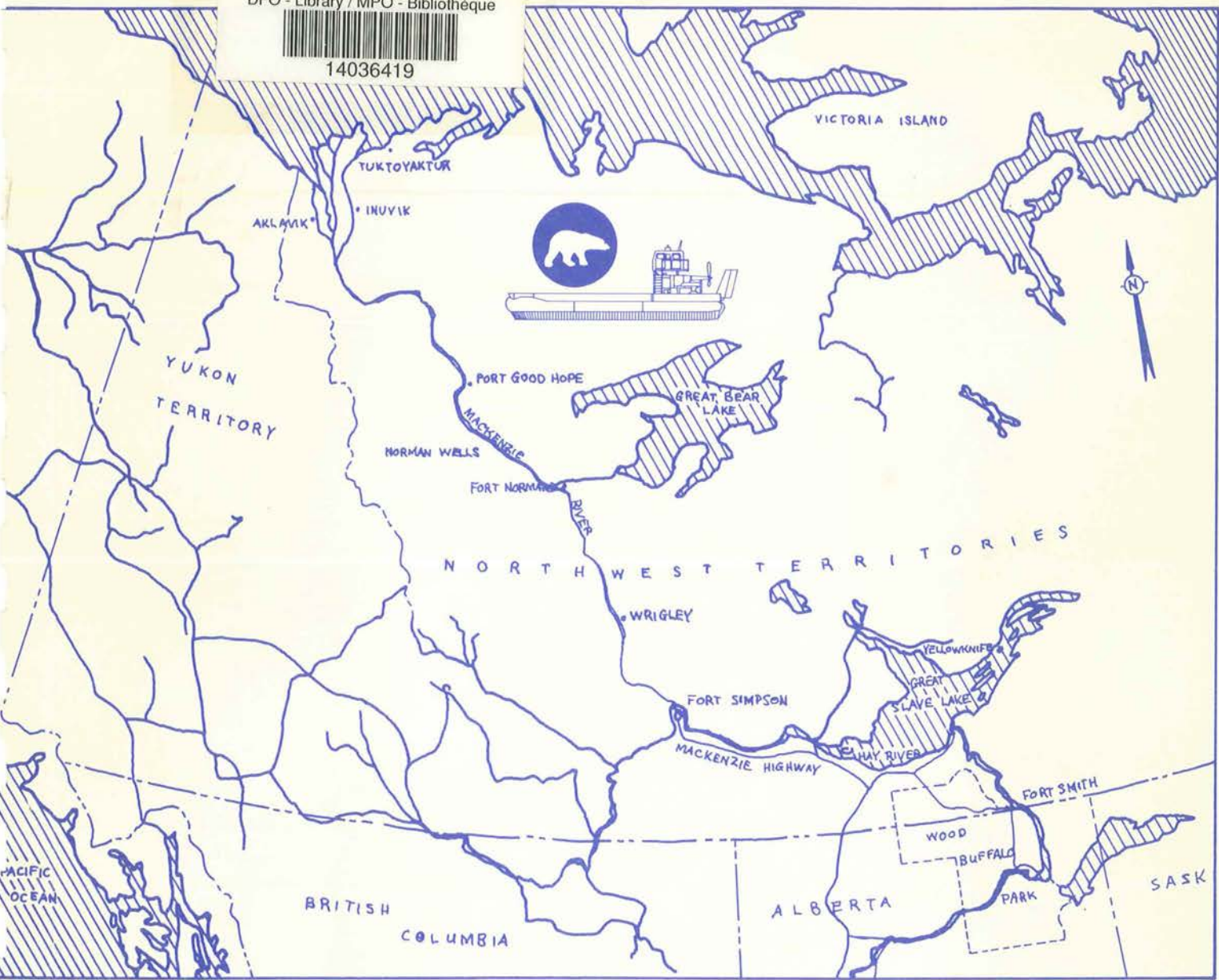


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NOVEMBER 1973

A REPORT OF PHASE II OF THE CANADIAN COAST GUARD EVALUATION
OF THE BELL AEROSPACE CANADA, VOYAGEUR HOVERCRAFT

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TABLE OF CONTENTS

	<u>PAGE</u>
SUMMARY	1
INTRODUCTION	2-4
CHAPTER 1, Work Programme and Results	5-12
CHAPTER 2, Operational Procedures	13-19
CHAPTER 3, Human Factors Assessment of the Voyageur A.C.V.	20-28
CHAPTER 4, Maintenance and Unserviceabilities	29-32
CHAPTER 5, Conclusions	33-34
APPENDIX "A" - Coast Guard Headquarters Trials Directive	35
APPENDIX "B" - Chronological Record of Project	36
APPENDIX "C" - Coast Guard Mission Data Sheets	37
APPENDIX "D" - Sonar Equipment	38
APPENDIX "E" - Working Paper on Mackenzie River Operation of Voyageur	39

SUMMARY

In 1972 from September 25th to December 4th a series of trials were conducted by the Coast Guard, on the Bell Aerospace Voyager A.C.V., to assess this vehicle's capability in the Coast Guard role.

Based on this assessment it was decided to conduct an Operational Evaluation for 8 weeks in June and July of 1973, on the Mackenzie River.

Regrettably, during this allotted period the vehicle underwent a series of major unserviceabilities, some of which required time consuming modifications, which seriously curtailed the intended Coast Guard programme, to the extent that it cannot be considered that an Operational Evaluation was conducted.

On only 13 days of the allotted time, was the vehicle operational in its designated work area, amassing 89.4 engine operating hours for a total of 109.6 Mission hours. For about half of this time, both the crew and the vehicle were in learning process, developing and establishing new operational methods, peculiar to the vehicle. It was only in the last week of the programme that the potential of the vehicle in the Aids Tender role commenced to be demonstrated, the vehicle successfully lifting and laying buoys in currents of up to 7 mph.

In its present configuration, the vehicle is unsuitable for an Aids Tender role on the Mackenzie River. This being due to lack of accommodation, comparatively short range and the requirement for a sonar system compatible to its speed. At best it could be used as a day tender, working from a fixed base, but the economics of this would not be practicable.

The off the shelf model can, with modification, be improved, but at the expense of payload and space. Limited crew accommodation can be fitted, and extra fuel tankage installed that would enable the vehicle to work away from base for up to 3 days but for the Mackenzie system this is not really sufficient and the vehicle would still require base facilities for personnel and maintenance.

INTRODUCTION

In 1972, Phase I of the Coast Guard evaluation of the Bell Aerospace Voyager A.C.V., assessed this vehicle as being capable of performing general Coast Guard duties in sheltered coastal or inland waters, where the largest floating navigational aid did not exceed the 4'6" dia. electric type buoy.

It was therefore decided that Phase II of the evaluation, scheduled for June and July of 1973, on the Mackenzie River, would be an evaluation of the vehicle, under operational conditions. A Directive with an explanation of the proposed evaluation issued by Coast Guard Headquarters, is contained in Appendix "A".

The Vehicle

A description of the vehicle is contained in the Phase I report, essentially the configuration of and the equipment on, the vehicle was unchanged for the Phase II evaluation, however some changes had been made as follows:

1. Just prior to the commencement of Phase II, it was discovered that the ballast system was leaking into some of the hollow core planking. The system was modified so that this could not re-occur and a solution of water and soluble oil was substituted for fuel, in the system. This left the vehicle without any emergency fuel and a 500 gallon tank was installed on the rear centre module between the engines. This tank was an effective counter weight to the buoy lifting package installed in the forepart of the vehicle. However this tank reduced the available payload by 4,000 lbs. and refuelling from it by a portable electric pump was a fairly lengthy process.
2. The buoy lifting package was slightly modified by widening the over bow sheave and cable guide, installing vertical rollers on the after cable guide and extending the winch control to the after end of the package.
3. A WESMAR SS110 Horizontal Scanning Sonar was purchased and a framework, for lowering and lifting the transducer into and out of the water, fabricated from aluminum scaffolding. A description of the Sonar is contained in Appendix "D".
4. The whole of the working deck area was covered with 1/2" plywood, to distribute loads and protect the deck from damage.

5. Large wooden boxes were fabricated and installed forward of and between the engines, for carriage of buoy and aids tending equipment.

6. Three specially modified flying helmets and VHF-FM portable radio sets were supplied for communication between the deck crew and operating cabin.

Evaluation Team

The vehicle was still under the operational control of the Northern Transportation Co. Ltd., who supplied a pilot and three mechanics. The Coast Guard section consisted of Project Officer/Pilot, Data Collection Officer, Mackenzie River system advisor from the Hay River Agency and 4 Seamen.

The Defence and Civil Institute of Environmental Medicine supplied 3 personnel to conduct a Human Factors Assessment related to the vehicle.

One Pilot and two mechanics from the Coast Guard Hovercraft Unit, Vancouver attended parts of the project for familiarization on the vehicle.

Evaluation Area

Although the intended area of operation was to be, between Arctic Red River and Wrigley with the main base of operations at Norman Wells, the vehicle only carried out work between Fort Good Hope (Mile 684) and Mile 413. A feasibility trip was also carried out to Whisky Jack Pt. on the Great Bear Lake. The vehicle also transited between Norman Wells and Hay River several times, a distance of 600 statute miles.

Environment and Meteorological Conditions

The main base of operations was Norman Wells. Marine Services maintain a storage shed at the west end of the settlement at approximately Mile 564, the only area available for landing and parking the vehicle, was at this point. This area was leased by Imperial Oil Company and the permission and co-operation of this company had to be obtained to use this area, as there were numerous capped oil wells in the area. Imperial Oil bulldozed the area free of driftwood and rocks. The parking area for the vehicle was some 50 yards from the water's edge, the grade being approximately 1 in 10.

During the majority of the project, very dry weather was experienced, as the approach and parking area consisted of very fine sand, considerable problems were encountered with the dust raised by the vehicle. Pilot visibility was at times reduced to zero and due to excessive ingestion of dust through the engine air

filtration system, a planned modification to the system had to be effected much earlier, seriously effecting the Coast Guard programme. Similar dust problems were encountered at the majority of landings the vehicle made, during the course of its work on the river.

Little rain was experienced in the evaluation area, winds varied from zero to 30 mph, the usual daily average being 5-10 mph. Temperatures varied from 60°F to 88°F. Wave heights experienced on the river were up to 2 ft., usually created by a wind against current condition. Visibility varied from 15 miles to 1 mile, in haze, smoke or blowing dust.

During June, perpetual daylight was experienced and in July one to two hours actual darkness encountered in the early morning hours.

CHAPTER I

WORK PROGRAMME AND RESULTS

As stated in the Summary the programme was plagued with unserviceabilities, a description of these is contained in Chapter 4.

Appendix "B" contains a chronological record of the project and it may be seen that, due to unserviceabilities, the actual time available for work fell into three periods, designated as Periods 1, 2 & 3 of which, Period 3 was the most successful.

Appendix "C" contains the Mission Data sheets, all distances are in Statute Miles, measured on the ship channel, which was not necessarily the true distance covered by the vehicle. Fuel consumption figures were unavailable due to 2 facts:

1. The vehicle was not always refueled after each Mission,
2. The fuel truck was not equipped with a meter.

However fuel may be approximated at 180 gallons per power hour and 140 gallons per idle hour.

Whilst the vehicle spent considerable time away from its designated area, this time was not entirely wasted, as the Coast Guard crew were employed painting buoys, drilling rock anchors and making range targets, which were later used in the programme and by vessels of the Agency.

The original programme was planned to commence on June 1st or earlier, should river break occur before that date. It was hoped that prior to commencing the work programme that 2 or 3 days could be spent practicing with the new type Sonar equipment and establishing some basic operating methods for laying and recovering buoys. This was not possible, due to vehicle being unable to reach its designated area until June 8th, by which time the Navigation season had been open for some ten days and there was an urgent requirement for the vehicle to proceed directly into a work programme.

PERIOD 1

The vehicle arrived at Norman Wells in the early morning hours of June 8th and the remainder of that and the following day were spent in reconfiguring the craft for its work programme and repairing some skirt damage received during the trip from Hay River.

A number of critical channel buoys had been reported out of position in the Sans Sault Rapids and when the vehicle was certified serviceable, mid-day on June 10th it proceeded directly to this area.

As may be seen from the Mission Data sheet for that day, difficulties were encountered, the reasons for which are as follows:

1. Inadequate buoy working equipment,
2. Lack of deck crew training,
3. Lack of operational experience and methods by pilots,
4. Unsuitable and malfunctioning Sonar equipment.

1. Buoy Working Equipment: The programme was extremely unprepared in respect to this, due to a lack of knowledge of conditions to be expected. The Phase I report had recommended that buoy lifting crane be made into a more flexible system, by installing a winch and wire fall on it, this was not possible due to time and cost factors. Previous buoy working trials had been carried out in no current situations, in which a boat hook had been adequate for hooking buoys. It was quickly realized that working in fast choppy water, where it was necessary to remain on cushion, attempting to recover partially or wholly submerged buoys, that such equipment was inadequate and that special strops and hooking systems would have to be made, to become effective.

2. Deck Crew: Only one member of the deck crew was experienced in buoy work on the Mackenzie and this was the first opportunity that the deck crew had to work as a team. In a self learning atmosphere, it was natural to expect teething problems, however they were quick to define and adapt to problems.

3. Operational Methods: Both pilots (the author being one) had had a minimum of experience in laying and recovering buoys, with the vehicle in comparatively ideal conditions of smooth and current free water and it was expected that difficulties would be encountered in such an area, as the Sans Sault Rapids. These difficulties and their resolvment are the subject of Chapter 2.

4. This was the first time that the Sonar had been utilized under operational conditions and it was found that water turbulence on the transducer seriously affected and cluttered the signal on the Cathode Ray Tube. With an approximate 6 mph current, the Sonar became unreadable if the vehicle proceeded at

more than 5 mph into the current. In addition it was found that the centre spot of the time base tended to drift, thus giving inaccurate readings and excluding the use of the scanning system. It was also difficult to gauge the depths of the transducer below the water surface, it fluctuating with different power settings and cushion heights. Recommendations to resolve this, are contained in Appendix "D".

Although, in the latter stages of the Mission the vehicle did successfully recover and replace buoys, because of the difficulties encountered and a low fuel situation, it was decided to terminate the mission and return to base, to make up suitable equipment and define operational methods. Team members felt that a good deal of experience had been gained and whilst the difficulties encountered were serious, it was felt that they were resolveable.

Apart from the malfunction of the Sonar equipment, the HF Radio and Doppler Speed Indicator had been malfunctioning. Without an operative HF Radio the vehicle could not be considered operationally serviceable, not being able to maintain Agency schedules, communicate with other water traffic or monitor safety frequencies. It was therefore requested that a technician be sent from Hay River to repair this equipment. The Marine Services District Manager advised that the Telecommunications Branch requested that the vehicle return to Hay River for these repairs, due to lack of facilities in Norman Wells.

June 11th was devoted to clearing the vehicle of non essential equipment and a trip was made to a buoy cache some 10 miles upstream. Twenty-four buoys were loaded and returned to the base for painting by the crew during the vehicle's absence.

On June 12th the vehicle departed for Hay River. The District Manager had advised the C.C.G.S.'s "TEMBAH" and "ECKALOO" of the vehicle's difficulties and ordered them to resume their full areas of responsibilities. It was hoped when the vehicle became serviceable again, that it could resume responsibility for its designated area.

PERIOD 2

By mid-day June 17th the vehicle was serviceable at Hay River, the HF Radio and Sonar having been tested and found satisfactory. The Doppler was still unserviceable as no maintenance manual was available.

The vehicle departed for Norman Wells arriving early on the morning of the 18th. The HF Radio again malfunctioned during the trip. The technician at Norman Wells ascertained that the Receiver Exciter unit was overheating and a new one was ordered.

The remainder of the 18th was used to reload the vehicle.

The majority of the buoys picked up from the cache, prior to the trip to Hay River, had been used by Agency vessels and it was necessary to make a trip on the 19th to the cache at Mile 516 to obtain more. These were brought back to the base for painting.

On June 20th, the vehicle proceeded up river to lay buoys between Norman Wells and Fort Norman. This Mission was considered to be reasonably successful, the vehicle placing 14 buoys in 6 hours over a distance of 39 miles. Again it was found that the centre spot of the Sonar wandered but allowances were made for this and as the current was not as strong in this area, as in the rapids, sounding speeds of up to 10 mph were achieved, before the signal was affected by water turbulence.

After placing the 14th buoy it was necessary to proceed to the buoy cache at Mile 516 for more rock anchors. The Mission was terminated after this, due to a low fuel condition and the vehicle returned to base.

On June 21st a large amount of driftwood was observed in the river and it was decided that until the river cleared, there was little point in placing buoys. This coincided with the requirement to carry out the 500 hr. inspection on the vehicle.

The vehicle was serviceable by mid-day on the 22nd, however the river was still choked with driftwood. It was therefore decided to replace the ranges at Patricia Island, 30 miles downstream.

This was a routine mission, the vehicle's duty, to transport men and materials to the site. These were landed only a few feet from the existing ranges but due to the steepness of the bank, the vehicle remained on cushion whilst discharging and then moved a couple of hundred yards to where it could land and shut down, to await completion of the job.

On the return trip to Norman Wells, the existing buoys were position checked and a couple of drifting buoys recovered.

On June 23rd the river was judged to be sufficiently clear of driftwood to resume buoy work and the vehicle proceeded to the Sans Sault Rapids to check and reposition buoys. On the way, a set of ranges were dropped off at Mile 595.5 with the intention, that if time and fuel permitted, that these would be erected on the return trip.

In the rapids, the vehicle was demonstrating reasonable capability in recovering and placing buoys, when the No. 4 engine failed. At the time of failure, a buoy was actually being lifted and this job was completed before proceeding to a beach to ascertain the malfunction.

It was found that No. 4 engine Fuel Control Unit was defective and it was decided, for safety reasons, to terminate the mission and return to base.

The vehicle's supply of rock anchors were off loaded on the beach and the vehicle returned to base on 3 engines without further incident.

Between June 24th and 27th, No. 4 engine was worked on and it was also discovered that all 4 engines were suffering from increasing erosion on the first stage compressors. The erosion on No.'s 1 and 2 engines was considered by the manufacturer to be close to allowable limits. It was therefore decided to return to Hay River to change No.'s 1 and 2 engines and also install a new engine air filtration system. This installation had been planned for, on completion of the C.G. trials, but due to the excessive erosion rate experienced in this area, it was decided that this modification was now of an urgent nature.

On June 28th the vehicle departed for Hay River. At this point it was concluded that any hope of an Operational Evaluation as originally planned should be excluded. It was felt that if, following the modifications, 2 weeks could be still utilized, that the vehicle would be able to demonstrate its basic capability. On this basis, it was decided to retain the C.G. team at Norman Wells and on completion of the modifications return the vehicle there, to carry out whatever work was available, but not to resume operational responsibility for the area.

PERIOD 3

On July 15th the vehicle was serviceable and it departed for Norman Wells. An overnight stop was made at Fort Simpson, this was due to having to make numerous stops, to clear the engine oil filters, which were clogging. The vehicle arrived at Norman Wells on the evening of the 16th. The 17th and 18th were used to prepare the vehicle for C.G. work and maintenance.

On July 19th, the vehicle was serviceable and proceeded upstream to check buoy positions and replace ranges. Prior to departure Defence Research Board, Human Performance Decrement Tests were carried out, a report of these is contained in Chapter 3.

The mission was considered successful, particularly in the recovery of partially or wholly submerged buoys, no problems were encountered in recovering or placing buoys, although in the placing of the buoys the vehicle was still hampered by having to sound at a very slow speed. On departing the area, the river's navigation system between Miles 564 and 516 was up to normal standard.

On July 20th the vehicle was again grounded, as excessive propellor vibration had been noted and metal fatigue on the 2 engine module boxes was spreading. These problems required a thorough inspection with appropriate repairs and it was not until July 24th that the vehicle was again serviceable. Due to further loss of time it was agreed to extend the C.G. programme to July 30th.

It was during this period July 24th to 29th inclusive, with the vehicle virtually trouble free, that the vehicle demonstrated its basic capabilities and indicated a real A.C.V. potential in Navigational Aids tendering on the Mackenzie system.

The vehicle ranged from Mile 414 the furthest upstream buoys in its designated area, to Fort Good Hope at Mile 680. Its primary duty was the checking and repositioning of buoys, although some range building work was accomplished. Few problems were encountered and the deck crew's, by this time reduced to 3, efficiency and experience increased daily. The range and duration of missions was restricted by fuel requirements. Fuel intended for caches at Fort Good Hope and Arctic Red River was not delivered. Fuel was a critical factor and was usually the cause for terminating a mission, with the vehicle returning to base, with very little in reserve. Provision had been made in the original programme, for the vehicle to remain out overnight, with the crew camping where possible, but due to the series of interruptions in the programme and the short time left, it was decided to return to base each night.

A feasibility trip, was made into the Great Bear Lake on July 29th. The vehicle carried 8 drums of Turbo fuel for caching at Fort Franklin, for the Agency helicopter and also inspected the light on Whisky Jack Point. No problems were encountered, although in the Great Bear River, considerable care was required in negotiating some of the bends.

July 30th was devoted to loading the vehicle for its return trip to Hay River and the C.G. programme terminated on that date.

The vehicle departed Norman Wells on July 31st and arrived Hay River on August 1st.

RESULTS

The objectives of the programme as set forth in the Directive contained in Appendix "A" were:

- I To establish operational costs,
- II To establish crew content,
- III To establish operational methods,
- IV To assess the vehicle's effectiveness compared to existing equipment.

It cannot be said that in the time available for evaluation that any of these objectives were fully or even partially attained. Data content is insufficient for anything other than a broad assessment of the vehicle.

I. Operational Costs: Assumptions can be made as to crew wages and expenses, if crew content could be firmly established together with their classifications. There is insufficient data on the amount of overtime the vehicle would be required to work. Fuel and maintenance costs based upon hourly useage of the vehicle cannot be estimated because it is not possible to establish the amount of hours the vehicle would be required to operate in a Navigational season.

II. Crew Content: To some extent this may be established, from the actual amount of persons required to carry out a job but only in the last week of the programme were the vehicle's working hours comparable to thos of an Agency vessel. Whether the vehicle and its crew could continue to work such hours for weeks on end, would be a matter of conjecture at this time. The Defence Research Board, set up tests to determine Human Performance Decrements, but due to the time available, the results are inconclusive. To commence with, the basic operational crew, was 2 pilots, who alternated in the driving and navigating positions and 4 seamen for the deck crew. This crew seemed adequate, although all were in a learning process. In the final week, the deck crew was reduced to 3, which was adequate for buoy work, but understrength for building ranges and other shore work.

III. Operational Methods: This subject is contained in Chapter 2 and it may be said that this objective came closest to being attained. Basic vehicle operating and deck work methods were established, which with practice, experience and suitable modifications to equipment, may be refined into an efficient operation.

IV. Effectiveness Comparison: Work performed and data collected, is inconclusive in this area. It is felt that the vehicle demonstrated, that with a properly trained and experienced crew, suitable equipment such as an improved, faster buoy lifting system and suitable Sonar equipment, that it could carry out all the duties presently done by existing equipment, with the added advantage of its speed and amphibious capabilities.

The results of the programme may be summed up as follows:

1. The vehicle in its existing configuration, demonstrated that it could place and recover Swift Current and Mississippi type buoys, whether submerged or not, in currents of up to 7 mph.
2. When fully fueled including the extra 500 gallon tank (5,000 lbs.) crew accommodation, equipment boxes and buoy lifting package, deck space and payload, allowed for 7 tons of buoys, anchors or material for building ranges.
3. The vehicle would be able to make a landing to discharge men and materials, at any point required, in its area of operation.
4. If required, the vehicle would be able to work, into the Great Bear Lake.
5. In its present configuration, the vehicle would not be able to replace any of the existing equipment, but could, should the requirement exist, be used as a fast response, trouble shooting type unit.

CHAPTER 2

OPERATIONAL PROCEDURES

This chapter is divided into 3 sections:

1. Deck Work Procedures,
2. Vehicle Operating Procedures,
3. Recommendations for Improvement.

The following procedures described, are those used during the final week of the programme, being the results of experience and practice, with existing equipment but it is not suggested that these are optimum procedures.

1. Deck Work Procedures

Buoy Recovery: On the buoy being located and the vehicle being manoeuvred into recovery position the procedure was as follows:

1. Buoy hooked and attached to crane,
2. Buoy lifted and swung inboard, anchor cable over sheave,
3. Anchor cable grabbed with patent cable clamp, attached to winch messenger cable,
4. Anchor cable retrieved in 15-20 feet lengths, stoppering off with patent cable clamp attached to crane carriage, until rock anchor at surface. During this, the buoy was lowered to the deck,
5. Rock anchor at surface and hooked to crane,
6. Rock anchor lifted and swung on deck.

Various procedures were used to hook buoys, depending on the strength of the current and position of the buoy.

If there was a weak current and the vehicle could be easily manoeuvred into recovery position in the displacement mode, a short wire strop, from the crane hook, with a snap hook on the end was used.

If there was a strong current, causing difficulties in manoeuvring the vehicle and requiring it to remain at partial hover, a special hooking arrangement had been fabricated. This consisted of a long wire strop from the crane with a snap hook on one end. A female screw socket was welded to the hook, to which a threaded iron rod, about 4 feet long, was screwed into. This enabled the crew member to guide the snap hook to the buoy's lifting lug. Once hooked, the iron rod was unscrewed and the weight taken by the crane on the strop.

In many cases, the buoy was either partially or wholly submerged, the lifting lug being hidden. Recovery in these cases, was effected by dropping a wire noose over the buoy or by grappling the anchor cable.

Buoy Placing: On the vehicle arriving at the approximate position the procedure was as follows:

1. Lower Sonar transducer into water and commence sounding runs,
2. Wooden anchor platform placed on starboard bow,
3. Rock anchor lifted by crane and placed on platform,
4. Buoy placed on port bow,
5. Anchor cable run from buoy across bow, under bow sheave and made fast to anchor. Surplus cable coiled on deck,
6. Crane hooked to strop on anchor platform,
7. Buoy position located and finalized,
8. "Drop" command given - crane lifts rear end of platform, causing anchor to slide off and buoy is pushed manually overboard,
9. Sounding checked,
10. Sonar transducer raised.

The reason for the anchor being positioned on the starboard side, was that the Sonar transducer was positioned on that side, thereby achieving a sounding as close to the anchor position as possible.

2. Vehicle Operating Methods

Whilst deck work methods are similar to that of an Agency vessel, vehicle/ship handling methods differ considerably. This is due to the position on the vehicle/ship that the buoys are worked at.

In the ship's case the buoys are recovered from an overside position. The ship's working deck has a low free-board, which allows for easy hooking of the buoy and a clear vision from the bridge.

The vehicle recovers buoys from over the bow. This is necessary, as it was determined during trials in 1970, that recovery and lifting buoys from over the side, caused lateral control problems when on cushion, the vehicle tending to slide towards and swing around the weight being lifted. Recovery from over the bow allows for a great deal of lateral control, the buoy and its anchor acting as a pivotal point, but has its disadvantages as when on cushion the deck is about 6 feet from the water, making it difficult to hook the buoy and causing the pilot to lose sight of it, before the vehicle is close enough to hook it.

Buoy Recovery: The vehicle approached down current of the buoy, when some 50 feet from the buoy, both puff ports were opened, simultaneously power was reduced and propellor pitch increased to maximum, this manoeuvre 'dumped' the bow, so that the deck was about 2 feet from the water, power was then increased to proceed against the current, increase in power tended to raise the stern, thus lessening water drag and the vehicle was able to proceed into a 6-8 mph current. Lateral control was effected by the rudders. As soon as the buoy was hooked, propellor pitch was reduced and the bow allowed to rise. This condition was maintained while raising the mooring. As soon as the rock anchor was clear of the water, the vehicle was able to proceed at a moderate speed (up to 20 mph) towards the next position, whilst the anchor was being lifted on deck.

Using the foregoing methods, problems were still encountered when recovering submerged buoys, as even with the bow down as low as possible, it was extremely difficult for the pilot to see the position of the buoy and the vehicle would sometimes over run the buoy.

Buoy Placing: The majority of buoy positions were marked by transits on the shore. Therefore these were first located, then the Sonar transducer was lowered and sounding runs on the transits commenced, to locate the correct depth. These runs were done at three quarter cushion height, with puff ports open, to reduce spray to a minimum. It usually required 2 to 3 sounding runs, at least one towards and one away from the transits to locate the required depth. These were done cross current, the vehicle angling into it and keeping the transits slightly open on the high side, to make allowance for the length of mooring cable. A final run on the transits were made and on reaching the required depth, the anchor and buoy dropped. As the vehicle was still cross current invariably the buoy was swept under the vehicle, but this caused no problem as normal procedure was to bring the vehicle to full power and cushion, at the instance of dropping. Following placing the buoy, it was usual to make a run close by the buoy, to check the sounding, after which the Sonar transducer was lifted and the vehicle proceeded to the next position.

Other vehicle operating methods, where landings on the river bank to build ranges or pick up buoys and anchors from caches, were routine, with the exception that, due to leaking power module boxes, it was inadvisable to shut the engines down. To do so, allowed the stern to sink sufficiently that water entered the lift fans, which on restart, could cause damage to the lift fan bearings. Therefore, if it was expected to be on site for any length of time and the vehicle was unable to make a dry landing, the shore party was disembarked and the vehicle, where possible, proceeded to a site where it was able to leave the water and shut down, remaining in radio contact with the shore party.

An important part of both Deck Work and Vehicle Operating methods was communication between the deck crew and pilot. Three specially modified flying helmets had been supplied for the programme. These helmets had been modified to be used with small portable VHF-FM radios and were fitted with special microphones, that transmitted voice through the crown of users head. It was hoped that these helmets and microphones would reduce noise levels on both receiving and transmitting. The system worked reasonably well, although considerable noise interference was still encountered and users found the equipment to be bulky. The pilot transmitted and received on the vehicle's main VHF-FM set.

3. Recommendations for Improvement

Deck Work Procedures: For the vehicle to work effectively on the Mackenzie River, where due to strong currents, speed in procedures is essential, the most obvious area for improvement is the buoy working package.

The Phase I report recommended that the crane be changed to one incorporating a winch and hoist and the Phase II programme demonstrated that for working in strong currents or choppy water, when the vehicle is on partial or full cushion, that the present equipment is too slow and inflexible for efficient use and at times these deficiencies constituted a real danger to the safety of both the crew and vehicle operation.

The present system was designed to lift loads of up to 7,000 lbs. the carriage positioned on rails, was intended to traverse, from the over bow position rearwards to approximately mid-vehicle. However, as the carriage could not traverse with a load on the crane, the traversing gear was not installed.

The Phase II programme demonstrated that if Mackenzie River operation only was envisioned for this vehicle, a system, considerably lighter and of less capacity would be sufficient. During the programme, the system was only required to lift loads of up to 1,000 lbs. and it is felt that a crane with a 4,000 lbs. capacity would be adequate for work on the river. If this crane had a longer boom (35 ft.) it could remain in a fixed position to work both overside and the deck, thus negating the requirement for a traversing system. Such a system would require a lesser power source and in general there would be considerable weight saving, increasing the vehicle's available payload and lessening Centre of Gravity problems.

It was noted during the programme that problems were sometimes encountered in the stowage of buoys and anchors on deck. To allow sufficient room for the crew to move around, buoys and anchors had to be piled on top of each other and it was almost impossible to safely secure them, for when the vehicle was on passage. Properly designed stowage cribs would ensure safe and even stowage of these items.

The wooden anchor platform was a rather hazardous arrangement, as placing the anchors on it was often time consuming, due to having to position the weight on the fulcrum. Several times the anchors inadvertently slipped off, fortunately they were still attached to the crane. It is recommended that

a safer and more permanent system be designed for dropping anchors. This could take the form of a metal platform protruding forward of the bow and hinged to the bow, with an appropriate quick release system. The same could be applied to buoy dropping, manually pushing the buoy over, at times being quite hazardous.

A further area requiring improvement is communication between personnel on deck and deck to control cab. As stated earlier in this Chapter, 3 flying helmets fitted with portable VHF-FM sets were supplied for deck communication. These were rather cumbersome units, hampering an individual in his movements and the quality of both transmissions and receptions was poor, often leading to confusion. It is recognized that due to high noise levels on deck that suitable equipment is difficult to find, but it is felt that further study and investigation is required in this area.

Vehicle Operating Procedures: The maxim of "practice makes perfect" does apply here, but no amount of practice will alter certain design aspects, which preclude optimum efficiency in operational methods.

Had more time been available, pilot proficiency would have increased and the time taken to effect buoy recovery or placing reduced, but this efficiency would have peaked at a point below which optimum efficiency might be reached by appropriate re-design, which in some aspects may require major modification.

Pilot visibility is one such aspect, and whether it can be even partially resolved is doubtful. The problem lies in that the pick up point is at the furthest point from the pilot and whether the vehicle is in displacement, partial or full hover modes, he always has a blind spot, forward of the bow, which is further increased by equipment on deck. The Mackenzie system buoys have the smallest above water profile of any buoy in use in Canadian waters, with the result that at some point prior to hooking the buoy, the pilot loses sight of it and although he can, to some extent, be guided by signals from deck, he invariably becomes disorientated.

The reasons for having the pick up point in its present position are given in Section 2 of this Chapter, the problem might be partially resolved by extending the over bow sheave and catwalk, to a point where the pilot can retain sight contact, but this extension would be

considerable. Another suggestion is to shift the control cab forward. This would be a major modification, however, if a permanent crew module is required it would be possible to situate the control cab atop the module which would raise the pilot's height of eye as well as positioning him closer to the pick up point.

A further area for improvement is in cockpit and control design. It is felt that, with appropriate modifications, the pilot and navigator can adequately handle all the duties necessary in buoy recovery and placing.

Some of these modifications were recommended in the Phase I report eg: Removal of the rear bench seat and considering the rear area as a navigation area, with the navigator having a push back, swivel type seat. Repositioning of the yaw duct switch, to foot control. Of further assistance to the navigator, could be the installation of a clear perspex dome in the cab top, affording him all round visibility. The pilot would be able to control the vehicle better in a strong current, if he could utilize full power without causing the bow to rise. An air dumping system should be devised, this might be managed by enlarging the yaw ducts.

CHAPTER 3

HUMAN FACTORS ASSESSMENT OF THE VOYAGEUR A.C.V.

Following the Phase I trials, there were many comments and discussions on the habitability of the vehicle. It was generally assessed as being poor and doubt was expressed as to whether the vehicle was suitable for the intensified operations required of a Mackenzie River unit.

For the vehicle to compare favourably with a conventional vessel, the Operating and Maintenance costs should be the same or less and a large part of Operating costs are crew wages. Therefore if the vehicle's habitability is such that it requires frequent changes of crew, crew costs will be considerably higher.

With respect to A.C.V.'s, little study appeared to have been done on the decrement of crew performance, caused by noise, vibration and human engineering. As each new type of vehicle appeared, these problems have been solved more on an individual basis rather than to A.C.V.'s collectively. Whilst the technology is past its infancy, many Administrations are still in the process of evolving legislation and regulations for these vehicles and can only offer guidelines to manufacturers. Factors such as Human Engineering, with respect to control systems and positions have therefore often evolved from personal preferences of test personnel rather than a scientific approach.

With the foregoing in mind and the fact that it was expected to carry out quite intense operations on the Mackenzie for 2 months, the Defence and Civil Institute of Environmental Medicine was contracted to carry out a Human Factors Assessment of the Voyageur A.C.V., with emphasis on the possible decrement of crew performance in a Mackenzie River type operation.

A short working paper (Appendix E) on the Mackenzie River Operation of the Voyageur, had been prepared, which suggested a method of comparison between the A.C.V. and vessel be based on mileage covered in a season against the Operating and Maintenance Costs. Mileage being a direct function of the operating crew of an A.C.V., it was important to establish the highest amount of daily hours a crew could safely function before suffering performance decrement and fatigue dangerous to health.

Unfortunately this study also suffered due to the interruptions of the programme, therefore the assessment is limited to Noise and Vibration data collected and observations made by DCIEM team on work conditions and methods. The final DCIEM report is not ready for inclusion in this report, but a preliminary draft has been received from which some of the data and conclusions are set forth as follows:

"That none of the data can be used directly to predict the presence or absence of a performance decrement in the crew."

"The data does not permit a valid assessment of operator fatigue factors of a valid estimate of crew requirements."

The report contains results and discussion on test data collected on the two physical factors, noise and vibration, which could limit the duration of crew performance on the vehicle.

Noise:

The following recommendations resulted from data collected:

1. Hearing protection equipment should be worn at all locations on the vehicle during hover and cruise conditions.

When the vehicle is idling, a six hour limit is recommended for personnel on deck who are not wearing ear defenders.

2. Personnel in the Trailer or Cabin who are wearing the best type of ear defenders should not be routinely exposed to the Sound Pressure Limits produced during cruising for more than six hours per day.

N.B. - This does not take into account noise from radios and intercom systems which operating personnel are subjected to, through headsets.

3. Personnel may work on deck for an unlimited period of time while the vehicle is hovering, if they are wearing the best type of ear defenders.

The report recommends "that whether the vehicle is modified (to reduce noise) or remains the same, the safest course of hearing protection would be for the crew to have regular hearing checks to protect highly sensitive individuals and detect unsafe noise levels".

Vibration

Vibration levels were measured over a two day period during transit of the vehicle from Hay River to Norman Wells. Data was collected from a variety of vehicle locations under several different conditions.

The data collected was summarized into 3 separate vehicle locations with two definitions.

1. Fatigue and/or Decreased Proficiency Boundary (DPB) described as "A daily rate of exposure below which human working efficiency is preserved. The DPB boundaries specify limits beyond which there is a significant risk of impaired work efficiency, particularly in the performance of tasks in which time-dependent (fatigue) effects are known to degrade performance, such as in piloting an aircraft."

2. Exposure Limits (EL) "A daily rate of exposure below which human health and safety are preserved." These limits are considered safe for routine exposure over long periods of time.

Data was collected in 2 sea state conditions described as being choppy (2 ft. seas) and calm. Due to limited time and equipment, each location could not be correlated to each condition.

From collected data the report concluded that "over choppy water the length of ride for the navigator and pilot should not in theory exceed the DPB of 4 to 5 hours and should definitely not exceed the EL of 10 1/2 hours on a routine basis. In addition unless the seating of the rear cabin occupants is improved, the routine exposure for these crew members should be no greater than 6 hours per day."

Vibratory data collected from the trailer location found no evidence requiring exposure limitations.

The report recommended that the vibration attenuation properties of all cabin seating be improved if routine daily exposures of 6 hours or more are anticipated.

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The working paper in Appendix E offered the highest daily average of 5.5 operating hours. This amount borders on the DPB for pilot and navigator and it would appear that the middle figure of 4.1 hours would be the optimum for all concerned.

The report discussed living conditions and duty cycles, comparing with both government and commercial operations in the area. It generally concluded that if the vehicle was to be self supporting and capable of being away for periods of time of 10 days, that it would have to be considerably larger, to satisfy crew and storage space requirements. It therefore recommended a base camp type operation be considered, with sufficient accommodation on the vehicle to support the crew for short periods of time (up to 3 days). It recommended that if work hours of 12 per day, seven days a week, were envisioned, that personnel be rotated on a 30 days-on, 10 days-off cycle. This to maintain optimum efficiency and moral.

The report contains an "Assessment of the Design and Operational Procedures", and makes recommendations to improve or solve deficiencies. In general these assessments and recommendations follow closely those contained in the Phase I report and in this present report.

From the DCIEM report and previous chapters contained in this report, it is obvious that if the vehicle is to compare favourably with existing units, either as a replacement or addition to the system, there should, in the areas of habitability and human engineering, be considerable redesign and modification to the present vehicle, for it to be effectively and economically utilized in the Mackenzie River system.

DCIEM HUMAN FACTORS ASSESSMENT

HUMAN FACTORS PROBLEMS AND RECOMMENDED SOLUTIONS

<u>POSITION OR EQUIPMENT</u>	<u>PROBLEM</u>	<u>RECOMMENDED SOLUTION</u>
Vehicle controls	<p>Pilot cannot operate puff-port, throttles and pitch (not shown) controls simultaneously.</p> <p>Puff-port and intercome controls are similar in size and shape and are located adjacent to each other. Frequent misuse was observed.</p>	<p>Redesign puff-port control and relocate it on the foot operated rudder controls (4).</p> <p>Redesign intercome control and relocate it on the starboard N2 throttle controls.</p>
Centre console	<p>Various labels are aligned at 0, 90 and 180 degrees to each other making it difficult for pilot to read them.</p> <p>Controls for the various communications systems are outside of the pilot's functional reach envelope.</p> <p>Navigator uses centre console as a chart table.</p>	<p>Clear off end of centre console for use by navigator by relocating the <u>displays and controls</u> for all communications systems to a deckhead panel immediately above the centre console and within arms reach of the pilot and navigator.</p>
Secondary display panel	<p>Panel is recessed and partially obscured by the main display panel.</p> <p>Labelling unclear.</p>	<p>Relabel and if possible rearrange instruments to form a smaller panel that can be moved more in line with MAIN panel without obstructing the pilot's entry and exit.</p>

POSITION OR EQUIPMENT	PROBLEM	RECOMMENDED SOLUTION
Bridge	Position aft on deck restricts pilot's view of water immediately forward of the bow.	Either move bridge forward or redesign buoy retrieval equipment to permit recovery forward of the bow and within the pilot's visual field.
Navigator's position	Lack of writing/chart surface.	<ol style="list-style-type: none">i. See item 2 above.ii. Design roll charts or equivalent to reduce the amount of space required.iii. Design retractable chart table or equivalent for area between navigator and radar.
Sonar	<p>Previous depth information is lost because of immediate decay on CRT face. Since sonar is used to position aids-to-navigation, it is desirable to store comparison data.</p> <p>Faces aft from central position and requires pilot and/or navigator to lean inward to read it accurately.</p>	<p>Replace sonar with a unit that saves previous information either in terms of a hard copy or memory display.</p> <p>Choose a display that can be seen from either position or mount it on a swivel.</p>
Navigator's position	<p>Difficulty to enter and exit.</p> <p>Seat is too low (13 inch floor clearance compared with 15-16 inch recommended clearance, Morgan et al, 1963).</p>	<p>Mount radar on a moveable frame that would permit unit to be stowed to assist entry & exit or be adjusted to eye height of navigator.</p> <p>Redesign seat, seat support assembly and radar mount.</p>

1
25
1

POSITION OR EQUIPMENT	PROBLEM	RECOMMENDED SOLUTION
Passenger position	No stowage area provided.	Provide stowage space for clipboards, life preservers, etc., either behind pilot/navigator's seats, overhead, or beneath seat bench.
Aids-to-navigation - stowage - recovery	Observed that - loose cable and equipment cover the deck even at the winch operator's position. - buoys and anchor stowage areas are in the path of winch cable. - buoys are dragged over targets and rocks as cable is recovered.	- deligate certain areas to work areas, stowage, buoy recover and winch travel, etc.
Winch cable	- unprotected over its entire length and a potential hazard in the event that it snaps.	- fit winch with overload protection, e.g. clutch, designed to halt operation at tensions below the sheer strength of the cable.
Sonar Transducer Mounting	Requires entire deck crew to lower the transducer into the water. Mount deforms under the water pressure produced by the speed of the craft. Sonar transducer is positioned approximately 20 feet from the point where the buoy is released.	Design a transducer housing which: i. requires minimum effort to activate. ii. is positioned closer to the actual drop zone.

POSITION OR EQUIPMENT	PROBLEM	RECOMMENDED SOLUTION
Emergency Exits and Equipment	<p>Normal cockpit exits are exposed to fire or explosion from the engine.</p> <p>Emergency life raft is located near the port engines and might be inaccessible in the event of engine fire or explosion.</p> <p>Cockpit passengers are seated in an unprotected position between the main propellers.</p>	<p>Occupants of the cockpit must be protected from any potential failure of the drive train which might create a fire or flying debris.</p> <p>An alternate means of emergency escape should be considered such as escape hatches in the deck head or pop out windshields accompanied with slides to the deck.</p>
Intercommunications	<p>Speech intelligibility in high ambient noise environment.</p> <p>Serviceability: High incidence of equipment malfunction.</p> <p>Marginal effectiveness of communications between deck crew.</p>	<p>Provide all deck crew with intercom equipped helmets.</p> <p>Provide adequate spares maintenance and stowage facilities for headsets.</p>
Deck crew accommodations and stowage	<p>Trailer accommodations are cramped.</p> <p>Equipment and food stowage facilities are poorly designed.</p> <p>No sanitation facilities or provision for heating trailer or drying wet gear are provided.</p> <p>Noise levels are annoying.</p>	<p>Design deck accommodation module (4) with planned stowage areas, head, heat, room to change and reduced noise levels.</p> <p>Specific requirements will depend on the future mission of the craft.</p>

POSITION OR EQUIPMENT	PROBLEM	RECOMMENDED SOLUTION
Deck spray	Spray, which is continually produced by the craft soaks equipment and men alike and creates slippery surfaces on deck and equipment.	Minimize spray production. Design surfaces for use when wet.

CHAPTER 4

MAINTENANCE AND UNSERVICEABILITIES

The vehicle was unserviceable or unavailable for C.G. duties, due to mechanical malfunctions, structure failures, maintenance requirements and modifications for a total of 38 days. A further 8 days were lost, rectifying electronic equipment unserviceabilities.

Mechanical and Structure

June 1st to 5th: During transit from Tuktoyaktuk it was discovered that fuel from the ballast system or the main fuel tanks was leaking into the vertical hollow core planking of the main buoyancy boxes.

To rectify this, the fuel cells were removed and replaced with new ones and the flooded hollow core, drained and purged. The ballast system was refilled with a mixture of water and soluble oil, excluding its use, as an emergency fuel source.

June 6th: The vehicle was unable to exceed "hump" speed at Maximum All Up Weight of 88,000 lbs. due to excessive droop on the power turbines, necessitating re-rigging of the N₂ controls.

June 8th and 9th: Considerable skirt damage, including separation of some of the inside skirt hinge lines, had occurred whilst manoeuvring over ice on the river bank. A modification to protect the hinge line, has since been designed by the manufacturer.

June 21st and 22nd: 500 hour inspection required by M.O.T. approved maintenance schedule.

June 24th to 27th: On the 23rd No. 4 engine failed due to a malfunctioning Fuel Control Unit. This was changed with a new spare, which also malfunctioned, power was attainable but with an extremely slow rate of acceleration. The problem was not fully rectified until Nos. 1 and 2 engines were changed at Hay River and an F.C.U. substituted from the old engine.

June 28th to July 16th: Measurement of the first stage compressor blades on all four engines, showed increasing erosion on Nos. 1 and 2, 0.25 of an inch and on Nos. 3 and 4, 0.1 of an inch. The allowable limits are 0.4 of an inch, but the manufacturer,

United Aircraft of Canada, advised that the 1 and 2 engines be changed. It was also felt that due to the area environment, of dry dust and silt laden waters, that a modification to the engine air filtration system to reduce erosion be made. This modification was planned for, following the C.G. programme, however as erosion appeared to be rapid it was felt that the modification was now urgent. It was therefore decided that the vehicle return to Hay River for both the engine change and filter installation.

The filters installed are of the Donaldson Vortex Separator type, modified to fit the existing knitmesh filters. Installation was prolonged, as the filters had been fabricated at Bell Aerospace, Grand Bend, using measurements for Voyager 001, which differed from 002. To this date, it appears that the new filtration system is working well. Other repairs done during this period were to the underside of the engine module boxes, where a number of fractures and holes were found in the buoyancy compartments, also some damage to the inner skirt hinge line and keel.

July 16th and 17th: On the return trip to Norman Wells considerable problems occurred with the engine oil filter on No. 4 engine, requiring frequent stops to back wash the filter. The problem appeared to be that when operating overland, sufficient dust entered the filter that when vehicle operated overwater, spray entering the filter turned the dust to mud, clogging the intake. This problem has since been rectified by moving the filters and attaching Donaldson Vortex Separator type filters. This system has worked satisfactory to date.

Also on this trip, the recently installed Nos. 1 and 2 engine, commenced stalling. This engine had recently undergone an overhaul by UACL, following erosion problems in the Phase I trials. It was determined that due to an oversight, the bleed valves from the compressors, which were badly worn prior to the overhaul, had not been changed.

The vehicle was also delayed at Fort Simpson due to a malfunctioning Ignitor Excitor Box on No. 3 engine.

July 20th and 23rd: Increased vibration from the propellers had been noted and it appeared that there was excessive movement on the shaft. It was also noted, that there was considerable cracking of the skin on the tops of the power module boxes, in the vicinity of the propellers. Considerable time was spent measuring the shaft movement and removing sections of module skin, to ascertain whether the structural integrity of the boxes were affected. Following this inspection it was determined that the shaft movement was within limits, and the integrity of the boxes retained.

Electronic

The following electronic equipment was unserviceable during various periods of the programme:

1. HFSSB Radio
2. Sonar
3. Gyro Compass Inverter
4. Doppler Speed Indicator

1. HF SSB Radio: This equipment was malfunctioning from the commencement of the programme and was not fully rectified until mid July. The cause, was an over heating Receiver Exciter unit. The set could be used for short periods of up to 1/2 hour before this unit overheated and therefore was confined to emergency useage only.

2. Sonar: The first transducer installed was found to be defective and returned to the manufacturer. A printed circuit panel, overheated and burnt out, the same nearly occurred with the replacement, before it was determined that the audio speaker system was overloading the circuits. The centre spot on the CRT display wandered, giving a false depth readout, although adjusted a number of times, this was never fully rectified.

3. Gyro Compass Inverter: This component failed due to the carbon brushes being completely worn away. It was ascertained that this component had been purchased as a used part. Component failed after 470 hours use. A second used inverter was purchased and installed.

4. Doppler Speed Indicator: This unit did not work during the entire programme. It was difficult to ascertain the cause, as the manufacturer was no longer in business and no maintenance manual was available. During the Phase I trials, the Sensitizer had been positioned on the rear of the cab facing aft, but speed indication had been erratic. Prior to the commencement of Phase II the Sensitizer had been repositioned on the port bow. It is felt that this was the main cause of the unit malfunctioning as no instructions were available on recalibration for the change in height from the water.

Another factor that affected the readiness of the vehicle for operations was the availability of fuel and time taken in refuelling.

At Norman Wells the only method available was from an Imperial Oil tank truck, which was not equipped with a filtration system. This necessitated passing the fuel from the truck through the vehicle's portable pump and filter, which considerably slowed the fuelling rate. This truck was not always available when required.

This Chapter might be considered as a rather discouraging record of the vehicle's serviceability, but it should be noted that prior to and following the C.G. programme, the serviceability record was very good. During the Environmental Trials that followed the C.G. programme, the vehicle operated for nearly 100 hours in 10 days with only minor maintenance being necessary.

In conclusion it should be remembered, that a prototype vehicle may be expected to encounter unforeseen problems, when operating in a new environment. It is hoped that the modifications that were carried out have solved those problems, which regrettably fell within and impaired the C.G. Programme.

CHAPTER 5

CONCLUSIONS

As stated in the Summary of this report, the vehicle in its present configuration is unsuitable for an Aids Tender role on the Mackenzie River. This is not to say that it is unsuitable for other Coast Guard areas of responsibility. There are many areas where the vehicle, with minor modifications, should be able to operate successfully, carrying out general Coast Guard duties.

Of all the areas of Coast Guard responsibility the Mackenzie system is unique, in its distances, isolation and lack of logistic support. Because of this, vessels presently utilized in the system and charged with a responsibility for an area, spend long periods away from home base and operate with a great deal of independence. To be effective in this role, they have to be self sufficient and are specially designed for this. Herein lies the difference, the Voyageur, in effect an off the shelf piece of equipment, was not designed to be self sufficient for anything but very short periods of time. The vehicle designed as a short haul freighter, requires base facilities for maintenance and personnel, has short range requiring frequent re-fueling and has limited space on board for personnel and specialized equipment necessary for an Aids Tender role.

In effect, this means that to satisfy all the requirements for operation in this area, a vehicle should be specifically designed to Coast Guard standards. The evaluations have shown that the Voyageur flat bed design is basically correct for Aids tendering, but a larger vehicle is required, incorporating greater payload, space and range capability.

Given that this vehicle had:

1. A properly designed accommodation, capable of supporting its crew for a week to 10 days;
2. Improved range;
3. A sonar system capable of sounding at 25 knots,

it could become an effective and valuable unit for this area.

The question of comparable economics is obviously raised and whilst capital outlay would be greater it is felt the Operating and Maintenance would compare favourably if the speed and amphibious capability of Air Cushion Vehicles are accepted as a plus factor for this area.

Since 1966, the Ministry of Transport and the Coast Guard, have carried out extensive testing of the Air Cushion Vehicle in various roles and the Coast Guard's SRN-5 in Vancouver has been operated very successfully in the SAR and Aids Checking role, for the past 4 years. The questions that the Phase I and II evaluations of the Voyageur A.C.V. have tried to resolve, is can this vehicle be effectively and economically used as an Navigational Aids Tender on the Mackenzie River? The answer is no, but it is felt that the answer would be affirmative if the question was rephrased, substituting Air Cushion Vehicle for Voyageur.

APPENDIX "A"

COAST GUARD HEADQUARTERS

TRIALS DIRECTIVE

D I R E C T I V E

PHASE II, COAST GUARD EVALUATION OF VOYAGEUR 002, 1973

ORGANIZATION

Coast Guard H.Q., Ottawa

All participating authorities are requested to co-ordinate activities with Voyageur Project Officer, Coast Guard H.Q., Ottawa.

AUTHORITIES IN LIAISON WITH H.Q.

Transportation Development Agency
Northern Transportation Company Ltd.
Regional Director Marine Services (Western)
District Manager, Hay River.

UNITS INVOLVED

Voyageur - 002
CCGS ECKALOO
CCGS TEMBAH

SITUATION

Trials were effected in 1972 to establish the Voyageur's capability in the general Coast Guard role. Based on the findings, approval was given to further evaluate the vehicle in the Operational role on the Mackenzie River.

Commandant, Coast Guard has therefore directed Coast Guard H.Q., to plan for and direct the Operational evaluation. The Senior Captain, Air Cushion Vehicle Division, Marine Safety has been designated as Project Officer.

MISSION

The Voyageur will be evaluated in and assessed for an Operational role in the Mackenzie River system. The Evaluation team will carry out a work programme as supplied by the District Manager, Hay River.

EXECUTION

The work programme will be executed as required by the District Manager, Hay River.

COMMAND AND COMMUNICATION

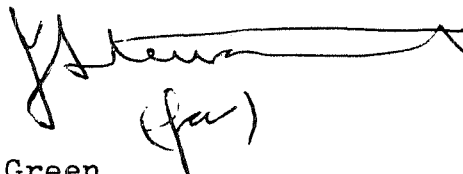
Director, Air Cushion Vehicle Operations, Northern Transportation Co. Ltd. has overall control of vehicle operations. Commandant Coast Guard, retains operational control of the Coast Guard Evaluation Team through District Manager, Hay River.

Daily reporting procedures will be as per Agency schedules.

PRIORITIES

The primary function of the vehicle will be to effect the Agency work programme as required by the District Manager. Requirements outside the work programme may be effected on an opportunity basis. Detachment of the vehicle from Coast Guard work will require clearance from the Commandant Coast Guard.

Issue under the authority of:



I. Green,
A/Commandant,
Canadian Coast Guard.

April 9, 1973.

APPENDIX "A"

COAST GUARD EVALUATION OF THE BELL AEROSPACE VOYAGEUR A.C.V.

PHASE II

Situation

The Phase I of this evaluation assessed the vehicle as being capable of performing general Coast Guard duties in sheltered coastal or inland water, where the largest floating navigational aid does not exceed the 4'6" dia. type buoy.

On this basis, approval was given and funds allocated for a further 2 months evaluation in 1973 when the vehicle is operating on the Mackenzie River.

The Aim

To assess the vehicle in the Coast Guard Operational role, for the Mackenzie River.

Objectives

- (i) To establish operational costs;
- (ii) To establish crew content;
- (iii) To establish operational methods;
- (iv) To assess the vehicle's effectiveness compared to existing equipment.

Plan

Eight (8) weeks are allocated to the Coast Guard evaluation from June 1st to July 27th. These dates are dependent upon river conditions and should "break up" be completed earlier, the programme will commence and end correspondingly earlier.

The vehicle's main base of operations will be Norman Wells. All trials personnel will be accommodated in Norman Wells and provisions are made for camp sites at overnight stops, should these prove necessary.

The vehicle will be assigned an area of responsibility bounded by Arctic Red River in the north and Wrigley in the south. This is equivalent to an area of responsibility presently assumed by an Agency tender.

The District Manager, Hay River, will supply details of all Aids, buoy caches etc. within the assigned area, from these, a daily work programme will be planned, to correspond to an aids activation programme, as presently performed by Agency

vessels. As a back up and until the vehicle has proven its capability, the Agency tenders, "Eckaloo" and "Tembah" will remain in the vicinity of the vehicle, when it is working in their respective areas of responsibility. On completion of the activation programme the vehicle will be assigned further duties as required by the District Manager and be on standby for Aids servicing as required, until the end of the evaluation programme.

Vehicle Maintenance

Maintenance will be progressive, with minor maintenance being effected on a pre and post mission basis. One day a week will be allocated for major maintenance with the vehicle maintaining a two (2) hour standby. If a maintenance item requires more than two (2) hours to rectify then the vehicle will be considered unserviceable and the Agency informed.

Reporting Procedures

When manned, the vehicle will maintain a continuous radio watch on the appropriate frequencies and will report on schedules to the Agency, as assigned by the District Manager. When at base and unmanned, a member of the trials team will be available at a known telephone number.

Data Collection

The assistant Project Officer will be mainly responsible for data collection and will co-ordinate with the Transportation Development Agency's Data Collection Officer as necessary. A Mission Data Sheet has been prepared and the data collector will record a detailed log of each mission and work performed:

- (i) Operational Costs: Certain costs such as crew salaries may be predicted. A detailed record of, engine power and idle times, fuel expenditure, fuel costs, maintenance and crew man hours and overtime percentage, will be kept.
- (ii) Crew Content: This will be established by two methods:
 - (a) Collection of data on man hours, required to operate and maintain the vehicle and man hours required to perform the work programme;
 - (b) Human fatigue evaluation, to be carried out by personnel of the Defence Research Board, particularly slanted to the operating crew, but evaluation will also be carried out on the work crew, in respect to noise and vibration factors;

(iii) Operational Methods: Data collection is not a main function but a record will be kept of time required to establish or service an aid against the time required to prepare for same. It is recognized that with the vehicle underway, work performed by the ships when underway such as the repairing, scraping and painting of buoys, will not be possible. Operational methods will be established by pre mission planning and post mission analysis with appropriate method changes so that vehicle and man hours reach optimum efficiency. Particular attention in mission planning, will be paid to co-ordinating fuel endurance versus payload.

(iv) Assessment of Vehicle's Effectiveness: Effectiveness will be assessed by analysing programme data with regard to the following.

- (a) Work performed;
- (b) Distances;
- (c) Times;
- (d) Man Hours;
- (e) Cost.

Similar data will be obtained from a typical vessel operation and a comparison made.

APPENDIX "B"

CHRONOLOGICAL RECORD OF PROJECTS

CHRONOLOGICAL RECORD OF PROJECT

DATE	OVERNIGHT LOCATION OF VEHICLE	ENGINE HOURS		SERVICEABILITY STATE	
		DAY HRS.	TOTAL HRS.	0800	REMARKS
June 1	Hay River	-	-	U/S)
2	Hay River	-	-	U/S)
3	Hay River	-	-	U/S) Repairing Ballast
4	Hay River	-	-	U/S) System
5	Hay River	-	-	U/S)
6	Hay River	4.0	-	U/S) Testing Vehicle
7	Hay River	14.6	18.6	S	Transit Hay River - Norman Wells
8	Norman Wells	2.0	20.6	S	Loading Vehicle & Maintenance
9	Norman Wells	-	-	U/S	Maintenance
10	Norman Wells	8.8	29.4	S	Buoy work - Sans Sous Rapids
11	Norman Wells	1.6	31.0	S	Trip to load buoys from Cache
12	Norman Wells	13.7	44.7	S	Transit Norman Wells - Hay River
13	Hay River	-	-	S	Radio & Sonar repairs
14	Hay River	0.5	45.2	S	Demonstration for MOT Management Group
15	Hay River	2.2	47.4	S	Radio & Sonar Tests
16	Hay River	-	-	S	Sonar Repairs
17	Transit	8.8	56.2	S	Transit Hay River to Norman Wells
18	Norman Wells	6.3	62.5	S	Transit Hay River - Norman Wells and Pilot Training
19	Norman Wells	3.2	65.7	S	Trip to Fort Norman buoy Cache and Pilot Training
20	Norman Wells	10.7	76.4	S	Buoy laying Norman Wells to Mile 521
21	Norman Wells	-	-	U/S	500 hr. Inspection
22	Norman Wells	3.1	79.5	S	Buoy & Range work - Norman Wells to Mile 598

CHRONOLOGICAL RECORD OF PROJECT

DATE	OVERNIGHT LOCATION OF VEHICLE	ENGINE HOURS		SERVICEABILITY STATE	
		DAY HRS.	TOTAL HRS.	0800	REMARKS
June 23	Norman Wells	6.3	85.8	S	Buoy work Norman Wells to Mile 598 #4 Engine U/S
24	Norman Wells	-	-	U/S	FCU Malfunction on #4 Engine
25	Norman Wells	-	-	U/S	As Above
26	Norman Wells	-	-	U/S	Vehicle grounded due to Erosion on #1 & 2 Engines
27	Norman Wells	-	-	U/S	As Above
28	Transit	16.5	102.3	S	Transit Norman Wells- Hay River
29	Hay River	-	-	U/S)
30	Hay River	-	-	U/S)
July 1	Hay River	-	-	U/S)
2	Hay River	-	-	U/S)
3	Hay River	-	-	U/S)
4	Hay River	-	-	U/S)
5	Hay River	-	-	U/S)
6	Hay River	-	-	U/S) Installation of Donaldson Filters
7	Hay River	-	-	U/S) and Change of
8	Hay River	-	-	U/S) #1 & 2 Engines
9	Hay River	-	-	U/S)
10	Hay River	-	-	U/S)
11	Hay River	-	-	U/S)
12	Hay River	-	-	U/S)
13	Hay River	-	-	U/S)
14	Hay River	1.2	103.5	U/S	Vehicle Testing
15	Fort Simpson	8.5	112.0	S	Transit Hay River - Fort Simpson #4 Engine Oil Filter U/S
16	Norman Wells	8.7	120.7	S	Transit Fort Simpson to Norman Wells
17	Norman Wells	-	-	U/S	Preparing Vehicle for Buoy work & Mainte- ance

CHRONOLOGICAL RECORD OF PROJECT

DATE	OVERNIGHT LOCATION OF VEHICLE	ENGINE HOURS		SERVICEABILITY STATE	
		DAY HRS.	TOTAL HRS.	0800	REMARKS
July 18	Norman Wells	-	-	U/S	Maintenance
19	Norman Wells	7.9	128.6	S	Buoy work and Range building Norman Wells to Mile 516
20	Norman Wells	-	-	U/S	Vehicle grounded due to Metal Fatigue & Propellor Vibration
21	Norman Wells	0.5	129.1	U/S	Vehicle Testing
22	Norman Wells	-	-	U/S	Vehicle Grounded due to Metal Fatigue
23	Norman Wells	-	-	U/S	Repairing Above
24	Norman Wells	8.6	137.7	S	Buoy Work Norman Wells to Mile 450
25	Norman Wells	10.8	148.5	S	Buoy Work Norman Wells to Mile 414
26	Norman Wells	3.4	151.9	S	Buoy & Range Work Norman Wells to Mile 515
27	Norman Wells	8.7	160.6	S	Buoy Work Norman Wells to Mile 422
28	Norman Wells	8.7	169.3	S	Buoy Work Norman Wells to Fort Good Hope
29	Norman Wells	7.6	176.9	S	Feasibility Trip to Great Bear Lake
30	Norman Wells	-	-	S	CG Programme Ended, Readying vehicle to Return to Hay River
31	Fort Simpson	9.9	186.8	S	Transit Norman Wells to Fort Simpson
Aug. 1	Hay River	6.0	192.8	S	Transit Fort Simpson to Hay River

APPENDIX "C"

COAST GUARD MISSION DATA SHEETS

COAST GUARD MISSION DATA SHEET

LOCATION		NORMAN WELLS, N.W.T. MILE 564				DATE	JUNE 10, 1973	
WIND SEA VIS. TEMP. WX.	Light Calm	MISSION TYPE	NAVIGATIONAL AIDS SUPPORT					
	15 69°F	START MISSION	1317	POWER TIME	8.5hrs	FUEL		
	Cloudy- Clear	END MISSION	0015	IDLE TIME		DIST	171 s.m.	
		TOT. TIME	10hr. 57min	TOT. TIME	8.5hrs	A.U.W.	65,000 lb.	
		CARGO DESCRIPTION						
CARGO LOADED		CARGO DISCHARGED		AIDS SERVICED	2			
BUOYS PLACED	3	BUOYS PICKED UP	4	BUOYS POS'N CHECKED	3			
MISSION LOG.								
1317 Engines Started								
1323 Underway for Sans Sault Rapids								
1406 Mile 600								
1440 Arrived Sans Sault Rapids								
1450 Checked Buoy Positions								
1505 Picked up three red swift current buoys from Cache Mile 630								
1520 Engine shut down to move buoy package into position Mile 640								
1630 Buoy package in position - Engine Start								
1650 Sonar tested and working								
1720 Removed drift wood from buoy								
1730 Picked up floating swift current buoy								
1737 Cleared drift wood from buoy and checked position								
1745 Attempted to pick up buoy for repositioning - no success								
1803 Engines shut down - Meal Break. Mile 632								
1840 Engines start								
1856 Back to pick up same buoy								
1940 No success on raising buoy - buoy almost completely submerged in fast water.								
1940 Attempting another buoy which is farther out of the water								
1955 Buoy raised - 10 minutes to raise anchor								

COAST GUARD MISSION DATA SHEET

LOCATION		NORMAN WELLS, N.W.T. MILE 564			DATE	JUNE 20, 1973	
WIND SEA VIS. TEMP. WX.	Light Calm -15	MISSION TYPE		NAVIGATIONAL AIDS SUPPORT			
	Overcast	START MISSION	0855	POWER TIME	7h 56m	FUEL	100 s.m. 77,000 lb
		END MISSION	2138	IDLE TIME	2h 48m	DIST	
		TOT. TIME	12h 43m	TOT. TIME	10h 44m	A.U.W.	
CARGO DESCRIPTION		23 Miss. buoys Approx. 6,000 lb. 11 Swift Current Rock Anchors					
CARGO LOADED	12,000 lb	CARGO DISCHARGED		AIDS SERVICED			
BUOYS PLACED	14	BUOYS PICKED UP	4	BUOYS POS'N CHECKED		14	
MISSION LOG.							
0855 Engine start - moved craft to load buoys							
0900 Engines at idle 34 buoys to load							
0932 Engines full power - craft picking up rock anchors made up the day previous at Norman Wells							
0945 Engines idle - In position to load anchors Mile 564							
1107 Engines full power - Approx. 6,000 lb. Roch Anchors on board							
1116 Craft landed Norman Wells Mile 561							
1118 Engines shut down Meal Break							
1245 Engines started							
1250 Craft underway to place four buoys between Miles 560.5 and 558.5							
1300 Sounder in water							
1317 Soundings taken							
1350 Buoy placed							
1358 Second buoy placed							
1415 Third buoy placed							
1435 Fourth - Last buoy placed at Norman Wells - Working up river Towards Fort Norman							
1455 Arrived next area to be buoyed Miles 550 to 548.5 sounder in water							
1500 Soundings taken							

COAST GUARD MISSION DATA SHEET

LOCATION						DATE	JUNE 20, 1973	
WIND SEA VIS. TEMP. WX.	MISSION TYPE							
	START MISSION		POWER TIME		FUEL			
	END MISSION		IDLE TIME		DIST			
		TOT. TIME		TOT. TIME	A.U.W.			
		CARGO DESCRIPTION						
CARGO LOADED		CARGO DISCHARGED		AIDS SERVICED				
BUOYS PLACED		BUOYS PICKED UP		BUOYS POS'N CHECKED				
MISSION LOG.								
1506 Buoy placed - Position checked and it was found out of position - Raising for repositioning								
1516 Buoy on deck - 10 minutes to raise - adding more weight to anchor								
1526 Buoy replaced								
1534 Buoy replaced								
1545 Buoy placed								
1600 Buoy placed - Submerged - Raising to replace								
1603 Craft in position								
1604 Buoy caught with buoy line								
1610 Buoy on deck - 6 minutes to raise								
1614 Buoy replaced using swick current type								
1617 Moving up river to next buoy positions								
1627 Arrived buoy positions Mile 542.5								
1630 Began soundings								
1640 Buoy placed								
1646 Buoy placed								
1651 Sounder up - Moving further up river								
1700 Arrived new position soundings taken Mile 534.5								
1720 11th Buoy placed								
1723 Underway next buoy position approx. 3 miles up river								

COAST GUARD MISSION DATA SHEET

LOCATION						DATE	JUNE 20, 1973	
WIND SEA VIS. TEMP. WX.	MISSION TYPE							
	START MISSION		POWER TIME		FUEL			
	END MISSION		IDLE TIME		DIST			
TOT. TIME			TOT. TIME		A.U.W.			
CARGO DESCRIPTION								
CARGO LOADED		CARGO DISCHARGED		AIDS SERVICED				
BUOYS PLACED		BUOYS PICKED UP		BUOYS POS'N CHECKED				
MISSION LOG.								
1734 Arrived new position - Sounding taken Mile 529.5								
1743 12th Buoy placed								
1745 Underway to place 2 buoys Mile 522								
1755 Arrived buoy position - Little Bear River Mile 522								
1758 Engines shut down Meal Break								
1830 Engines started								
1834 Underway - Sounding								
1846 13th Buoy placed								
1858 14th Buoy placed - Approx. Mile 521								
1854 Sounder up - Underway Fort Norman buoy Cache to load rock anchor for remainder of buoys on board								
1910 Arrived Fort Norman buoy Cache - Mile 517								
1915 Engines at idle								
2009 Engines full power - Approx. 10,000 lb. rock anchor loaded								
2020 Picked up Floating Miss. buoy								
2036 Picked up Floating Miss. buoy								
2138 Arrived Norman Wells - Engines shut down								

COAST GUARD MISSION DATA SHEET

LOCATION		NORMAN WELLS, N.W.T. MILE 564			DATE	JUNE 22, 1973	
WIND SEA VIS. TEMP. WX.	SW 15 1 foot 15+ 73°F Cloudy- Clear	MISSION TYPE		NAVIGATIONAL AIDS SUPPORT			
		START MISSION	1430	POWER TIME	2h 24m	FUEL	70 s.m. 68,000 lb
		END MISSION	1912	IDLE TIME	44m	DIST.	
		TOT. TIME	4h 42m	TOT. TIME	3h 8m	A.U.W.	
CARGO DESCRIPTION		Picked up floating 500 gal. fuel tank					
CARGO LOADED		CARGO DISCHARGED		AIDS SERVICED		1	
BUOYS PLACED		BUOYS PICKED UP		2	BUOYS POS'N CHECKED		7
MISSION LOG.							
1430 Engines started							
1435 Underway Mile 595 - Patricia Island - Change targets on range							
1455 Checked buoy position							
1504 Engines at idle to pick up floating 500 gal. fuel tank							
1509 Engines full power							
1538 Arrived Patricia Island							
1542 Landed engines at idle - unloading targets Mile 598.5							
1555 Engines full power - targets and equipment unloaded - moving craft to better landing							
1600 Engines at idle							
1604 Engines shut down							
1738 Engines started							
1743 Underway work site							
1746 Landed - Engines at idle - Loading equipment							
1750 Engines full power - Underway Norman Wells - Checking buoy positions from Patricia Island to Norman Wells							
1758 Landed to pick up beached swift current buoy - Engines idle							
1805 Engines full power							
1854 Picked up drifting swift current buoy - Engines Idle							

COAST GUARD MISSION DATA SHEET

LOCATION		NORMAN WELLS, N.W.T. MILE 564			DATE	JUNE 23, 1973	
WIND SEA VIS. TEMP. WX.	Light Calm 15+ 60°F Cloudy- Clear	MISSION TYPE		NAVIGATIONAL AIDS SUPPORT			
		START MISSION	0903	POWER TIME	6h 13m	FUEL	
		END MISSION	1721	IDLE TIME	7 min.	DIST	160 s.m.
		TOT. TIME	8h 18m	TOT. TIME	6h 20m	A.U.W.	74,000 lb
CARGO DESCRIPTION			Rock Anchors				
CARGO LOADED	5,000 lb	CARGO DISCHARGED		AIDS SERVICED			
BUOYS PLACED	2	BUOYS PICKED UP	1	BUOYS POS'N CHECKED		3	
MISSION LOG.							
0903 Engines started - Moving craft pick up approx. 5,000 lb rock anchors and targets							
0909 Craft in position Engines shut down							
0930 Engines start - Rock anchors on board							
0955 Re-positioning buoy Approx. Mile 580							
1000 In position raise buoy							
1007 Buoy on deck - 7 minutes to raise - Beginning sounding							
1030 Buoy placed - Position checked							
1035 Underway							
1106 Arrived target site Mile 595.5 - Unloaded targets and equipment							
1113 Underway San Sault Rapids - Check buoy positions							
1118 Landed target site finished previous day - June 22 to pick up tools - Mile 598.5 - Engines idle							
1125 Engines full power							
1136 Mile 610							
1158 Mile 630							
1210 Arrived San Sault Rapids Approx. Mile 635 - checking buoy positions							
1225 Landed Sans Sault - Engines shut down Meal Break Mile 640							
1305 Engines start							

COAST GUARD MISSION DATA SHEET

LOCATION		NORMAN WELLS, N.W.T. MILE 564			DATE	JULY 19, 1973	
WIND SEA VIS. TEMP. WX.	Light Calm 10 59°F Overcast	MISSION TYPE		NAVIGATIONAL AIDS SUPPORT			
		START MISSION	0830	POWER TIME	7h 10m	FUEL	110 s.m. 82,000 lb
		END MISSION	1940	IDLE TIME	43 min	DIST	
		TOT. TIME	11h 10m	TOT. TIME	7h 53m	A.U.W.	
CARGO DESCRIPTION							
CARGO LOADED	11,320 lb	CARGO DISCHARGED		AIDS SERVICED	1		
BUOYS PLACED	3	BUOYS PICKED UP	4	BUOYS POS'N CHECKED	13		
MISSION LOG.	Approx. 10,000 lb. rock anchors 2 sets targets. 8 swift current buoys. 1 Miss. buoy						
0830 Engines start							
0835 Underway							
0840 Commencing D.R.B. human decrement tests Norman Wells							
0851 Engines Idle - Clearing drift wood and re-positioning D.R.B. course markers							
0853 Engines full power							
0855 Engines idle - Changing pilots and doing D.R.B. course							
0856 Engines full power - commencing rotational tests							
0901 Rotational test complete - Commencing course test							
0907 Underway from Norman Wells landing site to Black buoy six mile island Mile 559							
0915 Arrived buoy							
0916 Hooked calibrated line into buoy for D.R.B. position holding Test - ENG. idle							
0921 Commencing test							
0925 Changing pilots and doing test again							
0930 Tests completed							
0936 Engines full power underway							
0941 Buoy position checked Mile 556							
0945 Checked buoy Cache Norman Wells - No buoys left							

COAST GUARD MISSION DATA SHEET

LOCATION						DATE	JULY 19, 1973		
WIND SEA VIS. TEMP. WX.	MISSION TYPE								
	START MISSION		POWER TIME		FUEL				
	END MISSION		IDLE TIME		DIST				
		TOT. TIME		TOT. TIME		A.U.W.			
		CARGO DESCRIPTION							
CARGO LOADED		CARGO DISCHARGED		AIDS SERVICED					
BUOYS PLACED		BUOYS PICKED UP		BUOYS POS'N CHECKED					
MISSION LOG.									
0952		Approx. Mile 552 buoy out of position							
0958		Underway up river							
1005		Buoy position checked Mile 550							
1006		Two buoy positions checked Mile 550							
1010		Submerged buoy Mile 550 - Picking up							
1012		Approaching buoy							
1017		Buoy on buoy line							
1020		Buoy on deck							
1030		Anchor raised							
1043		Sounder in water commenced sounding							
1050		Buoy repositioned							
1053		Sounder up - proceeding approx. Mile 543 - Check buoy positions							
1101		Arrived Mile 543 - Checked two buoy positions							
1103		Proceeding up river							
1106		Submerged buoy Mile 541 - Picking up							
1110		Approaching buoy - Two buoys tangled together							
1119		Removed drift wood with buoy line							
1121		First buoy hooked							
1123		Second buoy hooked							
1141		Both buoys untangled and on deck							

COAST GUARD MISSION DATA SHEET

LOCATION						DATE	JULY 19, 1973	
WIND SEA VIS. TEMP. WX.	MISSION TYPE							
	START MISSION END MISSION TOT. TIME		POWER TIME IDLE TIME TOT. TIME		FUEL DIST A.U.W.			
	CARGO DESCRIPTION							
CARGO LOADED		CARGO DISCHARGED		AIDS SERVICED				
BUOYS PLACED		BUOYS PICKED UP		BUOYS POS'N CHECKED				
MISSION LOG.								
1200		Placing buoy		Mile 533 - Sounding				
1216		Buoy placed -		Proceeding up river				
1226		Craft landed		Mile 534				
1227		Engines shut down		Meal Break				
1306		Engines start						
1309		Underway						
1327		Commenced sounding for buoy position approx.		Mile 532 -				
		Unmarked Shoal						
1358		Buoy positioned -		Checking position				
1404		Underway up river						
1409		Buoy position checked		Mile 529.5				
1422		Buoy position checked -		Little Bear River - Mile 523				
1425		Buoy submerged		Mile 522 - Picking up				
1445		Buoy hooked						
1451		Buoy on board						
1456		Two buoy positions checked						
1459		Buoy position checked						
1503		Buoy position checked		Mile 519				
1509		Arrived Fort Norman buoy Cache -		Approx. Mile 517				
1510		Landed						

COAST GUARD MISSION DATA SHEET

LOCATION						DATE	JULY 19, 1973	
WIND SEA VIS. TEMP. WX.	MISSION TYPE							
	START MISSION		POWER TIME		FUEL			
	END MISSION		IDLE TIME		DIST			
		TOT. TIME		TOT. TIME		A.U.W.		
		CARGO DESCRIPTION						
CARGO LOADED		CARGO DISCHARGED		AIDS SERVICED				
BUOYS PLACED		BUOYS PICKED UP		BUOYS POS'N CHECKED				
MISSION LOG.								
1526	Loaded 3 Swift Currents - 2 Miss. buoys - Underway							
1530	Landed Mile 516 - To replace range targets							
1531	Engines shut down							
1739	Engines start							
1744	Underway Norman Wells - Fuel remaining - Port 50% - Star 40%							
1845	Arrived Six Mile Island - Mile 559							
1850	Along side Black Miss buoy for DRB station keeping test - ENG idle							
1903	Change pilots to do test again							
1907	Test complete							
1910	Underway landing site Norman Wells to do DRB rotation and							
	course test - Engines full power							
1916	Arrived site commencing tests							
1930	Change pilots - Fuel remaining - Port 30% - Star. 23%							
1938	Completed DRB tests							
1940	Landed Norman Wells - Engines left running for engine wash							

COAST GUARD MISSION DATA SHEET

LOCATION		NORMAN WELLS, N.W.T. MILE 564				DATE	JULY 24, 1973	
WIND SEA VIS. TEMP. WX.	Light Calm 15	MISSION TYPE		NAVIGATIONAL AIDS SUPPORT				
	Overcast	START MISSION	0952	POWER TIME	8 hr.	FUEL	230 s.m. 83,000 lbs	
		END MISSION	1750	IDLE TIME	18 min	DIST		
		TOT. TIME	8h.52m	TOT. TIME	8h 18m	A.U.W.		
		CARGO DESCRIPTION		14 Swift Current buoys, 3 Miss. buoys approx. 10,000 lb. rock anchors				
CARGO LOADED		CARGO DISCHARGED		AIDS SERVICED				
BUOYS PLACED		2	BUOYS PICKED UP		2	BUOYS POS'N CHECKED		33
MISSION LOG.								
0952		Engines start						
0956		Underway for approx. Mile 450 - Buoy out of position - Checking buoy positions on route						
1020		Approx. Mile 550 - 5 buoy positions checked						
1040		Approx. Mile 540 - 11 buoy positions checked						
1058		Approx. Mile 530 - 14 buoy positions checked						
1125		Approx. Mile 515 - 22 buoy positions checked						
1150		Approx. Mile 500 - 31 buoy positions checked						
1209		Approx. Mile 490						
1216		Landed engines shut down approx. Mile 485 Meal Break						
1250		Engines start						
1257		Underway proceeding up river						
1309		Approx. Mile 475						
1325		Approx. Mile 465 - 32 buoy positions checked						
1343		Approx. Mile 455 - 33 buoy positions checked						
1346		Picking up out of position buoy Approx. Mile 453						
1351		Buoy hooked						
1355		Buoy on deck						
1400		Arrived Approx. Mile 450 - Picking up out of position buoy						
1408		Buoy hooked						

COAST GUARD MISSION DATA SHEET

LOCATION		NORMAN WELLS, N.W.T. MILE 564			DATE		JUNE ^{JULY} 25, 1973	
WIND SEA VIS. TEMP. WX.	Light Calm 15+ 65°F Clear, Sunny	MISSION TYPE		NAVIGATIONAL AIDS SUPPORT				
		START MISSION	0830	POWER TIME	10h38m	FUEL		
		END MISSION	1915	IDLE TIME	10min	DIST	310 s.m.	
		TOT. TIME	11h 45m	TOT. TIME	10h 48m	A.U.W.	77,000 lb	
CARGO LOADED		CARGO DISCHARGED		AIDS SERVICED				
BUOYS PLACED		8	BUOYS PICKED UP		7	BUOYS POS'N CHECKED		5
MISSION LOG.								
0830		Engine start						
0835		Underway proceeding up river						
0858		Picking up out of position buoy						
0901		Buoy hooked						
0905		Buoy on deck - Proceeding up river						
0950		Fort Norman Approx. Mile 512						
1005		Mile 504 - Searching for transits to lay buoy - Transits gone						
1120		Landing to check anti plow bag approx. Mile 485						
1037		Engines shut down						
1104		Engine start						
1105		Proceeding up river						
1120		Approx. Mile 475						
1145		Approx. Mile 460						
1153		Buoy out of position Mile 455 - repositioning						
1157		Buoy hooked						
1202		Buoy on deck - Changing anchor and repositioning - Fuel Port 75%						
		Starboard 60%						
1215		Buoy placed						
1220		Proceeding up river						

COAST GUARD MISSION DATA SHEET

LOCATION						DATE	JULY JUNE 25, 1973	
WIND SEA VIS. TEMP. WX.	MISSION TYPE							
	START MISSION	END MISSION	TOT. TIME	POWER TIME	IDLE TIME	TOT. TIME	FUEL DIST	A.U.W.
	CARGO DESCRIPTION							
CARGO LOADED		CARGO DISCHARGED		AIDS SERVICED				
BUOYS PLACED		BUOYS PICKED UP		BUOYS POS'N CHECKED				
MISSION LOG.								
1230		Buoy checked Mile 550 - Continuing up river to Fort Wrigley area from where craft left off last mission - Mile 550						
1243		Approx. Mile 542 Placing buoys						
1255		Buoy placed						
1256		Picking up out of position buoy						
1304		Buoy on deck						
1315		Buoy placed - Moving into position to place another						
1326		Buoy placed						
1330		Landed - Engines shut down Approx. Mile 442						
1400		Engines start						
1405		Underway proceeding up river						
1415		Repositioning buoy Mile 437						
1417		Buoy hooked						
1421		Buoy on deck - Moving to place - Fuel Port 50% - Starboard 50%						
1430		Buoy placed - Proceeding up river						
1436		Checked buoy position Mile 435						
1440		Checked buoy position Mile 433						
1445		Checking buoy position Mile 430						
1458		Buoy out of position - Picking up - Approx. Mile 424						
1500		Buoy hooked						

COAST GUARD MISSION DATA SHEET

LOCATION						DATE	July JUNE 25, 1973		
WIND SEA VIS. TEMP. WX.	MISSION TYPE								
	START MISSION		POWER TIME		FUEL				
	END MISSION		IDLE TIME		DIST				
		TOT. TIME		TOT. TIME		A.U.W.			
		CARGO DESCRIPTION							
CARGO LOADED		CARGO DISCHARGED			AIDS SERVICED				
BUOYS PLACED		BUOYS PICKED UP			BUOYS POS'N CHECKED				
MISSION LOG.									
1503		Buoy on deck - Moving for placing							
1525		Buoy placed							
1530		Checked buoy position							
1531		Placing buoy Approx. Mile 423							
1540		Buoy placed							
1552		Arrived Mile 414 - Last buoys before Fort Wrigley - Placing buoy							
1605		Buoy placed - Checking position of two buoys							
1610		Last two buoy positions checked - Proceeding Norman Wells -							
		Fuel remaining 34%							
1625-		Picking up beached Miss. buoy							
1630		Buoy on board - Picking up floating Swift Current buoy							
1642		Buoy on board - Underway Norman Wells							
1709		Approx. Mile 450							
1745		Engines idle - Check #4 engine - Oil hot							
1755		Engines full power - Port 25% - Starboard 25%							
1820		Fort Norman Mile 512							
1915		Landed Norman Wells Mile 562 - Engines shut down Approx. 10 Min.							
		Fuel remaining, in main tanks							

COAST GUARD MISSION DATA SHEET

LOCATION		NORMAN WELLS, N.W.T. MILE 564				DATE	JULY 26, 1973	
WIND SEA VIS. TEMP. WX.	Light Calm 15	MISSION TYPE		NAVIGATIONAL AIDS SUPPORT				
	Clear, Sunny	START MISSION	1410	POWER TIME	3h 44m	FUEL	100 s.m. 79,000 lb	
		END MISSION	2224	IDLE TIME	7min	DIST		
		TOT. TIME	8h 14m	TOT. TIME	3h 51m	A.U.W.		
CARGO DESCRIPTION		Rock anchors						
CARGO LOADED	7,000 lb	CARGO DISCHARGED	5,000 lb	AIDS SERVICED	2			
BUOYS PLACED		BUOYS PICKED UP	1	BUOYS POS'N CHECKED				
MISSION LOG.								
Cargo on Board - 3 Miss. buoys, 6 Swift Current buoys, 7,000 lb. rock anchors								
1410 Engines start								
1415 Underway - Pick up anchors - Norman Wells								
1422 Landed pick up anchors - Engines idle								
1424 Engines shut down								
1509 Engines start - Approx. 7,000 lb. rock anchors on board								
1514 Underway up river								
1550 Approx. Mile 543								
1605 Landed - set up new range targets - Engines shut down Mile 540								
1855 Engines start								
1900 Underway for Mile 515 Set up warning target								
1950 Landed Mile 515 Engines shut down								
2040 Engine start - Underway Norman Wells								
2055 Mile 517 - Clearing wood from buoy - Port 50%, Starboard 56%								
2100 Buoy hooked - Clearing wood								
2104 Underway Norman Wells								
2155 Dropping off set of targets Mile 558 - Landed engines idle								
2200 Engines full power								
2210 Landed Norman Wells - NT Dock - Unloading approx. 5,000 lb. rock								

COAST GUARD MISSION DATA SHEET

LOCATION		NORMAN WELLS, N.W.T. MILE 564				DATE	JULY 27, 1973	
WIND SEA VIS. TEMP. WX.	Light Calm	MISSION TYPE		NAVIGATIONAL AIDS SUPPORT				
	10	START MISSION	1055	POWER TIME	8h 33m	FUEL		
	Clear	END MISSION	2015	IDLE TIME	7min	DIST	300 s.m.	
		TOT. TIME	9h 20m	TOT. TIME	8h 40m	A.U.W.	73,000 lb	
CARGO DESCRIPTION								
CARGO LOADED		CARGO DISCHARGED			AIDS SERVICED			
BUOYS PLACED		5	BUOYS PICKED UP		3	BUOYS POS'N CHECKED		11
MISSION LOG.								
Cargo on Board - 3,500 lb. anchors 4-12' targets, 2-14' targets								
3 Miss. buoys, 6 Swift Current buoys								
1055 Engine start								
1058 Underway - Down river to CCGS Dumit - Drop off 1 set 14' targets at approx. Mile 565								
1104 Landed engines idle								
1111 Targets unloaded - Underway up river - Engines full power								
1211 Mile 515								
1335 Approx. Mile 450 - Checking buoy positions								
1415 Landed - Approx. Mile 422 Engines shut down Meal Break								
1455 Engines start								
1500 Underway - Place buoy Mile 423								
1503 Sounding								
1514 Buoy placed								
1530 Sounding for buoy Mile 430								
1603 Buoy placed								
1608 Picking up out of position buoy								
1611 Buoy hooked								
1615 Anchor attached to rock caught in skirt								
1617 Anchor released buoy on deck - Moving to position buou								

COAST GUARD MISSION DATA SHEET

LOCATION						DATE	JULY 27, 1973	
WIND SEA VIS. TEMP. WX.	MISSION TYPE							
	START MISSION END MISSION TOT. TIME		POWER TIME IDLE TIME TOT. TIME		FUEL DIST A.U.W.			
	CARGO DESCRIPTION							
CARGO LOADED		CARGO DISCHARGED		AIDS SERVICED				
BUOYS PLACED		BUOYS PICKED UP		BUOYS POS'N CHECKED				
MISSION LOG.								
1626 Buoy placed - Sounding								
1645 Sounding complete - Underway Mile 431 Pick up Submerged buoy								
1648 Picking up Buoy - Fuel Port 50% - Starboard 50%								
1655 Buoy hooked								
1700 Buoy on deck - Moving down river								
1725 Approx. Mile 450								
1820 Arrived Mile 503 - Sounding for buoy position								
1835 Buoy placed								
1847 Picking up out of position buoy								
1849 Buoy hooked								
1852 Buoy on deck - Sounding to re-position buoy								
1900 Buoy placed - Underway Norman Wells								
1920 Mile 512 - Fort Norman								
1940 Port 25% - Starboard 25% - Mile 535								
2015 Landed Norman Wells - Engines shut down								

COAST GUARD MISSION DATA SHEET

LOCATION		NORMAN WELLS, N.W.T. MILE 564				DATE	July 28, 1973	
WIND SEA VIS. TEMP. WX.	Light Calm 5	MISSION TYPE		NAVIGATIONAL AIDS SUPPORT				
	Clear Sunny	START MISSION	0920	POWER TIME	8h 8m	FUEL	240 s.m. 70,000 lb	
		END MISSION	1855	IDLE TIME	33min	DIST		
		TOT. TIME	9h 35m	TOT. TIME	8h 41m	A.U.W.		
CARGO DESCRIPTION		Anchors, Buoys						
CARGO LOADED	2,000 lb	CARGO DISCHARGED	3,000 lb	AIDS SERVICED				
BUOYS PLACED	3	BUOYS PICKED UP	6	BUOYS POS'N CHECKED		51		
MISSION LOG.								
0920 Engine start								
0922 Underway down river - To Fort Good Hope checking buoy positions								
0955 14 buoy positions checked - Approx. Mile 590								
1006 Approx. Mile 597 - Landed pick up beached swift current buoy								
1008 Buoy damaged - Not picking up								
1010 Mile 600								
1030 Mile 620 - Picking up beached buoy - 19 buoy positions checked								
1035 Buoy on board								
1055 Placing buoy Mile 632 Sans Sault Rapids								
1109 Buoy placed - Buoy out of position								
1113 Picking up buoy								
1116 Buoy hooked - Anchor caught in skirt								
1125 Buoy on Deck - Re positioning								
1130 Buoy placed								
1135 27 buoy positions checked								
1150 Landed Sans Sault buoy Cache - Load anchors - Unload set of 12' targets - 41 buoy positions checked.								
1151 Engines shut down Mile 635 Meal Break								
1245 Engine start								
1250 Underway Fort Good Hope								

COAST GUARD MISSION DATA SHEET

LOCATION						DATE	JULY 28, 1973		
WIND SEA VIS. TEMP. WX.	MISSION TYPE								
	START MISSION		POWER TIME		FUEL				
	END MISSION		IDLE TIME		DIST				
		TOT. TIME		TOT. TIME		A.U.W.			
		CARGO DESCRIPTION							
CARGO LOADED		CARGO DISCHARGED			AIDS SERVICED				
BUOYS PLACED		BUOYS PICKED UP			BUOYS POS'N CHECKED				
MISSION LOG.									
1300		Mile 640 Picking up out of position buoy							
1304		Buoy hooked							
1308		Buoy on deck - Picking up another out of position buoy							
1312		Buoy hooked							
1320		Buoy on deck							
1324		Landed shifting two rolls of cable across deck - Engines idle							
		Starboard 62% - Port 75% 44 buoy positions checked							
1330		Engines full power							
1340		Mile 650							
1346		Mile 656 Fuel tanker trailer in shallow water sighted							
1420		Landed Fort Good Hope Mile 680 - 51 buoy positions checked							
1421		Stuck across creek							
1500		Freed by winching craft off - Underway up river							
1545		Buoy out of position picking up Mile 640							
1555		Buoy hooked							
1601		Buoy on deck							
1610		Mile 635 - Unloading rock anchors and buoys Sans Sault buoy Cache							
		Engines idle - 2,000 lb. anchors unloaded - 6 swift current buoys							
1630		Engines full power							
1715		Mile 607 - Clearing submerged buoy							

COAST GUARD MISSION DATA SHEET

LOCATION		NORMAN WELLS, N.W.T. MILE 564				DATE	JULY 29, 1973	
WIND SEA VIS. TEMP. WX.	SW x 10 Rippled 10m+ 72° Fine & Clear	MISSION TYPE		FEASIBILITY TRIP - GREAT BEAR LAKE				
		START MISSION	0958	POWER TIME	7h16m	FUEL		
		END MISSION	1935	IDLE TIME	0h20m	DIST	280 s.m.	
		TOT. TIME	9h 37m	TOT. TIME	7h36m	A.U.W.	72,000 lb	
		CARGO DESCRIPTION						
CARGO LOADED	8 Drums Turbo Fuel	CARGO DISCHARGED	8 Drums Turbo Fuel	AIDS SERVICED	1			
BUOYS PLACED		BUOYS PICKED UP		BUOYS POS'N CHECKED				
MISSION LOG.								
0958		Engines started						
1000		Departed Norman Wells						
1140		Entered Great Bear River						
1225		Entered St. Charles Rapids						
1245		Clear of rapids						
1330		Entered Great Bear Lake						
1345		Arrived at Fort Franklin - Engines idle, Unloading Turbo fuel for Helicopter						
1405		Depart Fort Franklin for Whisky Jack Point						
1430		Landed at Whisky Jack Pt. and shut down engines - Meal Break Light on point checked						
1630		Departed Whisky Jack Point						
1650		Entered Great Bear River						
1820		Entered Mackenzie River						
1935		Landed at Norman Wells - Shut down engines						

APPENDIX "D"

SONAR EQUIPMENT

SONAR EQUIPMENT

The WESMAR SS 110 is a Horizontal Scanning Sonar with a maximum range of 1,000 feet.

Designed primarily for small craft and fishing vessels, it was felt that the scanning feature would be particularly useful aboard Voyageur in searching for channel depths ahead of the vehicle.

Description:

The SS 110 consists of two main units:

1. The console, containing all the controls, electronics and a visual readout CRT display.
2. The soundome, containing the transducer, tilt and scan motors.

The transducer beam width is 7° and is capable of being tilted from $+4^{\circ}$ above the horizontal to -90° below the horizontal, with a 360° lateral sweep. Any combination of tilt and sweep can be chosen, automatically scanning any sector from 30° to 360° , or manually scanning a 7° sector.

There are 5 ranges that may be selected on the CRT display 0-50, 100, 200, 500 or 1,000 ft.

For example if the 50 ft. range is selected and the transducer tilted to 30° below the horizontal a depth reading of 24 ft. could be obtained 50 ft. ahead of the transducer.

Equipment Position:

The console was fitted between the pilot and navigator above the engine switch panel and could be observed and controlled from either seat.

The soundome was positioned on the starboard side approximately 30 feet aft of the bow. A framework fabricated from aluminum scaffolding was used to support the soundome and when in the down position with the vehicle on cushion, the soundome was 3 feet from the vehicle's side, penetrating 2 feet below the water's surface. The inboard part of the framework was attached to two of the cargo tie downs, which acted as hinges, allowing the system to be lifted clear of the water and pulled inboard.

System Deficiencies:

1. The aluminum framework was a temporary system, that was often difficult to deploy and required all of the deck crew to lower or lift it, causing considerable delay.

2. Due to the soundome design and possibly the position of same, water turbulence caused the system to become ineffective, at through water speeds of greater than 10 mph. This excluded the vehicle from using its speed to quickly sound channel depths on ranges, as to do so at speeds of 10 mph or less would have caused high fuel consumption for short distances.

3. The start of the time base tended to wander away from the centre of the CRT causing an elliptical effect to the read out, excluding the use of the lateral scanning system.

4. The visual read out provides no record of soundings.

Recommendations:

The principal of the Horizontal Scanning Sonar appears to be ideal for the Aids Tending role, but requires major modifications for it to be effective on a high speed vehicle.

1. It is recommended that model tests be carried out to determine the optimum position of the soundome relating to turbulence caused by the vehicle's skirts.

2. It is recommended that the National Research Council be consulted as to the feasibility of incorporating the soundome into a fish type casing as designed for the Department of Energy, Mines and Resources, Polar Continental Shelf Project.

3. It is recommended that a hydraulic lifting and lowering system, operable from the control cab, be designed and fabricated.

4. It is recommended that an electrical read out system be designed to ascertain the depth of soundome below the water surface.

5. It is recommended that the manufacturers of the sonar be approached as to whether a paper recorder can be incorporated in the system.

APPENDIX "E"

WORKING PAPER ON

MACKENZIE RIVER OPERATION OF VOYAGEUR

MACKENZIE RIVER OPERATION OF VOYAGEUR

Three concepts are offered, based on 3 sets of engine hour utilization. These hours are divided into power and idle time estimating 85% power time. Average speed at power time is estimated at 30 knots. All three concepts are based on a one crew operation, although at this time, human fatigue factors are unknown.

1. 500 hrs @ 85% = 425' x 30 knots = 12,750 NM
Average daily operating hours = 2.7
2. 750 hrs. @ 85% = 637 x 30 knots = 19,110 NM
Average daily operating hours = 4.1
3. 1,000 hrs. @ 85% = 850 x 30 knots = 25,500 NM
Average daily operating hours = 5.5

Whilst not yet established it would appear that Norman Wells may offer the ideal base of operations as it is midway on the river. There are 2 possible methods of operation.

1. A vehicle equipped with a module capable of supporting the crew for 3 days at a time, with a trailer camp and maintenance facilities established at Norman Wells.
2. A stretch version of the vehicle with full crew accommodation allowing the vehicle to operate as a conventional vessel. The crew would live aboard throughout the season, with a small maintenance base established at Norman Wells.

The advantages gained from 2. would be a vehicle with greater freedom of action, with better utilization of engine hours.

For the purposes of budget estimates salaries are based on General Technical rates for July, 1973. Whilst it is possible that Hovercraft crews may be reverted to ships officer group, this is not yet established.

Salaries are prorated for 6 months and it is estimated that the vehicle will have similar work hours as a conventional vessel, up to 12 hours per day, 7 days a week, taking the high figure, it is estimated that overtime will be 100% of basic salary.

No estimates are made for capital cost items such as, crew modules, trailers, possible fuel caches or maintenance facilities.

	1 500 hrs.	2 750 hrs.	3 1,000 hrs.
CAPTAIN GT 5	13,831	13,831	13,831
NAVIGATOR GT 4	12,398	12,398	12,398
MECHANICS GT 3 x 2	21,292	21,292	21,292
SEAMEN DED 2 x 3	21,600	21,600	21,600
COOK	10,000	10,000	10,000
CATERING 8 x 180 x \$8.00	11,520	11,520	11,520
FUEL & OIL 180 GPH x 0.45	40,500	60,000	81,000
MAINTENANCE \$80. per power hr.	34,000	50,960	68,000
\$45. per idle hr.	3,375	5,085	6,750
SHIPS STORES & UNIFORM	5,000	5,000	5,000
TOTAL O&M Plus Below	172,516	211,686	251,391

BASE MAINTENANCE/OVERHEADS

DEPEND UPON WHETHER

VEHICLE HAS FULL CREW

ACCOMMODATION

TRAILER CAMP \$10,000.

MAINTENANCE FACILITY \$3,000.