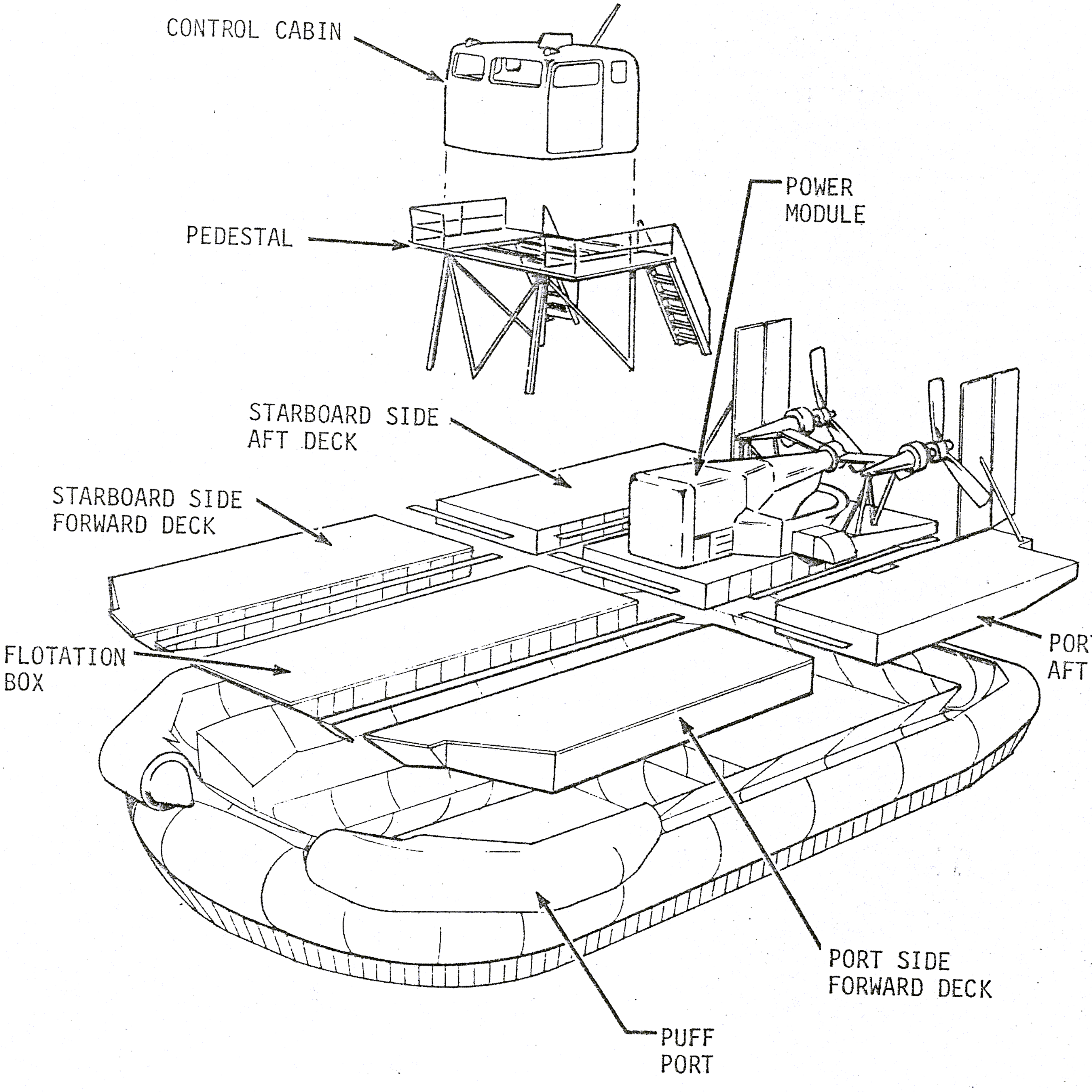
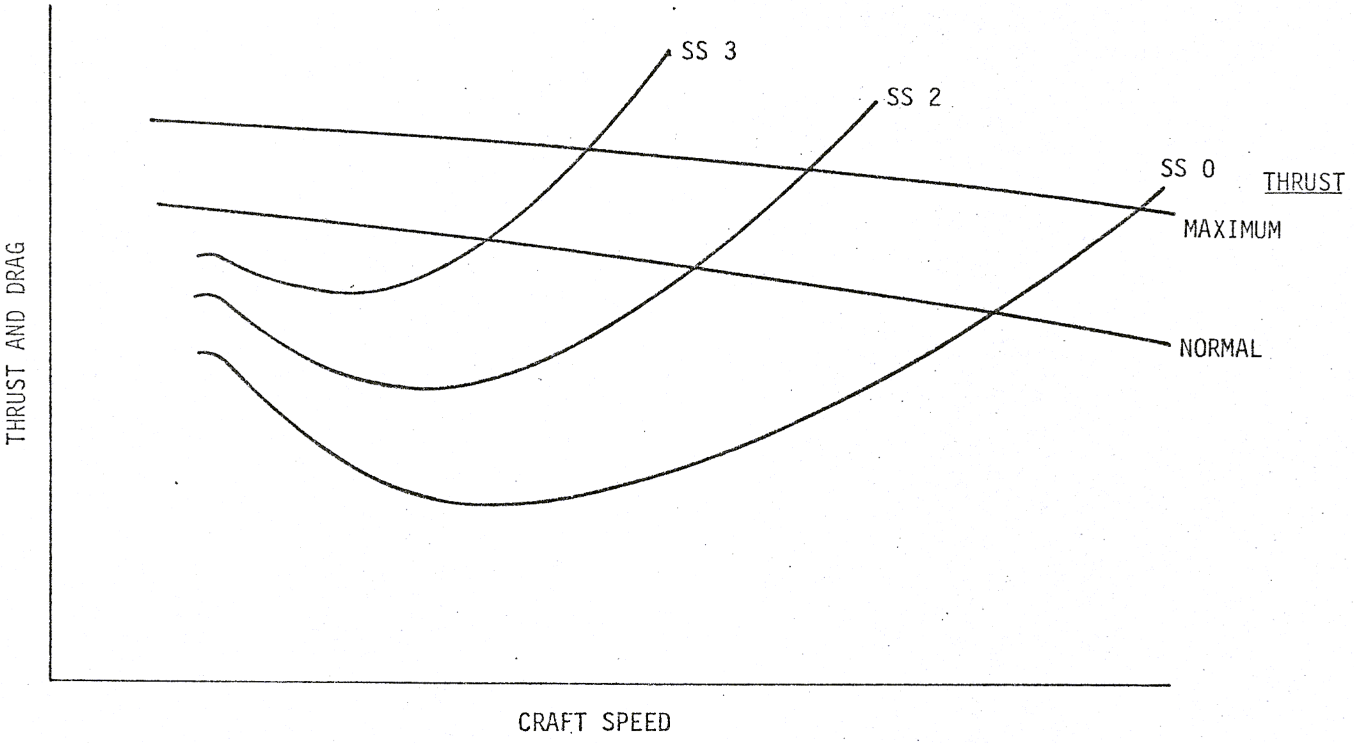


COMMONALITY ITEM

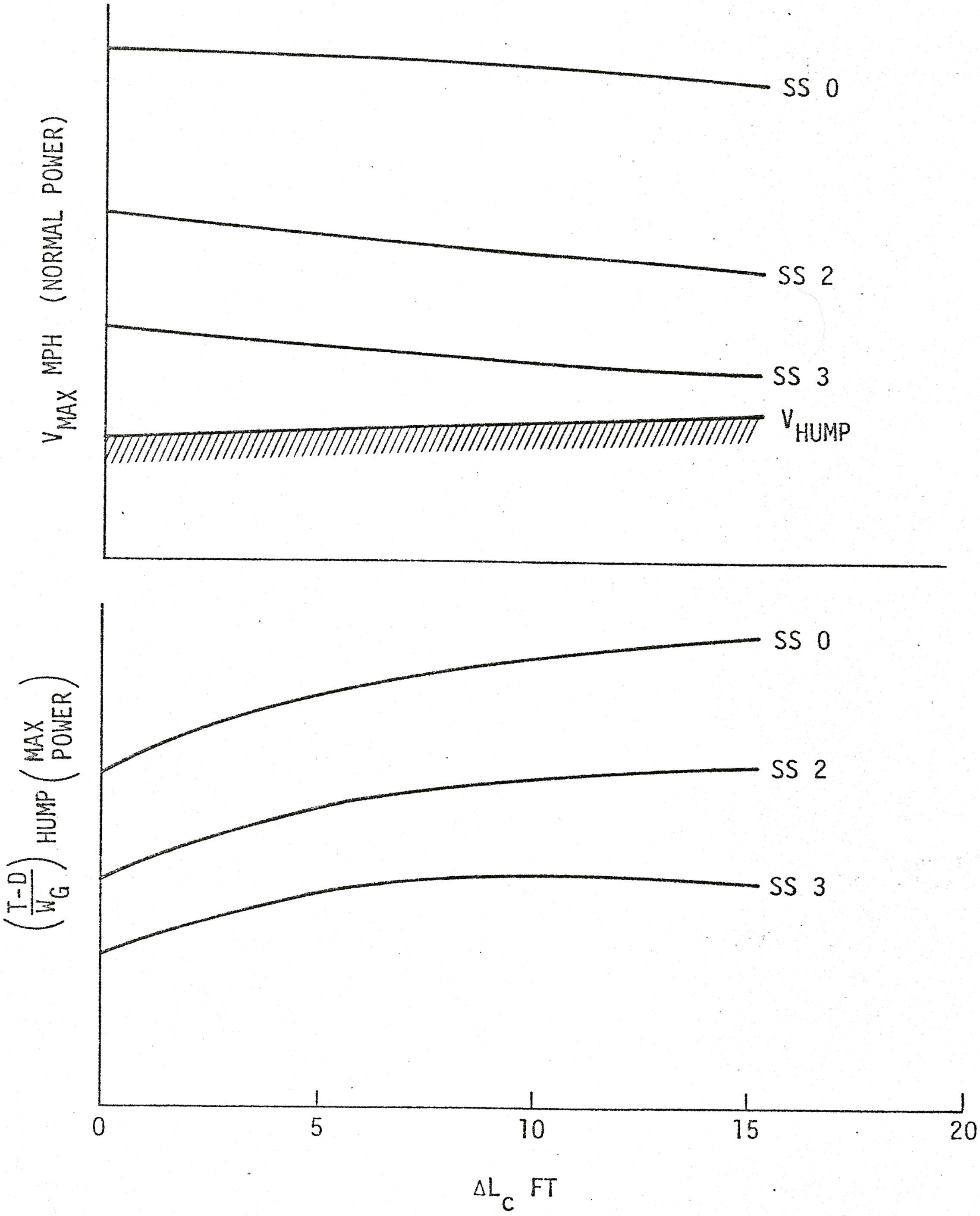
The Viking, following the Voyageur design philosophy, is constructed in modular form for ease in rapid deployment. Maximum use of Voyageur components has been accomplished as shown on facing page.

The structural modules are identical, with slight alterations at the ends to accommodate the planform of the smaller Viking. A single power module is used with a transmission change to permit the use of two propellers. The skirt system is identical but is adjusted to the lesser length.


SS 3
SS 2
SS 0
THRUST
MAXIMUM
NORMAL
THRUST AND DRAG
CRAFT SPEED

Typical thrust and drag curves for the vehicle at a gross weight of 35,250 lb with a payload of 5 tons, are shown on facing page.

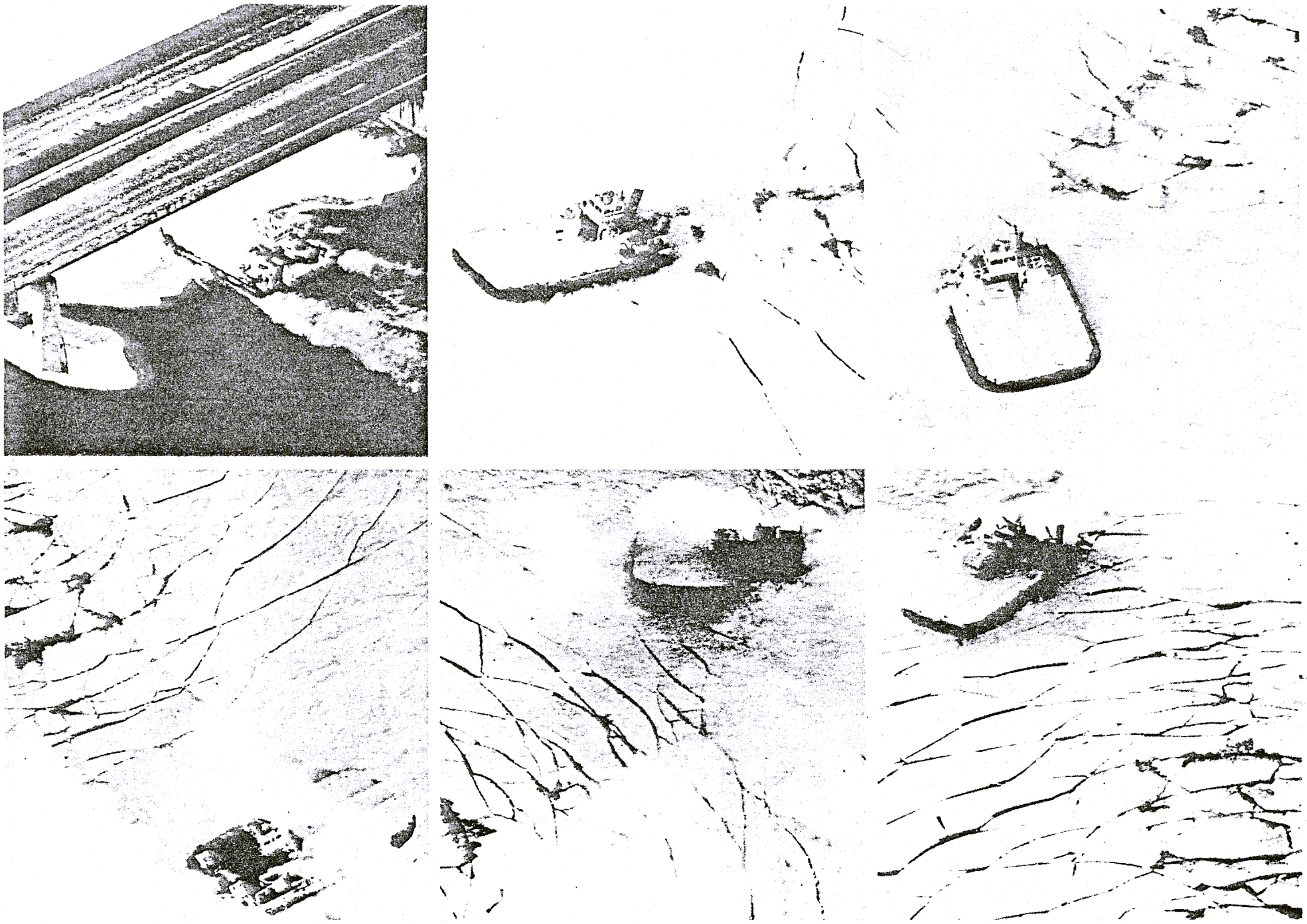
Maximum calm water speed is 57 mph with a continuous gradient capability from a standing start of 10%. Maximum range is 680 nautical miles. Vertical obstacle clearance is 4 ft; ditch crossing capability is 7 ft in width.

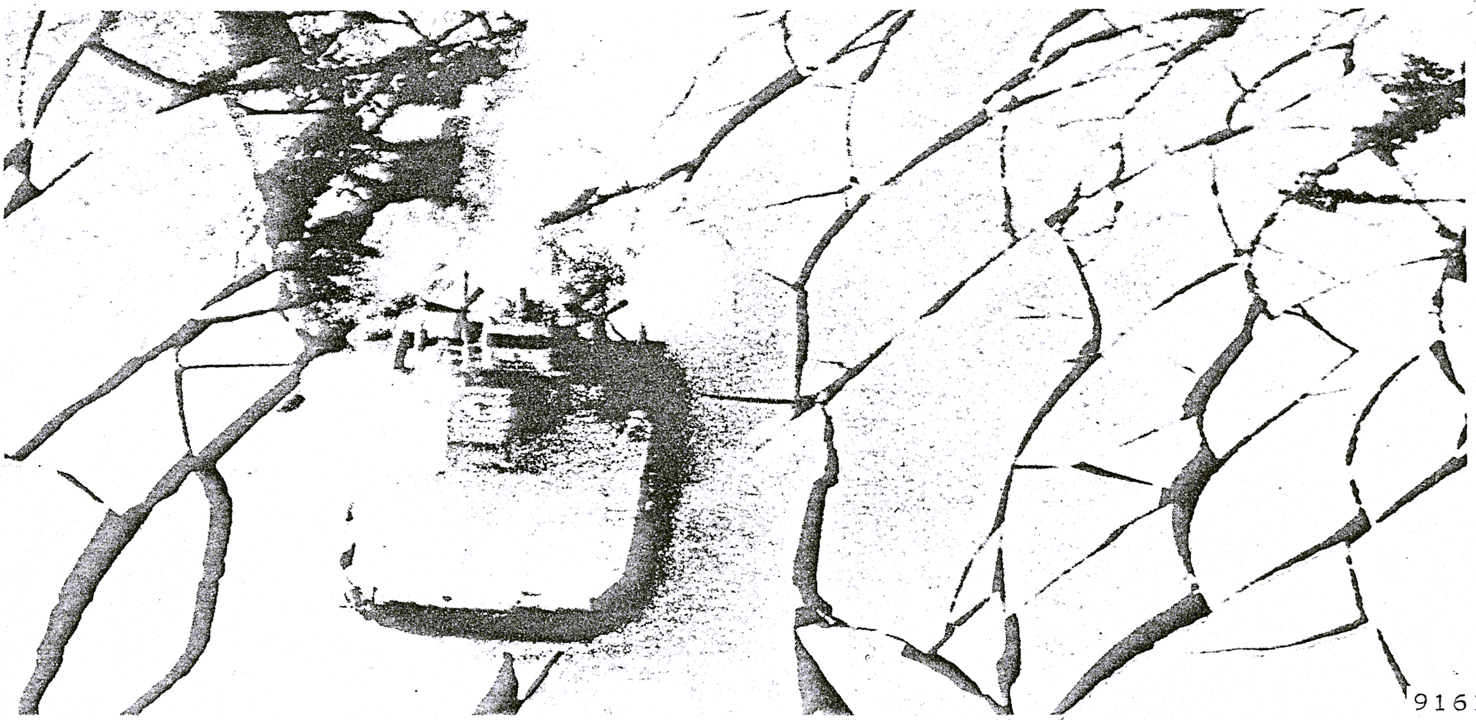

SS 0
SS 2
SS 3
V_HUMP
V_MAX MPH (NORMAL POWER)
SS 0
SS 2
SS 3
(T-D / W_G) HUMP (MAX POWER)
0
5
10
15
20
ΔL_C FT

The original Viking customer requirements specified a limit on length. Figures on facing page present the results of a study conducted to determine craft improvements possible through incremental increases in length.

A marked improvement in available hump acceleration can be gained through an increase of approximately 15 ft at only a slight penalty of maximum speed capability. With the additional hump margin it is possible to increase payload to 10 tons in SS 0 and SS 2.

OPERATIONAL EXPERIENCE





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VOYAGEUR DEVELOPS AS AN ICEBREAKEI

Annual spring flooding damage near Montreal, Quebec, is being avoided this year as a result of a Canadian Coast Guard icebreaking effort with a Voyageur Air Cushion Vehicle built by Bell Aerospace Canada. The 45-ton amphibious craft was transferred to Montreal in late 1974 from Parry Sound, Ontario, and has been used to break ice jams in several area rivers.

The largest project was a 3-1/2 mile ice jam in Riviere des Prairies north of Montreal. Each year water from the spring thaw in a lake upstream has been blocked by this jam, extensively flooding riverside properties. Previous efforts to break the ice with explosive charges had been largely unsuccessful. The river has depths ranging from 20 feet to a few inches and is navigable by small boats only—ruling out the use of ordinary icebreakers.

The Canadian Coast Guard Voyageur cleared out the jam at a rate of one mile each 12 operating hours, traveling to Riviere des Prairies from its base on Nun's Island in the St. Lawrence River near Montreal. The ice jam broken by the craft ranges in thickness. Some of the thickest chunks that turned sideways were tape measured and found to be 16 feet thick.

The jamup in Riviere des Prairies annually forms in mid-winter underneath a layer of solid ice about a foot thick. The steady river current brings chunks of snow and ice from upstream that are caught under the surface ice. The buildup of snow, ice and air pockets at a number of points extends to the river bottom.

The Voyageur crew found that this type of ice pack could be broken on a piecemeal basis by using the craft weight to compress and crack the jammed ice. Waves set up by Voyageur lift ice that has been grounded on the river bottom, and let it drift downstream with the current.

Operating from the downstream, open-water side of the ice jam, the captain operates the craft at about 10 knots to build up a series of trailing waves. Then he reduces speed so one of the waves can precede Voyageur into the ice pack.

As Voyageur repeats the procedure, the force of moving water gradually breaks the ice pack into large and small chunks that ar carried away by the river's three-knot current. Chunks that are too large to move safely downstream are broken up in the same manner.

A different kind of ice jam was cleared b the ACV on Riviere Chateauguay, which emptie into Lac St. Louis south of Montreal. This pack was solid and ranged from 13 inches thi at the mouth of the river to clear water 1-1, miles upstream.

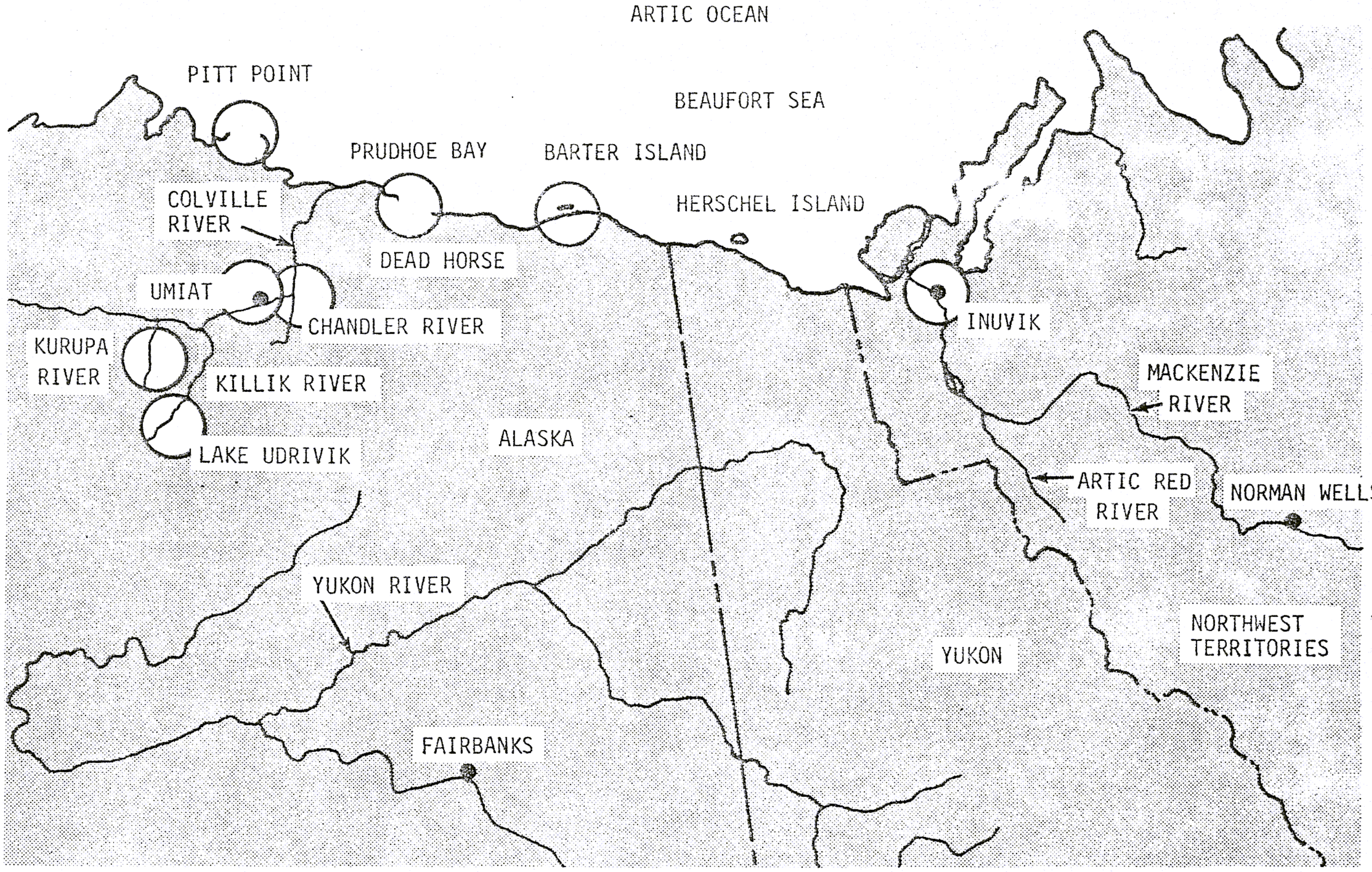
To break this thickness, Voyageur was operated at about 15 knots back and forth acro: the ice. This caused standing waves of ice that are similar to the types of waves formed in water. The wave action makes the ice crac and shatter with some violence, allowing it to be carried away by the current.

VOYAGEUR CRAFT NO. 003
OPERATIONS SUMMARY
15 AUGUST TO 15 NOVEMBER 1974

DATE	MISSION	AUW (~LB)	CARGO		FUEL LOAD (~LB)	RUNNING TIME (HR)	DISTANCE (MILES)	AVERAGE SPEED (MPH)
			ITEMS	WT-LB				
August 15, 1974	Inuvik to Barter Island. First leg of craft ferry from Inuvik to Umiat.	79,000	Support equip. and ship spares.	8,000	32,000	9.1	300	33
August 16, 1974	Barter Island to Umiat.	N.R.*	Support equip. and ship spares.	8,000	18,500	10.4	290	28
August 16-28, 1974	Umiat Local. Check runs and demonstrations for Bureau of Land Management Representatives.	N.R.*	Equipment.	1,000	21,700	4.3		
Sept. 3-4, 1974	Demonstration cargo run from Umiat to Kurupa River and return.	64,000	Fuel tank to Kurupa.	5,000	21,700			
		N.R.*	Drill equipment back to Umiat.	30,000	N.R.	8.3	220	26.5
Sept. 7, 1974	Cargo lift from Umiat to Udrivik Lake.	95,000	NODWELL drill rig.	35,000	21,700	8.2	115	14
Sept. 9, 1974	Cargo lift from Udrivik Lake to Umiat.	93,000	LOWBOY tractor.	33,000	21,700	7.4	115	15.6
Sept. 12-18 1974	Umiat Local.					1.3		
Sept 27, 1974	Umiat to Gubic oil rig to receive cargo load of drill collars.	66,800	Craft gear.	2,000	26,000	1.8	45	25
Sept. 27, 1974	Gubic Oil Rig to Pitt Point.	96,115	Drill collars.	36,300	21,000	8.1	170	21
Sept. 30, 1974	Pitt Point to Umiat.	56,600	Craft gear.	2,000	15,800	6.0	190	32
Oct. 7, 1974	Umiat Local.					0.5		
Oct. 8, 1974	Umiat to Prudhoe Bay.	66,500	Support equipment.	12,000	16,000	5.5	165	30
Oct. 9 - Nov. 15, 1974	Craft based at Dead Horse Airstrip-Local operators.					2.1		

*Not Reported

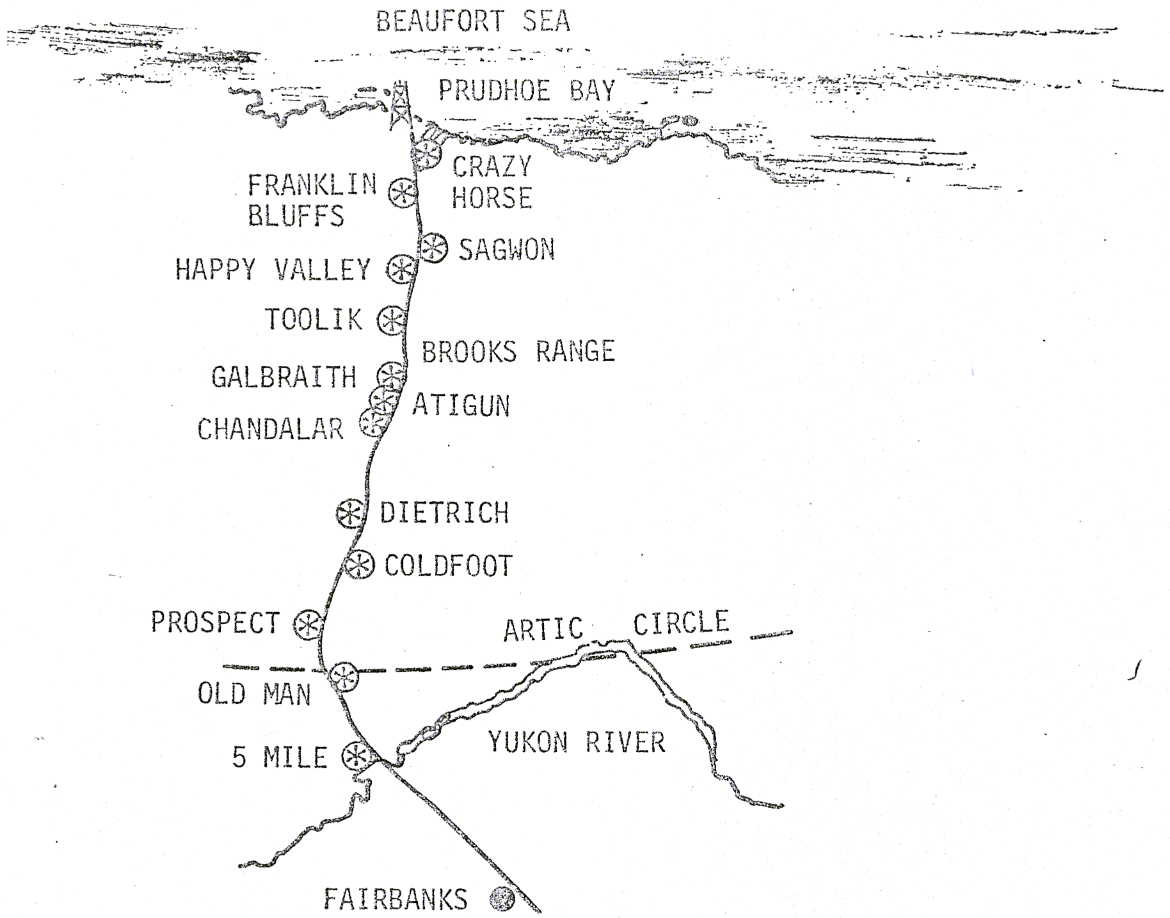
Cargo transport operations utilizing Bell Aerospace Voyageur Air Cushion Vehicle No. 003 were initiated in Alaska in August 1974. The craft was operated by a Bell crew on a charter basis to support geophysical, oil drilling and pipeline operations in remote regions of Alaska. Due to the rough terrain, ice, and snow, these areas are generally inaccessible to other modes of surface transport. The table on facing page presents a summary of the activities during this time period.



ARTIC OCEAN
PITT POINT
BEAUFORT SEA
PRUDHOE BAY
BARTER ISLAND
COLVILLE RIVER
HERSCHEL ISLAND
DEAD HORSE
UMIAT
CHANDLER RIVER
INUVIK
KURUPA RIVER
KILLIK RIVER
MACKENZIE RIVER
LAKE UDRIVIK
ALASKA
ARTIC RED RIVER
NORMAN WELLS
YUKON RIVER
NORTHWEST TERRITORIES
YUKON
FAIRBANKS

The figure on facing page is the area map of the major operations conducted during this period.

ROUTE FROM PRUDHOE TO YUKON RIVER CROSSING



VOYAGEUR CRAFT NO. 003 OPERATIONS SUMMARY 15 NOV. 1974 TO 15 FEB. 1975

DATE	CREW	MISSION	AUW	CARGO ITEMS	CARGO WEIGHT LB	FUEL LOAD LB	RUN TIME HR	DIST. MILES
Nov. 22-25 1974	Trucking	Craft transport by truck from Prudhoe to Yukon River crossing.	Empty wt.					360
Nov. 29, 1974	Herford & Hall	Two round trips for route reconnaissance.	57,000	None		4,300	0.5	4
Nov. 29, 1974	Herford & Hall - 4 Passengers	Demonstration cargo transport for Coast Guard.	87,700	Fuel Bowser	45,000	4,300	0.4	2
Dec. 1, 1974	Herford & Hall	Transport winch from South to North Shore.	91,000	Winch	48,000	4,500	0.5	2
Dec. 5, 1974	Herford & Wright plus Passengers	Two demonstration runs for visitors and Bechtel contracts personnel.	57,000	None		6,000	1.2	10
Dec. 6, 1974 to Dec. 23, 1974	Herford & Wright	Manned Standby.						
Dec. 23, 1974 to Feb. 15, 1975		Interim shutdown.						

The craft remained at Prudhoe Bay near Deadhorse Airstrip on interim shutdown until November 18 pending final contract negotiations with Alyeska Co. for use of the Voyageur as a freight transporter at Five Mile Camp, near Stevens Village, on the Yukon River pipeline crossing.

The craft was loaded at Deadhorse on November 22, in a fully assembled state (with propellers removed), and deployed by truck to the Yukon river crossing arriving on November 25.

The figure on facing page presents the summary of operations during this time period and the area map.

GULF OF ST. LAWRENCE NORTH SHORE SERVICE TYPICAL WORK SCHEDULE

Schedule Day	Unload Port	Travel To	Distance (nm)	Travel Time (hrs)		Lighterage Cycle (hrs) (1)	Total Ship Time (hrs) (2)	Cumulative Time (hrs) Ship	ACV Time		Cumulative ACV Time	
				ACV	Ship				Cruise	Idle	Cruise	Idle
1	Sept - Iles	Riv Au-Tonnerre	65	2.2	6.5	1.0	6.9	6.9	2.4	0.4	2.4	0.4
2	Riv Au-Tonnerre	Mingan	27	0.9	2.7	1.0	3.1	10.0	1.1	0.4	3.5	0.8
3	Mingan	Harve - St.-Pierre	16	0.5	1.6	1.0	2.0	12.0	0.7	0.4	4.2	1.2
4	Harve - St.-Pierre	Baie Joan Beetz	33	1.1	3.3	1.0	3.7	15.7	1.3	0.4	5.5	1.6
5	Baie Joan Beetz	Natashouan	40	1.3	4.0	1.0	4.4	20.1	1.5	0.4	7.0	2.0
6	Natashouan	Kegaska	26	0.9	2.6	1.0	3.0	23.1	1.1	0.4	8.1	2.4
7	Kegaska	Romaine	24	0.8	2.4	1.0	2.8	25.9	1.0	0.4	9.1	2.8
8	Romaine	Harrington	58	1.9	5.8	1.0	6.2	32.1	2.1	0.4	11.2	3.2
9	Harrington	Whalehead	14	0.5	1.4	1.0	1.8	33.9	0.7	0.4	11.9	3.6
10	Whalehead	Mutton Bay	10	0.3	1.0	1.0	1.4	35.3	0.5	0.4	12.4	4.0
11	Mutton Bay	La Tabatiere	14	0.5	1.4	1.0	1.8	37.1	0.7	0.4	13.1	4.4
12	La Tabatiere	St. Augustin	22	0.7	2.2	1.0	2.6	39.7	0.9	0.4	14.0	4.8
13	St. Augustin	St. Paul River	37	1.2	3.7	1.0	4.1	43.8	1.4	0.4	15.4	5.2
14	St. Paul River	Blanc - Sablow	18	0.6	1.8	1.0	2.2	46.0	0.8	0.4	16.2	5.6
15	Blanc - Sablow	Sept - Iles	404	13.5	40.4	—	40.8	86.8	13.5	–	29.7	–
Totals			808	26.9	80.8	14.0	86.8	86.8			29.7	5.6

(1) 0.4 hr load (Voyageur at Idle)
0.2 cruise to port
0.4 unload (Voyageur Shut Down)

(2) Includes underway time plus offload to Voyageur (0.4 hr) at each port.

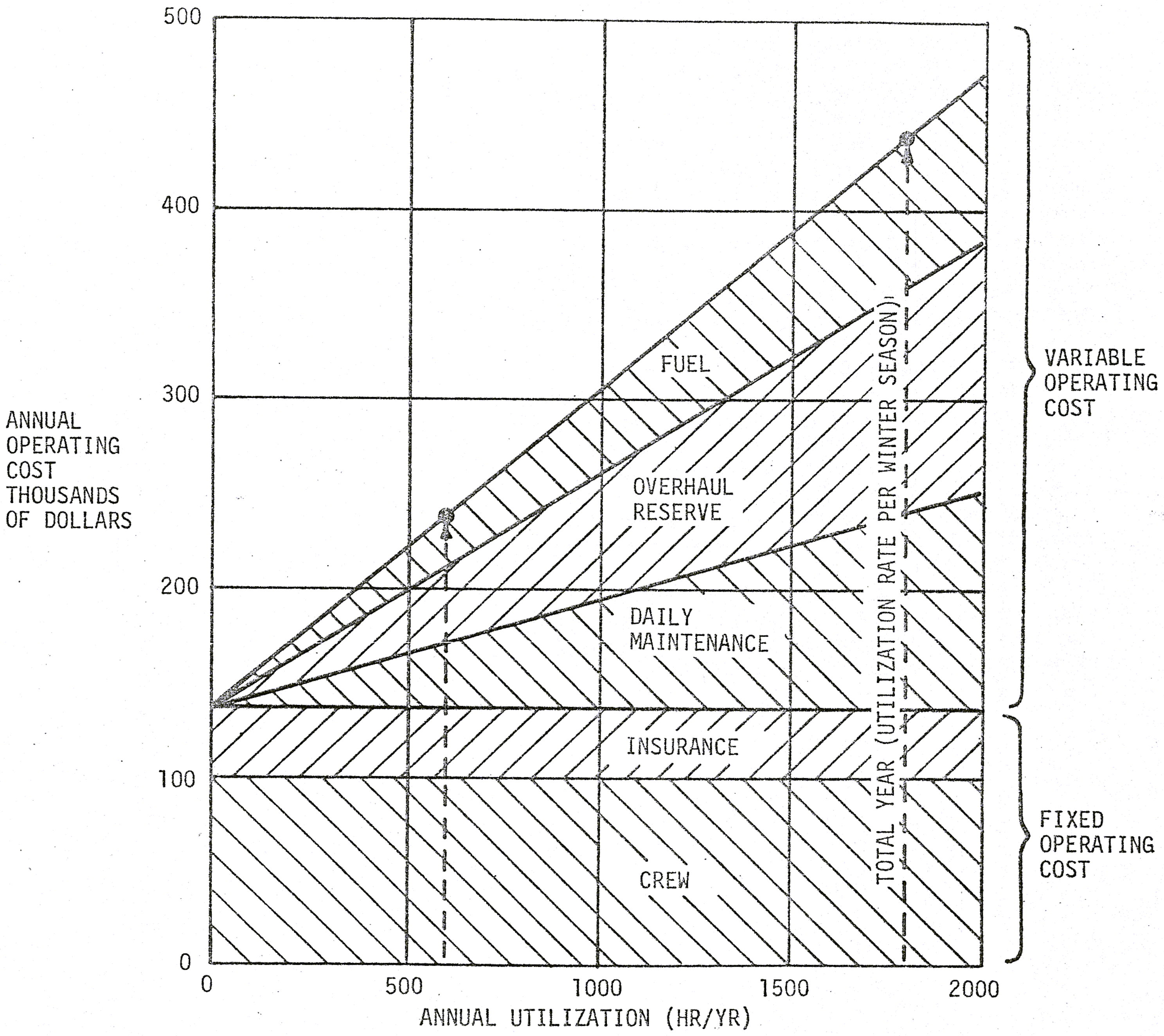
35.3 operating hours per week on Voyageur.

GULF OF ST. LAWRENCE NORTH SHORE LIGHTERAGE SERVIC

During recent years the increased cargo demand to the towns of the Quebec Lower North Shore has exceeded the capacity of the freight delivery system each fall. In addition, the ice and weather conditions are so severe between December 31 and April of each year that seaborne freight delivery service to these towns is not possible. In fact for these months and even longer the population, except where there are airstrips, is cut off from the rest of Quebec and Canada. Although the Federal and Provincial governments have made efforts to improve this service, the limitations of transportation technology and economic constraints have limited the options available. Late in 1973 operations analyses were performed by Bell Aerospace Canada, in conjunction with Agence Maritime and the Province of Quebec, to establish the feasibility of using an air cushion vehicle as an augment to the existing marine cargo delivery service. Based on the results of these analyses and previous favorable experiences with hovercraft in Canada, a decision was made to fund a Voyageur Air Cushion Vehicle Cargo Delivery Project for the Lower North Shore over a six-month winter trial period.

To perform this demonstration program, Voyageur serial 004 was deployed to the area. The table on facing page presents a typical work schedule used for this program.

OPERATING COST GRAPH (ANNUAL $ VERSUS UTILIZATION)

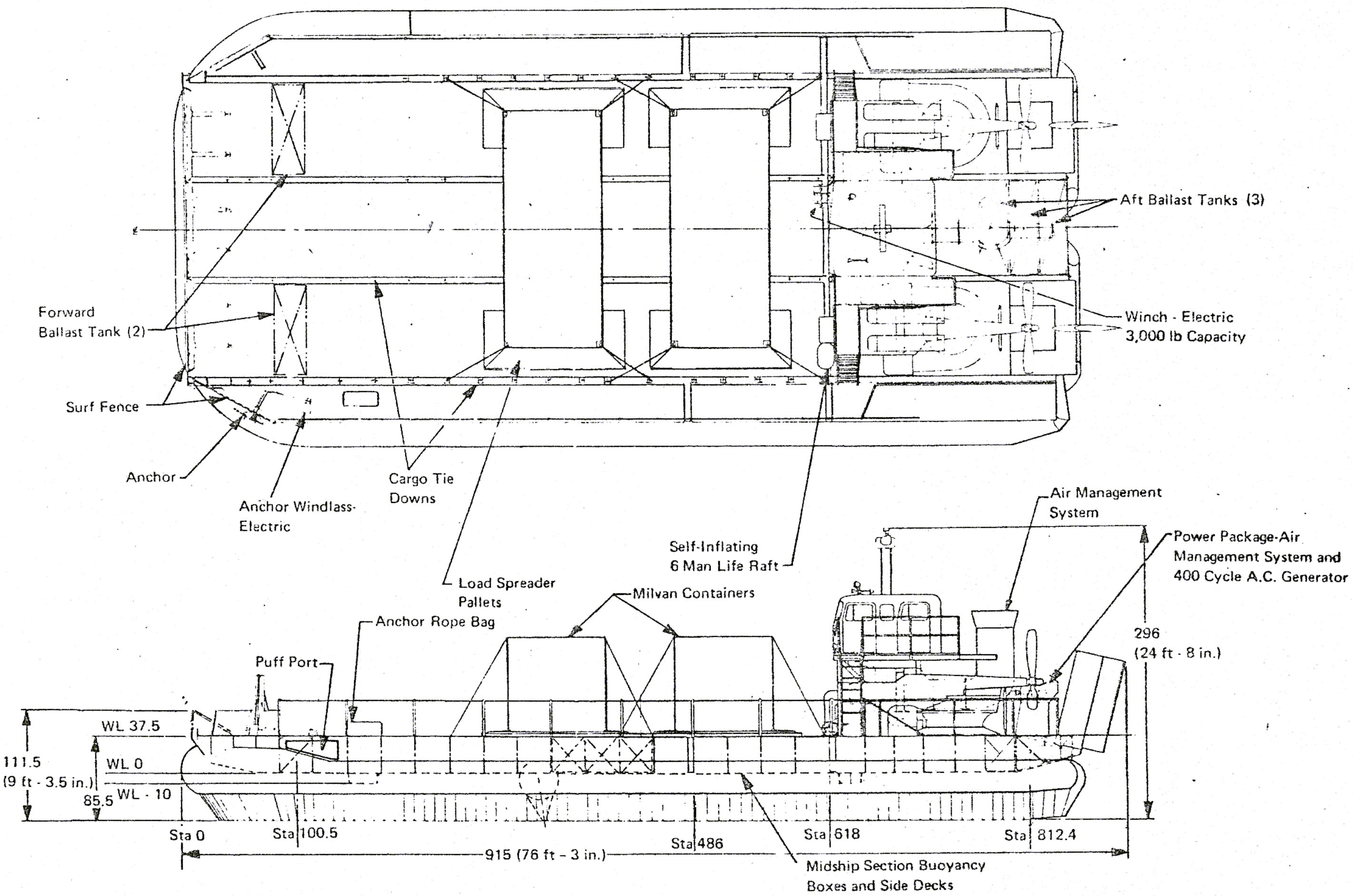


The figure on the facing page indicates cost projections associated with a North Shore Support Service System utilizing a supply ship cruising offshore in clear water in association with a Voyageur air cushion vehicle which performs ship-to-shore lighterage to the communities situated along the shoreline.

For a weekly service frequency (per the present Agence Maritime summer ship schedule) a craft utilization of 600 operating hours is required over the four-month winter period. Assuming that an equivalent utilization rate is obtained for the craft through the remainder of the year (either by continuing the lighterage system, or by deploying the craft on other duties), it is shown that the four-month winter lighterage operations will have a direct cost of approximately $240,000 per season.

LACV-30 CONFIGURATION

9167



LIGHTER, AMPHIBIAN AIR CUSHION VEHICLE - 30-TON PAYLOA

The proposed Bell Model LACV-30 (Lighter, Amphibian Air Cushion Vehicle-30-Ton Payload) is a fully amphibious high-speed craft planned to meet projected Army needs as identified in the Trans Hydro Craft Study 1975 - 1985. It is a high mobility vehicle capable of transporting military cargo payloads in the 25 to 30 short ton category (including MILVANS) primarily in support of the logistics over-the-shore (LOTS) mission involving operations over water, marginal areas and overland.

Overall craft length has been increased by 11.5 ft. This provides increased payload weight lifting capacity to meet U.S. Army needs, and also lengthens the usable cargo flatbed area to accommodate a wider variety of cargo (eg, 40 ft containers and/or trailer units). The stretch is obtained by inserting a parallel hull and skirt section at the station 486 transport joint of the standard commercial Model 7380 craft. This stretch consists of buoyancy boxes, side decks, and skirt segments constructed similarly to the Model 7380 modules and skirts. The splices at the joined sections are strengthened to accommodate the higher hull bending moments of the Model 7467, but the key modular/transportability feature of the Voyageur type is retained by making these new stretch elements in modular form to permit craft disassembly into portions no greater than approximately 40×8×3.2 ft.

Key features added to the base Voyageur are as follows:

ITEM — PROVIDES

Longitudinal Stretch - Increased payload weight and deck area capability.

Air Management System - Longer engine life (intake air filtration to remove sand/water). Improved quality air to cabin. More lift fan output for cushion air. APU power takeoff availability. High intake stack minimizes water ingestion in the surf zone.

Load-Spreader Pallets - Loading of U.S. Army specified tracked and wheeled vehicles and containers.

Surf Fence - Improved surf transition.

Cargo Securing System - Fast, effective cargo tie-down system.

Anchor System - Craft anchoring.

Deck Winch - Cargo handling. Craft self-retrieval and improved gradeability.

Special Equipment - To Army requirements.

Craft Marking - To Army requirements.

Bow Ramp System (Ground Support Equipment) - Roll-on/roll-off of specified tracked and wheeled Army vehicles and MHE (material handling equipment).

Craft Fendering (Ground Support Equipment) - Improved craft skirt protection during operations alongside container ships.

Swing Crane (optional) - Self-unload capability.

Principal Dimensions

Overall length (without optional swing crane)	76 ft 3 in.
Overall beam (skirts inflated)	36 ft 8 in.
Overall height on landing pads	21 ft 6 in.
Overall height from skirt hemlines (hovering)	24 ft 8 in.
Cargo deck length	51 ft 6 in. } 1673.75 ft
Cargo deck width	32 ft 6 in. }
Cargo deck height	3 ft 11.5 in.
Cushion height	4 ft 0 in.
Cushion area	2103 sq ft
Cushion pressure at max. gross weight	54.7 psf
Reserve buoyancy	155%

Performance (Estimated)

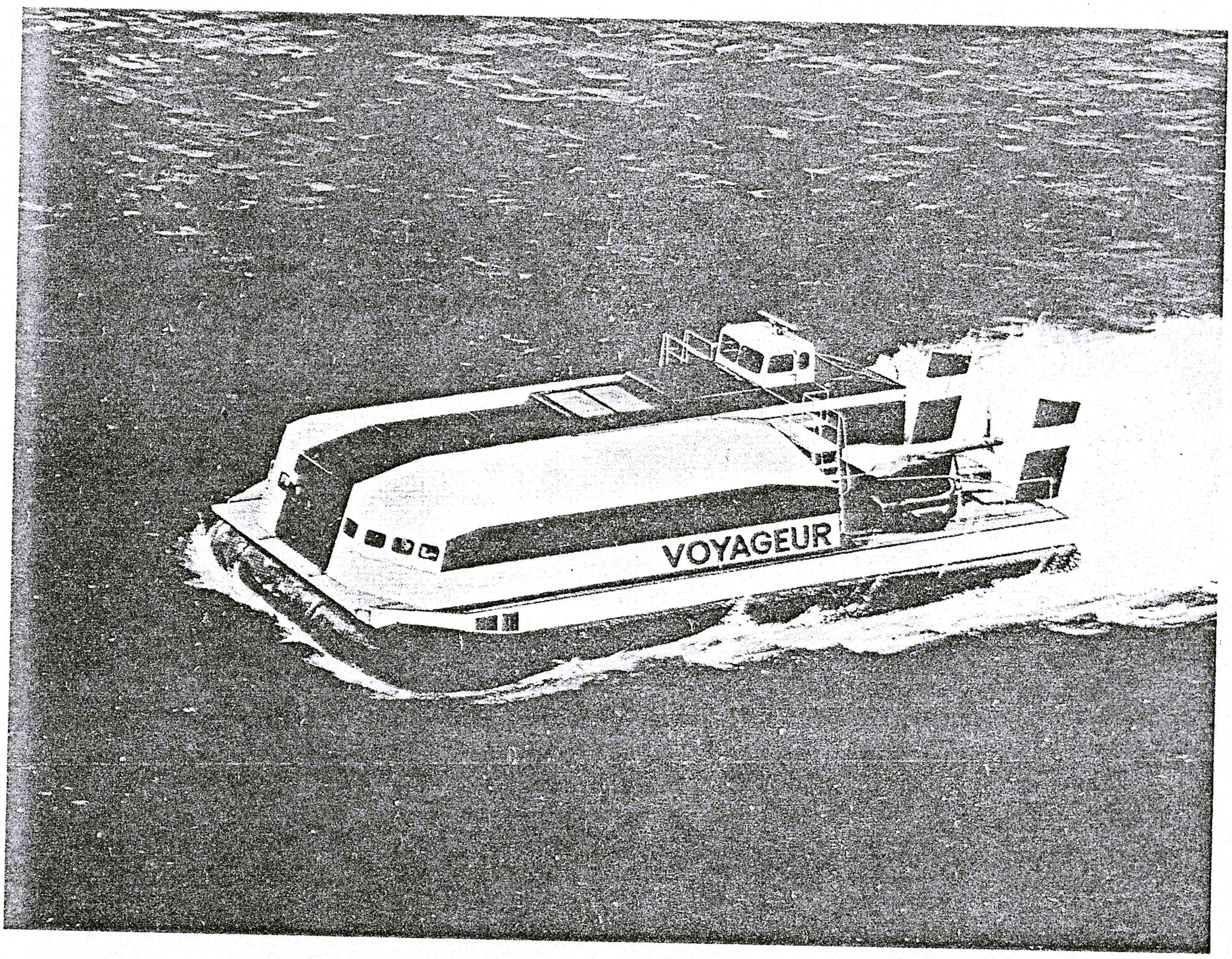
Maximum calm water speeds at 115,000 lb gross weight with zero wind (standard day)	Normal rating	47 mph
	Maximum rating	57 mph
Endurance with full main fuel	9.1 Cruise Hours	

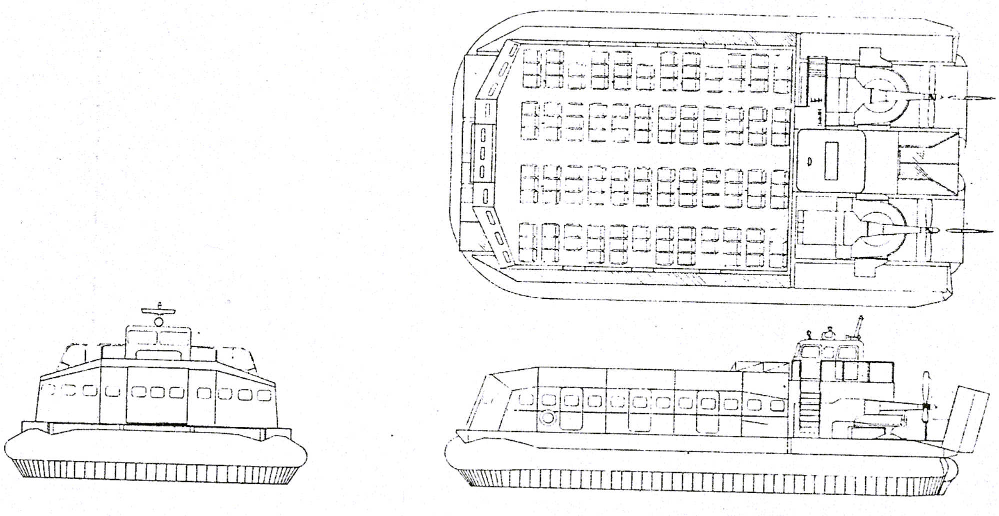
Power and Transmissions

Engines	Two UACL/Pratt & Whitney Twin Pac ST6T Gas Turbines
Maximum Rating (standard day)(Each)	1800 SHP
Normal Rating (standard day)(Each)	1400 SHP
Propellers	Two Hamilton Standard 3-blade variable pitch
Lift Fan	Two Bell/British Hovercraft Corporation, 7 ft centrifugal, 12-bladed, fixed pitch

LACV-30 CHARACTERISTICS

The table on facing page lists the principal characteristics of the LACV-30 craft.

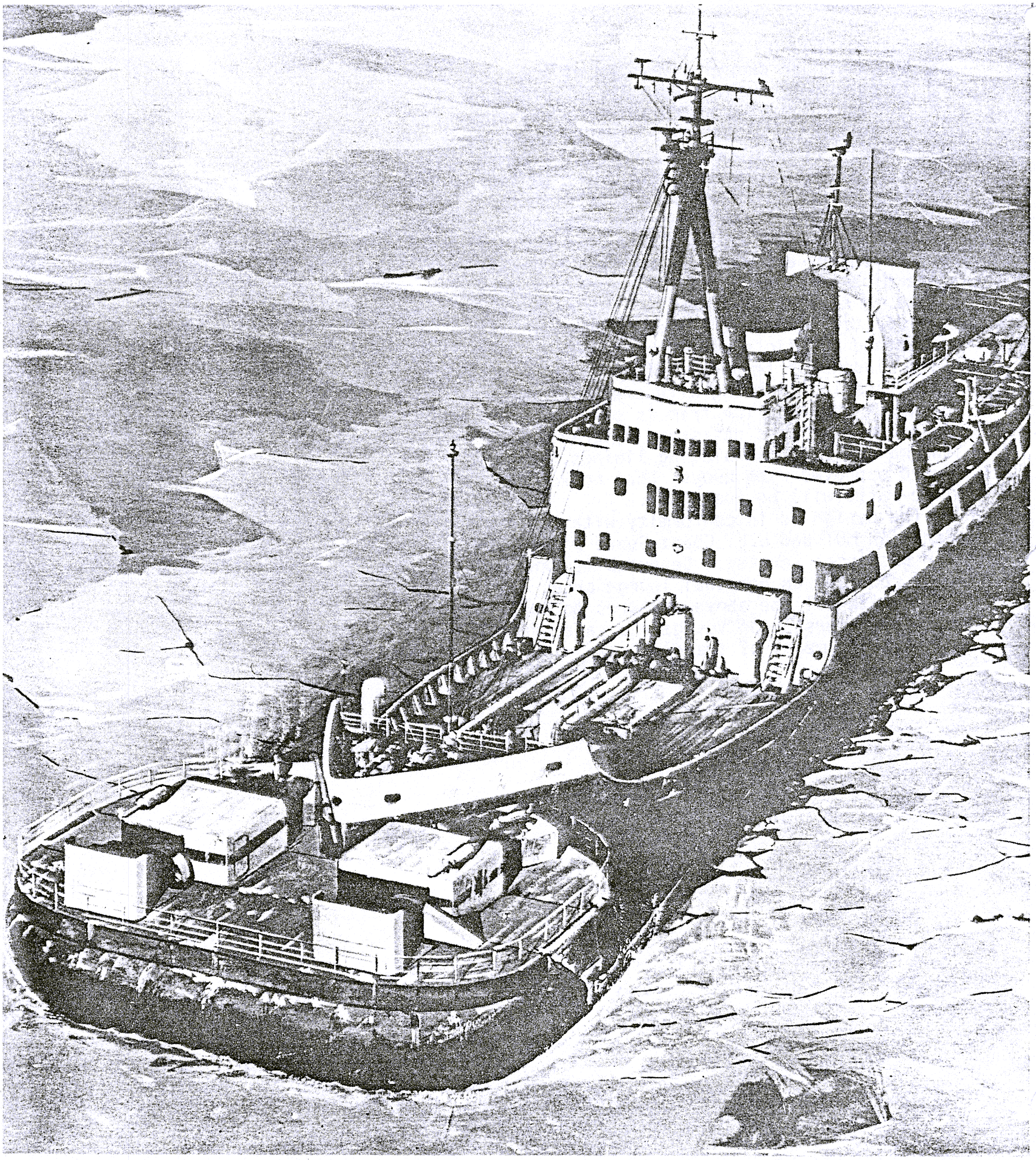

VOYAGEUR



VOYAGEUR . . . . PASSENGER AIR CUSHION VEHICLE

The passenger carrying version of the Voyageur Air Cushion Vehicle is formed by the addition of a self-contained passenger cabin on the basic Voyageur flatbed vehicle. This cabin is modularized and readily removable as a unit to restore the craft to the flatbed form as role requirements dictate. Alternatively, the seats may be removed through the wide loading doors, and any mix of passengers and freight carried as demand determines. Three emergency doors are provided in each cabin sidewall. Other features include tinted double glazed windows of stretched acrylic shatterproof plastic, forward windows of tempered safety glass, and full interior lighting with emergency power backup. The interior trim is of sound absorbent and dirt resistant material over thermal-acoustic insulating linings. Coast Guard approved ring buoys, boat-hooks and life-rafts will be installed.

The design is in conformity with known Canadian MOT and U.S. Coast Guard regulations for passenger ferries. Generous leg and baggage room and an optional lounge area, contrive with all the above features to make the passenger version of Voyageur a safe, fast and comfortable means of travel.



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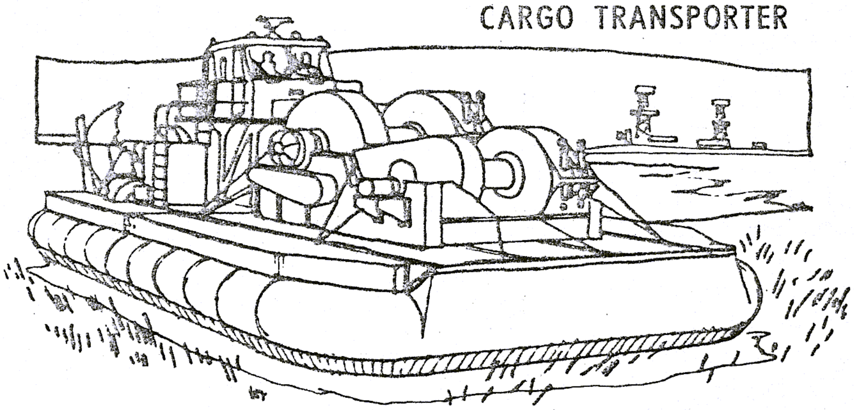
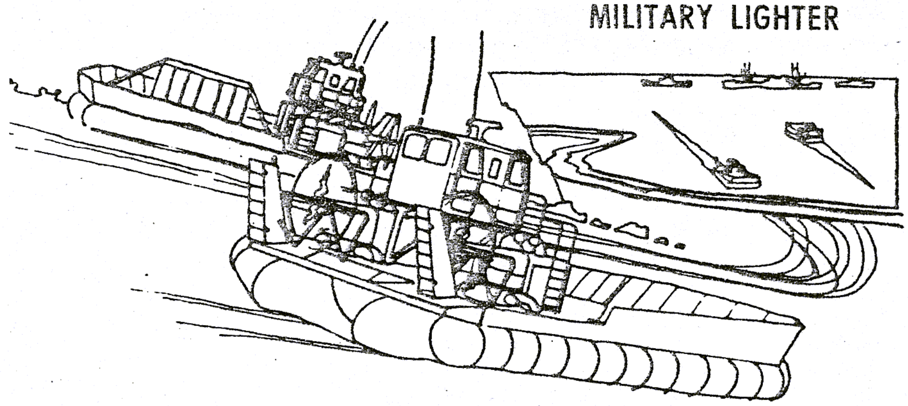
Air cushion icebreaker platform design for the Canadian Coast Guard ship Montcalm is shown on facing page. Developed under contract to the Air Cushion Vehicle Division, Marine Administration, Transport Canada, the concept is a result of tests with models and full scale ACV icebreakers. The platform is 53 ft wide by 32 ft long and is designed to provide a variety of weights and cushion pressures. Water pumped into the platform ballast tanks give it an operating weight range from 170,350 to 365,000 lb, with cushion pressures from .7 to 1.5 lb per square inch. If built, the platform would be used for full scale evaluations of the concept. Model tests have shown that an ACV platform provides significant improvement in the capabilities of an icebreaking ship.

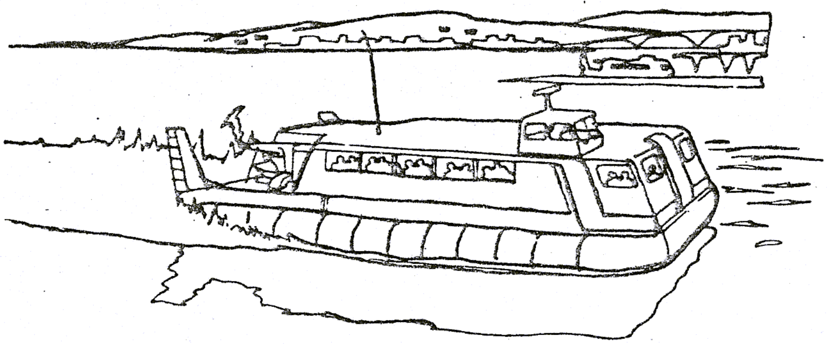
CARGO TRANSPORTER



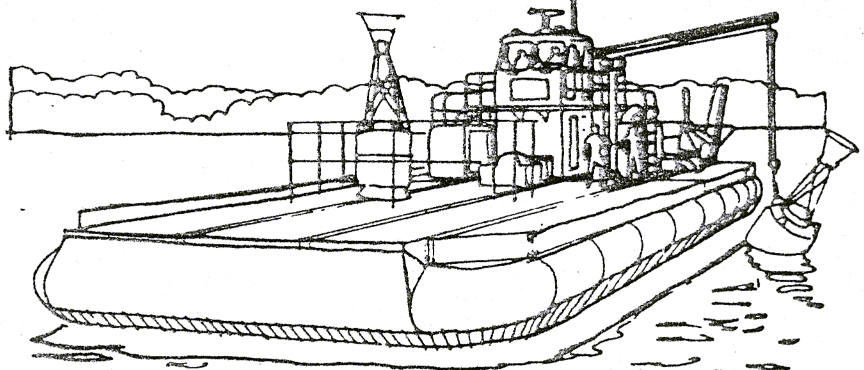
MILITARY LIGHTER



MASS TRANSIT FERRY



COAST GUARD BUOY TENDER



Voyageur incorporates a basic flatbed design to which specialized superstructures and equipment can be added to meet your individual load and operational requirements -- from logistics support to mass transit.

Fully amphibious, Voyageur offers economical year around mobility even over such remote region surfaces as ice, snow, tundra, mud and marsh.