SHIP PRODUCTION COMMITTEE
FACILITIES AND ENVIRONMENTAL EFFECTS
SURFACE PREPARATION AND COATINGS
DESIGN/PRODUCTION INTEGRATION
HUMAN RESOURCE INNOVATION
MARINE INDUSTRY STANDARDS
WELDING
INDUSTRIAL ENGINEERING
EDUCATION AND TRAINING

February 1994
NSRP 0406

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Build Strategy Development

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

in cooperation with
Newport News Shipbuilding

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THENATIONAL SHIPBUILDING RESEARCH P R O G R A M

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U. S. DEPARTMENT OF THE NAVY
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REPORT

ON

BUILD STRATEGY DEVELOPMENT

A Project of
The National Shipbuilding Research Program

for

The Society ofNaval Architects and Marine Engineers
Ship Production Committee

Design/Production Integration Panel (SP-4)

PREPARED BY

Thomas Lamb
Director of Engineering
Textron Marine Systems, Inc.
and
A&P Appledore International Ltd.

ACKNOWLEDGMENT

This report has been prepared jointly by A&P Appledore International Ltd. and Thomas Lamb, and covers the preparation% distribution and analysis of the responses to the Build Strategy and Shipyard Capabilities and Limitations Questionnaires and a summary of the visits to both U.S. and foreign shipyards; the attempt to develop U.S. shipyard Common Attributes prerequisites for the use of Build Strategies; and the Build Strategy Document and the examples of its use..

Both questionnaires were jointly developed by A & P Appledore International and Thomas Lamb. However, without the participation of the shipyards who took the time to respond to the questionnaires and those that agreed to allow the project to visit and discuss the subject further, this report would have no value. Their contributions are acknowledged with appreciation.

The study was funded by the National Shipbuilding Research Program Design/Production Integration Panel (SP-4), chaired by J. Getz of Bethlehem Steel Shipyard. The SP-4 Panel is one of the Ship Production Committee Panels of the Society of Naval Achitects and Marine Engineers, which was established with the purpose of improving U.S. shipbuilding performance.

EXECUTIVE SUMMARY

All ipbuilders plan how they will build their ships. The plan may be only in someone's head or a detailed and documented process involving many people. Often diiferent departments prepare independent plans which are then integrated by a "Master Plan/Schedule". A Build Strategy is much more than the normal planning and scheduling and a description of how the Production Department will build the ship. Many shipbuilders use the term "Build Strategy" for their Production Plan only. In terms of this project, this is incorrect. The term 'Build Strategy" as used throughout this report has a special, specific meaning.

A BUILD STRATEGY IS AN AGREED DESIGN, ENGineering, MATERIAL MANAGEMENT, PRODUCTION AND TESTING PLAN PREPARED BEFORE WORK STARTS, TO IDENTIFY AND INTEGRATE ALL NECESSARY PROCESSES.

A number of shipyards and the U.S. Navy believed in the benefit of the Build Strategy approach and this project was undertaken to accomplish the following objectives:

1. To determine, for a number of U.S. shipyards involved in building the selected ship type/s, capabilities and limitations and to classifiy them into common U.S. industry criteria
2. To determine how many U.S. shipbuilders currently use formal documented Build Strategies
3. To familiarize U.S. shipbuilding personnel with the Build Strategy approach, requirements and benefits
4. To determine U.S. shipyard perceived need for a formal Build Strategy
5. To prepare a generic Build Strategy that can be used by U.S. Navy program office during concept, preliminary and contract design as well as U.S. shipyards as the basis for the Build Strategy for a specific project
6. To prepare examples of the use of the generic Build Strategy for two selected ship types
7. To provide a final report on the findings of the shipyard survey on the use of formal Build Strategies, the perceived requirements, shipyard capabilities and limitations and how they were used/corporated into the generic Build Strategy

This report records the performance and findings of objectives 1 through 4 and accomplishes objective 7. Objectives 5 and 6 are presented in Appendices A, B and C.

When it was realized that the Naval Surface Warfare Center had a Generic Build Strategy project underway for the Mid Term Fast Sealift Ships, it was decided to clearly differentiate between the two projects by changing the title of the SP-4 project to BUILD STRATEGY DEVELOPMENT and to concentrate on commercial ships. Therefore the final examples that demonstrate the use of the Build Strategy Development framework area 42,400 tonne DWT Product Tanker and a 30,700 tonne DWT Container/RO RO ship.

Build Strategy and' Shipyard Capabilities and Limitations questionnaires were prepared for distribution to U.S. and Canadian shipbuilders. Three U.S. shipyards responded and, only one was willing to meet with the project team. Two other shipyards agreed to a team visit during telephone calls to solicit support for the project

AU five U.S. shipyards were familiar with the Build Strategy approach. Only one had never prepared a Build Strategy document although even that shipyard did prepare many of the listed content components and was of the opinion that it was not worth the effort to produce a single Build Strategy document.

The shipyards emphasized that the Build Strategy document should not be so structured that it discourage innovation or the introduction of improved methods or facilities. It should not attempt to tell shipyards how to prepare drawings, build ships, define or limit block size or dictate required production information. It should incorporate need for design for producibility and be a guide for continuous improvement and TQM.

Because of the reluctance of most shipyards that were contacted to share the detailed information requested by the Shipyard Capabilities and Limitations Questionnaire, no renewed attempt was made to obtain this information during the visit. Instead, each shipyard visited was asked what were their two or three major limitations. This information was then used to develop a “notional” U.S. shipyard for the Build Strategy development.

Visits to three foreign shipyards were made in June and July, 1993. All shipyards visited gave outstanding support in time and effort to the team and their hospitality was exceptional. They all stated that their willingness to participate in projects to assist the U.S. shipbuilding industry improve was based on the belief that everyone benefits from an open exchange of technology and a sharing of problems and the development of solutions for their resolution. They openly shared their facility capability and limitation data. Both Ferguson and Astilleros Espanoles use the Build Strategy approach. Odense Steel Shipyard does not but its approach to planning and the formal documentation and distribution of the planning documents achieves many of the Build Strategy approach objectives.

A contents list was developed for the Build Strategy Document from the questionnaire responses as well as shipyard visit discussions and each item listed was identified as being “recommended” to an effective Build Strategy or “optional” based on the shipyard responses. The actual Build Strategy Document and the two examples follow this contents list. An introduction outlining the purpose of the Build Strategy Document, its suggested distribution in a shipyard and the prerequisites for a successful Build Strategy is also provided.

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1.0 INTRODUCTION

1.1 General

All shipbuilders plan how they will build their ships. The plan may be only in someone's head or a detailed and documented process involving many people. Often different departments prepare independent plans which are then integrated by a "Master Plan/Schedule".

A Build Strategy is much more than the normal planning and scheduling and a description of how the Production Department will build the ship.

Many shipbuilders use the term "Build Strategy" for their Production Plan only. In terms of this project, this is incorrect. The term "Build Strategy" as used throughout this report has a special, specific meaning. It is also recognized that some shipbuilders have a process very similar to the Build Strategy approach but do not call it such.

What is meant by the term Build Strategy? It:

- Applies a company's overall shipbuilding policy to a contract
- Ensures all departments contribute to the strategy
- Provides a process for ensuring that design development takes full account of production requirements
- Systematically introduces production engineering principles that reduce ship work content and cycle time
- Identifies interim products and creates product-oriented approach to engineering and planning of the ship
- Determines resource and skill requirements and overall facility loading
- Identifies shortfalls in capacity in terms of facilities, manpower and skills
- Creates parameters for programming and detail planning of engineering procurement and production activities
- Provides the basis on which any eventual production of the product may be organized including procurement dates for "long lead" material items
- Identifies and resolves problems before work on the contract begins

  Ensures communication, Cooperation% collaboration and consistency between the various technical and production fiunctions

In summary:

A BUILD STRATEGY IS AN AGREED DESIGN, ENGINEERING, MATERIAL MANAGEMENT, PRODUCTION AND TESTING PLAN PREPARED BEFORE WORK STARTS, TO IDENTIFY AND INTEGRATE ALL NECESSARY PROCESSES.

Although it is known that a number of U.S. shipbuilders have utilized Build “Strategies, it was not known how many and how effective they were.

A number of shipyards and the U.S. Navy believed in the benefit of the Build Strategy approach and this project was undertaken to accomplish the following objectives:

1. To determine, for a number of U.S. shipyards involved in building the selected ship types, capabilities and limitations and to classify them into common U.S. industry criteria

2. To determine how many U.S. shipbuilders currently use formal documented Build Strategies

3. To familiarize U.S. shipbuilding personnel with the Build Strategy approach, requirements and benefits

4. To determine U.S. shipyard perceived need for a formal Build Strategy

5. To prepare a generic Build Strategy that can be used by U.S. Navy program office during concept, preliminary and contarct design as well as U.S. shipyards as the basis for the Build Strategy for a specific project

6. To prepare specific examples of the use of the generic Build Strategy for two selected ship types

7. To provide a final report on the findings of the shipyard survey on the use of formal Build Strategies, the perceived requirements, shipyard capabilities and limitations and how they were used/incorporated into-the generic Build Strategy

This report records the performance and findings of objectives 1 through 4 and accomplishes objective 7. Objectives 5 and 6 will be presented in Appendices A, B and C.

1.2 Background

In the late 1970's the shipbuilding world acknowledged the Japanese as the shipbuilding technology leaders. This was due to their further development of the U.S./European structural prefabrication and pre outfitting techniques into an advanced modular structural and zone outfitting approach.

In the early 1980's they commenced transferring this technology for monetary gain to the U. S., first by private agreements with individual shipyards and then by the MarAd sponsored SP-2 Panel activities. This activity is well documented in the many SP-2 Panel reports, which may be obtained through the University of Michigan Transportation Research Institute library.

About the same time a shipbuilding/consultig soup in Britain was also transferring its technology for gain to countries around the world but their efforts were not as well recognized in the U.S. as that of the Japanese shipbuilders.

That company was A&P Appledore International Ltd. Originally owned by London Overseas Freighters and Court Line, who operated the Austin & Pickersgill and Appledore shipyards, A&P Appledore was formed in 1971 to transfer technology, most notably to the Far East but also Europe, North and South America. A&P Appledore was largely responsible for the success of South Korean shipbuilding, having designed and managed the largest shipyard in the world at Hyundai, and then the largest building dock in the world at Daewoo, Okpo. Since then A&P Appledore has worked in over 60 different countries. It was A&P Appledore that conceived and developed the formal Build Strategy approach in the early 1970's. It developed from the ideas and processes generated to support the A&P Appledore associated "Ship Factories" at Sunderland and Appledore. The detailed work breakdow nformalized work sequencing andvery short build cycles associated with these ship factories required the communication, coordination and cooperation that are inherent in the Build Strategy approach.

British Shipbuilders adopted the Build Strategy approach for all their shipyards (l)* and A&P Appledore consulting group, which became a private company at the nationalization of the shipyards, continued to develop the approach as a service to their clients.

The Build Strategy approach was introduced into the U.S. by A.&P Appledore participation in IREAPS conferences as well as presentations to individual shipbuilders and the SP-4 Panel (2,3 and 4).

A&P Appledore consulting to NORSHIPCO, Lockheed Shipbuilding Company and Tacoma Boat introduced the use of the Build Strategy approach to U.S. shipbuilding projects. Finally, the Build Strategy approach was described in the DESIGN FOR PRODUCTION Manual, prepared by A&P Appledore for the SP-4 Panel (5).

The concept of the Build Strategy has existed for a number of years, and there has been an ongoing development of the concept in those shipyards which have adopted the Build Strategy approach. During this time, shipyards in Britain have had considerable experience in applying this

•See Section 10.0 REFERENCES

technology, and it is now appropriate to update the original Build Strategy approach in the light of this experience.

Why is this project necessary? It was perceived by some shipbuilders and the U.S. Navy that the formal documented Build Strategy approach had not been enthusiastically embraced by U.S. shipbuilders. If the Build Strategy approach is such a good idea and/or shipbuilding improvement tool, it is surely worthwhile to try to find out if this is the case and if so, why isn't it being used U.S. shipyards?

It is a known fact, but unfortunately, not often practiced approach, that the peformance of any endeavor will be improved by improvements in communications, moderation and collaboration. A Build Strategy improves all three. It cmmunicates the intended total shipbuilding project to all participants. By better communication it fosters improved cooperation as everyone is working to the same plan. It improves collaboration by involving most of the stakeholders (interested parties) in its development.

Figure 1.2.1 conceptually shows how a Build Strategy does this. It is taken from reference 1.

Figure 1.2.2 shows the required inputs to and output from a Build Strategy. It is taken from reference 2.

Figure 1.2.3 is a route map which interestingly shows the concept of a Preliminary Build Strategy being prepared during the preliminary design phase and a Detailed Build Strategy during the contract and transitional design phase. It is taken horn reference 5.

The U.S. Navy has expressed interest in preparing a Build Strategy for each new building program to help them develop production oriented designs and to foster its further use by U.S. shipbuilders, to the mutual benefit of both.

Even today it is fortunately still possible to find shipyard engineering and material schedules that do not support the production schedule. A major benefit of a Build Strategy is its integrating effect and thus, the elimination of this unacceptable situation in today's competitive world.

Japan and other countries have shown that by taking time before starting on a project to plan and integrate all the processes involved in building a ship, they can significantly improve on the performance of less strategically inclined shipbuilders.

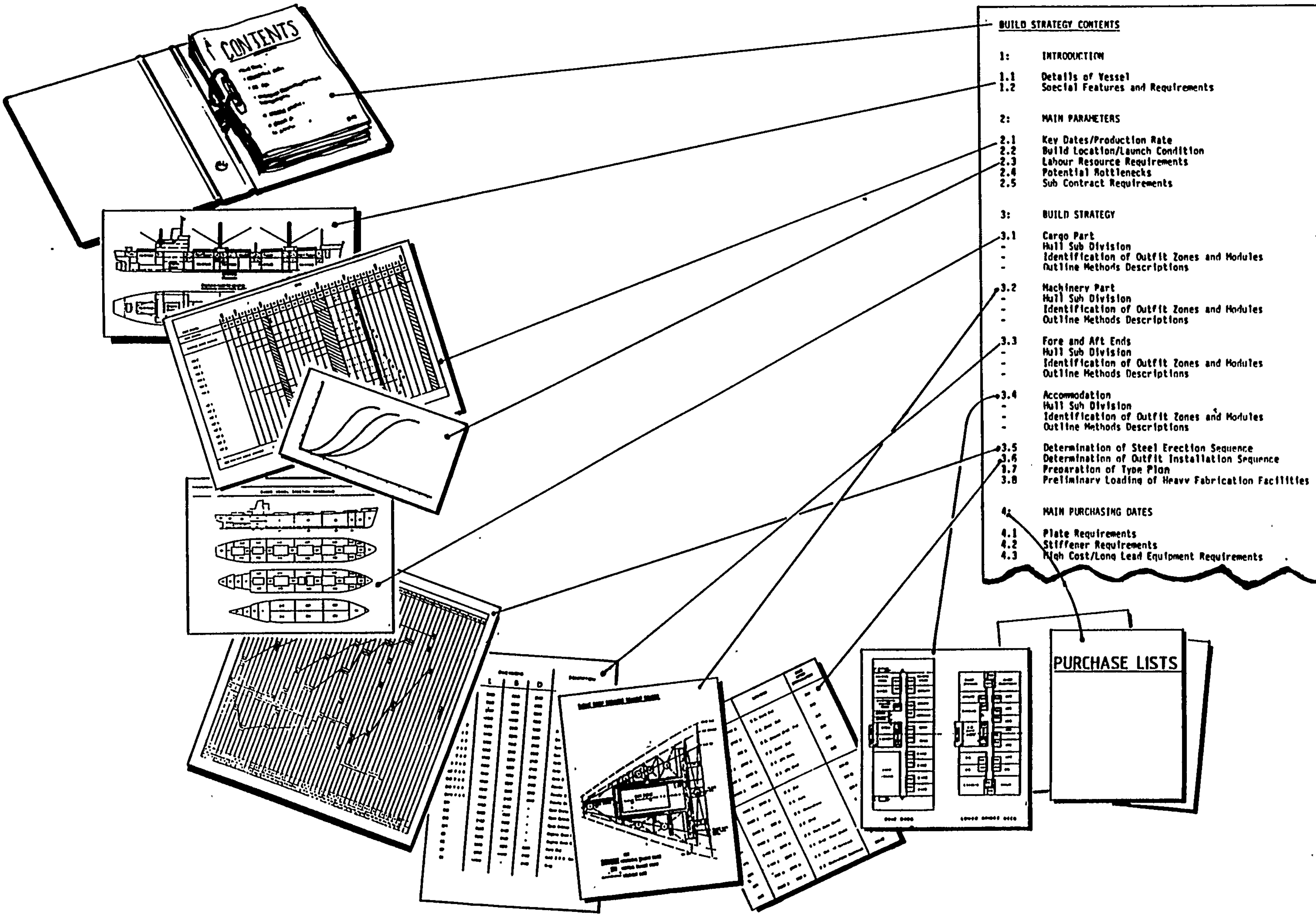

FIGURE !.2.1 - BUILD STRATEGY

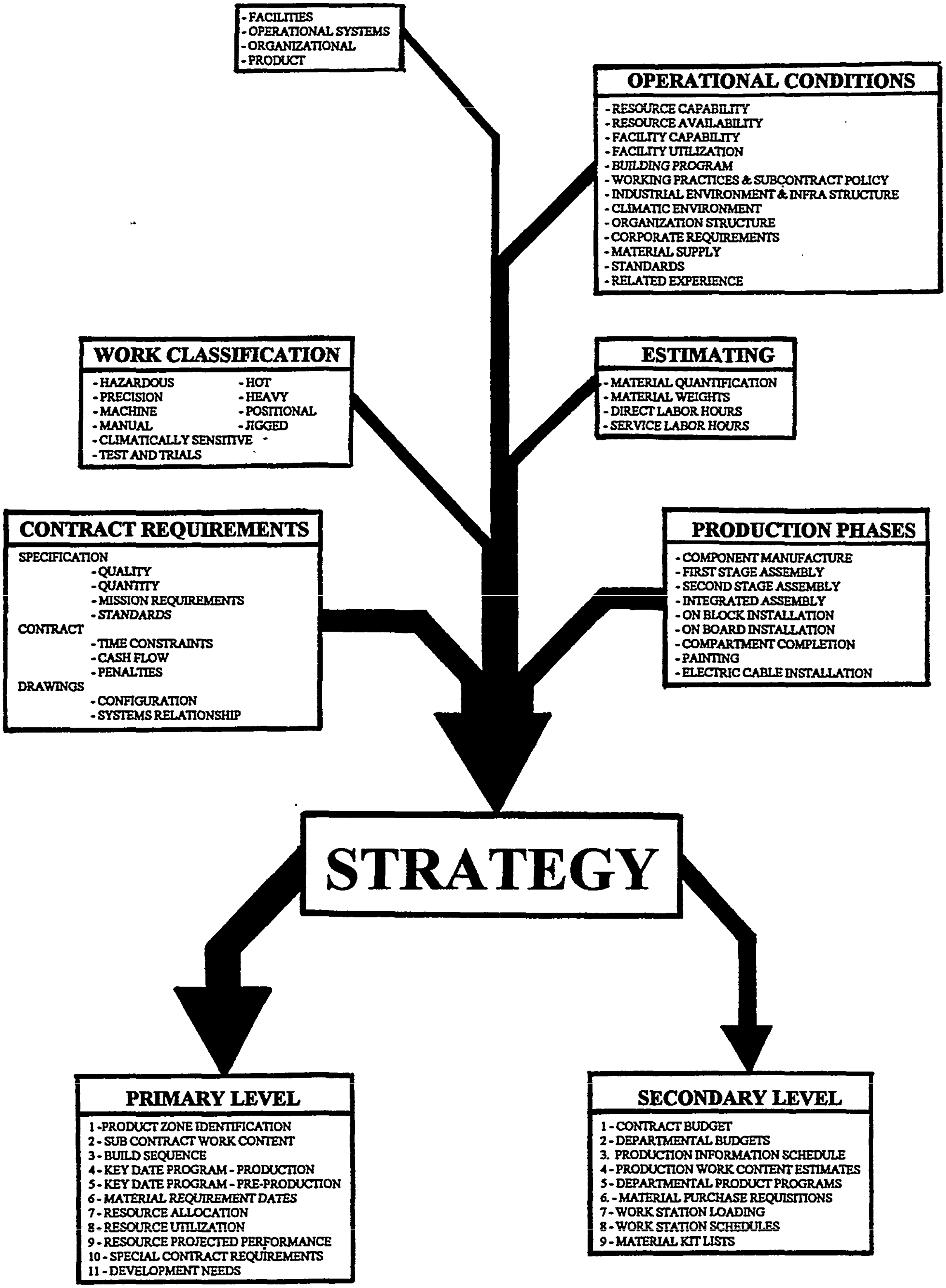

FIGURE 1.2.2 - BUILD STRATEGY PROCESS

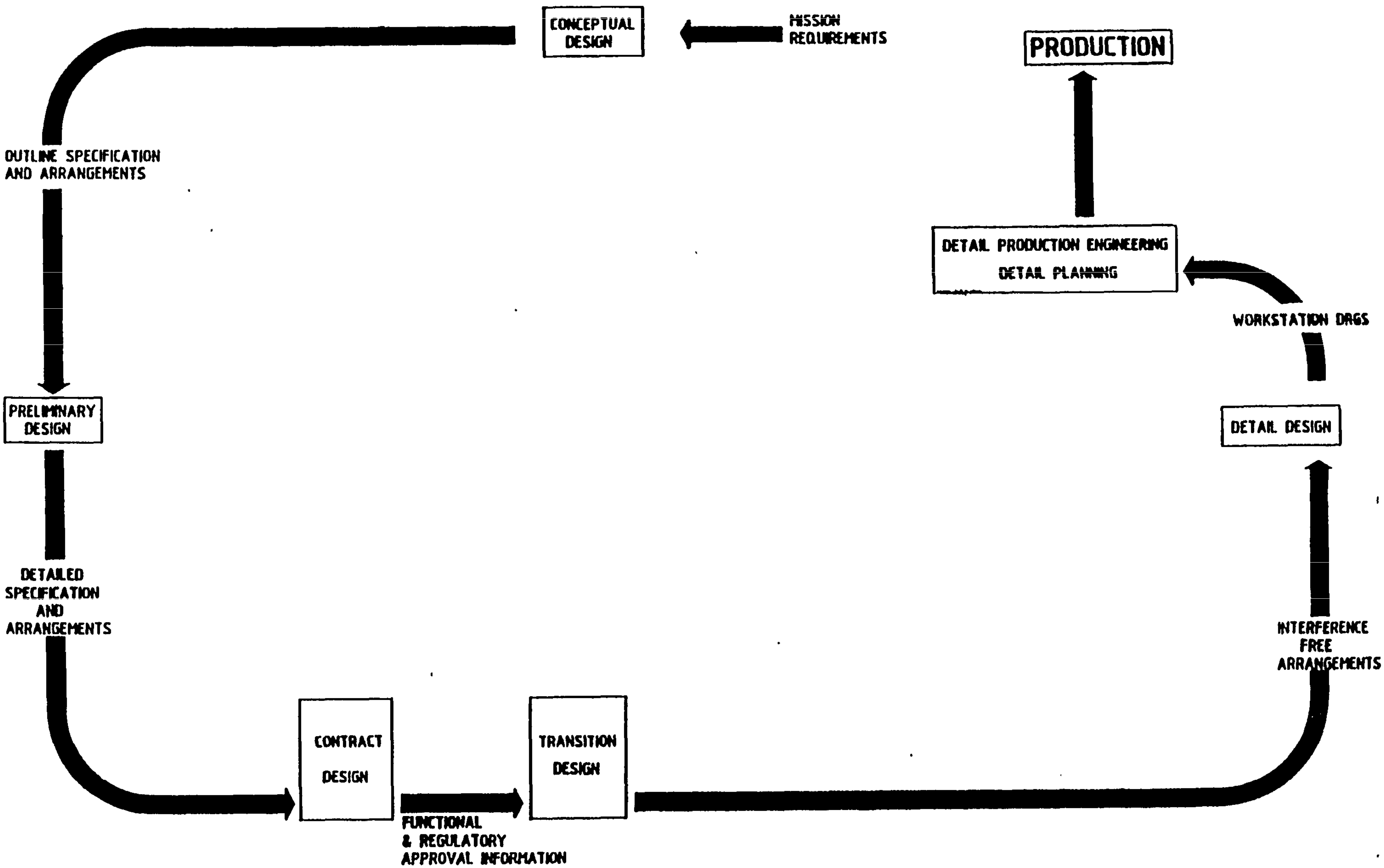

FIGURE 1.2.3 - BUILD STRATEGY ROUTE MAP

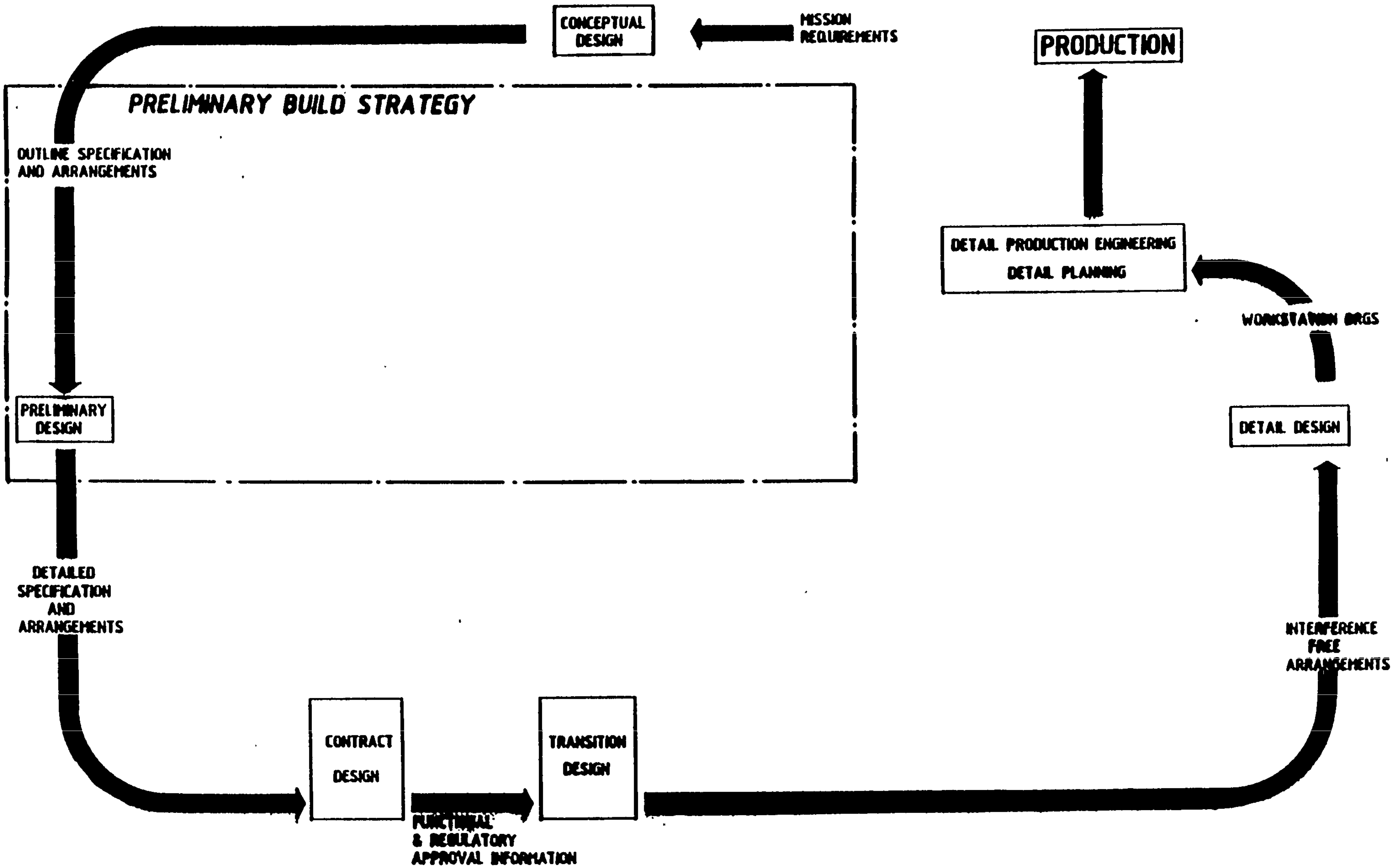

FIGURE 1.2.3 (continued) - BUILD STRATEGY ROUTE MAP

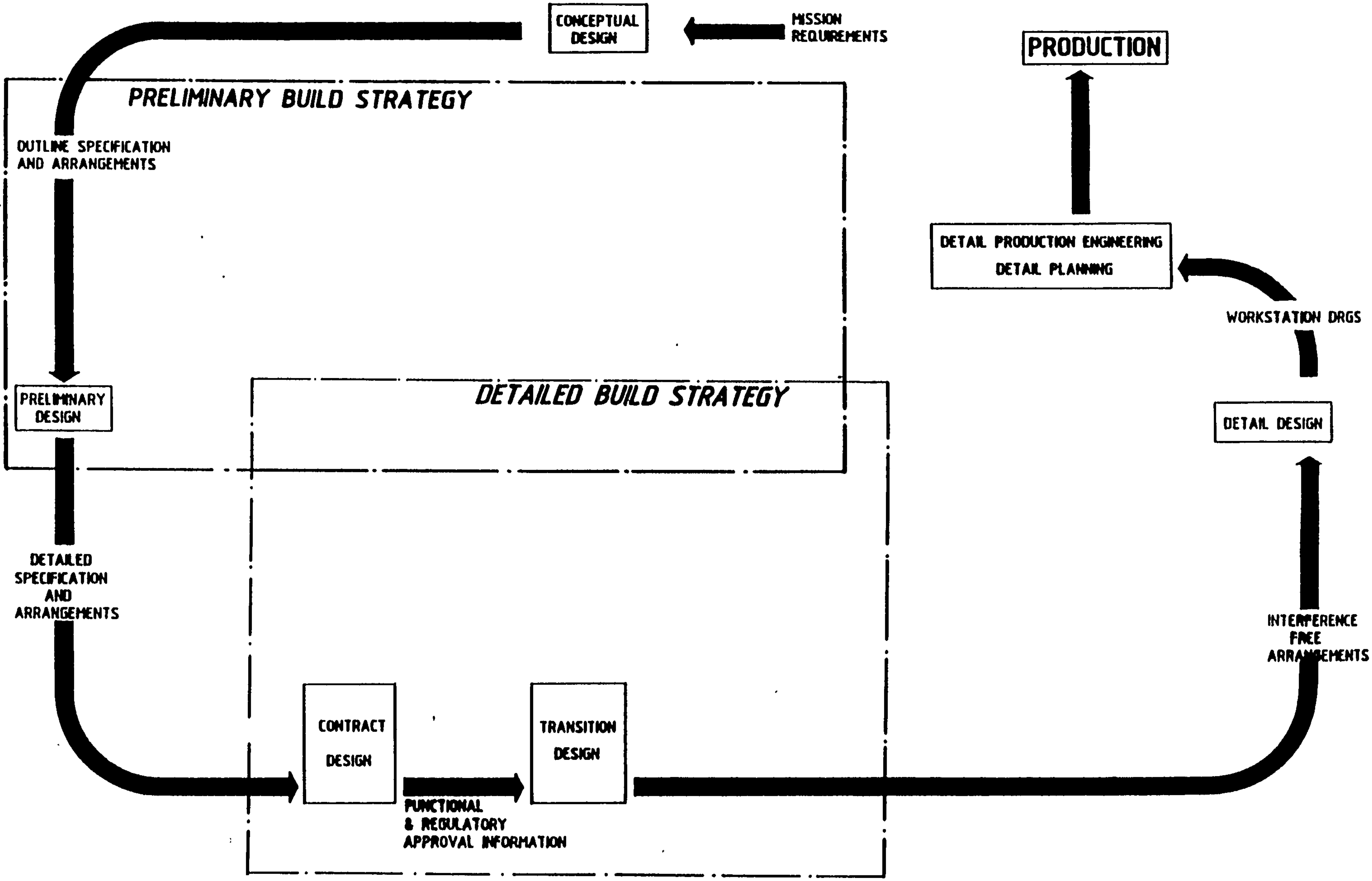

FIGURE 1.2.3 (continued) - BUILD STRATEGY ROUTE MAP

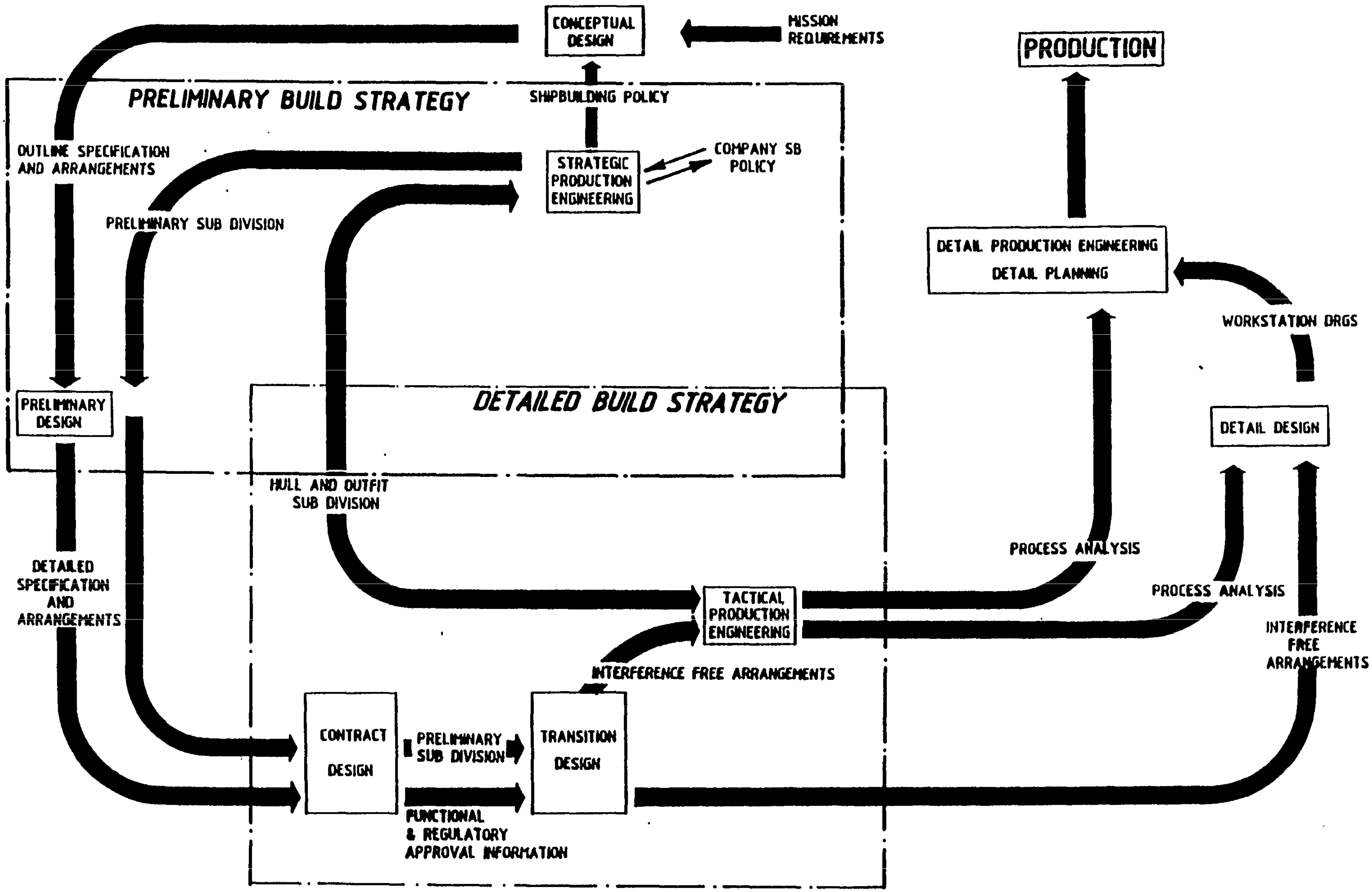

FIGURE 1.2.3 (continued) - BUILD STRATEGY ROUTE MAP

1.3 Selection of Ship Examples

Four ship types were offered to the Project Panel Ad Hoc Team, namely;

- Destroyer
- Fleet Oiler
- RO RO
- Container

The Ad Hoc Team selected the fleet oiler and the container ship in January 1993. As the project developed and the industry interest shifted even more from military to commercial ships, a number of sources recommended that the fleet oiler example be changed to a products tanker. Therefore the final examples that were selected to demonstrate the use of the Build Strategy Development framework are a 42,400 tonne DWT Product Tanker and a 30,700 tonne DWT Container/RO RO ship.

Attempts to get ship design information for ships recently designed and/or constructed, for the selected two ship types from U.S. sources were unsuccessful. Therefore, an A&P Appledore design for a Products Tanker and the MarAd PD-337 Commercial Cargo Ship (non-enhanced) design were used for the examples.

1.4 Project Team

The project was performed by A & P Appledore International with Thomas Lamb as total coordinator and for U.S. shipyard liaison. Originally, it was intended to include on the team a British shipbuilder experienced in the use of Build Strategies and in their application to the two selected ship types. This was not possible due to disinterest by suitable British shipbuilders. hstead, visits and discussions with a number of British and European shipbuilders were arranged in an attempt to be able to present to the U.S. shipbuilding industry information on how other successful shipbuilders perform integrated planning and scheduling, communication and coordination of important project interfaces.

1.5 Build Strategy Questionnaire

A questionnaire was prepared for distribution to U.S. and Canadian shipbuilders. Its purpose was to determine current understanding and use of the Build Strategy approach. THE BUILD STRATEGY QUESTIONNAIRE is shown in Appendix E.

As Build Strategy means different things to different people/shipbuilders, a description of the project meaning of Build Strategy, very similar to the introduction and background of this report, was prepared.

1.6 Shipyard Capabiity and Limitations Questionnaire

The project abstract required that the major U.S. shipbuilders be surveyed to determine current capabilities and limitations regarding building of selected ship types, so that “common capabilities and limitations” could be developed and used in the Generic Build Strategy and/or the two examples of its use. Appendix F shows the SHIPYARD CAPABILITIES AND LIMITATIONS QUESTIONNAIRE that was used for this purpose.

2.0 QUESTIONNAIRE RESPONSE

2.1 Questionnaire Distribution

Both questionnaires were sent to 22 private and Navy shipyards. Where a shipyard had a representative on a Ship Production Panel, the questionnaires were sent to the Panel member with the request to get questionnaires to the right people and to encourage participation.

Where the shipyards did not have people on the Ship Production Panels, the questionnaires were sent to known contacts with the same request or to the Vice President Production.

Appendix D shows the distribution list for questionnaires. Questionnaires were sent to two contacts in five of the shipyards.

2.2 Questionnaire Responses

Questionnaires were received from three shipyards. The Build Strategy Questionnaire was completely filled out in all three cases. The Shipyard Capability and Limitation Questionnaire was only completely filled out by one shipyard with the other shipyards completing from 30 to 50 percent. Only one of the shipyards that responded to the questionnaires was willing to meet with the project team. Two other shipyards agreed to a team visit during telephone calls to solicit support for the project

Build Strategy Questionnaires were completed for two shipyards that were visited but had not completed the questionnaires.

The information in the responses has been consolidated and is presented in Table 2.2.I for the Build Strategy and Table 2.2.II for the Shipyard Capability and Limitation Questionnaire.

2.3 Build Strategy Questionnaire Findings

All five shipyards responding to the Build Strategy Questionnaire were familiar with the Build Strategy approach. Only one had never prepared a Build Strategy document although even that shipyard did prepare many of the listed content components and was of the opinion that it was not worth the effort to produce a single Build Strategy document.

There were wide differences in the need for many of the listed content components to be in the Build Strategy document. However, 18 out of 51 were identified by at least four shipyards and another 11 by at least three shipyards. These 29 components were identified as Build Strategy 'recommended" components. Two components in the Construction Data group, namely: Number of Plate Parts and Number of Shape Parts were considered unnecessary by all five shipyards. They will not be included in the Build Strategy Document. The remaining 20 components were identified as "optional".

TABLE 2.1.I - BUILD STRATEGY QUESTIONNAIRE U.S. SHIPYARD RESPONSE

		YES	NO
Are you familiar with the Build Strategy approach described for this project?.		5	
Has your company ever prepared such a Build Strategy?		4	1
How many?		3to6	
What ship Types and Sizes?	Product Tankers, AOE's, Container ship, T-AKX and T-AGS		
IF YES Which Department had the major responsibility for Build Strategy Development?	Master & Production Planning and Production Planning & Control		

		YES	NO
Has your company ever used a Build Strategy for a complete design/build cycle?		4	1
How many?		lto2	
IF YES What ship types and Sizes?	Container ship, Destroyer, Sealift Conversion, T-AKX and T-AGS		

	YES	NO
Does your company use the Build Strategy approach for current projects?	4	1

IF NO, and your company previously used the Build Strategy approach why did you stop?

a) Build Strategy document not kept up to date
b) Not worth the effort based on resulting benefits
c) It was not enforced. No one followed it
d) Other

	YES	NO
Does your company intend to prepare and use the Build Strategy approach for future projects?	4	1

IF NO, why not?

a) Not perceived to be worth the effort	1
b) Too much information considered proprietary	
c) Other -	

ONE SHIPYARD'S COMMENT - HAVE MOST OF THE PARTS. DO NOT SEE NEED/BENEFIT TO FORMALIZE ONE DOCUMENT

If your company does not prepare and use a complete Build Strategy, please indicate in this column what parts it does document and distribute to all decision makers	Please indicate in this column what you feel should be in a Build Strategy document
Ship Description	5
Applicable Regulations	1
Classification	2
Quality	3
Contract Requirements	3
Product Work Breakdown Structure	5
Master Equipment List	5
Design & Engineering Plan	
Budget	1
Resource Allocation and Utilization	2
Key Drawings	5
Material Purchase Requisitions	4
Work Station Drawings	2
Material Lists	1
CAM Data	3
Schedule	4
Material Plan	
Budget	2
Material Required Dates	3
Schedule	5
Build Plan	
Key Dates/Production Rate	5
Productivity Targets	3
Budget	2
Resource Allocation and Utilization	2
Sub-contract Requirements	3
Build Location/Launch Condition	5
Module Definition	5
Product/Zone Identification	5
Machinery Units	5
Integrated Units	3
Accommodation	3

Build Plan (continued)

Paint Strategy	3
Subcontract Work Content	2
Production Required information	4
Reference System	3
Molded Definition	1
Accuracy Control	2
Tolerances	2
Distortion Control	1
Rework Procedures	2
Work Station Schedules	4
Weight Control	1
Material Kitting Lists	1
Tests and Trials	4

Construction Data

Number of Plate Parts	
Number of Shape Parts	
Number of Modules	5
Number of Assemblies	5
Number of Subassemblies	1
Joint Weld Length	2
Paint Areas	4
Deck Covering Areas	3
Pipe Lengths and Type	2
Number of Pipe & Assemblies	2
Electric Cable Lengths and Types	2

	YES	NO
DO YOU SEE THIS PROJECT AS WORTHWHILE?	4	1
DOES IT HAVE POTENTIAL BENEFIT TO YOU?	3	1

WHAT ADDITIONS WOULD YOU LIKE TO SEE COVERED IN THE STUDY?

OTHER RELATED COMMENTS:

	YES	NO
Would you be prepared to allow a visit to your shipyard by members of the project team to discuss Your use/interest in the Build Strategy approach?	3	2

TABLE 2.1.11- SHIPYARD CAPABILITIES AND LIMITATIONS QUESTIONNAIRE
U.S. SHIPYARD RESPONSE

MARKET

		YES	NO
Does your Company have a Marketing/Sales Department?		2	1
Does your Company engage in Market Research?		2	1
		Domestic	Foreign
What is your current primary market?	Military	2	1
	Commercial Ocean Going	1	
	Commercial Off shore		
	Commercial Small Boat		
	Pleasure Craft		
What is your desired market for the next 10 years?	Military	2	2
	Commercial Ocean Going	3	3
	Commercial Offshore		
	Commercial Small Boat		
	Pleasure Craft		

Typical recent Contracts

SHIP TYPE/SIZE	CUSTOMER	SIGNIFICANT DATES (Month/Year) CONTRACT AWARD	START FAB	LAUNCH	DELIVERY
First of Class- Combatant (Cruiser)		1/82	11/83	8/85 -	12/86
Last of Class- Combatant (Cruiser)		12/88	1 1/90	11/92	1/94
First of Class- Combatant (LHD)		2/84	7/84	8/87	5/89
Last of Class - Combatant (LHD)		9/86	7/88	3/89	7/92
First of Class - Combatant (Frigate)				4/81	3/82
Last of Class - Combatant (Frigate)				3/86	2/87
First of Class - Small Tanker				4/82	2/83
Last of Class - Small Tanker				9/83	1/84
First of Class- Combatant (Destroyer)		4/85	7187	9/89	4/91
Last of Class - Combatant (Destroyer)		1/93	8/95	6/97	9/98

PLANNING AND SCHEDULING

			YES	NO
Is all planning and scheduling performed by a single (central) department			1	2
IF **YES**	Is planning performed at three levels?	- Strategic (S)	1	
		- Tactical (T)	1	
		- Detailed (D)	1	
IF NO	Does each department plan and schedule work?		2	
	IF **YES** At what planning levels?	- Strategic (S)	2	
		- Tactical (T)	2	
		- Detailed (D)	2	
	Which department coordinates/integrates plans? Master Scheduling			
Do you use a Material Requirements Program?			3	
If no, what method is used?				
Do you use an integrated Resource Requirements Program?			3	
If no, what method is used?				
Do you use Computer Aided Process Planning?				3

MATERIAL

			YES	NO
Do you have a Material Planning (Control) Group?			2	1
Ifyes, what department is it in?	Material/Engineering and Manufacturing Engineering			
Who has responsibility for Material Schedule?	Master Scheduling/Production Planning & Sched			
Do you use a material coding system?			3	
Do you use material standards?			2	1
If yes, for what products?	All procured items			
Do you use MRPI or similar system?				3
Do you use MRPII (RRP) or similar system?			3	
Are any materials palletized?			3	
If yes, on what basis?	Kits by	Work Station	3	
		Shop	2	
		Block	1	
		Zone	1	

ENGINEERING

			YES	NO
Do you have a complete in-house Engineering capability?			1	1
Do you subcontract any of your engineering to Design Agents?			2	
Do you subcontract all your engineering to a Design Agent?				2
Do you use Design for Production approach?			2	
Do you use Design to Cost approach?				2
Do YOU utilize Group TechnoIogy?				2
Do you use company wide project teams?			2	
Do you utilize Concurrent Engineering?			2	
Do you use CAD?			2	
Is engineering for production presented in the traditional Systems approach?			1	1
Is engineering for production presented in the Modular and Zone approach?			2	
Do you have standard engineering procedures in place?			2	
Do you use engineering standards?			1	1
Do you utilize integrated machinery units?			2	
Do you have an in-house computer aided lolling capability?			2	
If yes, what department is responsible for Lofting?	Engineering 2	Manufacturing		
Do you use a Service for your Lofting and N/C documentation?				2
Does your CAD system prepare Manufacturing Piping Details?			2	
Are the Engineering drawings used directly by Manufacturing?			2	
Are work station/shop sketches used by Manufacturing?			2	
Who prepares the work Station/shop sketches?	Engineering 1	Manufacturing 1		
Do you have a separate Manufacturing5dustrial Engineering Group?			2	
If so, what department are they in?	Engineering	Manufacturing 2		
Number of engineers (Degreed professionals)?	Current 20	Maximum		
Number of designers?	Current 2 0	Maximum		
Number of drafters?	Current 50	Maximum		
How is engineering organized?	Function 2 Product	Matrix		
Are sections grouped traditionally, that is Hull, Machinery and Electrical?			2	
OR are sections grouped to suit Modular and Zone Design and Construction?				2

MATERIALS HANDLING

		YES	NO
Are all materials handled by cranes?		1	2
Plate yard material handling is by	Monobox Crane		
Shape yard material handling is by	Mobile Crane		
Pipe yard material handling is by	Mobile Crane and Buggy		
Structural shop material handling is by	Bridge Cranes		
Pipe shop material handling is by	Bridge and Jib Cranes		
Machine shop material handling is by	Bridge and Jib Cranes		
Outfit shop material handling is by:	Bridge and Jib Cranes		
Are self-elevating self-propelled transporters used?		2	1
If yes, what is capacity?		250 t	
Are self-elevating, non self-propelled transporters used?		2	1
If yes, what is capacity?		50 t	
Are non self-elevating trailers/transporters used?		3	
If yes, what is capacity?		up to 50 t	
Are fork lift trucks used?		..3	

If yes, what:	Number	Capacity
	75 .	1 to 14 t

What other material handling systems do you use?

Stake Bodies, Order Pickers and Material Stackers

MANUFACTURING

				YES	NO
Do you use the modular structural approach?					
What structural product breakdown do you use?	Part			2	
	Sub-assembly			2	
	Assembly			2	
	Block			2	
	Super Block			1	1
Do you use Zone Outfitting approach?				2	
Do you use Advanced Outfitting approach?				2	
Number of craft workers?	current 5000		Maximum	9000	
Number of laborers? -	Current 300		Maximum		
Number of support workers?	Current 500		Maximum		
Do you use subcontractors for work in the shipyard?					2
If yes, for what products?					
Do you have an Accuracy Control Group?				2	
If yes, what products is it used for?					

" Structural Assemblies, Hull Construction Piping Fabrication & Installation, Vent Fabrication & Installation, and Electrical Component Installation

	YES	NO
Do you utilize Advance Outfitting Integrated Machinery Units?	2	
Do you utilize Advance Outfitting On Block outfitting?	2	
Do you utilize Open Sky Advance Outfitting	2	
Is electrical outfitting including cable installed in blocks?	1	1

PAINTING

		YES	NO
Do you blast and prime coat	Plates	2	
	Shapes?	2	
	Pipe?	1	1
Do you use weld through primer?		2	
Do you blast assemblies or blocks to remove primer? .		2	
Do you have cells for blasting and painting of assemblies or blocks?		2	

If yes, at what stage/s of the structural build process? After initial Outfitting/Assembly & Block

;FACILITIES

Site Particulars	Total acreage	110 acres
	Covered shop area	900,000 sq ft
	Plate yard area	70,000 sq ft
	Shape yard area	170,000 sq ft
	Pipe yard area	190,000 sq ft
	Covered warehouse area	160,000 sq ft
Site Constraints	Width of river	2,000 ft
	Maximum draft at outfitting berth	32 ft
	Any Canal/lock access to sea width	
	Any bridge access to sea height	
Building Berths	Berth number	1 2 3
	Type	—Inclined Ways—
	Length	700 ft 700ft 700 ft
	Breadth	100 ft 100 ft 100 ft
	For dry-docks, max float off draft	
	For launch ways, max water depth	35ft 35ft 35ft
Berth Cranes	Number of cranes	3
	Type	**Gantry**
	Capacities	300 t, 225t and 40 t
	Outreach	249 ft, 246 ft and 133 ft
	Max Multi crane lift	Number of Cranes Lift
	Max lift for tuning blocks	225 t
Structural shop and platens	Shop Size	188,500 sq ft
	Length	
	Width	
	Height under crane 20 ft	
	Maximum throughput	
	Recent throughput	

	NUMBER	TYPE	CAPACITY
Burning machines	4	Plasma/Gas	48 ft by 13 ft
Plate Rolls	2		30 ft&8ft
Plate Press	3		500,400 & 300 t
Shape Bender	2 benders/3 presses		
Shop cranes	22	Bridge	3 to loot
Blast &Prime	4		
Panel line	1	Automated	50ft width
Assembly area			133,000 Sq ft
Block assembly			175,000 Sq ft
Block erection		3 positions@ 700 ft by 100 ft	
Maximum assembly	Size 50 ft by 18 ft Weight 40 t		
Maximum block	Size 80 ft by 50 ft Weight 200 t		
Max lift for turning	Assemblies 225 t Blocks 225 t		

Machine shop/s	Length 500 ft Width 100 ft	Height under crane 30 ft
	Equipment and capacity	

Piping shop/s	Length 450 ft Width 100 ft		Height under crane 17 ft		
	Shop Capacity By	Pipe Pieces	Pipe Assemblies	Weight	
				YES	NO
	Do you use N/C pipe cutting?				1
	Do you use N/C pipe bending?			1	
	Equipment and capacity:				

Outfitting shop/s	Length 400 ft Width 200 ft	Height under crane 36 ft	
	Do you have a machinery unit shop?		1
	If yes, Length 50 ft Width 20 ft	Height under crane 17 ft	
	unit Constraint Size	Weight	
	Equipment and capacity		

Welding Equipment/Processes		Percentage of Total Welding
What welding equipment/ processes do you use?	Fab Shop	15
	Platen	45
	Berth	40

Access Equipment	YES	NO
Do you use conventional staging?	2	
Do you use Patent staging?	1	1
Do you use "Cherry-pickers"?	2	
Do you use "Sky-Climbers"?		2
Do you use elevators?	2	
Do you use escalators?		2

2.4 Shipyard Capability and Limitations Questionnaire Findings

Only one shipyard answered all the questions. Another answered them all except those dealing with Facilities. The third shipyard only answered a few Planning and Material questions.

This lack of response makes it impossible to determine common capabilities and limitations. However, the following findings are presented.

Two shipyards have existing Marketing Departments which are involved in Market Research. Interestingly, they both have only been involved in Navy or government contracts during the past decade.

One shipyard has a central planning and scheduling department, the others have a Master Planning Group that integrates the planning and scheduling of the various departments.

Two shipyards have separate Material Planning/Control Groups and all three use material coding MRP II or similar systems.

Only one shipyard has a complete in house engineering capability. Both the other shipyards subcontract most of their engineering to marine design agents.

Two shipyards use CAD concurrent engineering production oriented drawings, standard engineering procedures and engineering standard details.

AU three shipyards have complete in-house lofting capability and they are part of the engineering department.

Two shipyards have Manufacturing Industrial Engineering groups and they are part of the Production Department.

Engineering in all three shipyards is fictionally organized into the traditional hull, machinery and electrical although their work is prepared for block construction and zone outfitting.

Two shipyards use self-elevating, self-propelled transporters up to 250 ton capacity, and both self and non-elevating trailers from 50 to 80 ton capacity. Fork lift trucks from 1 to 14 ton capacity are used for general material handling.

All three shipyards are using block construction, zone outfitting and packaged machinery units. They all use Accuracy Control for structure and one shipyard uses it for piping, ventilation and electrical components.

AU three shipyards have state of the art painting capabilities.

3.0 U.S. SHIPYARD VISITATION

3.1 Shipyards Visited

The project team visited BethShip, Avondale Shipyards and NASSCO. Each visit lasted a minimum of four hours with one taking six hours. A proposed agenda was sent to each shipyard prior to the meetings along with a number of additional questions which would be asked during the visit. The project team first presented background infornation on the project, such as description, objectives and approach. Then the purpose of the meeting was presented, which was to discuss face to face the questionnaire responses and clarify any questions. It was also to see what each shipyard had done and was doing with regard to Build Strategy. In addition, the Shipbuilding Technology Office of the Naval Surface Warfare Center at Carderock, Maryland was visited. The purpose of this visit was to learn about the Generic Build Strategy activity being worked on for the Mid Term Fast Sealift Ship (MTFSS) program. The purpose of the meeting was to determine how the two projects could and should interact. The Navy reported that there was considerable confusion in the industry because of identical project titles and concern regarding the relationship of the SP-4 Panel Build Strategy project and the U.S. Navy's Mid Term Fast Sealift Ship program. Questions being asked ranged from "Are they connected?" to "How are the two projects going to be differentiated?". There is no contractual connection. The MTFSS program is interested in using the Build Strategy approach for one specific ship in a number of shipyards to reduce the time taken from contract award to delivery of the ship. The SP-4 project is interested in showing many shipyards how to use the Build Strategy approach for any ship type. The visit was most beneficial in determining this difference and resulted in agreement that it was necessary to differentiate between the two projects to the maximum extent possible. It was mutually decided to rename the SP-4 project and further, to concentrating entirely on commercial shipbuilding and ship types. It was decided to clearly differentiate between the two projects by changing the title of the SP-4 project to BUILD STRATEGY DEVELOPMENT.

All shipyards and the Shipbuilding Technology 0ffice were very cooperative and generous in the giving of their time and sharing of their experiences and information.

3.2 Visit Findings for Build Strategy

All three shipyards were familiar with the Build Strategy approach and had prepared a number of Build Strategies in preparation of bids. Ship types involved were container ship and product tanker. Two had used Build Strategies for at least one complete design/build cycle. Ship types involved were container, sealift conversion and T-AGS.

The departments having the major responsibility for the Build Strategy Development were under Production in two shipyards and part of Advanced Product Planning and Marketing in the other shipyard.

All three shipyardswere committed to using the Build Strategy approach in continuing greater scope. This was entirely based on their own perceived needs/benefits and was not being driven by external demands or pressure.

The project team was able to review recent Build Strategies at each shipyard and was impressed by the level at which they.were being used. Build Strategy size ranged from 100 to 300 pages. Typical effort ranged from 400 to 2000 manhours. However, it was pointed out that most of the effort would be required in any case. It simply was being performed earlier, up front, in a formal and concurrent manner. Based on this, the additional effort to prepare a Build Strategy is likely to be about 400 hours. Obviously, the first time it is done, the additional effort may be considerably more as the new approach must be learned in a team environment and many traditional barriers broken down.

By this review and discussion of the Build Strategies, it was possible to determine the items which were considered an essential part,which items were optional and what should not be included in the Build Strategy document. This categorizing of the contents will be used in the actual Build Strategy document.

The project team emphasized that it was necessary for each shipyard to have a documented Shipbuilding Policy on which to base their Build Strategies. Otherwise, each Build Strategy must contain the required policy components.

The shipyards emphasized that the Build Strategy document should not be so structured that it discourage innovation or the introduction of improved methods or facilities. It should not attempt to tell shipyards how to prepare drawings, build ships, define or limit block size or dictate required production information. It should incorporate need for design for producibility and be a guide for continuous improvement and TQM. The Build Strategy document and examples of its use should be based entirely on commercial ships of the type likely to be built in the U.S. in the foreseeable future. It should not address military ships of any type. This will help to differentiate this project from the Navy Mid Term Fast Sealift Ship Project.

The Build Strategy document must treat all components of the design, build and test process with equal attention. So often the “simpler” or “better known” front end design and production decisions are more than adequately treated but the back end processes such as system tests and compartment check off are given minimum consideration in a Build Strategy.

The two examples of the Build Strategy document use should emphasize the ship type major differences and their impact on the Build Strategies.

The project should emphasize the benefits of the formal Build Strategy approach. In doing this an attempt should be made to determine which world class shipbuilders use the Build Strategy or similar approach. The project should also clearly describe the pre-requisites that a shipyard should have or develop before undertaking a Build Strategy to ensure the best chance of an effective Build Strategy being developed and implemented. The use of preliminary and detailed Build Strategies should be clearly described. Finally, the project should provide documentation that is suitable for use.as an educational tool.

3.3 Visit Findings for Shipyard Capabilities and Limitations

Because of the reluctance of most shipyards that were contacted to share the detailed information requested by the Shipyard Capabilities and Limitations Questionnaire, no renewed attempt was made to obtain this information during the visit. Instead, each shipyard visited was asked what were their two or three major limitations. All three shipyards mentioned crane capacity. They would all like to erect larger blocks than currently possible. One shipyard would like to increase crane capacity throughout the fabrucation and assembly shops as well as the block erection on the ways or in the dock. Another shipyard would like to have more covered (out of the weather) buildings for assembly and block construction. Finally, one shipyard mentioned that its major limitation was timely engineering.

4.0 U.S. SHIPYARD COMMON ATTRIBUTES

As previously mentioned, due to lack of response to the Shipyard Capabilities and Limitations Questionnaire, it was not possible to determine U.S. shipyard common attributes which could be used in the Build Strategy Document. In order to have a basis on which to prepare the project Build Strategy Document and examples of its use, a hypothetical shipyard was constructed by the project team. The hypothetical shipyard represents no existing U.S. shipyard but rather attempts to reflect some of the facilities and capabilities of a typical U.S. shipyard that would be interested in competing in the world commercial ship market. It does not reflect the lowest common capabilities. Table 4.1 describes or lists the hypothetical shipyard capabilities in sufficient detail to be used by the Build Strategy Document examples.

TABLE 4.I

NOTIONAL U.S. SHIPYARD

The shipyard has been in operation since the end of WWII or within a decade thereafter. It has undergone extensive modernization especially in the last two decades. Average annual improvement budget has been in the range of $5 to 10 million for new equipment structural shops, cranage, berths, outfitting shops, fitting out quays and technical and management software. It has either been a continuous builder of naval ships with an occasional commercial ship. or of commercial ships, but recently forced into naval support type ships because of the lack of U.S. commercial shipbuilding over the last 10 years.

Potential throughput is 70,000 CGT per year. This is equivalent to four 40,000 Tonne DWT Product Tankers or three and a quarter 30,000 Tonne DWT Container Ships.

The shipyard has mid 1980 technology steel processing and fabrication shops, equipment material handling and cranage. Equipment includes plate and shape pre-processing treatment with conveyor handling. N/C burning machines, plate rolls and presses. Line heating is used for plate shaping. Frame bending is accomplished by hydraulic machine utilizing computer generated templates or inverse lines. A panel line is used for flat stiffened panels with one sided welding and automatic stiffener welding. Webs and other subassemblies are processed in a designated subassembly area and fed to both panel line and shaped structure shop. Pin jigs are used for shape structure. Some panels and shaped structure is joined to form 3 dimensional blocks at outside platens. Multi-wheeled jack up transporters are used to move panels, assemblies and blocks to the various shops, platens and berth/s.

Equipment and piping modules are constructed in a special outfit packaging shop

Areas are designated for “On Block” outfitting either before or after block coating treatment.

Panels for the deckhouse are transported to a special deckhouse construction shop for “On Block’ outfitting and the to an erection area. Once the structure and distributive systems are completed the deckhouse is turned over to the joiner work and furnishing subcontractor.

Material handling consists of conveyors and overhead cranes in the shops, panel and block transporters, outfit pallet trucks, platen cranes and berth cranes.

The shipyard subcontracts a significant portion of its design and engineering work to design agents. Both the shipyard and the design agent have coordinating staff in each other's premises. CAD is used for all engineering and the engineering department prepares all lofting and pipe piece definition. Design for production is emphasized and engineering documentation is provided in the most suitable way to suit structural block and zone outfitting construction

The Production Engineering group performs process analysis and works with Engineering to develop the shipyard's Ship Definition.

AU machining is subcontracted.

The following particulars-describe the major physical attributes of the shipyard:

1.0 CRANES

In Preparation Shop	2 @ 5 tonne EOTC 1 tonne local as required for Profile Working
In Subassembly Shop	2 @ 5 tome EOTC
In Assembly Shop	2 @10 tonne EOTC
In Panel Line	1 @60 tonne EOTC with 18 m from floor to hook
In Block Assembly	2 @60 tonne EOTC
At Berths	2 @ 135 tonne at 27 m jib crane

2.0 BERTHS 2 @ 230 m x 35 m conventional building berths

3.0 ACCESS

Doors into/from Preparation Shop, and Subassembly Shop, and into Panel Assembly Shop	4 m high and 4 m wide
Door from Panel Assembly Shop	6 m high and15mwide
Doors into from Block Assembly	15 m highand 18 m wide

4.0 TRANSPORTERS

Into/from Preparation Shop and Subassembly Shop	5 tonne, capable of handling plates up to 13.615 m by 2.438 m and profiles up to 13.615 m by 0.4 m
Into/from Assembly Shop	10 tonne, capable of handling panels up to 13.615 m by 2.438 m
From Panel Line	60 tonne, capable of handling panels up to 15.4 m by 13.615 m
From Block Shop	250 tonne, capable of handling blocks up to 29.26 m by 13.615 m

5.0 SHOP AREA - Assembly Shop 20,000sq m

5.0 FOREIGN SHIPYARD VISITATION

5.1 Shipyards Visited

Eight foreign shipyards were contacted but only four responded and three of them agreed to a visit.

Visits to the three foreign shipyards were made in June and July, 1993. The shipyards were Ferguson's in Port Glasgow, Scotland, a successful small ship builder; Odense Steel Shipyard in Denmark, a successful large ship builder reputed to be one of the best shipbuilders in the world today; and Astilleros Espanoles in Spain, another successful large shipbuilding group which has utilized many of the NSRP project publications to assist them in their improvement program

All shipyards visited gave outstanding support in time and effort to the team and their hospitality was exceptional. They were most open in showing and describing their facilities, processes, goals and problems, and all stated that their willingness to participate in projects to assist the U.S. shipbuilding industry improve was based on the belief that everyone benefits from an open exchange of technology and a sharing of problems and the development of solutions for their resolution.

5.2 Visit Findings for Build Strategy

Ferguson Shipbuilders recognize that they do not have ideal facilities and their success is based on small size allowing a togetherness, valuing every one's participation allowing change from within rather than forcing change from the top, and improving productivity by better use of what they have.

Ferguson's does prepare a Build Strategy for each contract. They have done this for all contracts since start up. They cover most of the items listed as essential in the study proposed Build Strategy Document List. Most of the optional items are omitted, although they do include budgets. Build Strategy with budgets are given restricted distribution. The Production Engineering Group has the responsibility to prepare the Build Strategies with input from other groups/departments. They gave the Team a copy of the Build Strategy for the current contract under construction. A copy of the contents list of the Build Strategy is shown in Table 5.2.1.

Ferguson's Build Strategy is relatively simple (that's how they like it), but even with their small size they still see and achieve benefits from using the Build Strategy approach. Ferguson's uses previous Build Strategies as the basis for new Build Strategy.

Ferguson's subcontracts a considerable amount of their outfitting. Although they design the piping and HVAC, the fabrication and installation is done by subcontractors.

Odense Steel Shipyard has excellent facilities with up to date equipment and processes. Some of their robots are self developed. They have an extensive ongoing facilities improvement program. They are not satisfied with any phase of their operation and are always seeking continuous improvement. They are currently building today what they did in the past with 40% of man hours. Odense believes productivity is the key to future success in global shipbuilding. They have goal of 6% annual productivity improvement. Typical build cycle is 12 months with 3 months in building dock one month outfitting and 3 weeks deck trials and sea trials. Sea trials are normally 3 days and once the ship leaves the shipyard for sea trials it does not return to shipyard.

Odense Steel Shipyard does not use the Build Strategy approach but has a planning system that covers most of the Build Strategy components and recognizes the need to communicate this information in a formal manner to the many users in a shipyard. Odense Steel Shipyard (0SS) was not aware of the Build Strategy approach. However, the way they prepare and formally document and distribute their planning documents achieves some of the same objectives. 0SS does have along term business plan and the Phase I part of their planning process is similar to the Shipbuilding Policy. Their planning is totally integrated. 0SS said they agree with the benefits stated for the Build Strategy approach but did not like the project title of Generic Build Strategy as it was confusing. As Build Strategies are for a specific ship in a specific shipyard, how can they be Generic? 0SS has always used standard processes and standard details to the maximum extent and still do so. They are an effective part of 0SS high productivity in all departments and processes.

AstillerosUeros Espanoles is a grouping of diverse shipyards covering all sizes of commercial ships and offshore vehicles/rigs. They have a central office in Madrid. This central group performs much of the business planning and setting of each shipyard policy. However, at the meeting with representatives of all shipyards in the group and at meetings at Sestau and Peurto Real Shipyards the enthusiasm of individual managers for continuous improvement including the use of a Build Strategy approach was very clear. Each shipyard has its own 5 year plan covering goals, productivity, ship types and employees. A major point in their use of Build Strategy is the development of a catalog of interim products for each shipyard. Build Strategies were reviewed in two shipyards. They covered most of the recommended items in the study proposal Build Strategy Contents List. In addition, they added interesting information about the ship owner, his existing fleet and operations. The study proposed Build Strategy Contents List was modified to incorporate this additional item as an option. The Contents List for a Build Strategy at Puerto Real Shipyard is shown in Table 5.2.11.

5.3 Visit Findings for Shipyard Capabilities and Limitations

AU of the shipyards visited stated that improvement in productivity was the key to survivability and fiture success in the global shipbuilding market place. Ferguson’s approach was to accept mid 1980 facilities and to concentrate on using their people more effectively through integrated processes. The building berth limited them to ships up to 100 meters. Their limitations were temporary, in that they could be eliminated by investment, were berth cranage and block shop size, cranage and access dimensions.

Odense Steel Shipyard has very up to date capabilities and is in the fortunate position of having no known limitations for the foreseeable future.

Astilleros Espanoles shipyards cover the range from old shipyards to relatively new facilities, but in all cases have had significant modernization in the last few years, some of which is still underway. Only one shipyard acknowledged any limitations, and that was the clear width of a bridge through which its ships had to pass to get to the sea.

TABLE 5.2.1

FERGUSON SHIPBUILDERS BUILD STRATEGT CONTENTS

TABLE 5.2 II

ASTILLEROS ESPANOLES PUERTO REAL SHIPYARD BUILD STRATEGY CONTENTS

1. INTRODUCTION - PURPOSE OF DOCUMENT
2. OWNER
   - Background
   - Fleet
   - Past Relationship
   - Competition
   - Service - Special Aspects - Mission and Concept
3. CONTRACT
   - Important Dates
   - Priorities - Order of Precedence
   - Technical Characteristics
   - Supplemental Clauses for Contract
   - Cancellation
   - Drawing Approval and Supervision of Construction
   - Unique/Special Items
   - charterers Rights
   - Quality Standard
   - Selected Vendors
   - Sea Trials
   - Payment
   - Budget and Build Cycle
   - Productivity Goals
   - Administration Goals.
4. PRINCIPLE CHARACTERISTICS
5. CLASS & REGULATIONS
6. COMPARISON OF SHIP WITH OTHER SHIPS BUILT BY SHIPYARD
7. MASTER EQUIPMENT SCHEDULE
8. SHIPYARD SCHEDULE OF WORK FOR 4 YEARS
9. SCHEDULE FOR SHIP
10. MAN-HOUR LEVELING
11. ENGINEERING AND PLANNING
12. CONSTRUCTION STRATEGY
13. PRODUCTIVTTY IMPROVEMENT
14. QUALITY IMPROVEMENT
15. BLOCK BREAKDOWN

6.0 BUILD STRATEGY DOCUMENT CONTENTS LIST

A contents list was developed for the Build Strategy Document from the questionnaire responses as well as shipyard visit discussions and is shown in Table 6.I. As mentioned in Section 2.3- "Build Strategy Questionnaire Findings", each item listed was identified as being "recommended" to an effective Build Strategy or "optional" based on the shipyard responses. The contents list is changed from the listed items in the Build Strategy Questionnaire, based on shipyard suggestions, but it was still possible to designate each item as recommended and optional and follow the combined shipyards' intent. The actual Build Strategy Document and the two examples follow this contents list. An introduction outlining the purpose of the Build Strategy Document its suggested distribution in a shipyard and the prerequisites for a successful Build Strategy is also provided.

TABLE 6.1

PROPOSED BUILD STRATEGY DOCUMENT CONTENTS

1:	INTRODUCTION	
	1.1 Purpose of Document	RECOMMENDED
	1.2 Build Strategy Document Prerequisites	RECOMMENDED
	1.3 Distribution	RECOMMENDED
	1.4 summary	RECOMMENDED
2:	VESSEL DESCRIPTION	
	2.1 General Description &Mission	RECOMMENDED
	2.2 Principal Particulars	RECOMMENDED
	2.3 Special Characteristics & Requirements	RECOMMENDED
	2.4 Comparisons/Differences From Previous Vessels	RECOMMENDED
	2.5 Applicable Regulations & Classification	OPTIONAL
	2.6 Owner Particulars	
	2.6.1 Background	OPTIONAL
	2.6.2 Fleet	OPTIONAL
	2.6.3 Past Relationship	OPTIONAL
	2.6.4 Competition	OPTIONAL

3: CONTRACTUAL	
3.1 Contractual Dates & Time Constraints	RECOMMENDED
3.2 Payment	OPTIONAL
3.3 Liquidated Damages & Penalties	RECOMMENTED
3.4 Cancellation	OPTIONAL
3.5 Drawing Approval	OPTIONAL
3.6 Construction Inspection	OPTIONAL
3.7 Trials	OPTIONAL
3.8 Quality	RECOMMEND
4: DESIGN & ENGINEERING	
4.1 Strategy & Scope	
4.1.1 General	RECOMMENDED
4.1.2 Changes to Ship Definition Strategy	RECOMMENDED
4.1.3 Modeling & Composites	RECOMMENDED
4.2 Key Drawings	RECOMMENDED
4.3 Production Information requirements	
4.3.1 CAM information	RECOMMENDED
4.3.2 Manufacturing Information	RECOMMENDED
4.3.3 Parts Listings	RECOMMENDED
4.3.4 Installation Drawings	RECOMMENDED
4.3.5 Installation Procedures	RECOMMENDED
4.4 Design & Engineering Schedule	
4.4.1 Schedule	RECOMMENDED
4.4.2 Resourcing & Utilization	OPTIONAL
4.4.3 VFI Schedule	RECOMMENDED
4.5 Datum’s & Molded Definition	OPTIONAL
4.6 Design Standards	RECOMMENDED
4.7 Functional Space Allocations	RECOMMENDED
4.8 Detail Design Guidelines	
4.8.1 Steelwork	OPTIONAL
4.8.2 Machinery	OPTIONAL
4.8.3 Pipework	OPTIONAL
4.8.4 Electrical	OPTIONAL
4.8.5 JoinerWork	OPTIONAL
4.8.6 Paintwork	OPTIONAL

5	PROCUREMENT	
	5.1 Master Material List	OPTIONAL
	5.2 Master Equipment List	OPTIONAL
	5.3 Material Procurement Strategy	OPTIONAL
	5.4 Procurement Schedule	RECOMMENDED
	5.5 Critical/Long Lead Items	RECOMMENDED
6:	PLANNING & PRODUCTION	
	6.1 Strategic Planning	
	6.1.1 Key Event Program	RECOMMENDED
	6.1.2 Resourcing & Utilization	OPTIONAL
	6.1.3 Changes to Shipbuilding Policy	RECOMMENDED
	6.1.4 Required Facility, Tooling & Equipment Upgrade	RECOMMENDED
	6.2 Work Breakdown	
	6.2.1 Work Breakdown Structure	RECOMMENDED
	6.2.2 Coding	RECOMMENDED
	6.3 List of Planning unit	
	6.3.1 Hull Blocks	RECOMMENDED
	6.3.2 Zones	RECOMMENDED
	6.3.3 Equipment Units	RECOMMENDED
	6.3.4 Systems	RECOMMENDED
	6.4 Master Schedules	
	6.4.1 Hull Blocks	RECOMMENDED
	6.4.2 Zones	RECOMMENDED
	6.4.3 Equipment Units	- RECOMMENDED
	6.4.4 Systems	RECOMMENDED
	6.5 Hull Production Strategy	
	6.5.1 Preliminary Process Analysis Integration of outfit Process Analysis By Block	OPTIONAL
	6.5.2 Non Standard Interim Products	OPTIONAL
	6.5.3 Build Location & Launch Condition	RECOMMENDED
	6.5.4 Erection Schedule	RECOMMENDED
	6.6 Machinery Space outfit Strategy	
	6.6.1 Equipment Units	RECOMMENDED
	6.6.2 On Block outfitting	RECOMMENDED
	6.6.3 On Board Outfitting	RECOMMENDED

6.7 Accommodation Outfit Strategy	RECOMMENDED
6.8 Cargo & Other Space Outfit Strategy	
6.8.1 On Block Outfitting	RECOMMENDED
6.8.2 On Board Outfitting	RECOMMENDED
6.9 Painting Strategy	
6.9.1 Outline Paint Specification	OPTIONAL
6.9.2 Pre-Painting	RECOMMENDED
6.9.3 Primer Repair Strategy	RECOMMENDED
6.9.4 Unit/Block Painting Strategy	RECOMMENDED
6.9.5 Zone Painting Strategy	RECOMMENDED
6.9.5.1 Machinery Spaces	
6.9.5.2 Outside Shell and Decks	
6.9.6 Special Considerations	RECOMMENDED
6.10 Sub-Contract Requirements	
6.10.1 Bought-In Items	RECOMMENDED
6.10.2 Use of On-Site Sub-Contractors	RECOMMENDED
6.10.3 Industrial Relations Considerations	OPTIONAL
6.11 Productivity	
6.11.1 Productivity Targets	RECOMMENDED
6.11.2 Comparisons/Differences From Previous Vessels	RECOMMENDED
6.12 Temporary Services	
6.12.1 Staging Plan	RECOMMENDED
6.12.2 Access.& Escape Plan	OPTIONAL
6.12.3 Power & Lighting	OPTIONAL
6.12.4 Weather Protection	OPTIONAL
7: ACCURACY CONTROL MANAGEMENT PLAN	
7.1 System Critical Dimensions & Tolerances	RECOMMENDED
7.2 Interim Product Critical Dimensions & Tolerances	RECOMMENDED
7.3 sampling Plan	OPTIONAL
7.4 Special Procedures	OPTIONAL
7.5 Jigs & Fixtures	OPTIONAL
7.6 Hot Work Shrinkage	
7.6.1 Use of Extra Stock	OPTIONAL
7.6.2 Shrinkage Allowances	OPTIONAL
7.6.3 Distortion Control	OPTIONAL

8 TEST & TRIALS

8.1 Test Planning	
8.1.1 Strategy	RECOMMENDED
8.1.2 Schedule (High Level)	**RECOMMENDED**
8.2 Pre-Completion Testing	
8.2.1 Pre-Survey & Dry Survey	OPTIONAL
8.2.2 Pipe Pre-Testing	OPTIONAL
8.2.3 Equipment Unit Pre-Testing	OPTIONAL
8.3 Tank Test Schedule	RECOMMENDED
8.4 Equipment Unit Test Schedule	RECOMMENDED
8.5 Pipe Unit Test Schedule	RECOMENDED
8.6 Zone Close-Out Strategy	RECOMMENDED
8.7 Principal Trials Items	RECOMMENDED

9: PERSONNEL

9.1 Industrial Relations Aspects	
9.1.1 Design	OPTIONAL
9.1.2 Sub-Contract	OPTIONAL
9.2 Training	OPTIONAL
9.3 Project Organization	
9.3.1 Shipyard Organization Charts	RECOMMENDED
9.3.2 Client's Organization Charts	RECOMMENDED

10: WEIGHT CONTROL

10.1 General	
10.2 Outline Procedure	RECOMMENDED
10.3 Departmental Responsibilities	RECOMMENDED

7.0 PREREQUISITES FOR A BUILD STRATEGY

While any shipyard could develop a Build Strategy for any ship to be constructed by them there are certain prerequisites that make the process easier and more effective. Most shipyards will have a Business Plan covering a number of years. As a prerequisite for the Build Strategy approach a Shipbuilding Policy should be prepared. This policy, in effect, describes how the business plan will be implemented. Part of the Shipbuilding Policy is the Ship Definition. This describes in.detail how the types of work will be defied (Product Work Breakdown Structure) and what processes and formats will be used for technical documentation% material definition and ordering ,work station definition and other necessary technical procedures. If there is no Shipbuilding Policy, including a Ship Definition, then it must be developed for and as part of each Build Strategy. This is an ineffective approach, especially as much of the information Shipbuilding Policy is standard for a shipyard and will not change for individual ships to be built.

Therefore the prerequisites that must be in place for the successful introduction of the Build Strategy approach are -

Business Plan
Shipbuilding policy
Ship Definition
Product Work Breakdown Structure

8.0 RELATIONSHIP BETWEEN SHIPBUILDING POLICY AND BUILD STRATEGY

8.1 General

A Shipbuilding Policy is developed from a company's Business Plan.which is usually developed to cover a period of five years and includes such topics as:

- the product range which the shipyard aims to build
- shipyard capacity and targeted output
- targets for costs
- pricing policy

The product range is identified, usually as a result of a market study.

The relationship between a Business Plan Shipbuilding Policy and Build Strategy is shown in Figure 8.1.

8.2 Shipbuilding Policy

8.2.1 Introduction

A Shipbuilding Policy is the definition of the optimum organization and build methods within the company's shipbuilding ambitions as defined in the Business Plan. The Shipbuilding Policy is aimed primarily at design rationalization and standardization together with the related work organization to simulate the effect of series construction. This is achieved by the application of group technology and a product work breakdown which leads to the formation of interim product families.

The Business Plan sets a series of targets for the technical and production part of the organization. To meet these targets, a set of decisions is required on:

- facilities development
- productivity targets
- make, buy or subcontract
- technical and production organization

These form the core of the Shipbuilding Policy. The next level in the hierarchy defines the set of strategies by which this policy is rerlized, namely the Build Strategy.

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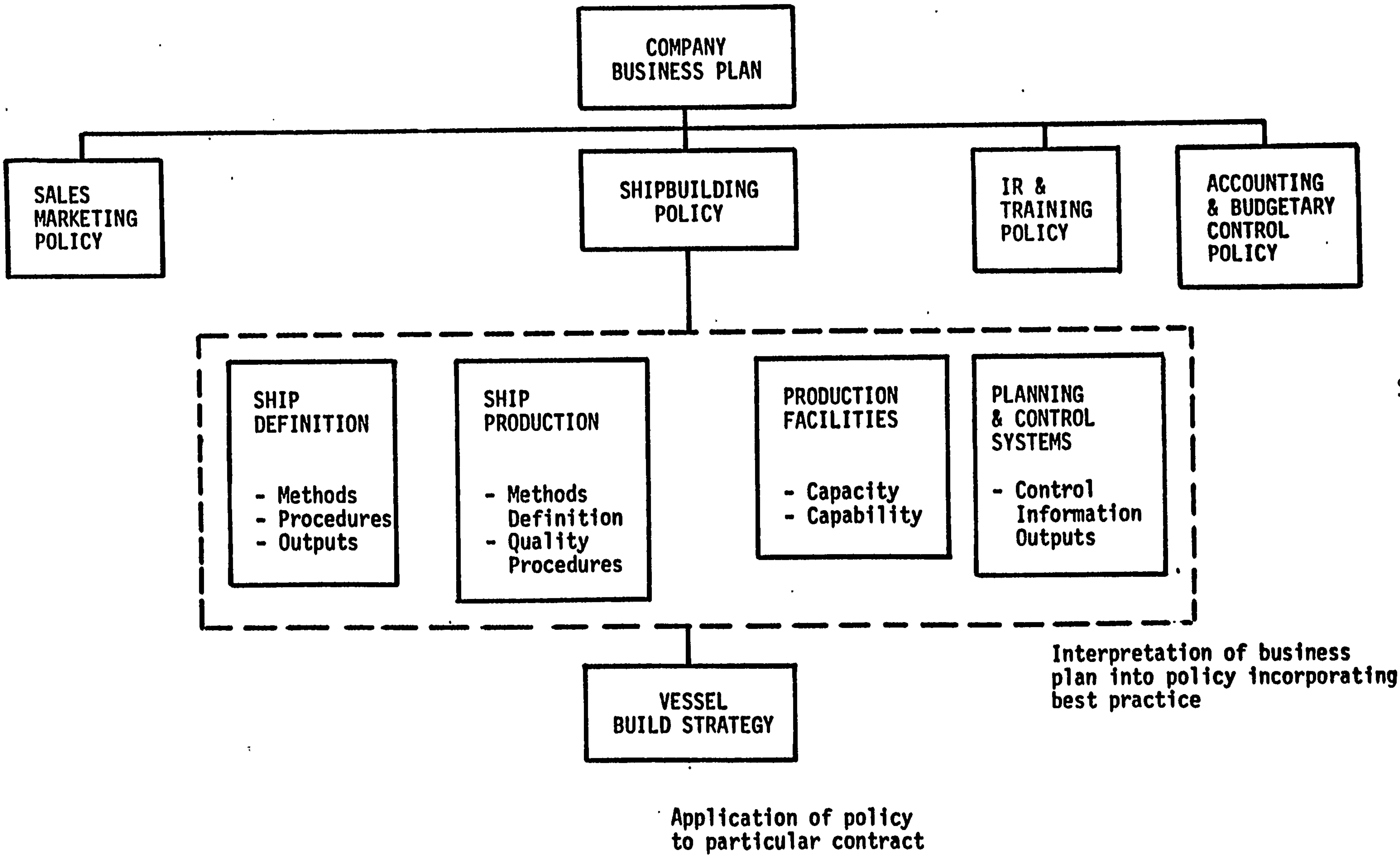

FIGURE 8.1 - BUILD STRATEGY AND SHIPBUILDING POLICY

8.2.2 Shipbuilding Policy

In essence, the Shipbuilding Policy comprises a set of standards, which can be applied to specific ship contracts. The standards apply at different levels:

> Strategic, related to type plans, planning units, interim product types, overall facility dimensions and so on, applied at the Conceptual and Preliminary Design stages.
>
> Tactical, related to analysis of planning units, process analysis, standard products and practices and so on, applied at the Contract and Transition Design stages.
>
> Detail, related to work station operations and accuracy tolerances, applied at the Detail Design stage.

Because shipbuilding is dynamic, there needs to be a constant program of product and process development. Also, the standards to be applied will change overtime with product type, facilities and technology development.

The shipbuilding policy is therefore consistent but at the same time will undergo a structured process of change, in response to product development new markets, facilities development and other variations.

The policy has a hierarchy of levels, which allow it to be applied in full at any time to a particular contract. However, the Policy which would be applied in a year's time would not necessarily be the same. Improvements in methods might be incoporated, as the result of experience or of a facilities development plan.

Therefore, to link the current policy with a future policy, there should be a series of projects for change, which are incorporated into an overall action plan to improve productivity. Since facilities are a major element in the policy, a long term development plan should exist which looks to a future policy in that area. This will be developed against the background of future business objectives, expressed as a plan covering a number of years.

These concepts aresummarized and illustrated in Tables 8.2.2.I and II.

TABLE 8.2.2.I

ELEMENTS OF SHIPBUILDING POLICY

POLICY OVERVIEW

- Policy Based on Business Plan Objectives
- Sets Objectives for Lower Levels

CURRENT PRACTICE

- Existing Standards
- “Last Best"Practice
- Procedures to be Applied to Next Contract

PRODUCTIVITY ACTION PLAN

- Covers Next Twelve Months
- Plans Improvements in Specific Areas
- Isa Set of projects

FUTURE PRACTICE

- Developed from Current Practice
- Incorporates Outcome of Action Plan
- Procedures to be Applied to Future Contracts

LONG TERM DEVELOPMENT PLAN

- Covers Facilities Development
- Covers a Five Year Period

TABLE 8.2.2.II

TYPICAL LIST OF CONTENTS IN A DETAILED SHIPBUILDING POLICY DOCUMENT

1.0 OVERVIEW

- 1.1 Objectives
- 1.2 Purpose and Scope
- 1.3 Structure

2.0 PRODUCT RANGE

- 2.1 Product Definition
- 2.2 Outline Build Methods

3.0 OVERALL PHILOSOPHY

- 3.1 Outline
- 3.2 Planned Changes and Developments
- 3.3 Related Documents
- 3.4 Work Breakdown Structure
- 3.5 coding
- 3.6 Technical Information
- 3.7 Workstations
- 3.8 Standards
- 3.9 Accuracy Control

4.0 PHYSICAL RESOURCES

- 4.1 Outline
- 4.2 Planned Changes and Developments
- 4.3 Related Documents
- 4.4 Major Equipment
- 4.5 Steel Preparation and Subassembly
- 4.6 Outfit Manufacture
- 4.7 Steel Assembly
- 4.8 Outfit Assembly
- 4.9 Pre-outfit Workstations
- 4.10 Berth/Dock Area
- 4.11 Engineering Department Resources

5.0 SHIP PRODUCITON METHODS
- 5.1 Outline
- 5.2 Planned Changes and Developments
- 5.3 Related Documents
- 5.4 Standard Interim Products, Build Methods,
- 5.5 Critical Dimensions and Tolerances
- 5.6 Steel Preparation
- 5.7 Steel Assembly
- 5.8 Hull Construction
- 5.9 Oufit Manufacture
- 5.10 Outfit Assembly
- 5.11 Outfit Installation
- 5.12 Painting
- 5.13 Services
- 5.14 Productivity Targets
- 5.15 Subcontract Work

6.0 SHIP DEFINITION METHODS
- 6.1 Outline
- 6.2 Planned Changes and Developments
- 6.3 Related Documents
- 6.4 Ship Definition Strategy
- 6.5 Pre-Tender Design
- 6.6 Post-Tender Design

7.o PLANNING FRAMEWORK
- 7.1 Outline
- 7.2 Planned Changes and Developments
- 7.3 Related Documents
- 7.4 Strategic Planning
- 7.5 Tactical Planning
- 7.6 Detail Planning
- 7.7 Perfpr,amce Monitoring and Control

8.0 HUMAN RESOURCES
- 8.1 Outline
- 8.2 Planned Changes and Developments
- 8.3 Related Documents
- 8.4 Organization
- 8.5 Training
- 8.6 Safety

9.0 ACTION PLAN
- 9.1 Outline
- 9.2 Projects and Time scales

8.2.3 Strategic

Work at this level provides inputs to:

The conceptual and preliminary design stages.
Contract build strategy.
Facilities development.
Organizational changes.
The tactical level of shipbuilding policy.

At the strategic level, a set of documents would be prepared which address the preferred product range. For each vessel type, the documents will include:

Definition of the main planning units.
Development of type plans, showing the sequence of erection. (See Figures B6.5 and C6.5 in Apendices B and C for an example of a type plan).
Analysis of main interim product types.

The strategic level will also address the question of facility capability and capacity.

Documentation on the above will provide input to the conceptual design stage except, of course, in those cases where a design agent is undertaking the design work and the builder has not been identified.

Documentation providing input to the preliminary stage will include

Preferred raw material dimensions.
Maximum steel assembly dimensions.
Maximum steel assembly weights.
Material forming capability, in terms of preferred hull configurations.
"Standard" preferred outfit assembly sizes, configuration and weights, based on facility capacity/capability.
"Standard" preferred service routes.

8.2.4 Tactical

At the tactical level standard interim products and production practices related to the contract and transition design stages and to the tactical planning level will be developed. All the planning units will be analyzed and broken down into a hierarchy of products. The policy documents will define preferences with respect to:

Standard interim products.
Standard product process and methods. (See Figures B & C6.6, 7 and 8 in Appendices B and C for an example of process analysis).
Standard production stages,
installation practices.
Standard material sizes.
Standard piece parts.

The capacity and capability of the major shipyard facilities will also be documented.

For the planning units, sub-networks will be developed which define standard times for all operations from installation back to preparation of production information. These provide input to the planning function.

8.2.5 Detail

At this level, the policy provides standards for production operations and for detail design.

The documentation will include:

- Workstation descriptions.
- Workstation capacity.
- Workstation capability.
- Design standards.
- Accuracy control tolerances.
- Welding standards.
- Testing requirements.

Reference to the standards should be made in contracts, and relevant information made available to the design, planning and production functions.

A with all levels of the shipbuilding policy, the standards are updated overtime, in line with product development and technological change.

8.2.6 Ship Definition

A ship definition is a detailed description of the procedures to be adopted and the information and format of that information to be produced by each department developing technical information within a shipyard. The description must ensure that the information produced by each department is in a form suitable for the users of that information. These users include

- Ship owners or their agents
- Shipyard management
- Classification societies
- Government bodies
- Other technical departments:
  - Design and drawing offices
  - CAD/CAM center
  - Lofting
  - Planning
  - Production engineering
  - Production control
  - Material control
  - Estimating
  - Procurement
- Production departments

Preferably the ship under consideration would also be of a type which has been identified in the Shipbuilding Policy as one which the shipyard is most suited to build.

The next best scenario would be that the ship being designed was of a type for which a build strategy exists within the shipyard.

8.3 Build Strategy

8.3.1 Need for Build Strategy

If mass production industries, such as automobile manufacture, are examined, there is no evidence of the use of build strategies.

Some shipyards, which have a very limited product variety, in terms of interim and final products, generally speaking also have no need for build strategies. If such shipyards, which are amongst the most productive in the world, do not use build strategies, then why should the U.S. industry adopt the build strategy approach?

The answer lies in the differences in the commercial environments prevalent and the gearing of operating systems and technologies to the product mix and marketing strategies. In a general sense, the most productive yards have identified market niches, developed suitable standard ship designs, standard interim products and standard build methods. By various means, these yards have been able to secure sufficient orders to sustain a skill base which has become familiar with those standards. As the degree of similarity in both interim and final products is high, there has been no need to re-examine each vessel to produce detailed build strategies, but many of them do as they find the benefits greatly outweigh the effort.

It is most likely that the U.S. shipbuilding industry’s re-entry into major commercial international markets will begin with one-offs or at best very limited series contracts. Furthermore, as many U.S. shipyards believe that it will be most effective to concentrate on complex vessels, the build strategy approach will be a key factor in enabling the yards to obtain maximum benefit from the many technologies which have been made available through the work of the NSRP Ship Production Panels, and to ensure that the way they are to be applied is well planned and communicated to all involved.

Most shipyards will have elements of a Build Strategy Document in place. However, without a formalized Build Strategy Document the lines of communication maybe too informal and variable for the most effective strategy to be developed.

8.3.2 What is a Build Strategy?

A well organized shipyard will have designed its facilities around a specific product range and standard production methods which are supported by a variety of technical and administrative functions that have been developed according to the requirements of production and detailed in a Shipbuilding Policy. In this case, when new orders are received only work which is significantly different to any previously undertaken needs to be investigated in depth, in order to identify possible difficulties.

Where it has not been possible to minimize product variety, such investigations will become crucial to the effective operation of the shipyard. The outcome of these investigations is the Build Strategy Document.

A Build strategy is a unique planning tool. By integrating a variety of elements together, it provides a holistic beginning to end perspective for the project development schedule. It is also a short hand way of capturing the combined design and shipbuilding knowledge and processes, so they can be continuously improved, updated and be used as a training tool.

A Build Strategy effectively concentrates traditional meetings that bring all groups involved, together to evaluate and decide on how the ship will be designed, procured constructed and tested, before any tasks are commenced or any information is “passed on”.

The objectives of the Build Strategy Document areas follows:

- To identify the new vessel.
- To identify the design and features of the new vessel.
- To identify contractual and management targets.
- To identify departures from the shipyard’s Shipbuilding Policy.
- To identify constraints, based on the new vessel being designed/constructed, particularly with reference to other work underway or envisaged.
- To identify what must be done to overcome the above constraints.

The last objective is particularly important as decisions taken in one department will have implications for many others. This means that effective inter-departmental communication is vital.

9.0 BENEFITS OF A BUILD STRATEGY

9.1 Development of the Build Strategy

The very act of developing a Build Strategy will have benefits due to the fact that it requires the various departments involved to communicate and to think rationally about how and where the work for a particular contract will be performed. Itwill also highlight any potential problems and enable them to be addressed well before the “traditional” time when they will arise.

If a Shipbuilding Policy exists for the company then it should be examined in order to ascertain if a ship of the type under consideration is included in the preferred product mix. If such a ship type exists then certain items which would othenwise go into a Build Strategy will have been addressed. These items include

- Outline build methods.
- Work breakdown structure.
- Coding.
- Workstations.
- Standard interim products.
- Accuracy control.
- Ship definition methods.
- Planning framework
- Physical resources at shipyard.
- Human resources.

One thing which is unique to any new ship order is how it fits in with the ongoing work in the shipyard. The current work schedule must be examined in order to fit the ship under consideration into this schedule. Key dates, such as cutting steel, keel laying, launch and delivery will thus be determined.

Using the key dates other events can be planned. These events are

- Key event program.
- Resource utilization.
- Material and equipment delivery schedule.
- Material and equipment ordering schedule.
- Drawing schedule.
- Schedule of tests and trials.
- Stage payment schedule and projected cash flow.

Once the major events and schedules are determined they can be examined in detail to expand the informationto a complete build strategy. For example the key event program can be associated with the work breakdown to produce planning units and master schedules for hull, blocks, zones, equipment units and systems.

9.2 Usage

The Build Strategy Document should be used by all of the departments listed above and a formal method of feedback of problems and/or proposed changes must be in place so that agreed procedures cannot be changed without the knowledge of the responsible person. Any such changes must then be passed on to all holders of controlled copies of the Build Strategy.

The Build Strategy is used to facilitate and strengthen the communication links. It should bring up front and be used to resolve potential conflicts between departments in areas of design details, manufacturing processes, maked/buy decisions and delivery goals.

A Build Strategy can be used as an effective people empowerment tool by giving participants the opportunity to workout all their needs together in advance of performing the tasks.

The intent of a Build Strategy is to disseminate the information it contains to all who can benefit from knowing it. Throughout this report it is described as a hard copy document,but today it could well be electronically stored and disseminated through local area network work stations.

9.3 Benefits

Producing a Build Strategy Document will not guarantee an improvement in productivity, although, as stated earlier, the process of producing the document will have many benefits. Full benefits will only be gained if the strategy is implemented and adhered to.

Positive effects of the Build Strategy approach are two-fold:

> During production managers and foremen have a guidance document which ensures that they are fully aware of the construction plan and targets, even those relating to other departments. This reduces the likelihood of individuals taking decisions which have adverse effects in other departments. Although often quoted by shipyards as being the reason for a Build Strategy, the benefits accruing from this are not major.
>
> Prior to production the use of the Build Strategy approach ensures that the best possible overall design and production philosophy is adopted. Crucial communication between relevant departments is instigated early enough to have a significant influence on final costs. It is therefore the structured, cross-discipline philosophy which provides the downstream reductions in costs and this is the major benefit.

A yard which develops a strategy by this method will gain all the advantages, whether or not a single Build Strategy Document is produced. However, the imposition of the requirement for a single document should ensure that the development of the strategy follows a structured approach.

Perhaps the single most beneficial aspect of a Build Strategy is, that by preparing one, the different departments have to talk to each other as a team at the right time. A Build Strategy is a “seamless” document. It crosses all traditional department boundaries. It is an important step in the direction of the seamless enterprise. The most evident benefit is improved communication brought about by engaging the whole company in discussions about project goals and the best way to achieve them. It eliminates process/rework problems due to downstream sequential hand over of tasks horn one department to another by deciding concurrently how the ship will be designed and constructed.

Some of the advantages mentioned by users of the Build Strategy approach are

- helps prioritize work
- is an effective team building tool
- requires that people share their viewpoints because they need to reach a consensus
- places engineers face to face with their customers - purchasing production, test, etc.
- expands peoples view of the product (ship) to include such aspects as maintenance, customer training support service, etc.
- fosters strong lateral communication
- concentration on parallel versus sequential effort saves time
- differences and misunderstandings are discussed and resolved much earlier
- greatly improves commitment ("buy in") by participants and the effectiveness of the hand over later
- is a road map that everyone can see and reference as to what is happening
- facilitates coordinated communication
- develops a strong commitment to the process and successful completion of the project

There are a few disadvantages mentioned by users, such as:

- effort and time to prepare the formal Build Strategy document
- total build cycle appears longer to some participants due to their earlier than normal involvement
- cross functional management is not the norm and most people currently lack the skills to make it work
- experts who used to make independent decisions may have difficulty sharing this decision with others in developing the Build Strategy
- a Build Strategy describes the complete technology utilized by a shipyard and if given to a competitor, it could negate any competitive advantage.

However, the users felt that the advantages greatly outweigh the disadvantages.

10.0 REFERENCES

1. PRODUCTIVITY IN SHIPBUILDING, by R Vaughan,NECIE&S, December 1983

2. BUILD STRATEGY DEVELOPMENT, by J. D. F. Craggs, SPC/lREAPS Technical Symposium, 1983

3. Presentations to Norfolk Shipbuilding in 1983, Lockheed Shipbuilding and Tacoma Boatbuilding in 1984

4. PRODUCTIVITY IMPROVEMENT. Presentation by A&P Appledore to SP-4 Panel in Sturgeon Bay, Wisconsin, July 1984

5. DESIGN FOR PRODUCTION MANUAL, NSRP Report, December 1986

APPENDIX A

BUILD STRATEGY DOCUMENT

PREAMBLE

The Build Strategy Document should be used as a framework on which a Build Strategy for a specific Ship Contract could be prepared. The framework includes all the components that at least one U.S. shipyard indicated as being useful.

The intended use is not that every component listed should be included, but rather that the components would be selected by individual shipyards as they develop their own specific Build Strategies.

Obviously, inclusion of all the components would maximize the benefits and usefulness of a Build strategy as a shipyad's specific ship information integrator and communicator, thus fostering cooperation, collaboration and teamwork. This, in turn, would result in up-front identification and resolution of problems and documentation of important decisions.

In addition to the Build Strategy Document, two examples of its use are presented in Appendices B and C. The examples are based on two ship types that are considered highly probable ship types that U.S. shipyards are most likely to offer as they attempt to break into the world commercial shipbuilding market.

In order to present these examples it was necessary to decide what facilities and capability levels were appropriate. These were based on U.S. and foreign shipyard visits and are described in Table 4.1 of the report. The Build Strategy examples must be appropriately adjusted to suit actual or planned facilities and capability levels for a specific shipyard.

The Build Strategy Document (Appendix A) is available on 3 ¼" disc in WORD PERFECT and WORD FOR WINDOWS and can be obtained from:

NSRP Coordinator
The University of Michigan
Transportation Research Institute
Marine Systems Division
2901 Baxter Road
Ann Arbor, MI 48109-2150

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Al: INTRODUCTION

A1.l Purpose of Document

This Build Strategy is approved and endorsed by senior management It should be used as the primary working document for this Contract The accomplishment of the objectives and corresponding performance is essential for the ongoing success of the company and complete satisfaction of the customer.

Understand its implications for your department or group and follow it where actions are required to ensure that the strategy is fully implemented. Any significant deviations from the Build Strategy necessary during the performance of the Contract, must be fully documented and processed through the Build Strategy Control Board.

This is a COMPANY CONFIDENTIAL document and must be handled accordingly. However, distribution is broad enough to ensure that its communication value is not diminished. AU copies have been assigned a control number and tracked to individual, group or department level.

The purpose of the Build Strategy is to apply the agreed method to. build the ship to suit the facilities, processes, ship definition strategy and the objectives of the Shipbuilding Policy, and to facilitate communication and collaboration of departmental actions to meet the aims of the Build Strategy.

This Build Strategy provides a framework for the effective development and coordination of the many aspects of a specific ship contract It also ensures that the design is developed in line with current, or projected, methods to be used by the production departments.

Emphasis is placed on the outfitting and engineering aspects of the design and production of the ship as it is in these areas where the most significant benefits of improvements in productivity can be obtained.

During the development of the Build Strategy, efforts have been made to reduce the work content inherent in the finished product by the extensive use of standards and the application of production engineering techniques at all stages of production.

The Build Strategy also provides an analysis for each stage of production in order to identify the methods and processes to be used. This analysis identifies problem areas to which special attention will have to be paid to avoid any bottlenecks during the production of the ship.

This Build Strategy has been prepared by several departments and the integrated approach is confirmed by the department heads who, as members of the Build Strategy Control Board, have signed below.

Vice President, Finance

Vice President, Engineering

Vice President, Production

Vice President, Planning

Vice President, Procurement

A1.2 Build Strategy Document Prerequisites

The preparation of this Build Strategy is based upon the company's current Shipbuilding Policy and Ship Definition Strategy. Any modification required because of special characteristics or needs for the ship are described in Sections A4.2, A4.3 and A4.4.

A1.3 Distribution

This Build Strategy Document distribution is as follows:

A1.4 Summary

This Build Strategy is prepared for

Hull number :
Contract number :
Number of ships :

It is prepared to record, integrate and communicate important specific ship design, material definition, planning, production and testing information in one internal (within the company) accessible shipyard controlled document

It has been signed by the Vice Presidents of Finance, Engineering, Production, Planning and Procurement and represents company policy and must be strictly adhered to.

This Build Strategy

- Defines what is to be built.
- Defines the parameters of the build cycle, including schedule, budget and manning, as dictated by the contract
- Shows the adopted block breakdown, sequence of erection and initial process engineering

- Identifies outfit zones, machinery arrangements and equipment units.

- Identifies interim products and creates a production oriented approach to engineering and planning of the ship.

Ž Defines material purchasing requirements necessary to support the production process.

- Indicates any special requirements in terms of the facilities, manpower, skills, etc., and highlights potential problems and how they will be overcome.

A2: VESSEL DESCRIPTION

A2.1 General Description and Mission

The General Arrangement of the ship is shown in Figure A2.1, from which it can be seen that it is ,.Suitable for the transport of , and is to be fitted with
The ship has a bow, stem, and a stern.
It has The deckhouse is located and has deck levels.
There is sheer on the deck There is camber on the main deck and camber on decks.

The hull is subdivided by transverse bulkheads into main watertight compartments. The engine room is located , between the and the bulkheads.

Additional features are that the ship has

The mission of the ship is to transport

A2.2 Principal Particulars

The ship has the following dimensions:

Length overall	=	m
Length between perpendiculars	=	m
Breadth molded	=	m
Depth molded	=	m
Design draft	=	m
Freeboard and scntling draft	=	m
Deadweight on design draft	=	tome

Figure A2.1 - GENERAL ARRANGEMENT

A2.3 Special Characteristics and Requirements

a) The ship is designed to comply with and has.

b)

c)

A2.4 Comparisons and Differences from Previous Ships

.

A2.5 Applicable Regulations and Classification

The ship shall comply with all applicable laws of the and the requirements of for the following class:

The ship shall also comply with the latest IMO regulations for the prevention of pollution at sea.

A2.6 Owner Particulars

The ships built under this contract are for .

A2.6.1 Background

A2.6.2 Fleet

A2.6.3 Past Relationship

A2.6.4 Competition

A3: CONTRACTUAL

A3.1 Contractual Dates and Time Constraints

The ship to which this Build Strategy applies is due for delivery as follows:

The ship is

To achieve the contracted delivery date requires that the first block of steel for this ship is laid on

This date requires that sufficient steel is defined, ordered and delivered

It is imperative that all of these targets are achieved.

A3.2 Payment

The payment terms are related to identifiable stages in the build program. They are shown below:

	%'/	Value US $
Contract signing		
cut first steel		
Lay keel (first block on berth)		
50% steel erected		
Launch		
Delivery		

This again reinforces the need to meet specified target dates, in particular timely delivery.

A3.3 Liquidated Damages Penalties

There are no liquidated damages applying to this contract, but the following penalties apply

For the first days, no penalty.

For every additional calendar day the shipyard will pay US $ -, Up to a maximum of % of the contract price

If delivery is delayed by from the contracted delivery date extended by permissible delays, then the owners will be entitled to cancel the contract. In such case the shipyard is obliged to repay immediately all payments made by the owners, plus interest from the date of payment to the date of the repayment. The interest rate is set out at

A3.4 Cancellation

The paying of any penalties is to be avoided but cancellation would be disastrous for the company. Cancellation can be caused by

Late delivery,
Attained speed % less than specified.
Fuel consumption % greater than specified.
Deadweight % lower than specified.
Cargo volume % less than specified.

The last four items are technical and the existing design procedures should ensure that they do not apply. The first item reinforces the need to keep to schedules at all stages of the contract as all delays have a knock-on effect far greater than their apparent effect.

A3.5 Drawing Approval

In the contract the owners have up to weeks to approve or make comments upon submitted drawings, otherwise they can be assumed to be approved unaltered. This arrangement must be strictly enforced to prevent undue time being taken for approval.

It is vitally important that they receive any information which has to be approved by them on time and that they approve it within the time scale shown above.

Both and the have been approached and have agreed to achieve better than a three week turnaround on drawing approval.

A3.6 Construction Inspection

The construction of the ship will be subject to inspection by the following:

Owners:

Classification Society

Flag state

They should be given every cooperation to assist then undertake their duties.

For structural surveys the inspectors should be called to view the structure from the major assembly stage onward in order that any problems are identified and rectified where they have occurred.

For tests on equipment and systems the inspectors should be given 24 hours notice and invited to attend. Should they not attend the test will not be repeated. As many tests as possible should be undertaken in the workshop where the equipment will be connected to the necessary services in order to demonstrate its compliance with requirements.

A3.7 Trials

Trials will be attended by the same persons who undertake the inspections of A3.6 above.

The following dock trials will have to be undertaken alongside the outfitting quay:

Before calling in the inspectors to witness a trial, the equipment or system will have been fully tested by the QA department and accepted as being in order. Upon successful completion of the shipyard test the relevant inspectors are to be given the required 24 hours notice to attend the official trial.

Sea trials will be undertaken at the end of the basin trials and will consist of:

These will be undertaken at a draft agreed by the owners.

Before proceeding on the sea trials all systems and equipment possible will have been tested by . the shipyard. Exceptions are those which require the ship being at sea in order to prove, i.e., speed, fuel consumption, compass adjusting etc.

The sea trials will take place off the coast of in the vicinity of the measured mile course at They are scheduled to last for days.

B3.8 Quality

The quality of the finished steel products is to be in accordance with the shipyard's Steelwork Standards, Document No , issued

The quality of the other products is to be in accordance with the relevant QA department procedures and/or applicable industry standards which apply, whichever is higher.

A4: DESIGN AND ENGINEERING

A4.1 Strategy and Scope

A4.1.1 General

The design and engineering drawings are being undertaken by

All design calculations and drawings required for approval purposes and by production departments will be produced by the teams setup for the purposes.

When production drawings are being developed, multi-distipline (cross-functional) teams will be set up in order to ensure that the drawings:

follow shipbuilding **policy;**

follow ship definition strategy, as modified in A4.1.2 below,

satisfy special requirements of all users.

A4.1.2 Changes to Ship Definition Strategy

A4. 1.3 Modeling and Composites

Clear of the machinery space, composite digital models showing structure, equipment and systems will be prepared for:

The composites will be prepared directly from the approved diagrammatics

A4.2 Key Drawings

Key drawings have been produced and show the main transit routes for all of the semices in the ship (piping vent trnking and wireways). The key drawing shows all of the functional spaces within each of the compartments of the ship. Figure A4.1 shows the Key Drawing for a part of the machinery space.

The actual size of the transit routes will be determined later but every effort must be made to ensure that the services are located within the routes shown on the key drawings.

Key drawings have sufficient space in them for adding notes and tables when they are used for routing the services.

A4.3 Production Information Requirements

A4.3.1 CAM Information

Computer Aided Manufacture is used in the following areas in the shipyard:

Figure A4.1 - KEY DRAWING SHOWING ENGINE ROOM SERVICES TRANSIT ROUTES

A4.3.2 Manufacturing Information

The format of manufacturing information must reflect the manner in which the work is to be performed at the appropriate workstation or zone, and the tools or equipment to be used. This is as described in the company Ship Definition Strategy.

A4.3.3 Parts Listings

The parts numbering system is defined in the company document "Parts Numbering for Merchant Ships, Rev" ", produced by the in

A Parts List for each drawing, in accordance with the new numbering system, is to be produced by the Design and Engineering Department.

A4.3.4 Installation Drawings

Installation drawings are to reflect the manner in which the installation is performed and the tools and equipment to be used. The information they should contain and the format of this information is as described in the company Ship Definition Strategy.

A4.3.5 Installation Procedures

Installation procedures are to be determined from manufacturers' instructions and company procedures. They are to be clearly written up and forwarded to the relevant installation department Production Control and QA for action.

A4.4 Design and Engineering Schedule

A4.4.1 Schedule

Figure A4.2 shows the key events for all ships in the current order book. From the Figure it can be seen that the key events are

Sign contract (C)
cut first steel (S)
Erect first block on the berth (K) :
Launch (L)
Deliver (D)

These dates determine when bought-in materials and equipment have to be available in the yard. The delivery dates from ordering of the materials and equipment determines the date when the equipment should be ordered and this, in turn, specifies when the technical information should be available to enable orders to be placed.

Table A4.1 shows the schedule for when the requisitions for the ordering of the major items of materials and equipment are required from the Technical Departments. It was derived using Table A5. 1 Production Times of Critical/Long Lead Time Items, and Figure A6.1 Equipment Installation Dates and .Required Delivery. To enable requisitions to be produced the relevant shipyard technical information in the form of drawings and specifications must be available.

A4.4.2 Resourcing and Utilization

The total design and engineering manhours required for this ship is Based upon 40 hours per week, this represents man weeks of effort.

Table A4.2 shows the allotted time scales, % of total effort and manhours required to produce the technical information for the various phases. It should be noted that there is significant overlap between all phases and that the total elapsed time for producing the design and engineering information is weeks.

Figure A4.2 KEY EVENTS FOR THE CURRENT ORDER BOOK

DRAWING No.:-GBSA 00/37 ORIG
ORIGINAL DRAWN 16-DEC-93/K.H.

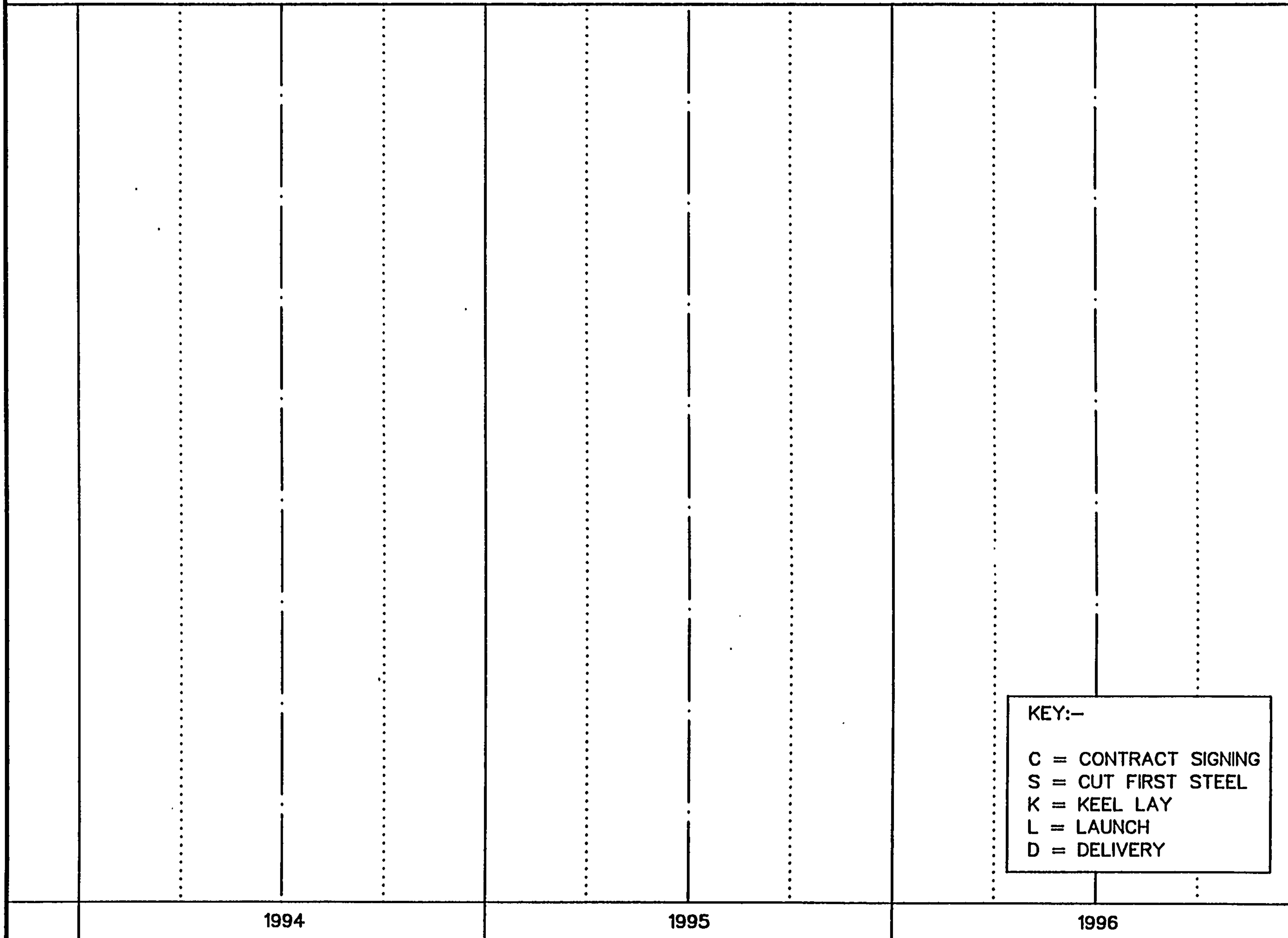

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Table A4.1

REQUISITION SCHEDULE FOR MAJOR lTEMS

Item	Required Requisition Date week/Year

Table A4.2

ALLOTTED TIME SCALES, % OF TOTAL EFFORT AND MANHOURS REQUIRED FOR THE VARIOUS PHASES OF PRODUCING TECHNICAL INFORMATION

Phase	Allotted Time weeks	% of Total Effort	Required Manhours
Design Information			
Information for Approval			
Transition Definition (from systems to zones)			
Production information			

Thus the manweeks and manpower required for the phases have been calculated and shown in Table A4.3 below

Table A4.3

MANWEEKS AND MANPOWER REQUIREMENTS FOR EACH PHASE

Phase	Man weeks	Manpower
Design		
Approval		
Transition		
production		

A4.4.3 Vendor Furnished Information (VFI) Schedule

The vendors shown in Table A4.4 below are required to provide information regarding their product by the date shown alongside their name. The relevant product is also shown in the table.

Table A4.4

VENDORS, PRODUCTS AND LATEST DATES FOR RECEIVING VFI

Vendor	Product	Latest Date for VFI Week/Year

To ensure that the VFI is received on schedule the vendors must receive the purchase order for their product in the time scale they offer in their bid. At least weeks before thejatest date for receiving the information (if it has not been received) the vendor must be contacted to expedite the information.

A4.5 Datums and Molded Definition

The system of datums to be used is as shown in Figure A4.3. Briefly the origin for the datums is:

After perpendicular.
On the base line.
On the centerline.

With +ve going forward from the after perpendicular, moving to board from the centerline and upwards from the base line.

The boundaries of planning units, that is, blocks, zones and outfit units, are defined in terms of the primary datums while details of piece parts and interim products are related to the secondary datums.

The molded definition is important to ensure the correct aligment of adjacent and continuous structure. The molded defintion for this ship is shown in Figure A4.4

A4.6 Design Standards

As new ship designs are adopted and orders for them are placed, it will be necessary to develop the designs for production. This will require not only ensuring that the design of the ship conforms to the capability of the production equipment, but it will also be necessary to develop the expertise to design so that, for example, steel and outfit standard assemblies and parts are considered from the concept design stage.

A4.7 Functional Space Allocation

Functional spaces have been allocated within each of the compartments in the ship. Figure A4.5 shows the arrangement of the compartments of the ship and Figure A4.6 shows the functional spaces determined for the lower flat in the engine room.

The functional spaces have been determined by locating groups of related equipment together so that the lengths and runs of interconnecting services are kept to a minimum and made simpler. Collecting related equipment together allows for the development of equipment units.

Figure A4.3 - SYSTEM OF DATUMS

Figure A4.4 - MOLDED DEFINITION

Figure A4.5 - GENERAL ARRANGEMENT

Figure A4.6 - ENGINE ROOM FUNCTIONAL SPACE ALLOCATION

A4.8 Detail Design Guidelines

A4.8.1 Steelwork

Steelwork standards, such as manholes, cut-outs, brackets, hangers, etc., have been developed over a number of years. It is the responsibility of detail design to ensure that these standards are continuously and rigorously applied to all detail design work

A4.8.2 Machinery

Installation to be in accordance with standards laid down in the company's Shipbuilding policy.

A4.8.3 Pipe Work

Pipework standards such as material types, bore sizes, pipe configuration (i.e., straight pipes, pipes with one bend of 45 or 90 degree, pipes with no bends, either 45 or 90) have been developed. Detail design will be responsible for ensuring that these design standards are continuously and rigorously applied to all detail design work

A4.8.4 Electrical

Standards for cable trays, cable ladders and hangers have been developed and detail design will be responsible for ensuring that these design standards are continuously and rigorously applied to all detail design work

A4.8.5 Joiner Work

Standard furniture and fittings for the accommodation area have been developed and detail design will be responsible for ensuring that these design standards are continuously and rigorously applied to all detail design work

A4.8.6 Paint Work

To be in accordance with standards laid down in the company's Shipbuilding policy and paint specification.

A5: PROCUREMENT

A5. 1 Master Material List

During the design process material will be quantified and specifications prepared, and a master material list must be developed similar to the master equipment list.

A5.2 Master Equipment List

During the design process equipment will be defined and specifications prepared, and a master equipment list must be developed. (Reference Table A5.1).

A5.3 Material Procurement Strategy

For this contract the company has adopted a policy of using the suppliers of large quantities of materials (steel, piping pipe fittings, electric cables, joiners panels, etc.) as a supplementary store. It has been agreed with such suppliers that the company will order the total quantity of materials necessary for the contract with them and they will guarantee that it will be available to be drawn down upon as required.

This policy will reduce the inventory which is usually held in the yard and help the cash flow, as the products do not have to be paid for until they are drawn upon.

The onus is upon the company to request draw downs in good time to ensure the materials are in the yard when required. A draw down schedule will be prepared by the Planning Department and issued to the Procurement Department.

A5.4 Critical/Long Lead Time Items

Table A5.2 shows the list of items which are either critical or long lead time items, or both.

The times are quoted by the suppliers and are their shortest periods, ex-works, from the placing of a firm order.

A5.5 Procurement Schedule

The procurement schedule for the critical and/or long lead time items is shown in Figure A5. 1 below. The schedule was derived by adding delivery times to the shortest ex-works times shown in Table A5.2. Total delivery times thus obtained were then deducted from the required installation times shown in Table A6. 1 in order to produce the procurement schedule.

Table A5.1

MASTER EQUIPMENT LIST

Table A5.2

PRODUCTION TIMES OF CRITICAL/LONG LEAD TIME ITEMS

Materials or Equipment	Shortest Times (Weeks)

SHIP:- EQUIPMENT PROCUREMENT SCHEDULE

YEAR:- MONTH:- LAUNCH →

EQUIPMENT / WEEK NUMBER	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	1	2	3
MAIN ENGINES																																													
GEARBOX & COUPLING																																													
SHAFTING & C.P. PROPELLER																																													
AUX. ENGINES																																													
GENERATORS																																													
BOW THRUSTER																																													
STEERING GEAR																																													
DECK AUXILIARY MACHINERY																																													
HATCH COVERS																																													
DECK CRANES																																													
LIFEBOATS																																													
DAVITS																																													
AIR CONDITIONING & FANS																																													
NAVIGATION EQUIPMENT AND RADIO																																													
MAIN SWITCHBOARD & SWITCHGEAR,																																													
MACHINERY CONTROL SYSTEMS																																													
REFRIGERATION SYSTEMS, ELECTRIC MOTORS																																													
SEWAGE PLANT, HYDRAULIC POWER PACK.																																													
PUMPS, SEPARATORS, BOILER, CO_2 SYSTEM,																																													
F.W. DISTILLER, CABLING & LIGHTING																																													

● PLANNED EQUIPMENT ORDERING

Figure A5.1

Figure A5.1

A6: PLANNING

A6.1 Strategic Planning

A6. 1.1 Key Event Program

A key event program has been prepared and is shown in Figure A6.1. This program shows the most important events of the build program, which must be attained in order to achieve the contract delivery dates.

It should be noted that procurement dates have been included. This is because they are items which are long lead time and/or are items which it is necessary to have in place to allow subsequent work to be undertaken.

A6.1.2 Resourcing and Utilization

The manpower resources and their utilization required during the period of building this ship are shown in Figure A6.2 below. It includes the requirements for the other ships in the current order book over this period.

Figure A6.2 clearly shows the fall-off in requirement for steelworkers during . It should not be taken that this will happen as the company is making every effort to secure orders which will reverse the trend shown with the current order book

Apart from it is not intended to use any subcontractors on this contract.

The total steel throughput in for the present order book will be tonne net steel. Net working area of the assembly shop is m2. This represents a utilization of tonne/m2/year, which can be accomplished in a single shift. The utilization of the assembly shop is therefore tonne/m2/shift/year.

Maximum number of steelworkers required during the build period of this ship is of these will be in the assembly shop at this stage in the contract. This gives a labor loading density in the assembly shop of m2/person. This is a heavy density, but as it represents the peak it is acceptable.

Figure A6.1

KEY EVENT PROGRAM

DRAWING No:-GBSA 00/35 ORIG
ORIGINAl DRAWN 16-DEC-93/K.H,

TIMESCALE IN WEEKS

	C	10	20	30	40	50	60	70	L 80	90	100
STEELWORK APPROVAL DRAWINGS COMPLETE.											
ORDER STEEL											
SYSTEM DIAGRAMATICS COMPLETE											
BUILD STRATEGY COMPLETE											
QUALITY PLAN APPROVED.											
ORDER MAIN ENGINE											
ORDER SWITCHBOARD											
ORDER MACHINERY CONTROL SYSTEM											
CUT FIRST STEEL											
ORDER ELECTRICAL GENERATORS											
ORDER LIFEBOATS											
ORDER AIR CONDITIONING SYSTEMS											
FIRST BLOCK ON BERTH											
50% STEELWORK ERECTED											
LAUNCH											
DELIVERY											

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Figure A6.2

EMPLOYEE RESOURCES AND UTILIZATION DURING BUILD PERIOD

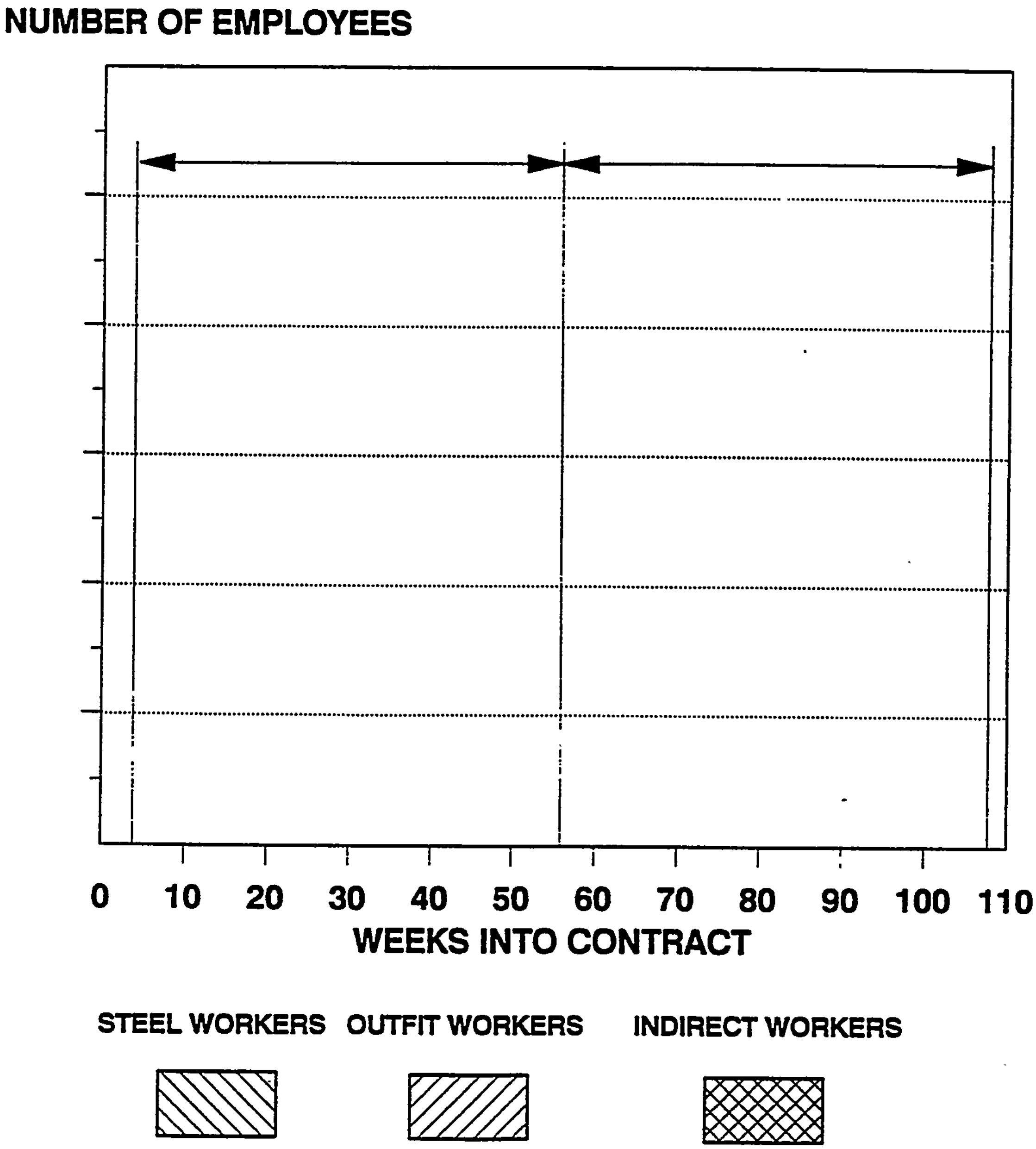

TABLE A6.2 **PANELS & BLOCKS FOR THE SHIP**	FLAT PANELS				FORMED PANELS				SANDWICH BLOCKS		3 - D BLOCKS	
	WITH STIFFS. ONLY		WITH STIFFS. & SUBASSEMBLIES		WITH STIFFS. ONLY		WITH STIFFS. & SUBASSEMBLIES					
LOCATION	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.
STERN BLOCKS												11.500 x
E.R. BLOCKS												
CARGO TANK BLOCKS												
FORE END BLOCKS												
TRANSVERSE O.T. BULKHEAD												
FLUSH HULL												
DECKHOUSES												
TOTAL SHIP												
TO BERTH												
MAXIMUM SIZE			PANEL LINE BLOCK SHOP									

[GBSA110A 16-DEC-93]

A6.2 Work Breakdown

A6.2.1 Work Breakdown Structure

Tables A6.1 and A6.2 list the work breakdown for the structure of the ship.

Table A6.1 shows the number of structural piece parts for the ship and their average sizes, divided up as follows:

Skin Plates. These are plates for the shell, compartment boundaries, or plates for which other parts, such as brackets, are nested from.

They are distinguished by the fact that the final product of these plates do not have any notches, manholes, or other cut-outs in them.

Skin plates are subdivided into flat, formed and nested plates.

Flat Plates with Contours. These are non-watertight floors, girders or webs, and have notches and/or manholes, or other cutouts in them.

Profiles. These are the standard shipbuilding profiles (offset bulb flats, angles, tee bars, etc.) and are sub-divided into straight and formed.

Flat Bars. These are face flats, and minor stiffeners to floors, girders or webs.

Table A6.2 shows the number of panels and blocks for the ship and their average sizes, divided up as follows:

Flat Panels. These are further subdivided into those which only have stiffeners attached and those which have both stiffeners and subassemblies attached.

Formed Panels. These are both curved shell panels and the corrugated panels of the transverse cargo tank bulkheads. Again, they are divided into those which have only stiffeners attached and those which have both stiffeners and subassemblies attached.

Sandwich Blocks. These are blocks formed from at least one flat panel with only stiffeners attached plus either a flat or formed panel with stiffeners and subassemblies attached.

TABLE A6.1 STRUCTURAL PIECE PARTS FOR THE SHIP	PLATES FOR SHELL OR COMPARTMENT BOUNDARIES, OR NESTING PLATES						NWT FLOORS, NWT GIRDERS, WEBS, ETC.		O.B.F's, TEE BARS, ANGLE BARS, ETC.				FACE FLATS, MINOR STIFFENERS TO FLOORS, GIRDERS AND WEBS.			
	SKIN PLATES						FLAT PLATES WITH CONTOURS		PROFILES				FLAT BARS					
LOCATION	FLAT		FORMED		NESTED				STRAIGHT		BENT		STRAIGHT		BENT			
	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.		
STERN BLOCKS																		
E.R. BLOCKS																		
CARGO TANK BLOCKS																		
FORE END BLOCKS																		
FLUSH HULL																		
DECKHOUSES																		
TOTAL SHIP																		

[GBSA109A 16-DEC-93]

TABLE A6.2 **PANELS & BLOCKS FOR THE SHIP**	FLAT PANELS				FORMED PANELS				SANDWICH BLOCKS		3 - D BLOCKS	
	WITH STIFFS. ONLY		WITH STIFFS. & SUBASSEMBLIES		WITH STIFFS. ONLY		WITH STIFFS. & SUBASSEMBLIES					
LOCATION	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.
STERN BLOCKS												11.500 x
E.R. BLOCKS												
CARGO TANK BLOCKS												
FORE END BLOCKS												
TRANSVERSE O.T. BULKHEAD												
FLUSH HULL												
DECKHOUSES												
TOTAL SHIP												
TO BERTH												
MAXIMUM SIZE			PANEL LINE BLOCK SHOP									

[GBSA110A 16-DEC-93]

3D Blocks. These are blocks which have significant dimensions in all three planes, longitudinal, transverse and vertical. In the ship they all occur clear of the cargo tank region.

Also shown in Table A6.2 are the number of panels and blocks which are actually erected on the building berth with their average size.

Finally, the maximum sizes of the panels and blocks are shown.

The maximum dimensions and weights of parts and interim products are shown in Table A6.3.

A6.2.2 Coding

Table A6.3

MAXIMUM DIMENSIONS AND WEIGHTS OF PARTS AND INTERIM PRODUCTS

Maximum Weights and Dimensions

Maximum Plate Dimensions	:	mx m
Maximum Plate Weight	:	tonne
Maximum profile Dimensions	:	mx mx mm
Maximum Profile Weight	:	tonne
Maximum Subassembly Weight	·	tonne
Maximum Panel Weight Panel Line	:	tonne
Maximum Panel Weight Block Shop	:	tonne
Maximum Sandwich Block Weight	:	tonne
Maximum 3D Block Weight	.	tonne

A6.3 List of Planning Units

A6.3.1 Hull Panels and Blocks

Table A6.4 lists the hull panels and blocks which are planning units and which are erected on the building berth. They are shown in Figure A6.3.

Table A6.4

HULL PANELS AND BLOCKS (PLANNING UNITS)

Location	No	Identity
Total Panels and Blocks (Planning Units)		

A6.3.2 Zones

Table A6.5 lists the onboard zones for outfiting purposes. Figure A6.4 shows the locations of the zones.

The onboard zones will be used as a basis for the management and control of all onboard outfit installation work.

Table A6.5

ONBOARD ZONES

Location	Number	Identity
Total Onboard Zones		

A6.3.3 Equipment Units

Assembly of the engine room equipment units (including banks of pipes) will take place in the Equipment Unit Assembly Shop. Assembly of outfit units is scheduled so as to allow as much of the machinery space outfitting as possible to take place in parallel with the machinery space steelwork

Table A6.6 shows a list of the equipment units which will be produced for this ship.

A6.3.4 Systems

None of the systems on this ship are considered to be planning units as they are all distributed over more than one planning unit. The work performed on systems is that taken into account in the relevant planning units over which the system is distributed.

Table A6.6

LIST OF EQUIPMENT UNITS

Equipment Unit	Identity	Location

Figure A6.3 - BUILD STRATEGY DOCUMENT HULL PANELS & BLOCKS

Figure A6.4 - BUILD STRATEGY DOCUMENT ON-BOARD ZONES

A6.4 Master Schedules

A6.4.1 Hull Blocks

Figure A6.5 shows the hull block erection sequence and schedule. The schedule has been used to determine when material and equipment will be installed, when it should be-delivered to the yard, when it should be ordered, and when the engineering information should be available.

A6.4.2 Zones

Table A6.7 shows when the onboard zones are available for open sky outfitting and when they become closed off for final outfitting. These dates are also dictated by the hull erection schedule.

A6.4.3 Equipment Units

Table A6.8 shows the installation schedule for the equipment units listed in Table A6.6. It also shows whether the unit is installed on-block or onboard.

A6.4.4 Systems

As stated in A6.3.4 the systems on this ship are being installed on-block and/or within zones. However the completed systems will require to be tested. See Section 8 for Tests and Trials.

Figure A6.5

HULL BLOCK ERECTION SEQUENCE & SCHEDULE

TOTAL BLOCKS	BLOCKS/WEEK		WEEK No.	YEAR

GBSA.DO/36.REV.4.

Table A6.7

AVAILABILITY OF ONBOARD ZONES

Zone	Location	Availability Week No 199 Open sky	closed Off
M1			

Table A6.8

INSTALLATION SCHEDULE FOR EQUIPMENT UNITS

Equipment Unit	Installed Week No 1995 On-Block	Installed Week No 1995 Onboard	Zone or Block No
EU1			

A6.5 Hull Production Strategy

A6.5. 1 Preliminary Process Analysis

Figures A6.6, A6.7 and A6.8 show the preliminary process analyses of a flat panel, a sandwich block and a 3D block The method of building up the panels and blocks horn the piece parts and interim products is clearly shown.

Figures A6.9,A6.10 and A6.11 show when and how the outfit items are to be integrated with the structure of the panels and blocks shown in Figures A6.6, A6.7 and A6.8.

A6.5.2 Non-Standard Interim Products

A6.5.3 Build Location and Launch Condition

When the ship is launched all major steelwork will be complete, the main engine and all machinery space equipment units will be in place, all other equipment units will be installed, the accommodation deckhouse will be in situ, all hotwork and paintwork in the will be complete. Elsewhere the paintwork will be complete apart from erection joints and where hotwork will occur.

Figure A6.6 - PROCESS ANALYSIS OF A FLAT PANEL (DECK H PANELS)

Figure A6.7 - PROCESS ANALYSIS OF A SANDWICH BLOCK

Figure A6.8 - PROCESS ANALYSIS OF A 3D BLOCK

Figure A6.9 - INTEGRATION OF OUTFIT WITH DECK PANELS

Figure A6.10 - INTEGRATION OF OUTFIT' WITH SANDWICH BLOCKS

Figure A6.11 - INTEGRATION OF OUTFIT WITH 3D BLOCK

A6.6 Machinery Space Outfit Strategy

AS much equipment and pipework as is practically possible will be assembled into equipment units inclusive of steel support structure, pipework, minor electrical equipment and ventilation trunking pipe unit assemblies inclusive of support structure, and pipe assemblies.

AU equipment and pipe units will be painted before installation onboard ship.

To ensure that space is available for installig the units, the main engine will be the last piece of major equipment to be installed.

A6.6.1 Equipment Units

Equipment units have been identified and are shown in Table A6.6. They will be assembled in a shop workstation instead of onboard ship. The assembly work package will incorporate the steel support foundations and support bases, equipment, small tanks, pipes, fittings, electric cable, painting and testing before installation “on block” or “on board”. A typical assembly process is shown in Figure A6. 12

A6.6.2 On Block outfitting

On block outfitting will be divided into two stages. The first stage of on block outfitting will consist of completing all minor steel “hot work”, such as manholes, penetrations, equipment foundations, ladders, pipe and electrical systems hangers and equipment units appropriate to each block. A typical on block outfitting process is shown in Figure A6.13.

The second stage will include the fitting of “cold work” such as pipework, cable ladders or trays, HVAC systems and steel doors as may be appropriate.

6.6.3 On Board outfitting

On board outfitting involves installing equipment units, individual pieces of equipment and individual manufactured parts such as pipes, HVAC ducting, cable trays and insulation lagging. The installation of on board outfitting will be work packaged and scheduled in accordance with the zone “close out” schedule. A typical on board outfitting process is shown in Figure A6.14.

Figure A6.12 EQUIPMENT UNIT No.........

PROCESS ANALYSIS
EQUIPMENT UNIT ASSEMBLY PROCESS

DRAWING No.:-GBSA 00/53 ORIG
ORIGINAL DRAWN 19-JAN-94/K.H.

ACTIVITY								

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Figure A6.13	STEEL BLOCK No.........	PROCESS ANALYSIS ON BLOCK OUTFIT PROCESS	DRAWING No.:-GBSA 00/54 ORIG ORIGINAL DRAWN 19-JAN-94/K.H.

ACTIVITY	STAGE							
	1	2	3	4	5	6	7	8

Figure A6.14	ONBOARD ZONE No.........	PROCESS ANALYSIS ON BOARD OUTFIT PROCESS	DRAWING No.:-GBSA 00/55 ORIG ORIGINAL DRAWN 19-JAN-94/K.H.

ACTIVITY	STAGE							
	1	2	3	4	5	6	7	8

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A6.7 Accommodation outfit Strategy

At the time of lifting to the ship, the accommodation will be completely outfitted except for the following:

navigation equipment and
soft furnishings.

This is achieved by having a cofferdam between the bottom tier of the accommodation block and the ship's deck to which the accommodation is to be fitted. The cofferdam will also serve as a space for passing or connecting services between the accommodation and engine room.

A6.8 Cargo Space and Other Space Outfit Strategy

Before steel blocks are lifted to the Building Berth all "hot work" should be completed. This will include the cutting of all manholes, access openings, and penetrations for pipe, cable and HVAC systems. All brackets and foundations for equipment must be fitted and welded together with hangers for pipe, cable and HVAC systems. As much "cold work" will be fitted wherever possible and should include pipework, cable trays/ladders, ventilation trunking and equipment.

A6.8.1 On Block Outfitting

On block outfitting will be divided into two stages. Stage 1 will include completion of all minor steel "hot work" such as manholes, penetrations, minor equipment foundations, ladders, pipe and electrical system hangers and HVAC system hangers. Stage 2 will include the installation of individual items of equipment together with manufactured parts such as loose tanks, steel doors, windows, pipe systems, electrical systems and HVAC systems. A typical process analysis is shown in Figure A6. 15.

A6.8.2 On Board Outfitting

On board outfitting will consist of connecting up the systems previously installed on block, at the block joints after the blocks have been joined, welded and tested, together with the pulling of electric cable. The on board installation work will be packaged and scheduled in accordance with the zone close out program. A typical process analysis is shown in Figure A6.16.

Figure A6.15	STEEL BLOCK No.........	PROCESS ANALYSIS ON BLOCK OUTFIT PROCESS	DRAWING No.:-GBSA 00/56 ORIG ORIGINAL DRAWN 19-JAN-94/K.H.

ACTIVITY	STAGE							
	1	2	3	4	5	6	7	8

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Figure A6.16	ONBOARD ZONE No........	PROCESS ANALYSIS	DRAWING No.:-GBSA 00/57 ORIG ORIGINAL DRAWN 19-JAN-94/K.H.

ACTIVITY	STAGE							
	1	2	3	4	5	6	7	8

A6.9 Painting Strategy

A6.9.1 Outline Paint Specification

All steel is to enter the preparation workshop via the treatment line where it is to be shot blasted to standard and coated with a zinc silicate shop primer.

The areas of the ship listed below are to have the paint systems shown applied:

Underwater, exterior shell:

Topside, exterior shell,
exterior and interior decks

Deckhouses and deck fittings

cargo spaces

Water ballast tanks

Fresh water tanks

Steelwork behind linings,
void spaces and cofferdams

A6.9.2 Pre-Painting

Double bottom blocks in way of the cargo are to have the exterior shell and internal structure sweep blasted to and the upper side of the inner bottom blast cleaned to in the paint cells before the final paint systems are applied.

Side blocks in way of the cargo are to have the exterior shell and internal structure sweep blasted to and the inboard side of the longitudinal bulkhead blast cleaned to in the paint cells before the final paint systems are applied

Deck panels in way of the cargo are to have their exterior surface sweep blasted to and the underside blast cleaned to in the paint cells before final paint systems are applied.

All other blocks are to have all surfaces sweep blasted to before final paint systems are applied in the paint chambers.

A6.9.3 Primer Repair Strategy

Where the shop primer is damaged in a workshop, the damaged area should be disc-ground and wire brushed, then touched up with a stripe coat as soon as possible. On all occasions this should be performed before passing the work on to the subsequent workstation.

A6.9.4 Panel/Block Painting Strategy

All panels which go directly to the building berth, will be painted in the paint chambers to mm of the edges which will be welded on the building berth.

The flat panels which have stiffeners and subassemblies added and form part of a sandwich block will be painted in the block assembly shop to mm of the edges which will be subsequently welded.

Complete sandwich blocks will have the remainder of their paintwork undertaken in a paint chamber to mm of the berth joints.

3D blocks will be painted in the paint chambers to mm of the edges which will be welded at the building berths.

A6.9.5 Zone Painting Strategy

Zone painting will be completed after all structural joining and outfit installation work has been finished, both within the zone and on the other side of zone boundaries.

Bought-in items of equipment will arrive finish painted, with a protective cover over the paintwork. When placed on frameworks, to create outfit units, the framework will be finish painted to mm from the interface with the ship’s structure.

The exterior shell and decks will receive their final coating just prior to sea trials.

A6.9.6 Special Considerations

A6.10 Subcontract Requirements

A6.10. 1 Bought-in Items

The following is a list of “supply and fit” subcontract items:

The supplier not only provides the material for the above items but also the labor which is under his control. However the timing and manner of performing the work is under the control of the shipyard and the supplier will comply with the established schedules.

A6.10.2 Use of On-Site Subcontractors

Other on-site subcontractors, apart form those associated with supply and fit items, will be those

A6.10.3 Industrial Relations Considerations

As the use of supply and fit subcontracts and subcontractors for these other items is normal practice for the company, all of the existing agreements on their use will apply to this contract.

A6.11 Productivity Targets

The direct steelworker productivity for this ship has been set at manhours/tonne net steel. This is productivity for a ship of this type and size.

Another measure of productivity used for comparative purposes by the international community is manhours/compensated gross ton (CGT). This vessel has a gross tonnage of and au associated compensated gross tonnage factor of, giving a compensated gross tonnage of x = The total employee manhours required to produce this ship is, therefore the manhours/CGT = This is about of the world average but the good European yards are only using about and the Japanese about manhours/CGT.

A6.12 Temporary Services

A6.12.1 Staging

To enable fairing and welding of block joints and subsequent finishing off operations to take place it will be necessary to provide access ways to these areas.

Traditional shipbuilding techniques made it necessary to surrond the ship completely with staging. The modem approach to ship constuction has the potential to substantially reduce the amount of staging equipment required.

A6.12.2 Access and Escape Plan

In the event of an emergency, rapid access to confined spaces by rescue services or fast evacuation will be necessary. An access and escape plan will be prepared and updated for the various stages of the ship construction. It shall be framed and posted at all major access points to the ship.

A6.12.3 Power and Lighting

Services required for construction activities include:

- water
- compressed air
- oxygen
- acetylene gas
- electricity

A7: ACCURACY CONTROL

In order to be competitive in the commercial shipbuilding world, rework must be minimized. Accuracy Control (A/C) has been proven to be an effective way to reduce rework

A/C is “the regulation of accuracy as a means for continuously improving design details and work methods so as to maximize productivity”.

A/C has both a short and a long term benefit. The short term benefit is that it will minimize delays and rework during erection of structure and installation of equipment by monitoring and controlling the fabrication of interim products. The long term benefit is the implementation of a management system that develops a database of quantitative information that can be used to continuously improve productivity.

Although the shipyard has been utilizing A/C for naval ships over the past 10 years, the differences between naval and commercial ships is such that most of the data is not transferable. It will be necessary to develop from scratch the quantitative information from the commercial ships as they are being constructed.

However, the shipyard has the experience and knows how to plan, execute and evaluate A/C. The shipyard will implement its proven A/C procedure by modifying it to suit the requirements of the commercial shipbuilding.

A7.1 System Critical Dimensions and Tolerances

For steelwork the key system dimensions are the finished overall dimensions of assemblies and blocks as well as alignment of internal joining structural members.

For outfit the key dimensions all relate to installation interfaces.

These must be defined with suitable tolerances that would ensure the required performance of the vessel in terms of:

These will be controlled and monitored by use of appropriate control chart techniques and capability studies as described in the shipyard’s A/C Procedure for Commercial Ships, issued December 1993.

A7.2 Interim Product Critical Dimensions and Tolerances

They can be divided into two categories

Principal dimensions and tolerances.
Local dimensions and tolerances.

A principal dimension/tolerance for an interim product is one which will directly affect the ability to meet system critical dimensions/tolerances. For example, that may be the overall dimensions of a steelwork unit. If these are not achieved to a desired tolerance then there will be a failure in any attempt to assemble the system from the component interim products.

A local dimension/tolerance for an interim product is one which will affect the ability of a workstation to assemble that particular interim product from its component piece parts or assemblies. For example, that may be the positioning of a stiffener so that its fit-up with a slot is achieved to the required tolerance.

These will be controlled and monitored by use of appropriate control chart techniques and Capability studies.

A7.3 Sampling Procedures

A list of interim products to be sampled will be prepared in accordance with the shipyard's A/C Procedure for Commercial Ships.

A7.4 Special procedures

A7.4.1 One-Off Manufacture

In the case of genuine one-off products requiring manufacture and/or assembly, specific monitoring and control procedures will be put in place to ensure that these meet specified targets.

A7.4.2 Poor Performance

In addition, if in the evaluation of system and interim product required accuracy, it becomes evident that specific processes are unable to meet specified requirements first time then special analysis will be undertaken to determine cause and eliminate the rework that arises.

A7.5 Jigs and Fixtures

A list of jigs and fixtures that are required for the assembly process will be prepared and appropriate resources defined for their design, manufacture and installation.

The levels of accuracy for the jigs and fixtures must be commensurate to those required for systems and interim products.

Where possible jigs and fixtures will minimize welded attachments.

A7.6 Hot Work Shrinkage

A7.6.1 Use of Extra Stock

Because of the limitations in shell development methods and forming of shaped plates extra stock will be required on certain blocks. Also the commercial ships, with their heavier scantlings, will have different shrinkage and distortion than the naval ships

The initial aim is to control and manage the use of extra stock material and gradually eliminate it as more and more data on distortion and shrinkage for commercial ships is collected and analyzed.

A7.6.1 Shrinkage Allowances

For all dimensions, shrinkage allowances will be made on the basis of:

shrinkage at subassembly;
shrinkage at assembly;
shrinkage at erection.

A shrinkage excess will be derived and allocated to the structure in such a manner as to ensure that both principal and local dimensions/tolerances are met.

This allowance will be based on a database with regard to past performance at each work stage and for each welding process.

Shrinkage allocation should be consistent either by lump sum allocation or evenly distributed to retain correct stiffiner spacing.

A7.7 Distortion Control

Specific procedures have been developed for control of distortion. These cover two distinct aspects:

a) Pre-set that anticipates distortion from welding.

b) Distortion removal that removes distortion that results from the normal production process.

Taking each of the above in turn:

a) Pre-set:

Suitable data will be collected and analyzed to derive pre-sets so that this information can be included in drawing information provided to the workstation.

b) Distortion Removal:

Specific workstations will be identified and suitably equipped to remove distortion by appropriate processes such as heat line bending.

This is a time consuming activity and its use will be managed with an emphasis on design improvement and use of pre-set or improved processes to minimise the need for distortion removal.

A8: TESTS AND TRIALS

A8.1 Test Planning

A8.1.1 Strategy

Before any tests are undertaken the components will be systematically prepared so that those called to witness the tests actually only see the tests performed and not any preparation which is necessary for it to take place. Preparation will include:

cleaning the item and the adjacent area;

connecting all of the necessary services and checking that the required quantities are available;

checking that all recording devices are available, working correctly and are within their calibration date;

ambient temperature is acceptable;

lighting is adequate;

ventilation is adequate.

The strategy for preparing items for test is shown below.

A8.1.2 Schedule (High Level)

Table A8.1 shows the high level test schedule. It has a total duration of working days and it is imperative that all tests be successfully completed within this time duration.

A8.2 Pre-Completion Testing

Before items are complete and installed in a ship a large amount of testing can be performed. The various pre-completion tests are discussed below.

A8.2.1 Pre-Survey and Dry Survey

As much of the structural survey work as possible is to be performed in the workshops.

Before a regulatory, owner's or classification surveyor is called to survey any structure it will be examined by a steel shop supervisor and any faults found, rectified.

The use of dimensional control and self-checking of all work at each stage in the process should mean that any faults discovered prior to calling in a surveyor will be minimal aud minor. The aim is to have no faults found by a surveyor, not because they are well disguised but because they do not exist.

A8.2.2 Pipe Pre-Testing

Where banks of pipes involve the joining of pipe parts and or pipes to fittings they will be pressure tested in the pipe shop, either by water or air, prior to being installed on the unit, block or on the ship. Any faults discovered will be rectified before the item leaves the shop.

A8.2.3 Equipment Unit Pre-Testing

While still in the workshop all equipment units will have their fluid and electrical services connected and be supplied with the required quantity of the relevant mediums in order to test that they operate correctly and that the services are intact.

Whenever possible the test procedures developed by the equipment suppliers will be used. These procedures will be reviewed by the Test and Trials department as they are received. If they are acceptable they will be forwarded to the owner's representative for comment. When the procedure has been agreed by both the shipyard and the owner's representative it will be signed off as the master copy and kept in the Test and Trials file.

Prior to the conduct of a test the shipyard will notify the owner's representative and any other interested parties such as
classification and statutory body surveyors so that they can be present.

A8.3 Tank Test Schedule

Table A8.2 shows the schedule for tank/compartment testing. This schedule defines when all work within the tanks and hot work on the tank boundaries will be complete. It also indicates which tanks can be tested prior to the unit or block going to the berth.

A8.4 .Equipment Unit Test Schedule

Table A8.3 shows the schedule for the testing of equipment units. The schedule defines when each equipment unit will be completely assembled and identifies all tests required and their duration's.

A8.5 Pipe Unit Test Schedule

Table A8.4 shows the schedule for the testing of pipe units. The schedule defines when each pipe unit will be completely assembled and identifies all tests required and the duration's.

A8.6 Zone Close-Out Strategy

Table A8.5 shows the zone close-out strategy. This defines when all work within the zones, including tests and trials of equipment, will be completed and the zone closed up.

Figure A8.1

HIGH LEVEL SCHEDULE
COMPRESSED AIR SYSTEM ONBOARD TEST SCHEDULE

DRAWING No.:–GBSA 00/58 ORIG
ORIGINAL DRAWN 19–JAN–94/K.H.

ACTIVITY	WEEK 1							WEEK 2							WEEK 3							WEEK 4						
	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S

Figure A8.2

ONBOARD STRUCTURAL TANK TEST SCHEDULE

DRAWING No.:-GBSA 00/59 ORIG
ORIGINAL DRAWN 19-JAN-94/K.H.

TANK NUMBER	INSTALLATION WORK PACKAGE COMPLETE	CHECK INSTALLATION	CORRECT ANY DEFICIENCIES	TANK TEST		
				WATER	AIR	VACCUM

Figure A8.3

EQUIPMENT UNIT No.......... TEST SCHEDULE

DRAWING No.:-GBSA 00/60 ORIG
ORIGINAL DRAWN 19-JAN-94/K.H.

ACTIVITY	WEEK 1							WEEK 2							WEEK 3							WEEK 4						
	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S

Figure A8.4

PIPE UNIT TEST SCHEDULE

DRAWING No.:-GBSA 00/61 ORIG
ORIGINAL DRAWN 19-JAN-94/K.H.

ACTIVITY	WEEK 1							WEEK 2							WEEK 3							WEEK 4						
	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S

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Figure A8.5

ZONE CLOSE OUT SCHEDULE

DRAWING No.:-GBSA 00/62 ORIG
ORIGINAL DRAWN 19-JAN-94/K.H.

ZONES			WEEK NUMBERS									
			1	2	3	4	5	6	7	8	9	10
ACCOMMODATION ZONE	1st DECK	A1										
		A2										
		A3										
		A4										
	2nd DECK	A5										
		A6										
		A7										
		A8										
	3rd DECK	A9										
		A10										
		A11										
		A12										
	4th DECK	A13										
		A14										
		A15										
		A16										

A8.7 Principal Trials Items

A list of the principal items which require trials and the schedule for the trials is shown in Table A8.6.

A8.7.1 Dock Trials

After the individual equipment units have been installed and connected up to the relevant systems on board the ship then complete systems will be available for trials. Initially these will be undertaken while the ship is alongside and in accordance with a predetermined schedule. This schedule is shown in Table A8.7.

A8.7.2 Sea Trials

Ultimately the ship will undergo sea trials which will be undertaken in accordance with a program drawn up by the technical and planning departments.

If the test progression

preparation for tests;
pipe pre-testing
equipment unit pre-testing
dock trials;

has been followed then sea trials should mainly be a series of proving events. The exceptions to this are speed and maneuvering trials.

The program dates for both the Builder's and Acceptance Sea Trials and their completion date is shown in Table A8.8.

Figure A8.6	PRINCIPAL TRIALS ITEMS	DRAWNG No:-GBSA 00/63 ORIG ORIGINAL DRAWN 19-JAN-94/K.H..

Figure A8.7

PRINCIPAL DOCK TRIALS SCHEDULE

DRAWING No.:-GBSA 00/64 ORIG
ORIGINAL DRAWN 19-JAN-94/K.H.

ACTIVITY	WEEKS												
	1	2	3	4	5	6	7	8	9	10	11	12	13

Figure A8.8

SEA TRIALS SCHEDULE

DRAWING No.:-GBSA 00/65 ORIG
ORIGINAL DRAWN 19-JAN-94/K.H.

	DAY 1												DAY 2												DAY 3											
	HOURS												HOURS												HOURS											
ACTIVITY	2	4	6	8	10	12	14	16	18	20	22	24	2	4	6	8	10	12	14	16	18	20	22	24	2	4	6	8	10	12	14	16	18	20	22	24

A9: PERSONNEL

A9.1 Industrial Relations Aspects

In moving from naval ship to commercial ship construction significant changes will be required. The mix of skills will change and this will result in the need for flexibility in trade demarcation and extensive retraining. Throughout this change process the Industrial Relations Section of the Himan Resources Department will be responsible for working with both management and employees to ensure a smooth personnel transition.

The shipyard has an excellent relationship with all its employees and this will be maintained by building on the existing mutual trust and loyalty through effective communication and cooperation in implementing all the necessary changes.

A9.2 Training

The change over from navaI to commercial ships will not affect the basic skills requires for ship construction. However, as mentioned above, it will require a redistribution of the skills.

Training for the employees will center on discussing the details of the types of commercial ships to be built and will focus on the important differences. The major challenge is to ensure that the employees will accept the necessary changes and not persist in doing commercial work in the same way they did naval work It cannot be “work as usual”. While the highest quality is still important it is of a different level, especially in the area of documentation.

Also, the successful management of the transition together with some technology changes, will require some training of the management team will be necessary. All training will be “in-house” in the form of seminars carried out by appropriate in-house and brought-in specialists.

All training will be the responsibility of the Training Director.

A9.3 Project Organization

A9.3.1 Shipyard Organization Charts

Figure A9.1 shows the shipyard organization to the levels at which contact with the owner's representatives will occur. Contacts with ABS and USCG take place at the same levels.

Figure A9.1 - SHIPYARD HIERARCHY TO SENIOR MANAGEMENT LEVEL

A9.3.2 Client's Organization Chart

The client's organization, to the level at which continuous contact with the shipyard will take place, is shown in Figure A9.2. Prior to the placing of the contract there was frequent contact between the respective Presidents, Finance VPs and Engineering VPs. These contacts will continue but not frequently.

Figure A9.2 - CLIENT'S HIERARCHY TO SENIOR MANAGEMENT LEVEL

AlO: WEIGHT CONTROL

A10.1 General

The actual weight of the completed ship decides how much of the design full load displacement is available for the carriage of cargo. Generally, the required weight control for commercial ships is much less than that for a naval ship. This is because much more of the full load displacement is for carrying the cargo. That is the deadweight for most commercial ships is greater than the lightship weight. Whereas the opposite is true for naval ships where the payload might be only a small fraction of the full load displacement. Also the systems for a naval ship are much more complex than those for the normal commercial ship and therefore the estimation of the weight of the systems requires much more detail and effort.

Weight estimation for commercial ships have much more similarity from one ship to another. This enables designers to use parametric methods plus greater margins for the unusual. Parametric methods of weight estimation require up to date databases for the various ship types. While this is available to the current designers of the world's commercial ships, U.S. designers do not have the database or experience necessary to use a parametric approach with confidence. Therefore, until sufficient experience is developed, the shipyard will utilize a weight control program to obtain the data and experience to ensure that the required deadweight is achieved.

The weight control procedure is a modified version of the shipyard's successful naval ship weight control procedure, but of considerably reduced scope. This will use the weight control team's familiarity with the existing procedure to ensure its easy transition for the first commercial ship.

A10.2 Outline Procedure

The weight control program will be established and managed in accordance with the shipyard's Weight Control Procedure for Commercial Ships, dated

The weight control procedure consists of the following phases:

- Calculations from drawings
- Equipment vendor weight reporting
- Lightship weight and center check

The calculation of the weight items will be under the three major groupings

- Steel
- outfit
- Machinery

They will be summarized as:

Total Steel
Total Outfit
Total Machinery

together with their associated centers of gravity and suitable margins on all items.

A10.3 Departmental Responsibilities

The Weights Section of the Naval Architectural Department will be responsible for the weight control. A Weight Manager will be assigned for this contract. Individual weights and centers of gravity will be calculated by the Weignt Section engineers. A Weight Manager will be assigned for this contract.

All weight information obtained by the other design sections will be forwarded to the Naval Architectural Department for processing.

APPENDIX B

BUILD STRATEGY FOR A 42,400 TONNE DWT PRODUCT TANKER

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B1: INTRODUCTION

B1.1 Purpose of Document

This Build Strategy is approved and endorsed by senior management. It should be used as the primary working document for this Contract. The accomplishment of the objectives and corresponding performance is essential for the ongoing success of the company and complete satisfaction of the customer.

Understand its implications for your department or group and follow it where actions are required to ensure that the strategy is fully implemented. Any significant deviations from the Build Strategy necessary during the performance of the Contract, must be fully documented and processed through the Build Strategy Control Board.

This is a COMPANY CONFIDENTIAL document and must be handled accordingly. However, distribution is broad enough to ensure that its communication value is not diminished. All copies have been assigned a control number and tracked to individual, group or department level.

The purpose of the Build Strategy is to apply the agreed method to build the ship to suit the facilities, processes, ship definition strategy and the objectives of the Shipbuilding Policy, and to facilitate communication and collaboration of departmental actions to meet the aims of the Build Strategy.

This Build Strategy provides a framework for the effective development and coordination of the many aspects of a specific ship contract. It also ensures that the design is developed in line with current, or projected, methods to be used by the production departments.

Emphasis is placed on the outfitting and engineering aspects of the design and production of the ship as it is in these areas where the most significant benefits of improvements in productivity can be obtained.

During the development of the Build Strategy, efforts have been made to reduce the work content inherent in the finished product by the extensive use of standards and the application of production engineering techniques at all stages of production.

The Build Strategy also provides an analysis for each stage of production in order to identify the methods and processes to be used. This analysis identifies problem areas to which special attention will have to be paid to avoid any bottlenecks during the production of the ship.

This Build Strategy has been prepared by several departments and the integrated approach is confirmed by the department heads who, as members of the Build Strategy Control Board, have signed below.

M ONEY
Vice President, Finance

T E C H Nical
Vice President, Engineering

M Hours
Vice President, Production

N E T Work
Vice President, Planning

B U Ying
Vice President, Procurement

B1.2 Build Strategy Document Prerequisites

The preparation of this Build Strategy is based upon the company's current Shipbuilding Policy and Ship Definition Strategy. Any modification required because of special characteristics or needs for the ship are described in Sections B4.2, B4.3 and B4.4 below.

B1.3 Distribution

This Build Strategy Document distribution is as follows:

All vice presidents.
All senior managers.
All other managers and supervisors.
Engineering department section leaders.
Production engineering department section leaders.
Classification society representatives (excluding budget schedules).

B1.4 Summary

This Build Strategy is prepared for:

Hull number 1001.
Contract number 93/E9875/1001.
Number of ships. First ship of a three ship contract.

It is prepared to record, integrate and communicate important specific ship design, material definition, planning, production and testing information in one internal (within the company) accessible shipyard controlled document.

It has been signed by the Vice Presidents of Finance, Engineering, Production, Planning and Procurement and represents company policy and must be strictly adhered to.

This Build Strategy:

Defines what is to be built.

Defines the Parameters of the build cycle, including schedule, budget and manning, as dictated by the contract.

Shows the adopted block breakdown, sequence of erection and initial process engineering.

Identifies outfit zones, machinery arrangements and equipment units.

Identifies interim products and creates a production oriented approach to engineering and planning of the ship.

Defines material purchasing requirments necessary to support the production process.

Indicates any special requirements in terms of the facilities, manpower, skills, etc, and highlights potential problems and how they will be overcome.

B2 : VESSEL DESCRIPTION

B2.1 General Description and Mission

The General Arrangement of the ship is shown in Figure B2.1, from which it can be seen that it is a single screw, diesel engine propelled, steel product tanker, suitable for the transport of petroleum oil, and is to be fitted out with eight cargo tanks. The ship has a bulbous bow, raked stem, and a transom stern. It has no superstructures, only a deckhouse. The deckhouse is located aft and has five deck levels. There is 2,000 mm sheer on the main deck only. There is 500 m straight line camber on the main deck, and no camber on any other deck.

The hull is subdivided by 11 transverse bulkheads into 12 main watertight compartments. The engine room is located aft, between the after peak and the forward engine room bulkheads.

Loading and unloading operations are performed by. means of deepwell pumps located in each cargo tank.

Additional features are that the ship has a double hull to comply with 0PA90.

The mission of the ship is to transport a range of petroleum products between the US Gulf Coast and Japan or North West Europe. The ship will be registered in Panama and" operated by a Phillipino crew.

B2.2 Principal Particulars

The ship has the following dimensions:

Length overall	= 183.00m
Length between perpendiculars	= 174.00m
Breadth moulded	= 29.26 m
Depth moulded	= 16.63 m
Design draft	= 12.20 m
Freeboard and scantling draft	= 13.00 m
Deadweight on design draft	= 42,400 tonne

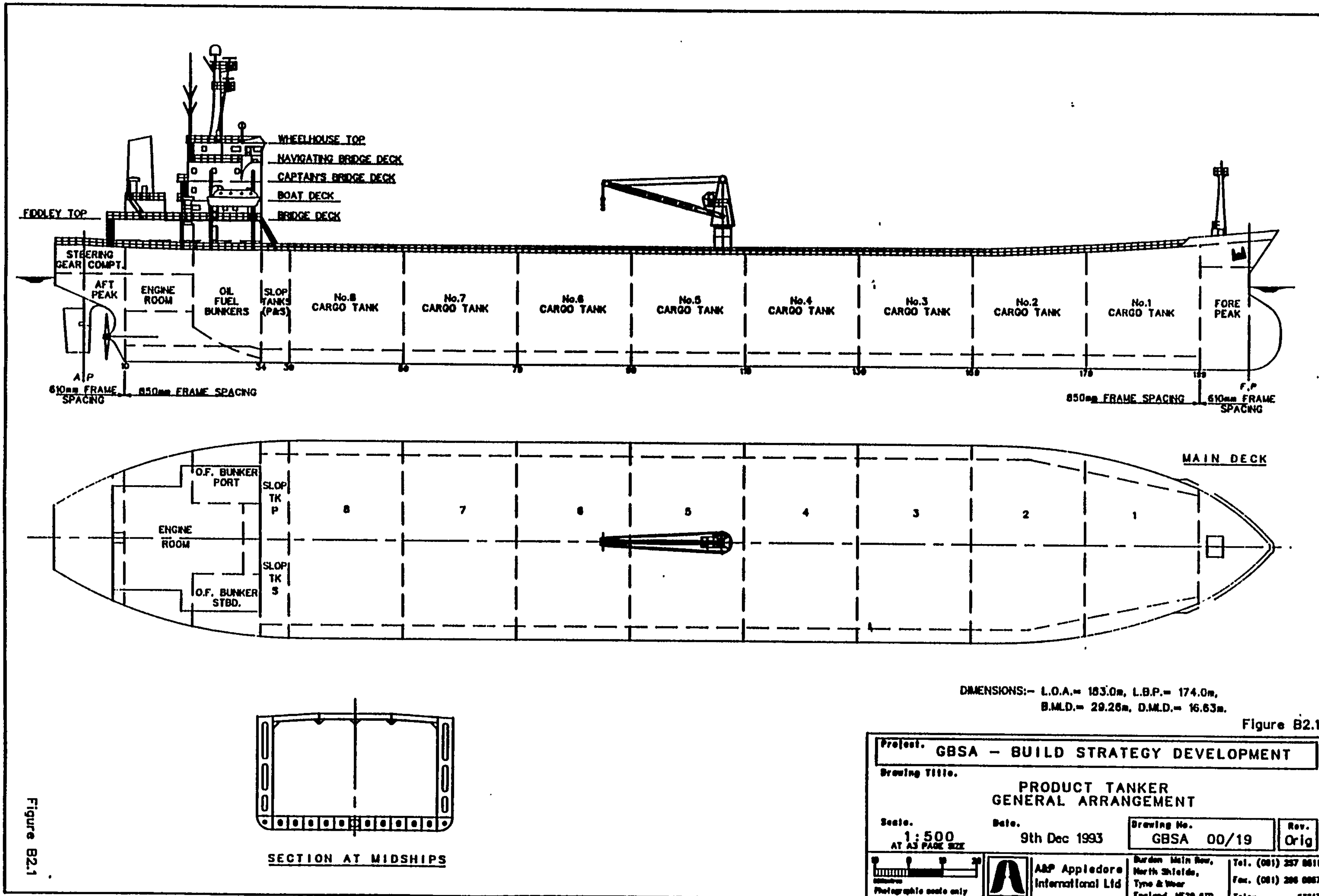


Figure B2.1

Figure B2.1

B202

B2.3 Special Characteristics and Requirements

a) The ship is designed to comply with OPA 90 and thus has a double hull at the bottom and sides of the cargo and slop tanks. Figure B2.2 is the Midship Section for the ship and clearly shows the double hull. Water ballast is carried in the double bottom and "double" side tanks which are required to be coated with a coal tar epoxy paint.

b) The main engine is a slow speed marine diesel.

c) Electric power generation is by means of a steam turbine generator served by a waste heat recovery boiler and also by means of two diesel driven generators.

B2.4 Comparisons and Differences from Previous Ships

For the past 15 years the company has been engaged in building naval ships for the US Navy and this ship is the first merchant vessel to be built in that time. The major differences which will be encountered are:

The scantlings of a merchant ship are much thicker and hence individual structural items are heavier than those of a naval ship.

The method of erecting and outfitting the ship is much more under the control of the shipyard. Hence the importance of this document.

Merchant standards and quality requirements are less than those required for a naval ship. This does not mean that quality is unimportant - it is essential, but not to such a high standard. There will still be standards which apply but these will be either in-house standards or the commercial standards of ISO, IEC, ITU, ANSI, etc. 'Classification society standards will also have to be met.

A slow speed marine diesel engine is something completely new for this shipyard. For this reason a number of engine department personnel are being sent to Europe for training in the building and installation of these engines. For this contract the engines are being purchased ready built, but investigations are underway regarding the feasibility of becoming a licenser for building such engines.

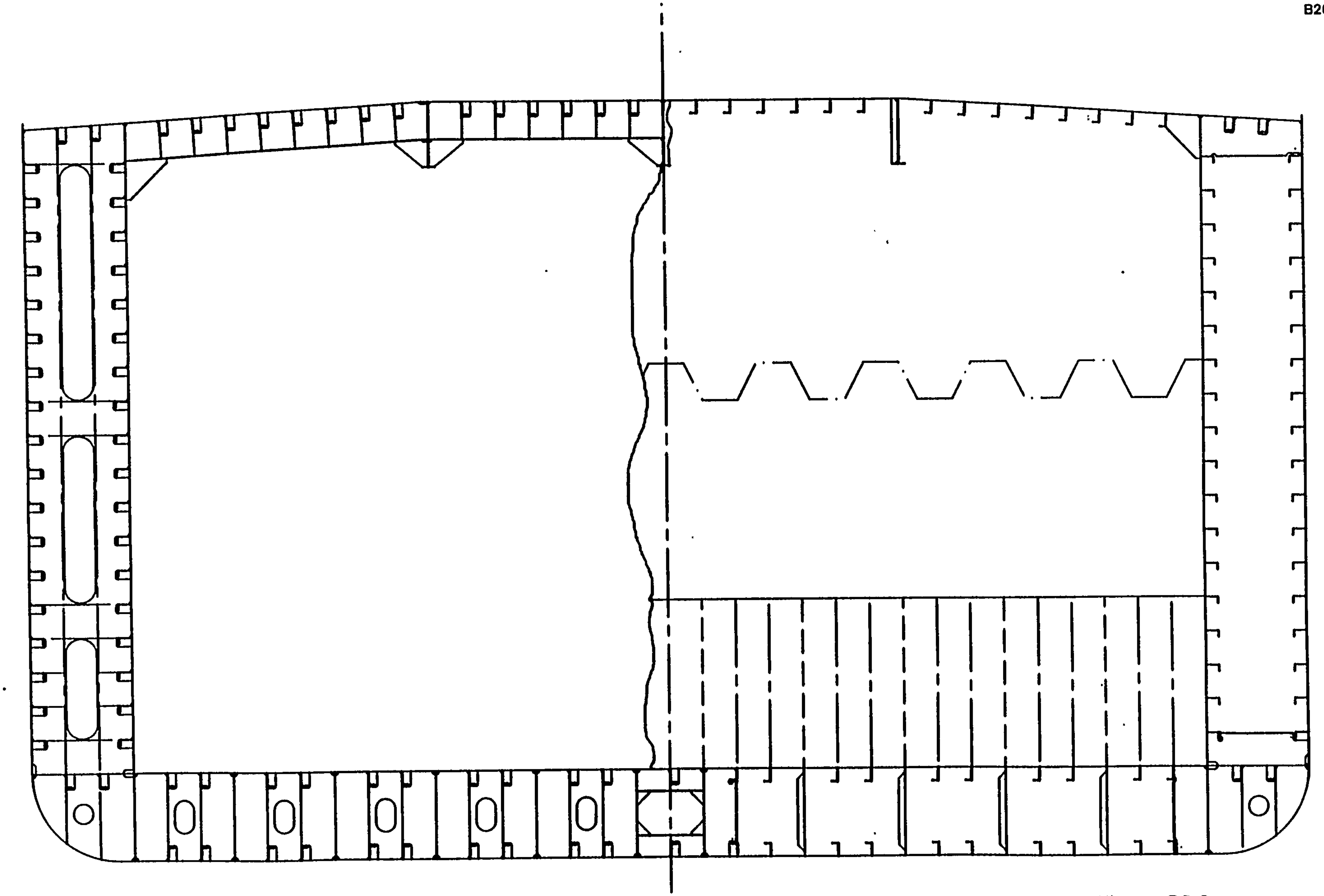


Figure B2.2
PRODUCT TANKER
MIDSHIP SECTION

DRAWING No.:- GBSA 00/38 ORIG
ORIGINAL DRAWN 6-JAN-94/K.H.

There will be far fewer owners representatives in the ship yard but they still have to be satisfied that the ship complies with contractual requirements. owners representatives will be supplemented by classification society and United States Coastguard (USCG) surveyors who will ensure that their requirements are met.

The units in which linear measurement, areas, moments, forces, stresses, powers, etc, are expressed are in accordance with the Systeme International des Unites (SI).

B2.5 Applicable Regulations and Classification

The ship shall comply with all applicable laws of the Panamanian Marine Administration and the requirements of The American Bureau of Shipping for the following class: + Al E Oil Carrier + AMS + ABCU and the US Government OPA90 act.

The ship shall also comply with the latest IMO regulations for the prevention of pollution at sea.

B2.6 Owner Particulars

The ships built under the contract are for Master Tankers Inc (MTI) of New York.

B2.6.1 Background

MTI have been established since 1947 with the purpose of carrying US petroleum products to Japan and North West Europe.

B2.6.2 Fleet

MTI currently operate a fleet of 36 product tankers and have decided upon a process of fleet modernization, particularly to ensure that their ships comply with OPA 90.

B2.6.3 Port Relationship

Up until 1978 50% of the MTI fleet was built in this shipyard, but since then all new buildings have been undertaken in the Far East.

These orders are an opportunity to re-establish our past relationship with this prestigious owner and it must be taken.

B2.6.4 Competion

Not only shipbuilders face competition, but also shipowners have intense competition and it is imperative to them that their ships are builton schedule and to the quoted price.

The competition faced by MTI comes mainly from Japanese and European shipowners, none of whom have a track record of ordering in the USA. It is in the shipyard's best interests to ensure that MTI obtains what they have contracted for.

B3 : CONTRACTUAL

B3.1 Contractual Dates and Time Constraints

The ship to which this Build Strategy applies is the first of a series of three ordered by C Lean Tankers of Panama. The ships are due for delivery as follows:

Ship 1: 10 December 1995
Ship 2: 14 March 1996
Ship 3: 29 April 1996.

To achieve these contracted delivery dates requires that the first block of steel for this ship is laid on berth two on 24 December 1994, the first block of steel for Ship 2 is laid on berth one on 30 April 1995. The first date requires that sufficient steel is defined, ordered and delivered by the end of July 1994. The second date requires that the last existing naval ship on order is launched on 29 April 1995.

It is imperative that all of these targets are achieved.

B3.2 Payment

The payment terms are related to identifiable stages in the build program. They are shown below:

	%	Value US$
Contract signing	5	1,750,000
Cut first steel	5	1,750,000
Lay keel (first block on berth)	5	1,750,000
50% steel erected	10	3,500,000
Launch	15	5,250,000
Delivery	60	21,000,000

This again reinforces the need to meet specified target particular timely delivery.

B3.3 Liquidated Damages Penalties

There are no liquidated damages applying to this contract, but the following penalties apply:

For the first 15 days, no penalty.

For every additional calender day the shipyard will pay US$ 10,000, up to a maximum of 5% of the contract price.

If delivery is delayed by three months from the contracted delivery date extended by permissible delays, then the owners will be entitled to cancel the contract. In such case the shipyard is obliged to repay immediately all payments made by the owners, plus interest from the date of payment to the date of the repayment. The interest rate is set out at the London Interbank Offered Rate (LIBOR) 12 months, plus 3%.

B3.4 Cancellation

The paying of any penalties is to be avoided but cancellation would be disastrous for the company. Cancellation can be caused by:

Late delivery, over 91 days.
Attained speed 4.0% less than specified.
Fuel consumption 5.5% greater than specified.
Deadweight 6.0% lower than specified.
Cargo volume 6.0% less than specified.

The last four items are technical and the existing design procedures should ensure that they do not apply. The first item reinforces the need to keep to schedules at all stages of the contract as all delays have a knock-on effect far greater than their apparent effect.

B3.5 Drawing Approval

In the contract the owners have up to three weeks to approve or make comments upon submitted drawings; otherwise they can be assumed to be approved, unaltered. This arrangement must be strictly enforced to prevent undue time being taken for approval.

It is vitally important that they receive any information which has to be approved by them on time and that they approve it within the timescale shown above.

Both ABS and the USCG have been approached and have agreed to achieve better than a three week turnaround on drawing approval.

B3.6 Construction Inspection

The construction of the ship will be subject to inspection by the following:

> Owners: a hull and paint inspector, a machinery inspector and an electrical inspector.
>
> ABS: a hull surveyor and a machinery and electrical surveyor.
>
> USCG: a ship surveyor, a machinery surveyor, an electrical surveyor and a nautical surveyor.

They should be given every co-operation to assist them undertake their duties.

For structural surveys the inspectors should be called to view the structure from the major assembly stage onward, in order that any problems are identified and rectified where they have occured.

For tests on equipment and systems the inspectors should be given 24 hours notice and invited to attend. Should they not attend the test will not be repeated. As many tests as possible should be undertaken in the workshop where the equipment will be connected to the necessary services in order to demonstrate its compliance with requirements.

B3.7 Trials

Trials will be attended by the same persons who undertake the inspections of B3.6 above.

The following dock trials will have to be undertaken alongside the outfitting quay:

Main engine.
Auxiliary machinery.
Deck machinery.
Controls and instrumentation.
Standby and emergency systems.
Electric power and lighting systems.
Chain stoppers.
Steering gear.
Lifeboats and davits.
Pumps and all fluid systems.
Air and sounding pipes.
Heating, ventilation and a/c systems.
Domestic refrigeration plant.
Commnunications systems.

Before calling in the inspectors to witness a trial, the equipment or system will have been fully tested by the QA department and accepted as being in order. Upon successful completion of the shipyard test the relevant inspectors are to be given the required 24 hours notice to attend the official trial.

Sea trials will be undertaken at the end of the basin trials and will consist of:

Measured mile speed trial.

Torsion meter measurement of torque developed by main engine.

12 hour endurance and fuel consumption trials at 25%, 50%, 75% and 85% of full power.

Maneuvering, turning and stopping.

Crash/Astern, Crash/Ahead and Astern Trial.

Windlass trial, with full extent of cable out.

Setting up remote control and other equipment which requires the ship to be at sea.

Adjustment and calibration of navigational equipment.

These will be undertaken at a ballast draught agreed by the owners.

Before proceeding on the sea trials all systems and equipment possible will have been tested by the shipyard. Exceptions are those which require the ship being at sea in order to prove, ie, speed, fuel consumption, compass adjusting, etc.

The sea trials will take place off the coast of Zanadoo in the vicinity of the measured mile course at Brigadoon. They are scheduled to last for three days.

63.8 Quality

The quality of the finished steel products is to be in accordance with the shipyard's Steelwork Standards, Document No QAO027, issued thly 1983.

The quality of the other products is to be in accordance with the relevant QA department procedures and/or applicable industry standards which apply, whichever is higher.

B4: DESIGN AND ENGINEERING

B4.1 Strategy and Scope

B4.1.1 General

The design and engineering drawings are being undertaken by an outside agency, Messrs D E Signer Inc, but they are to supply staff to work in-house, under the control of the company Design and Engineering Department.

All design calculations and drawings required for approval purposes and by production departments will be produced by the teams set up for the purposes.

When production drawings are being developed, multi-discipline (cross-functional) teams wil1 be set up in order to ensure that the drawings:

- follow shipbuilding policy;
- follow ship definition strategy, as modified in B4.1.2 below;
- satisfy special requirements of all users.

B4.1.2 Changes to Ship Definition Strategy

Because the existing company ship definition strategy was developed for naval ships, it will have to remodified to suit merchant ships. The following changes will be made:

Datums. For naval ships the point of origin for datums is the forward perpendicular, the base line and the centre line. This will be changed to the after perpendicular, the base line and the centre line.

Definition of Datums. For naval ships the definition of datums is positive ve moving aft from the forward perpendicular, moving up from the base line and moving to port from the centre line. This will change to positive ve moving forward from the after perpendicular, moving up from the base line and moving to starboard from the centre line.

All units of measurement, force, moments, stress, power, etc, are to be in accordance with SI. There will be no intermediate stage when both SI and the present system are shown on drawings, but all employees will be issued with conversion tables. Training courses on the use of SI will be held throughout the company prior to anyone being expected to apply the new system of units.

B4.I.3 Modelling and Composites

A 1:25 scale model of the machinery space is to be constructed of clear perspex sheets for the structure, solid plastic pieces for machinery and equipment, coloured plastic tubes for pipework, coloured plastic rectangular section pieces for duct work and coloured plastic strips for wire ways.

The model will clearly show block seams and butts, equipment units, pipe banks, etc.

Final runs for pipework, duct work and wire ways will be determined from the model.

Clear of the machinery space, composite digital models showing structure, equipment and systems will be prepared for:

Steering gear compartment.

Upper Deck Accommodation.

Bridge Deck Accommodation.

Boat Deck Accommodation.

Captain’s Bridge Deck Accommodation.

Navigating Bridge Deck.

The composites will be prepared directly from the approved diagrammatic.

B4.2 Key Drawings

Key drawings have been produced and show the main transit routes for all of the services in the ship (piping, vent trunking and wire ways). The key drawing shows all of the functional spaces within each of the compartments of the ship. Figure B4.1 shows the Key Drawing for a part of the machinery space.

The actual size of the transit routes will be determined later but every effort must be made to ensure that the services are located within the routes shown on the key drawings.

Key drawings have sufficient space in them for adding notes and tables when they are used for routing the services.

B4.3 Production Information Requirements

B4.3.1 CAM Information

Computer Aided Manufacture is used in the following areas in the shipyard:

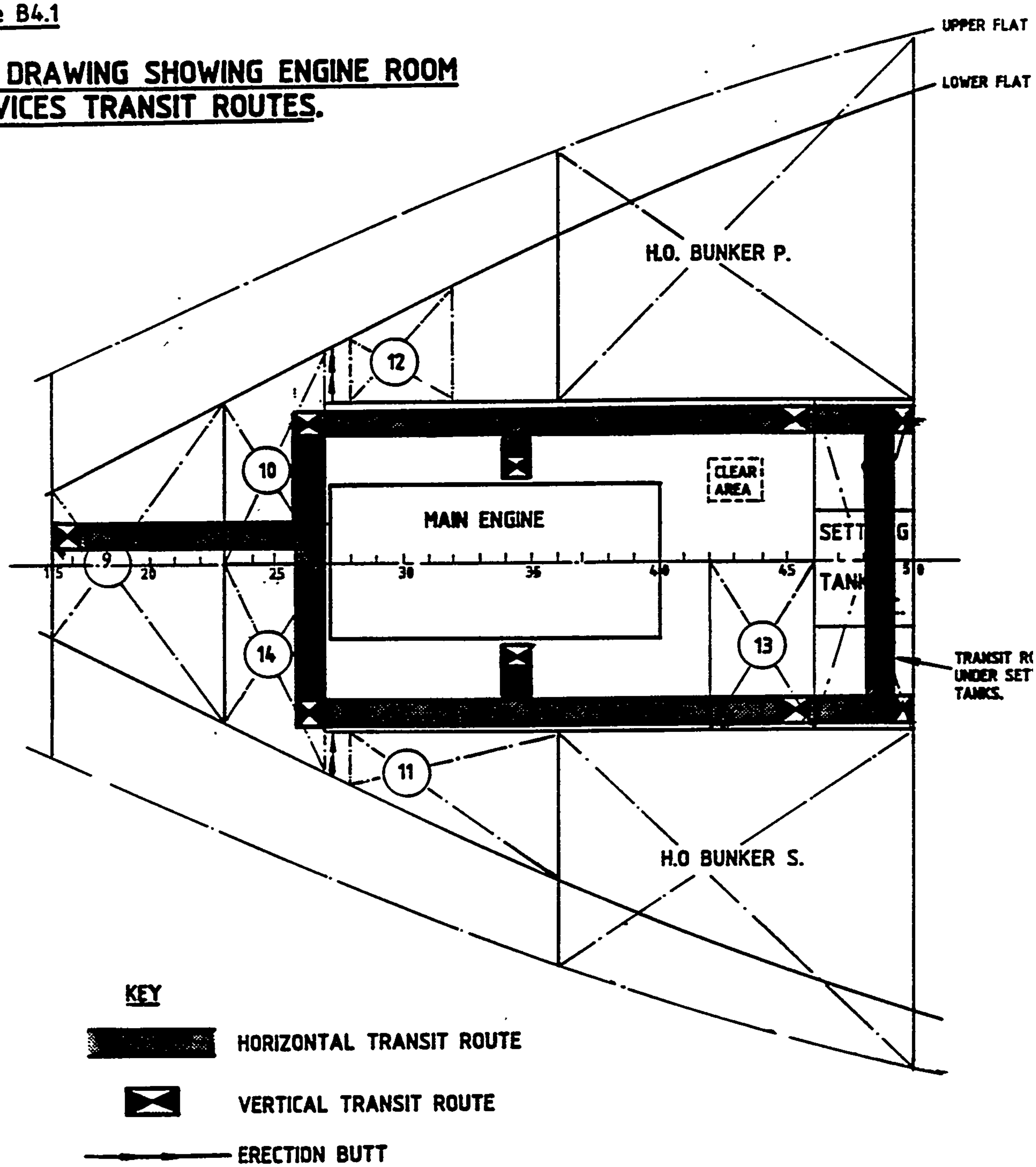
- Steel storage and retrieval.
- Burning machines.
- Frame bending machines.
- Stores location and retrieval.

Information must be provided to the steel stockyard on the quantities of steel plates and profiles, their sizes and weights, when they will arrive and when they will be withdrawn, so that forward planning for logical storage can be prepared.

The preparation workshop must be informed of the numbers and sizes of the steel material to be worked upon in a given period in the shop and be supplied with magnetic tapes with the N/C instructions for performing the work on the material. They should also be provided with the new steelwork manufacturing standards, the standard plate edge preparations for welding operations and the standard stiffener notches and other cut-outs, all for merchant ships. See Section B4.8.1, Steelwork Design Guidelines, for further information on steelwork standards.

Figure B4.1

KEY DRAWING SHOWING ENGINE ROOM SERVICES TRANSIT ROUTES.



LOWER FLAT

The information required for stores location and retrieval is as for other ships, with the exception that the parts numbering is different from that of naval ships. A copy of the new parts numbering system must be made available to the stores department.

B4.3.2 Manufacturing Information

The format of manufacturing information must reflect the manner in which the work is to be performed at the appropriate workstation or zone, and the tools or equipment to be used. This is as described in the company Ship Definition Strategy.

B4.3.3 Parts Listings

Product Work Breakdown Structure and associated part numbering is different for merchant ships, to that used for naval ships. The new parts numbering system is defined in the company document "Parts Numbering for Merchant Ships, Rev A", produced by the planning Department in October 1993. The new system is to be adopted for this contract.

A Parts List for each drawing, in accordance with the new numbering system, is to be produced by the Design and Engineering Department.

B4.3.4 Installation Drawings

Installation drawings are to reflect the manner in which the installation is performed and the tools and equipment to be used. The information thev should contain and the format of this information is as desiribed in the company Ship Definition Strategy.

B4.3.5 Installation Procedures

Installation procedures are to be determined from manufacturers' instructions and company procedures. They are to be clearly written up and forwarded to the relevant installation department, Production Control and QA, for action.

04.4 Desian and Engineering Schedule

B4.4.1 Schedule

Figure B4.2 shows the key events for all ships in the current order book. From the Figure it can be seen that the key events for Ship 1 of the Products Tankers, for which this Build Strategy has been developed, are:

Sign contract (C)	: 10 Dec 1993
Cut first steel (S)	: 20 Aug 1994
Erect first block on the berth (K)	: 24 Dec 1994
Launch (L)	: 23 Jun 1995
Deliver (D)	: 10 Dec 1995

These dates determine when bought-in materials and equipment have to be available in the yard. The delivery dates from ordering of the materials and equipment determines the date when the equipment should be ordered and this, in turn, specifies when the technical information should be available to enable orders to be placed.

Table B4.1 shows the schedule for when the requisitions for the ordering of the major items of materials and equipment are required from the Technical Departments. It was derived using Table B5.1 - Production Times of Critical/Long Lead Time Items, and Figure B6.1 - Equipment Installation Dates and Required Delivery. To enable requisitions to be produced the relevant shipyard technical information in the form of drawings and specifications must be available.

B4.4.2 Resourcing and Utilisation

The total design and engineering manhours required for this ship is 120,000. Based upon 40 hours per week, this represents 3,000 man weeks of effort.

Table B4.2 shows the allotted timescales, % of total effort and manhours required to produce the technical information for the various phases. It should be noted that there is significant overlap between all phases and that the total elapsed time for producing the design and engineering information is 75 weeks.

Figure B4.2

KEY EVENTS FOR THE CURRENT ORDER BOOK

DRAWING No.:-GBSA 00/07 ORIG
ORIGINAL DRAWN 28-SEP-93/K.H.

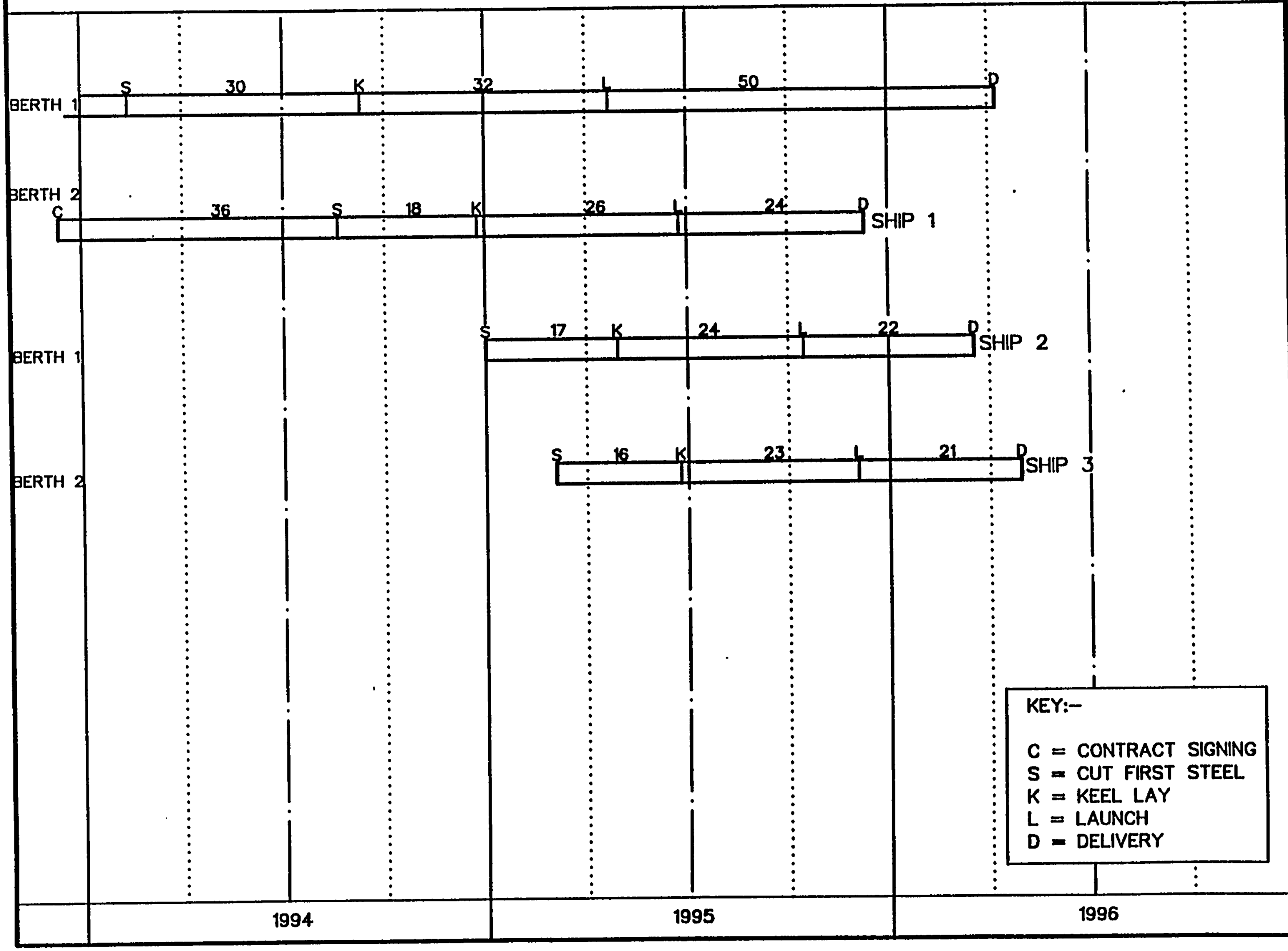


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Table B4.1

REQUISITION SCHEDULE FOR MAJOR ITEMS

Item	Required Recauisition Date Week/Yera
Steel	10/94
Main Engine	38/94
Shafting and Propeller	33/94
Auxiliary Machinery	48/94
Electrical Generators	38/94
Waste Heat Recovery Boiler	5/95
Steering Gear	48/94
ER Pumps	5/95
Cargo Pumps	5/95
Air Compressors and Receivers	46/94
C02 System	1/95
Machinery Controls and Instrumentation	31/95
Lighting and Electric Cables	3/95
Switchboard	31/94
Hydraulic Power pack	49/94
Sewage Plant	49/94
Air Conditioning and Fans	42/94
Refrigeration Machinery	43/94
Deck Machinery (Mooring and Anchor Handling)	4/95
Deck Crane	5/95
Lifeboats and Davits	42/94
Navigation Equipment	26/95
Communications Equipment	26/95

Table B4.2

ALLOTTED TIMESCALES, % OF TOTAL EFFORT AND MANHOURS REQUIRED FOR THE VARIOUS PHASES OF PRODUCING TECHNICAL INFORMATION

Phase	Allotted Time Weeks	% of Total Effort	Required Manhours
Design Information	15	7	8,400
Information for Approval	24	28	33,600
Transition Definition (from systems to zones)	18	19	22,800
Production information	50	46	55,200

Thus the manweeks and manpower required for the phases have been calculated and shown in Table B4.3 below:

Table B4.3

MANWEEKS AND MANPOWER REQUIREMENTS FOR EACH PHASE

Phase	Man Weeks	Manpower
Design	210	14
Approval	840	35
Transition	570	32
Production	1,380	28

B4.4.3 Vendor Furnished Information (VFI) Schedule

The vendors shown in Table B4.4 below are required to provide information regarding their product by the date shown alongside their name. The relevant product is also shown in the table.

Table B4.4

VENDORS. PRODUCTS AND LATEST DATES FOR RECEIVING VFI

Vendor	Product	Latest Date for VFI
D Iesel Inc	Main Engine	48/94
S Haft Inc	Shafting	43/94
P Repel Inc	Propeller	43/94
E Gene Inc	Electrical Generators	46/94
B Oiler Inc	Waste Heat Recovery Boiler	10/95
S Teer Inc	Steering Gear	8/95
P Ump Inc	ER pumps	12/95
D Well Inc	Cargo Pumps	12/95
A Comp Inc	Air Compressor & Receivers	6/95
C Arbon Inc	CO_2 System	9/95
C&I Inc	Controls & Instrumentation	40/94
S B Oard Inc	Switchboard	6/95
H Y D Raulic Inc	Hydraulic Power Packs	
`SMell Inc	Sewage Plant	6/95
F Ayre Inc	A/C and Fans	3/95
V Cool Inc	Refrig Machinery	
W Inch Inc	Deck Machinery	10/95
H Lift Inc	Deck Crane	10/95
L Save Inc	Lifeboats and Davits	2/95
D I Rection Inc	Navigation Equipment	32/95
T Balk Inc	Communications Equipment	32/95

To ensure that the VFI is received on schedule the vendors must receive the purchase order for their product in the timescale they offer in their bid. At least two weeks before the latest date for receiving the information (if it has not been received) the vendor must be contacted to expedite the information.

B4.5 Datumx Molded Definitions

The system of datums to be used is as shown in Figure B4.3. Briefly the origin for the datums is:

After perpendicular.
On the base line.
On the centreline.

With +ve going forward from the after perpendicular, moving to starboard from the centreline and upwards from the base line.

The boundaries of planning units, ie, blocks, zones and outfit units, are defined in terms of the primary datums while details of piece parts and interim products are related to the secondary datums.

The molded definition is important to ensure correct alighment of adjacent and continuous structure. The molded definition is shown in Figure B4.4.

B4.6 Design Standards

As new ship designs are adopted and orders for them are placed, it will be necessary to develop the designs for production. This will require not only ensuring that the design of the ship conforms to the capability of the production equipment, but it will also be necessary to develop the expertise to design so that, for example, steel and outfit standard assemblies and parts are considered from the concept design stage.

B4.7 Functional Space Allocation

Functional spaces have been allocated within each of the compartments in the ship. Figure B4.5 shows the arrangement of the compartments of the ship and Figure B4.6 shows the functional spaces determined for the lower flat in the engine room.

The functional spaces have been determined by locating groups of related equipment together so that the lengths and runs of interconnecting services are kept to a minimum and made simpler. Collecting related equipment together allows for the development of equipment units.

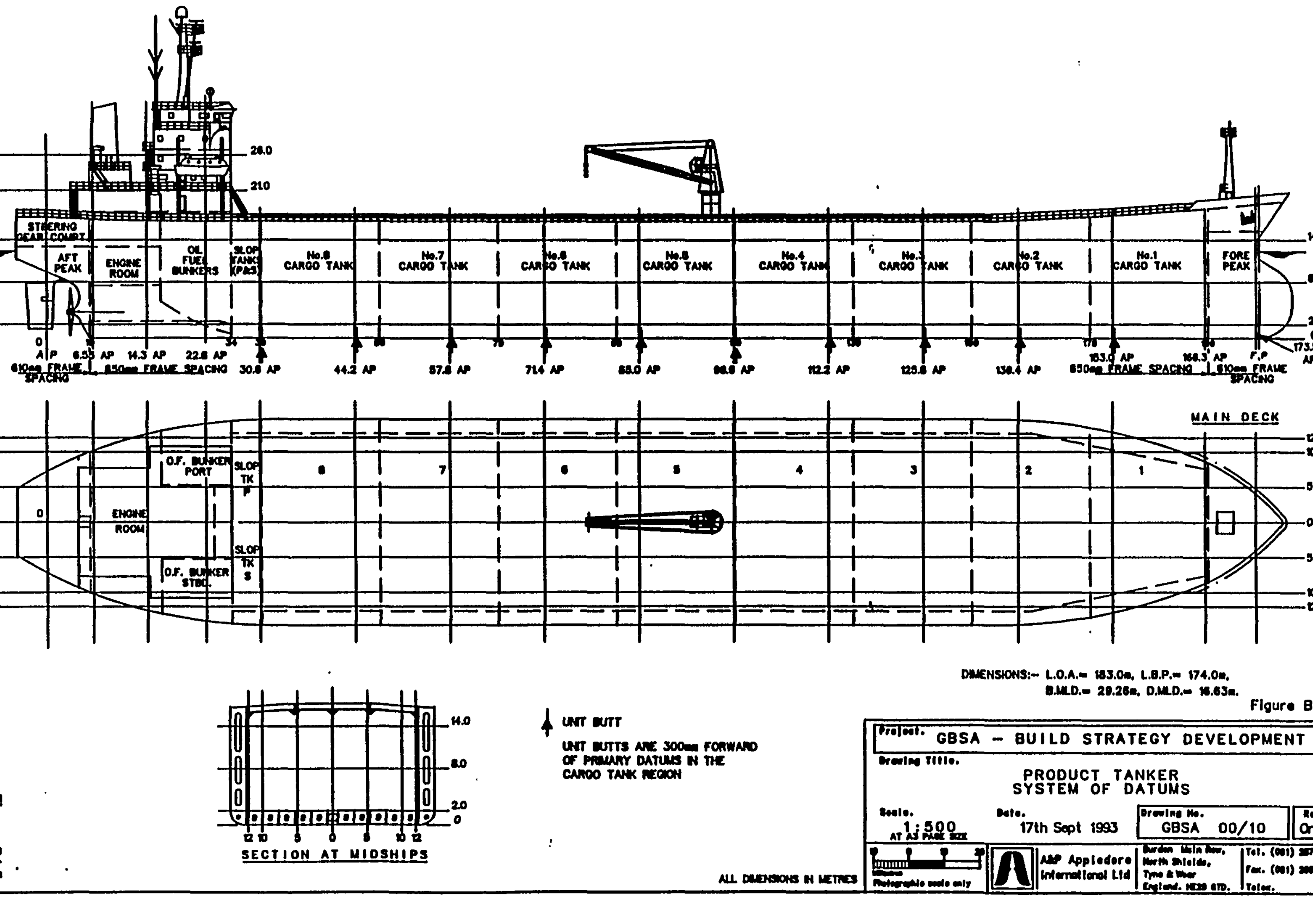
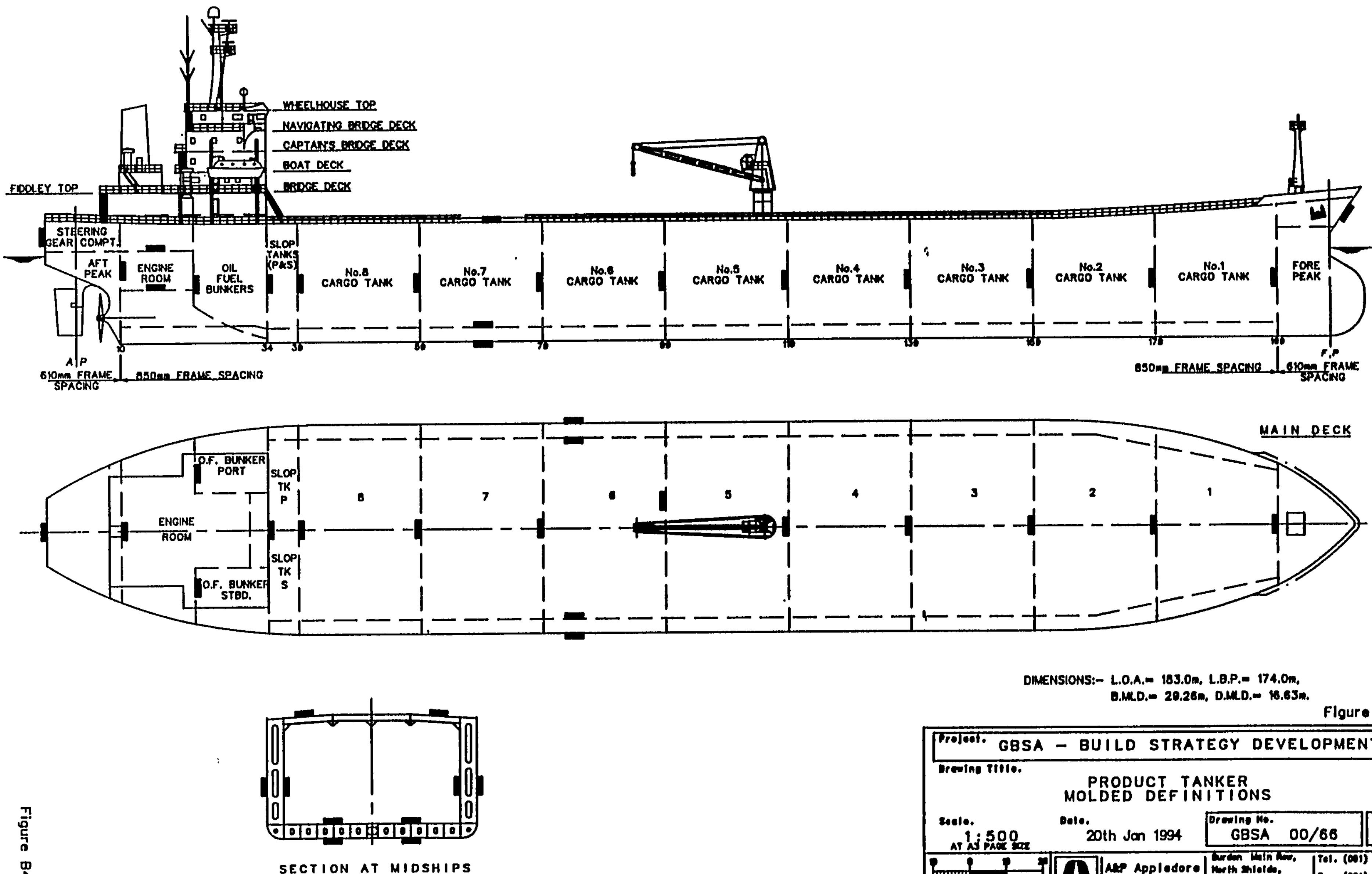

STEERING GEAR COMPT.
AFT PEAK
ENGINE ROOM
OIL FUEL BUNKERS
SLOP TANKS (P&S)
No.8 CARGO TANK
No.7 CARGO TANK
No.6 CARGO TANK
No.5 CARGO TANK
No.4 CARGO TANK
No.3 CARGO TANK
No.2 CARGO TANK
No.1 CARGO TANK
FORE PEAK
28.0
21.0
A.P
F.P
6.55 AP
14.3 AP
22.8 AP
30.6 AP
44.2 AP
57.8 AP
71.4 AP
85.0 AP
98.6 AP
112.2 AP
125.8 AP
139.4 AP
153.0 AP
166.3 AP
610mm FRAME SPACING
850mm FRAME SPACING
MAIN DECK
O.F. BUNKER PORT
O.F. BUNKER STBD.
SLOP TK P
SLOP TK S
ENGINE ROOM
DIMENSIONS:- L.O.A.= 183.0m, L.B.P.= 174.0m,
B.MLD.= 29.26m, D.MLD.= 16.63m.
14.0
8.0
2.0
0
SECTION AT MIDSHIPS
UNIT BUTT
UNIT BUTTS ARE 300mm FORWARD OF PRIMARY DATUMS IN THE CARGO TANK REGION
ALL DIMENSIONS IN METRES
Project. GBSA – BUILD STRATEGY DEVELOPMENT
Drawing Title. PRODUCT TANKER SYSTEM OF DATUMS
Scale. 1:500 AT A3 PAGE SIZE
Date. 17th Sept 1993
Drawing No. GBSA 00/10
A&P Appledore International Ltd
Photographic scale only

Figure B4.3



DIMENSIONS:- L.O.A.= 183.0m, L.B.P.= 174.0m,
B.MLD.= 29.26m, D.MLD.= 16.63m.

Figure B4.4

Project. GBSA - BUILD STRATEGY DEVELOPMENT

Drawing Title.

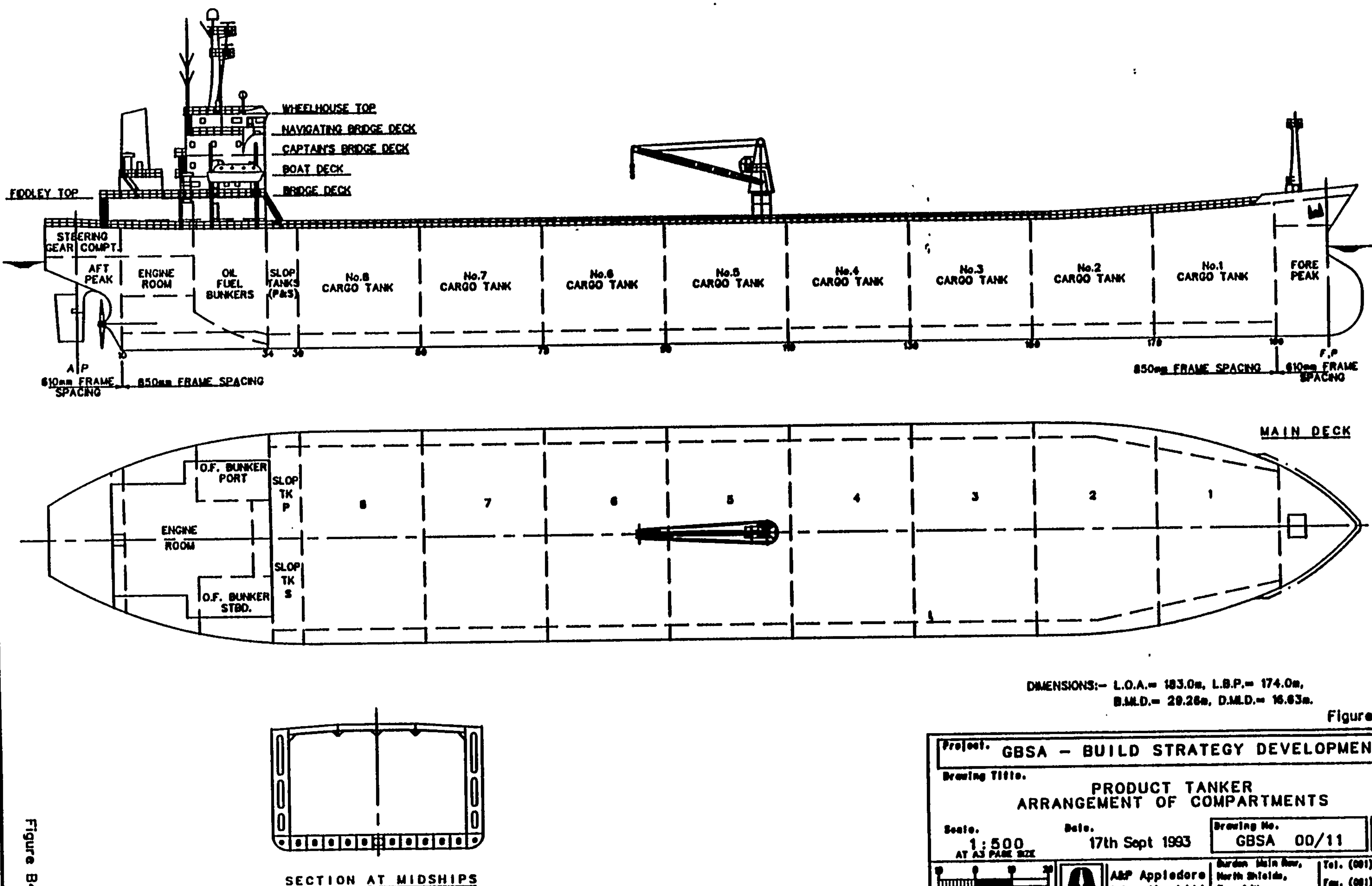
PRODUCT TANKER
MOLDED DEFINITIONS

Scale.	Date.	Drawing No.	Rev.
1:500 AT A3 PAGE SIZE	20th Jan 1994	GBSA 00/66	Orig

Photographic scale only

A&P Appledore International Ltd
Burdon Main Row, North Shields, Tyne & Wear England, NE29 6TD.
Tel. (091) [illegible]
Fax. (091) [illegible]
Telex. 53217

Figure B4.4



DIMENSIONS:- L.O.A.= 183.0m, L.B.P.= 174.0m, B.MLD.= 29.26m, D.MLD.= 16.63m.

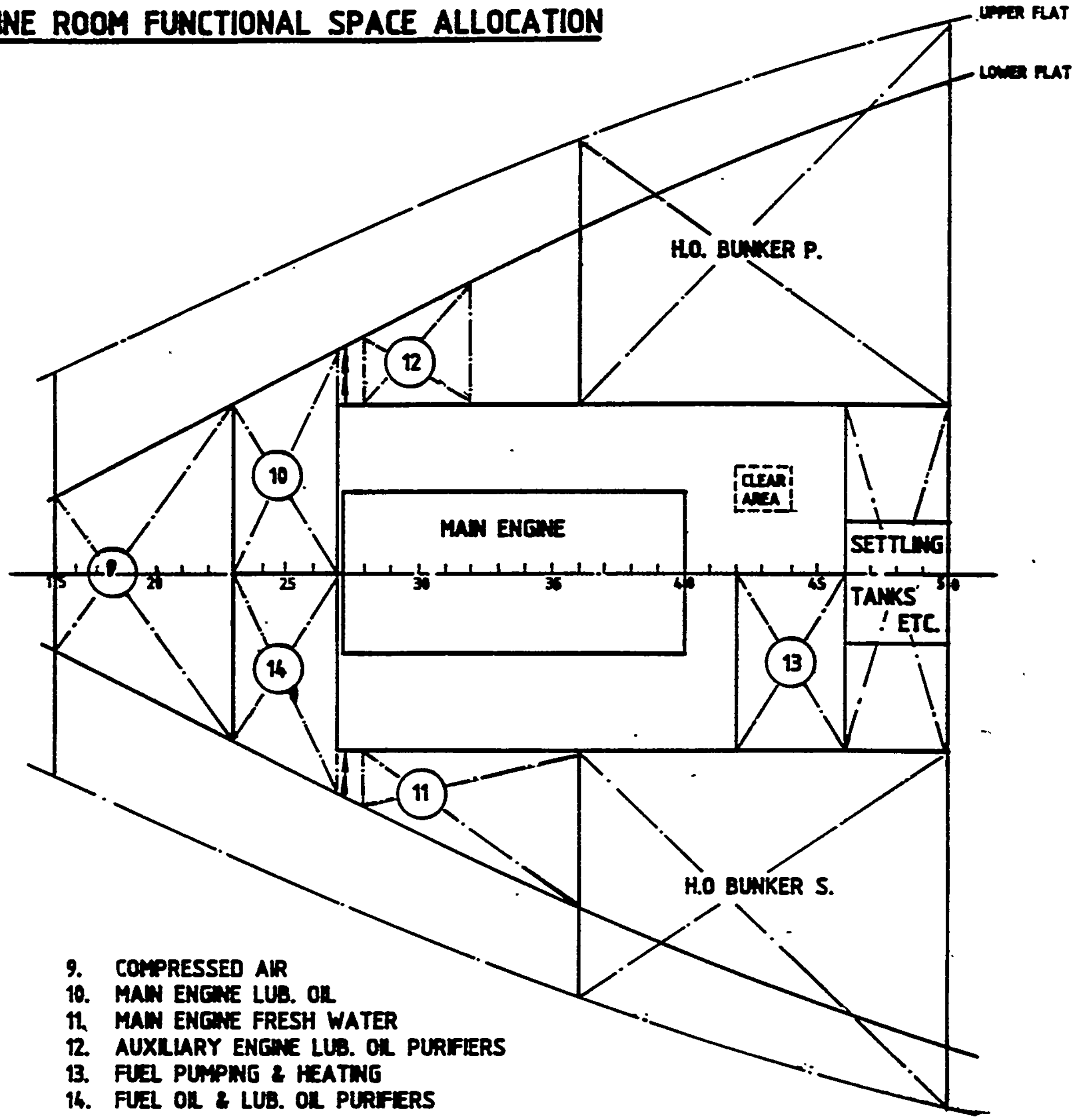
Figure B4.5

Project. GBSA - BUILD STRATEGY DEVELOPMENT			
Drawing Title. PRODUCT TANKER ARRANGEMENT OF COMPARTMENTS			
Scale. 1:500 AT A3 PAGE SIZE	Date. 17th Sept 1993	Drawing No. GBSA 00/11	Rev. Orig
Photographic scale only	A&P Appledore International Ltd	Burdon Main Row, North Shields, Tyne & Wear England. NE29 6TD.	Tel. (091) 257 0011 Fax. (091) 296 0067 Telex. 53217

Figure B4.5

Figure B4.6

ENGINE ROOM FUNCTIONAL SPACE ALLOCATION



9. COMPRESSED AIR
10. MAIN ENGINE LUB. OIL
11. MAIN ENGINE FRESH WATER
12. AUXILIARY ENGINE LUB. OIL PURIFIERS
13. FUEL PUMPING & HEATING
14. FUEL OIL & LUB. OIL PURIFIERS

——— ERECTION BUTT

LOWER FLAT

B4.8 Detail Design Guidelines

B4.8.1 Steelwork

Steelwork standards, such as manholes, cut-outs, brackets, hangers, etc, have been developed over a number of years. It is the responsibility of detail design to ensure that these standards are continuously and rigorously applied to all detail design work.

B4.8.2 Machinery

Installation To be in accordance with standards laid down in the company's Shipbuilding policy.

B4.8.3 Pipe Work

Pipework standards such as material types, bore sizes, pipe configuration (ie, straight pipes; pipes with one bend of 450 or 900, pipes with no bends, either 450 or 900) have been developed. Detail design will be responsible for ensuring that these design standards are continuously and rigorously applied to all detail design work.

B4.8.4 Electrical

Standards for cable trays, cable ladders and hangers have been developed and detail design will be responsible for ensuring that these design standards are continuously and rigorously applied to all detail design work.

B4.8.5 Joiner Work

Standard furniture and fittings for the accommodation area have been developed and detail design will be responsible for ensuring that these design standards are continuously and rigorously applied to all detail design work.

B4.8.6 Paint Work

To be in accordance with standards laid down in the company's Shipbuilding policy and paint specification.

B5 : PROCUREMENT

B5.1 Master Material List

During the design process material will be quantified and specifications prepared, and a master material list must be developed similar to the master equipment list.

B5.2 Master Equiment List

During the design process equipment will be defined and specifications prepared, and a master equipment list must be developed. Reference Table B5.1.

B5.3 Material Procurement Strategy

For this contract the company has adopted a policv of using the suppliers of large quantities of materials (steel, piping, pipe fittings, electric cables, joiners panels, etc) as a supplementary store. It has been agreed with such suppliers that the company will order the total quantity of materials necessary for the contract with them and thev will quarantee that it will be available to be drawn down upon as-required:

This policy will reduce the inventory which **is** usually held in the yard and help the cash flow, as the products **do** not have to be paid for until they are drawn upon.

The onus is upon the company to request draw downs in good time to ensure the materials are in the yard when required."A draw down schedule will be prepared by the Planning Department and issued to the Procurement Department.

B5.4 Critical/Long Lead Time Items

Table B5.2 shows the list of items which are either critical or long lead time items, or both.

The times are quoted by the suppliers and are their shortest periods, ex-works, from the placing of a firm order.

B5.5 Procurement Schedule

The procurement schedule for the critical and/or long lead time items is shown in Figure B5.1 below. The schedule was-derived by adding delivery times to the shortest ex-works time: shown in Table B5.2. Total delivery times thus obtained were then deducted from the required installation times shown in Table 66.1 in order to produce the procurement schedule.

TABLE B5.1

MASTER EQUIPMENT LIST

ITEM No.	DESCRIPTION	SUPPLIER	REQU No..	REQU DATE	ORDER No.	ORDER DATE	NUMBER REQUIRED	REQUIRED IN YARD	RECEIVED IN YARD.	FITTED ON BLOCK	FITTED IN ZONE
1	MAIN ENGINE	D. IESEL INC.	1234	19/9/94	5678	3/10/94	1	12/7/95		-	M1
2	SHAFTING	S. HAFT INC.	1235	15/8/94	5679	29/8/94x	1	12/7/95		-	M1
3	PROPELLER	P. ROPEL INC.	1235	15/8/94	5679	29/8/94x	1	12/7/95		-	M1
4	GENERATORS	E GENE INC.	1236	19/9/94	5680	3/10/94	2	17/5/95		-	M2
5	WASTE HEAT RECOVERY BOILER	B OILER INC.	1237	2/2/95	5681	16/2/95	1	23/6/95		-	M2
6	STEERING GEAR	S. TEER INV									
7	ER PUMPS	P. UMP INC									
8	CARGO PUMPS	D WELL INC									
9	COMPRESSORS	A. COMP INC									
10	RECEIVERS	A. COMP INC									
11	CO 2 SYSTEM	C. ARBON INC									
12	CONTROLS AND INSTRUMENTATION	C & I. INC									
13	SWITCHBOARD	S. BOARD INC									
14	HYDRAULIC POWER PACKS	H.Y.D.RAULIC INC									
15	SEWAGE PLANT	S. MELL INC									
16	A/C & FANS	F. AYRE INC									
17	REEFER MACHINERY	V. COOL INC.									
18	DECK MACHINERY	W INCH INC									
19	DECK CRANE	LIFT INC									
20	LIFEBOATS & DAVITS	L. SAVE INC.									
21	NAVIGATION AIDS	D.I.RECTION INC									
22	COMMUNICATION EQUIPMENT	T.BACK INC									

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Table B5.2

PRODUCTION TIMES OF CRITICAL/LONG LEAD TIME ITEMS

Materials or Equipment	Shortest Times (weeks)
Steel	14
Main Engines	30
Propellers and Shafting	40
Auxiliary Machinery	20
Generators	30
Centrifugal Pumps	12
Screw Displacement Pumps	12
Compressors	8
Bow Thrusters	26
Separators	8
Deck Machinery and Hose Handling Crane	22
Hydraulic Power Pack	20
Steering Gear	22
CO_2 System	8
Sewage Treatment Unit	20
Refrigerating System	24
Gyro Compass, Auto Pilot	12
Radar System	12
W/T System	16
Echo Sounder	10
Electric Motors	22
Fresh Water Distiller	12
Lifeboats	39
Boat Davits	17
Deckhouse Bulkheads	8
Air Conditioning System	24
Fans	18
Cabling and Lighting Systems	10
Main Switchboard and Switchgear	35
Machinery Control Systems	35

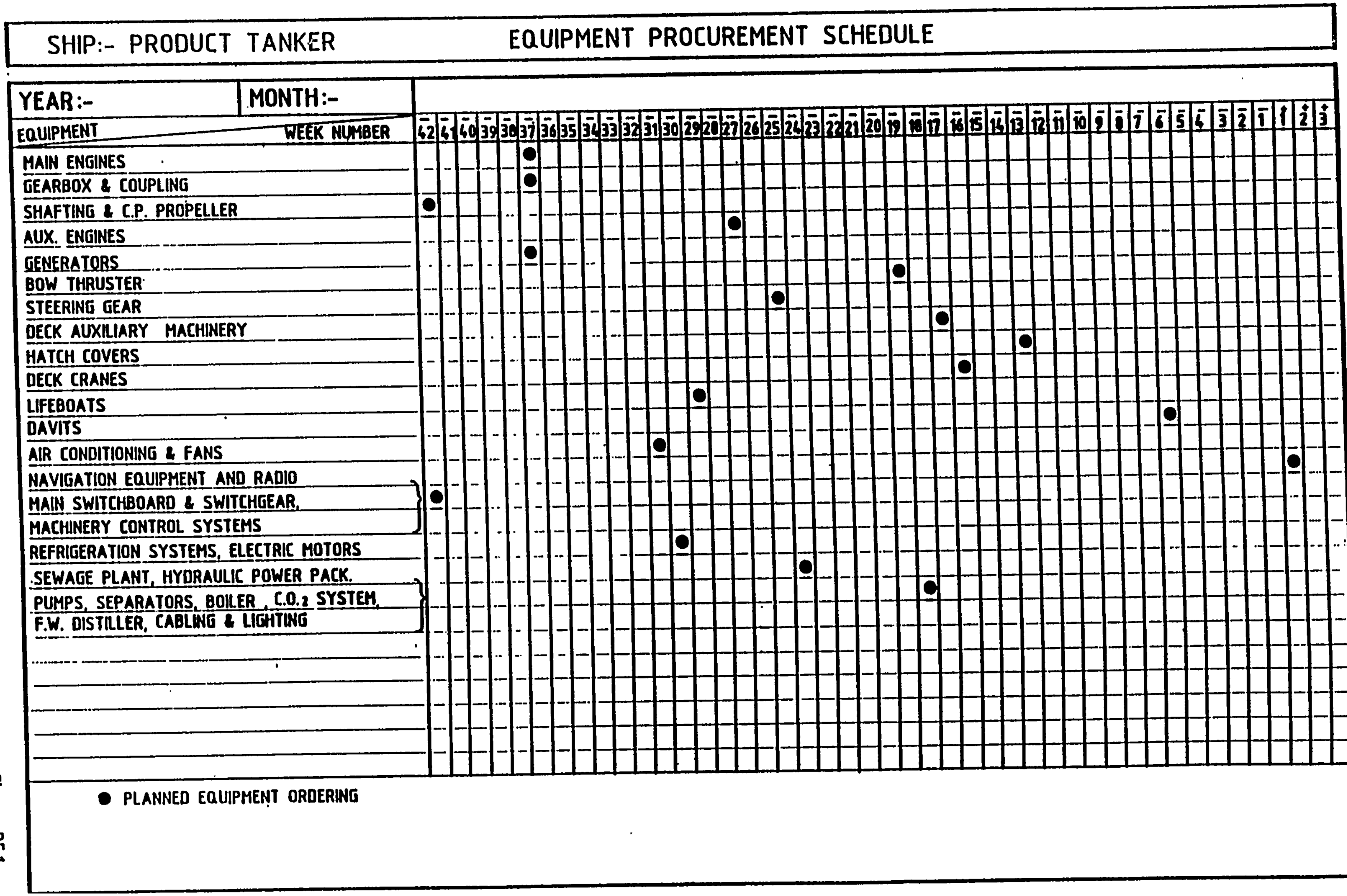


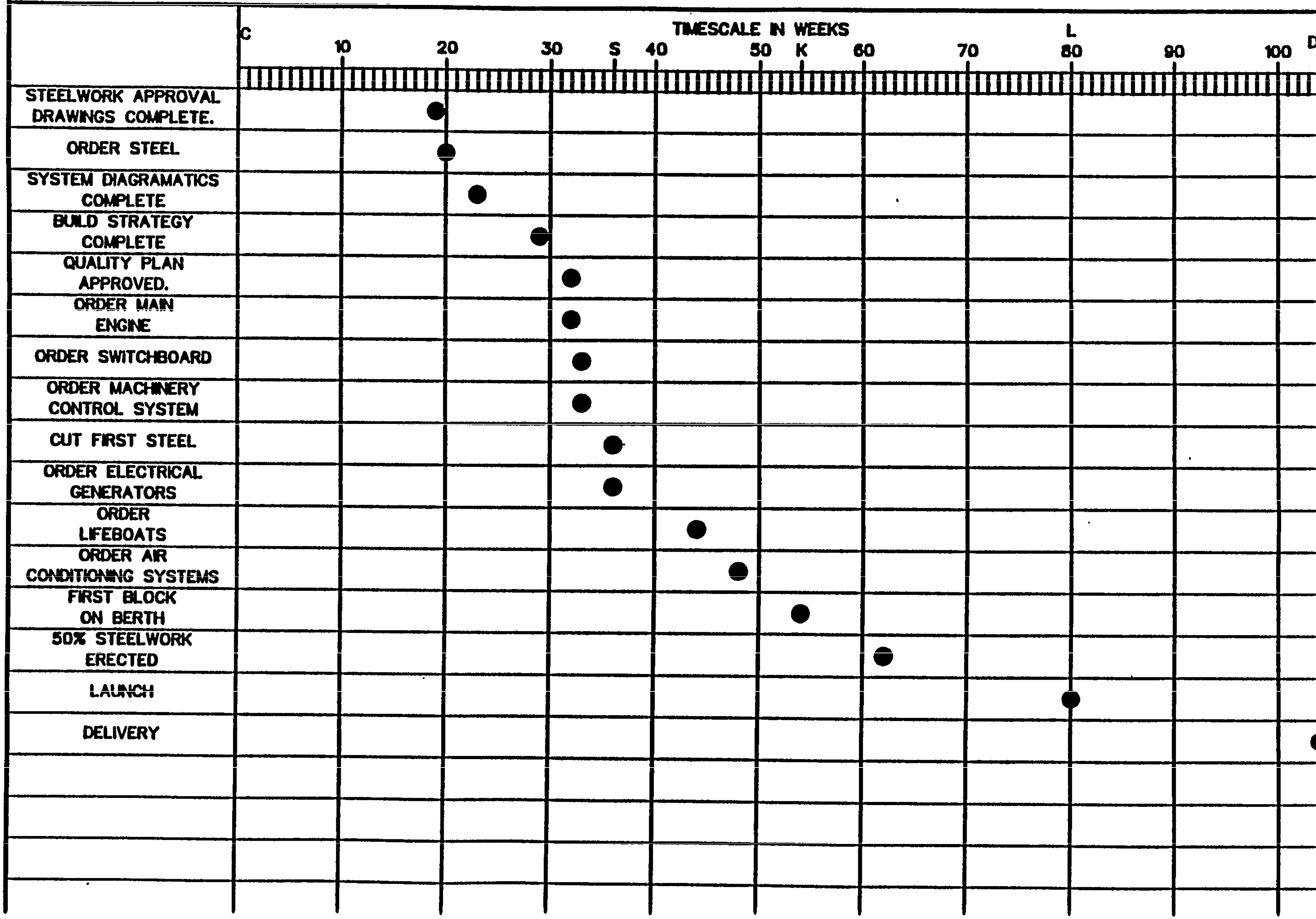
Figure B5.1

B505

Figure B6.1

KEY EVENT PROGRAM

DRAWING No.:-CBSA 09/93 ORIG
ORIGINAL DRAWN 22-SEP-93/K.H.



B6: PLANNING

B6.,1 Strategic Planning

B6.1.1 Key Event Program

A key event program has been prepared and is shown in **Figure B6.1.** This program shows the most important events of the build program, which must be attained in order to achieve the contract delivery dates.

It should be noted that for the first time procurement dates have been included. This is because they are items which are long lead time and/or are items which it is necessary to have in place to allow subsequent work to be undertaken.

B6.1.2 Resourcing and Utilization

The manpower resources and their utilization required during the period of building this ship are shown in Figure B6.2 below. It includes the requirements for the other two ships in the contract over this period.

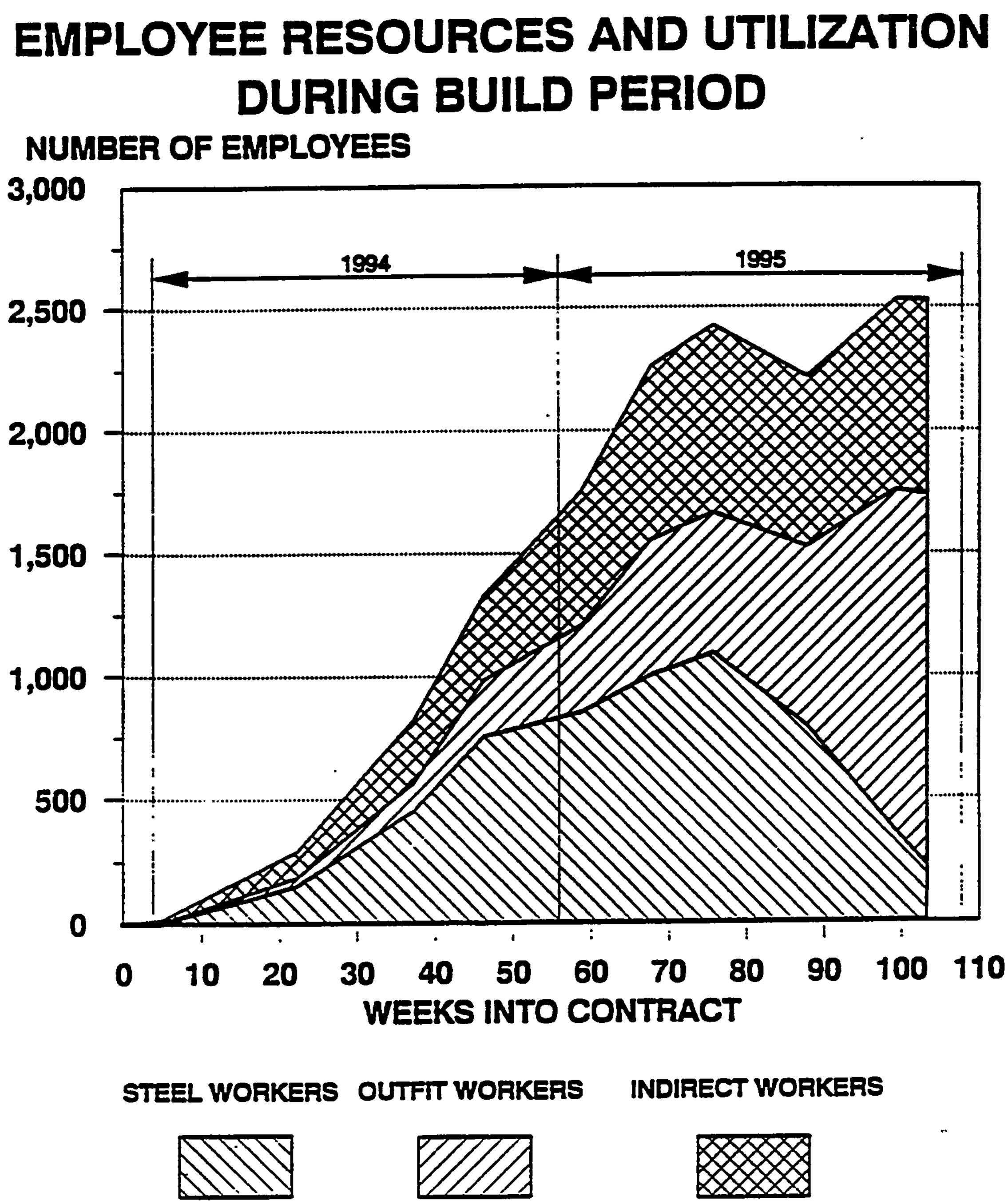
Figure B6.2 clearly shows the fall-off in requirement for steelworkers durinq the latter half of 1995. It should not be taken that this will happen as the company is making every effort to secure orders which will reverse the trend shown with the current order book.

Apart from the production of design and engineering information it is not intended to use any subcontractors on this contract.

The total steel throughput in 1995 for the present order book will be 24,600 tonne nett steel. Networking area of the assembly shop is 20.000 m^2. This represents a utilization of 1.23 tonne/m^2/Year, which can be accomplished in a single shift. The utilization ion of the assembly shop is therefore 1.23 tonne/m^2/shift/year.

Maximum number-of steelworkers required during the build period of this ship is 1.086. 460 of these will be in the assembly shop at this stage in the contract. This gives a labour loading to density in the assemblv shop of 43.5 m^2/person. This is a hew density, but as it represents the peak it is acceptable.

Figure B6.2



[GSSA1008 17-NOV-93]

The first ship will be erected on the berth in 102 blocks and panels in a period of 26 weeks. During this period 76 other blocks will be lifted on to berth 1 for the other, existing Ship and Ship No 2. Therefore average weekly number of blocks to berth is 6.9. In addition there will be large items of machinery and outfit units being installed during this period.

B6.1.3 Changes to Shipbuilding Policy

The company is making a major change in the type of ships it is intending to build. The emphasis in the future will be to build merchant ships of up to 50,000 tonne deadweight. Types of merchant ships which will be best suited to the facilities (enhanced, as described below) will be product tankers, bulk carriers and container ships, with general cargo ships and ro-ro ships as the next best options.

A new Shipbuilding Policy has been developed to cover the above situation.

66.1.4 Required Facility, Tooling and Equipment Upgrade

Because of the major change in shipbuilding policy towards the building of merchant ships which have large numbers of flat panels in their structure, it has been decided to install a six station panel line to replace the six workstations for producing panels which are in operation at present. This will be a nighly mechanized line with gantry supported fairing and welding equipment.

To enable larger blocks to be erected on the building berths it has been decided to purchase a 250 tonne capacity trailer for transporting blocks from the block assembly hall. A 250 tonne capacity lifting beam is also being purchased so that the two cranes serving the building berth can be combined to lift 230 tonne blocks.

The result is that blocks of up to 230 tonne total weight can be created in the block assembly shop against the 135 tonne previous maximum.

Two paint chambers are to be constructed adjacent to the block assembly shop so that blocks can be finish painted as far as practicable before being erected on the berths.

The Shipbuilding Policy has been modified to include the new facilities.

TABLE B6.2

PANELS & BLOCKS FOR THE SHIP

LOCATION	FLAT PANELS: WITH STIFFS. ONLY		FLAT PANELS: WITH STIFFS. & SUBASSEMBLIES		FORMED PANELS: WITH STIFFS. ONLY		FORMED PANELS: WITH STIFFS. & SUBASSEMBLIES		SANDWICH BLOCKS		3 - D BLOCKS	
	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.
STERN BLOCKS	-	-	4	10.375 x 14.425	4	7.100 x 8.626	6	8.300 x 6.675	-	-	2	11.500 x 16.700 x 7.300
E.R. BLOCKS	-	-	35	14.006 x 5.482	-	-	20	9.506 x 6.445	2	14.200 x 10.000 x 2.5	12	17.248 x 6.135 x 5.150
CARGO TANK BLOCKS	48	13.615 x 11.248	63	13.615 x 9.783	12	13.615 x 3.500	15	13.615 x 11.935	48	13.615 x 11.631 x 2.087	-	-
FORE END BLOCKS			19	6.064 x 4.419	10	6.636 x 3.094	10	8.660 x 6.360	-	-	4	10.950 x 7.450 x 6.36
TRANSVERSE O.T. BULKHEAD	7	24.384 x 3.910	7	24.384 x 3.810	14	22.384 x 5.525	-	-	-	-	7	24.384 x 1.702 x 3.810
FLUSH HULL	55	14.986 x 10.314	128	13.218 x 7.502	40	14.288 x 4.620	51	10.407 x 8.094	50	13.638 x 11.566 x 2.104	25	18.194 x 5.535 x 5.141
DECKHOUSES	-	-	85	8.903 x 3.360	-	-	-	-	-	-	3	17.633 x 17.333 x 8.333
TOTAL SHIP	55	14.986 x 10.314	213	11.496 x 5.849	40	14.288 x 4.620	51	10.407 x 8.094	50	13.638 x 11.566 x 2.104	28	18.134 x 6.799 x 5.483
TO BERTH	-	-	10	13.615 x 23.578	* 14	22.384 x 5.525 x 0.851	-	-	50	13.638 x 11.566 x 2.104	28	18.134 x 6.799 x 5.483
MAXIMUM SIZE		14.630 x 13.615	PANEL LINE BLOCK SHOP	14.630 x 12.615 29.260 x 13.615		15.400 x 13.615		15.400 x 13.615		14.630 x 13.615 x 2.300		17.400 x 13.150 x 10.550

[GBSA102A 21-SEP-93]

* CORRUGATED BULKHEAD PANELS

3D Blocks. These are blocks which have significant dimensions in all three planes, longitudinal, transverse and vertical. In the ship they all occur clear of the cargo tank region.

Also shown in Table B6.2 are the number of panels and blocks which are actually erected on the building berth with their average size.

Finally, the maximum sizes of the panels and blocks are shown.

The maximum dimensions and weights of parts and interim products are shown in Table B6.3.

B6.2.2 Coding

A coding system to suit merchant ships has been prepared as part of the new Ship Definition Strategy.

Table B6.3

MAXIMUM DIMENSIONS AND WEIGHTS OF PARTS AND INTERIM PRODUCTS

Maxinum Weights and Dimensions

Maximum Plate Dimensions	13.615m x 2.438 m
Maximum Plate Weight	4.671 tonne
Maximum Profile Dimensions	13.615m x 0.400m x 13.00mm
Maximum Profile Weight	0.828 tonne
Maximum Subassembly Weight	2.380 tonne
Maximum Panel Weight Panel Line	53.24 tonne
Maximum Panel Weight Block Shop	86.24 tonne
Maximum Sandwich Block Weight	85.61 tonne
Maximum 30 Block Weight	230.0 tonne

B6.2 Work Breakdown

B6.2.1 Work Breakdown Structure

Tables B6.1 and B6.2 list the work breakdown for the structure of the ship.

Table B6.1 shows the number of structural piece parts for the ship and their average sizes, divided up as follows:

> Skin Plates. These are plates for the shell, compartment boundaries, or plates for which other parts, such as brackets, are nested from.
>
> They are distinguished by the fact that the final product of these plates do not have any notches, manholes, or other cut-outs in them.
>
> Skin plates are subdivided into flat, formed and nested plates.
>
> Flat Plates with Contours. These are non-watertight floors, girders or webs, and have notches and/or manholes, or other cut-outs in them.
>
> Profiles. These are the standand spipbuilding profiles (offset bulb flats, angles, etc) and are subdivided into straight and formed.
>
> Flat Bars. These are face flats, and minor stiffeners to floors, girders or webs.

Table B6.2 shows the number of panels and blocks for the ship and their average sizes, divided up as follows:

> Flat Panels. These are further subdivided into those which only have stiffeners attached and those which have both stiffeners and subassemblies attached.
>
> Formed Panels. These are both curved shell panels and the corrugated panels of the transverse cargo tank bulkheads. Again, they are divided into those which have only stiffeners attached and those which have both stiffeners and subassemblies attached.
>
> Sandwich Blocks. These are blocks formed from at least one flat panel with only stiffeners attached plus either a flat or formed panel with stiffeners and subassemblies attached.

TABLE B6.1

STRUCTURAL PIECE PARTS FOR THE SHIP

LOCATION	PLATES FOR SHELL OR COMPARTMENT BOUNDARIES, OR NESTING PLATES						NWT FLOORS, NWT GIRDERS, WEBS, ETC.		O.B.F's, TEE BARS, ANGLE BARS, ETC.				FACE FLATS, MINOR STIFFENERS TO FLOORS, GIRDERS AND WEBS.			
	SKIN PLATES						FLAT PLATES WITH CONTOURS		PROFILES				FLAT BARS			
	FLAT		FORMED		NESTED				STRAIGHT		BENT		STRAIGHT		BENT	
	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.
STERN BLOCKS	80	6.125 x 1.634	20	7.940 x 2.136	7	4.950 x 1.800	87	5.351 x 2.253	420	5.002 x 0.180	26	4.100 x 0.300	156	1.507 x 0.116	-	-
E.R. BLOCKS	365	6.006 x 1.623	70	8.262 x 2.196	29	3.802 x 1.760	42	6.667 x 2.256	468	5.484 x 0.262	108	5.683 x 0.300	981	1.680 x 0.127	58	6.269 x 0.200
CARGO TANK BLOCKS	747	12.521 x 2.170	554	6.825 x 1.729	87	12.794 x 2.330	1507	3.963 x 1.926	1558	11.571 x 0.325	141	13.615 x 0.330	4665	3.253 x 0.118	-	-
FORE END BLOCKS	40	6.955 x 2.032	38	7.151 x 2.338	17	4.736 x 1.676	26	8.214 x 1.771	196	7.164 x 0.206	108	6.579 x 0.277	55	3.413 x 0.143	-	-
FLUSH HULL	1232	9.995 x 1.969	682	7.023 x 1.823	140	9.561 x 2.130	1662	4.170 x 1.949	2642	9.122 x 0.282	383	8.804 x 0.305	5857	2.978 x 0.120	-	-
DECKHOUSES	135	7.037 x 2.492	-	-	5	8.000 x 1.800	-	-	1435	2.700 x 0.180	-	-	-	-	-	-
TOTAL SHIP	1367	9.703 x 2.021	682	7.023 x 1.823	145	9.507 x 2.119	1662	4.170 x 1.949	4077	6.862 x 0.246	383	8.864 x 0.305	5857	2.978 x 0.120	58	6.269 x 0.200

[GBSA101A 20-SEP-93]

B6.3 List of Planning Units

B6.3.1 Hull Panels and Blocks

Table B6.4 lists the hull panels and blocks which are planning units and which are erected on the building berth. They are shown in Figure B6.3.

Table B6.4

HULL PANELS AND BLOCKS (PLANNING UNITS)

Location	No	Identity
Lower Stern Block	1	B1
Upper Stern Block	1	B2
Engine Room Double Bottom	2	A1 & A2
Lower Engine Room Blocks	3	A3, A4 & A5
Mid Engine Room Blocks	4	A6, A7(p), A7(s) & A8
Upper Engine Room Blocks	3	A9, A10 & A11
Cargo Tank Double Bottom Centre Blocks	10	C1 to C10
Cargo Tank Double Bottom Side Blocks	20	F1(p) to F10(p) F1(s) to F10(s)
Cargo Tank Double Side Blocks	20	K1(p) to K10(p) K1(s) to K10(s)
Upper Deck Panels	10	H1 to H10
Transverse Bulkhead Panels	14	D2,3,5,6,8,9,11,12,15, 17&18, 20&21
Transverse Bulkhead Stools	7	D1,4,7,10,13,16 & 19
Lower Fore End Block	1	T1
Mid Fore End Block	1	T1
Fore End Bulb Block	1	T3
Fore End Upper Block	1	T4
Deckhouse	3	R1, R2 & R3
Total Panels and Blocks (Planning Units)	102	

B6.3.2 Zones

Table B6.5. lists the onboard zones for outfitting purposes. Figure B6.4 shows the locations of the zones.

The onboard zones will be used as a basis for the management and control of all onboard outfit installation work.

Table B6.5

ONBOARD ZONES

Location	Number	Identity
Stern	2	S1 & S2
Machinery Space	4	M1 to M4
Slop Tanks and Cargo Tanks	9	C1 to C9
Bow	2	B1 & B2
Upper Deck	5	D1 to D5
Accommodation	2	A1 & A2
Total Onboard Zones	24	

B6.3.3 Equipment Units

Assembly of the engine room equipment units (including banks of pipes) will take place in the Equipment Unit Assembly Shop. Assembly of-outfit units is scheduled so-as-to allow as much of the machinery space outfitting as possible to take place in parallel with the machinery space steelwork.

Table B6.6 shows a list of the equipment units which will be produced for this ship.

B6.3.4 Systems

None of the systems on this ship are considered to be planning units as they are all distributed over more than one planning unit. The work performed on systems is that taken into account in the relevant planning units over which the system is distributed.

Table B6.6

LIST OF EQUIPMENT UNITS

Equipment Unit	Identity	Location
Lub Oil Pumps & Camshaft Lub Oil Pump	EU1	Engine Room Floor Plate
Sea Water Pumps	EU2	"
Stuffing Box Drains	EU3	"
Oily Water Separator	EU4	"
Bilge & Fire Pumps	EU5	"
Ballast Pumps	EU6	"
Fuel Oil Transfer	EU7	"
Sewage Plant	EU8	"
Air Compressor and Receiver	EU9	Engine Room Lower Flat
Main Engine Fresh Water Pumps	EU10	"
Auxiliary Engine Lub Oil Purifiers	EU11	"
Fuel Pumping and Heating	EU12	"
Fuel and Lub Oil Purifiers	EU13	"
Diesel Alternators	EU14	Engine Room Upper Flat
Domestic Fresh Water Pumps	EU15	"
Hydraulic Power Pack	EU16	"
Main Switchboard	EU17	"
Engine Uptakes and Silencers	EU18	Casing
Deck Cargo Piping Banks (10)	EU19 to 28	Upper Deck
Cargo Piping Manifold	EU29	"
Cargo Tank Piping and Deepwell Pump (10)	EU30 to 39	Cargo Tanks

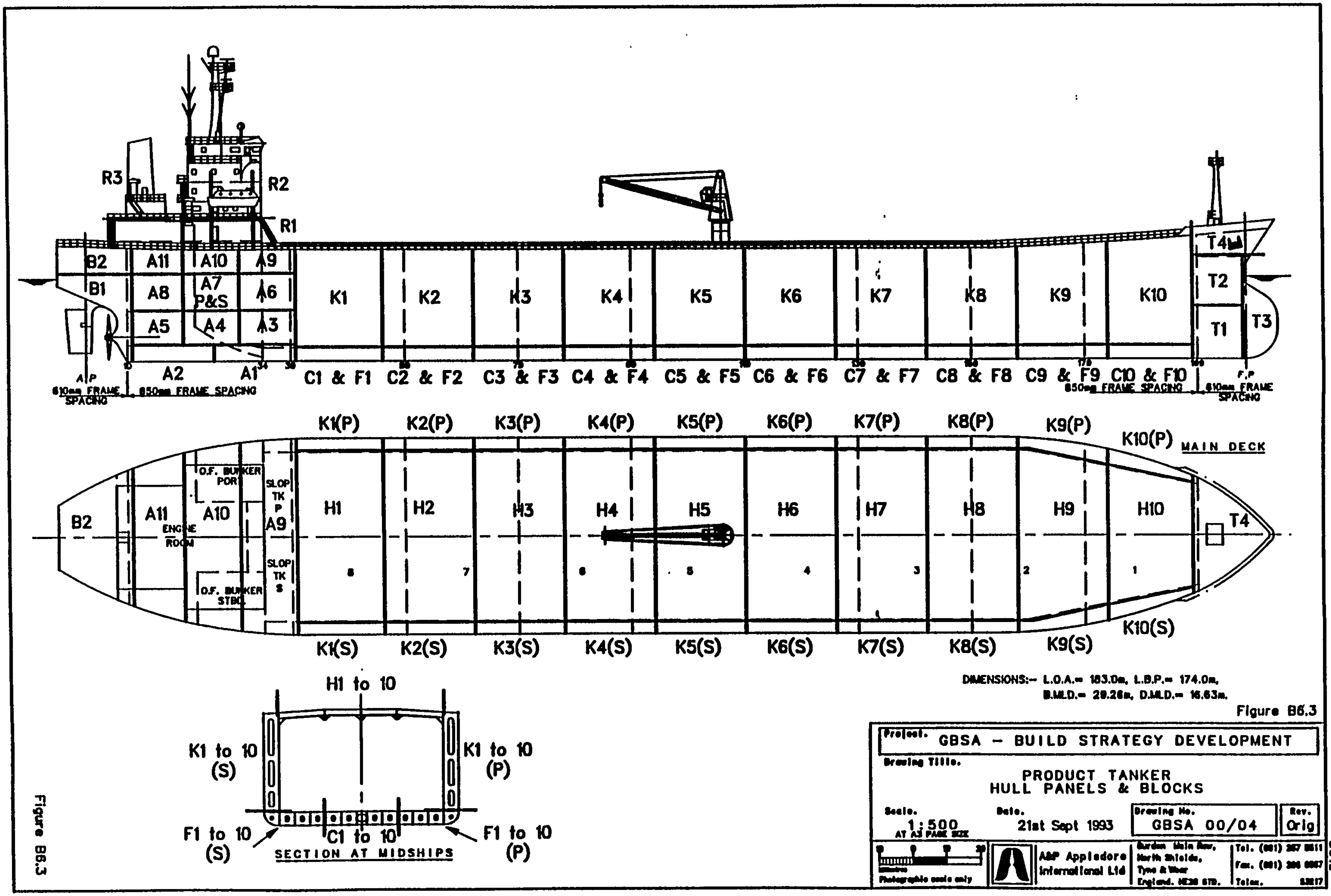


Figure B6.3

Figure B6.3

B612

B6.4 Master Schedules

B6.4.1 Hull Blocks

Figure B6.5 shows the hull block erection sequence and schedule. The schedule has been used to determine when material and equipment will be installed, when it should be delivered to the yard, when it should be ordered, and when the engineering information should be available.

B6.4.2 Zones

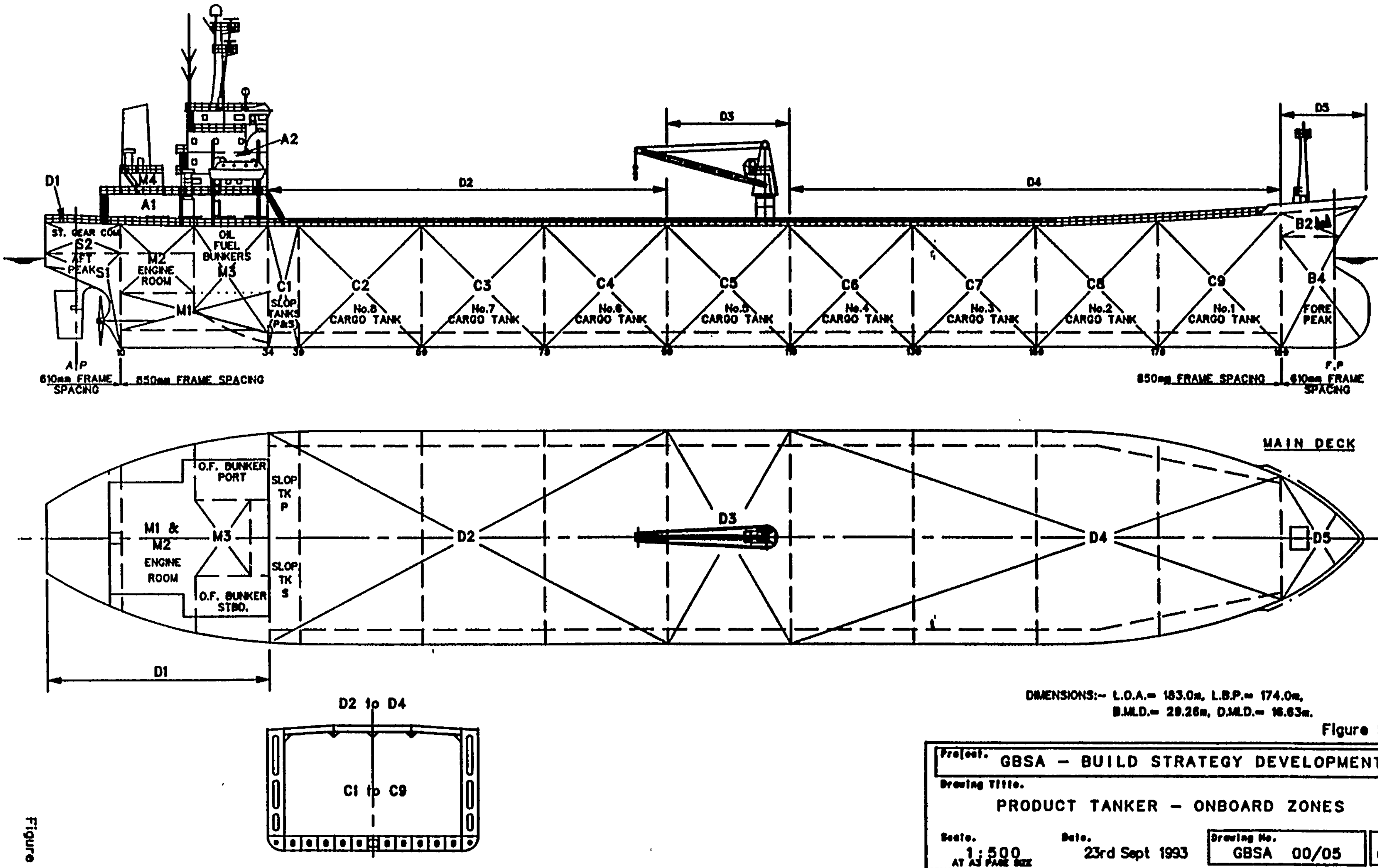
Table B6.7 shows when the onboard zones are available for open sky outfitting and when they become closed off for final outfitting. These dates are also dictated by the hull erection schedule.

B6.4.3 Equipment Units

Table B6.8 shows the installation schedule for the equipment units listed in Table B6.6. It also shows whether the unit is installed on-block or onboard.

B6.4.4 Systems

As stated in B6.3.4 the systems on this ship are being installed on-block and/or within zones. However the completed systems will require to be tested. See later, Chapter 8 for Tests and Trials.



DIMENSIONS:- L.O.A.= 183.0m, L.B.P.= 174.0m,
B.MLD.= 29.26m, D.MLD.= 16.63m.

Figure B6.4

Project.	GBSA - BUILD STRATEGY DEVELOPMENT
Drawing Title.	PRODUCT TANKER - ONBOARD ZONES
Scale.	1:500 AT A3 PAGE SIZE
Date.	23rd Sept 1993
Drawing No.	GBSA 00/05
Rev.	Orig

A&P Appledore International Ltd

Tyne & Wear

Figure B6.4

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Figure B6.5

HULL BLOCK ERECTION SEQUENCE & SCHEDULE

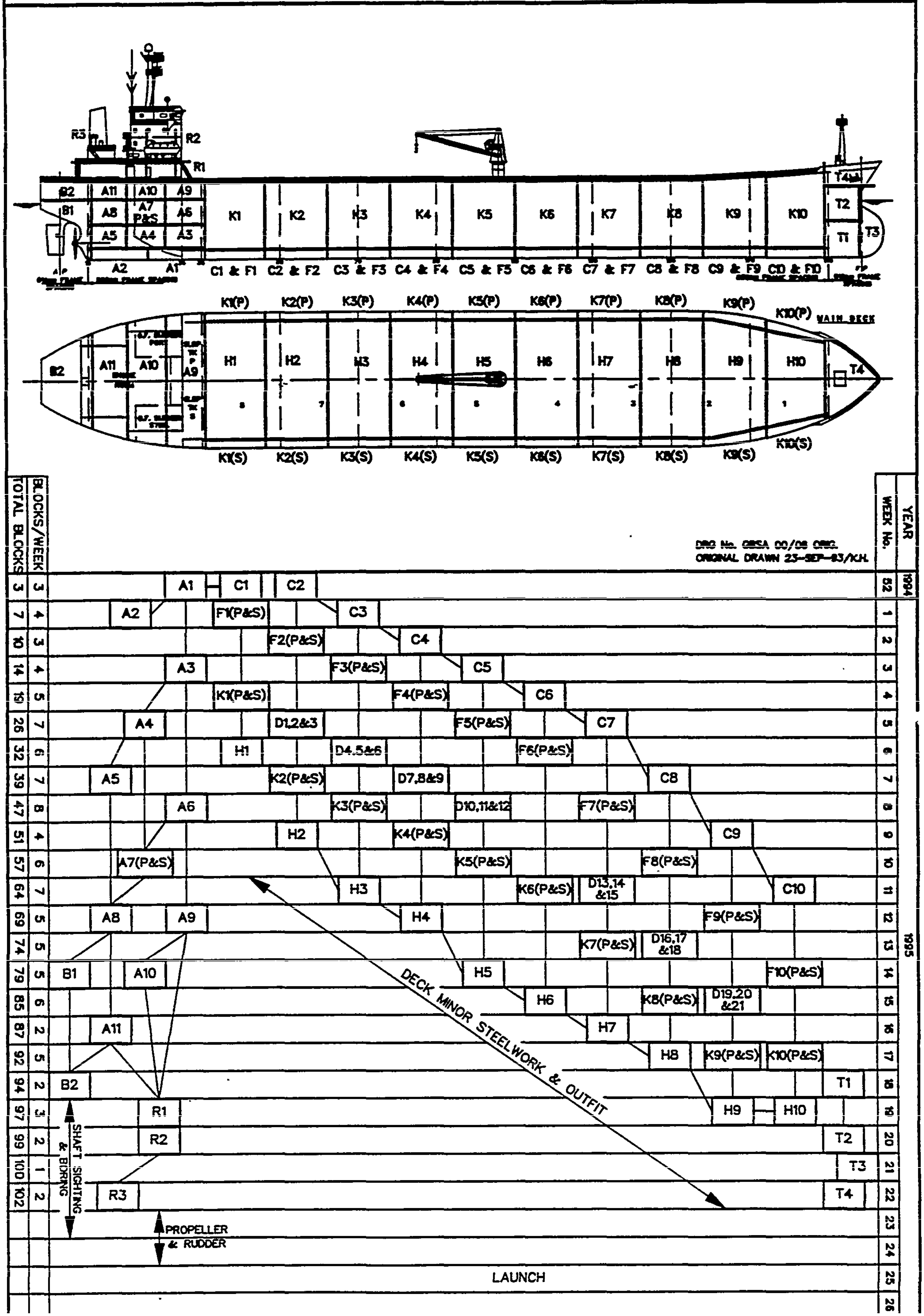

Table B6.7

AVAILABILITY OF ONBOARD ZONES

Zone	Location	Availability Week No 1995 Open Sky	Availability Week No 1995 Closed Off
M1	Lower Portion of Engine Room Aft	2	7
M2	Upper Portion of Engine Room Aft	8	16
M3	Forward Portion of Engine Room	2	14
M4	Casing and Funnel	-	22
C1	Slop Tanks	2	12
C2	No 8 Cargo Tank	1	6
C3	No 7 Cargo Tank	3	9
C4	No 6 Cargo Tank	5	11
C5	No 5 Cargo Tank	6	14
C6	No 4 Cargo Tank	7	15
C7	No 3 Cargo Tank	9	16
C8	No 2 Cargo Tank	13	19
C9	No 1 Cargo Tank	15	19
S1	Aft Peak Tank	-	14
S2	Steering Gear Flat	-	18
B1	Fore Peak Tank	19	21
B2	Fore Peak Flat Stores	-	22
D1	Aft Portion of Upper Deck	13	-
D2	Aft Portion of Upper Deck iwo Cargo Tanks	10	-
D3	Cargo Manifold on Upper Deck	15	-
D4	Forward portion of Upper Deck iwo Cargo Tanks	17	-
D5	Forward Portion of Upper Deck	23	-
A1	Accommodation on Upper Deck	-	20
A2	Accommodation on Higher Decks	-	21

Table B6.8

INSTALLATION SCHEDULE FOR EQUIPMENT UNITS

	Equipment Unit	Installed Week No 1995 On-Block	Installed Week No 1995 Onboard	Zone or Block No
EU1	LO Pumps	-	4	M1
EU2	Sea Water Pumps	-	5	M1
EU3	Stuffing Box Drains	-	5	M1
EU4	Oily Water Separator	-	6	M1
EU5	Bilge & Fire Pumps	-	4	M3
EU6	Ballast Pumps	-	5	M3
EU7	Fuel Oil Transfer Pumps	-	6	M3
EU8	Sewage Plant	-	7	M3
EU9	Air Compressors & Receivers	-	9	M3
EU10	Main Engine FW Pumps	-	11	M3
EU11	Auxiliary Engine LO Purifiers	-	13	M2
EU12	Fuel Pumping & Heating	-	14	M2
EU13	Fuel & LO Purifiers	-	15	M2
EU14	Diesel Alternators	-	16	M2
EU15	Domestic FW Pumps	-	12	M3
EU16	Hydraulic Power Pack	-	13	M3
EU17	Main Switchboard	-	14	M3
EU18	Engine Uptakes & Silencers	22	-	R3
EU19	Deck Cargo Piping	6	-	H1
EU20	Deck Cargo Piping	6	-	H1
EU21	Deck Cargo Piping	-	10	D2
EU22	Deck Cargo Piping	9	-	H2
EU23	Deck Cargo Piping	9	-	H2
EU24	Deck Cargo Piping	-	12	D2
EU25	Deck Cargo Piping	11	-	H3
EU26	Deck Cargo Piping	11	-	H3
EU27	Deck Cargo Piping	-	16	D2
EU28	Deck Cargo Piping	15	-	H4
EU29	Cargo Piping Manifold	14	-	H5
EU30	Cargo Tank Piping & Pump	-	3	A3
EU31	Cargo Tank Piping	-	8	A6
EU32	Cargo Tank Piping	-	13	A9
EU33	Cargo Tank Piping & Pump	-	5	D1
EU34	Cargo Tank Piping & Pump	-	6	D4
EU35	Cargo Tank Piping & Pump	-	7	D7
EU36	Cargo Tank Piping & Pump	-	8	D10
EU37	Cargo Tank Piping & Pump	-	11	D13
EU38	Cargo Tank Piping & Pump	-	13	D16
EU39	Cargo Tank Piping & Pump	-	15	D19

B6.5 Hull Production Strategy

B6.5.I Preliminary Process Analysis

Figures B6.6, B6.7 and B6.8 show the preliminary process analyses of a flat panel, a sandwich block and a 3D block. The method of building up the panels and blocks from the piece parts and interim products is clearly shown.

Figures B6.9, B6.1O and B6.11 show when and how the outfit items are to be integrated with the structure of the panels and blocks shown in Figures B6.6, B6.7 and B6.8.

B6.5.2 Non-Standard Interim Products

All interim products used to construct this ship are standard ones which are defined in the company Shipbuilding Policy.

B6.5.3 Build Location and Launch Condition

The first and third ships are to be constructed on berth number 2, which is at present vacant so that the date of erecting the first block on the berth is only dependent upon considerations related to the first ship. The second ship will be constructed On berth number 1, which is at present occupied by the other existing contract ship.

When the ship is launched all major steelwork will be complete, the main engine and all machinery space equipment units will be in place, all other equipment units will be installed, the accommodation deckhouse will be in situ, all hotwork and paintwork in the cargo tanks and slop tanks will be complete. Elsewhere the paintwork will be complete apart from erection joints and where hotwork will occur.

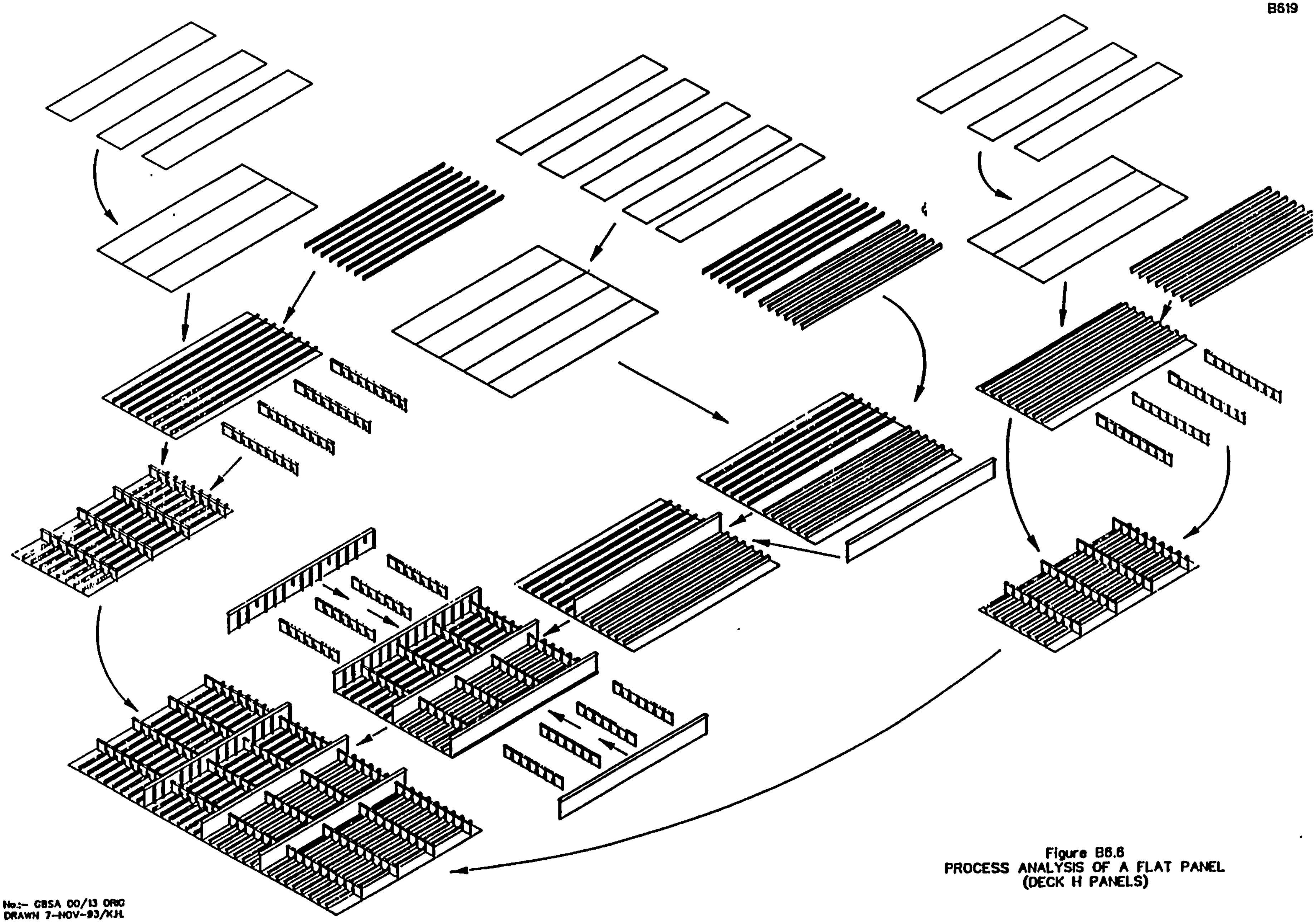

Figure B6.6
PROCESS ANALYSIS OF A FLAT PANEL
(DECK H PANELS)

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ORIGINAL DRAWN 7-NOV-93/KH.

DRAWING No.:- OBSA 00/14 ORIG
ORIGINAL DRAWN 7-NOV-93/K.H.

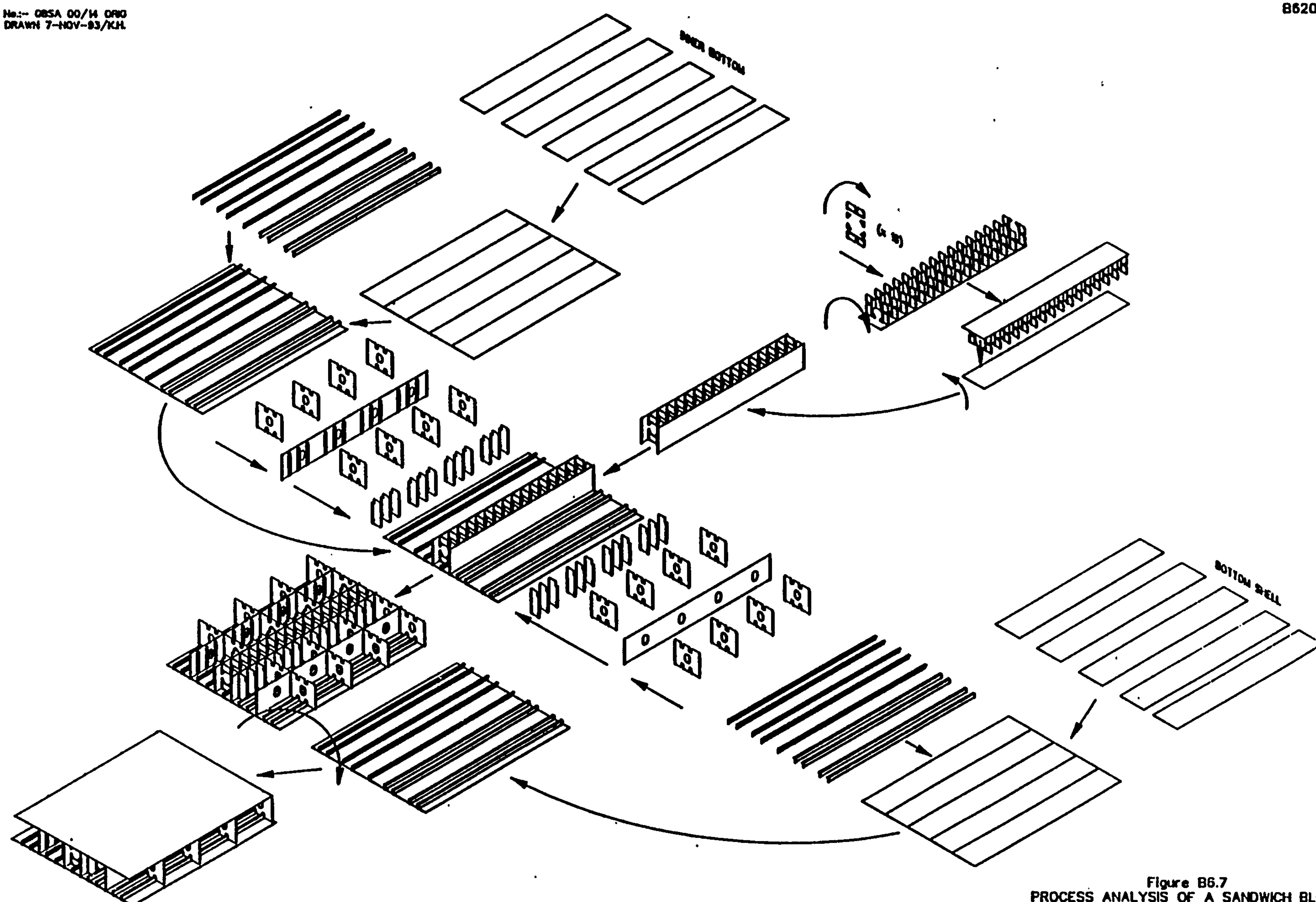


Figure B6.7
PROCESS ANALYSIS OF A SANDWICH BLOCK
(DOUBLE BOTTOM C BLOCKS)

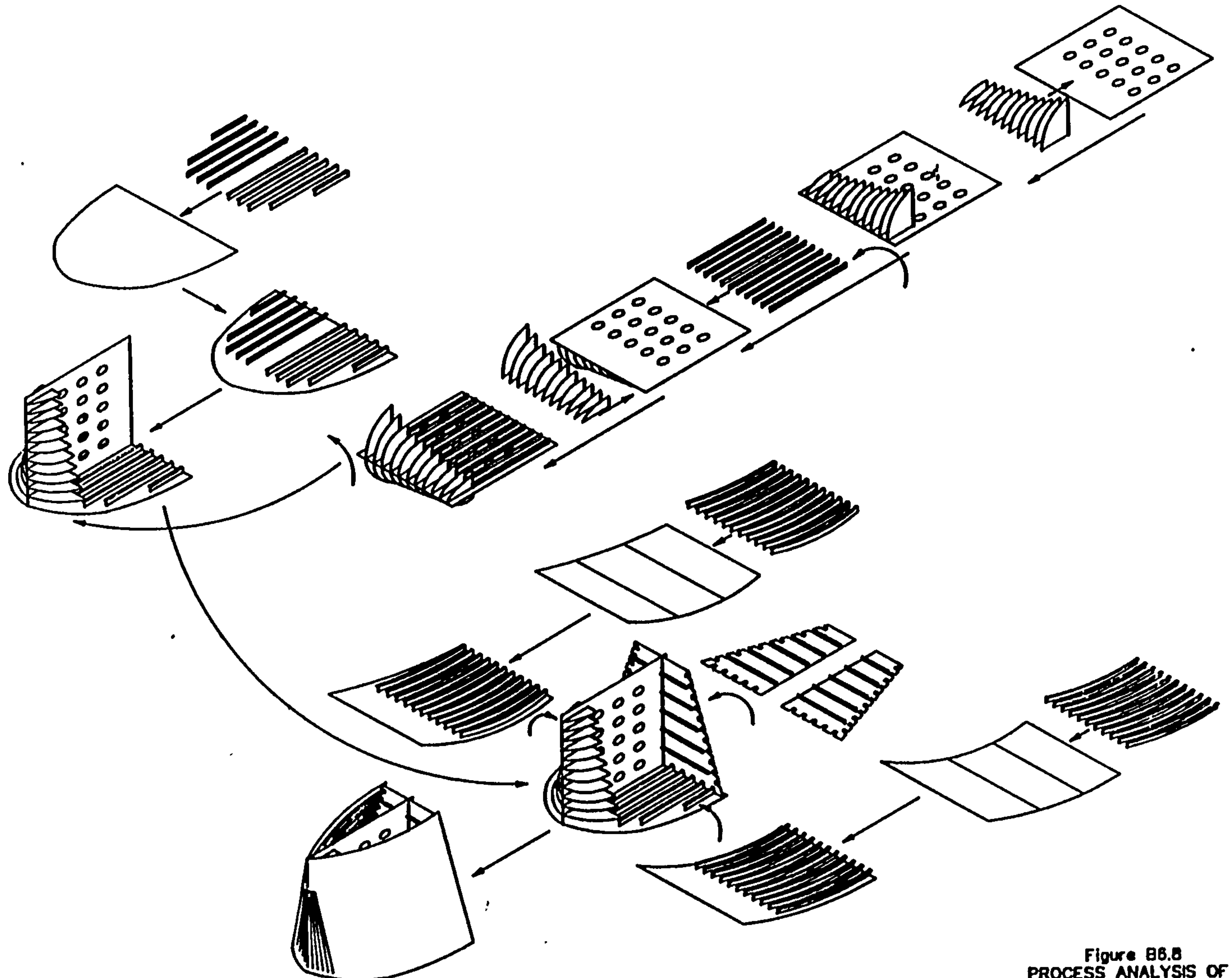
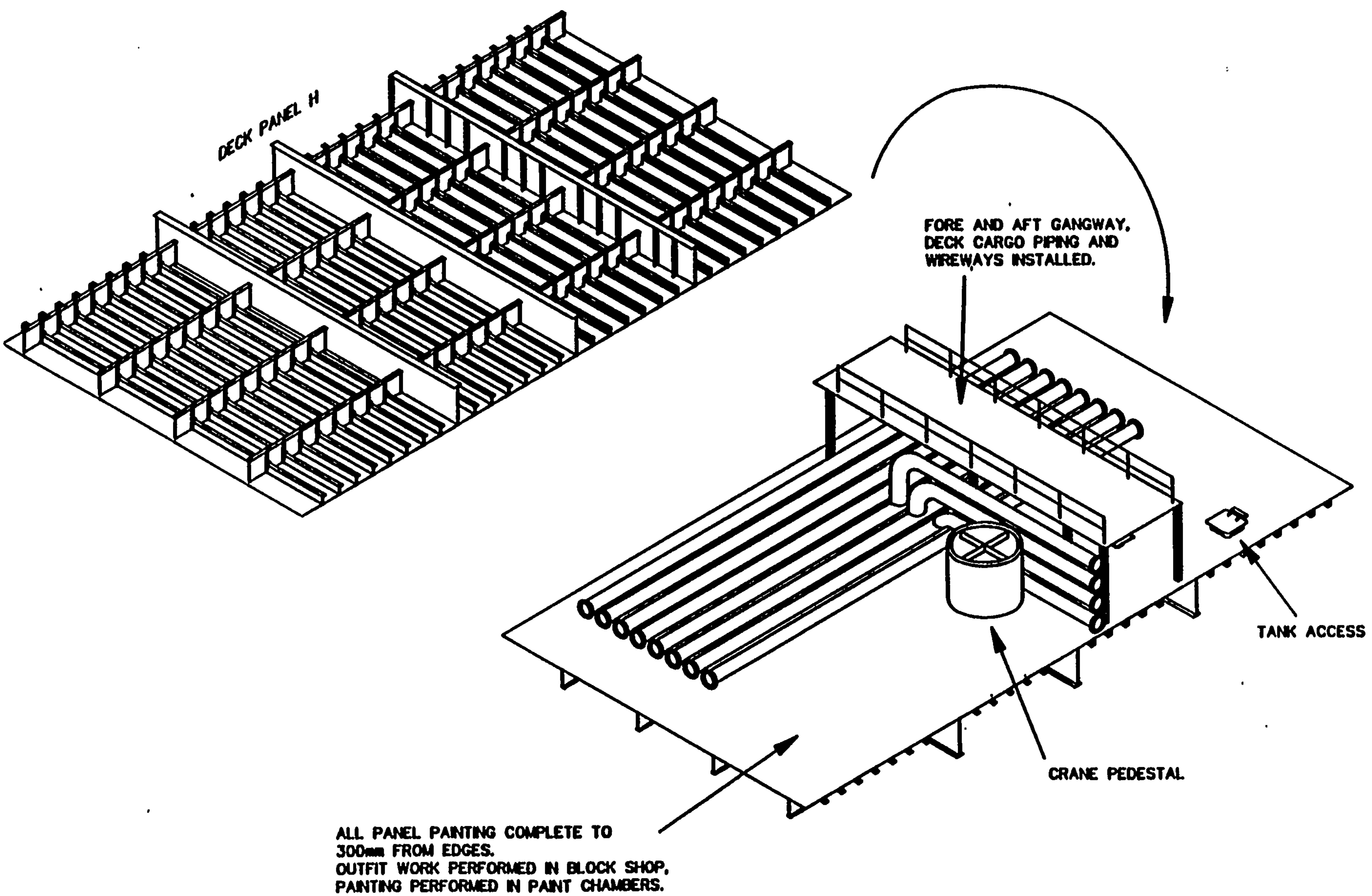


Figure B6.8
PROCESS ANALYSIS OF
A 3D BLOCK

DRAWING No:- GBSA 00/15 ORIG
ORIGINAL DRAWN 12-NOV-93/K.H.



DRAWING No.:- GBSA 00/16 ORIG
ORIGINAL DRAWN 10-NOV-93/K.H.

Figure B6.9
INTEGRATION OF OUTFIT
WITH DECK PANELS.

B6ZZ

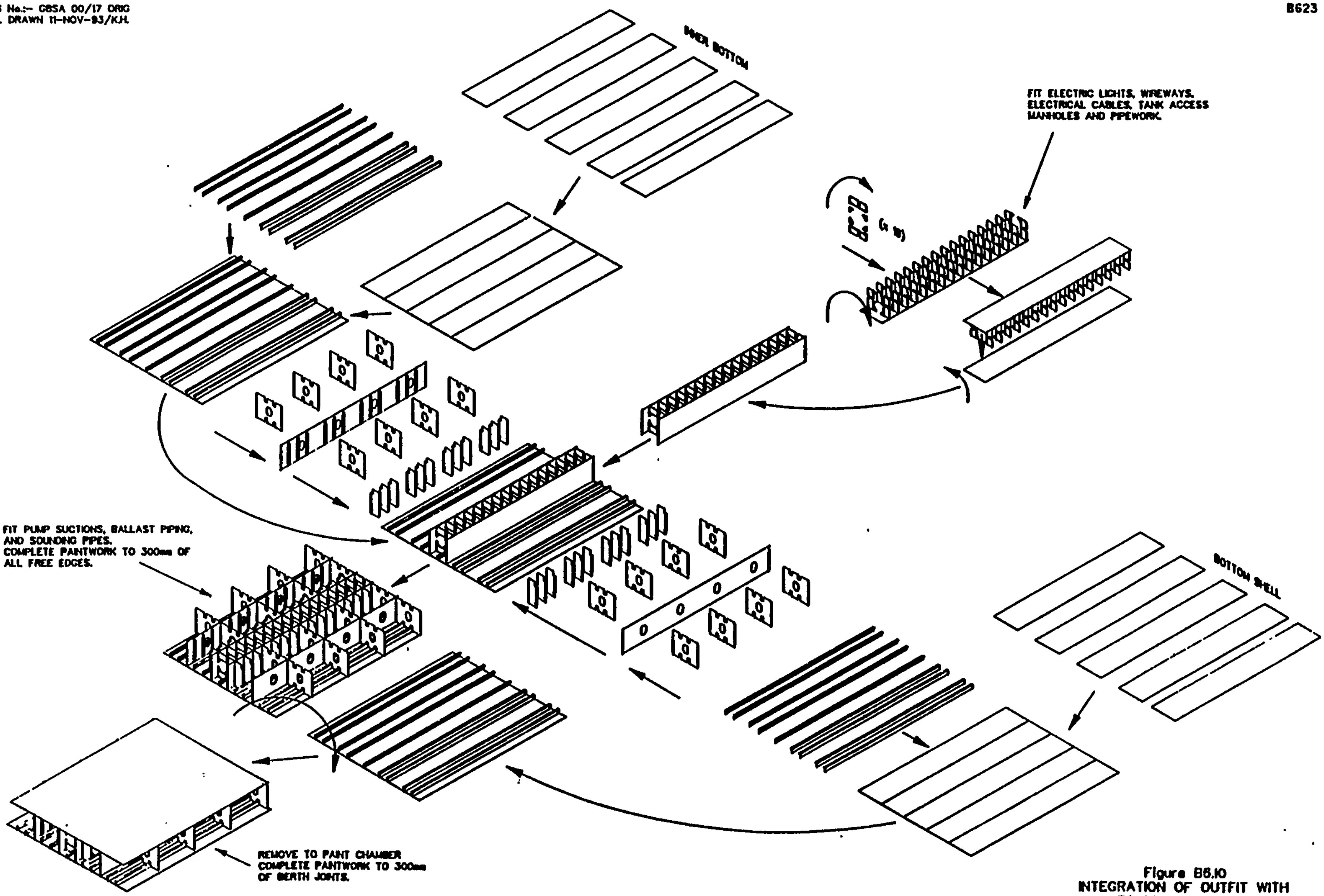
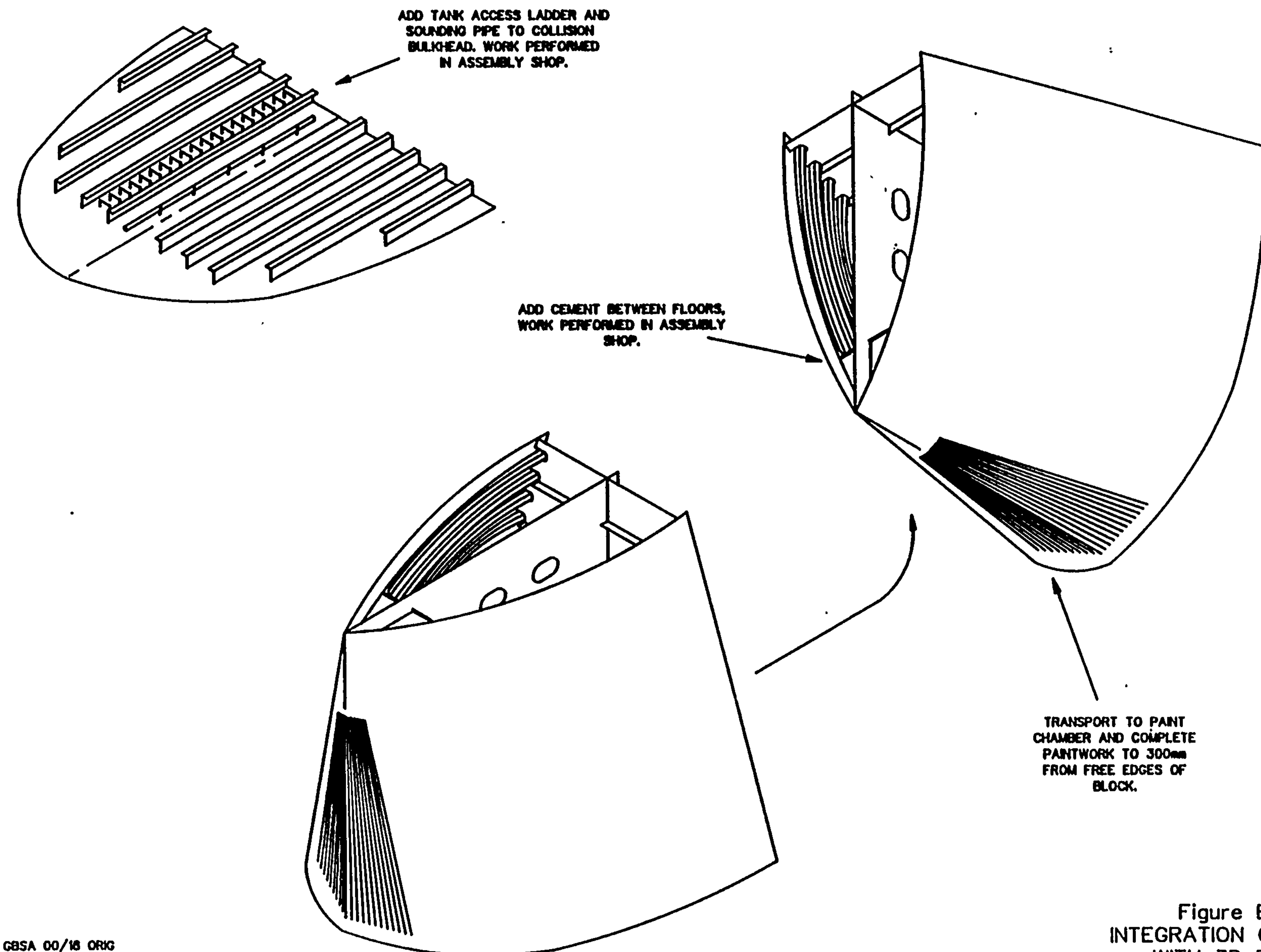


Figure B6.10
INTEGRATION OF OUTFIT WITH SANDWICH BLOCKS.



DRAWING No.:- GBSA 00/18 ORIG
ORIGINAL DRAWN 12-NOV-93/K.H.

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Figure B6.11
INTEGRATION OF OUTFIT
WITH 3D BLOCK.

Figure B6.12	EQUIPMENT UNIT No. EU1	PROCESS ANALYSIS EQUIPMENT UNIT ASSEMBLY PROCESS	DRAWING No.:-GBSA 00/40 ORIG ORIGINAL DRAWN 18-JAN-94/K.H.

ACTIVITY	STAGE							
	1	2	3	4	5	6	7	8
STEEL FRAME ASSEMBLY COMPLETE	EU 1							
INSTALL MECHANICAL EQUIPMENT		111 112 113						
HVAC			H12 H13 H14					
INSTALL ELECTRIC EQUIPMENT				E01 E02 E03 E04				
PIPE WORK					SYS21 SYS22 SYS23			
WIREWAYS						W10 W11 W12 W13		
ELECTRIC CABLE							C33 C34 C35 C36	
PAINT								P21 P22 P23 P24
UNIT COMPLETE								

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B6.6 Machinery Space Outfit Strategy

As much equipment and pipework as is practically possible will be assembled into equipment units inclusive of steel support structure, pipework, minor electrical equipment and ventilation trunking, pipe unit assemblies inclusive of support structure, and pipe assemblies.

All equipment and pipe units will be painted before installation onboard ship.

To ensure that space is available for installing the units, the main engine will be the last piece of major equipment to be installed.

B6.6.1 Equipment Units

Outfit units have been identified and are shown in Table B6.6. They will be assembled in a shop workstation instead of onboard ship. The assembly work package will incorporate the steel support foundations and support bases, equipment, small tanks, pipes, fittings, electric cable, painting and testing before installation "on block" or "on board". A typical assembly process is shown in Figure B6.12.

B6.6.2 On Block Outfitting

On block outfitting will be divided into two stages. The first stage of block outfitting will consist of completing all minor steel "hot work" such as manholes, penetrations, equipment foundations, ladders, pipe and electrical systems, hangers and equipment units appropriate to each block. A typical on block outfitting process is shown in Figure B6.13.

The second stage will include the fitting of "cold work" such as pipework, cable ladders, cable trays, HVAC systems and steel doors as may be appropriate.

B6.6.3 On Board Outfitting

On board outfitting involves installing equipment units, individual pieces of equipment and individual manufactured parts such as pipes, HVAC trunking, cable trays and insulation lagging. The installation of on board outfitting will be work packaged and scheduled in accordance with the zone "close out" schedule. A typical on board outfit process is shown in Figure B6.14.

Figure B6.13	STEEL BLOCK No. ER 3	PROCESS ANALYSIS ON BLOCK OUTFIT PROCESS	DRAWING No.:-GBSA 00/41 ORIG ORIGINAL DRAWN 18-JAN-94/K.H.

ACTIVITY	STAGE 1	2	3	4	5	6	7	8
STEEL BLOCK ASSEMBLY COMPLETE	ER 3							
FIT PENETRATIONS FIT LADDERS		P001 L001						
FIT EQUIPMENT FOUNDATIONS			EF10 EF11					
FIT HANGERS FOR:– PIPES WIREWAYS HVAC				P W HVAC				
FIT EQUIPMENT FIT HVAC					E HVAC			
FIT PIPES FIT WIREWAYS						P W		
FIT ELECTRIC CABLE							EC	
PAINT				P01 P02 P03				P04 P05 P06
BLOCK COMPLETE								

Figure B6.14 | ONBOARD ZONE No. ZE 4

PROCESS ANALYSIS ON BOARD OUTFIT PROCESS

DRAWING No.:-GBSA 00/42 ORIG
ORIGINAL DRAWN 18-JAN-94/K.H.

ACTIVITY	STAGE 1	2	3	4	5	6	7	8
STRUCTURAL STEELWORK COMPLETE ZONE ZE4 AVAILABLE								
EQUIPMENT UNITS		EU1 EU2 EU3						
VENT TRUNKS			V10 V11 V12					
PIPE SYSTEMS				P21 P22 P23				
WIRE WAYS					WW31 WW32 WW33			
ELECTRICAL CABLE						EC41 EC42 EC43		
JOINERY WORK							JW51 JW52 JW53	
PAINT				P11 P12 P13				P14 P15 P16
ZONE COMPLETE								

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B6.7 Accoummdation Outfit Strategy

At the time of lifting to the ship, the accommodation will be completely outfitted except for the following:

- navigation equipment, and
- soft furnishings.

This is achieved by having a cofferdam between the bottom tier of the accommodation block and the ship's deck to which the acconunodation is to be fitted. The cofferdam will also serve as a space for passing or connecting services between the accommodation and engine room.

B6.8 Cargo Space and Other Space Outfit Strategy

Before steel blocks are lifted to the Building Berth all 'hot work" should be completed. This will include the cutting of all manholes, access openings, and penetrations for pipe, cable. and HVAC systems. All brackets and foundations for equipment must be fitted and welded together with hangers for pipe, cable and HVAC systems. As much "cold work" will be fitted wherever possible and should include pipework, cable trays/ladders, ventilation trunking and equipment.

B6.8.1 On Block Outfitting

On block outfitting will be divided into two stages. Stage I will include the completion of all minor steel "hot work" such as manholes, penetrations, minor equipment foundations, ladders, pipe hangers, electrical cable tray hangers and ventilation system hangers. Stage 2 will include the installation of individual items of equipment together with manufactured parts such-as loose tanks, steel doors, windows, pipe systems, electric systems, HVAC systems, etc. A typical process analysis is shown in Figure B6.15.

B6.8.2 On Board Outfitting

On board outfitting will consist of connecting up the systems, previously installed on block, at the block joints after the joints have been joined, welded and tested together with the pulling and connecting of electric cable. The on board installation work will be packaged and scheduled in accordance with the zone close out programme. A typical process analysis is shown on Figure B6.16.

Figure B6.15 | STEEL BLOCK No. C10 | PROCESS ANALYSIS ON BLOCK OUTFIT PROCESS | DRAWING No.:-GBSA 00/43 ORIG ORIGINAL DRAWN 18-JAN-94/K.H.

ACTIVITY	STAGE 1	2	3	4	5	6	7	8
STEEL BLOCK ASSEMBLY COMPLETE	C10							
OUTFIT STEEL		S11 S12 S13 S14						
PIPE SYSTEMS			P31 P32 P33					
WIRE WAYS				WW14 WW15 WW16				
ELECTRICAL CABLE					EC10 EC11 EC12			
HVAC SYSTEMS						H01 H02 H03		
PAINT				P03 P04 P05				P06 P07 P08
OUTFITTING COMPLETE								

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Figure B6.16	ONBOARD ZONE No. ZC 120	PROCESS ANALYSIS	DRAWING No.:-GBSA 00/44 ORIG ORIGINAL DRAWN 18-JAN-94/K.H.

ACTIVITY	STAGE							
	1	2	3	4	5	6	7	8
STRUCTURAL STEELWORK COMPLETE ZONE ZC 120 AVAILABLE	ZC 120							
EQUIPMENT		EQ10 EQ11 EQ12						
HVAC SYSTEMS			H31 H32 H33					
PIPE SYSTEMS				SY11 SY12 SY13				
ELECTRICAL CABLE					C20 C21 C22			
JOINERY WORK						JW31 JW32 JW33 JW34 JW35		
PAINT				P20 P21 P22			P23 P24	
ZONE COMPLETE								

B6.9 Painting Strategy

B6.9.1 Outline Paint Specification

All steel is to enter the preparation workshop via the treatment line where it is to be shotblasted to SIS Sa2.5 -standard and coated with a zinc silicate shop primer.

The areas of the ship listed below are to have the paint systems shown applied:

Underwater, exterior shell	: High solid tar free epoxy system with a long life anti-fouling system - 8,500 m^2.
Topside, exterior shell, exterior decks	: High solid epoxy system. Total three coats 7,670 m^2
Deckhouses and deck fittings	: Chlorinated rubber system. Total three coats - 11,840 m^2.
Cargo and slop tanks	: Modified phenolic system. Total three coats 54,000 m^2
Water ballast tanks	: Coal tar epoxy coating system .Total two coats 71,000 m^2
Fresh water tanks	: High build pure epoxy system. total two coats - 1,200 m^2
Steelwork behind linings, void spaces and cofferdams	: High build bitumastic system. Total two coats - 7,500 m^2.

B6.9.2 Pre-Painting

Double bottom blocks in way of the cargo tanks are to have the exterior shell and internal structure sweep blasted to SPSS-SS and the upper side of the inner bottom blast cleaned to S1S Sa2.5 in the paint cells before the final paint systems are applied.

Side blocks in way of the cargo tanks are to have the exterior shell and internal structure sweep blasted to SPSS-SS and the inboard side of the longitudinal bulkhead blast cleaned to S1S Sa2.5 in the paint cells before the final paint systems are applied.

Deck panels in way of the cargo tanks are to have their exterior surface sweep blasted to SPSS-SS and the underside blast cleaned to S1S Sa2.5 in the paint cells before final paint systems are applied.

All other blocks are to have all surfaces sweep blasted to SPSS-SS before final paint systems are applied in the paint chambers.

B6.9.3 Primer Repair Strategy

Where the shop primer is damaged in a workshop, the damaged area should be disc-ground and wire brushed, then touched UP with a stripe coat as soon as possible. On all occasions this should be performed before passing the work on to the subsequent workstation.

B6.9.4 Panel/Block Painting Strategy

All panels which go directly to the building berth, will be painted in the paint chambers to 300mn of the edges which will be welded on the building berth.

The flat panels which have stiffeners and subassemblies added and form part of a sandwich block will be painted in the block assembly shop to 300mm of the edges which will be subsequently welded.

Complete sandwich blocks will have the remainder of their paintwork undertaken in a paint chamber to 300mm of the berth joints.

3D blocks will be painted in the paint chambers to 300mm of the edges which will be welded at the building berths.

B6.9.5 Zone Painting Strategy

Zone painting will be completed after all structural joining and outfit installation work has been finished, both within the zone and on the other side of zone boundaries.

Bought-in items of equipment will arrive finish painted, with a protective cover over the paintwork. When placed on frameworks, to create outfit units, the framework will be finish painted to 300mm from the interface with the ship's structure.

The exterior shell and decks will receive their final coating in the dry dock, just prior to sea trials.

B6.9.6 Special Considerations

There are no special considerations for this vessel.

B6.1O Subcontract Requirements

B6.10.1 Bought-in Items

The following is a list of "supply and fit" subcontract items:

Mechanical ventilation and **air conditioning.**

Deck coverings.

Acoustic, fire protection and thermal insulation..

The supplier not only provides the material for the above items but also the **labour** which is under his control. However the timing and manner of performing the work is under the control of the shipyard and the supplier will comply with the established schedules.

B6.10.2 Use of On-Site Subcontractors

The only other on-site subcontractors, apart form those associated with supply and fit items, will be those producing the design and engineering information. Their numbers and associated timescales are discussed in Chapter B4, paragraph B4.6.2 earlier.

B6.1O.3 Industrial Relations Considerations

As the use of supply and fit subcontracts and subcontractors to produce design and engineering information is normal practice for the company, all of the existing agreements on their use will apply to this contract.

B6.11 Productivity Targets

The direct steelworker productivity for this ship has been set at 60 manhours/tonne nett steel. This is world average productivity for a ship of this type and size.

Another measure of productivity used for comparative purposes by the international community is manhours/compensated gross ton (CGT). This vessel has a gross tonnage of 24,100 and an associated compensated gross tonnage factor of 0.73, giving a compensated gross tonnage of 24,100 x 0.73 = 17,593. The total employee manhours required to produce this ship is 1,176,000, therefore the manhours/ CGT= 66.8. This is about two-thirds of the world average but the good European yards are only using about 45 and the Japanese about 29 manhours/CGT.

The above are not directly comparable to recently completed ships as they have all been naval vessels.

A6.12 Temorarv Services

A6.12.1 Staging

To enable fairing and welding of unit joints and subsequent finishing off operations to take place it will be necessary to provide access ways to these areas.

Traditional shipbuilding techniques made it necessary to surround the ship completely with staging. The modern approach to ship construction has the potential to substantially reduce the amount of staging equipment required.

Consequently we will use a combination of modular staging systems, permanent built in systems, and hydraulic articulated booms (cherry pickers).

The modular systems are capable of rapid assembly and dismantling and will be used where access is limited. Permanent built in staging will apply to cargo holds of tankers where specified longitudinal stiffeners will be extended to form permanent galleries to be used for staging and access.

Cherry pickers will be used for fairing and welding of hull unit joints.

A6.12.2 Access and Escape Plan

In the event of an emergency where rapid access to confined spaces by rescue services or fast evacuation is necessary.

An access and escape plan **will be prepared,** framed and sited at all major access points to the ship.

The engineering office will consider how the ship will be constructed and provide adequate access and work levels for men and equipment during the construction and subsequent maintenance of the ship.

A6.12.3 Power and Lighting

Services required for construction activities include:

- water;
- compressed air;
- oxygen;
- ccetylene gas;
- electricity.

Traditional practice was to connect each item of plant or tool to the nearest outlet manifold at the quay or dockside, which led to a mass of cables and pipes looped and criss-crossed to the various work areas.

Portable service outlet units will be used, which consist of a framework on to which the various pipes are attached. These units are quickly connected and positioned on board the ship and operators connect their equipment to the nearest outlet.

Electrical power will be initially fed from shore supply and cables are run from the main switchboard to sub-switchboards and distribution boards to which the equipment is connected. The **sub-switchboards and distribution boards will be located throughout the ship, serving all areas as appropriate.**

B7 : ACCURACY CONTROL

In order to be competitive in the commercial shipbuilding world, rework must be minimized. Accuracy Control (A/C) has been proven to be an effective wayto reduce rework.

A/C is ‘the regulation of accuracy as a means for continuously improving design details and work methods so as to maximize productivity”.

A/C has both a short and a long term benefit. The short term benefit is that it will minimize delays and rework during erection of sructure and installation of equipment by monitoring and controlling the fabricaiton of interim products. The long term benefit is the implementation of a management system that develops a database of quantitative information that can be used to continuously improve productivity.

Although the shipyard has been utilizing A/C for naval ships over the past 10 years, the differences between naval and commercial ships is such that most of the data is not transferable. It will be necessary to develop from scratch the quantitative information from the consnercial ships as they are being constructed.

However, the shipyard has the experience and knows how to plan, execute and evaluate A/C. The shipyard will implement its proven A/C procedure by modifying it to suit the requirements of the commercial shipbuilding.

B7.1 System Critical Dimensions and Tolerances

For steelwork the key system dimensions are the finished overall dimensions of assemblies and blocks as well as alignment of internal joinint structural members.

For outfit the key dimensions all relate to installation interfaces.

These must be defined with suitable tolerances that would ensure the required performance of the vessel in terms of:

cargo carrying capacity;
speed;
draft/beam restrictions;
etc.

These will be controlled and monitored by use of appropriate control chart techniques and capability studies as described in the shipyard's A/C Procedure for Commercial Ships, issued December 1993.

B7.2 Interim Product Critical Dimensions and Tolerances

They can be divided into two categories:

Principal dimensions and tolerances.
Local dimensions and tolerances.

A principal dimension/tolerance for an interim product is one which will directly affect the ability to meet system critical dimensions/ tolerances. For example, that may be the overall dimensions of a steelwork unit. If these are not achieved to a desired tolerance then there will be a failure in any attempt to assemble the system from the component interim products.

A local dimension/tolerance for an interim product is one which will affect the ability of a workstation to assemble that particular interim product from its component piece parts or assemblies. For example, that may be the positioning of a stiffener so that its fit-up with a slot is achieved to the required tolerance.

These can be controlled and monitored by use of appropriate control chart techniques and capability studies.

B7.3 Sampling Procedures

A list of interim products to be sampled will be prepared in accordance with the shipyard's A/C Procedure for commercial ships.

B7.4 Special Procedures

B7.4.1 One-Off Manufacture

In the case of genuine one-off products or components requiring manufacture and/or assembly, specific monitoring and control procedures will be put in place to ensure that these meet specified targets.

B7.4.2 Poor Performance

In addition, if in the evaluation of **system and interim product required accuracy it becomes evident that specific** processes are unable to meet specified requirements first time then special analysis will be undertaken to determine **cause** and eliminate the rework that arises.

B7.5 Jigs and Fixtures

A list of jigs and fixtures that are required for the assembly process will be prepared and appropriate resources defined **for their** design, manufacture and installation.

The levels of accuracy for the jigs and fixtures must be **commensurate to those required** for systems and interim products.

Where possible jigs and fixtures will minimize welded attachments.

B7.6 Hot Work Shrinkage

B7.6.1 Use of Extra Stock

Because of the limitations in shell development methods and forming of shaped plates extra stock will be required on certain blockks. Also the commercial ships, with their heavier scantlings, will have difference shrinkage and distortion that the naval ships.

The initial aim is to control and **manage the use of extra stock material and gradually eliminate it** as more and more data on distortion and shrinkage for commercial ships is collected and analysed.

B7.6.1 Shrinkage Allowances

For all dimensions, shrinkage allowances will be made on the basis of:

shrinkage at subassembly;
shrinkage at assembly;
shrinkage at erection.

A shrinkage excess will be derived and allocated to the structure in such a manner as to ensure that both principal and local dimensions/tolerances are met.

This allowance will be based on a database with regard to past performance at each work stage and for each welding process.

Shrinkage allocation should be consistent either by lump sum allocation or evenly distributed to retain correct stiffener spacing.

B7.7 Distortion Control

Specific procedures should be developed for control of distortion. These should cover two distinct aspects:

a) Pre-set that anticipates distortion from welding.

b) Distortion removal that removes distortion which results from the normal production process.

Taking each of the above in turn:

a) Pre-set:

Suitable data will be collected and analyzed to derive pre-sets so that this information can be included in drawing information provided to the workstation.

b) Distortion Removal:

Specific workstations will be identified and suitably equipped to remove distortion by appropriate processes such as heat line bending.

This is a time consuming activity and its use will be managed with an emphasis on design improvement and use of pre-set or improved processes to minimize the need for distortion removal.

B8: TESTS AND TRIALS

B8.1 Test Planning

B8.I.I Strategy

Before any tests are undertaken the components will be systematically prepared so that those called to witness the tests actually only see the tests performed and not any preparation which is necessary for it to take place. Preparation will include:

- cleaning the item and the adjacent area;
- connecting all of the necessary services and checking that the required quantities are available;
- checking that all recording devices are available, working correctly and are within their calibration date;
- ambient temperature is acceptable;
- lighting is adequate;
- ventilation is adequate.

The strategy for preparing items for test is shown below.

B8.1.2 Schedule (High Level)

Figure 68.1 shows the high level test schedule. It has a total duration of . . . . working days and it is imperative that all tests be successfully completed within this time duration.

B8.2 Pre-Completion Testing

Before items are complete and installed in a ship a large amount of testing can be performed. The various pre-completion tests are discussed below.

B8.2.1 Pre-Survey and Dry Survey

As much of the structural survey work as possible is to be performed in the workshops.

Before a regulatory, owner's or classification surveyor is called to survey any structure it will be examined by a steel shop supervisor and any faults found, rectified.

The use of dimensional control and self-checking of all work at each stage in the process should mean that any faults discovered prior to calling in a surveyor will be minimal and minor. The aim is to have no faults found by a surveyor, not because they are well disguised, but because they do not exist.

B8.2.2 Pipe Pre-Testing

Where banks of pipes involve the joining of pipe parts and/or pipes to fittings they will be pressure tested in the pipe shop, either-by water or air, prior to being installed on the unit, block or on the ship. Any faults discovered will be rectified before the item leaves the shop.

B8.2.3 Equipment Unit Pre-Testing

While still in the workshop all equipment units will have their fluid and electrical services connected and be supplied with the required quantity of the relevant mediums in order that they operate correctly and that the services are intact.

Whenever possible the test procedures developed by the equipment suppliers will be used. These procedures will be reviewed by the Test and Trials department as they are received. If they are acceptable they will be forwarded to the owner's representative for comment. When the procedure has been agreed by both the shipyard and the owner's representative it will be signed off as the master copy and kept in the Test and Trials file.

Prior to the conduct of a test the shipyard will notify the owner's representative and any other interested parties such as classification and statutory body surveyors so that they can be present.

B8.3 Tank Test Schedule

Figure B8.2 shows the schedule for tank/compartment testing. This schedule defines when all work within the tanks and hot work on the tank boundaries will be complete. It also indicates which tanks can be tested prior to the unit or block going to the berth.

B8.4 Equiment Unit Test Schedule

Figure B8.3 shows the schedule for the testing of equipment units: The schedule defines when each equipment unit will be completely assembled and identifies all tests required and their durations.

B8.5 Pipe Unit Test Schedule

Figure B8.4 shows the schedule for the testing of pipe units. The schedule defines when each pipe unit will be completely assembled and identifies all tests required and the durations.

B8.6 Zone Close-Out Strategy

Figure B8.5 shows the zone closeout strategy. This defines when all work within the zones, including tests and trials of equipment, will be completed and the zone closed up.

B8.7 Principal Trials Items

A list of the principal items which require trials and the schedule for the trials is shown in Figure B8.6.

B8.7.1 Dock Trials

After the individual equipment units have been installed and connected up to the relevant systems on board the ship then complete systems will be available for trials. Initially these will be undertaken while the ship is alongside and in accordance with a predetermined schedule. This schedule is shown in Figure B8.7.

B8.7.2 Sea Trials

Ultimately the ship will undergo sea trials which will be undertaken in accordance with a program drawn up by the technical and planning departments.

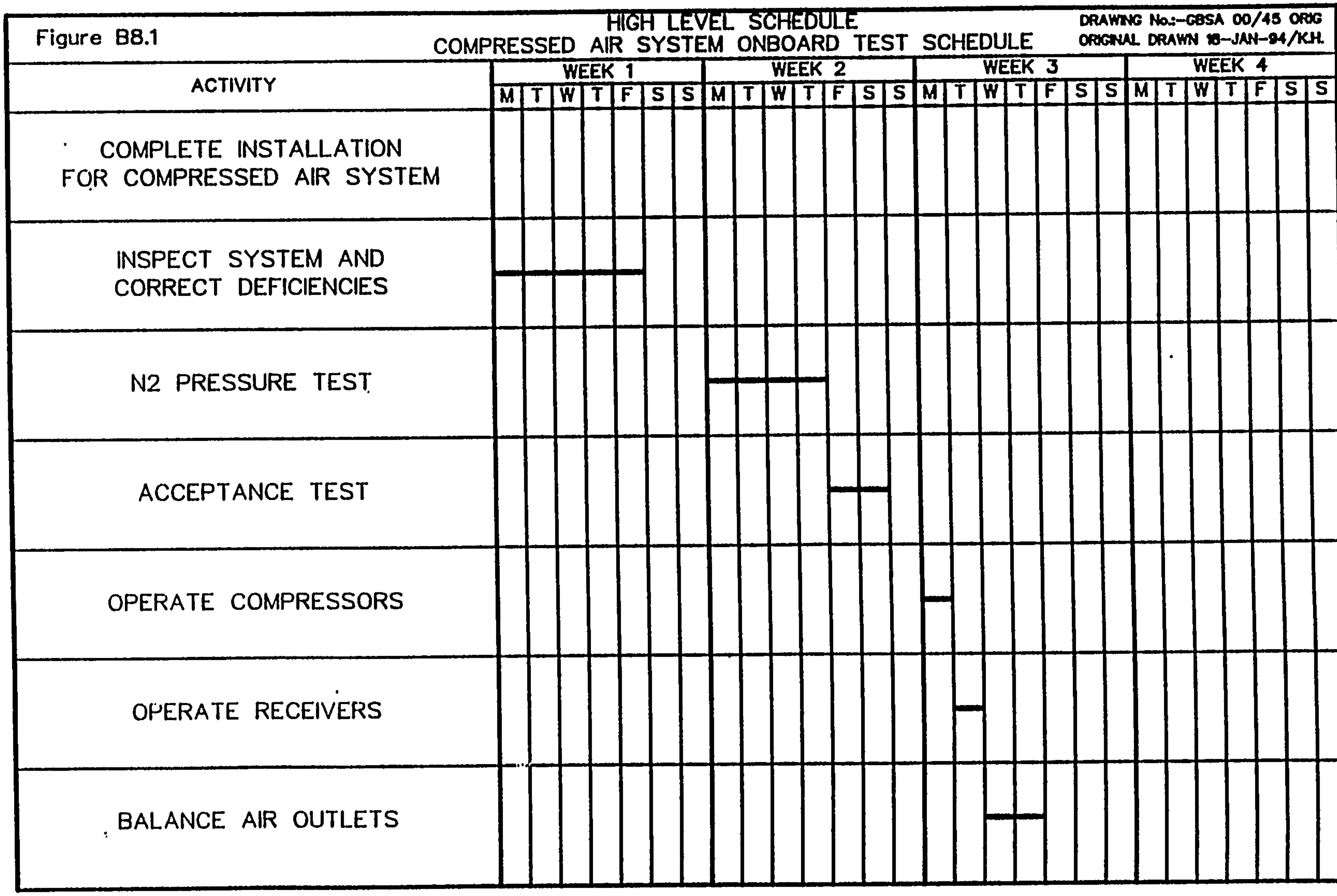
If the test progression:

preparation for tests;
pipe pre-testing;
equipment unit pre-testing;
dock trials;

has been followed then sea trials should mainly be a series of proving events. The exceptions to this are speed and maneuvering trials.

The program dates for both the Builder's and Acceptance Sea Trials and their completion date is shown in Figure B8.8.

Figure B8.1



B805

Figure B8.2 ONBOARD STRUCTURAL TANK TEST SCHEDULE

DRAWING No.:-GBSA 00/48 ORIG
ORIGINAL DRAWN 17-JAN-94/K.H.

TANK NUMBER	INSTALLATION WORK PACKAGE COMPLETE	CHECK INSTALLATION	CORRECT ANY DEFICIENCIES	TANK TEST		
				WATER	AIR	VACCUM
1	WEEK 10	WEEK 11	WEEK 11/12	N/A	WEEK 13	N/A
2	WEEK 12	WEEK 13	WEEK 13/14	N/A	WEEK 15	N/A
3	WEEK 14	WEEK 15	WEEK 15/16	N/A	WEEK 17	N/A
4	TANK TEST ON BLOCK 16 BEFORE ERECTION					

B806

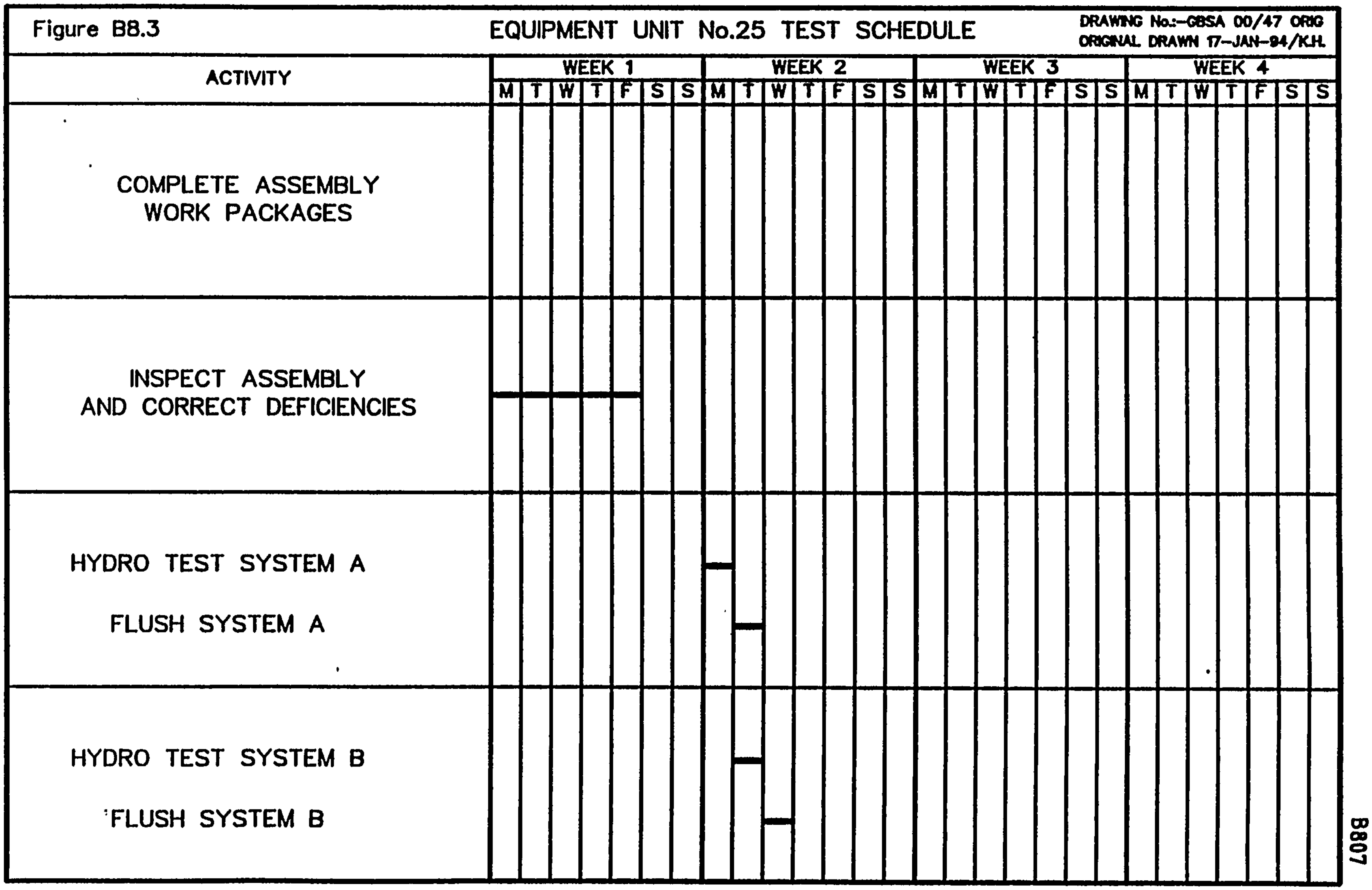


Figure B8.3
EQUIPMENT UNIT No.25 TEST SCHEDULE
DRAWING No.:-GBSA 00/47 ORIG
ORIGINAL DRAWN 17-JAN-94/K.H.
ACTIVITY
WEEK 1
WEEK 2
WEEK 3
WEEK 4
M T W T F S S M T W T F S S M T W T F S S M T W T F S S
COMPLETE ASSEMBLY WORK PACKAGES
INSPECT ASSEMBLY AND CORRECT DEFICIENCIES
HYDRO TEST SYSTEM A
FLUSH SYSTEM A
HYDRO TEST SYSTEM B
FLUSH SYSTEM B
B807

Figure 88.4

PIPE UNIT TEST SCHEDULE

DRAWING No.;GOSA 00/40 ORIG
ORIGNAL DRAWN 17-JAN-04/KM

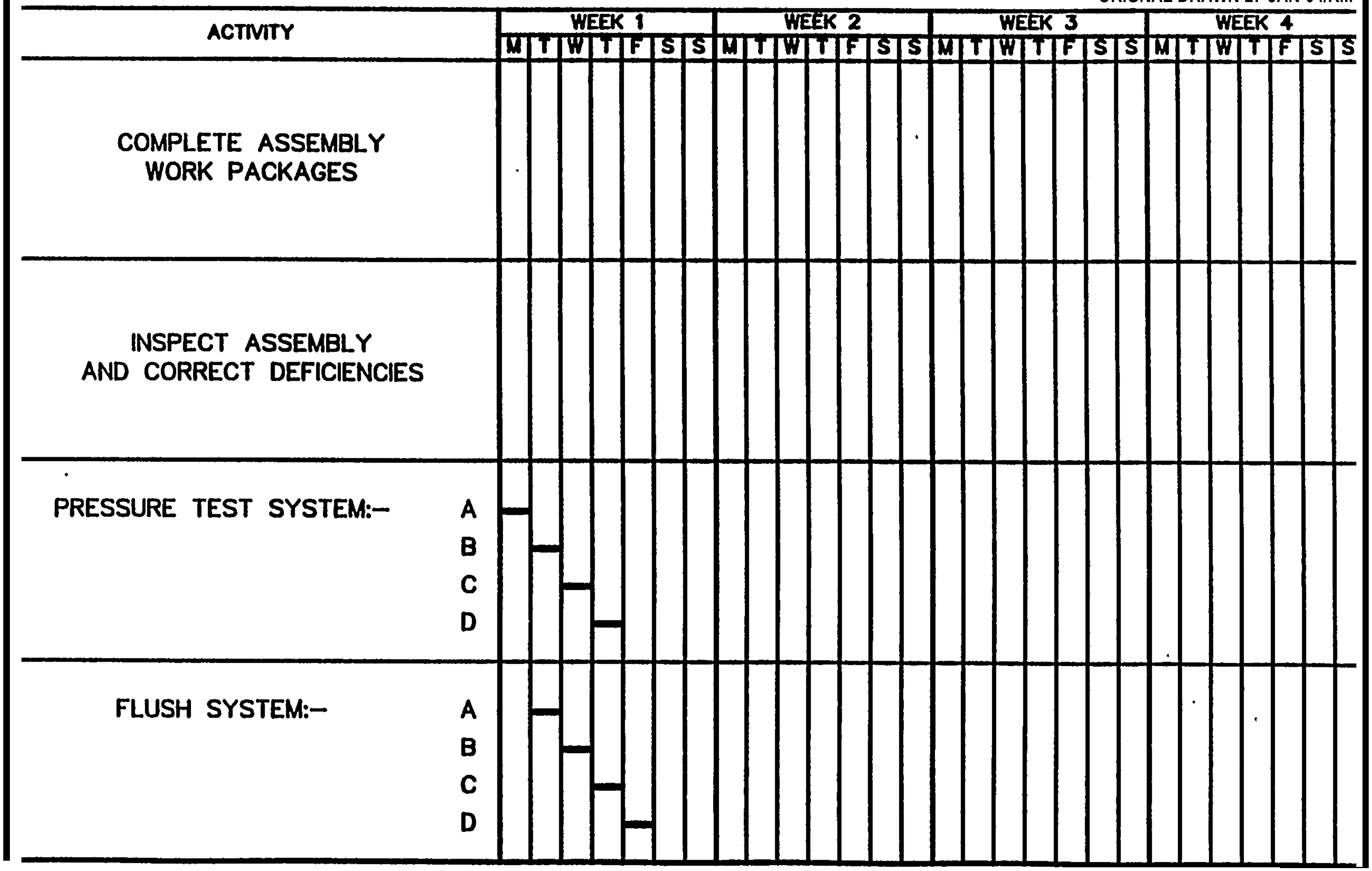


Figure B8.5

ZONE CLOSE OUT SCHEDULE

DRAWING No.:–GBSA 00/49 ORIG
ORIGINAL DRAWN 17–JAN–94/K.H.

ZONES			WEEK NUMBERS 1	2	3	4	5	6	7	8	9	10
ACCOMMODATION ZONE	1st DECK	A1									●	
		A2								●		
		A3							●			
		A4						●				
	2nd DECK	A5				●						
		A6			●							
		A7		●								
		A8	●									
	3rd DECK	A9		●								
		A10			●							
		A11				●						
		A12					●					
	4th DECK	A13					●					
		A14						●				
		A15							●			
		A16								●		

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Figure B8.6	PRINCIPAL TRIALS ITEMS	DRAWNG NO. 00/50 ORIG ORGINAL ORAWN 17—JAN—94/KH.

Main engine.
Auxiliary machlnery.
Deck machinery.
Cargo cranes.
Hatch covers.
Container location & security.
Contols and instrumentation.
Standby and emergency systems.
Electrical power and lighting systems.
Chain stoppers. .
Steering gear.
Quarter ramp.
Portable car decks.
Lifeboats and davits.
Pumps and all fluid systems.
Air and sounding pipes.
Heating, ventilation and a/c systems.
Domestic refrigeration plant.
Communications systems.
Radar and navigation systems.

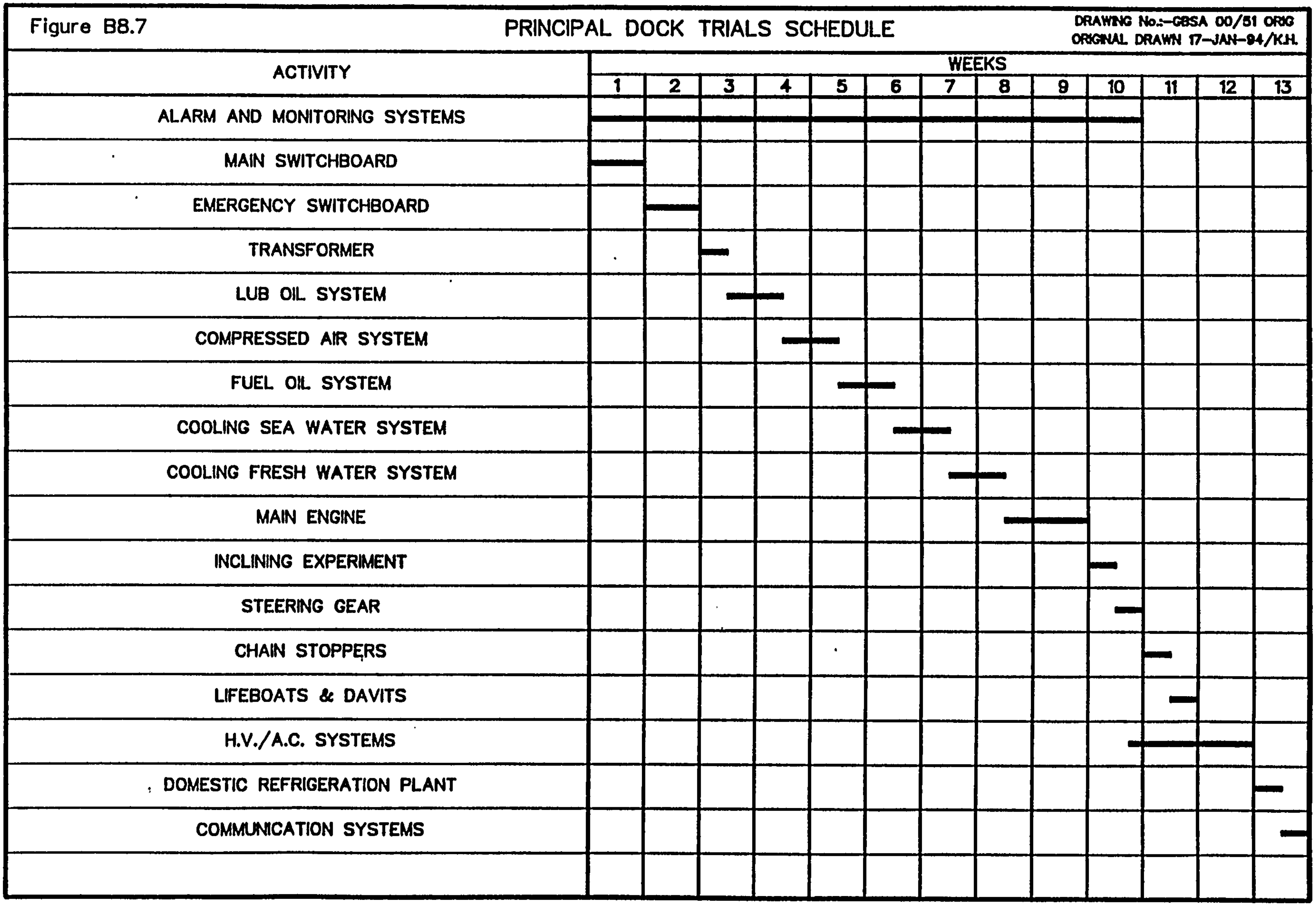
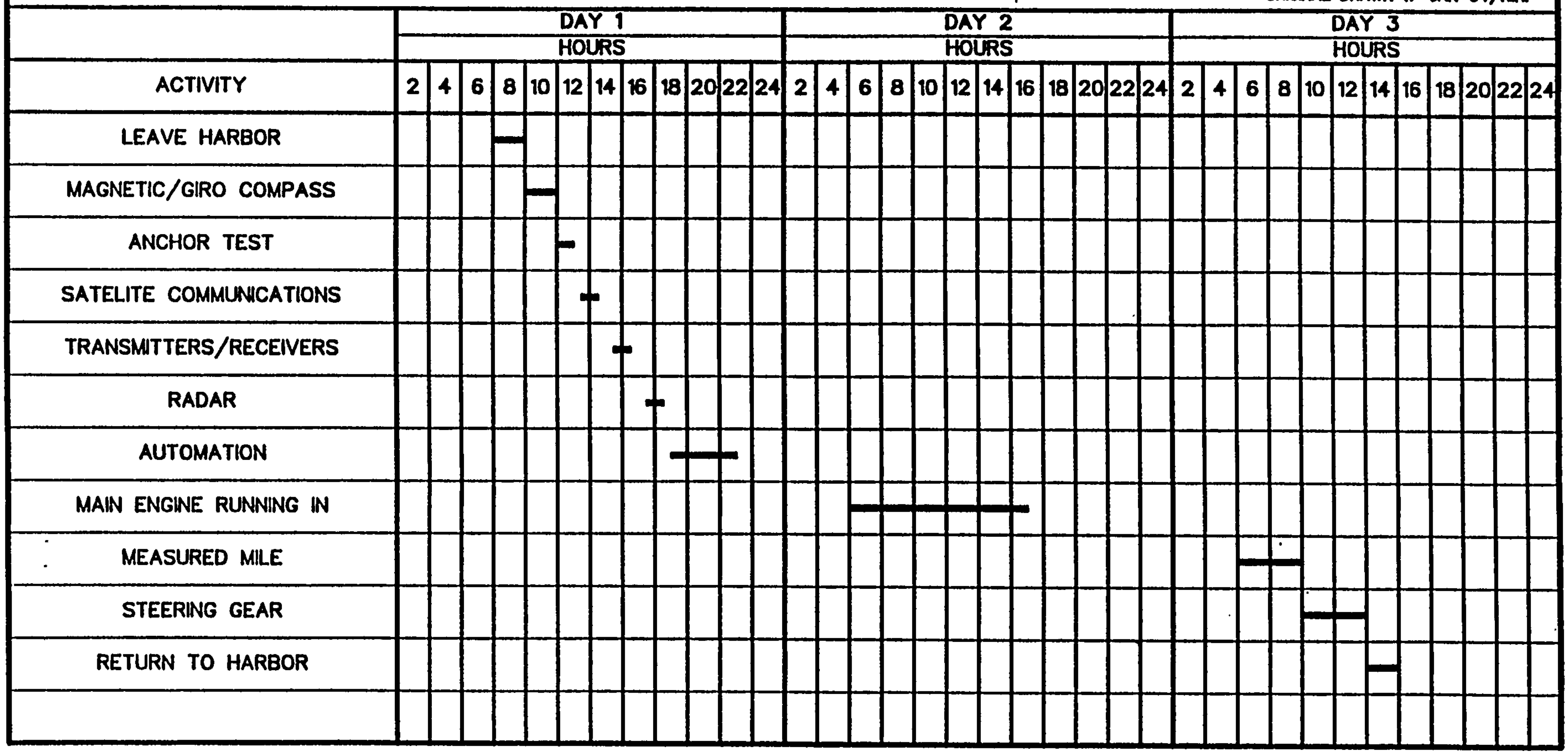


Figure B8.7 PRINCIPAL DOCK TRIALS SCHEDULE

Figure B8.8 SEA TRIALS SCHEDULE

DRAWING No.:–GBSA 00/52 ORIG
ORIGINAL DRAWN 17–JAN–94/K.H.



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B9: PERSONNEL

B9.1 Industrial Relations Aspects

In moving from naval ship to commercial ship construction significant changes will be required. The mix of skills will change and this will result in the need for flexibility in trade demarcation and extensive retraining. Throughout this change process the Industrial Relations Section of the Human Resources Department will be responsible for working with both management and employees to ensure a smooth personnel transition.

The shipyard has an excellent relationship with all its employees and this will be maintained by building on the existing mutual trust and loyalty through effective communication and cooperation in implementing all the necessary changes.

B9.2 Training

The change over from naval to commercial ships will not affect the basic skills required for ship construction. However, as mentioned above, it will require a redistribution of skills.

Training for the employees will center on discussing the details of the types of commercial ships to be built and will focus on the important differences. The major challenge is to ensure that the employees will accept the necessary changes and not persist in doing commercial work in the same way they did naval work. It cannot be "work as usual". While the highest quality is still important, it is of a different level, especially in the area of documentation.

Also, the successful management of the transition together with some technology changes, will require some training of the management team will be necessary. All training will be "in-house" in the form of seminars carried out by appropriate in-house and brought-in specialists.

All training will be the responsibility of the Training Director.

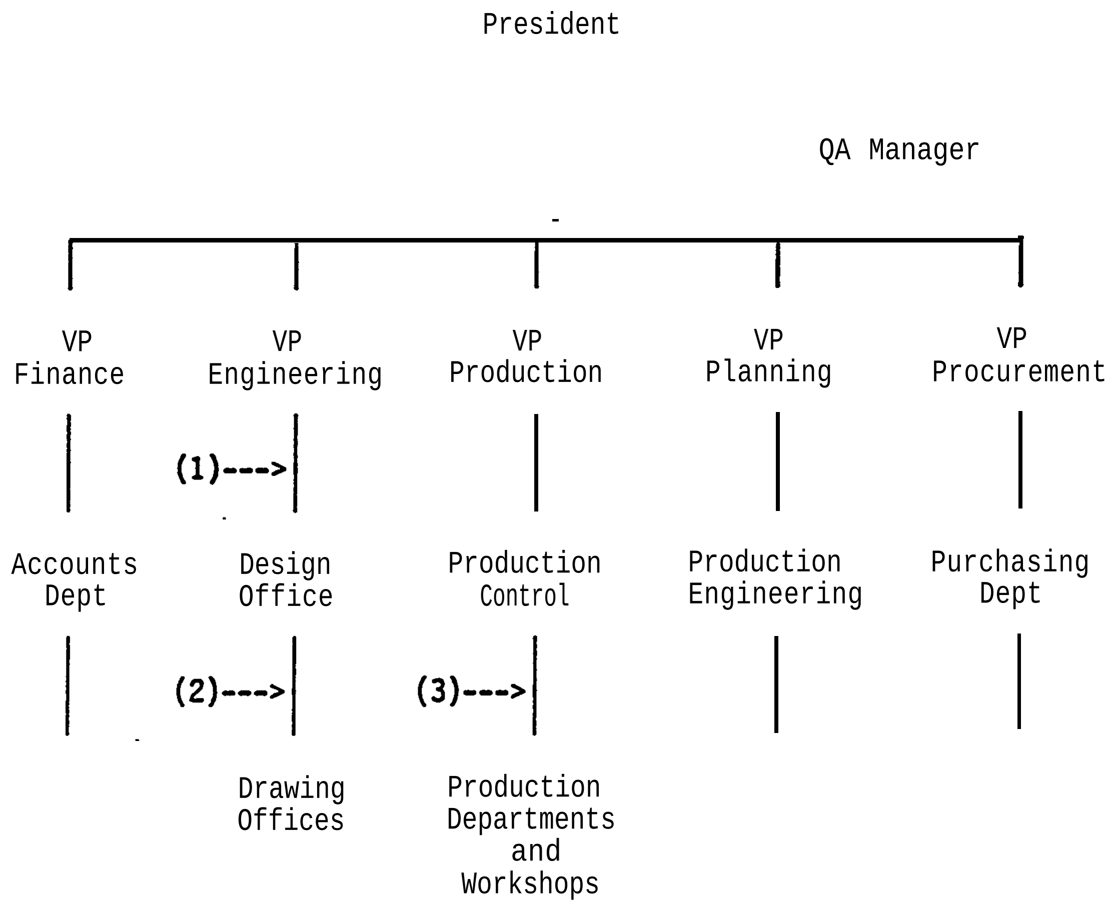
B9.3 Project Organization

B9.3.1 Shipyard Organization Charts

Figure B9.1 shows the shipyard organization to the-levels at which contact with the owner's representatives will occur. Contacts with ABS and USCG take place at the same levels.

Figure B9.1

SHIPYARD HIERARCHY TO SENIOR MANAGEMENT LEVEL



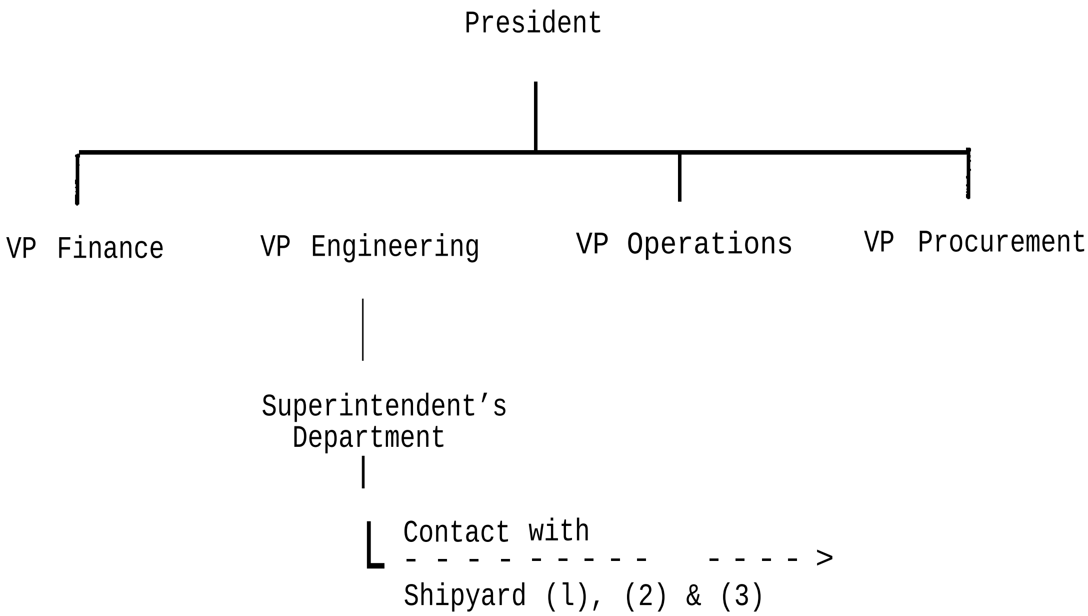
(1), (2) and (3) are points of contact with the owners.

B9.3.2 Client's Organization Chart

The client's organization, to the level at which continuous contact with the shipyard will take place, is shown in Figure B9.2. Prior to the placing of the contract there was frequent contact between the respective Presidents, Finance VPs and Engineering VPs. These contacts will continue but not frequently.

Figure B9.2

CLIENT'S HIERARCHY TO SENIOR MANAGEMENT LEVEL



B10: WEIGHT CONTROL

B10.1 General

The actual weight of the completed ship decides how much of the design full load displacement is available for the carriage of cargo. Generally, the required weight control of commercial ships is much less than that for a naval ship. This is because much more of the full load displacement is for carrying the cargo. That is the deadweight for most commercial ships is greater than the lightship weight. Whereas the opposite is true for naval ships where the payload might be only a small fraction of the full load displacement. Also the systems for a naval ship are much more complex than those for the normal commercial ship and therefore the estimation of the weight of the systems requires much more detail and effort.

Weight estimation for commercial ships have much more similarity from one ship to another. This enables designers to use parametric methods plus greater margins for the unusual. Parametric methods of weight estimation require up to date databases for the various ship types. While this is available to the current designers of the world's commercial ships, US designers do not have the database or experience necessary to use a parametric approach with confidence. Therefore, until sufficient experience is developed, the shipyard will utilize a weight control program to obtain the data and experience to ensure that the required deadweight is achieved.

The weight control procedure is a modified version of the shipyard's successful naval ship weight control procedure, but of considerably reduced scope. This will use the weight control team's familiarity with the existing procedure to ensure its easy transition for the first commercial ship.

B10.2 Outline Procedure

The weight control program will be established and managed in accordance with the shipyard's Weight Control Procedure for Commercial Ships, issued December 1993.

The weight control procedure consists of the following phases:

Calculations from drawings.
Equipment vendor weight reporting.
Lightship weight and center check.

The calculation of the weight items will be under the three major groupings:

Steel
Outfit
Machinery

They must be summarized as:

Total Steel
Total Outfit
Total Machinery

together with their associated centres of gravity and suitable margins on all items.

B10.3 Denartmental Resporisibilities

The Weights Section of the Naval Architectural Department will be responsible for the weight control. A Weight Manager will be assigned for this contract. Individual weights and centers of gravity will recalculated by the Weight Section engineers. A Weight Manager will be assigned for this contract.

All weight information obtained by the other design sections will be forwarded to the Naval Architectural Department for processing.

APPENDIX C

BUILD STRATEGY FOR A 30,700 TONNE DWT CONTAINER/RO-RO SHIP

APPENDIX C - CONTENTS

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APPENDIX C - CONTENTS **Page No**

C1: INTRODUCTION

C1.1 Purpose of Document

This Build Strategy is approved and endorsed by senior management. It should be used as the primary working document for this Contract. The accomplishment of the objectives and corresponding performance is essential for the ongoing success of the company and complete satisfaction of the customer.

Understand its implications for your department or group and follow it where actions are required to ensure that the strategy is fully implemented. Any significant deviations from the Build Strategy necessary during the performance of the Contract, must be fully documented and processed through the Build Strategy Control Board.

This is a COMPANY CONFIDENTIAL document and must be handled accordingly. However, distribution is broad enough to ensure that its communication value is not diminished. All copies have been assigned a control number and tracked to individual, group or department level.

The purpose of the Build Strategy is to apply the agreed method to build the ship to suit the facilities, processes, ship definition strategy and the objectives of the Shipbuilding Policy, and to facilitate communication and collaboration of departmental actions to meet the aims of the Build Strategy.

This Build Strategy provides a framework for the effective development and coordination of the many aspects of a specific ship contract. It also ensures that the design is developed in line with current, or projected, methods to be used by the production departments.

Emphasis is placed on the outfitting and engineering aspects of the design and production of the ship as it is in these areas where the most significant benefits of improvements in productivity can be obtained.

During the development of the Build Strategy, efforts have been made to reduce the work content inherent in the finished product by the extensive use of standards and the application of production engineering techniques at all stages of production.

The Build Strategy also provides an analysis for each stage of production in order to identify the methods and processes to be used. This analysis identifies problem areas to which special attention will have to be paid to avoid any bottlenecks during the production of the ship.

This Build Strategy has been prepared by several departments and the integrated approach is confirmed by the department heads who, as members of the Build Strategy Control Board, have signed below.

M ONEY
Vice President, Finance

T E C H Nical
Vice President, Engineering

M Hours
Vice President, Production

N E T Work
Vice President, Planning

B U Ying
Vice President, Procurement

C1.2 Build Strategy Document Prerequisites

The preparation of this Build Strategy is based upon the company's current Shipbuilding Policy and Ship Defination Strategy. Any modification required because of special characteristics or needs for the ship are described in Sections C4.2, C4.3 and C4.4 below.

C1.3 Distribution

This Build Strategy Document distribution is as follows:

All vice presidents.
All senior managers.
All other managers and supervisors.
Engineering department section leaders.
Production engineering department section leaders.
Classification society representatives (excluding budget schedules).

C1.4 Summary

This Build Strategy is prepared for:

Hull number 1004.
Contract number 93/E9887/1004.
Number of ships. First ship of a two ship contract.

It is prepared to record, integrate and communicate important specific ship design, material definition, planning, production and testing information in one internal (within the company) accessible shipyard controlled document.

It has been signed by the Vice Presidents of Finance, Engineering, Production, Planning aid Procurement and represents company policy and must be strictly adhered to.

This Build Strategy:

Defines what is to be built.

Defines the parameters of the build cycle, including schedule, budget and manning, as dictated by the contract.

Shows the adopted block breakdown, sequence of erection and initial process engineering.

Identifies outfit zones, machinery arrangements and equipment units.

Identifies interim products and creates a production oriented approach to engineering and planning of the ship.

Defines material purchasing requirements necessary to support the production process.

Indicates any special requirements in terms of the facilities, manpower, skills, etc, and highlights potential problems and how they will be overcome.

C2: VESSEL DESCRIPTION

C2.1 General Description and Mission

The General Arrangement of the steel container/ro-ro ship is shown in Figure C2.1, from which it can be seen that it is a single screw, diesel engine propelled steel container/ro-ro ship, suitable for the carriage of 20 foot and 40 foot containers/highway trailers and automobiles. The ship has a bulbous bow, raked stem, and a transom stern. It has superstructure and a deckhouse located aft. The deckhouse has five deck levels. There is no sheer on any decks. There is 500 mm straight line camber on the main deck, and no camber on any other deck.

The hull is subdivided by eight transverse bulkheads into nine main watertight compartments. The engine room is located aft, between the after peak and the forward engine room bulkheads.

Loading and unloading operations are performed by means of two twin cranes located between holds 1/2 and 3/4 and via the stern quarter ramp for the ro-ro cargo.

The mission of the ship is to transport containers and ro-ro cargo between the USA and the Caribbean/South America/South Africa/West Africa. The ship will be registered in the USA and operated by a crew of US nationals.

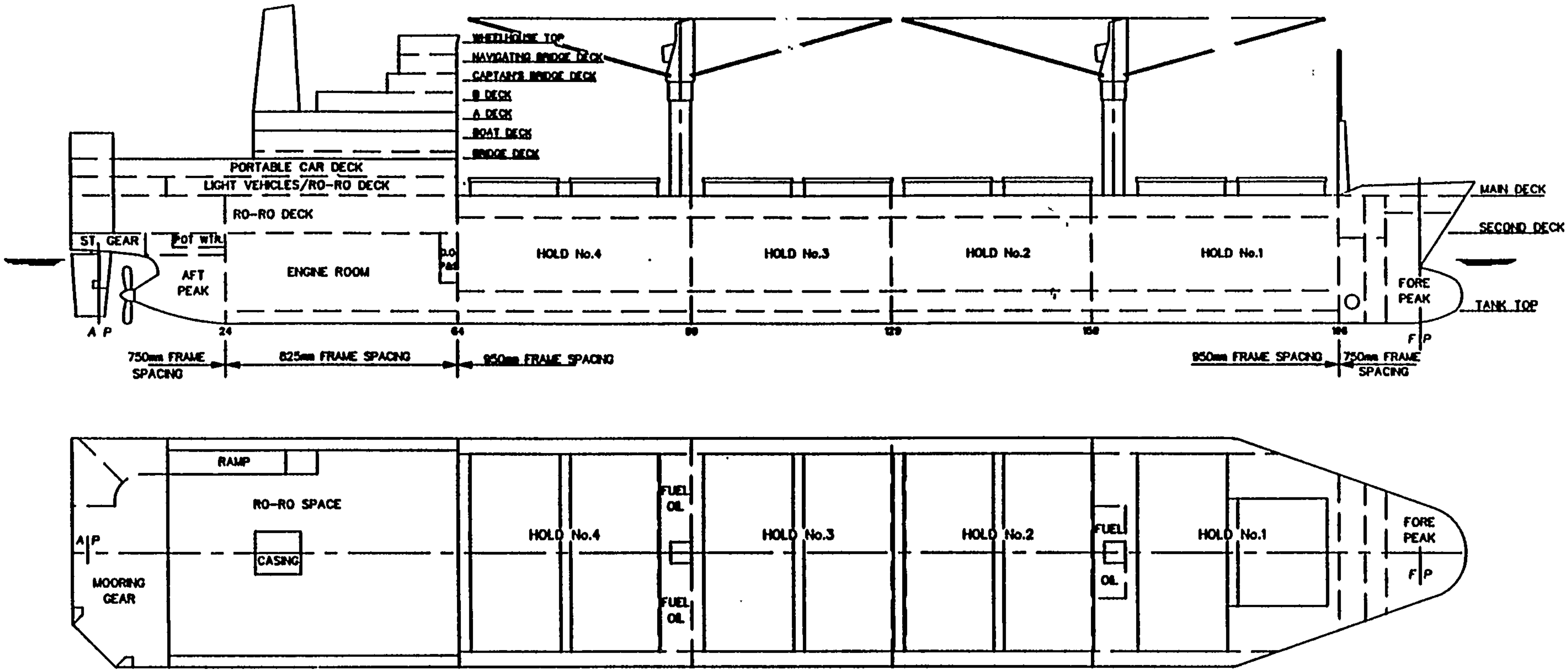
C2.2 Principal Particulars

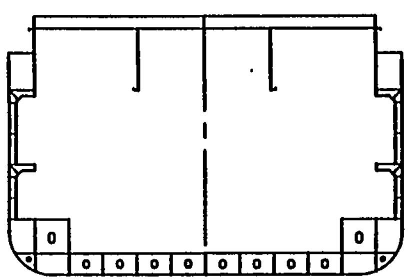
The ship has the following dimensions:

Length overall	= 199.80 m
Length between perpendiculars	= 188.00m
Breadth moulded	= 32.20 m
Depth moulded	= 18.00 m
Design draft	= 9.15 m
Maximum draft	= 11.00 m
Deadweight on design draft	= 21,500 tonne
Deadweight on maximum draft	= 30,700 tonne

C2.3 Special "Characteristics and Requirements

The ship has a stern quarter ramp, an internal ramp and portable car decks to deal with the ro-ro cargo.





SECTION AT MIDSHIPS

DIMENSIONS:- L.O.A.= 199.8m, L.B.P.= 188.0m,
B.MLD.= 32.2m, D.MLD.= 18.0m.

Figure C2.1

Project. GBSA – BUILD STRATEGY DEVELOPMENT

Drawing Title. CONTAINER/RO-RO SHIP GENERAL ARRANGEMENT

Scale.	Date.	Drawing No.	Rev.
1:600, 1:400 AT A3 PAGE SIZE	9th Dec 1993	GBSA 00/32	Orig

Photographic scale only

A&P Appledore International Ltd
Burdon Main Row, North Shields, Tyne & Wear England. NE29 6TD.
Tel. (091) 257 8611
Fax. (091) 296 0657
Telex. 53217

Figure C2.1

C202

The wheelhouse is located in the eighth tier of deckhouse above the main deck to provide good forward vision above the five container tiers stowed on the hatch covers.

The main engine is a slow speed marine diesel.

A knuckle is arranged from the top of the propeller arch to approximately the forward end of the engine room to allow for good water flow into the propeller disc and for maximum width of decks for ro-ro cargo. Figure C2.2 is the midship section for the ship.

C2.4 Comparisons and Differences from Previous Ships

For most of the past 15 years the company has been engaged in building naval ships for the US Navy and this ship will be the fourth merchant vessel to be built in that time. The major differences which will be encountered are:

The scantlings of a merchant ship are much thicker and hence individual structural items are heavier “than those of a naval ship.

The method of erecting and outfitting the ship is much more under the control of the shipyard. Hence the importance of this document.

Merchant standards and quality requirements are less than those required for a naval ship. This does not mean that quality is unimportant - it is essential, but not to such a high standard. There will still be standards which apply but these will be either in-house standards or the commercial standards of ISO, IEC, ITU, ANSI, etc. Classification society standards will also have to be met.

The shipyard has only recently gained - experience of installing slow speed marine diesel engines. For this contract the engines are being purchased ready built, but the company has decided to become a licensor for building such engines and these engines will be the last purchased complete.

There will be far fewer owners representatives in the ship yard but they still have to be satisfied that the ship complies with contractual requirements. owners representatives will be supplemented by classification society and United States Coastguard (USCG) surveyors who will ensure that their requirements are met.

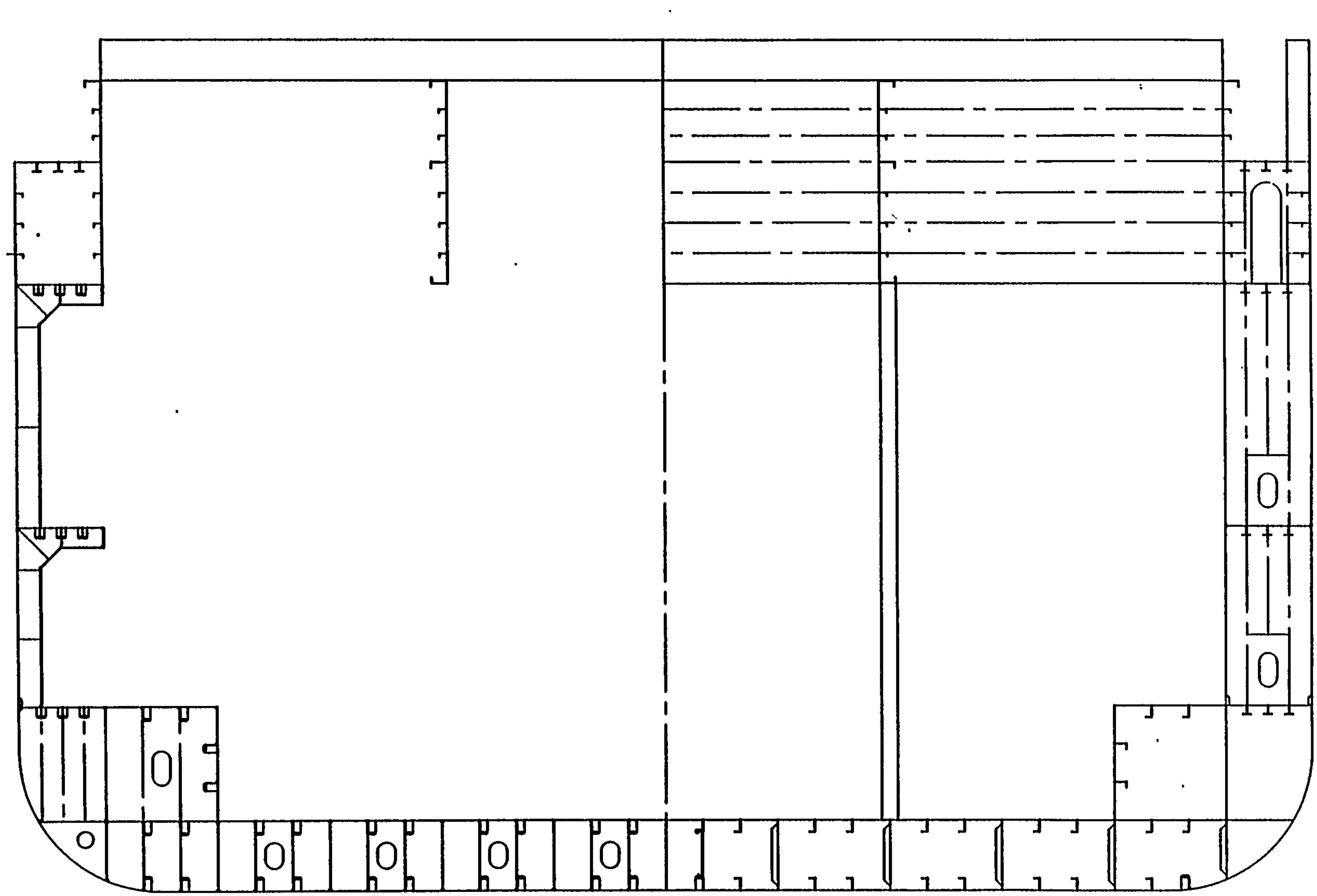


Figure C2.2
CONTAINER/RO-RO
MIDSHIP SECTION

DRAWING No.:- GBSA 00/39 ORIG
ORIGINAL DRAWN 6-JAN-94/K.H.

C2.5 Applicable Regulations and Classification

The ship complies with the relevant conventions of the International Maritime Organization (IMO) for a ship of its type and size. These are being applied by the USCG.

The ship is to be classed with the American Bureau of Shipping (ABS), with the notations +Al **E CONTAINER CARRIER** + AMS + **ABCU**

C2.6 Owner Particulars

The ships built under the contract are for Box Carriers Inc (BCI) of New Or leans.

C2.6.1 Background

BCI were established in 1969, initially servicing US ports and North West Europe, but have not established themselves in the US/ Caribbean/South America/South Africa/West Africa routes. They have always been at the forefront of unitised cargo carriage and were early in the field of hybrid container/ro-ro ships.

C2.6.2 Fleet

BCI operate a fleet of 16 pure container ships and four hybrid container/ro-ro ships. All of the latter ships are capable of being utilised by the Military Sealift Command.

C2.6.3 Port Relationship

Six of BCI'S pure container ships were built a the shipyard but to date we have not build a hybrid ship. The last ship built for this owner was delivered in 1976.

C2.6.4 Competition

BCI faces severe competition on the routes from both South American and West African shipowners.

It is in the shipyard's own best interest to provide BCI with the ships on schedule and to budget as their competition have not, and are unlikely to, order ships in the USA.

CONTRACTUAL

C3.1 Contractual Dates and Time Constraints

The ship to which this Build Strategy applies is the first of two ordered by Box Carriers of New Orleans. The ships are due for delivery as follows:

Ship 1: 11 September 1996
Ship 2: 5 October 1996

These dates are very close together and the fact that the company could deliver the ships in this time was a major factor in obtaining the order.

To achieve the contracted delivery dates requires that the first block of steel for this ship is laid on berth two on 16 September 1995, the first block of steel for Ship 2 is laid on berth one on 2 December 1995. The first date requires that sufficient steel is defined, ordered and delivered by mid June 1995.

It is imperative that all of these targets are achieved.

C3.2 Payment

The payment terms are related to identifiable stages in the build program. They are shown below:

	%	Value US$
Contract signing	5	2,350,000
Cut first steel		2,350,000
Lay keel (first block on berth)	5:	7,050,000
		7,050,000
Delivery	60	28,200,000

This again reinforces the need to meet specified target dates, in particular timely delivery.

C3.3 Liquidated Damages and Penalties

There are no liquidated damages applying to this contract, but the following penalties apply:

For the first 10 days, no penalty.

For every additional calender day the shipyard will pay US$ 25,000, up to a maximum of 5% of the contract price.

If delivery is delayed by three months from the contracted delivery date extended by permissible delays, then the owners will be entitled to cancel the contract. In such case the shipyard is **obliged to repay immediately all payments made by the owners, plus interest from the date of payment to-the date of the repayment.** The interest rate is set out at the London Interbank Offered Rate (LIBOR) 12 months, plus 3%.

C3.4 Cancellation

The **paying of any penalties is to be avoided but cancellation would be disastrous** for the company. Cancellation can be caused by:

Late delivery, over 91 days.
Attained speed 0.5 knot less than specified.
Fuel consumption 5.0% greater than specified.
Deadweight 1,500 tonne lower than specified.
Cargo. volume 3,000 cubic metres less than specified.

The last four items are technical and the existing design procedures should ensure that they do not apply. The first item reinforces the need to keep to schedules at all stages of the contract as all delays have a knock-on effect far greater than their apparent effect.

C3.5 Drawing Approval

In the contract the owners have up to fifteen working days to approve or make comments upon submitted drawings, otherwse they can be assumed to be approved, unaltered. This arrangement must be strictly enforced to prevent undue time being taken for approval.

It is vitally important that they receive any information which has to be approved by them on time and that they approve it within the timescale shown above.

Both ABS and the USCG have been approached and have agreed to achieve better than a fifteen working days turnaround on drawing approval.

C3.6 Construction Inspection

The construction of the ship will be subject to inspection by the following:

Owners: a hull/paint inspector and a machinery/electrical inspector.

ABS: a hull surveyor and a machinery and electrical surveyor.

USCG: a ship surveyor, a machinery surveyor, an electrical surveyor and a nautical surveyor.

They should be given every co-operation to assist them undertake their duties.

For structural surveys the inspectors should be called to view the structure from the major assembly stage onward, in order that any problems are identified and rectified where they have occured.

For tests on equipment and systems the inspectors should be given 24 hours notice and invited to attend. Should thev not attend the test will not be repeated. As many tests as possible should be undertaken in the workshop where the equipment will be connected to the necessary services in order to demonstrate its compliance with requirements.

C3.7 Trials

Trials will be attended by the same persons who undertake the inspections of C3.6 above.

The following dock trials will have to be undertaken alongside the outfitting quay:

- Main engine.
- Auxiliary machinery.
- Deck machinery.
- Cargo cranes.
- Hatch covers.
- Container location and security.
- Controls and instrumentation.
- Standby and emergency systems.
- Electric power and lighting systems.
- Chain stoppers.
- Steering gear.
- Quarter ramp.
- Portable car decks.
- Lifeboats and davits.
- Pumps and all fluid systems.
- Air and sounding pipes.
- **Heating, ventilation and a/c systems.**
- **Domestic refrigeration plant.**
- **Communications systems.**

Before calling in the inspectors to witness a trial, the equipment or system will have been fully tested by the QA department and accepted as being in order. Upon successful completion of the shipyard test the relevant inspectors are to be given the required 24 hours notice to attend the official trial.

Sea trials will be undertaken at the end of the basin trials and will consist of:

- Measured mile speed trial.
- Torsion meter measurement of torque developed by main engine.
- 12 hour endurance and fuel consumption trials at 25%, 50%, 75% and 90% of full power.
- Maneuvering, turning and stopping.
- Crash/Astern, Crash/Ahead and Astern Trial.
- Windlass trial, with full extent of cable out.
- Setting up remote control and other equipment which requires the ship to be at sea.
- Adjustment and calibration of navigational equipment.

These will be undertaken at a ballast draught agreed by the owners.

Before proceeding on the sea trials all systems and equipment possible will have been tested by the shipyard. Exceptions are those which require the ship being at sea in order to prove, ie, speed, fuel consumption, compass adjusting, etc.

The sea trials will take place off the coast of Zanadoo in the vicinity of the measured mile course at Brigadoon. They are scheduled to last for three days.

C3.8 **Qualitv**

The quality of the finished steel products is to be in accordance with the shipyard’s Steelwork Standards, Document No QAO027, issued July 1983.

The quality of the other products is to be in accordance with the relevant QA department procedures and/or applicable industry standards which apply, whichever is higher.

C4: DESIGN AND ENGINEERING

C4.1 Strategy and Scope

C4.1.1 General

The design and engineering drawings are being undertaken by an outside agency, Messrs D R Aftsman Inc, but they are to supply staff to work in-house, under the control of the company Design and Engineering Department.

All design calculations and drawinas required for appoval purposes and by production departments will be produced by the teams set up for the purposes.

When production drawings are being developed, multi-discipline (cross functional) teams will be set up in order to ensure that the drawings:

- follow shipbuilding policy;
- follow ship definition strategy;
- satisfy special requirements of all users.

C4.1.2 Changes to Ship Definition Strategy

There are no changes to the Ship Definition Strategy to suit this ship and those developed for Ship Numbers 1001, 1002 and 1003 will apply.

C4.1.3 Modelling and Composites

A 1:20 scale model of the machinery space is to be constructed of clear perspex sheets for the structure, solid plastic pieces for machinery and equipment, coloured plastic tubes for pipework, coloured plastic rectangular section pieces for duct work and coloured plastic strips for wire ways.

The model will. clearly show block seams and butts, equipment units, pipe banks,.etc.

Final runs for pipework, duct work and wire ways will be determined from the model.

Clear of the machinery space, composite digital models showing all structure, equipment and systems will be prepared for:

Second Deck Ro-Ro Space.

Upper Deck Ro-Ro Space.

Each of the Accommodation Decks.

Navigating Bridge Deck.

The composites will be prepared directly from the approved diagrammatic.

C4.2 Key Drawings

Key drawings have been produced and show the main transit routes for all of the services in the ship (piping, vent trunking and wire ways). The key drawing shows all of the functional spaces within each of the compartments of the ship. Figure C4.1 shows the Key Drawing for a part of the machinery space.

The actual size of the transit routes will be determined later but every effort must be made to ensure that the services are located within the routes shown on the key drawings.

Key drawings.have sufficient space in them for adding notes and tables when they are used for routing the services.

C4.3 Production Information Requirements

C4.3.1 CAM Information

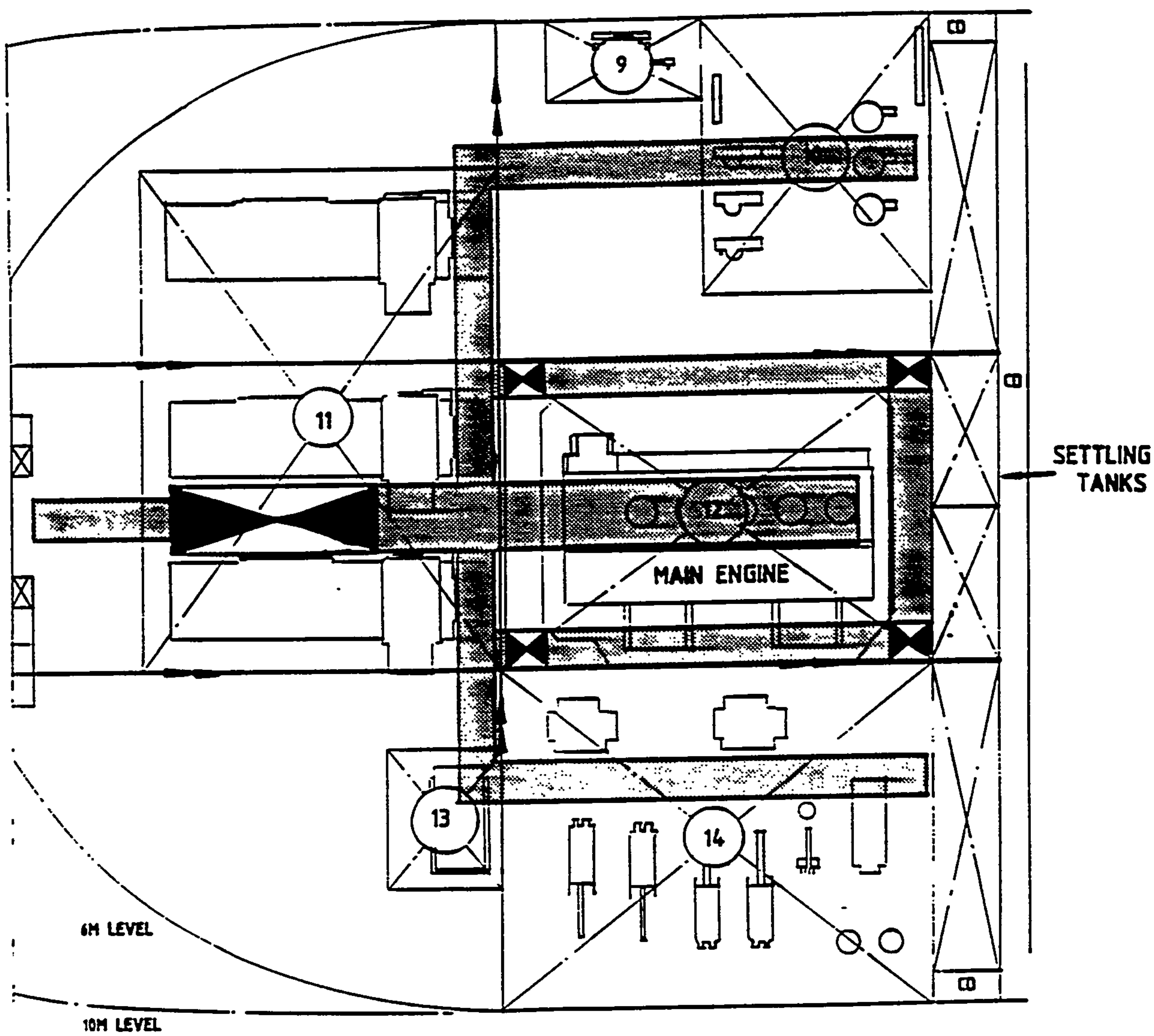
Computer Aided Manufacture is used in the following areas in the shipyard:

Steel storage and retrieval.
Burning machines.
Frame bending machines.
Stores location and retrieval.

Information must be provided to the steel stockyard on the quantities of steel plates and profiles, their sizes and weightst when they will arrive and when they will be withdrawn, so that forward planning for logical storage can be prepared.

Figure C4.1

KEY DRAWING SHOWING ENGINE ROOM SERVICES TRANSIT ROUTES



KEY:-

HORIZONTAL TRANSIT ROUTE

VERTICAL TRANSIT ROUTE

ERECTION BUTT

6-10M LEVELS

The preparation workshop must be informed of the numbers and sizes of the steel material to be worked upon in a given period in the shop and be supplied with magnetic tapes with the N/C instructions for performing the work on the material.

The information required for stores location and retrieval is as for other ships.

C4.3.2 Manufacturing Information

The format of manufacturing information must reflect the manner in with the work is to be performed at the appropriate workstation or zone, and the tools or equipment to be used. This is as described in the company Ship Definition Strategy.

C4.3.3 Parts Listings

The parts numering system is defined in the company document “Parts Numbering for Merchant Ships, Rev A“, produced by the planning Department in October 1993. This system will apply to this contract.

A Parts List, in accordance with the numbering system, is to be produced by the Design and Engineering Department.

C4.3.4 Installation Drawings

Installation drawings are to reflect the manner in which the installation is performed and the tools and equipment to be used. The information they should contain and the format of this information is as described in the company Ship Definition Strategy.

C4.3.5 Installation Procedures

Installation procedures are to be determined from manufacturers’ instructions and company procedures. They are to be clearly written up and forwarded to the relevant installation department, Production Control and QA, for action.

C4.4 Design and Engineering Schedule

C4.4.1 Schedule

Figure C4.2 shows the key events for all ships in the current order book. From the Figure it can be seen that the key events for Ship 1 of the Container/Ro-Ro Carriers for which this Build Strategy has been developed, are:

Sign contract (C)	: 21 Oct 1994
Cut first steel (S)	: 03 Jul 1995
Erect first block on the berth (K)	: 20 Oct 1995
Launch (L)	: 10 May 1996
Deliver (D)	: 11 Sep 1996

These dates determine when bought-in materials and equipment have to be available in the yard. The delivery dates from ordering of the materials and equipment determines the date when the equipment should be ordered ‘and this, in turn, specifies when the technical information should be available to enable orders to,be placed.

Table C4.1 shows the schedule for’ when the requisitions for the ordering of the major items of materials and equipment are required red from the Technical ‘Departments. It was derived using Table B5.1 - Production Times of Critical/Long Lead Time Items, and Figure B6.1 - Equipment Installation Dates and Required Delivery. To enable requisitions to be produced the relevant shipyard technical information in the form of drawings and specifications must be available.

C4.4.2 Resourcing and Utilization

The total design and engineering manhours required fur this ship is 165,000. As the contract personnel work 40 hours per week, this represents 4,125 man weeks of effort.

Table C4.2 shows the allotted timescales, % of total effort and manhours required to produce the technical information for the various phases. There is significant overlap between all phases, and the total elapsed time for producing the design and engineering information is .70 weeks.

Figure C4.2 KEY EVENTS FOR THE CURRENT ORDER BOOK

DRAWING No.:-GBSA 00/25 ORIG
ORIGINAL DRAWN 7-NOV-93/K.H

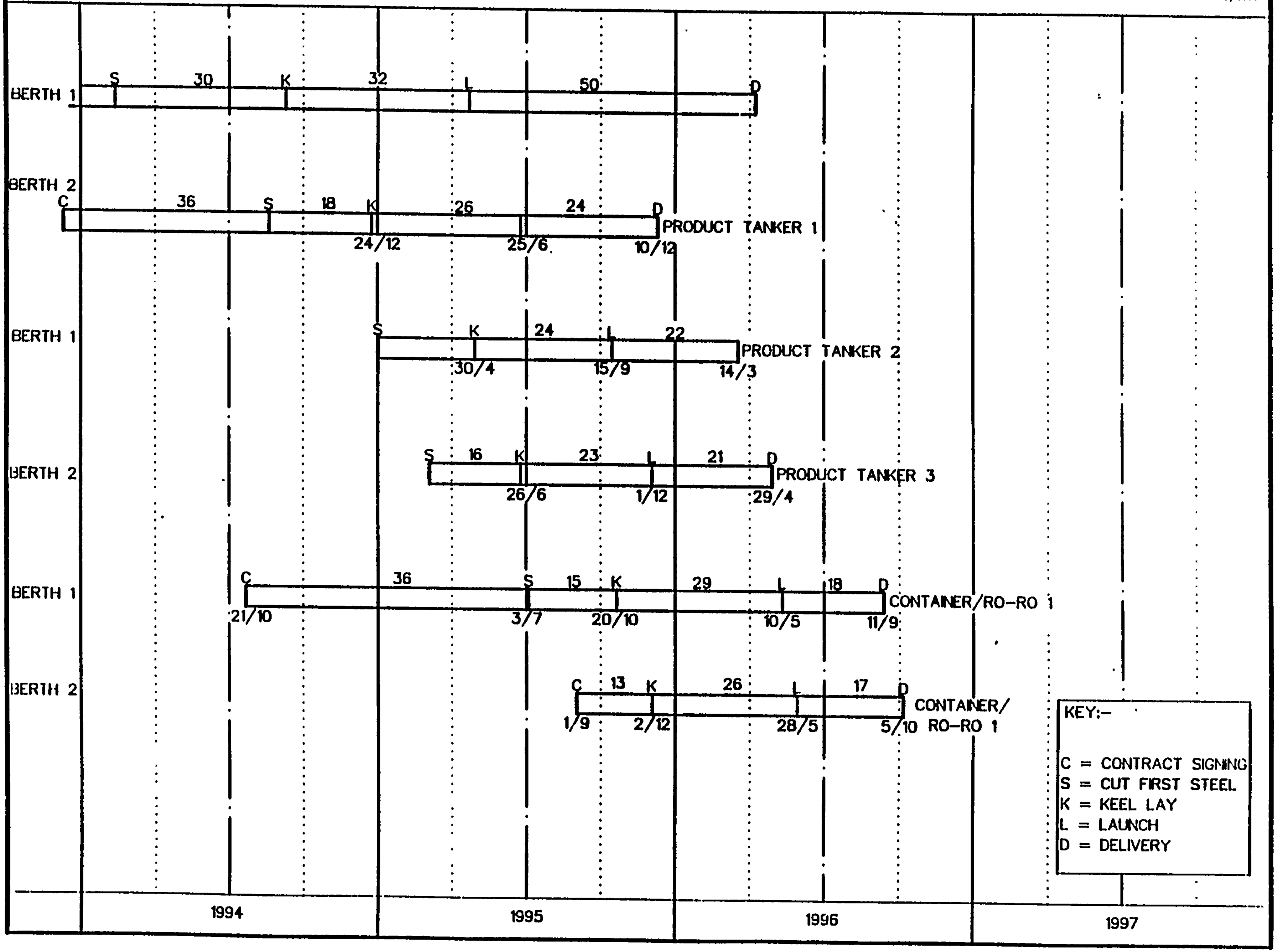


Table C4.1

REQUISITION SCHEDULE FOR MAJOR ITEMS

Item	Required Requisition Date Week/Year
Steel	6/95
Hatch Covers	18/95
Main Engine	10/95
Quarter Ramp	16/95
Portable Decks	18/95
Shafting and Propeller	12/95
Auxiliary Machinery	14/95
Bow Thruster	20/95
Electrical Generators	12/95
Steering Gear	22/95
ER Pumps	24/95
Air Compressors and Receivers	28/95
CO_2 System	26/95
Machinery Controls and Instrumentation	12/95
Lighting and Electric Cables	26/95
Switchboard	10/95
Sewage Plant	18/95
Air Conditioning and Fans	22/95
Refrigeration Machinery	14/95
Deck Machinery (Mooring and Anchor Handling)	44/95
Cargo Cranes	
Lifeboats and Davits	26/95
Navigation Equipment	50/95
Communications Equipment	50/95

Table C4.2

ALLOTTED TIMESCALES, % OF TOTAL EFFORT AND MANHOURS REQUIRED FOR THE VARIOUS PHASES OF PRODUCING TECHNICAL INFORMATION

Phase	Allotted Time Weeks	% of Total Effort	Required Manhours
Design Information	15	9	14,850
Information for Approval	22	30	49,500
Transition Definition (from systems to zones)	17	16	26,400
Production information	48	45	74,250

Thus the manweeks and manpower required for the phases have been calculated and shown in Table C4.3 below:

Table C4.3

MANWEEKS AND MANPOWER REQUIREMENTS FOR EACH PHASE

Phase	Man Weeks	Man~ower
Design	371	25
Approval	1,238	
Transition	660	56
Production	1,856	39

C4.4.3 Vendor Furnished Information (VFI) Schedule

The vendors shown in Table C4.4 below are required to provide information regarding their product by the date shown alongside their name. The relevant product is also shown in the table.

Table C4.4

VENDORS, PRODUCTS AND LATEST DATES FOR RECEIVING VFI

Vendor	Product	Latest Date for VFI Week/Year
H Lids Inc	Hatch Covers	28/95
S Lope Inc	Quarter Ramp	26/95
H Oist	Portable Decks	28/95
D Iesel Inc	Main Engine	16/95
S Haft Inc	Shafting	18/95
P Repel Inc	Propeller	18/95
S Ways Inc	Bow Thruster	30/95
E Gene Inc	Electrical Generators	18/95
S Teer Inc	Steering Gear	32/95
P Ump Inc	ER Pumps	34/95
A Comp Inc	Air Compressor & Receivers	36/95
C Arbon Inc	C02 System	30/95
C&I Inc	Controls & Instrumentation	18/95
S B Oard Inc	Switchboard	16/95
H Y D Raulic Inc	Hydraulic Power Packs	26/95
S Mell Inc	Sewage Plant	24/95
F Ayre Inc	A/C and Fans	26/95
V Cool Inc	Refrig Machinery	24/95
W Inch Inc	Deck Machinery	50/95
H Lift Inc	Cargo Cranes	48/95
L Save Inc	Lifeboats and Davits	
D I Rection Inc	Navigation Equipment	55/95
T Balk Inc	Communications Equipment	55/95

To ensure that the VFI is received on schedule the vendors must receive the purchase order for their product in the timescale they offer in their bid. At least two weeks before the latest date-for receiving the information (if it has not been received) the vendor must be contacted to expedite.

C4.5 Datums and Molded Definition

The system of datums used is as shown in Figure C4.3. Briefly the origin for the datums is:

After perpendicular.
On the base line.
On the centreline.

With +ve going forward from the after perpendicular, moving to starboard from the centreline and upwards from the base line.

The boundaries of planning units, ie, blocks, zones and outfit units, are defined in terms of the primary datums while details of piece parts and interim products are related to the secondary datums.

The molded definition is important to ensure the correct alignment of adjacent and continuous structure. The molded definition is shown in Figure C4.4.

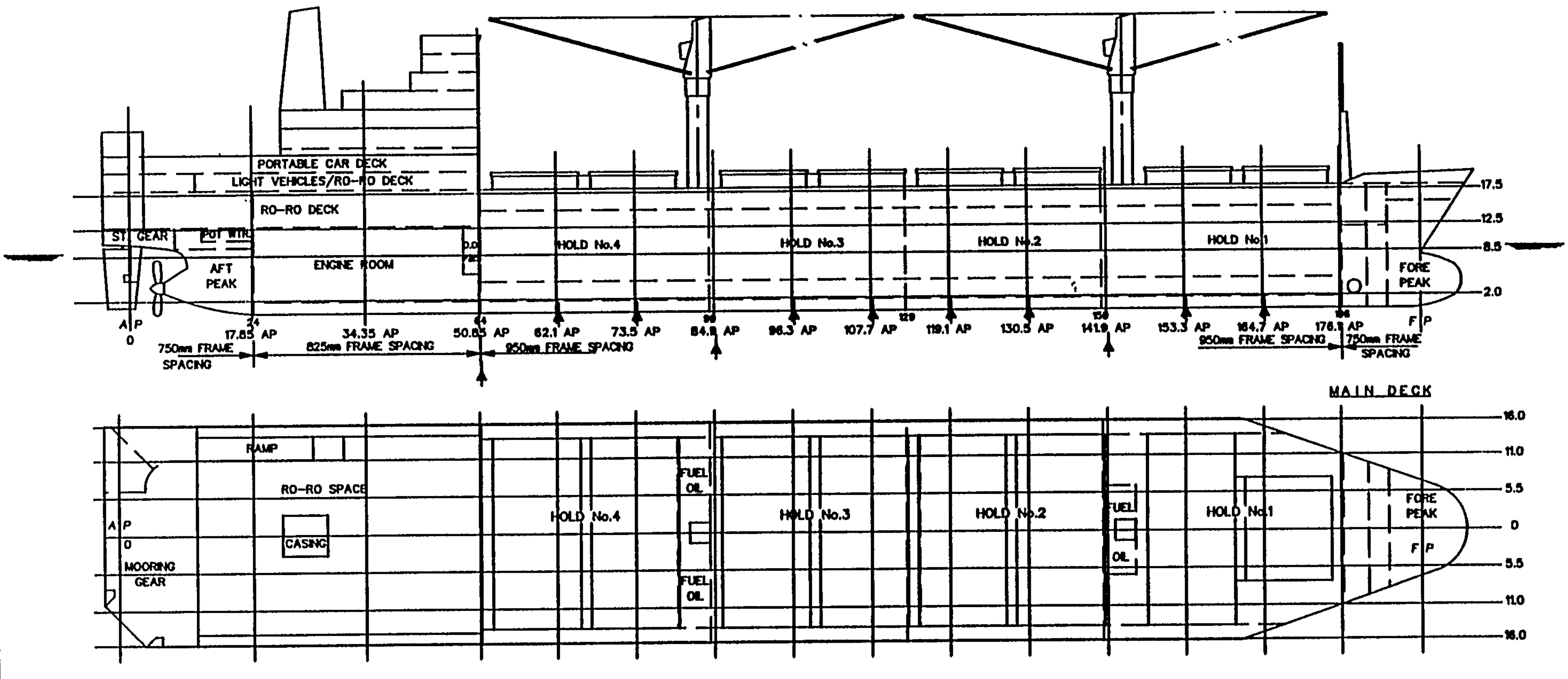
C4.6 Design Standards

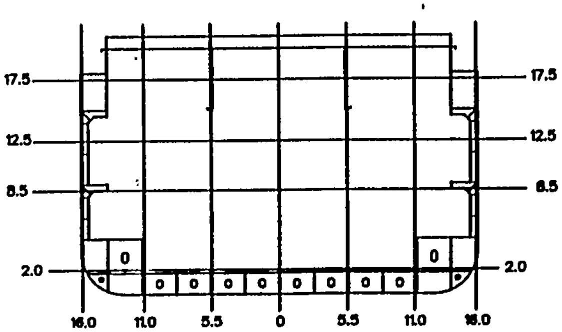
As new ship designs are adopted and orders for them are placed, it will be necessary to develop the designs for production. This will require not only ensuring that the design of the ship conforms to the capability of the production equipment, but it will also be necessary to develop the expertise to design so that, for example, steel and outfit standard assemblies and parts are considered from the concept design stage.

C4.7 Functional Space Allocation

Functional spaces have been allocated within each of the compartments in the ship. Figure C4.5 shows the arrangement of the compartments of the ship and Figure C4.6 shows the functional spaces determined for the lower flat in the engine room.

The functional spaces have been determined by locating groups of related equipment together so that the lengths and runs of interconnecting services are kept to a minimum and made simpler. Collecting related equipment together allows for the development of equipment units.





SECTION AT MIDSHIPS

BLOCK BUTT

UNIT BUTTS ARE 300mm FORWARD OF PRIMARY DATUMS IN THE CARGO HOLD REGION

DIMENSIONS:- L.O.A.= 199.8m, L.B.P.= 188.0m, B.MLD.= 32.2m, D.MLD.= 18.0m.

Figure C4.3

Project. GBSA - BUILD STRATEGY DEVELOPMENT

Drawing Title. CONTAINER/RO-RO SHIP SYSTEM OF DATUMS

Scale. 1:600, 1:400 AT A3 PAGE SIZE

Date. 7th Nov 1993

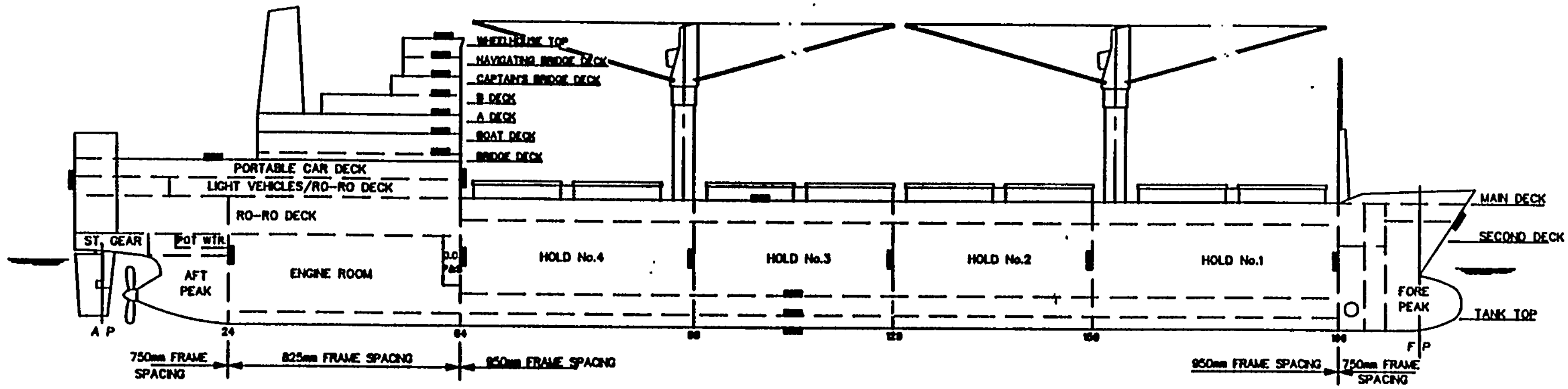
Drawing No. GBSA 00/21

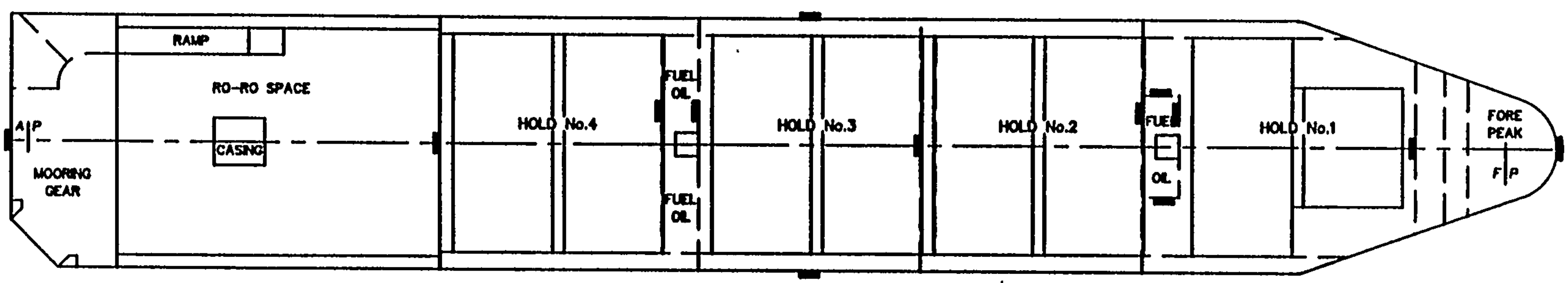
Rev. Orig

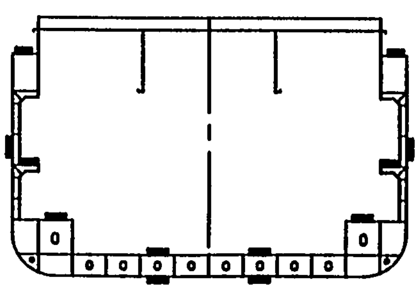
Photographic scale only

A&P Appledore International Ltd
Burdon Main Row, North Shields, Tyne & Wear England. NE29 6TD.
Tel. (091) 257 8611
Fax. (091) 296 8667
Telex. 53217

Figure C4.3







SECTION AT MIDSHIPS

DIMENSIONS:- L.O.A.= 199.8m, L.B.P.= 188.0m,
B.MLD.= 32.2m, D.MLD.= 18.0m.

Figure C4.4

Project.	GBSA - BUILD STRATEGY DEVELOPMENT
Drawing Title.	CONTAINER/RO-RO SHIP MOLDED DEFINITIONS
Scale. 1:600, 1:400 AT A3 PAGE SIZE	Date. 20th Jan 1994
Drawing No. GBSA 00/67	Rev. Orig

Photographic scale only

A&P Appledore International Ltd
Burdon Main Row, North Shields, Tyne & Wear England. NE29 6TD.
Tel. (091) 257 5611
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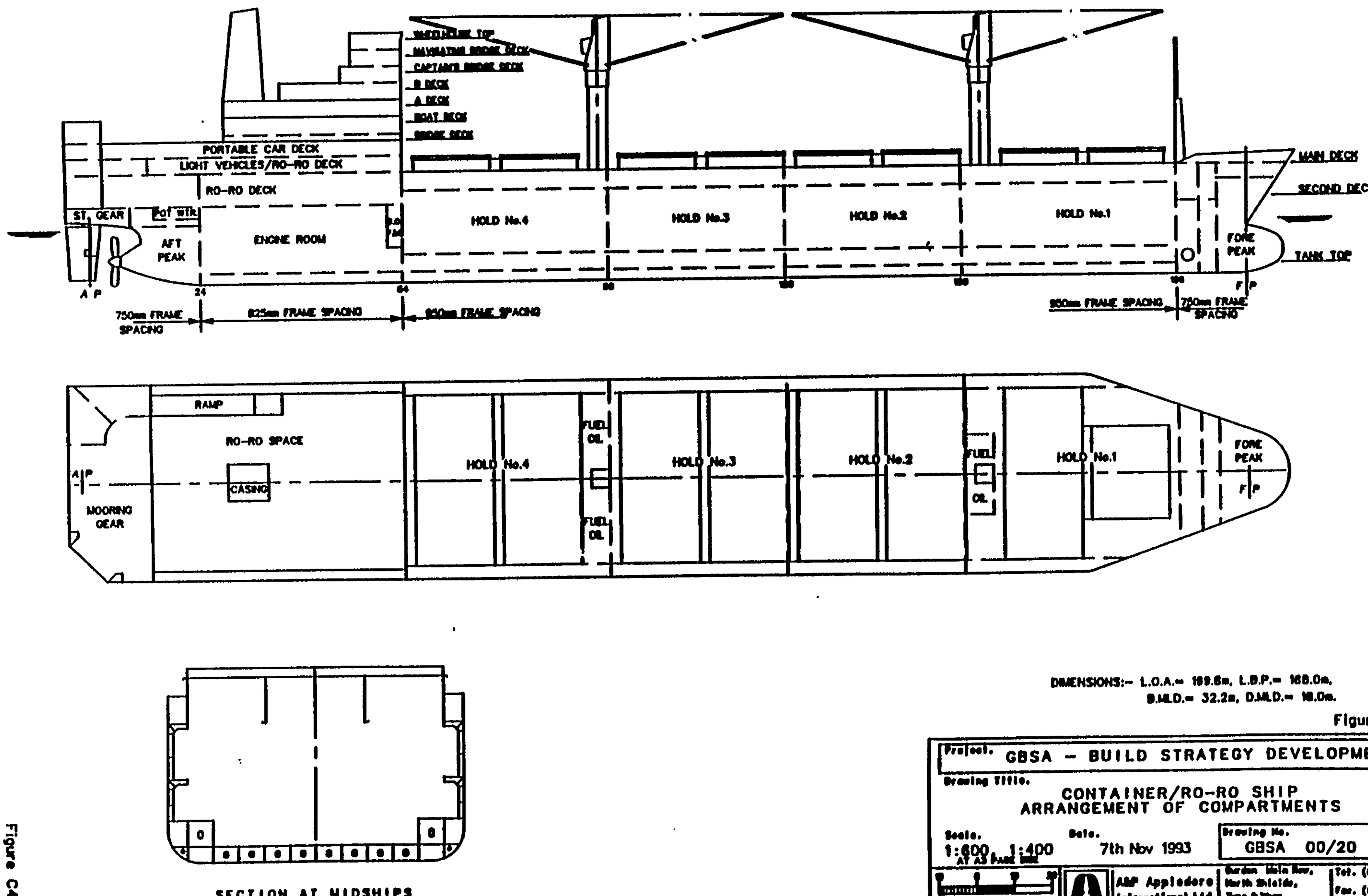
Figure C4.4



DIMENSIONS:- L.O.A.= 199.6m, L.B.P.= 188.0m, B.MLD.= 32.2m, D.MLD.= 18.0m.

Figure C4.5

Project. GBSA - BUILD STRATEGY DEVELOPMENT

Drawing Title. CONTAINER/RO-RO SHIP ARRANGEMENT OF COMPARTMENTS

Scale. 1:600, 1:400 AT A3 PAGE SIZE

Date. 7th Nov 1993

Drawing No. GBSA 00/20

Rev. Orig

Photographic scale only

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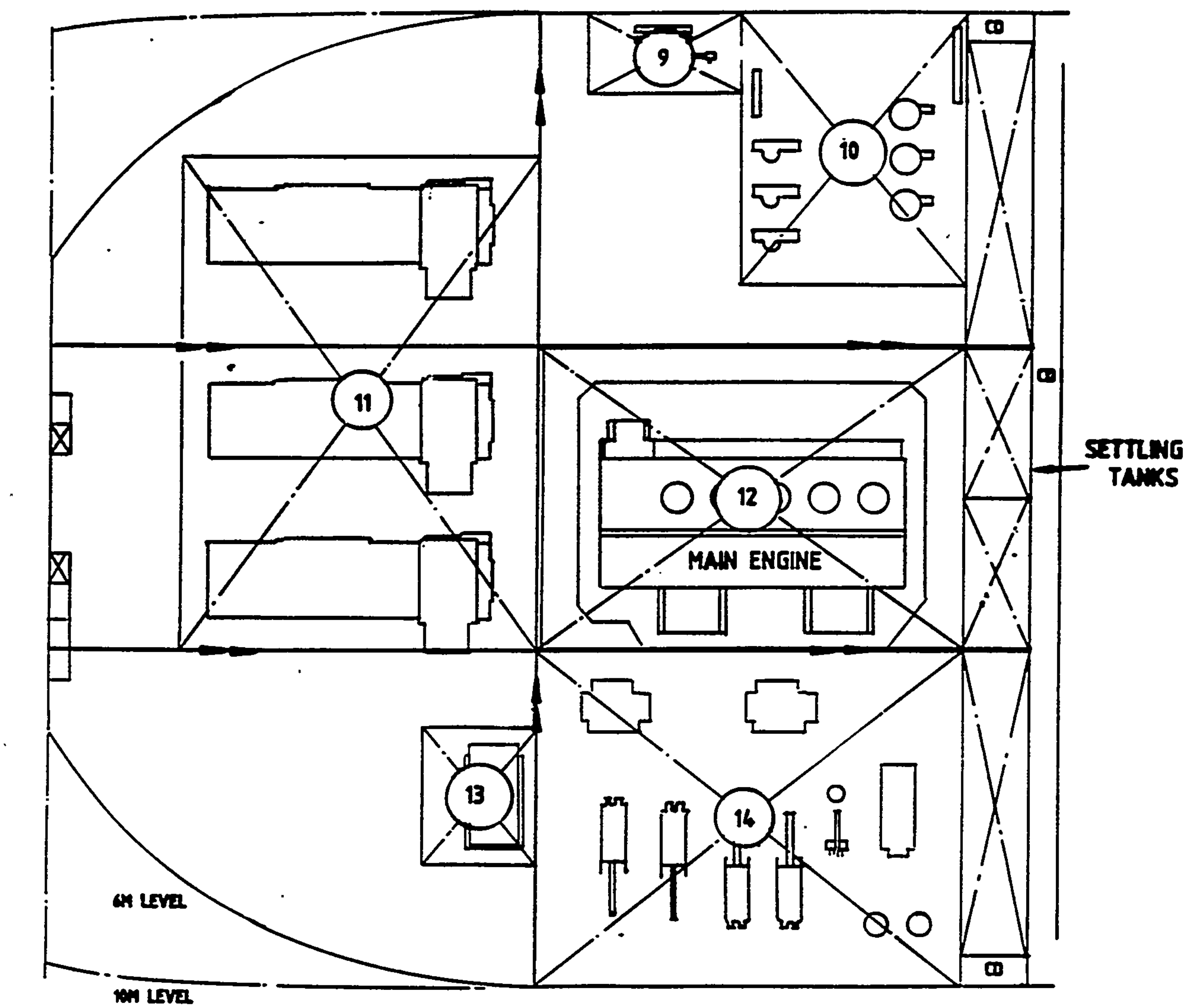
Tyne & Wear

Figure C4.5

C413

Figure C4.6

ENGINE ROOM FUNCTIONAL SPACE ALLOCATION



9. FUEL PUMPS
10. PURIFIERS
11. ELECTRICAL GENERATORS
12. MAIN ENGINE
13. SEWAGE HANDLING
14. COOLER

——— ERECTION BUTT

6-10M LEVELS

C4.8 Detail Design Guidelines

C4.8.1 Steelwork

Steelwork standards, such as manholes, cut-outs, brackets, hangers, etc, have been developed over a number of years. It is the responsibility of detail design to ensure that these standards are continuously and rigorously applied to all detail design work.

B4.8.2 Machinery

Installation To be in accordance with standards laid down in the company's Shipbuilding policy.

B4.8.3 Pipe Work

Pipework standards such as material types, bore sizes, pipe configuration (ie, straight pipes, pipes with one bend of 450 or 900, pipes with no bends, either 450 or 900) have been developed. Detail design will be responsible for ensuring that these design standards are continuously and rigorously applied to all detail design work.

B4.8.4 Electrical

Standards for cable trays, cable ladders and hangers have been developed and detail design will be responsible for ensuring that these design standards are continuously and rigorously applied to all detail design work.

B4.8.5 Joiner Work

Standard furniture and fittings for the accommodation area have been developed and detail design will be responsible for ensuring that these design standards are continuously and rigorously applied to all detail-design work.

B4.8.6 Paint Work

To be in accordance with standards laid down in the company's Shipbuilding policy and paint specification.

C5 : PROCUREMENT

C5.I Master Material List

During the design material will be quantified and specifications prepared and a master material list must be developed similar to the master equipment list.

C5.2 Master Equiument List

During the design process equipment will be defined and specifications prepared, and a master equipment list must be developed. Reference Table C5.1.

C5.3 Material Procurement Strateqy

For this contract the company has adopted a policy of using the suppliers of large quantities of materials (steel, piping, pipe fittings, electric cables, joiners panels, etc) as a supplementary store. It has been agreed with such suppliers that the company will order the total quantity of materials necessary for the contract with them and they will guarantee that it will be available to be drawn down upon as required.

This policy will reduce the inventory which is usually held in the yard and help the cash flow, as the Products do not have to be paid for until they are drawn upon.

The onus is upon the company to request draw downs in good time to ensure the materials are in the yard when required. A draw down schedule will be prepared by the Planning Department and issued to the Procurement Department.

C5.4 Critical/Long Lead Time Items

Table C5.2 shows the list of items which are either critical or long lead time items, or both.

The times are quoted by the suppliers and are their shortest periods, ex-works, from the placing of a firm order.

C5.5 Procurement Schedule

The procurement schedule for the critical and/or long lead time items is shown in Figure C5.1 below. The schedule was derived by adding delivery times to the shortest ex-works times shown in Table C5.2. Total delivery times thus obtained were then deducted from the required installation times shown in Table B6.l”in order to produce the procurement schedule.

TABLE C5.1

MASTER EQUIPMENT LIST

ITEM No.	DESCRIPTION	SUPPLIER	REQU No..	REQU DATE	ORDER No.	ORDER DATE	NUMBER REQUIRED	REQUIRED IN YARD
1	HATCH COVERS	H. LIDS INC						
2	QUARTER RAMP	S. LOPE INC.	1237	19/4/95	5681	3/5/95	1	18/10/95
3	PORTABLE DECKS	H. OIST INC						
4	MAIN ENGINE	D. IESEL INC.	1234	8/3/95	5678	22/3/95	1	4/10/95
5	SHAFTING	S. HAFT INC.	1235	12/4/95	5679	28/4/95	1	8/11/95
	PROPELLER	P. ROPEL INC.	1235	12/4/95	5679	28/4/95	1	8/11/95
6	BOW THRUSTER	S. WAYS INC						
7	GENERATORS	E GENE INC.	1236	22/3/95	5680	12/4/95	2	18/10/95
8	STEERING GEAR	S. TEER INC						
9	E.R. PUMPS	P. UMP INC.						
10	COMPRESSORS	A. COMP INC						
11	RECEIVERS	A. COMP INC						
12	CO 2 SYSTEM	C. ARBON INC						
13	CONTROLS AND INSTRUMENTATION	C & I. INC						
14	SWITCHBOARD	S. BOARD INC						
15	HYDRAULIC POWER PACKS	H.Y.D.RAULIC INC						
16	SEWAGE PLANT	S. MELL INC						
17	A/C & FANS	F. AYRE INC						
18	REEFER MACHINERY	V. COOL INC.						
19	DECK MACHINERY	W INCH INC						
20	CARGO CRANE	LIFT INC						
21	LIFEBOATS & DAVITS	L. SAVE INC.						
22	NAVIGATION AIDS	D.I.RECTION INC						
23	COMMUNICATE SYSTEM	T.BACK INC						

Table C5.2

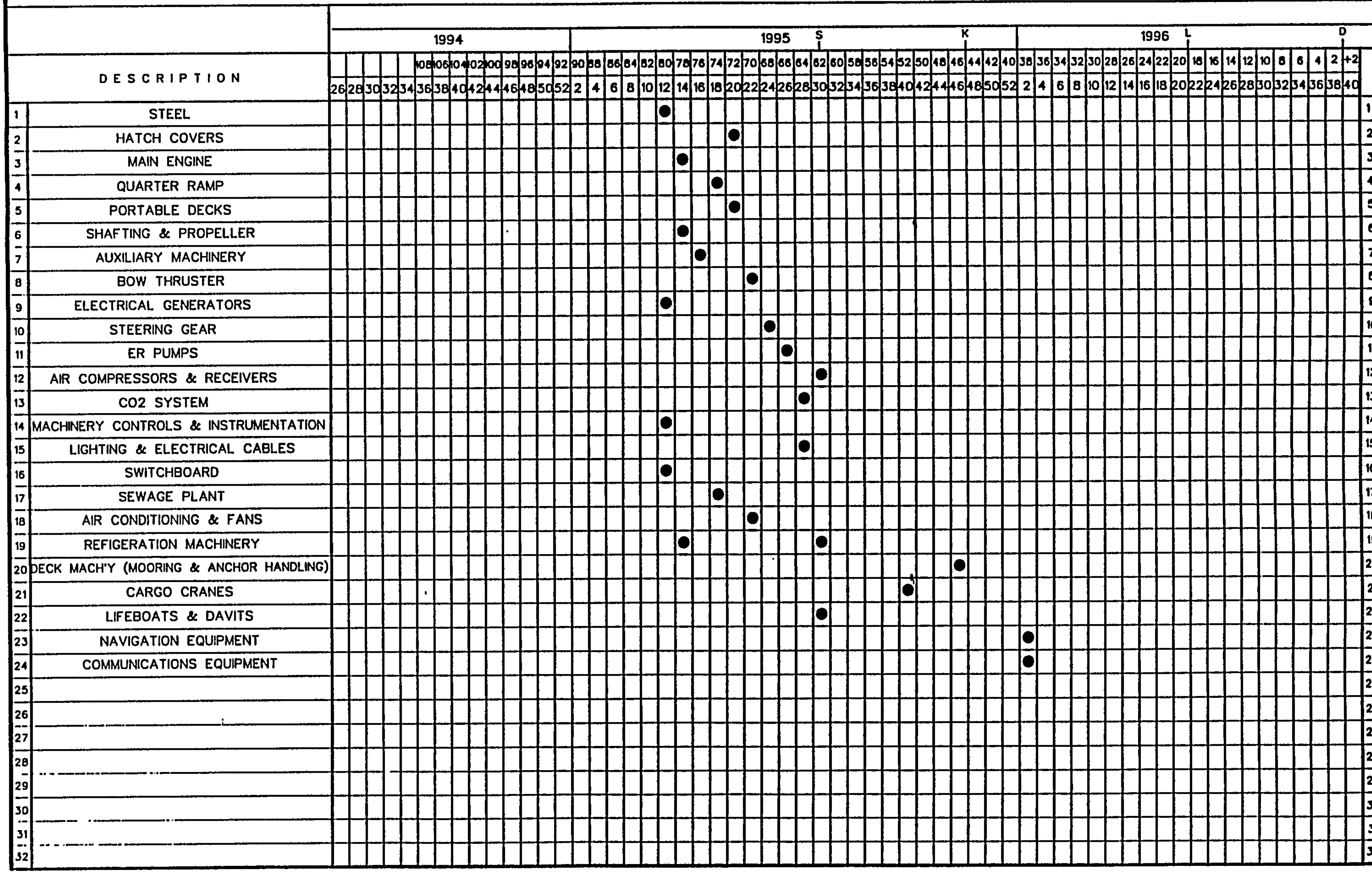
PRODUCTION TIMES OF CRITICAL/LONG LEAD TIME ITEMS

Materials or Equiument	Shortest Times (weeks)
Stee1	14
Hatch Covers	26
Main Engine	30
Quarter Ramp	26
Portable Decks	26
Shafting and Propeller	30
Auxiliary "Machinery	20
Bow Thruster	26
Electrical Generators	30
Steering Gear	22
ER Pumps	12
Air Compressors and Receivers	8
C02 System	8
Machinery Controls and Instrumentation	30
Lighting and Electric Cables	10
Switchboard	30
Sewage Plant	20
Air Conditioning and Fans	20
Refrigeration Machinery	20
Deck Machinery (Mooring and Anchor Handling)	20
Cargo Cranes	22
Lifeboats and Davits	39/17
Navigation Equipment	12
Communications Equipment	12

SHIP:- CONTAINER/RO-RO
Figure C5.1

EQUIPMENT PROCUREMENT SCHEDULE

DRG NUMBER:- GBSA 00/33 ORIG
ORIGINAL DRAWN/9-DEC-93/KH



C505

C6 : **PLANNING**

C6.1 Strateaic Planning

C6.1.1 Key Event Program

A key event program has been prepared and is shown in Figure C6.1. It shows the most important events of the build program, which must be attained in order to achieve the contract delivery dates.

It should be noted that certain procurement dates have been included. This is because they are items which are long lead time and/or are items which it is necessary to have in place to allow subsequent work to be undertaken.

C6.I.2 Resourcing and Utilization

The manpower resources and their utilization required during the period of building this ship are shown in Figure C6.2 below.

Figure C6.2 clearly shows the fall-off in requirement for employees during of 1996. It should not be taken that this will happen as the company is making every effort to secure orders which will reverse the-trend shown with the current order book.

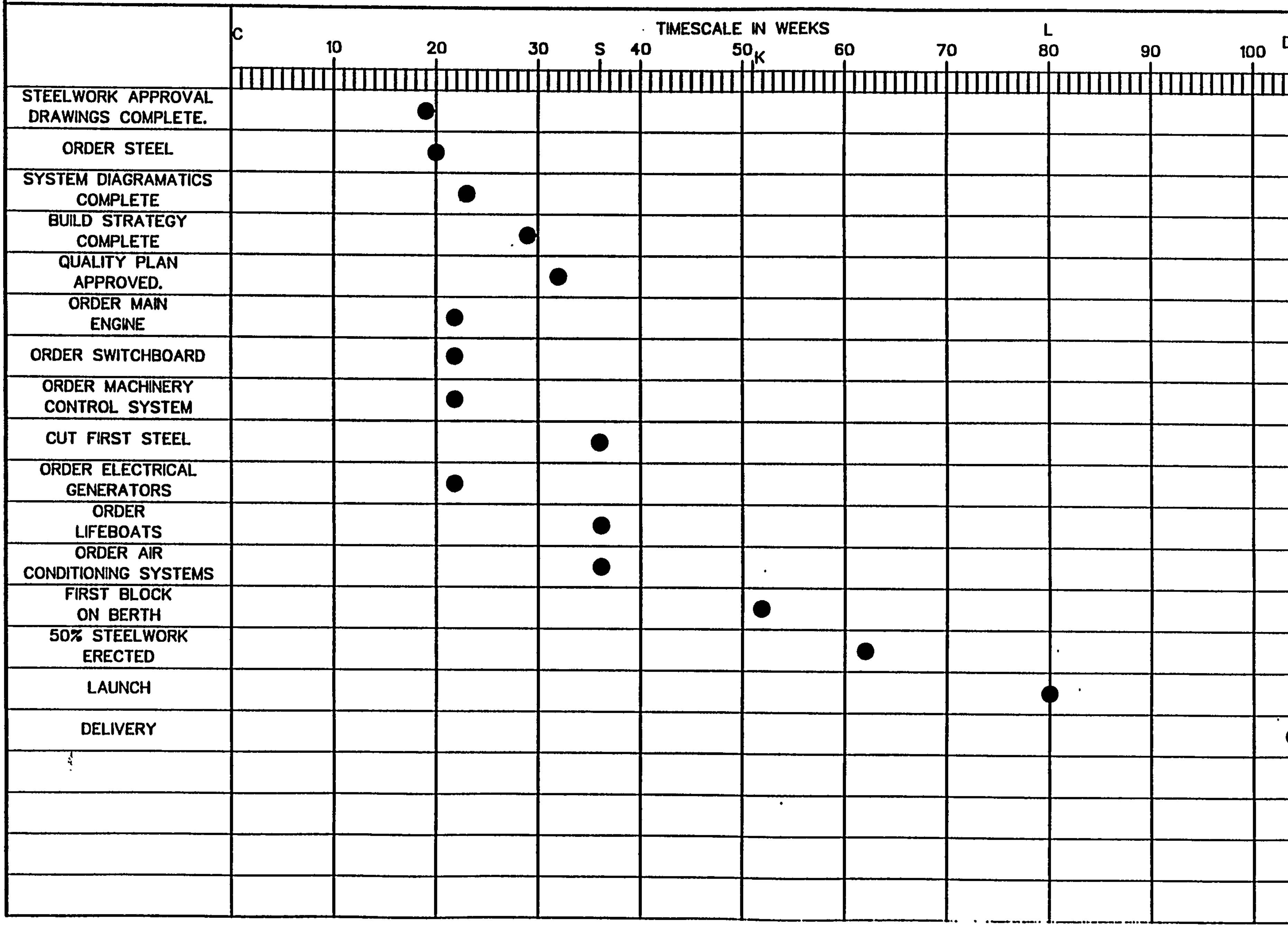
Apart from the production of design and engineering information it is not intended to use any subcontractors on this contract.

The total steel throughput in 1995 for the present order book will be 33,190 tonne nett steel. Nett working area of the assembly shop is 20,000 m^2. This represents a utilization of 1.66 tonne/m^2/year which can be accomplished in a single shift. The utilization of the assembly shop is therefore 1.66 tonne/m^2/shift/year.

Maximum number of steelworkers required during the build period of this ship is 1,210. 510 of these will be in the assembly shop at this stage in the contract. This gives a labour loading density in the assembly shop of 39.2 m^2/person. This is a heavy density, but as it represents the peak it is acceptable.

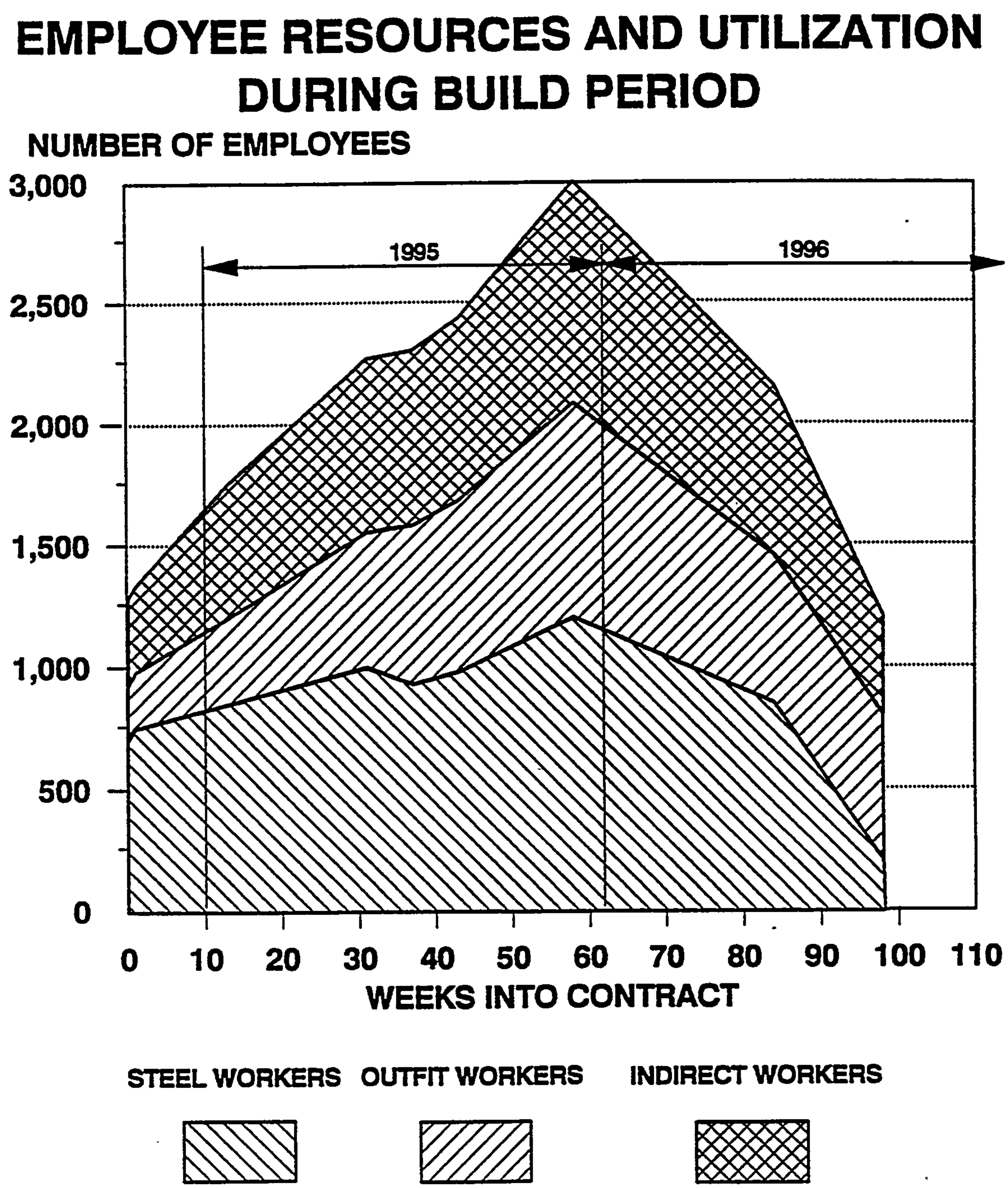
Figure C6.1 KEY EVENT PROGRAM

DRAWING No.:-GBSA 00/34 ORIG
ORIGINAL DRAWN 9-DEC-93/K.H.



C602

Figure C6.2



[GBSA105A 17-NOV-93]

The first ship will be erected on berth 1 in 115 blocks and panels in a period of 29 weeks. During this period 104other blocks will be lifted on to berth 2 for the third Product Tanker and the second Container/Ro-Ro. Therefore average weekly number of blocks to berth is 7.6. In addition there will be large items of machinery and outfit units being installed during this period.

C6.1.3 Changes to Shipbuilding Policy

The company has made a major change in the ships it is intending to build. The emphasis in the future will be to build merchant ships of up to 50,000 tonne deadweight. Types of merchant ships which will be best suited to the facilities will be product tankers, bulk carriers and container ships, with general cargo ships and ro-ro ships as the next best options.

A new Shipbuilding Policy has been developed to cover the above situation, and new facilities installed to enable ships in the targeted product mix to be built efficiently.

The Container/Ro-Ro ships therefore do not require any changes to be made to the new Shipbuilding Policy.

C6.2 Work Breakdown

C6.2.1 Work Breakdown Structure

Tables C6.1 and C6.2 list the work breakdown for the structure of the ship.

Table C6.1 shows the number of structural piece parts for the ship and their average sizes, divided up as follows:

> Skin Plates. These are plates for the shell, compartment boundaries, or plates for which other parts, such as brackets, are nested from.
>
> They are distinguished by the fact that the final product of these plates do not have any notches, manholes: or other cut-outs in them.
>
> Skin plates are subdivided into flat, formed and nesting plates.

TABLE C6.1

STRUCTURAL PIECE PARTS FOR THE SHIP

LOCATION	PLATES FOR SHELL OR COMPARTMENT BOUNDARIES, OR NESTING PLATES						NWT FLOORS, NWT GIRDERS, WEBS, ETC.		O.B.F's, TEE BARS, ANGLE BARS, ETC.				FACE FLATS, MINOR STIFFENERS TO FLOORS, GIRDERS AND WEBS.			
	SKIN PLATES						FLAT PLATES WITH CONTOURS		PROFILES				FLAT BARS			
	FLAT		FORMED		NESTING				STRAIGHT		FORMED		STRAIGHT		FORMED	
	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.	No.	AVE. DIM.
HOLD MATERIAL	652	11.06 x 2.29	153	11.4 x 2.39	127	9.57 x 2.26	284	9.99 x 2.01	1256	10.732 x 0.28	50	11.40 x 0.31	855	9.56 x 0.143	48	13.167 x 0.15
FORE END BLOCKS	37	8.11 x 2.42	28	9.46 x 2.31	11	6.6 x 1.94	22	7.20 x 2.15	39	12.20 x 0.29	61	10.66 x 0.300	32	7.05 x 0.24	-	-
E.R. BLOCKS	119	7.65 x 2.58	22	9.4 x 2.50	27	10.45 x 2.32	63	11.52 x 2.00	609	7.40 x 0.30	132	11.90 x 0.30	227	11.16 x 0.141	58	11.90 x 0.15
AFT END BLOCKS	109	9.70 x 2.49	72	6.58 x 2.63	13	8.17 x 1.60	154	6.8 x 1.80	178	9.91 x 0.275	9	10.50 x 0.30	246	8.86 x 0.148	-	-
FLUSH HULL	917	10.33 x 2.36	275	9.78 x 2.46	178	9.42 x 2.21	523	9.71 x 1.96	2082	9.72 x 0.29	252	11.45 x 0.31	1360	9.65 x 0.147	92	12.56 x 0.15
SUPERSTRUCTURES & DECKHOUSES	313	10.40 x 2.60	-	-	45	7.70 x 1.82	-	-	797	9.5 x 0.265	-	-	148	10.70 x 0.13	-	-
TOTAL SHIP	1230	10.35 x 2.42	275	9.78 x 2.46	223	9.07 x 2.13	523	9.71 x 1.96	2879	9.66 x 0.28	252	11.45 x 0.31	1508	9.75 x 0.145	92	12.56 x 0.15

[GBSA103A 16-NOV-93]

TABLE C6.2

PANELS & BLOCKS FOR THE SHIP

LOCATION	FLAT PANELS: WITH STIFFS. ONLY No.	FLAT PANELS: WITH STIFFS. ONLY AVE. DIM.	FLAT PANELS: WITH STIFFS. & SUBASSEMBLIES No.	FLAT PANELS: WITH STIFFS. & SUBASSEMBLIES AVE. DIM.	FORMED PANELS: WITH STIFFS. ONLY No.	FORMED PANELS: WITH STIFFS. ONLY AVE. DIM.	FORMED PANELS: WITH STIFFS. & SUBASSEMBLIES No.	FORMED PANELS: WITH STIFFS. & SUBASSEMBLIES AVE. DIM.	SANDWICH BLOCKS No.	SANDWICH BLOCKS AVE. DIM.	3 - D BLOCKS No.	3 - D BLOCKS AVE. DIM.
STERN BLOCKS	-	-	15	11.62 x 9.13	6	12.00 x 10.13	-	-	-	-	7	12.14 x 13.17 x 8.29
E.R. BLOCKS	-	-	35	10.44 x 5.42	-	-	12	16.50 x 6.5	2	16.50 x 17.25 x 1.75	16	17.248 x 6.138 x 5.150
CARGO HOLD BLOCKS	27	11.40 x 9.46	66	11.40 x 5.27	22	11.40 x 7.77	12	11.40 x 14.50	11	11.40 x 10.59 x 1.75	16	11.40 x 9.49 x 4.72
FORE END BLOCKS	-	-	10	8.40 x 5.2	8	9.45 x 6.62	8	9.45 x 6.62	-	-	4	9.20 x 8.25 x 8.55
TRANSVERSE BULKHEAD	-	-	15	18.00 x 10.73	-	-	-	-	-	-	6	18.00 x 10.73 x 4.75
FLUSH HULL	27	11.40 x 9.46	131	11.19 x 5.96	36	11.07 x 7.91	32	12.83 x 9.53	13	12.18 x 11.61 x 1.75	49	13.71 x 10.47 x 5.51
DECKHOUSES	-	-	48	14.10 x 8.25	-	-	-	-	-	-	15	14.80 x 10.58 x 5.50
TOTAL SHIP	27	11.40 x 9.46	179	11.97 x 6.57	36	11.07 x 7.91	32	12.83 x 9.53	13	12.18 x 11.61 x 1.75	64	13.97 x 10.50 x 5.68
TO BERTH	-	-	25	13.60 x 8.25	-	-	12	16.25 x 11.40	13	12.18 x 11.61 x 1.75	64	13.97 x 10.50 x 5.68
MAXIMUM SIZE		11.40 x 10.15	PANEL LINE BLOCK SHOP	11.40 x 11.60 22.00 x 10.00		11.40 x 10.15		16.25 x 11.40		16.50 x 26.30 x 1.75		22.00 x 10.00 x 7.50

[GBSA104A 18-NOV-93]

Flat Plates with Contours. These are non-watertight floors, girders or webs, and have notches and/or manholes, or other cut-outs in them.

Profiles. These are the standard shipbuilding profiles (offset bulb flats, angles, tee bars, etc!) and are subdivided into straight and formed.

Flat Bars. These are face flats, and minor stiffeners to floors, girders or webs.

Table C6.2 shows the number of panels and blocks for the ship and their average sizes, divided up as follows:

Flat Panels. These are further subdivided into those which only have stiffeners attached and those which have both stiffeners and subassemblies attached.

Formed Panels. These are both curved shell panels and the corrugated panels of the transverse cargo tank bulkheads. Again, they are divided into those which have only stiffeners attached and those which have both stiffeners and subassemblies attached.

Sandwich Blocks. These are blocks formed from at least one flat panel with only stiffeners attached plus either a flat or formed panel with stiffeners and subassemblies attached.

3D Blocks. These are blocks which have significant dimensions in all three planes, longitudinal, transverse and vertical. In the ship they all occur clear of the cargo tank region.

Also shown in Table C6.2 are the number of panels and blocks which are actually erected on the building berth with their average size.

Finally, the maximum sizes of the panels and blocks are shown.

The maximum dimensions and weights of parts and interim products are shown in Table C6.3.

C6.2.2 Coding

The coding to be used for this ship is shown in the Coding Manual, Document No FLO036, Rev D, July 1976.

Table C6.3

MAXIMUM DIMENSIONS AND WEIGHTS OF PARTS AND IHTERIM PRODUCTS

Maximum Weights and Dimensions

Maximum Plate Dimensions	:	11.40mx 2.693m
Maximum Plate Weight	:	4.10 tonne
Maximum Profile Dimensions	:	11.40m x 0.30mx 11.00mm
Maximum Profile Weight	:	0.45 tonne
Maximum Subassembly	:	2.89 tonne
Maximum Panel Weight Panel Line	:	39.02 tonne
Maximum Panel Weight Block Shop	:	57.72 tonne
Maximum Sandwich Block Weight	:	58.83 tonne
Maximum 3D Block Weight	:	156.80 tonne

C6.3 List of Planning Units

C6.3.1 Hull Panels and Blocks

Table C6.4 lists the hull panels and blocks which are planning units and which are erected on the building berth. They are shown in Figure C6.3.

C6.3.2 Zones

Table C6.5 lists the onboard zones for outfitting purposes. Figure C6.4 shows the locations of the zones.

The onboard zones will be used as a basis for the management and control of all onboard outfit installation work.

Table C6.4

HULL PANELS AND BLOCKS (PLANNING UNITS)

Location	No	Identity
Lower Stern Block	1	B1
Upper Stern Block, Forward	3	B2(p), B2(c) & B2(s)
Upper Stern Block, Aft	3	B3(p), B3(c) & B3(s)
Engine Room Double Bottom Blocks	2	A1 & A2
Lower Engine Room Blocks	4	A3(p), A3(s), A4(p), & A4(s)
Mid Engine Room Blocks	6	A5(p), A5(c), A5(s) A6(p), A6(c), A6(s)
Upper Engine Room Blocks	6	A7(p), A7(c), A7(s) A8(p), A8(c), A8(s)
Cargo Hold Double Bottom Centre Blocks	11	C1 to C11
Cargo Tank Double Bottom Side Blocks	16	F1(p) to F8(p) F1(s) to F8(s)
Cargo Tank Side Blocks	22	K1(p) to K11(p) K1(s) to K11(s)
Transverse Bulkhead Panels	3	D4(p), D5(c) & D6(s)
Fuel Tanks between Holds	6	D2(p), D2(c) & D2(s) D6(p), D6(c) & D6(s)
Box Beams between Hatched	12	D1(p), D1(c) & D1(s) D3(p), D3(c) & D3(s) D5(p), D5(c) & D5(s) D7(p), D7(c) & D7(s)
Lower Fore End Block, Aft	1	T1
Upper Fore End Block, Aft	1	T2
Bulb Block	1	T3
Stern Block	1	T4
Superstructure Blocks	12	R1(p), R1(c) & R1(s) R2(p), R2(c) & R2(s) R3(p), R3(c) & R3(s) R4(p), R4(c) & R4(s) R5(p) & R5(s)
Deckhouse Blocks	3	R6(O), R6(s), R8
Casing and Funnel Block	1	R7
Total Panels and Blocks (Planning Units)	115	

Table C6.5

ONBOARD ZONES

Location	Number	Identity
"Stern	4	S1 to S4
Machinery Space	8	M1 to M8
Cargo Hold Region	6	C1 to C6
Bow	4	B1 to B4
Superstructure	1	C7
Upper Deck	5	D1 to D5
Accommodation	6	A1 to A6
Total Onboard Zones	34	

C6.3.3 Equipment Units

Assembly of the engine room equipment units (including banks of pipes) will take place in the Equipment Unit Assembly Shop. Assembly of outfit units is scheduled so as to allow as much of the machinery space outfitting as possible to take place in parallel with the machinery space steelwork.

Table C6.6 shows a list of the equipment units which will be produced for this ship.

C6.3.4 Systems

None of the systems on this ship are considered to be planning units as they are all distributed over more than one planning unit. The work performed on systems is that taken into account in the relevant planning units over which the system is distributed.

Table C6.6

LIST OF EOUIPMENT UNITS

Equiument Unit	Identity	Location
Lub Oil Pumps/Strainers	EU1	ER Floor Plate (p)
Fuel Oil Pumps	EU2	" (P)
Sea Water Pumps	EU2	" (S)
Fuel Oil Boosters/Heaters	EU3	" (P)
Fire Bilge & Ballast	EU4	" (P)
Auxiliary Boiler Pumps	EU5	" (S)
HFO Feed Pump	EU6	" (S)
Sludge/Diesel Transfer	EU7	" (P)
FW Circulating Pumps	EU8	" (P)
Bilge/Ballast/Heeling	EU9	" (S)
Oily Bilge Pump/Separator	EU10	" (P)
Evaporator Pumps	EU11	" (S)
Bilge & Bilge Well Pumps	EU12	" (P)
FO Purifiers & Heaters	EU13	(C)
LO Purifiers & Heaters	EU14	6.0 m Flat (P)
Jacket Water Pumps/Heater/Cooler	EU16	" (S)
Desalination Plant	EU17	" (S)
FW/LO Coolers	EU18	" (S)
Generator Booster Pumps/Heaters	EU19	" (P)
Sewage Pump/Tank	EU20	" (S)
Electric Generators	EU21	" (C)
Switchboard	EU22	10.0 m Flat (P)
Control Console	EU23	" (P)
A/C Plants	EU24	" (P)
Refrig Plants	EU25	" (P)
Auxiliary Boiler	EU26	" (S)
Boiler Pumps/Heaters	EU27	" (S)
Air Compressors/Receivers	**EU28**	" **(P)**
Main Engine Air Receivers	EU29	" (P)
Silencers	EU30	Casing
Supply Vents	EU31	"
Exhaust Gas Boiler	EU32	"
Vent Fans	EU33	"

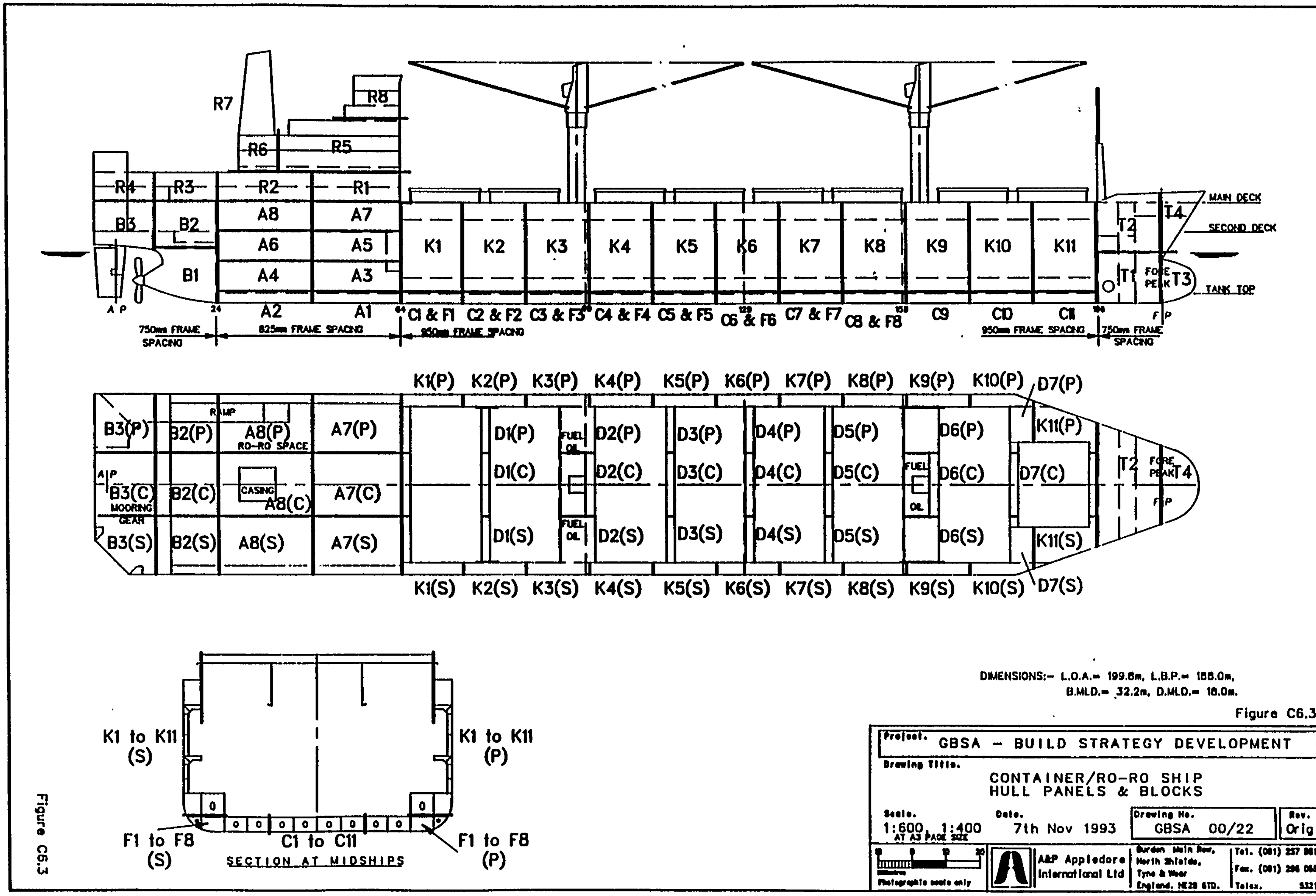
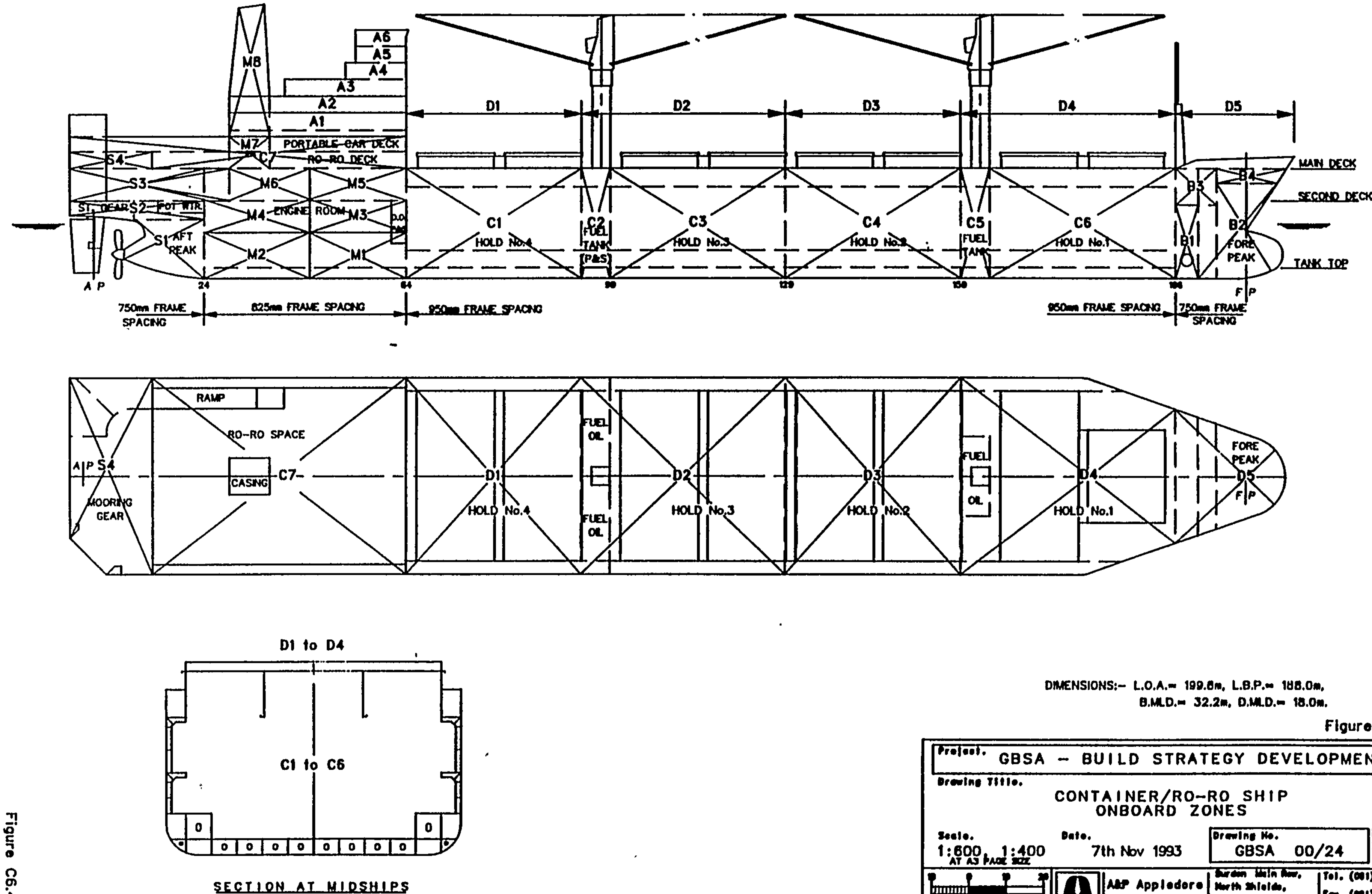


Figure C6.3

C612



DIMENSIONS:– L.O.A.= 199.6m, L.B.P.= 188.0m,
B.MLD.= 32.2m, D.MLD.= 18.0m.

Figure C6.4

Project.	GBSA – BUILD STRATEGY DEVELOPMENT
Drawing Title.	CONTAINER/RO-RO SHIP ONBOARD ZONES
Scale.	1:600, 1:400 AT A3 PAGE SIZE
Date.	7th Nov 1993
Drawing No.	GBSA 00/24
Rev.	Orig

Photographic scale only

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Figure C6.4

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C6.4 Master Schedules

C6.4.1 Hull Blocks

Figure C6.5 shows the hull block erection sequence and schedule. The schedule has been used to determine when material-and equipment will be installed, when it should be delivered to the yard, when it should be ordered, and when the engineering information should be available.

C6.4.2 Zones

Table C6.7 shows when the onboard zones are available for open sky outfitting-and when they become closed off for final outfitting. These dates are also dictated by the hull erection schedule.

C6.4.3 Equipment Units

Table C6.8 shows the installation schedule for the equipment units listed in Table C6.6. It also shows whether the unit is installed on-block or onboard.

C6.4.4 Systems

As stated in C6.3.4 the systems on this ship are being installed on-block and/or within zones. However the completed systems will require to be tested. See later, Chapter 8 for Tests and Trials.

Figure C6.5 HULL BLOCK ERECTION SEQUENCE & SCHEDULE

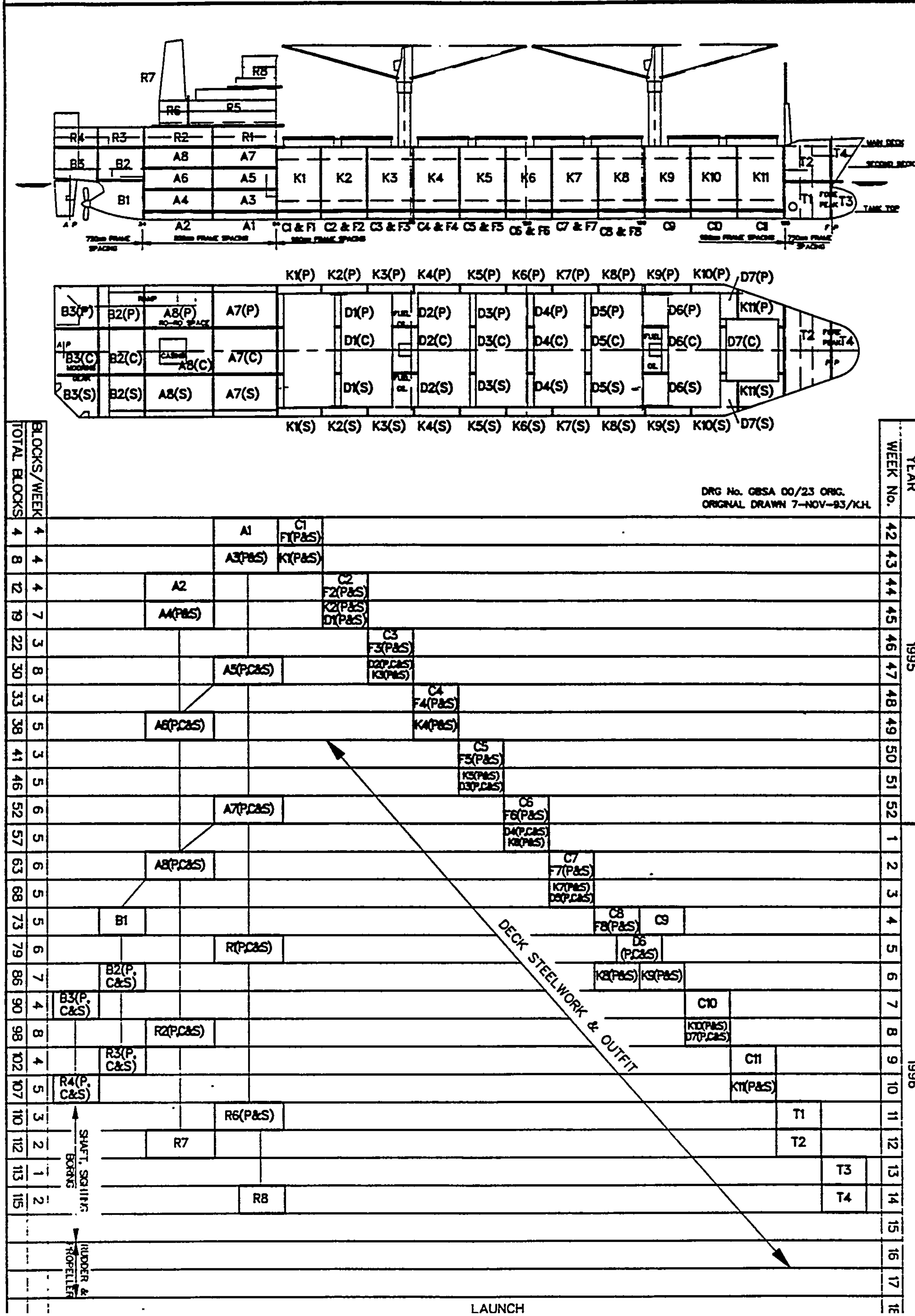

Table C6.7

AVAILABILITY OF ONBOARD ZONES

Zone	Location	Availability Week No 1995 Open Sky	Closed Off
M1	Lower ER Forward	43	47
M2	Lower ER Aft	45	49
M3	Mid ER Forward	47	52
M4	Mid ER Aft	49	2
M5	Upper ER Forward	52	5
M6	Upper ER Aft	2	8
M7	Casing in Superstructure	8	12
M8	Casing and Funnel	-	12
C1	No 4 Hold	43	47
C2	Fuel Oil Tanks P&S	-	47
C3	No 3 Hold	48	1
C4	No 2 Hold	52	6
C5	Fuel Oil Tank	-	5
C6	No 1 Hold	4	10
S1	Aft Peak Tank	-	4
S2	Steering Gear/Potable Water Tank	-	7
S3	Aft Ro-Ro Space	-	7
S4	Mooring Space	-	10
C7	Superstructure Ro-Ro Space	7	10
A1	Lowest Accommodation Deck	-	11
A2	2nd Lowest Accommodation Deck	-	11
A3	3rd Lowest Accommodation Deck	-	11
A4	4th Lowest Accommodation Deck	-	14
A5	5th Lowest Accommodation Deck	-	14
A6	6 Navigating Bridge	-	14
D1	Upper Deck iwo No 4 Hold	44	-
D2	Upper Deck iwo No 3 Hold	50	-
D3	Upper Deck iwo No 2 Hold	3	-
D4	Upper Deck iwo No 1 Hold	7	-
D5	Forward End of Upper Deck	13	-

Table C6.8

INSTALLATION SCHEDULE FOR EQUIPMENT UNITS

	Equipment Unit	Installed Week No 1995/1996 On-Block	Installed Week No 1995/1996 Onboard	Zone or Block No
EU1	Lub Oil Pumps/Strainers	-	44	M1
EU2	Fuel Oil Pumps	42	-	A1
EU3	Sea Water Pumps	-	44	M1
EU4	Fuel Oil Boosters/Heaters	-	45	M1
EU5	Fire Bilge and Ballast	-	45	M1
EU6	Auxiliary Boiler Pumps	-	46	M1
EU7	HFO Feed Pumps	-	46	M1
EU8	Sludge/Diesel Transfer	-	46	M2
EU9	FW Circulating Pumps	-	47	M2
EU10	Bilge/Ballast/Heating	-	47	M2
EU11	Oily Bilge Pump/Separator	-	47	M2
EU12	Evaporator Pumps	-	48	M2
EU13	Bilge and Bilge Wall Pumps	-	48	M2
EU14	FO Purifiers and Heaters	48	-	A5 (p)
EU15	LO Purifiers and Heaters	48	-	A5 (p)
EU16	Jacket Water Pumps/Heater/Cooler	49	-	A5 (s)
EU17	Desalination Plant	49	-	A5 (s)
EU18	FW/LO Coolers	50	-	A5 (s)
EU19	Generator Booster Pumps/Heaters	50	-	A5 (p)
EU20	Sewage Pump/Tank	52	-	A6 (s)
EU21	Electric Generators	-	1	M4
EU22	Switchboard	-	3	M5
EU23	Control Console	-	4	M5
EU24	A/C Plants	-	3	M6
EU25	Refrig Plants	-	4	M6
EU26	Auxiliary Boiler	-	5	M6
EU27	Boiler Pumps/Heaters	-	6	M6
EU28	Air Compressors/Receivers	-	7	M6
EU29	Main Engine Air Receivers	-	7	M6
EU30	Silencers	-	10	R7
EU31	Supply Vents	12	-	R7
EU32	Exhaust Gas Boiler	12	-	R7
EU33	Vent Fans	12	-	R7

C6.5 Hull Production Strategy

C6.5.1 Preliminary Process Analysis

Figures C6.6. C6.7 and C6.8 show the Preliminary Process analyses of a Flat uanell a sandwich block and a 3D block. The method of building-up the panels and blocks from the piece parts and interim products is clearly shown.

Figures C6.9, C6.1O and C6.11 show when and how the outfit items are to be integrated with the structure of the panels and blocks shown in Figures C6.6, C6.7 and C6.8.

C6.5.2 Non-Standard Interim Products

All interim products used to construct this ship are standard ones which are defined in the company Shipbuilding Policy.

C6.5.3 Build Location and Launch Condition

The first ship is to be constructed on berth number 1, beginning after the launch of the second of the product tankers currently being built. The second ship will be constructed on berth number 2, after the launch of the third product tanker.

When the ship is launched all major steelwork will be complete, the main engine and all machinery space equipment units will be in place, all other equipment units will be installed, the accommodation deckhouse will be in situ, all hotwork and paintwork in the cargo holds and water ballast tanks will be complete. Elsewhere the paintwork will be complete apart from erection joints and where hotwork will occur.

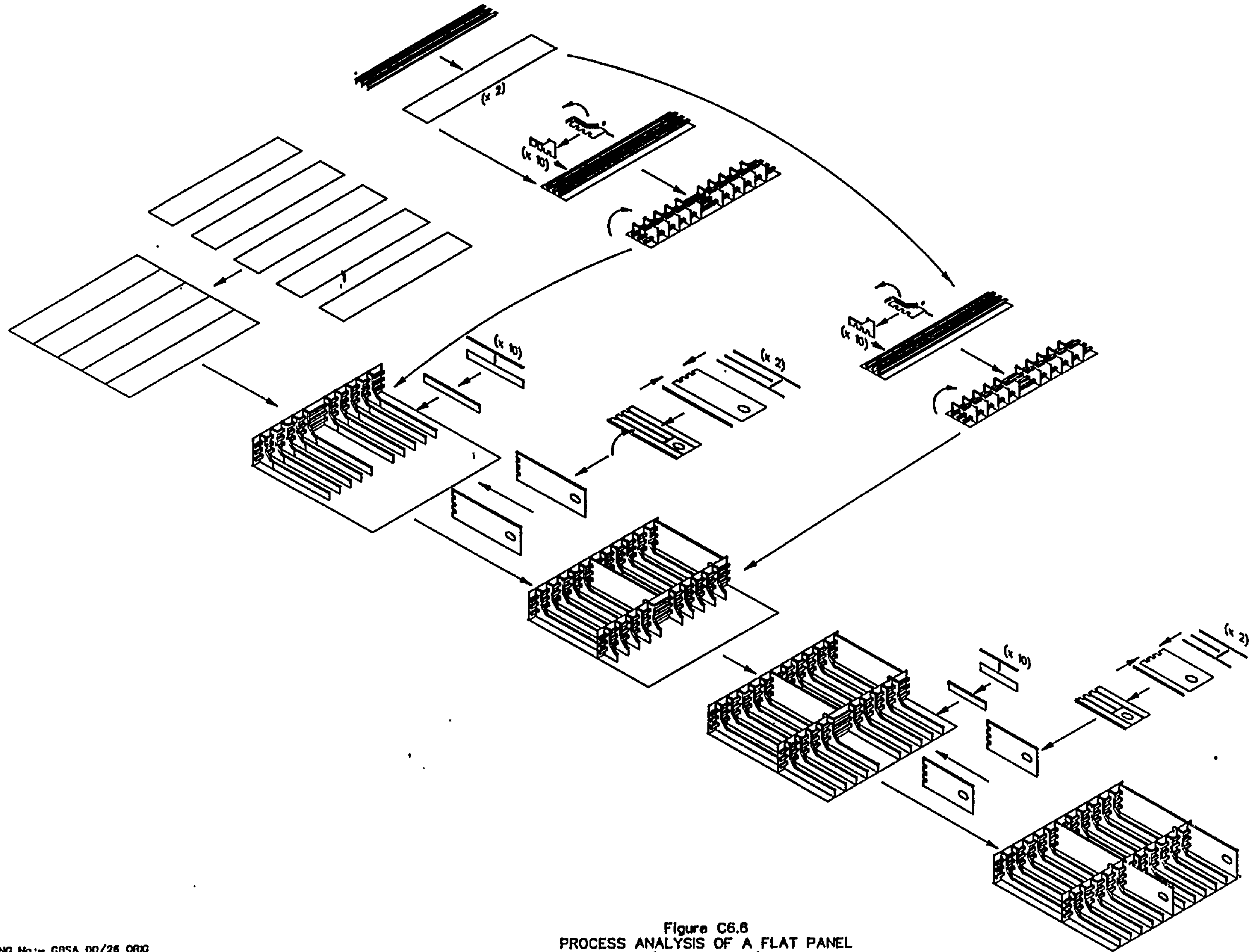

Figure C6.6
PROCESS ANALYSIS OF A FLAT PANEL
(SHELL PANEL)

DRAWING No.:- GBSA 00/26 ORIG
ORIGINAL DRAWN 3-DEC-93/K.H.

DRAWING No.:- CBSA 00/27 ORIG
ORIGINAL DRAWN 30-NOV-93/K.H.

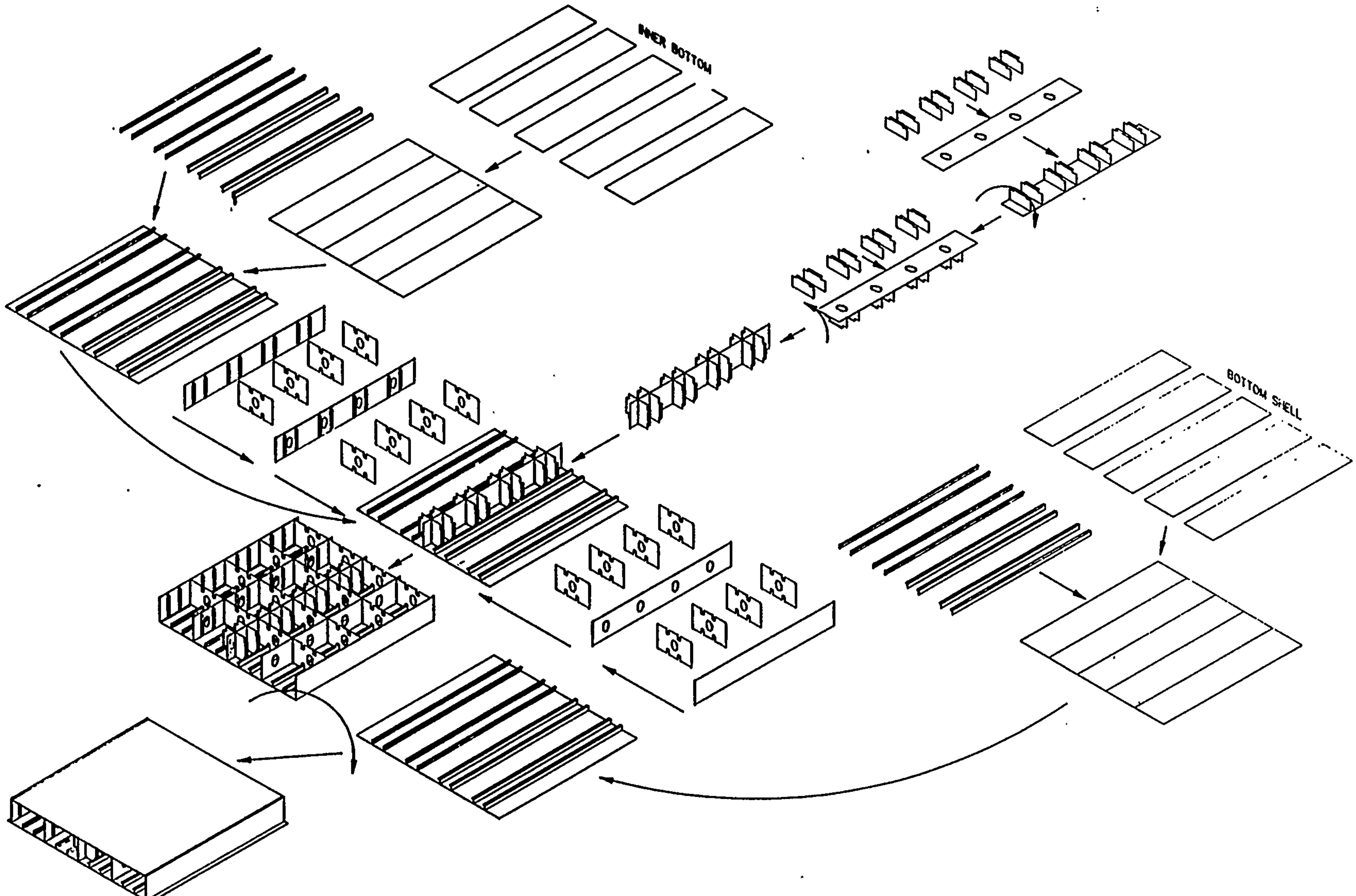

Figure C6.7
PROCESS ANALYSIS OF A SANDWICH BLO
(DOUBLE BOTTOM C BLOCKS)

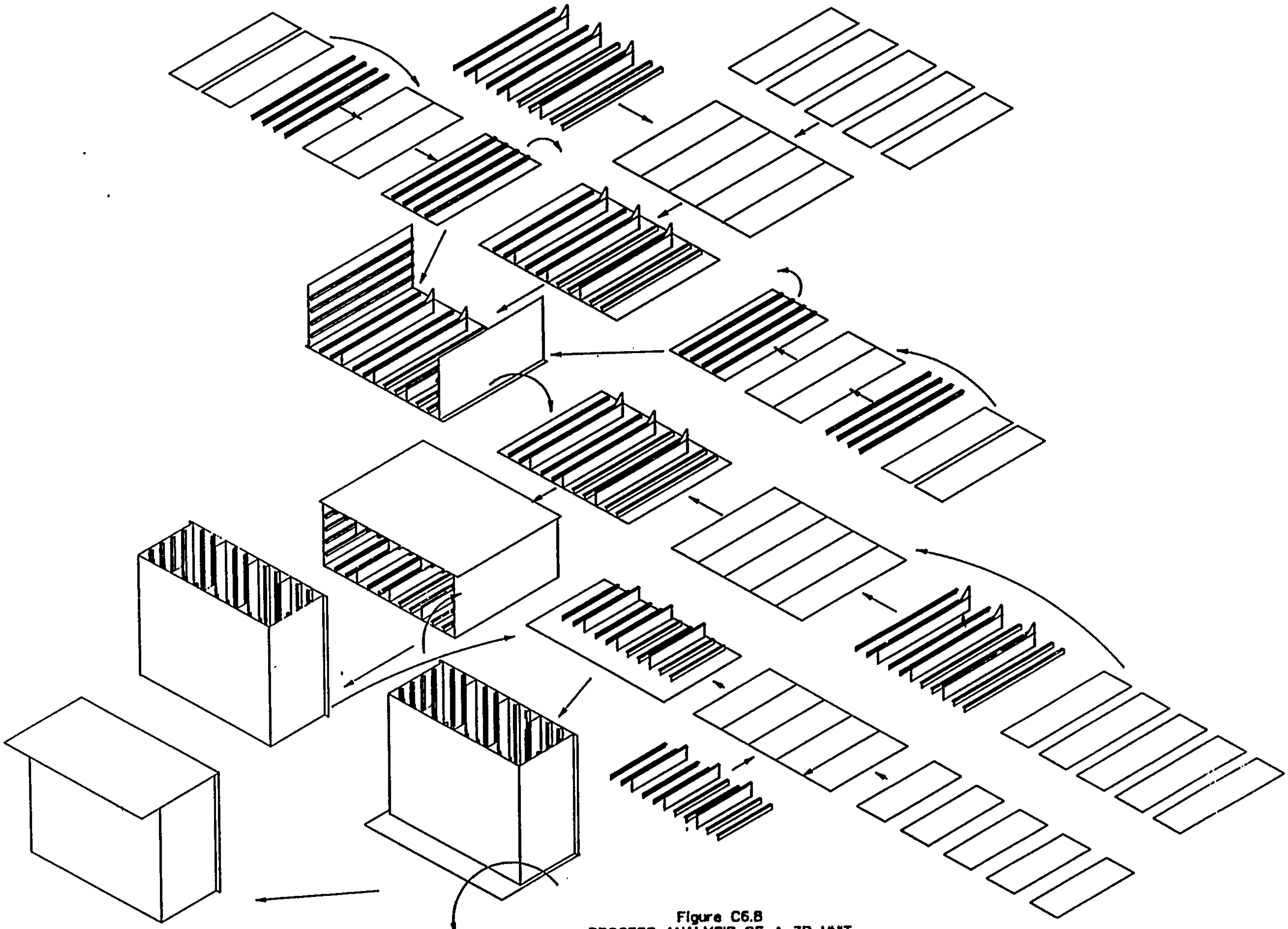

Figure C6.8
PROCESS ANALYSIS OF A 3D UNIT
(FORWARD OIL TANK)

DRAWING No.:- GBSA 00/28 ORIG
ORIGINAL DRAWN 8-DEC-93/K.H.

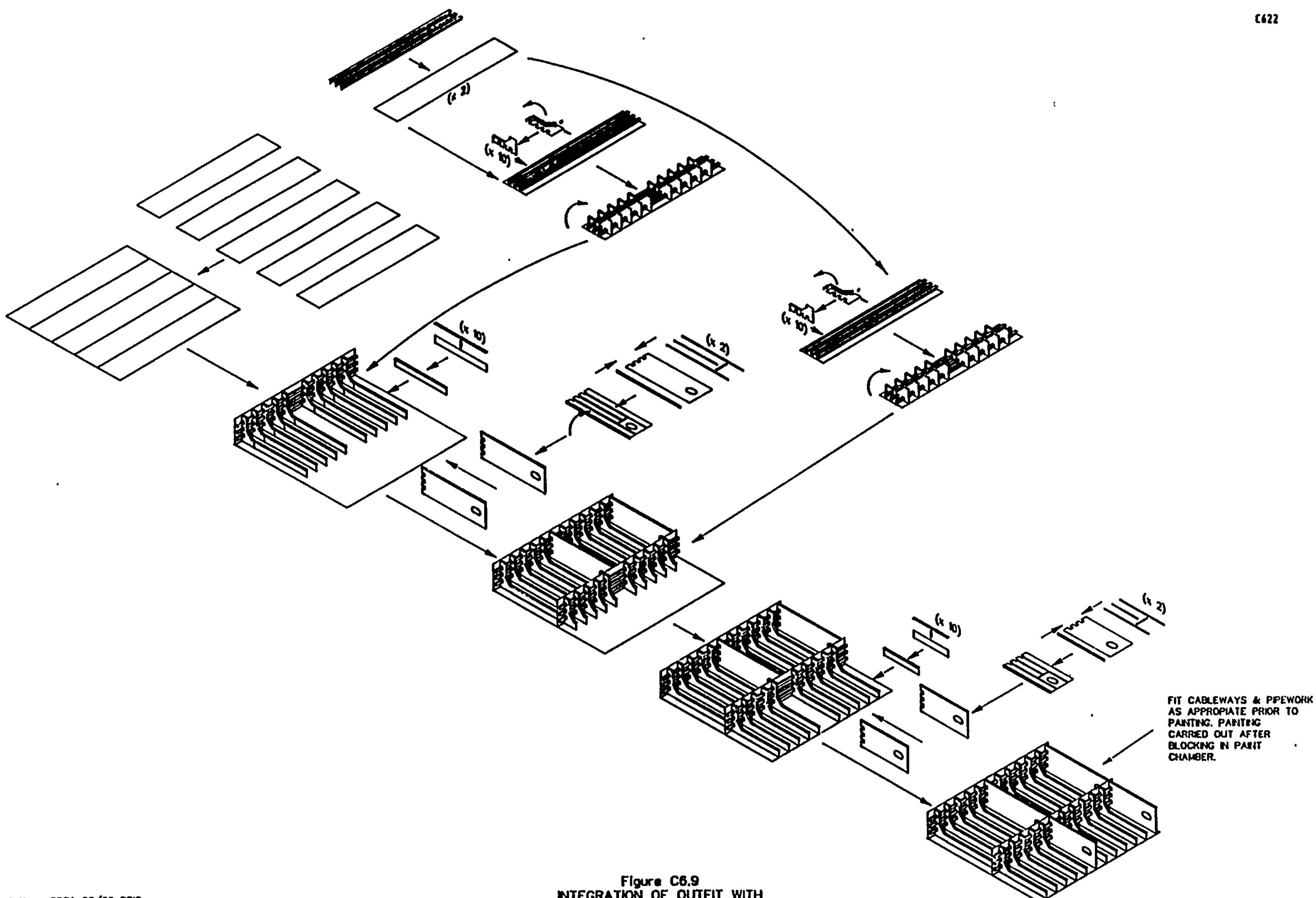

Figure C6.9
INTEGRATION OF OUTFIT WITH
A FLAT PANEL

DRAWING No.:- GBSA 00/29 ORIG
ORIGINAL DRAWN 9-DEC-93/K.H.

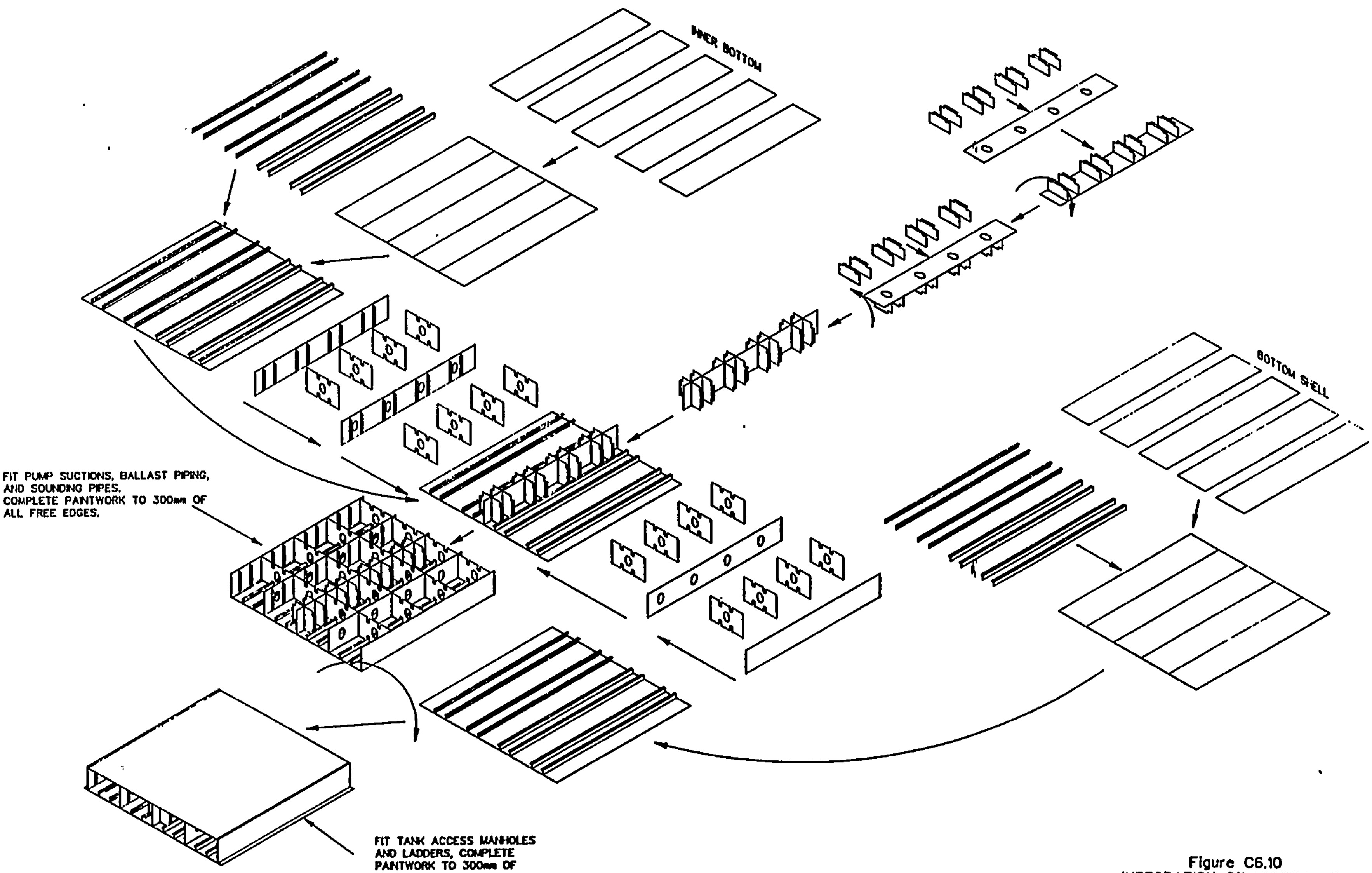

Figure C6.10
INTEGRATION OF OUTFIT WITH SANDWICH BLOCKS

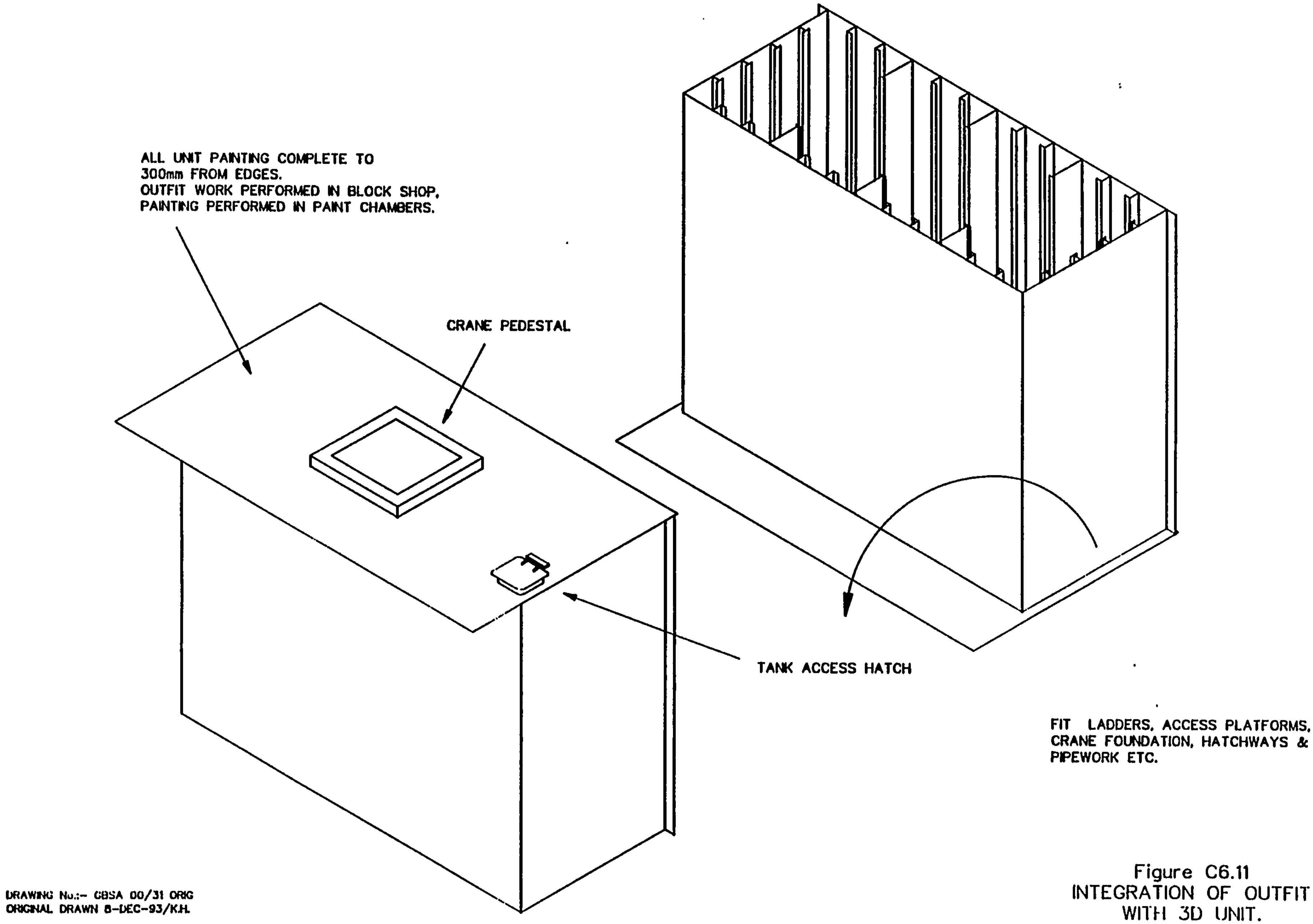

Figure C6.11
INTEGRATION OF OUTFIT
WITH 3D UNIT.

C6.6 Machinery Space Outfit Strategy

As much equipment and pipework as is practically possible will be assembled into equipment units inclusive of steel support structure, pipework, minor electrical equipment and ventilation trunking, pipe unit assemblies inclusive of support structure, and pipe assemblies.

All equipment and pipe units will be painted before installation onboard ship.

To ensure that space is available for installing the units, the main engine will be the last piece of major equipment to be installed.

C6.6.1 Equipment Units

Outfit units have been identified and are shown in Table C6.6. They will be assembled in a shop workstation instead of onboard ship. The assembly work package will-incorporate the steel, support foundations and support bases, equipment, small tanks, pipes, fittings, electric cable, painting and testing before installation "on block" or "on board". Atypical assembly process is shown in Figure C6.12.

C6.6.2 On Block Outfitting

On block outfitting will be divided into two stages. The first stage of block outfitting will consist of completing all minor steel "hot work" such as manholes, penetrations, equipment foundations, ladders, pipe and electrical systems, hangers and equipment units appropriate to each block. A typical on block outfitting process is shown in Figure C6.13.

The second stage will include the fitting of "cold work" such as pipework, cable ladders, cable trays, HVAC systems and steel doors as may be appropriate.

C6.6.3 On Board Outfitting

On board outfitting involves installing equipment units, individual pieces of equipment and individual manufactured parts such as p pipes, HVAC trunking, cable trays and insulation lagging. The instal" ation of on board outfitting will be work packaged and schedule in accordance with the zone "close out" schedule. A typical on board outfit process is shown in Figure C6.14.

Figure C6.12 | EQUIPMENT UNIT No. EU1 | PROCESS ANALYSIS EQUIPMENT UNIT ASSEMBLY PROCESS | DRAWING No.:-GBSA 00/40 ORIG ORIGINAL DRAWN 18-JAN-94/K.H.

ACTIVITY	STAGE 1	2	3	4	5	6	7	8
STEEL FRAME ASSEMBLY COMPLETE	EU 1							
INSTALL MECHANICAL EQUIPMENT		111 112 113						
HVAC			H12 H13 H14					
INSTALL ELECTRIC EQUIPMENT				E01 E02 E03 E04				
PIPE WORK					SYS21 SYS22 SYS23			
WIREWAYS						W10 W11 W12 W13		
ELECTRIC CABLE							C33 C34 C35 C36	
PAINT								P21 P22 P23 P24
UNIT COMPLETE								

Figure C6.13 | STEEL BLOCK No. ER 3 | PROCESS ANALYSIS ON BLOCK OUTFIT PROCESS | DRAWING No.:–GBSA 00/41 ORIG ORIGINAL DRAWN 18–JAN–94/K.H.

ACTIVITY	STAGE 1	2	3	4	5	6	7	8
STEEL BLOCK ASSEMBLY COMPLETE	ER 3							
FIT PENETRATIONS FIT LADDERS		P001 L001						
FIT EQUIPMENT FOUNDATIONS			EF10 EF11					
FIT HANGERS FOR:– PIPES WIREWAYS HVAC				P W HVAC				
FIT EQUIPMENT FIT HVAC					E HVAC			
FIT PIPES FIT WIREWAYS						P W		
FIT ELECTRIC CABLE							EC	
PAINT				P01 P02 P03				P04 P05 P06
BLOCK COMPLETE								

Figure C6.14	ONBOARD ZONE No. ZE 4	PROCESS ANALYSIS ON BOARD OUTFIT PROCESS	DRAWING No.:—GBSA 00/42 ORIG ORIGINAL DRAWN 18-JAN-94/K.H.

ACTIVITY	STAGE 1	2	3	4	5	6	7	8
STRUCTURAL STEELWORK COMPLETE ZONE ZE4 AVAILABLE								
EQUIPMENT UNITS		EU1 EU2 EU3						
VENT TRUNKS			V10 V11 V12					
PIPE SYSTEMS				P21 P22 P23				
WIRE WAYS					WW31 WW32 WW33			
ELECTRICAL CABLE						EC41 EC42 EC43		
JOINERY WORK							JW51 JW52 JW53	
PAINT				P11 P12 P13				P14 P15 P16
ZONE COMPLETE								

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C6.7 Accommodation Outfit Strategy

At the time of lifting to the ship, the accommodation will be completely outfitted except for the following:

- navigation equipment, and
- soft furnishings.

This is achieved by having a cofferdam between the bottom tier of the accommodation block and the ship's deck to which the accommodation is to be fitted. The cofferdam will also serve as a space for passing or connecting services between the accommodation and engine room.

C6.8 Cargo Space and Other Space Outfit Strategy

Before steel blocks are lifted to the building berth all "hot work" should be completed. This will include the cutting of all manholes, access openings, and penetrations for pipe, cable and HVAC systems. All brackets and foundations for equipment must be fitted and welded together with hangers for pipe, cable and HVAC systems. As much "cold Work" will be fitted wherever possible and should include pipework, cable trays/ladders, ventilation trunking and equipment.

C6.8.1 On Block Outfitting

On block outfitting will be divided into two stages. Stage 1 will include the completion of all minor steel "hot work" such as manholes, penetrations, minor equipment foundations, ladders, pipe hangers, electrical cable tray hangers and ventilation system hangers. Stage 2 will include the installation of individual items of equipment together with manufactured parts such as loose tanks, steel doors, windows, pipe systems, electric systems, HVAC systems, etc. A typical process analysis is shown in Figure C6.15.

C6.8.2 On Board Outfitting

On board outfitting will consist of connecting up the systems, previously installed on block, at the block joints after the joints have been joined, welded and tested together with the pulling and connecting of electric cable. The on board installation work will be packaged and scheduled in accordance with the zone close out programme. A typical process analysis is shown on Figure C6.16.

Figure C6.15	STEEL BLOCK No. C10	PROCESS ANALYSIS ON BLOCK OUTFIT PROCESS	DRAWING No.:-GBSA 00/43 ORIG ORIGINAL DRAWN 18-JAN-94/K.H.

ACTIVITY	STAGE 1	2	3	4	5	6	7	8
STEEL BLOCK ASSEMBLY COMPLETE	C10							
OUTFIT STEEL		S11 S12 S13 S14						
PIPE SYSTEMS			P31 P32 P33					
WIRE WAYS				WW14 WW15 WW16				
ELECTRICAL CABLE					EC10 EC11 EC12			
HVAC SYSTEMS						H01 H02 H03		
PAINT				P03 P04 P05				P06 P07 P08
OUTFITTING COMPLETE								

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Figure C6.16	ONBOARD ZONE No. ZC 120	PROCESS ANALYSIS	DRAWING No.:-GBSA 00/44 ORIG ORIGINAL DRAWN 16-JAN-94/K.H.

ACTIVITY	STAGE 1	2	3	4	5	6	7	8
STRUCTURAL STEELWORK COMPLETE ZONE ZC 120 AVAILABLE	ZC 120							
EQUIPMENT		EQ10 EQ11 EQ12						
HVAC SYSTEMS			H31 H32 H33					
PIPE SYSTEMS				SY11 SY12 SY13				
ELECTRICAL CABLE					C20 C21 C22			
JOINERY WORK						JW31 JW32 JW33 JW34 JW35		
PAINT				P20 P21 P22			P23 P24	
ZONE COMPLETE								

C6.9 Painting Strategy

C6.9.1 Outline Paint Specification

All steel is to enter the preparation workshop via the treatment line where it is to be shotblasted to S1S Sa2.5 standard and coated with a zinc silicate shop primer.

The areas of the ship listed below are to have the paint systems shown applied:

Underwater, exterior shell	:	High solid tar free epoxy system with a long life anti-fouling system - 9,270 m2.
Topside, exterior shell, exterior decks	:	High solid epoxy system. Total three coats - 7,560 m^2.
Deckhouses and deck fittings	:	Chlorinated rubber system. Total three coats - 13,440 m2.
Cargo holds	:	Epoxy system, total two coats - 40,100 m2.
Water ballast tanks	:	Coal tar epoxy coating system. Total two coats - 20,200 m^2.
Fresh water tanks	:	High build pure epoxy system. total two coats - 1,600 m^2.
Steelwork behind linings, void spaces and cofferdams	:	High build bitumastic system. Total two coats - 8,100 m^2.

C6.9.2 Pre-Painting

All structure to be sweep blasted to SPSS-SS before having the final paint system applied.

C6.9.3 Primer Repair Strategy

Where the shop primer is damaged in a workshop, the damaged area should be disc-ground and wire brushed, then touched up with a stripe coat as soon as possible. On all occasions this should be performed before passing the work on to the subsequent workstation.

C6.9.4 Panel/Block Painting Strategy

All panels which go directly to the building berth, will be painted in the paint chambers to 3001mm of the edges which will be welded on the building berth.

The flat panels which have stiffeners and subassemblies added and form part of a sandwich block will be painted in the block assembly shop to 300mm of the edges which will be subsequently welded.

Complete sandwich blocks will have the remainder of their paintwork undertaken in a paint chamber to 300mm of the berth joints.

3D blocks will be painted in the paint chambers to 300mm of the edges-which will be welded at the building berths.

C6.9.5 Zone Painting Strategy

Zone painting will be completed after all structural joining and outfit installation work has been finished, both within the zone and on the other side of zone boundaries.

Bought-in items of equipment will arrive finish painted, with a protective cover over the paintwork. When placed on frameworks, to create outfit units, the framework will be finish painted to 300mm from the interface with the ship's structure.

The exterior shell and decks will receive their final coating in the dry dock, just prior to sea trials.

C6.9.6 Special Considerations

There are no special considerations for this vessel.

C6.10 Subcontract Requirements

C6.10.1 Bought-in Items

The following is a list of “supply and fit” subcontract items:

- Mechanical ventilation and air conditioning.
- Deck coverings.
- Acoustic, fire protection and thermal insulation.

The supplier not only provides the material for the above items but also the labour which is under his control. However the timing and manner of performing the work is under the control of the shipyard and the supplier will comply with the established schedules.

C6.10.2 Use of On-Site Subcontractors

The only other on-site subcontractors, apart form those associated with supply and fit items, will be those producing the design and engineering information. Their numbers and associated timescales are discussed in Chapter C4, paragraph C4.6.2 earlier.

C6.10.3 Industrial Relations Considerations

As the use of supply and fit subcontracts and subcontractors to produce design and engineering information is normal practice for the company, all existing agreements on their use will apply to this contract.

C6.11 Productivity Targets

The direct steelworker productivity for this ship has been set at 80 manhours/tonne nett steel. This is world average productivity for a ship of this type and size.

Another measure of productivity used for comparative purposes by the international comnunity is manhours/compensated gross ton (CGT). This vessel has a gross tonnage of 26,900 and an associated compensated gross tonnage factor of 0.795, giving a compensated gross tonnage of 26,900 x 0.795 = 21,385. The total employee manhours required to produce this ship is 1,428,000, therefore the manhours/ CGT = 66.8. This is about two-thirds of the world average but the good European yards are only using about 45 and the Japanese about 29 manhours/CGT.

The manhours per CGT is the same as for the recently completed product tanker but the target is to reduce these to at least the level of the good European yards

C6.12 Temporary Services

C6.12.1 Staging

To enable fairing and welding of unit joints and subsequent finishing off operations to take place it will be necessary to provide access ways to these areas.

Traditional shipbuilding techniques made it necessary to surround the ship completely with staging. The modern approach to ship construction has the potential to substantially reduce the amount of staging equipment required.

Consequently we will use a combination of modular staging systems, permanent built in systems, and hydraulic articulated booms (cherry pickers).

The modular systems are capable of rapid assembly and dismantling and will be used where access is limited. Permanent built in staging will apply to cargo holds of tankers where specified longitudinal stiffeners will be extended to form permanent galleries to be used for staging and access.

Cherry pickers will be used for fairing and welding of hull unit joints.

C6.12.2 Access and Escape Plan

In the event of an emergency where rapid access to confined spaces by rescue services or fast evacuation is necessary.

An access and escape plan will be prepared, -framed and sited at all major access points to the ship.

The engineering office will consider how the ship will be constructed and provide adequate access and work levels for men and equipment during the construction and subsequent maintenance of the ship.

C6.12~3 Power and Lighting

Services required for construction activities include:

- water;
- compressed air;
- oxygen;
- ccetylene gas;
- electricity.

Traditional practice was to connect each item of plant or tool to the nearest outlet manifold at the quay or dockside, which led to a mass of cables and pipes looped and criss-crossed to the various work areas.

Portable service outlet units will be used, which consist of a framework on to which the various pipes are attached. These units are quickly connected and positioned on board the ship and operators connect their equipment to the nearest outlet.

Electrical power will be initially fed from shore supply and cables are run from the main switchboard to sub-switchboards and distribution boards to which the equipment is connected. The sub-switchboards and distribution boards will be located throughout the ship, serving all areas as appropriate.

C7: ACCURACY CONTROL

In order to be competitive in the commnercial shipbuilding world, rework must be minimized. Accuracy Control (A/C) has been proven to be an effective way to reduce rework.

A/C is “the regulation of accuracy as a means for continuously improving design details and work methods so as to maximize productivity”.

A/C has both a short and a long term benefit. The short term benefit is that it will minimize delays and rework during erection of sructure and installation of equipment by monitoring and controlling the fabricaiton of interim products. The long term benefit is the implementation of a management system that develops a database of quantitative information that can be used to continuously improve productivity.

Although the shipyard has been utilizing A/C for naval ships over the past 10 years, the differences between naval and commercial ships is such that most of the data is not transferable. It will be necessary to develop from scratch the quantitative information from the commercial ships as they are being constructed.

However, the shipyard has the experience and knows how to plan? execute and evaluate A/C. The shipyard will implement its proven A/C procedure by modifying it to suit the requirements of the commercial `shipbuilding.

C7.1 System Critical Dimensions and Tolerances

For steelwork the key system dimensions are the-finished overall dimensions of assemblies and blocks as well as alignment of internal joinint structural members.

For outfit the key dimensions all relate to installation interfaces.

These must be defined with suitable tolerances that would ensure the required performance of the vessel in terms of:

cargo carrying capacity;
speed;
draft/beam restrictions;
etc.

These will be controlled and monitored by use of appropriate control chart techniques and capability studies as described in the shipyard's A/C Procedure for Commercial Ships, issued December 1

C7.2 Interim Product Critical Dimensions and Tolerances

They can be divided into two categories:

Principal dimensions and tolerances.
Local dimensions and tolerances.

A principal dimension/tolerance for an interim product is one which will directly affect the ability to meet system critical dimensions/ tolerances. For example, that may be the overall dimensions of a steelwork unit. If these are not achieved to a desired tolerance then there will be a failure in any attempt to assemble the system from the component interim products.

A local dimension/tolerance for an interim product is one which will affect the ability of a workstation to assemble that particular interim product from its component piece parts or assemblies. For example, that may be the positioning of a stiffener so that its fit-up with a slot is achieved to the required tolerance.

These can be controlled and monitored by use of appropriate control chart techniques and capability studies.

C7.3 Sampling Procedures

A list of interim products to be sampled will be prepared in accordance with the shipyard's A/C Procedure for commercial ships.

C7.4 Special Procedures

C7.4.1 One-Off Manufacture

In the case of genuine one-off products or components requiring manufacture and/or assembly, specific monitoring and control procedures will be put in place to ensure that these meet specified targets.

C7.4.2 Poor Performance

In addition, if in the evaluation of system and interim product required accuracy it becomes evident that specific processes are unable to meet specified requirements first time then special analysis will be undertaken to determine cause and eliminate the rework that arises.

C7.5 Jigs and Fixtures

A list of jigs and fixtures that are required for the assembly process will be prepared and appropriate resources defined for their design, manufacture and installation.

The levels of accuracy for the jigs and fixtures must be commnensurate to those required for systems and interim products.

Where possible jigs and fixtures will minimize welded attachments.

C7.6 Hot Work Shrinkage

C7.6.1 Use of Extra Stock

Because of the limitations in shell development methods and forming of shaped Plates extra stock will be required on certain blockks. Also the commercial ships, with their heavier scantlings, will have difference shrinkage and distortion that the naval ships.

The initial aim is to control and manage the use of extra stock material and gradually eliminate it as more and more data on distortion and shrinkage for commercial ships is collected and analysed.

C7`.6.1 Shrinkage Allowances

For all dimensions, shrinkage allowances will be made on the basis of:

shrinkage at subassembly;
shrinkage at assembly;
shrinkage at erection.

A shrinkage excess will be derived and allocated to the structure in such a manner as to ensure that both principal and local dimensions/tolerances are met.

This allowance will be based on a database with regard to past performance at each work stage and for each welding process.

Shrinkage allocation should be consistent either by lump sum allocation or evenly distributed to retain correct stiffener spacing.

C7.7 Distortion Control

Specific procedures should be developed for control of distortion. These should cover two distinct aspects:

a) Pre-set that anticipates distortion from welding.

b) Distortion removal that removes distortion which results from the normal production process.

Taking each of the above in turn:

a) Pre-set:

Suitable data will be collected and analyzed to derive pre-sets so that this information can be included in drawing information provided to the workstation.

b) Distortion Removal:

Specific workstations will be identified and suitably equipped to remove distortion by appropriate processes such as heat line bending.

This is a time consuming activity and its use will be managed with an emphasis on design improvement and use of pre-set or improved processes to minimize the need for distortion removal.

C8: TESTS AND TRIALS

C8.1 Test Planning

C8.1.1 Strategy

Before any tests are undertaken the components will be systematically prepared so that those called to witness the tests actually only see the tests performed and not any preparation which is necessary for it to take place. Preparation will include:

cleaning the item and the adjacent area;

connecting all of the necessary services and checking that the required quantities are available;

checking that all recording devices are available, working correctly and are within their calibration date;

ambient temperature is acceptable;

lighting is adequate;

ventilation is adequate.

The strategy for preparing items for test is shown below.

C8.1.2 Schedule (High Level)

Figure C8.1 shows the high level test schedule. It has a total duration of . . . . working days and it is imperative that all tests be successfully completed within this time duration.

C8.2 Pre-Conpletion Testing

Before items are complete and installed in a ship a large amount of testing can be performed. The various pre-completion tests are discussed below.

C8.2.1 Pre-Survey and Dry Survey

As much of the structural survey work as possible is to be performed in the workshops.

Before a regulatory, owner's or classification surveyor is called to survey any structure it will be examined by a steel shop supervisor and any faults found, rectified.

The use of dimensional control and self-checking of all work at each stage in the process should mean that any faults discovered prior to calling in a surveyor will be minimal and minor. The aim is to have no faults found by a surveyor, not because they are well disguised, but because they do not exist.

C8.2.2 Pipe Pre-Testing

Where banks of pipes involve the joining of pipe parts and/or pipes to fittings they will be pressure tested in the pipe shop, either by water or air, prior to being installed on the unit, block or on the ship. Any faults discovered will be rectified before the item leaves the shop.

C8.2.3 Equipment Unit Pre-Testing

While still in the workshop all equipment units will have their fluid and electrical services connected and be supplied with the required quantity of the relevant mediums in order that they operate correctly and that the services are intact.

Whenever possible the test procedures developed by the equipment suppliers will be used. These procedures will be reviewed by the Test and Trials department as they are received. If they are acceptable they will be forwarded to the owner's representative for comment. When the procedure has been agreed by both the shipyard and the owner's representative it will be signed off as the master copy and kept in the Test and Trials file.

Prior to the conduct of a test the shipyard will notify the owner's representative and any other interested parties such as classification and statutory body surveyors so that they can be present.

C8.3 Tank Test Schedule

Figure C8.2 shows the schedule for tank/compartment testing. This schedule defines when all work within the tanks and hot work on the tank boundaries will be complete. It also indicates which tanks can be tested prior to the unit or block going to the berth.

C8.4 Equipment Unit Test Schedule

Figure C8.3 shows the schedule for the testing of equipment units. The schedule defines when each equipment unit will be completely assembled and identifies all tests required and their durations.

C8.5 Pipe Unit Test Schedule

Figure C8.4 shows the schedule for the testing of pipe units. The schedule defines when each pipe unit will be completely assembled and identifies all tests required and the durations.

C8.6 Zone Close-Out Strategy

Figure C8.5 shows the zone close out strategy. This defines when all work within the zones, including tests and trials of equipment, will be completed and the zone closed up.

C8.7 Principal Trials Items

A list of the principal items which require trials and the schedule for the trials is shown in Figure C8.6.

C8.7.1 Dock Trials

After the individual equipment units have been installed and connected up to the relevant systems on board the ship then complete systems will be available for trials. Initially these will be undertaken while the ship is alongside and in accordance with a predetermined schedule. This schedule is shown in Figure C8.7.

C8.7.2 Sea Trials

Ultimately the ship will undergo sea trials which will be undertaken in accordance with a program drawn up by the technical and planning departments.

If the test progression:

preparation for tests;
pipe pre-testing;
equipment unit pre-testing;
dock trials;

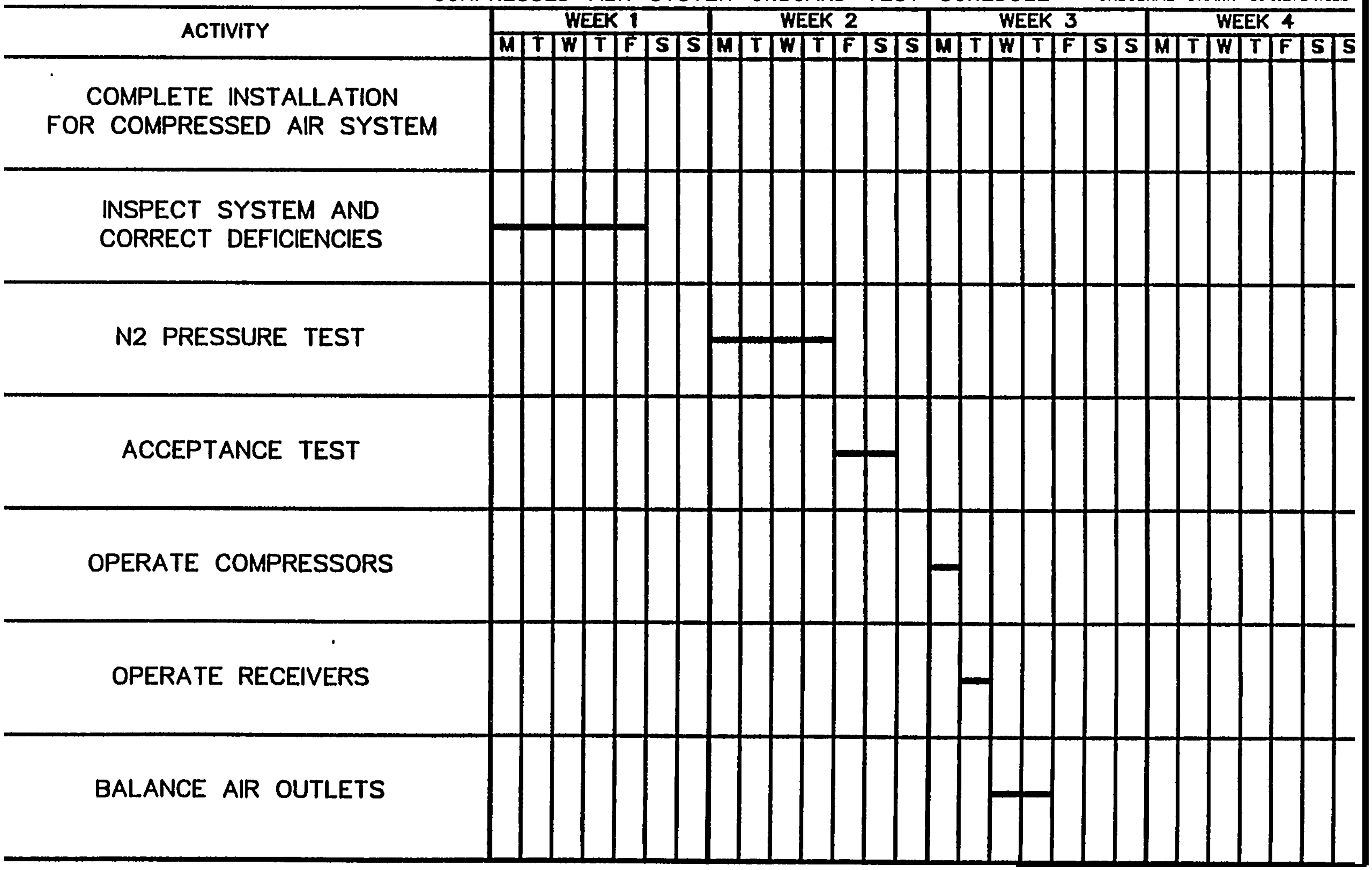
has been followed then sea trials should mainly be a series of proving events. The exceptions to this are speed and maneuvering trials.

The program dates for both the Builder's and Acceptance Sea Trials and their completion date is shown in Figure C8.8.

Figure C8.1

HIGH LEVEL SCHEDULE
COMPRESSED AIR SYSTEM ONBOARD TEST SCHEDULE

DRAWING No.:-GBSA 00/45 ORIG
ORIGINAL DRAWN 18-JAN-D4/KM



C805

Figure C8.2

ONBOARD STRUCTURAL TANK TEST SCHEDULE

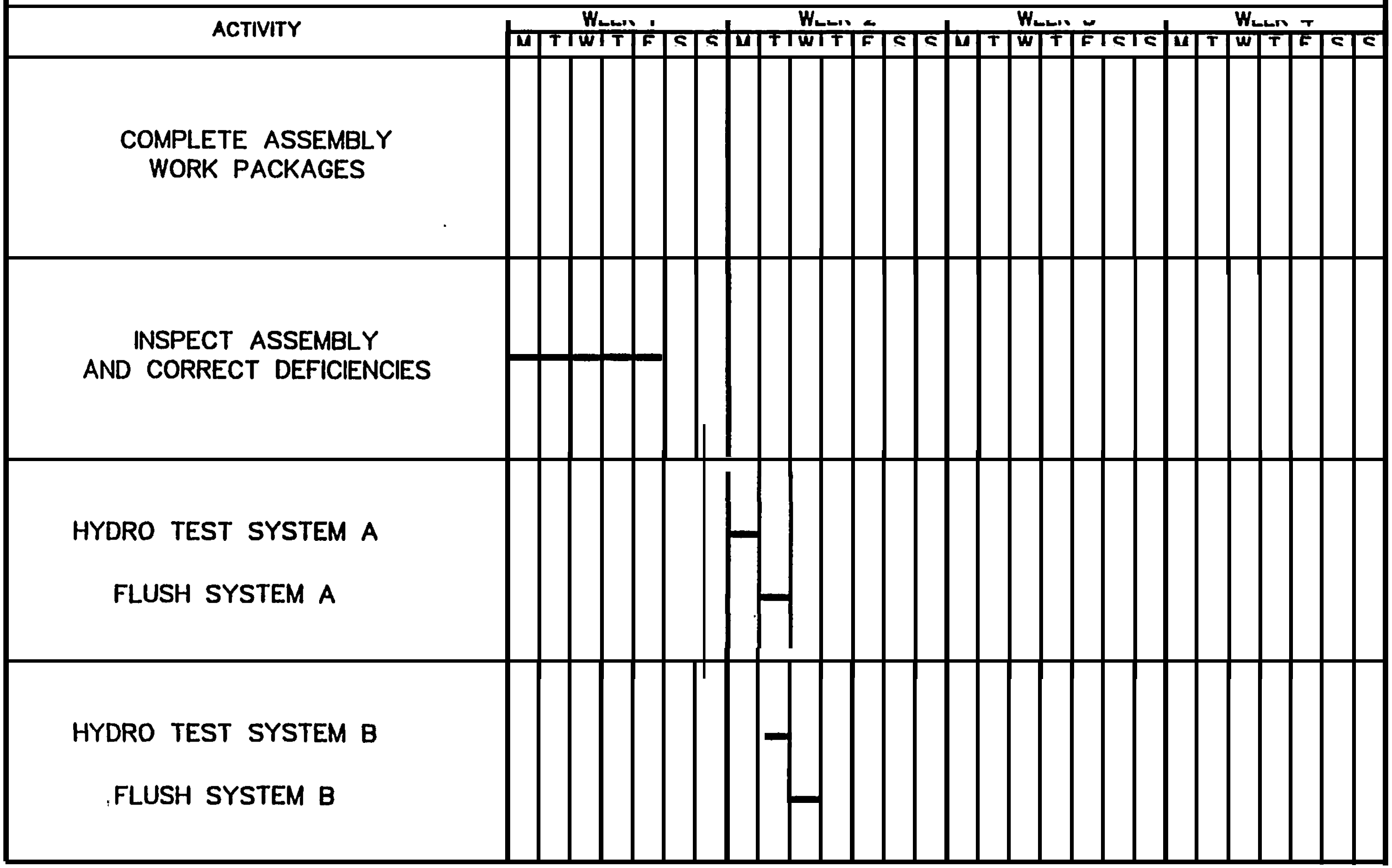
DRAWING No.:-GBSA 00/46 ORIG
ORIGINAL DRAWN 17-JAN-94/K.H.

TANK NUMBER	INSTAUATION WORK PACKAGE COMPLETE	CHECK NSTALLATlON	CORRECT **ANY** DEFICIENCIES	TANK TEST		
				WATER	AIR	**VACCUM**
1	WEEK 10	WEEK 11	WEEK 11/12	N/A	WEEK 13	N/A
2	WEEK 12	WEEK 13	WEEK 13/14	N/A	WEEK 15	N/A
3	WEEK 14	WEEK 15	WEEK 15/16	N/A	WEEK 17	N/A
4	TANK TEST ON BLOCK 16 BEFORE ERECTION					

C806

Figure C8.3 EQUIPMENT UNIT No.25 TEST SCHEDULE

DRAWING No:-GBSA [illegible] ORIG
ORIGINAL DRAWN 17-JAN-94/KH



C807

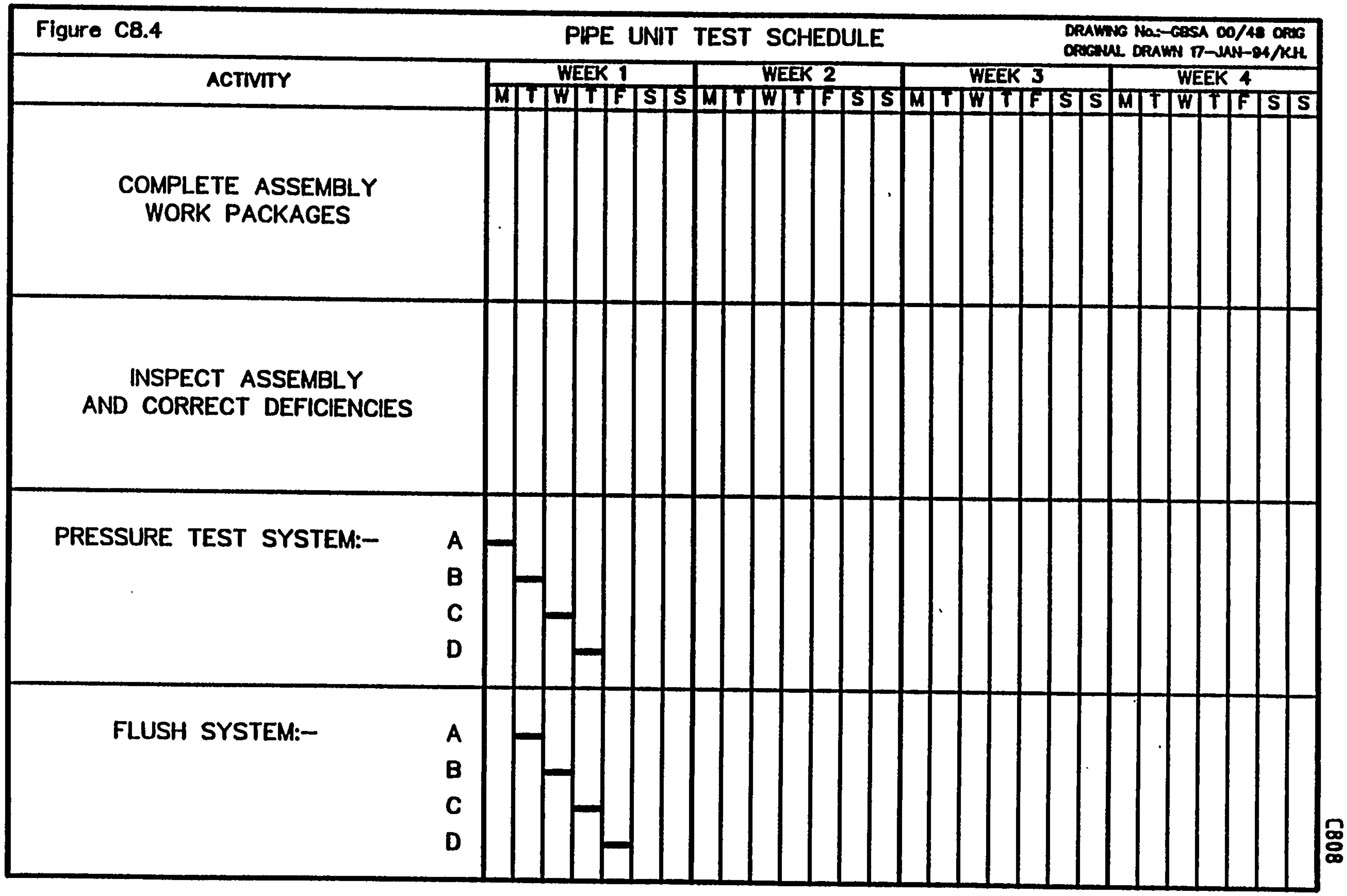

PIPE UNIT TEST SCHEDULE
DRAWING No.:-GBSA 00/48 ORIG
ORIGINAL DRAWN 17-JAN-94/K.H.
ACTIVITY
WEEK 1
WEEK 2
WEEK 3
WEEK 4
M T W T F S S
COMPLETE ASSEMBLY WORK PACKAGES
INSPECT ASSEMBLY AND CORRECT DEFICIENCIES
PRESSURE TEST SYSTEM:-
A
B
C
D
FLUSH SYSTEM:-
A
B
C
D
C808

Figure C8.4

Figure C8.5

ZONE CLOSE OUT SCHEDULE

DRAWING No.:-GBSA 00/49 ORIG
ORIGINAL DRAWN 17-JAN-94/K.H.

ZONES			WEEK NUMBERS 1	2	3	4	5	6	7	8	9	10
ACCOMMODATION ZONE	1st DECK	A1									●	
		A2								●		
		A3							●			
		A4						●				
	2nd DECK	A5				●						
		A6			●							
		A7		●								
		A8	●									
	3rd DECK	A9		●								
		A10			●							
		A11				●						
		A12					●					
	4th DECK	A13					●					
		A14						●				
		A15							●			
		A16								●		

C809

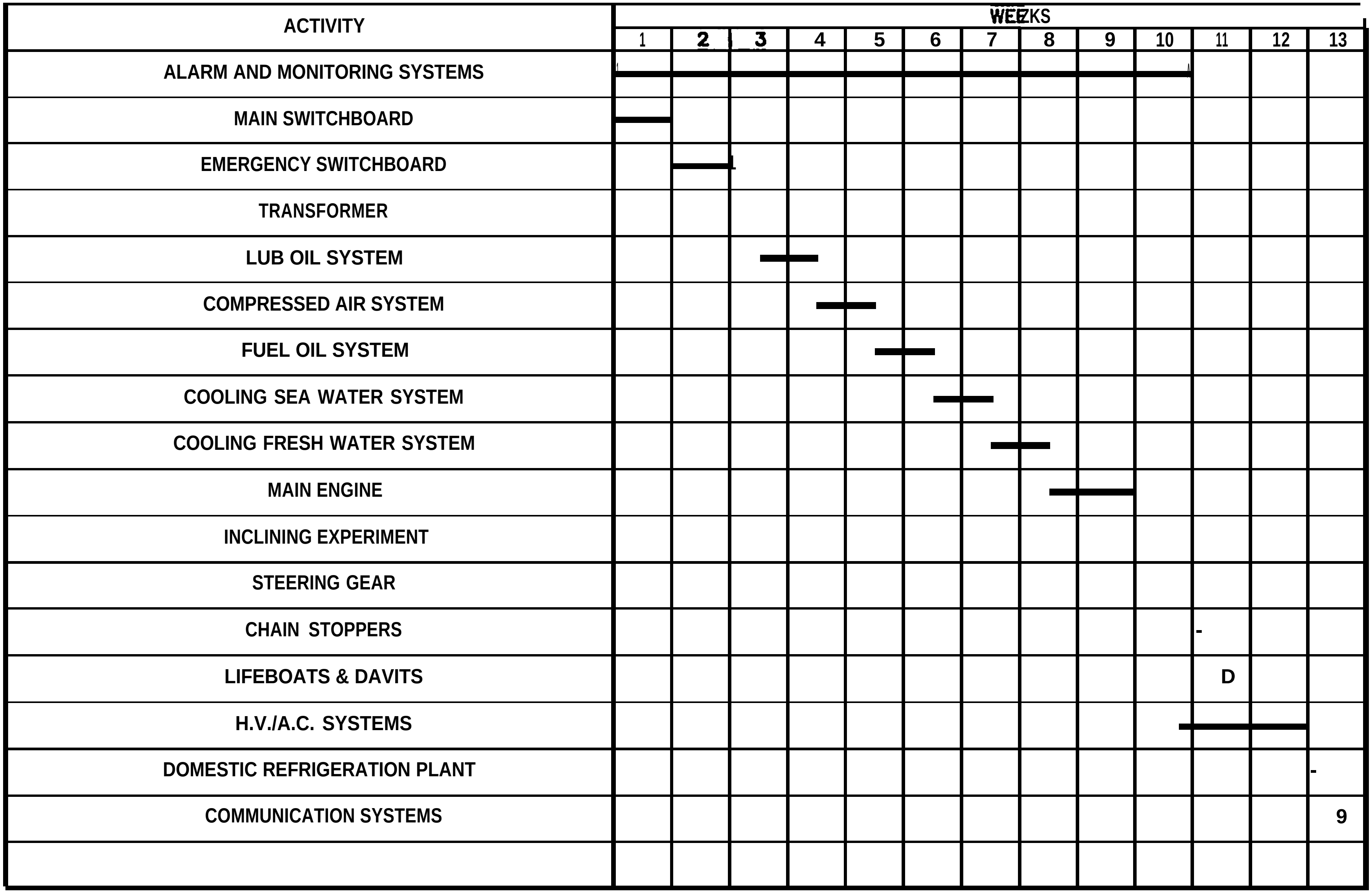
Figure C8.6 PRINCIPAL TRIALS ITEMS

DRAWING No.:-GBSA 00/50 ORIG
ORIGINAL DRAWN 17-JAN-94/K.H.

Main engine.
Auxiliary machinery.
Deck machinery.
Cargo cranes.
Hatch covers.
Container location & security.
Contols and instrumentation.
Standby and emergency systems.
Electrical power and lighting systems.
Chain stoppers.
Steering gear.
Quarter ramp.
Portable car decks.
Lifeboats and davits.
Pumps and all fluid systems.
Air and sounding pipes.
Heating, ventilation and a/c systems.
Domestic refrigeration plant.
Communications systems.
Radar and navigation systems.

Figure C8.7 PRINCIPAL DOCK TRIALS SCHEDULE

DRAWING No.:-GBSA 00/51 ORIG
ORIGINAL DRAWN 17-JAN-94/K.H.



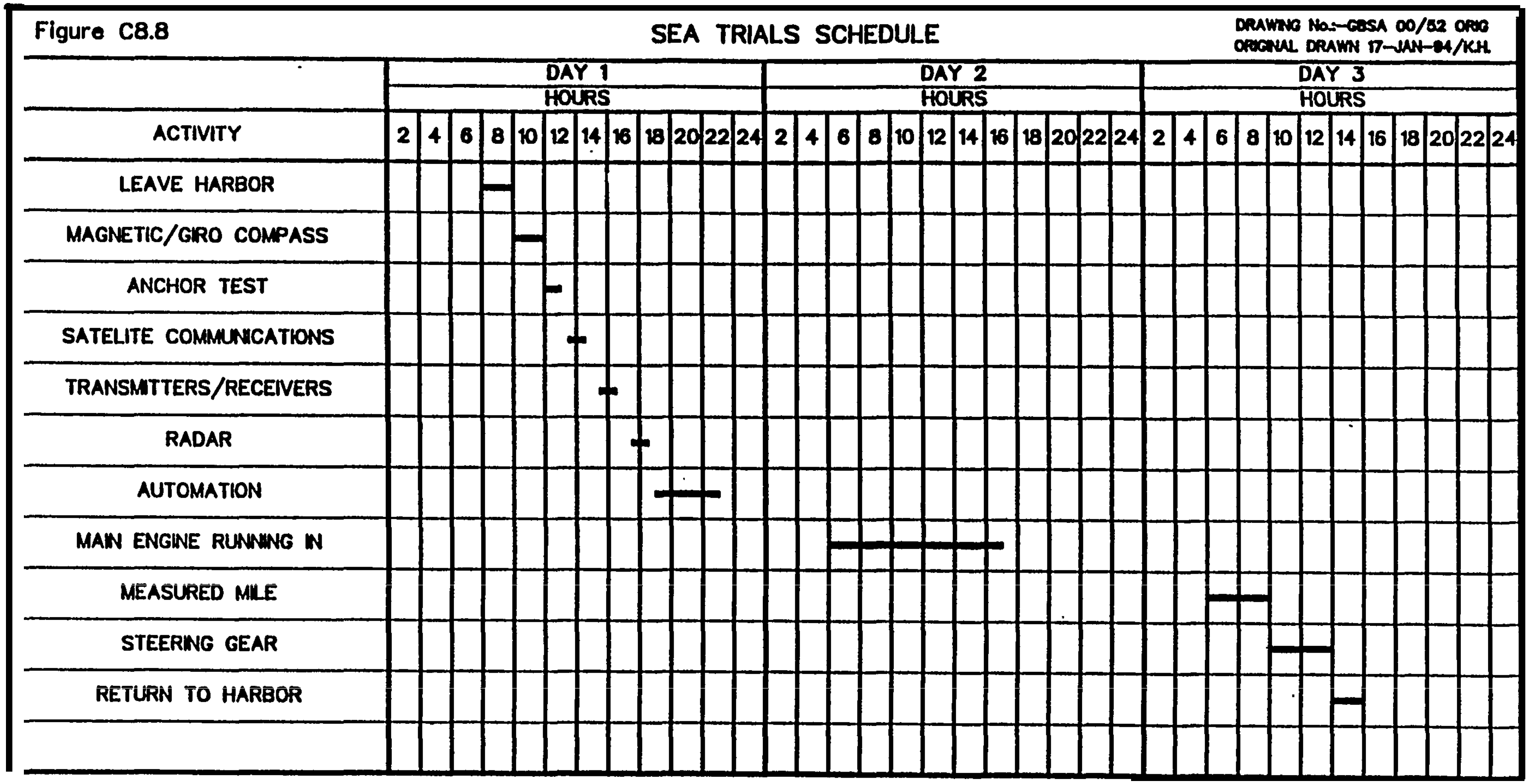


Figure C8.8
SEA TRIALS SCHEDULE
DRAWING No.:-GBSA 00/52 ORIG
ORIGINAL DRAWN 17-JAN-94/K.H.
DAY 1
HOURS
DAY 2
HOURS
DAY 3
HOURS
ACTIVITY
2 4 6 8 10 12 14 16 18 20 22 24
2 4 6 8 10 12 14 16 18 20 22 24
2 4 6 8 10 12 14 16 18 20 22 24
LEAVE HARBOR
MAGNETIC/GIRO COMPASS
ANCHOR TEST
SATELITE COMMUNICATIONS
TRANSMITTERS/RECEIVERS
RADAR
AUTOMATION
MAIN ENGINE RUNNING IN
MEASURED MILE
STEERING GEAR
RETURN TO HARBOR

C9: PERSONNEL

C9.1 Industrial Relations Aspects

In moving from nava1 ship to commercial ship construction significant changes will be required. The mix of skills will change and this will result in the need for flexibility in trade demarcation and extensive retraining. Throughout this change process the Industrial Relations Section of the Human Resources Department will be responsible for working with both management and employees to ensure a smooth personnel transition.

The shipyard has an excellent relationship with all its employees and this will be maintained by building on the existing mutual trust and loyalty through effective communication and cooperation in implementing all the necessary changes.

C9.2 Training

The change over from naval to comercial ships will not affect the basic skills required for ship construction. However, as mentioned above, it will require a redistribution of skills.

Training for the employees will center on discussing the details of the types of commercial ships to be built and will focus on the important differences. The major challenge is to ensure that-the employees will accept the necessary changes and not persist in doing commnercial work in the same way they did naval work. It cannot be "work as usual". While the highest quality is still important, it is of a different level, especially in the area of documentation.

Also, the successful management of the transition together with some technology changes, will require some training of the management team will be necessary. All training will be “in-house” in the form of seminars carried out by appropriate in-house and brought-in specialists.

All training will be the responsibility of the Training Director.

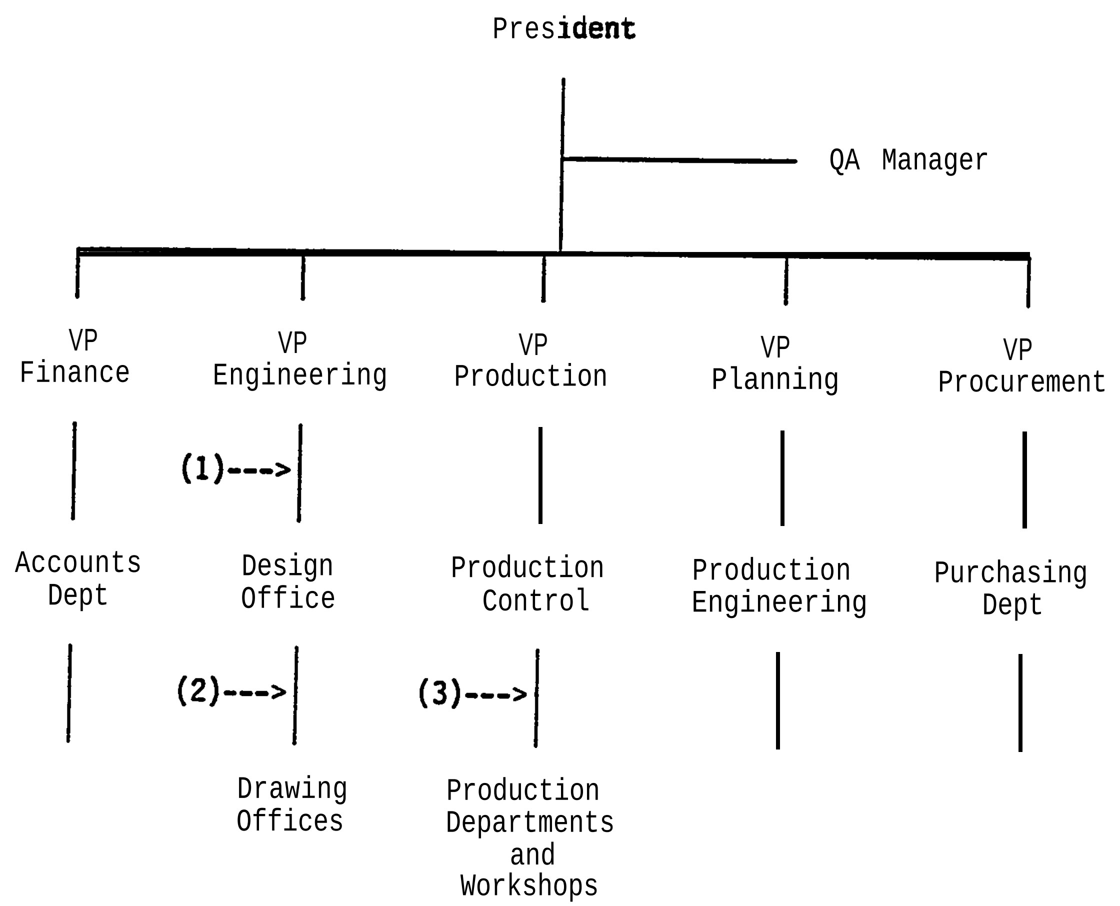
C9.3 Project Organization

C9.3.1 Shipyard Organization Charts

Figure C9.1 shows the shipyard organization to the levels at which contact with the owner's representatives will occur. Contacts with ABS and USCG take place at the same levels.

Figure C9.1

SHIPYARD HIERARCHY TO SENIOR MANAGEMENT LEVEL



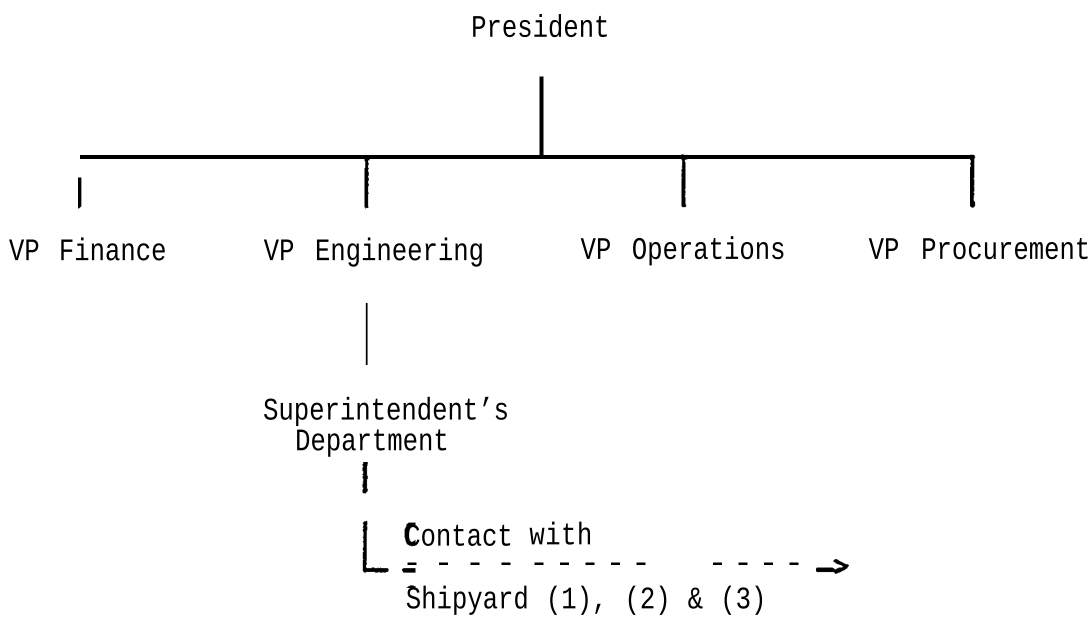
(1), (2) and (3) are points of contact with the owners.

C9.3.2 Client's Organization Chart

The client's organization, to the level at which continuous contact with the shipyard will take place, is shown in Figure C9.2. Prior to the placing of the contract there was frequent contact between the respective Presidents, Finance VPs and Engineering VPs. These contacts will continue but not frequently.

Figure C9.2

CLIENT'S HIERARCHY TO SENIOR MANAGEMENT LEVEL



C10: WEIGHT CONTROL

C10.1 General

The actual weight of the completed ship decides how much of the design full load displacement is available for the carriage of cargo. Generally, the required weight control of commercial ships is much less than that for a naval ship. This is because much more of the full load displacement is for carrying the cargo. That is the deadweight for most commercial ships is greater than the lightship weight. Whereas the opposite is true for naval ships where the payload might be only a small fraction of the full load displacement. Also the systems for a naval ship are much more complex than those for the normal comercial ship and therefore the estimation of the weight of the systems requires much more detail and effort.

Weight estimation for commercial ships have much more similarity from one ship to another. This enables designers to use parametric methods plus greater margins for the unusual. Parametric methods of weight estimation require up to date databases for the various ship types. While this is available to the current designers of the world's commercial ships, US designers do not have the database or experience necessary to use a parametric approach with confidence. Therefore, until sufficient experience is developed, the shipyard will utilize a weight control program to obtain the data and experience to ensure that the required deadweight is achieved.

The weight control procedure is a modified version of the shipyard's successful naval ship weight control procedure, but of considerably reduced scope. This will use the weight control team's familiarity with the existing procedure to ensure its easy transition for the first commercial ship.

C10.2 Outline Procedure

The weight control program will be established and managed in accordance with the shipyard's Weight Control Procedure for Commercial Ships, issued . . . .

The weight control procedure consists of the following phases:

- Calculations from drawings.
- Equipment vendor weight reporting.
- Lightship weight and center check.

The calculation of the weight items will be under the three major groupings:

Steel
Outfit
Machinery

They must be summarized as:

Total Steel
Total Outfit
Total Machinery

together with their associated centres of gravity and suitable margins on all items.

C10.3 Departmental Responsibilities

The Weights Section of the Naval Architectural Department will be responsible for the weight control. A Weight Manager will be assigned for this contract. Individual weights and centers of gravity will be calculated by the Weight Section engineers. A Weight Manager will be assigned for this contract.

All weight information obtained by the other design sections will be forwarded to the Naval Architectural Department for processing.

APPENDIX D

SHIPYARDS TO WHICH QUESTIONNAIRES WERE SENT

APPENDIX D

SHIPYARDS TO WHICH QUESTIONNAIRES WERE SENT

Norfolk Shipbuilding and Drydock Company
Box 2100
Norfolk, VA 23501

Bath Iron Works
Washington Street
Bath ME 04530

Ingalls Shipbuilding
Pascagoula, MS 39568-0149

Avondale Industries, Inc.
BOX 50280
New Orleans, LA 70150-0280

Peterson Builders, Inc.
BOX 650
Pennsylvania Street
Sturgeon Bay, WI 54235

Newport News Shipbuilding
Newport News, VA 23607

National Steel and Shipbuilding Co.
BOX 85278
Harbor Drive and 28th Street
San Diego, CA 92186-5278

Bethlehem Steel Corporation
BETHSHIP, Sparrows Point Yard
Sparrows Point MD 21219-2599

St John Shipbuilding Company, Ltd.
Box 970
St John, New Brunswi‘ck E2L 4E5
Canada

Trinity Marine
P.O. BOX 3029
Gulfport, MS 39503

McDermott International
Morgan City Shipyard
P.O. BOX 588
Amelia, La 70340

Bender Shipbuilding & Repair Company
Mobile, Al36601

Tampa Shipyards, Inc
6001 South West Shore Blvd
Tampa, FL 33616

Todd Pacific Shipyard
16th Avenue SW
Seattle, WA 98134

Marco Seattle
2300 W. Commodore Way
Seattle, WA 98199

Swiftships, Inc.
Morgan City
La. 70380

Textron Marine Systems, Inc
Shipyard Division
Chef Menteur Highway
New Orleans, La

PMC Corporation
Portland
Oregon

General Dynamics Corporation
Electric Boat Division
Groton
Connecticut

Puget Sound Naval Shipyard
Bremerton
WA.

Philadelphia Naval Shipyard
Philadelphi, PA 19112

Bollinger Machine Shop & Shipyard
P.O. BOX 250
Lockport, La. 70374-0250

APPENDIX E

BUILD STRATEGY QUESTIONNAAIRE

NATIONAL SHIPBUILDING RESEARCH **PROGRAM**

SP-4 (DESIGN/PRODUCTION INTEGRATION) PANEL PROJECT

BUILD STRATEGY QUESTIONNAIRE

Every shipbuilder plans how they will build their ships. The plan may be only in someone's head or a detailed and documented process involving many people. Often different departments prepare independent plans which are then integrated by a "Master Plan/Schedule".

A Build Strategy is much more than the normal planning and scheduling and a description of how the Production Department plans to build the ship.

A Build Strategy is a formal documented, integrated strategy for a single ship type and size for the whole company prepared by a team representing all disciplines that will be involved in the design engineering planning material procuring building and testing processes. The Build Strategy documents are well distributed and available to all levels of decision makers in the company.

A Build Strategy will be just as important and more used than the traditional ship specification and contract to most decision makers in a shipyard. In fact it can be viewed as an internal contract or agreement between the departments as to how the ship will be produced from design through testing.

It is recommended that the enclosed brief description of the Build Strategy approach be read BEFORE completing the questionnaire.

Your participation in this important project will be appreciated. A copy of the questionnaire findings will be provided to all participants. To ensure confidentiality for all participants, company names will not be used in the report

COMPANY NAME	
PERSON COMPLETING QUESTIONNAIRE	**NAME**
	POSITION
	TELEPHONE

		YES	NO
Are you familiar with the Build Strategy approach described for this project?			
Has your company ever prepared such a Build Strategy?			
IF YES	How many?		
	What ship Types and Sizes?		
	Which Department had the major responsibility for Build Strategy Development?		

		YES	NO
Has your comany ever used a Build Strategy for a complete design/build cycle?			
IF YES	How manly?		
	what ship types and Sizes?		

	YES	NO
Does your company use the Build Strategy approach for current projects?		

IF' NO, and your company previously used the Build Strategy approac, why did you stop?

a) Build Strategy document not kept up to date	
b) Not worth the effort based on resulting benefits	
c) It was not enforced. No one followed it	

d) Other

	YES	NO
Does your company intend to prepare and use the Build Strategy approach for future projects?		

IF NO, why not?

a) Not perceived to be worth the effort	
b) Too much information considered proprietary	

c) Other

If your company does not prepare and use a complete Build Strategy, please indicate in this column what parts it does document and distribute to all decision makers		Please indicate in this column what you feel should be in a Build Stategy document
Ship Description		
Applicable Regulations		
Classification		
Quality		
Contract Requirements		
Product Work Breakdown Structure		
Master Equipment List		
Design & Engineering Plan		
Budget		
Resource Allocation and Utilization		
Key Drawings		
Material Purchase Requisitions		
Work Station Drawings		
Material Lists		
CAM Data		
Schedule		
Material Plan		
Budget		
Material Required Dates		
Schedule		
Build Plan		
Key Dates/Production Rate		
Productivity Targets		
B u d g e t		
Resource Allocation and Utilization		
Sub-contract Requirements		
Build Location/Launch Condition		
Module Definition		
Product/Zone Identification		
Machinery Units		
Integrated Units		
Accommodation		

Build Plan (continued)		
Paint Strategy		
Subcontract Work Content		
Production Required Information		
Reference System		
Molded Definition		
Accuracy Control		
Tolerances		
Distortion Control		
Rework Procedures		
Work Station Schedules		
Weight Control		
Material Kitting Lists		
Tests and Trials		
Construction Data		
Number of Plate Parts		
Number of Shape Parts		
Number of Modules		
Number of Assemblies		
Number of Subassemblies		
Joint Weld Length		
Paint Areas		
Deck Covering Areas		
Pipe Lengths and Type		
Number of Pipe Assemblies		
Electric Cable Lengths and Types		

	YES	NO
DO YOU SEE THIS PROJECT AS WORTHWHILE?		
DOES IT HAVE POTENTIAL BENEFIT TO YOU?		

WHAT ADDITIONS WOULD YOU LIKE TO SEE COVERED IN THE STUDY?

OTHER RELATED COMMENTS:

	YES	NO
Would you be prepared to allow a visit to your shipyard by members of the project team to discuss your use/interest in the Build Strategy approach?		
Is US **citienship required for such a visit?**		

APPENDIX F

SHIPYARD CAPABILITIES AND LIMITATIONS QUESTIONNAIRE

NATIONAL SHIPBUILDING RESEARCH PROGRAM

SP-4 (DESIGN/PRODUCTION INTEGRATION) PANEL PROJECT

SHIPYARD CAPABILITIES AND LIMITATIONS QUESTIONNAIRE

In order to develop a Generic Build Strategy (GBS) that will be usefid to the largest possible number of U.S. shipbuilders, it is necessary to determine the general capabilities and any limitations of the shipyards under consideration. These general capabilities and limitations will be used to develop an envelop of industry common characteristics on which the GBS will be based.

Your participation in this important project will be appreciated. A copy of the questionnaire findings will be provided to all participants. To ensure cofidentiality of all participants, company names will not be used in the report

COMPANY NAME		
PERSON COMPLETING QUESTIONNAIRE	**NAME**	
	POSITION	
	TELEPHONE	

	YES	NO
Would you be prepared to allow a visit to your shipyard by members of the project team to discuss this questionnaire and its intended use?		
Is U.S. citizenship required for such a visit?		

Provision of the following documents would greatly help this study:

- **Shipyard layout drawn to scale**
- **Shop layout to scale with list of major equipment**
- **Company organization chart with numbers in each department**

MARKET

	YES	NO
Does your Company have a Marketing/Sales Department?		
Does your Company engage in Market Research?		

		Domestic	Foreign
What is your current primary market?	Military		
	Commercial Ocean Going		
	Commercial Offshore		
	Commercial Small Boat		
	Pleasure Craft		
What is your desired market for the next 10 years?	Military		
	Commercial Ocean Going		
	Commercial Offshore		
	Commercial Small Boat		
	Pleasure Craft		

List Contracts for the past 10 years:

SHIP **TYPE/SIZE**	**CUSTOMER**	**SIGNIFICANT DATES (Month/Year)**			
		CONTRACTS AWARD	START FAB	LAUNCH	DELIVERY

PLANNING AND SCHEDULING

				YES	NO
Is all planning and scheduling performed by a single (central) department					
IF YES	Is planning performed at three levels?		- Strategic (S)		
			- Tactical (T)		
			- Detailed (D)		
IF NO	Does each department plan and schedule work?				
	IF YES	At what planning levels?	- Stategic (S)		
			- Tactical (T)		
			- Detailed (D)		
		Which department Coordinate#integrates plans?			
Do you use a Material Requirements Program?					
If no, what method is used?					
Do you use an integrated Resource Requirements Program?					
If no, what method is used?					
Do you use Computer Aided Process Planning?					

MATERIAL

			YES	NO
Do you have a Material Planning (Control) Group?				
If yes, what department is it in?				
Who has responsibtity for Material Schedule?				
Do you use a material coding system?				
Do you use material standards?				
If yes, for what products?				
Do you use MRPI or similar system?				
Do you use MRPII (RRP) or similar system?				
Are any materials palletised?				
If yes, on what basis?	Kits by	Work Station		
		Shop		
		Block		
		Zone		

ENGINEERING

	YES	NO
Do you have a complete inhouse Engineering capabiity?		
Do you subcontract any of your engineering to Design Agents?		
Do you subcontract all your engineering to a Design Agent?		
Do you use Design for Production approach?		
Do you use Design to Cost approach?		
Do you utilize Group Technology?		
Do you use company wide project teams?		
Do you utilize Concurrent Engineering?		
Do you use CAD?		
Is engineering for production presented in the traditional Systems approach?		
Is engineering for production presented in the Modular and Zone approach?		
Do you have standard engineering procedures in place?		
Do YOU Use engineering standards?		
Do you utilize integrated machinery units?		
Do you have an inhouse computer aided lofling capability?		

If yes, what department is responsible for Lofting?	**Engineering**	**Manufacturing**

Do you use a Service for your Lofting and N/C documentation?		
Does your CAD system prepare Manufacturing Piping Details?		
Are the Engineering drawings used directly by Manufacuturing?		
Are work station/shop sketches used by Manufacturing?		

Who prepares the work station/shop sketches?	Engineering		Manufacturing	
Do you have a separate Manufacturing/industrial Engineering Group?				
If so, what department are they in?	Engineering		**Manufacturing**	
Number of engineers (Degreed professionals)?	Current		Maximum	
Number of designers?	Current		Maximum	
Number of drafters?	**Current**		Maximum	

How is engineering organized?	**Function**		**Product**		**Matrix**	

Are sections grouped traditionally, that is Hull Machinery and Electrical?		
OR, are sections grouped to suit Modular and Zone Design and Construction?		

MATERIALS HANDLING

	YES	NO
Are all materials handled by cranes?		

Plate yard material handling is by	
Shape yard material handling is by	
Pipe yard material handling is by	
Structural shop material handling is by	
Pipe shop material handling is by	
Machine shop material handling is by	
Outfit shop material handling is by	

Are self+elevating, self-propelled transporters used?	I	I
If yes, what is capacity?		
Are self-elevating non self-propelled transporters used?	I	I
If yes, what is capacity?		
Are non self-elevating trailers/transporters used?	I	I
If yes, what is capacity?		
Are fork lift trucks used?	I	I

If yes, what:	Number	Capacity

What other material handling systems do you use?

MANUFACTURING

		YES	NO
Do you use the modular structural approach?			
What Structural product breakdown do you use?	Part		
	Sub-assembly		
	Assembly		
	Block		
	Super Block		
Do you use Zone Oufitting approach?			
Do you use Advanced Outfitting approach?			

Number of craft workers?	**Current**	**Maximum**
Number of laborers?	Current	Maximum
Number of support workers?	current	Maximum

Do you use subcontractors for work in the shipyard?		
If yes, for what products?		
Do you have an Accuracy Control Group?		
If yes, what products is it used for?		
Do you utilize Advance Outfitting Integrated Machinery Units?		
Do you utilize Advance Outfitting On Block outitting?		
Do you utilize Open Sky Advance Outfitting		
Is electrical outfitting including cable installed in blocks?		

PAINTING

		YES	NO
Do you blast and prime mat	Plates		
	Shapes?		
	Pipe?		
Do you use weld through primer?			
Do you blast assemblies or blocks to remove primer?		t	1’
Do you have cells for blasting and painting of assemblies or blocks?			
If yes, at what stage/s of the structural build process?			

FACILITIES

<table>
<tr><td rowspan="6">Site Particulars</td><td colspan="2">Total acreage</td><td colspan="4"></td></tr>
<tr><td colspan="2">Covered shop area</td><td colspan="4"></td></tr>
<tr><td colspan="2">Plate yard area</td><td colspan="4"></td></tr>
<tr><td colspan="2">Shape yard area</td><td colspan="4"></td></tr>
<tr><td colspan="2">Pipe yard area</td><td colspan="4"></td></tr>
<tr><td colspan="2">Covered warehouse area</td><td colspan="4"></td></tr>
<tr><td rowspan="4">Site Constraints</td><td colspan="2">Width of river</td><td colspan="4"></td></tr>
<tr><td colspan="2">Maximum draft at outfitting berth</td><td colspan="4"></td></tr>
<tr><td colspan="2">Any Canal/lock access to Sea Width</td><td colspan="4"></td></tr>
<tr><td colspan="2">Any bridge access to sea height</td><td colspan="4"></td></tr>
<tr><td rowspan="6">Building Berths</td><td colspan="2">Berth number</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Type</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Length</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Breadth</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">For drydocks,
max float off draft</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">For launch ways,
max water depth</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="6">Berth Cranes</td><td colspan="2">Number of cranes</td><td colspan="4"></td></tr>
<tr><td colspan="2">Type</td><td colspan="4"></td></tr>
<tr><td colspan="2">Capacities</td><td colspan="4"></td></tr>
<tr><td colspan="2">Outreach</td><td colspan="4"></td></tr>
<tr><td colspan="2">Max Multi crane lift</td><td>Number of Cranes</td><td></td><td>Lift</td><td></td></tr>
<tr><td colspan="2">Max lift for turning blocks</td><td colspan="4"></td></tr>
<tr><td rowspan="21">Structural shop and plattens</td><td rowspan="3">Shop Size</td><td>Length</td><td colspan="4"></td></tr>
<tr><td>Width</td><td colspan="4"></td></tr>
<tr><td>Height under crane</td><td colspan="4"></td></tr>
<tr><td colspan="2">Maximum throughput</td><td colspan="4"></td></tr>
<tr><td colspan="2">Recent throughput</td><td colspan="4"></td></tr>
<tr><td colspan="2"></td><td>NUMBER</td><td>TYPE</td><td colspan="2">CAPACITY</td></tr>
<tr><td colspan="2">Burning machines</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2">Plate Rolls</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2">Plate Press</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2">Shape Bender</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2">Shop cranes</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2">Blast & Prime</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2">Panel line</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2">Assembly area</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2">Block assembly</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2">Block erection</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2">Maximum assembly</td><td colspan="2">Size</td><td colspan="2">Weight</td></tr>
<tr><td colspan="2">Maximum block</td><td colspan="2">Size</td><td colspan="2">Weight</td></tr>
<tr><td colspan="2">Max lift for turning</td><td colspan="2">Assemblies</td><td colspan="2">Blocks</td></tr>
</table>

Machine shop/s	Length	Width	Height under crane	
	Equipment and capacity:			
Piping shop/s	Length	Width	Height under crane	
	Shop Capacity By	Pipe Pieces	Pipe Assemblies	Weight
			YES	NO
	Do you use N/C pipe cutting?			
	Do you use N/C pipe bending?			
	Equipment and capacity:			
outfitting shop/s	Length	Width	Height under crane	
	Do you have a machinery unit shop?			
	If yes, Length	Width	Height under crane	
	Unit constraint	Size	Weight	
	Equipment and capacity			

Welding Equipment/Processes			Percentage of Total Welding
	What welding equipment/ processes do you use?	Fab Shop	
		Platten	
		Berth	

Access Equipment		YES	NO
	Do you use conventional staging?		
	Do you use Patent staging?		
	Do you use "Cherry-pickers"?		
	Do YOU Use "Sky-Climbers"?		
	Do you use elevators?		
	Do you use escalators?		

NATIONAL SHIPBUILDING RESEARCH PROGRAM

SP-4 (DESIGN/PRODUCTION INTEGRATION) PANEL PROJECT

SHIPYARD CAPABILITIES AND LIMITATIONS QUESTIONNAIRE

NOMENCLATURE

The following terms are used in the Shipyard Capabilities and Limitations Questionnaire. It is recognized that they may have different meanings for different shipyards. Therefore the intended meaning is as stated below.

PART	Individual interim product as cut from raw material
SUB-ASSEMBLY	Interim product consisting of two or more parts joined together
ASSEMBLY	Major structural component made up of parts and assemblies such as Web Frames, Bulkheads, Flats, shell, decks, etc.
BLOCK	3 D structure consisting of joined assemblies and parts such as bow, stem, double bottom tank, wing tank, machinery space overhed, etc.
SUPER BLOCK	Large 3 D structure consisting of two or more blocks joined together before erection at the building berth
PIPE PIECE	Single pipe part which may be bent
PIPE ASSEMBLY	Interim product consisting of one or more pipe pieces joined to fittings, valves, etc., by welding brazing or bolting
INTEGRATED MACHINERY UNIT	A combined equipment, piping electrical and support structure for major machinery systems assembled and tested in a shop environment and installed onboard the ship as a unit

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