Appledore for the SP-4 Panel (8) and in the revision of the DESIGN FOR PRODUCTION MANUAL (9).

It is a known fact, but, unfortunately, not an often practiced approach, that the performance of any endeavor will be improved by improvements in communications, cooperation and collaboration. The Build Strategy Approach improves all three. It communicates a shipyard's way of doing business, its preferred shipbuilding approach and practices, and the specifics for the intended shipbuilding project, to all participants. This communication 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.

The Build Strategy approach can be described by positioning the three parts at the corners of a triangle as shown in Figure 14.90. This shows the shipyard's Business Plan at the top being supported by the *Shipbuilding Policy* and the *Build Strategies*.

The business plan sets the company's vision for the immediate future. The shipbuilding policy develops the business plan into the preferred way the shipyard wants to achieve the business plan.

It covers use of facilities, how the different types of ships in its selected product range will be built, including their block breakdown and zone definition, and the processes to be used for design, purchasing, production and testing. In addition, the SP identifies productivity targets and future improvement plans. The SP also includes the shipyard's *Product-oriented Work Breakdown Structure* or *Interim Product Database.*

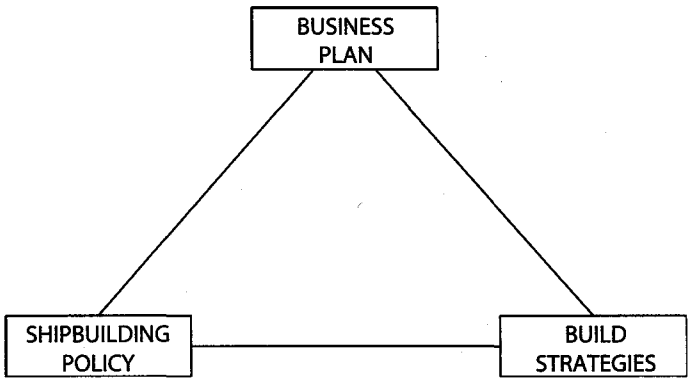

Figure 14.90 Build Strategy Approach Triangle

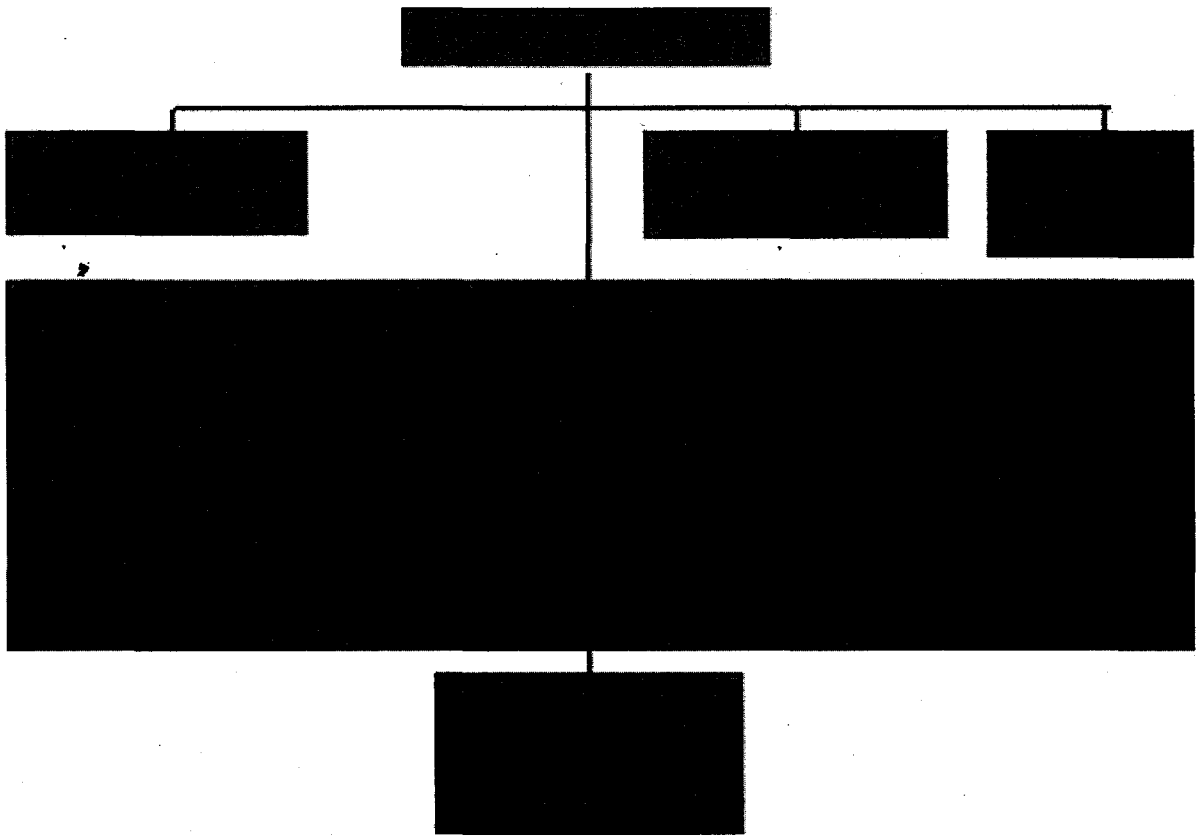

Figure 14.91 Build Strategy and Shipbuilding Policy

14.4.2 Shipbuilding Policy

A *Shipbuilding Policy* is the definition of the optimum organization and its operations, including the design and build methods required to produce the product mix contained 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.

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

- product range which the shipyard aims to build,
- shipyard capacity and targeted output,
- targets for costs, and
- 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 14.91.

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, and
- 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 realized, namely the Build Strategy.

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, and
- *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 over time 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 allows it to be applied in full at any time to a particular contract.

Therefore, to link the current policy with a future policy, a series of projects for change should be 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 are summarized and illustrated in Tables 14.VI and VII.

Work at the *Strategic* level provides inputs to:

- conceptual and preliminary design stages,
- contract build strategy,
- facilities development,
- organizational changes, and
- tactical level of shipbuilding policy.

TABLE 14.VI 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
Is a 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 14.VII Typical List of Contents in A Detailed Shipbuilding Policy Document

1.0 OVERVIEWN
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 PRODUCTION 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 Outfit 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

7.0 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 Performance 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

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, and
- 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 design 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, and
- *standard* preferred service routes.

At the *Tactical* level standard interim products and production practices related to the contract and transition de-

sign 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,
- standard production stages,
- installation practices,
- standard material sizes, and
- standard piece parts.

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

For the planning units, subnetworks 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.

At the *Detail* 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, and
- testing requirements.

Reference to the standards should be made in contracts, and relevant information made available to the design, planning and production functions. As with all levels of the shipbuilding policy, the standards are updated over time, in line with product development and technological change.

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:

- shipowners 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, and
- production departments

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

While the scope of the Shipbuilding Policy requires that it be developed by a cross-functional team with members from all departments in a shipyard, it is clear that it would benefit from utilizing Concurrent Engineering (CE) in its development. However, its existence negates the need for CE in subsequent activities as all the decisions have been made and documented in the Shipbuilding Policy.

The very act of developing a Shipbuilding Policy 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. It will also highlight any potential problems and enable them to be addressed well before the *traditional* time when they will arise.

A Shipbuilding Policy 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 from one department to another by defining concurrently how the ship will be designed and constructed.

Some of the advantages mentioned by users of the Build Strategy Approach are:

- serves as 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, namely purchasing, production, test, etc.,
- expands people's view of the product (ship) to include such aspects as maintenance, customer training, and support service,
- fosters strong lateral communication,
- saves time through concentration on parallel versus sequential effort,
- facilitates resolution of differences and misunderstandings much earlier,
- greatly improves commitment (*buy in*) by participants and the effectiveness of the hand-over later,

- serves as a road map that everyone can see and reference as to what is happening,
- facilitates coordinated communication, and
- develops a strong commitment to the process and successful completion of the project.

There are a few disadvantages mentioned by some 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 these decisions with others in developing the Build Strategy, and
- 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.

14.4.3 Why Should Shipbuilders Use the Build Strategy Approach?

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

Some shipyards that have a very limited product variety, in terms of interim and final products, generally speaking, also have no need for build strategies, due to their familiarity with the products. If such shipyards, which are among the most productive in the world, do not use build strategies, then why should a shipbuilder 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, and have 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, 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. Also, the Build Strategy Approach will ensure that the way they are to be applied is well planned and communicated to all involved.

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

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 that is significantly different from 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 Shipbuilding Policy document.

14.4.4 Build Strategy

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 an effective way of capturing the combined design and shipbuilding knowledge and processes, so they can be continuously improved, updated, and used as training tools.

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 are to identify:

- the new vessel,
- the design and features of the new vessel,
- contractual and management targets,
- departures from the shipyard's Shipbuilding Policy.
- constraints, based on the new vessel being designed/constructed, particularly with reference to other work underway or envisaged.
- 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 interdepartmental communication is vital.

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 will already 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, and
- human resources.

The Build Strategy applies the shipbuilding policy to a specific ship contract. A Build Strategy:

- applies a company's overall shipbuilding policy to a contract,
- 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 a 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,
- ensures all departments contribute to the strategy,
- identifies and resolves problems before work on the contract begins, and
- ensures communication, cooperation, collaboration and consistency between the various technical and production functions.

In summary, *a Build Strategy is an agreed design, material management, production and testing plan, prepared before any work starts, with the aim of identifying and integrating all necessary processes.*

The Build Strategy is used to facilitate and strengthen the communication links. It should be up front and be used to resolve potential conflicts between departments in areas of design details, manufacturing processes, make/buy decisions, and delivery goals. The intent of a Build Strategy is to disseminate the information it contains to all who can benefit from knowing it. Throughout this chapter it is described as a hard copy document, but today it could well be electronically stored and disseminated through local area network workstations.

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

The Build Strategy Document should be used by all of the departments involved in designing, planning, procuring material, material handling and building the ship, 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 Build Strategy team/committee. Any such changes must then be passed on to all holders of controlled copies of the Build Strategy.

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:

- 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.
- 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 individual making decisions which have adverse effects in other departments.

A shipyard, 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.

14.4.4.1 Prerequisites for a build dtrategy

A Build Strategy could be produced as a stand-alone document for any ship to be built by a shipyard, without having a Shipbuilding Policy for the shipyard, as is done in many U.S. shipyards, but it is a waste of effort by having to repeat the information that should be in the Shipbuilding Policy. It also runs the risk of having different design and building methods for different Build Strategies.

It is argued that, for shipyards that cannot define a nar-

row range of ship types, because of a low demand for the ships, and therefore have to be flexible and willing to build any type that comes along, preparing a Shipbuilding Policy would not be effective. This is not the case, as it is easier and faster to modify the shipbuilding approach and practices in an existing Shipbuilding Policy and this would still ensure that the same team that produced the Shipbuilding Policy would be responsible for the modifications for the new ship type.

It is believed that shipyard management is reluctant to

TABLE 14.III Proposed Build Strategy Document Contents

1: INTRODUCTION		
1.1	Purpose of Document	R[1]
1.2	Build Strategy Document Prerequisites	R
1.3	Distribution	R
1.4	Summary	R
2: VESSEL DESCRIPTION		
2.1	General Description & Mission	R
2.2	Principal Particulars	R
2.3	Special Characteristics & Requirements	R
2.4	Comparisons/Differences From Previous Vessels	R
2.5	Applicable Regulations & Classification	O
2.6	Owner Particulars	
2.6.1	Background	O
2.6.2	Fleet	O
2.6.3	Past Relationship	O
2.6.4	Competition	O
3: CONTRACTUAL		
3.1	Contractual Dates & Time Constraints	R
3.2	Payment	O
3.3	Liquidated Damages & Penalties	R
3.4	Cancellation	O
3.5	Drawing Approval	O
3.6	Construction Inspection	O
3.7	Trials	O
3.8	Quality	R
4: DESIGN & ENGINEERING		
4.1	Strategy & Scope	
4.1.1	General	R
4.1.2	Changes to Ship Definition Strategy	R
4.1.3	Modeling & Composites	R
4.2	Key Drawings	R
4.3	Production Information Requirements	
4.3.1	CAM Information	R
4.3.2	Manufacturing Information	R
4.3.3	Parts Listings	R
4.3.4	Installation Drawings	R
4.3.5	Installation Procedures	R
4.4	Design & Engineering Schedule	
4.4.1	Schedule	R
4.4.2	Resourcing & Utilization	O
4.4.3	VFI Schedule	R
4.5	Datum's & Molded Definition	O
4.6	Design Standards	R
4.7	Functional Space Allocations	R
4.8	Detail Design Guidelines	
4.8.1	Steelwork	O
4.8.2	Machinery	O
4.8.3	Pipework	O
4.8.4	Electrical	O
4.8.5	Joinerwork	O
4.8.6	Paintwork	O
5: PROCUREMENT		
5.1	Master Material List	O
5.2	Master Equipment List	O
5.3	Material Procurement Strategy	O
5.4	Procurement Schedule	R
5.5	Critical/Long Lead Items	R
6: PLANNING & PRODUCTION		
6.1	Strategic Planning	
6.1.1	Key Event Program	R
6.1.2	Resourcing & Utilization	O
6.1.3	Changes to Shipbuilding Policy	R
6.1.4	Required Facility, Tooling & Equipment Upgrade	R
6.2	Work Breakdown	
6.2.1	Work Breakdown Structure	R
6.2.2	Coding	R
6.3	List of Planning Unit	
6.3.1	Hull Blocks	R
6.3.2	Zones	R
6.3.3	Equipment Units	R
6.3.4	Systems	R
6.4	Master Schedules	
6.4.1	Hull Blocks	R
6.4.2	Zones	R
6.4.3	Equipment Units	R
6.4.4	Systems	R
6.5	Hull Production Strategy	
6.5.1	Preliminary Process Analysis —Integration of Outfit —Process Analysis by Block	O
6.5.2	Non-standard Interim Products	O
6.5.3	Build Location & Launch Condition	R
6.5.4	Erection Schedule	R
6.6	Machinery Space Outfit Strategy	
6.6.1	Equipment Units	R
6.6.2	On-block Outfitting	R
6.6.3	On-board Outfitting	R
6.7	Accommodation Outfit Strategy	R
6.8	Cargo & Other Space Outfit Strategy	
6.8.1	On-block Outfitting	R
6.8.2	On-board Outfitting	R
6.9	Painting Strategy	
6.9.1	Outline Paint Specification	O
6.9.2	Pre-Painting	R
6.9.3	Primer Repair Strategy	R
6.9.4	Unit/Block Painting Strategy	R
6.9.5	Zone Painting Strategy	R
6.9.5.1	Machinery Spaces	
6.9.5.2	Outside Shell and Decks	
6.9.6	Special Considerations	R
6.10	Sub-Contract Requirements	
6.10.1	Bought-In Items	R
6.10.2	Use of On-Site Sub-Contractors	R
6.11	Productivity	
6.11.1	Productivity Targets	R
6.11.2	Comparisons/Differences From Previous Vessels	R
6.12	Temporary Services	
6.12.1	Staging Plan	R
6.12.2	Access & Escape Plan	O
6.12.3	Power & Lighting	O
6.12.4	Weather Protection	O
7: ACCURACY CONTROL MANAGEMENT PLAN		
7.1	System Critical Dimensions & Tolerances	R
7.2	Interim Product Critical Dimensions & Tolerances	R
7.3	Sampling Plan	O
7.4	Special Procedures	O
7.5	Jigs & Fixtures	O
7.6	Hot Work Shrinkage	
7.6.1	Use of Extra Stock	O
7.6.2	Shrinkage Allowances	O
7.6.3	Distortion Control	O
8: TEST & TRIALS		
8.1	Test Planning	
8.1.1	Strategy	R
8.1.2	Schedule (High Level)	R
8.2	Pre-Completion Testing	
8.2.1	Pre-Survey & Dry Survey	O
8.2.2	Pipe Pre-Testing	O
8.2.3	Equipment Unit Pre-Testing	O
8.3	Tank Test Schedule	R
8.4	Equipment Unit Test Schedule	R
8.5	Pipe Unit Test Schedule	R
8.6	Zone Close-Out Strategy	R
8.7	Principal Trials Items	R
9: PERSONNEL		
9.1	Industrial Relations Aspects	
9.1.1	Design	O
9.1.2	Sub-Contract	O
9.2	Training	O
9.3	Project Organization	
9.3.1	Shipyard Organization Charts	R
9.3.2	Client's Organization Charts	R
10: WEIGHT CONTROL		
10.1	General	
10.2	Outline Procedure	R
10.3	Departmental Responsibilities	

1. R is recommended, O is optional.

spend its own money on actions that would benefit all projects, and would rather spend the customer's money on each project. This attitude is only sustainable in a captive or protected market and is not acceptable in a truly competitive market where every opportunity to save effort and improve a company's competitive position is the goal.

14.4.4.2 Build Strategy document contents list

A contents list, shown in Table 14.VIII, was developed for the NSRP Build Strategy project (15). The actual Build Strategy Document and the two examples followed 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 was also provided.

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