July 15, 1998

The initial results indicate that after calibrating the existing hull CFD results, they compare reasonably with the trials data and show that the existing hull would need over 30,000 pounds of thrust to attain 12 knots. That would probably require at least a 50% increase in the stern thruster capacity.

The interesting part is that the initial results of the modified hull form indicate that the hull resistance may be reduced by approximately 30%. As a result, the currently available 18,000 pounds of thrust may then attain a speed up to 11 knots. From the HRP trials data, it indicates that 18,000 lb. of thrust is available with all four thrusters at 80% capacity or just the aft ones at 90% capacity. However, to attain 12 knots the thrusters would have to be upgraded to provide about 25-30% more thrust. We are finishing up our review of the HRP report to provide you with recommendations on possible upgrade options on the thruster system and will forward to you when available later this week or next week. Hopefully the results of the model tests will corroborate our findings.

July 17, 1998

2.0 Conclusions
a. Summarize results of 1.0a, 1.0b, and 1.0c
b. Summarize recommendations of 1.0e, 1.0f, 1.0g
3.0 Procedures
a. Discuss process of intrepreting 2.0a
b. Discuss process for coming up with 2.0b
4.0 Assumptions
a. Discuss any assumptions taken in 3.0a
b. Discuss any assumptions taken in 3.0b
5.0 References

Appendix
A. Interpretation data and results of 2.0a
B. Supporting data and results for 2.0b

The following attached results plots from the CFD analysis include two disc plots of the existing hull showing inflow velocity contours at the forward (fc1v8.jpg, fc1v10.jpg) and rear (rc1v8.jpg, rc1v10.jpg) thruster propeller locations for 8 and 10 knots. We have used these as a basis for our wake fraction for now until we receive revised values or model test data. Also attached is a 3D under view plot of the existing hull stream lines along the hull. In addition, I have attached a revised Excel file, which includes your HRP trials interpretation sheets. The main change is that I have refined the trials thrust curve and incorporated updated appendage and air resistance in the CFD total resistance instead of a composite 20%. The trend is interesting but we are pressing for another value at lower speed to confirm the trend.

July 23, 1998

We have completed the CFD resistance analysis and review. Attached below is a spreadsheet, which includes the results of the CFD analysis, our calculations of the HRP sea trial resistance, and your spreadsheet data.

I would like you to review the attached results and prepare a final summary report of your findings and recommendations in the following format:

1. Purpose

NautiCAN was contracted to review HRP azimuth thruster's performance, interpret HRP information, evaluate sea trial data and propose three levels of recommendations:

a. Recommend for optimizing existing HRP thrusters

b. Recommend for upgrading HRP thrusters.

c. Recommendation for attaining 12 knots.

2. Conclusions and Recommendations

The HRP trials data results shown are based on the data taken from the HRP repair and measurements report dated December 1997. The HRP original thrust predictions for single thruster are taken directly from the September 1994 data fax provided by HRP.

Provided calculations agree well with the open water data for the propeller in nozzle 19a, for the design condition. There is no information on how thrust is calculated for the "off design" condition and since there is no RPM shown, I could not reproduce same numbers. In my calculations, I am assuming constant power allowing RPM to change to approximate the electric motor performance.

From the sea and dock trials it is clear that power shown in the HRP report is measured electric power (V x A). To find what are electrical and mechanical transmission losses and to determine power that actually reaches propellers, I have compared dock trials results with the calculated power that propeller should absorb at bollard for the given RPM. Unfortunately, there are no results for the higher RPM and results had to be extrapolated. Results are shown appendix A.

I have used this calculated delivered power (to the propeller) to determine wake factors for the forward and aft thrusters. From the results of speed trials and calculated power absorbed by the propeller and than averaging results to correct for the effect of tide or wind, resulting wake calculation agree well with the results of CFD calculation for the original hull. Those results are shown in the appendix B.

All sea trials have to be taken with some reservation, since accuracy of measurements, sea and weather conditions are not known.

a. Recommendation for optimizing existing HRP units.

Existing azimuth units are operating at near optimum efficiency for the propellers in nozzle 19a. Skewed type nozzle propeller would help reducing vibrations. Replacing existing 19a nozzles with the

b. Minor upgrade recommendations for % increase in thrust
c. Best use of existing thruster recommendation

d. Major upgrade recommendation for best performance
3.0 Assumptions
a. Assumptions used from HRP data
b. Assumptions used for recommended upgrades
4.0 References

c. Appendices
A. Interpreted input data
B. Resulting Data of Existing Vessel Data Review
C. Resulting Data of Proposed Upgrade Review

Further improvement could be made by lowering propeller RPM and increasing propeller size. I will examine this in more detail when I get results of the CFD analysis and model tests.

Please, contact me if you have any questions.

Best regards,