

**HIGH SPEED SEALIFT TECHNOLOGY CONFERENCE
HELD AT NSW CARDEROCK - 21 to 23 OCTOBER 1997**

RECORD OF EVENTS OF SHIP/SYSTEM CONCEPT WORKING GROUP

In attendance :

Dr C Kennel	: Co Chair - NSW Carderock
Mr D R Lavis	: Co Chair - Band, Lavis & Associates
Mr J D Adams	- Maritime Dynamics Inc
Mr G M Ashe	- ABS Americas
Mr M Bebar	- NAVSEA
Mr P A Dent	- British Defence Staff
Dr C Everett Brett	- College of Engineering, University of Alabama
Mr D Fry	- NQEA Australia Pty Ltd
Mr W A Hockberger	- Hockberger Consultants
Mr M Hoggard	- NSW Carderock
Mr J Howell	- NAVSEA
Mr R Johnson	- Syntek
Mr R Kaufmann	- MMS Inc
Mr H D Kaysen	- Gibbs & Cox Inc
Mr N Kobitz	- Applied Graphics Technologies Inc
Mr J Offutt	- NSW Carderock
Mr R L Schaffer	- AME Inc
Mr J F Sladky Jr	- Kinetics Inc
Mr M Templeman	- NSW Carderock
Mr R Vulovic	- Sea-Land Service Inc
Mr S Wheatley	- Maritime Contract Services

Aim of Ship/System Concept Working Group

1. It was confirmed that the aim of the Ship/System Concept Working Group was to :
 - a) establish an approach to evaluate and compare the merits of the technology projections provided by other Working Groups, for post-workshop analysis.
 - b) formulate a method, or methods, to capture the output from other Working Groups in order to complete item a) above.
 - c) develop a structure/format to enable the output of all Working Groups and the post workshop analysis to be reported to the Workshop sponsors, in February 1998.

Post-Workshop Analysis

2. It was stated, and agreed, that the post-workshop analysis should be completed in February 1998.

3. The post-workshop analysis will assess and present the projected improvements in sealift transport performance arising from the technology forecasts provided by the other Working Groups. This will be achieved by establishing the relative merits and limitations for each technology, either individually or in combination (to distinguish the most promising technologies). Achievable values of speed, range and payload will be defined for the technologies considered. These results will be reported to the Workshop sponsors, and other potential users, in Feb 1998 to determine which of the possible solutions best fulfills the user requirement in the near, medium and far terms.
4. The Group envisage that conceptual ship designs, and associated costing data, will be required to adequately validate workshop results.
5. The post workshop analysis will be limited to Surface Ships only. Solutions utilizing airship or submarine technology will not be addressed. WIG's will be included on basis of acknowledgment that they are a potential solution to very high speed sealift requirements, but further development for the sealift role is not envisaged.

Technology Evaluation Methods for Post Workshop Analysis

5. The Group discussed methods to compare the relative merits of the technologies advocated by other Working Groups, and how to assess the feasibility of implementation.
6. Such methods are shown at the Annexes, where :

Annex A - provides a means by which the technologies advocated by other Working Groups can be compared in terms of payload, speed and range, by defining a so-called Transport Factor, to highlight candidate solutions.

Annex B- provides a methodology to evaluate those candidate solutions on the basis of need, RDTE status and product development timeframe, and allows a simplistic "road map" to be produced to state how candidate solutions can be brought to maturity in the near, medium and far terms. An example of such an evaluation is also given.

Annex C - provides a technology feasibility evaluation method which is compatible with, and can be used in conjunction with, Annex B.

the Group recognized that the methods advocated at the Annexes above represents one approach of many. In addition :

Annex D - provides a preliminary structure/format to enable the output of all Working Groups and the post workshop analysis to be reported to the Workshop sponsors, in February 1998.

Annex E - is a statement from this Group to ensure that the data provided by the other Working Groups for the post workshop analysis would be compatible with the information needed for the analysis methods. This was presented to the other Working Groups on 22 October. The other Working Groups were requested to provide numerical values that technologies would support in the near, medium and far terms.

7. The Group considered the following items worthy of particular mention for inclusion in the post workshop analysis :

7.1 Transport Factor

- a) it was agreed that the proposed Transport Factor analysis would provide a good foundation to compare the relative merits of the various technologies, representing those technologies in a design space by plotting Range/Speed /Payload on axes. It was expected that this will define design clouds, where vessels & technology types can be delimited in space. However, the Group recognized that any overall assessment should consider the “Delivery System” as a whole, and not focus on one aspect alone.
- b) the Transport Factor curves, shown at Annex A, need to be ratified by the individual Working Groups to benchmark the data which defines the current State of the Art. It was noted that each technology may impact several Transport Factor curves.
- c) other Working Groups will provide information to mark up Transport Factor plots with technology trend lines & future projections. It is necessary to define limits of applicability of technologies - this will be achieved from both information received by the Working Groups (eg some technologies may be Platform specific), and the assessments defined at Annexes B and C (eg some technologies might be incompatible, either wholly or in part, on some platforms).
- d) the accuracy of the Transport Factor curves is not absolute. The scatter of the curves is such that care will be needed not to unduly penalize or favor, in particular, breakthrough technology.

7.2 Platform Characterization Analysis and Technology Feasibility Analysis

- a) the analyses can capture technology that is Platform specific, the contribution to the delivery system of non-platform technology (eg shore-based cargo handling), and can account for technologies developed in other fields (by describing the state of development). It should also examine the secondary effects of the technologies proposed, if any (eg extra power consumption which might increase Lightship weight).
- b) it was considered important to highlight technology risk versus return by, for example, using S curves to graphically compare high risk/high payoff technology against more mature technologies. This would also address the impact of new drivers or new technologies evolved elsewhere but with potential marine applications.
- c) the methods involve a degree of subjective assessment, in some instances, to determine in terms of payload, range, speed etc. what is technologically feasible to fit into overall equation of the delivery system. Therefore, consistency is needed to assess the relative merits of each technology area.
- d) it was noted that different attributes have varying degrees of importance depending on the role of the vessel. Care must therefore be exercised to highlight those technologies which give the greatest benefit to range, speed, payload etc.
- e) it was highlighted that there needs to be a visible assessment of scaling factors (both technical and operational), which should include, where necessary, application of technology from one hull type, or role, to another.
- f) whilst Annex B presents a funding line proforma to mature the technologies, it was recognized that a POA&M, or similar, would be necessary.

Military/Commercial applications

8. There was consensus that there is no reason, at this stage of the Workshop, to consider either Military or Commercial requirements as dominant.

9. The Group noted that the Sealift requirements provided by the US Army are not definitive for either Commercial sector or the USMC. The Group therefore expanded the US Army Sealift requirements, as follows :

500 nm <Range<10000nm	: (a 5000nm lower limit is relevant for US Army purposes)
500 short tons <Payload<5000 short tons payload	: noting that 5000 stons is a small in commercial terms. The Group agreed to retain the upper limit, unless
challenged	otherwise (a 2000ston lower limit is relevant for US Army purposes)
10KSF <Cargo Space< 150 KSF	: modified to be consistent with the payload change, at the same density (a 75 KSF lower limit is relevant for US Army purposes)
40 knots <Speed<100 knots	

Post Workshop analysis will cover these ranges of values.

10. The Group broadly discussed the likelihood of solutions common to both Commercial and Military sectors, noting that the intersection between the requirement sets of military/commercial areas is still to be defined. It was concluded that a Commercial vessel with Military technology is a potential solution. It is also possible that, once the users look at which technologies will best fulfill their requirements, that Military and Commercial requirements will diverge.

Other Issues

11. It was concluded that it is correct to consider “technology push” at the present time. This will change to “requirements pull” after the post workshop analysis is presented to the User community, to determine which technology projections best fulfill their needs. It is anticipated that, upon selection of the most promising technologies, there will be some preliminary ship design work required to develop conceptual ideas to fulfill the User requirement and validate Workshop results. These conceptual ideas would also address :

- a) whether future requirements might be soluble by the State of the Art technology.
- b) the ability to incorporate all promising technologies on a conceptual sealift vessel.

12. At Annex F is a summary of a presentation given to the group by Mr D Fry, NQEA Pty Ltd, regarding practical risk management.

13. At Annex G is a copy of the presentation given by Mr D R Lavis, Co-Chair, to the Workshop on 10/23/97, summarizing the findings of this Group during the Workshop.

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ANNEX A

**HIGH SPEED SEALIFT TECHNOLOGY CONFERENCE
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ANNEX B

PLATFORM TECHNOLOGY EVALUATION METHODOLOGY

1. INTRODUCTION

A procedure has been developed in order to evaluate the development status of those technologies which are incorporated, or are expected to be incorporated, in a candidate design and which are not currently state-of-the-art technologies approved for full production. This methodology, designated the Platform Technology Evaluation (PTE) procedure, evaluates specific proposed technologies on the basis of need (relative to the candidate design), current state-of-development, RDT&E status, and development timeframe (relative to proposed funding). Assessments of cost and development timeframe for individual technologies, and for the total platform, are developed within the procedure. The assessment of overall risk for individual technologies, and for the total platform, is the principal output of the PTE procedure. The proposed methodology involves the completion of a matrix entitled the "Platform Technology Evaluation Summary Sheet". The process was developed in the mid 1980's and used originally for the NAVSEA CONFORM program. It was subsequently used for the work of NATO Special working Group Six (SWG/6).

2 EVALUATION OF REQUIRED TECHNOLOGIES

The completion of some sections of a Platform Technology Summary Sheet involves subjective assessment by individual evaluators. However, the terms which are to be selected to describe the status of a given technology are well defined within the PTE evaluators instructions. Thus, evaluators sharing similar opinions on the status of a given technology should always select identical descriptors to reflect these opinions. All evaluators must refer to the terminology definitions contained on pages 4 through 8 and must rigorously follow these definitions in order to provide for consistent and useful evaluations.

Additionally, evaluators must provide the rationale behind each of their status assessments.

It is recommended that the PTE procedure and terminology definitions presented herein be reviewed by the evaluator in their entirety, prior to undertaking such an evaluation.

The procedure for filling out a Platform Technology Evaluation sheet (Figure 1) is as follows :

1. Select the candidate point design
2. List all **TECHNOLOGIES** which are incorporated, or are expected to be incorporated, in the subject ship and **which are not currently state-of-the-art technologies approved for full ship production**. As will become evident to the evaluator upon further understanding of the PTE procedure, the degree to which the specific technologies comprising a general technology area are listed separately must be consistent among all ship designs evaluated. That is, one cannot choose to evaluate the technology "Signature Predictions" for one design and choose to evaluate the technologies "Acoustic Signature Prediction", "Infrared Radiation Signatures", "Radar Cross-Section Prediction" and "Magnetic Signature Prediction" for another design.
3. Select the appropriate **NEED** descriptor for each technology area (See Technology Need Definitions, Section 3.1).
4. Select the appropriate **STATE-OF-DEVELOPMENT** descriptor for each technology (see Technology State-of-Development definitions, Section 3.2).
5. Enter the **PLATFORM TECHNICAL STATUS** rating for each technology from the Platform Technical Status Matrix (Table 1).
6. Select the appropriate **CURRENT RDT&E ACTIVITY** descriptor for each technology (see Section 3.3).

Table 1

Platform Technical Status Matrix Scale

State of Development	Need		
	Enhancing	Critical	Essential
High	1	2	3
Significant	1.5	4	6
Moderate	2	6	9
Low	2.5	8	12
Minimal	3	10	15

Table 2

Platform RDT&E Status Matrix Scale

Current RDT&E Activity	Timeframe		
	Short-Term	Mid-Term	Long-Term
Considerable	1.0	1.2	1.5
Some	1.2	1.5	2.0
None	1.5	2.0	2.5

The **DEVELOPMENT INDEX** is the summation of the technology platform status ratings and provides for a quantitative means of assessing the overall development effort required to bring a platform, meeting its predicted performance and mission capabilities, to an initial operating capability. The higher the **DEVELOPMENT INDEX** number for a candidate design, the higher is the risk of developing all the required technologies to production within a given IOC timeframe.

The **DEVELOPMENT INDEX** number can also be utilized to quantify potential technology advances (i.e. to lower the **DEVELOPMENT INDEX** numbers) which might be expected while pursuing an acquisition program, for a specific platform type, based on building platforms of incrementally larger displacements. If a PTE summary sheet were completed and a **DEVELOPMENT INDEX** number computed for each proposed ship in the development series, the technology advances (lessons learned) which might be expected at each stage could be quantified. This can provide an analytical tool for determining the developmental value of each proposed step.

3. **EVALUATION DEFINITIONS**

3.1 **Technology Need Definitions**

The appropriate **NEED** descriptor for each technology will be selected from the following :

ESSENTIAL : Platform cannot be constructed or cannot perform its mission without achieving this technology and no higher-state-of-development technology is available as a fall-back position.

CRITICAL : A failure to achieve this technology will have a serious impact on ship performance, mission capability , or cost. The failure to achieve this technology will result in a fall-back to an alternate, but less desirable, higher-state-of-development technology (hardware), or, an acceptance of the “as built” ship performance and characteristics (performance and parameter predictions).

ENHANCING : A failure to achieve this technology will have a minor impact on ship performance, mission capability, or cost. The failure to achieve this technology will result in a fall-back to an alternate, but less desirable, higher-state-of-development technology (hardware), or, an acceptance of the “as-built” ship performance and characteristics (performance and parameter predictions).

For the purposes of impact assessments, the baseline ship performance, mission capability and cost is considered to be that expected when all candidate technologies perform as predicted and as required by the ship designer. It should also be noted that “technology” as used in the above definitions refers to both hardware technologies and to performance prediction technologies. That is, “a failure to achieve **this technology**” can be read “a failure to achieve **predicted and required seakeeping performance**”, “a failure to achieve **predicted on-cushion resistance**”, “a failure to achieve **predicted ship weight**” etc.

It is difficult to quantify what constitutes a “serious impact” versus a “minor impact” relative to ship performance and mission capability. For the purpose of this evaluation procedure, a serious impact can be considered one which would abort, seriously jeopardize or stall a development of acquisition program. A minor impact is one which would not substantially interrupt a development or acquisition program.

The following examples are presented to aid in the understanding of **NEED** assessments (the “shortfall” scenarios are assumed for the examples) :

ESSENTIAL NEED :

Platform : 600 Ton Patrol Hydrofoil
Technology : Foil/Strut Steering System
Shortfall : No single-kingpost “T” foil arrangement or system suitable for a pi-foil system can be developed
Fallback : None. A foil/strut steering system is essential to the operation of the fully submerged foil hydrofoil
Impact : Platform cannot be constructed.

CRITICAL NEED :

Platform : High L/B Logistic Transport SES
Technology : Stability for High L/B SES Platforms
Shortfall : Insufficient Stability
Fallback : Increase cushion beam
Impact : Ship cannot operate through Panama Canal. On-cushion resistance at design speed increases.

ENHANCING NEED :

Platform : 1000-Ton High-Speed Monohull
Technology : LM-5000 Gas Turbines at 40000 hp
Shortfall : LM-5000 not qualified at 40000 hp
Fallback : Utilize qualified LM 2500 gas turbines. Two LM 2500s required.
Impact : Slight increase in ship weight, change in arrangements and transmission system,
slight decrease in overall propulsive efficiency.

3.2 **Technology State-of-Development Definitions**

The appropriate **STATE-OF-DEVELOPMENT** descriptor for each technology will be selected from the following :

HIGH : Hardware has been demonstrated, or performance prediction verified, satisfactorily on a large scale on either manned testcraft or at a land-based test site, the results and scaling laws (if any) are fully understood and detailed plans exist for implementing full-scale hardware. Few unknowns remain.

SIGNIFICANT : Some hardware testing, or performance prediction verification has been done on manned ships or testcraft or extensive sub-scale testing has been conducted at land based test sites. Results and scaling laws are sufficiently understood to permit design within acceptable margins. As a minimum, general plans exist for implementing full-scale hardware. Some unknowns remain, but their impact is unlikely to cause major redesign.

MODERATE : Some data exist from subscale testing to indicate that the hardware approach is valid or performance predictions are reasonable. Scaling Laws (if any) are not fully verified and unknowns still remain which could require some redesign.

LOW : Some testing has been done, but results have not been judged totally satisfactory or a lack of credible data makes results inconclusive and performance predictions unverified. Several unknowns exist and, as they are unresolved, redesign will be likely.

MINIMAL : Technology base is mainly theoretical and what testing has been done has not been conclusive. Unknowns exist in sufficient quantity to make any design effort highly conceptual.

In assessing the State-of-Development of subject technologies, developments in the Government and private industry, as well as in the governments and private industries of other countries where U.S access to the technology is assured, should be considered.

State-of-Development assessments should be based upon actual developments to date, not on anticipated or on-going programs (these factors will be considered in the Platform RDT&E Status Assessments).

The following examples, based on SES technologies (3/10/86) are presented to aid in the selection of State-of-Development descriptors.

HIGH

Platform : 35 knot, 450-ton High L/B SES
Technology : Bag-and-Finger Bow Seals
Rationale : Bag-and-Finger bow seals of the size and at this speed have been operated on commercial and Military ACVs and SES. Some minor unknowns remain in the area of seal durability for extended military operations

SIGNIFICANT

Platform : High L/B SES Designs
Technology : On-cushion Resistance Predictions
Rationale : Some testing has been done in moderately high-L/B manned test craft and some model testing of high L/B configurations has been undertaken. The scaling laws for SES on-cushion resistance are sufficiently well understood to permit design within acceptable margins.

MODERATE

Platform : 15,000 Ton Military Sealift Command SES
Technology : Transversely-Stiffened-Membrane (TSM) Bow Seals
Rationale : Model tests have indicated that TSM Bow Seals may be a valid approach.

Considerable unknowns remain in scaling these seals up to sizes suitable for a 15,000 ton SES and manned ship testing has been minimal and inconclusive.

LOW

Platform : 15,000-ton, 60-knot SES
Technology : Surface-Piercing, Super-Cavitating, Overlapping, Counter-Rotating, Controllable
Pitch, 50,000 hp Propellers.
Rationale : Only one known model test has been conducted for this configuration and it was minimal-level test. Very little data exists from the tests. Many unknowns exist.

MINIMAL

Platform : High-Speed, Forward-Deployed Battle Group Escort
Technology : A small, quick response, high-velocity surface-to-air missile capable of intercepting a submarine launched ballistic missile in its boost phase is critical to the operational concept and mission effectiveness of the proposed ship.
Rationale : Analysis has indicated the feasibility of developing a mach 7-8 range missile will require improvements in missile performance parameters and a major breakthrough in current materials technology. Any design effort is highly conceptual.

3.3 **Current RDT&E Activity Definitions**

The evaluation of current RDT&E Activity should be based on current funding levels and allocations of manpower and resources in both the Government and in private industry. On-going RDT&E programs in the governments and private industries of other countries should also be considered where U.S access to the technology is assured. The current RDT&E Activity definitions are as follows :

CONSIDERABLE : Technology is presently receiving funding and allocations of manpower and resources adequate to develop the technology to AFP status at a level commensurate with other approved RDT&E programs (within the Government) or commensurate with other commercial priority RDT&E programs (with private industry).

SOME : Technology is presently receiving some funding and allocations of manpower and resources, but at the minimal level necessary to explore the feasibility of the technology, to slowly advance the technology or to maintain a technology base developed as the result of earlier programs.

NONE : Technology is presently receiving no funding or allocations of manpower and resources. The feasibility of this new technology is not being explored; the technology is not being advanced, and the technology bases developed during past programs are stagnating.

It should be noted that Current RDT&E Activity evaluations should be based only on current funding and activity levels or on committed near-term allocations. The evaluations should not consider past programs (past RDT&E activity is considered in the Technology State-of-Development evaluations). Nor should they consider potential future activities which have not yet received firm commitments of resources.

The following are examples of technology development activity (evaluated as of 3/10/86) :

CONSIDERABLE :

Platform : Multiple SES Designs

Platform Total													

Figure 2. Development Funding Chart

Figures 3 and 4 show worked examples of the Platform Technology Evaluation Summary Sheet and the Development Funding Chart respectively.

PLATFORM TECHNOLOGY EVALUATION SUMMARY SHEET							
Technology	Need	State Of Development	Platform Technical Status	Current RDT&E Activity	RDT&E Timeframe To Prod	Platform RDT&E Status	Platform Status
Z Drive Power transmission - 13000 hp	Essential	High	3	None	MT	2	6
Fully submerged, Super Cavitating Propeller - 13000 hp, Fixed Pitch	Essential	High	3	None	MT	2	6
Automatic Control System	Essential	High	3	Some	ST	1.2	3.6
Foil/Strut Steering System	Essential	Moderate	4	None	MT	2	18
HY-130 Anti-corrosion Coatings	Critical	Significant	4	Some	ST	1.2	4.8
Lightweight, Hi-power Hydraulic Pumps	Critical	Significant	1.5	None	MT	2	3
Foilborne Resistance Predictions							
Foilborne Seakeeping Predictions							
Foilborne Stability Predictions							
Hullborne Seakeeping Predictions							
Weight & Volume Predictions (Design Synthesis Models)	Critical	High	2	None	ST	1.5	3
Underwater Acoustic Predictions	Enhancing	Moderate	2	None	ST	1.5	3
Infrared Radiation Signature Predictions	Enhancing	Moderate	2	None	ST	1.5	3
Surface Weapons Vulnerability Predictions	Enhancing	Moderate	2	None	ST	1.5	3
Development Index							53.4
600 Ton Hydrofoil - Patrol							

Figure 3. Example PTE Summary Sheet for 600-Ton Hydrofoil

Development Funding (in Thousands of Dollars)													
Technology	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Total
Z-Drive Power Transmission - 13000 hp	500	2000	300										2800
Fully Submerged Super Cavitating Propeller - 13000 hp	100	250	300										650
Automatic Control System	350	400											750
Foil/Strut Steering System	300	300	200										800
HY-130 Anti-corrosion Coatings	80	100											180
Lightweight, Hi-power Hydraulic Pumps	300	300	200										800
Foilborne Resistance Predictions	-												
Foilborne Seakeeping Predictions	-												
Foilborne Stability Predictions	-												
Hullborne Seakeeping Predictions	-												
Weight & Volume Predictions (Design Synthesis Models)	40												40
Underwater Acoustic Predictions	100	50											150
Infrared Radiation Signature Predictions	50	50											100
Surface Weapons Vulnerability Predictions	50	50											100
Platform Total													6370
600 Ton Hydrofoil - Patrol													

Figure 5. Example Development Funding Chart - 600 Ton Hydrofoil

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ANNEX C

SHIP CONCEPT RISK EVALUATION

1. **DEFINITION OF RISK** :

RISK (R_f) = PROBABILITY OF OCCURRENCE (P_f) x SEVERITY OF CONSEQUENCE (C_f)

2. **INTERPRETATION OF RISK**

$R_f < 0.25$ LOW RISK

$0.25 < R_f < 0.5$ MODERATE RISK

$R_f > 0.5$ HIGH RISK

3. **RISK RATING - CONSEQUENCE OF FAILURE (C_f)**

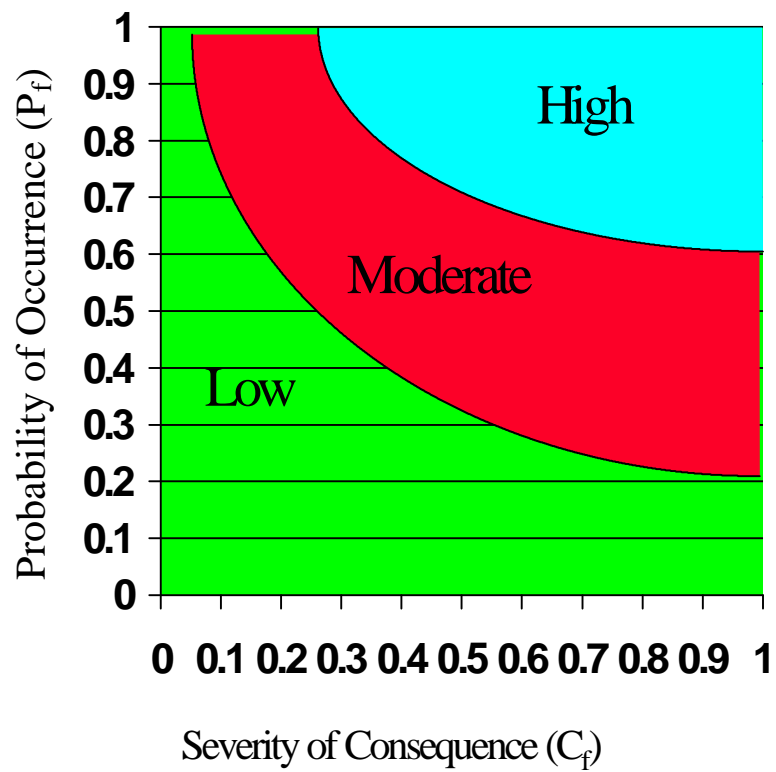
		SCHEDULE		COST OVERRUN		TECHNICAL	
	Rating	Slip Probability	Amount	Probability	Amount	Alternatives	Performance
HIGH	0.9	Certain, Program threatening	>12 months	Certain, Program threatening	>10%	Cannot achieve	Not adequate
HIGH	0.8	Extensive, Program threatening	> 10 months	Extensive, Program threatening	>9%	Redesign or alternate reqd to achieve	Inadequate
HIGH	0.7	Probable Program threat	> 8 months	Probable Program threat	>7%	No adequate backup	Significantly degraded
MODERATE	0.6	Possible program threat	> 6 months	Possible program threat	>6%	Inferior backup	Degraded
MODERATE	0.5	Potential Program threat	> 5 months	Within budgeted range	>5%	Several adequate alternatives	Reduced
MODERATE	0.4	Serious subsystem slip with alternatines	> 4 months	Well within acceptable range	>4%	Several adequate alternatives	Slight reduction
MODERATE	0.3	Subsystem slip requires workaround	> 3 months	Within uncertainty range	>3%	Adequate alternatives exist	Minor reduction
LOW	0.2	Minor subsystem slip	> 2 months	Minor	>2%	Many adequate alternatives	Minor to none
LOW	0.1	Possible minor slip, noncritical path	> 1 month	Negligible	>1%	Many adequate alternatives	No significant impact
LOW	0	No schedule impact	None	None	None	Many adequate alternatives	None

4. PROBABILITY OF OCCURRENCE

RATING	FREQUENCY	TECHNOLOGY	HARDWARE	REQUIREMENTS	TESTING	SOFTWARE	PRODUCIBILITY
0.9	Frequent * likely to occur frequently ** continuously experienced	Maximum technology/Maximum capability	Theoretical design based on advanced research	Good probability of significant deficiencies in meeting requirements	Technology not tested	Extensive new complex s/w for new untested applications	Maximum manufacturing processes required
0.8		Theoretical technology	New theoretical design	Good probability of some moderate deficiencies in meeting all requirements	Approach not tested	Extensive s/w development, new approach, new language	Theoretical manufacturing processes
0.7	Probable *will occur several times in lifetime ** Will occur frequently	Newer technology	All new design	Moderate chance of moderate requirement deficiencies	Unimproved design has been tested	Extensive s/w development - beyond experience base	Newer manufacturing processes
0.6		Available technology. Feasible by analogy	New design to moderately improve existing design	Moderate chance of minor requirement deficiencies	Other analogous items have been tested	Major changes in s/w development approach and application	Available manufacturing processes feasible by analogy
0.5	Occasional *likely to occur in the life of an item **will occur several times	Existing technology and feasibility ideas	Major design change	Some chance of minor requirement deficiencies	Old design has been tested	Readily adaptable s/w approach, conversion form similar application, expanded to new application	Existing manufacturing processes
0.4		Proven technology and approach. Feasibility analysis complete	Redesign, significant modifications	Slight chance of minor requirement deficiencies	Similar designs and technology have been tested	Extensive modification and tailoring of existing approach	Proven manufacturing processes
0.3	Remote *unlikely, but possible to occur in the life of an item ** unlikely, but can reasonably be expected to occur	Proven technology and approach, used by some design agents	Existing proven components, combined or minor mods to function	Should meet all requirements with little margin	Limited testing done on existing components	Slightly modified approach, language conversion	Proven manufacturing processes with some experience
0.2		Proven technology and approach with significant design agent experience	Existing proven components, repackaged and/or minor usage variation	Should meet all requirements, and exceed many	Testing has been done on existing components	Some modification of existing s/w approach	Proven manufacturing processes used with significant experience
0.1	Improbable *so unlikely, assume it may not occur **unlikely to occur, but possible	Proven technology and approach with significant design agent experience	Functional hardware. Mods in form only	Will meet all requirements, exceeding many	Thoroughly tested hardware	Minor revision and checkout of existing s/w	Proven manufacturing processes used with significant experience
0		Off the shelf hardware proven in operational environment	Functional hardware	Will exceed all requirements with margin	Thoroughly tested and exceeds requirements	Use of existing s/w, checked out s/w	NDI off the shelf manufacturing

Mil-Std-882B *Specific Individual Item **Fleet or Inventory

Ship Platform Criticality Chart



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ANNEX D

HIGH SPEED SEALIFT TECHNOLOGY WORKSHOP

PROJECTED FORMAT OF SUMMARY REPORT

1. Introduction
 2. Objective
 3. Working Group summaries :
 - 3.1 High speed hull forms and propulsor technology
 - 3.2 High density/efficiency propulsion/prime mover technology
 - 3.3 Load materials high strength/lightweight structures technology
 - 3.4 Critical ship/port interface (load/unload, C4I) technologies
 - 3.5 Shipbuilding/manufacturing
 4. Integration considerations
 5. Technology assessment (requirement/maturity)
 6. Commercial/military dual use considerations
 7. Recommendation for follow-on projects
- Appendices :
- A. Introductory briefings
 - B. Workshop summaries
 - C. References/previous related studies
 - D. On-going related projects

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ANNEX E

HIGH SPEED SEALIFT TECHNOLOGY WORKSHOP
SHIP SYSTEMS WORK GROUP - INFORMATION REQUIRED FROM OTHER WORK
GROUPS

Note : Items highlighted in bold type are priority items.

1. **High Speed Hullforms and Propulsor Technology**

a. **Hullform**

- **Resistance/Weight ratio vs Froude N^0**
- **effective hp/ton vs Froude N^0**
- **absolute performance limits with various technologies eg hydrofoil cavitation**
- **seakeeping/motions & defining limits**
- **largest demonstrable size of hull form & technology to date**
- **projections : 5, 10 years and beyond**
- absolute dimension limits
- density
- speed degradation in waves
- high and low speed maneuverability
- payload/volume ration
- compatibility with loading/unloading requirement
- compatibility
- extra data points to performance curves for extrapolation
- maturity and risk
- produceability

b) **Propulsors**

- **power density (thrust/ton : power per unit propulsor area etc)**
- **cavitation limits**
- **shallow water operational limits**
- **efficiency vs speed & efficiency vs size**

- flange diameter/thrust ratio limits

- power level limits, current and absolute
- life of unit, MTTF
- hullform hydrodynamic impact
- hullform internal impact
- susceptibility to damage
- signatures and wake
- effects of sea state on propulsor efficiency
- steerability and reversibility
- novel propulsor concepts

2. Load Materials high strength/lightweight Structures Technology

- density

- overall size limits

- working stress and fatigue limits
- resistance to fire, corrosion
- cost per unit weight
- repairability
- robustness
- produceability
- maturity
- development timescale
- inspectability
- stiffness
- environmental material limits
- structural load prediction

3. Critical ship/port interface (load/unload, C4I) technologies

- **payload density**

- **handling, handling system weights and volume and power**
- **integration with hull**
- throughput capability
- sea state limits & general environmental limits for in-stream offload
- manning
- dependency on other resources
- packaging flexibility
- infrastructure requirements
- selective offload capability and cargo accessibility
- seaway imparted loading
- ancillary system requirements eg HVAC etc

4. High density/efficiency propulsion/prime mover technology

- **sfc versus power versus year (including part power performance)**
- **power per unit volume**
- **power to weight ratio vs speed vs power**
- **absolute size limits**
- alternative fuels
- duty cycle
- fuel versatility
- environmental impact
- manning requirements
- tolerance to high speed operation. Noise & vibration
- mtbf & mtrr
- prime mover/propulsor interaction
- handling of working fluids
- support equipment requirements
- transmission systems

- signatures

- environmental operating limits (internal to vessel)

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ANNEX F

SUMMARY OF PRESENTATION REGARDING PRACTICAL RISK REDUCTION MANAGEMENT
MR D FRY : NQEA AUSTRALIA PTY LTD

1. A case study was presented by Mr D Fry, NQEA Australia Pty Ltd, which included design risk mitigation for a projected commercial transport vessel. This presentation was at the invitation of the Group, with the primary intention of establishing whether the methods advocated at Annexes A, B and C would capture the risks perceived by NQEA Australia Pty Ltd during design.

2. A projected semi SWATH fast ferry was described (Seajet 2000 SS-T), with a Full Load Displacement of some 12000 mtons carrying 4000 mtons of fuel and a 2-300 mton payload over a 4000 nm range at 60 knots average speed. This projected vessel is an extrapolation of existing technology based on a vessel built 2 years ago (a 900 mton semi SWATH, the Seajet 250) & technology developed over the last 6 years.

3. Whilst the perceived benefits of selecting a semi SWATH form were described, a degree of risk management would be necessary to realize those benefits. Certain aspects are described below :

a) intended use of LM9000 Gas Turbines - chosen to achieve the power density required to propel the vessel at high speed. In making this selection, Mr Fry believed he was committing himself to a financial, rather than technical, risk since the cost of development would be reflected in the eventual market price of each GT.

b) water jet propulsion - chosen because of the high propulsive efficiency at high platform speeds. This is a reasonably mature area of technology. The major detrimental impact of water jet propulsion arose at the transom, where the flange diameter makes the transom layout inefficient. An increase in Water Jet thrust density would mitigate against this.

c) the structural loading is severe, therefore the structural weight fraction is high. Low speed loading is more severe than high speed in the sea states considered. This is a major design driver as a structural weight reduction can be directly translated into extra payload or fuel. There is a need to optimize the structural weight fraction by using a mix of Aluminum & composites. This is achievable, but improvements are always welcome.

d) scaling issues - in scaling from 900 mton to 12000 mton, there needs to be a method of formally assessing scaling factors (both technical & operational).

e) the frequency of wave encounter & wave induced accelerations at high speed could accelerate wear on equipment and this requires assessment. Equally, as there is a trade-off on range vs payload/fuel weight, there is a need to develop a typical seaway encounter scenario over the proposed route to optimize speed and seakeeping to maintain range and reliability, noting that there is (deliberately) no method of compensating for the weight loss as fuel is burned, so resistance reduces as draft reduces (at the expense of seakeeping).

f) loading/discharge of cargo - the use of automatic docking devices for rapid onload/offload by eg latching & height compensation is envisaged, with minimal (or no) crew involvement during cargo onload./offload,

4. NQEA Australia consider that they are taking little technical risk, and that the projected vessel is in today's design space. The Group believed it important to benchmark NQEA Australia's design against the Transport Factor curves for the State of the Art.

5. In conclusion, the Group were content that the issues discussed would have been addressed by the methods advocated at Annexes A, B and C.

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ANNEX G