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TITLE

STRATEGIC LIFT CONCEPT STUDY AND ANALYSIS: UTILITY OF SEALIFT CAPABILITY OF THE PROPOSED SHIP DESIGN FOR PROJECT M2673 - ALSC

System Number:

Patron Number:

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DEPARTMENT OF NATIONAL DEFENCE
CANADA

OPERATIONAL RESEARCH DIVISION

DIRECTORATE OF OPERATIONAL RESEARCH (JOINT & LAND)

DOR(J&L) RESEARCH NOTE RN 9902

STRATEGIC LIFT CONCEPT STUDY AND ANALYSIS: UTILITY OF SEALIFT CAPABILITY OF THE PROPOSED SHIP DESIGN FOR PROJECT M2673 - ALSC

BY

Mr. R. Dickson
Maj. M. MacDonald
Mr. P. Comeau

APRIL 1999

OTTAWA, CANADA

National Defence Défense nationale

OPERATIONAL RESEARCH DIVISION

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OTTAWA, ONTARIO

APRIL 1999

ABSTRACT

The Strategic Lift Concept study team was requested by the Director Force Planning and Program Coordination to examine in more detail the utility provided by the lift component in the proposed design of the ALSC (Afloat Logistics and Sealift Capability) vessel as part of project M2673. The project team utilized the STRATL mobility model to analyze potential strategic movement scenarios involving specific operational structures, the proposed ship design, and several levels of strategic air transport capability. The utility of the ALSC capability in the transport of current and future Canadian Forces operational units to a potential theatre of operations was quantified in terms of deployment timeline.

RÉSUMÉ

Une étude sur l'utilité de transport maritime du navire proposé pour le projet capacité de soutien logistique à la mer et de transport maritime (ALSC) fut conduite à la demande du Directeur - Planification des Forces et coordination du programme. Le modèle STRATL fut utilisé pour examiner certains scenarios de movement stratégique de formations de forces terrestres. L'utilité du ALSC pour le transport maritime fut demontré avec différents niveaux de transport aérien par rapport au temps de deploiement.

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ACKNOWLEDGEMENTS

The authors wish to acknowledge the advice provided by LCdr B. Irvine of the Directorate Maritime Policy and Project Development, LCol M. Cessford of the Directorate of Land Strategic Concepts, and LCol R.E. Thompson and Cdr M. Cowen of the Directorate of Force Planning and Program Coordination in the analysis and preparation of this report.

STRATEGIC LIFT CONCEPT STUDY AND ANALYSIS:

UTILITY OF SEALIFT CAPABILITY OF THE PROPOSED SHIP DESIGN

FOR

PROJECT M2673 - ALSC

INTRODUCTION

1. On November 17, 1998, two of the authors prepared and presented a briefing (Ref. 1) to a meeting of senior members of the NDHQ staff who were stakeholders in Project M2673, Afloat Logistics and Sealift Capability (ALSC) Project. This work examined the full spectrum of lift requirements currently represented in CF OPLANS and, using strategic mobility modelling, examined the constituent elements of the notional ALSC sealift capability. Particular emphasis was placed upon the payload capacity, platform availability, and fleet size of these vessels as part of the overall strategic mobility analysis.

2. In February, 1999, the Director Force Planning and Program Coordination asked the authors to examine the utility of a specific proposed ship design in the transportation of army operational units to proposed theatres of operations.

PROPOSED ALSC DESIGN

3. The proposed ALSC design has a total lift capacity of 2195 lane metres (lm). Approximately 66% of this cargo space is located below deck with the balance being on the flight deck/exposed upper deck of the vessel. This is a roll-on/roll-off ship which will provide fast, flexible loading and unloading of the vessel. The flight deck area can be used either for cargo carriage or for flight operations, but both cannot be conducted concurrently. The ship is assumed to have a mean transit speed of 17 knots (Ref. 2). In general, cargo packing must allow for irregular shapes and spacing for fire lanes. Thus, a "stow factor" of eighty percent has been applied to the available cargo space for this type of ship consistent with basic mobility planning factors (Ref. 3). For this analysis, the availability of the ALSC to conduct sealift tasks as opposed to other Maritime tasks was not examined in detail. Operational availability at Halifax was assumed and excursions were modelled using one, two, and three ALSC ships.

STRATEGIC AIRLIFT AND ITS POTENTIAL CONTRIBUTION

4. Strategic mobility is a multi-modal transport problem. Although this specific question involves sealift, a complete examination of the solution space needs to consider the impact of concurrent airlift operations on the overall movement problem. The requirement for sealift is thus the overall demand less the portion of that demand that can

be satisfied by concurrent airlift. In reality there are a number of competing demands on the limited CF airlift resources, and in considering future force structures for the CF, there are a variety of possible fleet configurations and availabilities.

5. For the purposes of this analysis, airflift has been modelled and the resultant product used to alleviate the demand upon the ALSC. Three airlift capability levels have been used:

a. No airlift - this illustrated the ability of the ALSC to support operations where higher priority movements have consumed available airlift (concurrent deployments for example);

b. Current airlift capability (surge) - the current surge capability of 29 CC130 and 4 CC150 aircraft has been used (illustrative of a discrete deployment where all of Canada's assets are focussed on one strategic movement); and

c. Enhanced future airlift capability - based on previous work, three C17 equivalent aircraft have been added to the current fleet to represent a potential future capability level.

OPERATIONAL STRUCTURES

6. Sealift demand for a large spectrum of potential operations has been examined previously (Ref. 1). From this work, it is possible to identify the range of force structures in which the ALSC is likely to provide a high level of utility. Relatively small structures

such as the Disaster Assistance Relief Team (DART) and the Rapid Reaction Force (Air) (RRF(A)) Squadron are purpose-built for air transportability in order to achieve rapid deployment. With the exception of the fuel requirement for the RRF(A), these small elements can be transported by the notional ALSC design in question. The Immediate Reaction Force (Land) (IRF(L)) Battalion Group is likewise designed for air deployment in order to meet specific timelines.

7. Very large structures, such as the OP SABRE Brigade Group or the Main Contingency Force require so much lift (> 20,000 lm) that the contribution of the ALSC would be marginal. It is accepted that these structures will require a large amount of Allied or contracted commercial sealift to be deployed.

8. For these reasons the logical structure for detailed examination here is one that is not specifically designed for air-transportability but is in the sub-10,000 lm range. Two structures fall within these parameters, the "Vanguard" Battle Group and the Joint Task Force Headquarters (JTFHQ).

9. Further scrutiny reveals that examination of the JTFHQ is complex. A detailed examination of this structure needs to consider a variety of possible tasks which would lead both to a variety of structures and more importantly a changing set of demands upon the ALSC. The JTFHQ could potentially operate from the platform, indeed many consider that this is a very desirable feature of any ALSC design. The variable

configurations and deck space requirements are too complex for consideration here but could be the subject of a separate analysis if desired.

THE VANGUARD BATTLE GROUP

10. The Vanguard Battle Group appears to be the ideal structure for examination here. The Directorate of Land Strategic Concepts (DLSC) has provided a "future" battle group structure for detailed review (Ref. 4). It is a five operational sub-unit construct based upon LAV III, a notional wheeled Armoured Combat Vehicle (ACV), and a notional medium howitzer. Although the exact composition of the battle group would be adjusted prior to any operation being conducted, the five sub-unit size is ideal for analysis in that it is a balanced, capable structure. The current NATO Stabilization Force (SFOR) Battle Group, for example, is a five sub-unit construct. Finally to represent a potential future operation, this battle group is resourced to conduct a peace-enforcement rather than combat operation. This type of operation represents the middle-range of the requirement for ammunition and other commodities. In reality, these levels would be adjusted for the specific operation.

11. Key assumptions used in developing the structure, attached as Annex A, are:

   a. not deploying into immediate operations;

   b. seven days of supply (DOS) of ammunition and fuel;

   c. thirty DOS of other commodities;

   d. forklifts/material handling equipment are included; and

e. the structure consists of two rifle companies, one ACV squadron, one field engineer squadron, one close support medium battery, battalion HQ, administration company, and combat support company.

12. Under current practice, the CF rotates personnel onto major pieces of equipment in theatre and does not, as a matter of course, rotate equipment on a regular basis. Rotation of personnel and sustainment of the force in theatre for a battle group of the size being considered here can be done entirely by airlift. Thus, given that the aim of this study is to assess the utility of a notional ALSC design, long term rotation and sustainment issues have not been considered.

THE REQUIREMENT FOR A NATIONAL SUPPORT ELEMENT

13. One oversight often made in examining the deployability of a structure is the failure to consider the logistic support requirements of that deployed force. The inclusion of a National Support Element (NSE) as part of the overall movement of the battle group is deemed to be of value. In reality the battle group outlined above cannot operate in the absence of the second and limited third-line support provided by an NSE. A notional NSE was also developed by DLSC to support the battle group. Although the level of detail is not as great in this structure as in the battle group, an effort has been made to create a support unit of a size sufficient to support the deployed force. Details of this

structure, which has not been broken out to the sub-unit level, are attached at Annex B. The same operational assumptions that are outlined above apply to this unit.

14. A National Command Element (NCE) would also be required in this operation however it would be so small that it would not significantly alter the results and thus is not represented in the modelling.

DEPLOYMENT LOCATION

15. In order to build upon previous work (Ref. 1), the operational structures have been moved within the NATO area to Eastern Turkey. The Air Port of Embarkation (APOE) was assumed to be Trenton, Air Port of Debarkation (APOD) was Iskenderun, Turkey, the Sea Port of Embarkation (SPOE) was Halifax and the Sea Port of Debarkation (SPOD) was also Iskenderun. The sailing route was based on Lloyd's shipping routes with no weather delay imposed. No constraints in terms of slot availability, attrition, diplomatic clearances etc. have been utilized.

FINANCIAL COST

16. Including a lift capability in the proposed M2673 ship (rough order of magnitude cost: $409M +/- 10%) consists of adding an additional deck to the vessel at an estimated

incremental cost of $20M per hull (rough order of magnitude cost, +/- 50%) (Ref.2). There is no recurring CF strategic sea movement of equipment that would serve as a baseline against which this cost could be compared. A historical examination of actual sea movement expenditures indicates that these vary widely on a year to year basis due to variable demand. In short, the provision of the integral strategic sea deployment capability modelled here would cost Canada $20M for each hull required. However, given that this evaluation focuses on the operational effectiveness of a proposed ALSC design, cost will not be part of this assessment.

THE ANALYSIS

17. In modelling the two operational structures, the future battle group with a total size of approximately 4400 lm, and the future battle group plus its NSE with a total size of approximately 7600 lm have been moved to Eastern Turkey using one, two, or three ALSC ships of the proposed design. Airlift excursions consisted of 3 cases: non-availablility, current fleet capability, and a notional future capability consisting of the current air assets enhanced by the addition of three C17-equivalent aircraft. Note that both army structures contain a sizeable quantity of outsize cargo (non-CC130 transportable). Thus, deployment is impossible with the current air fleet capability alone, and impractical in terms of the time required if this fleet is augmented with three C17's. (Approximately 150 C17 missions would be needed to deploy the battle group alone with an additional 100 required for the National Support Element. These missions would be in

addition to chalks flown by the CC130 and CC150 aircraft presently in the fleet). Passenger airflow was assumed to occur by charter in the absence of CF assets or by CC150 in excursions where air capability is present. Aircraft surge utilization rates have been respected and crew availability has not been constrained although the model is capable of representing this constraint. Cargo transportability has been considered for all structures on all lift assets.

18. Given that the aim of this study is to evaluate the utility of the proposed ALSC hull, only the movement dimension has been taken into consideration. Aspects of strategic mobility such as the time needed to move the equipment and lift platforms to the APOE and SPOE have not been studied. Cargo has been assumed to be available to load on day 1 of the deployment, with lift assets present to receive the cargo at that time. Any force mounting delays would need to be added to deployment times.

19. Also note that while the discussion thus far has focused on the force size/cargo area (lane metres) to be moved, the results that follow are reported as cumulative tonnage deployed. The strategic mobility model used has been designed to represent closure goals in theatre in tons. Given the physical dimensions and weight of the individual pieces of cargo to be moved, a simple lane metre-to-tonnage conversion can be applied as required. In total, the Vanguard Battle Group without NSE comprises approximately 8,800 tons of equipment. The addition of the NSE brings the total to approximately 14,500 tons.

VANGUARD BATTLE GROUP WITHOUT NSE

20. Figure 1 displays the results of the analysis for the deployment of the unsupported Vanguard Battle Group when three ALSC ships are available. Without airlift, closure of the force in theatre can be achieved in 16 days and requires only one sailing by each of the three ships. Complementing the three hulls with the current CF airlift assets does not alter the overall time required to deploy the force, nor does it change the need to employ all three hulls. As such, this excursion has not been included in the graph. Using the enhanced airlift option where three C17 aircraft are available does have the effect of eliminating the need for one of the three ships as explained below.

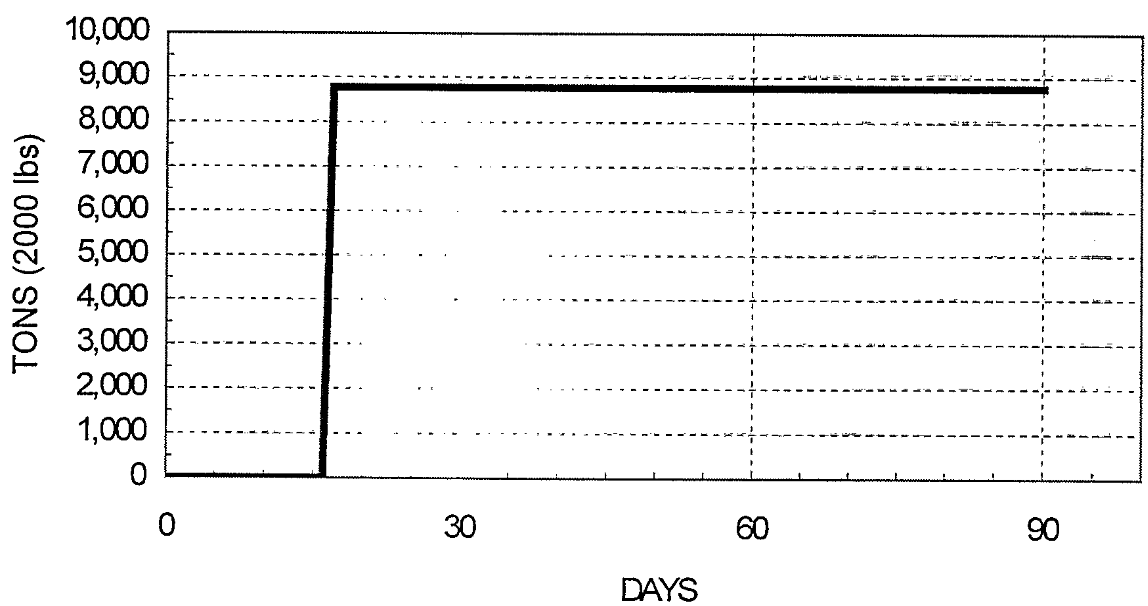

Figure 1. Battle Group Deployment Timeline- 3 ALSC Ships

21. Given only two ALSC's, the results change as depicted in Figure 2. With no airflow, two sailings are required with both hulls deploying in one movement and a single hull needed for the other sailing. Closure is achieved 48 days after the deployment begins. Given that this study has been based on the premise of closing the force as rapidly as possible, the graph depicts both ships travelling in the first flow to close as much cargo as possible within 16 days. Note that it is equally feasible to deploy a single hull in the first sea movement and still be able to meet the final closure date. In this case the hull would return to the SPOE to make a second movement with closure after 48 days while the second hull could in fact deploy at any time within 32 days of the available load date with full closure of the force being achieved in 48 days.

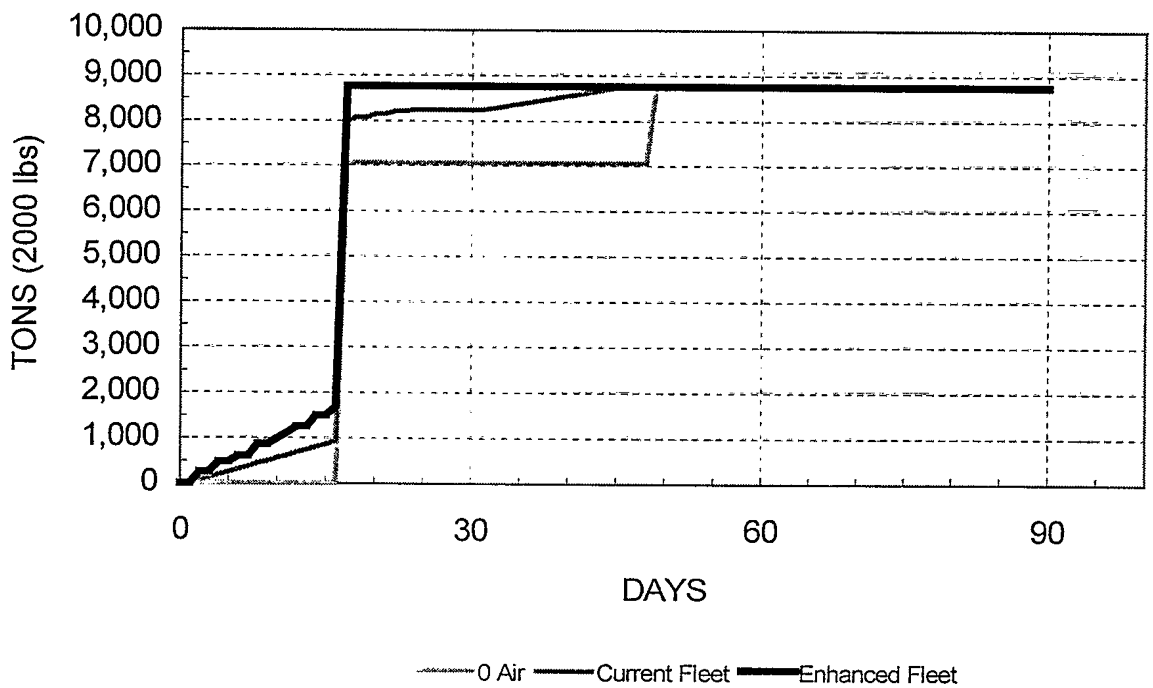

Figure 2. Battle Group Deployment Timeline - 2 ALSC Ships

22. Adding airlift to the available lift options, the closure of the force can be significantly altered. Given three C17's in addition to the current CF airlift assets, the battle group can actually be in theatre within 16 days as was observed when three ALSC hulls were available. In short, adding three C17 aircraft to the CF fleet can eliminate the need to deploy an ALSC hull for the given battle group (without any National Support Element) provided all mobility assets can be dedicated to the movement.

23. Augmenting the two ALSC hulls with the present airlift assets, an intermediate result is obtained. Both vessels must still deploy, but each is only required for one movement. Closure can be obtained 45 days after the available load date of the cargo. When viewed against the closure in 48 days by sealift alone, commanders would have the option of getting the force into theatre three days earlier, or having the air fleet available for other tasks.

24. When only one ALSC is available, Figure 3 indicates that three sailings are required with the force arriving in theatre in 80 days should no airlift be used. Closure can be achieved in 48 days if two sailings are made in conjunction with the employment of the existing CF air resources. Should these air assets be enhanced by the introduction of three C17's, closure can be obtained one day earlier with only one sailing of the ALSC required.

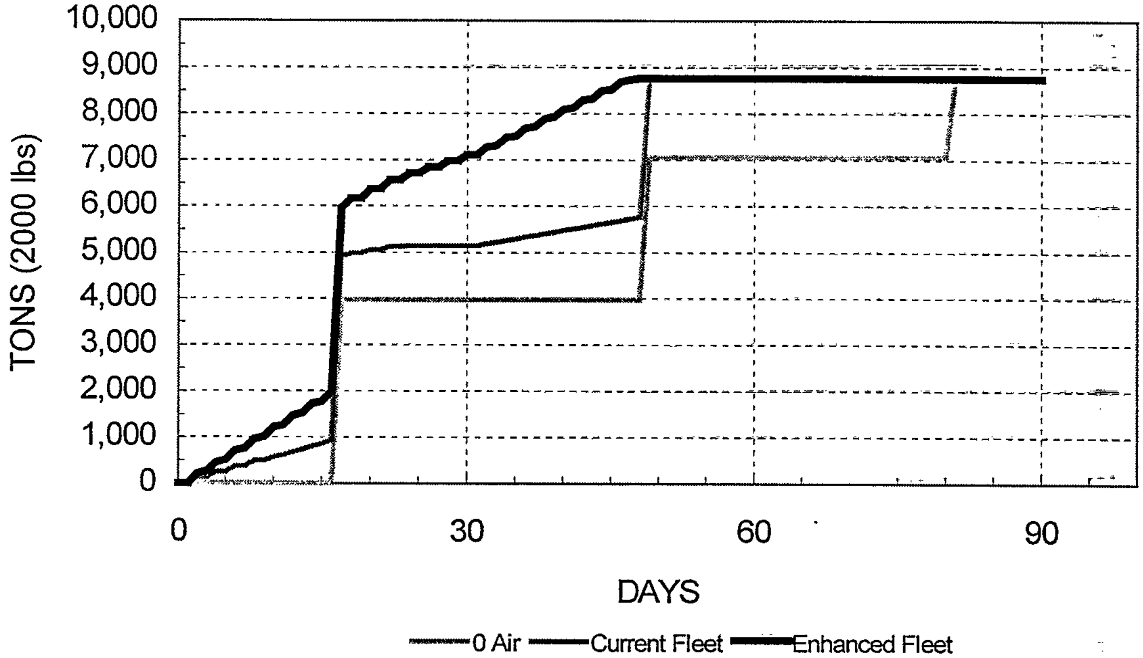

Figure 3. Battle Group Deployment Timeline - 1 ALSC Ship

VANGUARD BATTLE GROUP WITH NSE

25. Should the Vanguard Battle Group be deployed with its National Support Element, the lift requirement changes significantly as five distinct ship voyages are required in the absence of airlift. Figure 4 illustrates the case when three ALSC's are available. Without an airlift element, the three ships will close the majority of the battle group within 16 days, with two more shiploads required to complete the closure 32 days later. As with the case of the Battle Group alone with two ALSC hulls making three voyages, these five shiploads can travel in a variety of ways. The important point is that

two of the hulls must be in continuous operation with initial shipments closing 16 days after the available load date in order to have everything in theatre within 48 days.

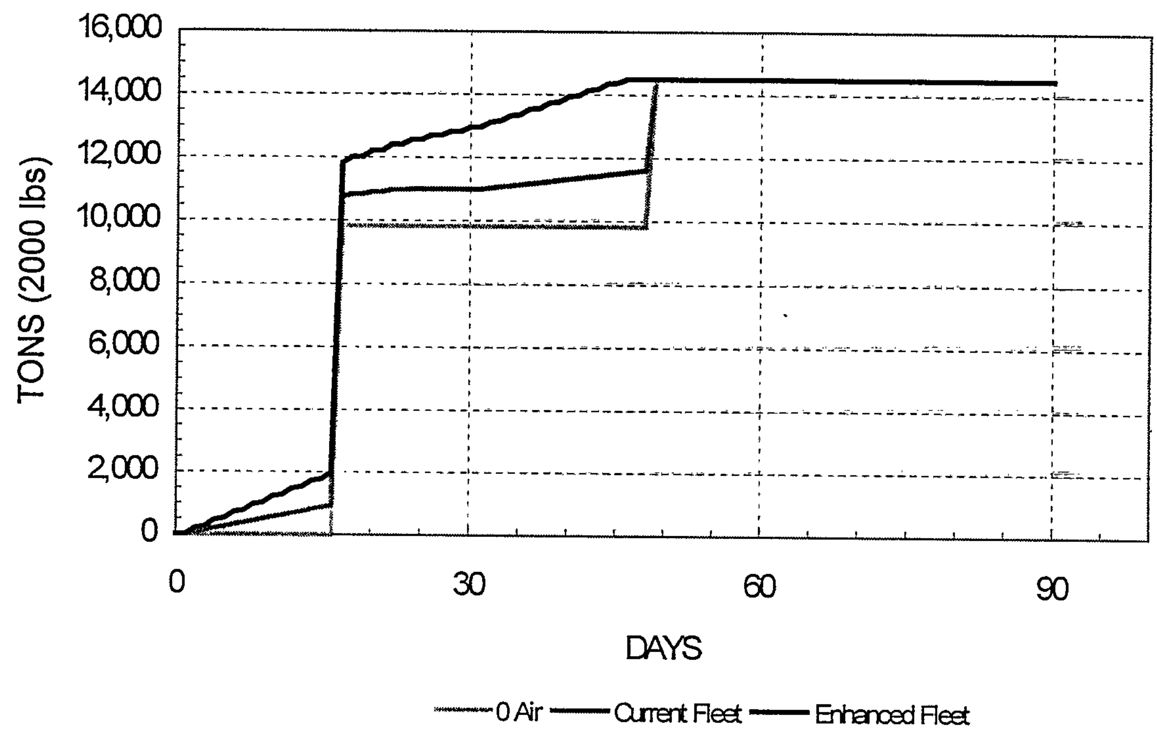

Figure 4. Battle Group plus NSE Deployment Timeline – 3 ALSC Ships

26. When our existing air assets are employed, four sea voyages are all that is needed, with the CC130 and CC150 delivering the remainder of the supplies. Provided that one of the sea voyages closes in 16 days, the battle group can once again be completely in theatre within 48 days.

27. With the addition of three C17 aircraft to the existing air fleet, closure can be achieved three days earlier. As with the case of one ALSC moving the Battle Group

only, this presents commanders with a series of options to consider. One could use the C17's to aid in closing the force in 45 days, employ the existing air assets to get the force in theatre within 48 days, or achieve the 48 day deployment by sealift alone.

28. When two ALSC hulls are used to deploy the Battle Group enhanced by its National Support Element, the five shiploads required in the absence of air assets can close 80 days after the available load date. Figure 5 depicts two shiploads arriving in theatre within 16 days, two more closing after 48 days, and the final ship movement arriving in theatre in 80 days. To close by this date, one ship must be in constant use, making three sailings with arrival in theatre 16, 48, and 80 days after the cargo is ready to load. In order to meet the 80 day target, the second ship must make its first delivery within 48 days in order to allow its return to the SPOE and make its second required voyage.

29. Splitting the lift requirement between the ALSC hulls and air assets, closure can be achieved 48 days after the available load date. Using existing air resources, two sailings for each hull are required. Should we have the use of three C17 aircraft in addition to our current assets, only one of the two hulls will be required to make a second voyage into theatre with the 48 day closure still being achieved.

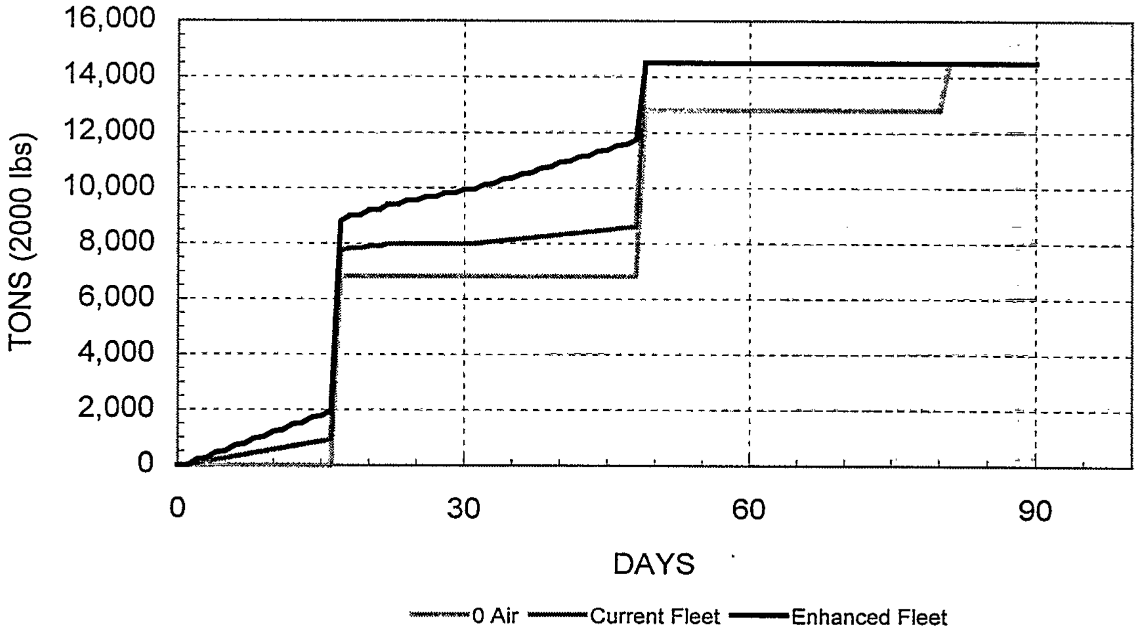

Figure 5. Battle Group plus NSE Deployment Timeline – 2 ALSC Ships

30. Having only one ALSC hull available to move the supported Battle Group presents a difficult lift situation. Without concurrent airlift, the ship would have to make five voyages into theatre, closing the force 144 days after the supplies were ready to be loaded. As Figure 6 shows, augmenting the single hull with our current fleet of air assets reduces the time required to 112 days with four ALSC voyages being required. Note from the graph that the final sea voyage sees a partially loaded ALSC going into theatre. As it turns out, the final portion of the airlift beyond day 80 could be eliminated if the fourth ALSC trip deployed more fully loaded. (Note that the horizontal scale on this graph differs from the other figures in order to capture the longer deployment times.

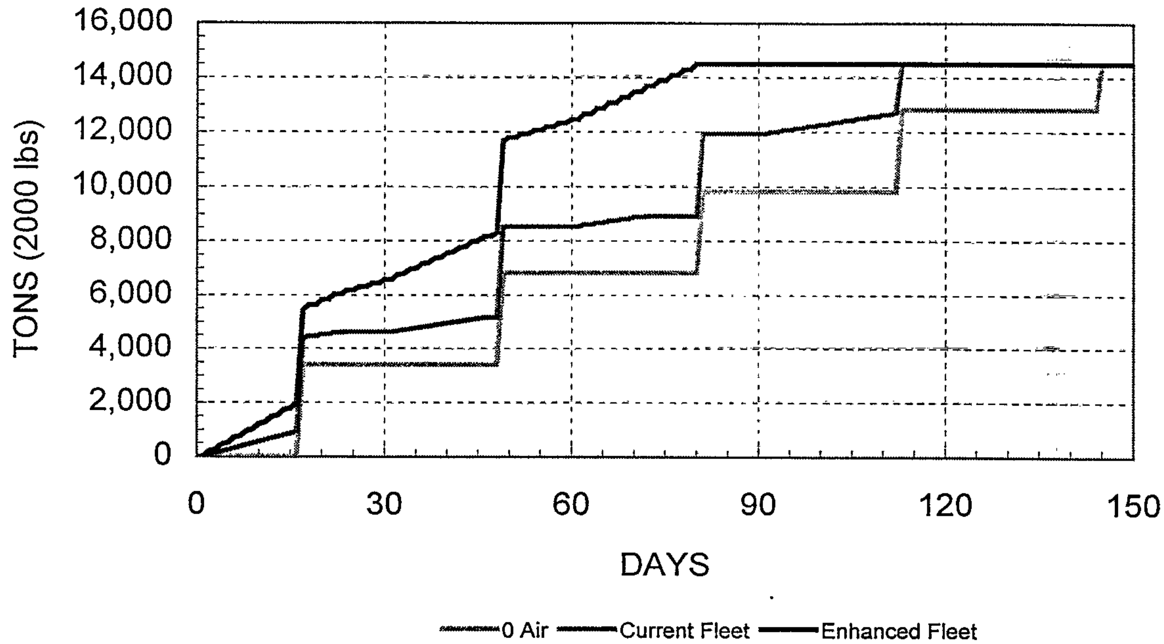

Figure 6. Battle Group plus NSE Deployment Timeline – 1 ALSC Ship

31. Should three C17 aircraft be available in addition to the ALSC hull and the current airlift assets, closure of the force can be achieved in 80 days with two ALSC voyages and concurrent airlift. Note that 80 days is also the amount of time needed to make three sea voyages so the final stretch of airlift after day 48 could be eliminated and replaced with a third sailing of the ALSC. Airlift, however, does maximize the arrival of forces in theatre in all cases.

SUMMARY RESULTS

32. The key times in this study are those associated with the length of time it takes an ALSC to arrive in theatre based on continual usage until the force is completely

deployed, namely, 16, 48, 80, 112, and 144 days. Figures 7 and 8 below summarize the results of the analysis done here in terms of the percentage of the force deployed, by weight, by the dates given. The critical points have been connected with lines to facilitate following the excursions. These lines are indicative and do not represent exact deployment times. Figure 7 gives the results for the Battle Group alone while Figure 8 presents the percentages for the Battle Group accompanied by its National Support Element.

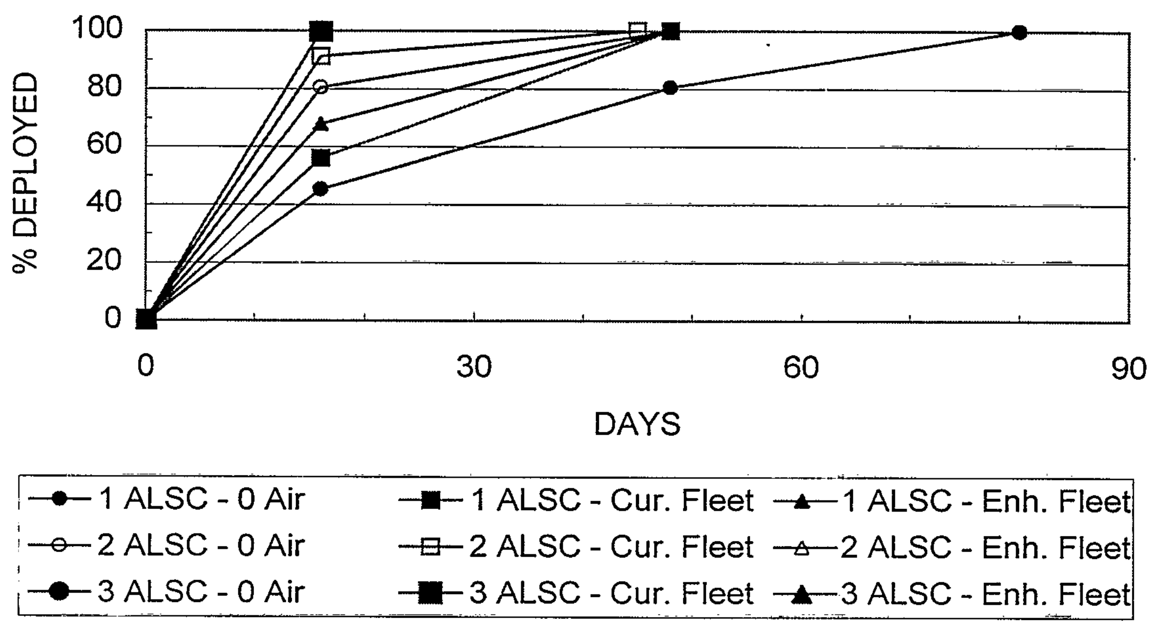

Figure 7: Deployment of Vanguard Battle Group for various Air and Sealift capabilities

33. From the point of view of the time required to complete the deployment of the Vanguard Battle Group without its NSE, a capability of three ALSC's alone is the same

as three ships with concurrent airlift. This airlift may consist of either the current CF assets, or an enhanced airlift capability of an additional three C17 aircraft. A capability of two ALSC's with enhanced airlift can also completely deploy the force in the same amount of time. The symbols displaying this result overlap in Figure 7 and are all located at the 100% deployed (16 day) point.

34. Two ALSC's alone can completely deploy the unsupported battle group in the same time as a single ALSC complemented by the current CF airlift assets (48 days). The time required is almost the same if the deployment is conducted with one ALSC plus enhanced airlift (47 days), or 2 ALSC's with the current airlift assets (45 days).

35. Of course, each of these capability combinations provide partial forces in theatre at different times, as shown in Figures 1 to 3.

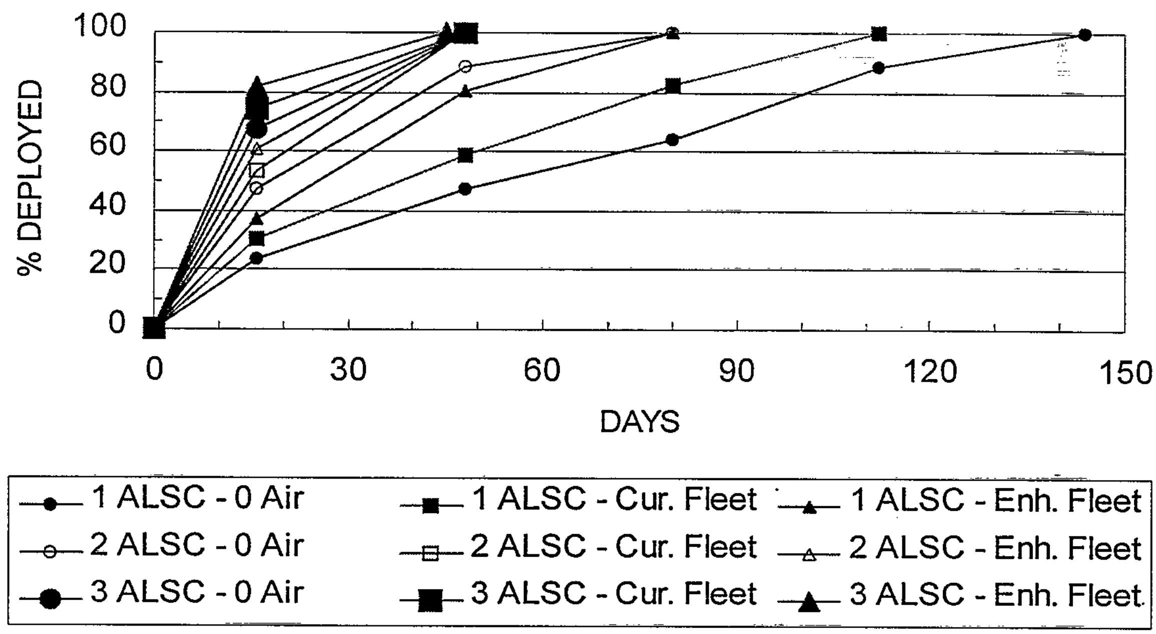

Figure 8: <u>Deployment of Vanguard Battle Group with NSE for various Air and Sealift capabilities</u>

36. For the Vanguard Battle Group accompanied by its NSE, three ALSC's either alone or with the current CF airlift assets completely deploy the force in the same time it takes to do it with two ships with either the current or enhanced airlift assets (48 days). Three ships with enhanced airlift takes almost as much time (45 days).

37. One ALSC used in conjunction with enhanced airlift can deploy the Vanguard Battle Group with its NSE in the same time it takes to do it with 2 ALSC's alone (80 days).

38. Once again, these different capability combinations provide partial closure of the force in theatre at different times, this time as shown in Figures 4 to 6.

CONCLUSIONS

39. Due to the quantity of outsize cargo involved in both the main force and the NSE, sealift is a very effective and necessary means of deployment. Given the mandate of the study, the issue of ownership of lift has not been examined here. However, from the work that has been done, it is clear that acquiring ALSC platforms can provide the CF with a significant lift capability that is available on short notice. But an analysis of this lift capability cannot be studied in isolation. Consideration of the available airlift capability contribution must be taken into account as well. Indeed, it must be remembered that the ALSC hull provides the CF with much more than just the ability to perform strategic lift. In fact, a lift capability is an *additional* feature of the proposed design. It may well turn out that the requirements for the other functions of the vessel could override its use as a lift platform in a given operation.

40. As expected, with only one ALSC hull available, air assets contribute more, by greatly reducing deployment times in all cases. For the battle group alone, one sailing of the ALSC can be eliminated using the existing CF air fleet, although approximately 80% (by weight) of the cargo still moves by ship. Enhancing the air fleet with three C17 aircraft provides a minimal further improvement in closure date, but reduces the need to a single sailing of the hull (roughly 45% of the lift is done by sea).

41. For the battle group deploying with its NSE, the current mix of air resources can once again eliminate the need for one voyage of the ALSC. In this case, the ALSC will deploy about 80% of the cargo. This can be increased to 85% should the final element of airlift be eliminated with the final ALSC movement carrying the needed supplies. Given the addition of three C17's, a further reduction by either one or two sailings can be achieved with closure of the force in theatre on the same date. In this case, the hull will transport either 47% or 67% of the cargo.

42. If two or three ALSC hulls are available, the current CF air assets have a small effect on the overall closure time for the battle group alone. The timelines given are met with sealift deploying between 80 and 100% of the cargo. However, enhancing the fleet with three C17 aircraft has a significant effect on the movement. In this case, only two of the ships would be required, with closure of the force being observed in the same time it would take three ships to do it alone. The two ships transport 80% of the cargo here as well.

43. Given three available ALSC's, airlift has a minimal effect on the deployment time required for the battle group accompanied by its National Support Element. (The ships deploy 68% or 88% of the cargo depending on whether three C17 aircraft are available or not). Having only two ships however, one sailing can be eliminated by using air assets. Enhancing the fleet with three C17's does not give any improvement in deployment time,

but does remove the need for a second sailing for one of the two hulls. In these cases, the two ships lift 88% and 66% of the cargo respectively.

44. This analysis has clearly demonstrated the need for sealift in a significant land force deployment. The marginal utility of a third ALSC is smaller than a second available ship. The utility of the second ALSC in this role is clearly higher than investing in enhanced airlift capability at a much smaller cost. As airlift capability is improved, a larger proportion of forces arrive in theatre much sooner and in some cases, removes the need for additional sailings. These fundamental mobility concepts apply to a force of any practical size deployed over any large distance. Sealift remains the mainstay of larger deployments and the CF cannot consider such movements without access to this capability in some form.

References

1. Comeau, P., MacDonald, Maj. M., Strategic Lift Concept Study and Lift Analysis: Sealift Capability and Concepts for Project M2673 ALSC, DOR(J&L) Research Note RN 9830, December, 1988.

2. Information provided by DMPPD staff.

3. DoD Logistics Handbook for Strategic Mobility Planning, MTMCTEA 97-700-2, August, 1997.

4. Structuring detail provided by DLSC staff.

Possible Future Vanguard Battle Group Composition (Ref. 4)

	INF BN	ACV Sqn	CS Bty	Fd Engr Sqn	Total
LAV III	88	14	15	27	144
COYOTE	7				7
ACV		18			18
ACV Rec		2			2
Howitzer SP			6		6
MPEV				6	6
LUVW + (Trailers)	13 + (13)	1 + (1)	7 + (7)	1 + (1)	22 + (22)
LSVW + (Trailers)	32 + (25)	2 + (2)	3 + (3)		37 + (30)
MLVW + (Trailers)	51 + (37)	4 + (4)	5 + (5)	8 + (5)	68 + (51)
HLVW + (Trailers)	41 + (2)	5	16 + (1)	7	69 + (3)
Misc Vehicles	4		2	1	7
20 foot Containers					200

Note: it has not been deemed necessary to provide a breakdown of the cargo deployed in the 20 foot containers, or give a breakdown of the number of containers required by each unit of the battle group. It is also acknowledged that the CF does not possess 200 of these containers although they are assumed available if required. The figure given simply provides a rough order of magnitude on the quantity of miscellaneous cargo required. It could be transported via containers or as bulk palletised cargo.

Composition of Accompanying National Support Elements (Ref. 4)

LUVW + (Trailers)	25 + (20)
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STRATEGIC LIFT CONCEPT STUDY AND ANALYSIS:
UTILITY OF SEALIFT CAPABILITY OF THE PROPOSED SHIP DESIGN FOR PROJECT M2673– ALSC (U)

4. AUTHORS (last name, first name, middle initial)
Mr. R. Dickson, Maj. M. MacDonald, Mr. P. Comeau

5. DATE OF PUBLICATION (month Year of Publication of document) APRIL 1999	6a. NO OF PAGES (total containing information. Include Annexes, Appendices, etc.) 33	6b. NO OF REFS (total cited in document) 4

7. DESCRIPTIVE NOTES (the category of document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Directorate of Operational Research (Joint & Land) Research Note

8. SPONSORING ACTIVITY (the name of the department project office or laboratory sponsoring the research and development. Include the address).

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9a. PROJECT OR GRANT NO. (if appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.)	9b. CONTRACT NO. (if appropriate, the applicable number under which the document was written.)
10a. ORIGINATOR's document number (the official document number by which the document is identified by the originating activity. This number must be unique to this document.) DOR(J&L) Research Note RN 9902	10b. OTHER DOCUMENT NOS. (Any other numbers which may be assigned this document either by the originator or by the sponsor.)

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The Strategic Lift Concept study team was requested by the Director Force Planning and Program Coordination to examine in more detail the utility provided by the lift component in the proposed design of the ALSC vessel as part of project M2673. The project team utilized the STRATL mobility model to analyze potential strategic movement scenarios involving specific operational structures, the proposed ship design, and several levels of strategic air transport capability. The utility of the ALSC in the transport of current and future Canadian Forces operational units to a potential theatre of operations was quatified in terms of deployment timeline.

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