

Scantling Design & Approval Process Project Status



Product Design & Materials Technologies Panel
NSRP Joint Panel Meeting
Biloxi, Mississippi
11 March 2010

Scantling Design & Approval Process

I Overview

- Background
- Problem
- Approach
- Status

Scantling Design & Approval Process

I Background

- GD NASSCO has designed, built and delivered 4 classes of large vessels for a total of 21 ships since 1994
- All these vessels have been structurally designed to a combination of ABS Steel Vessel Rules and unique owner requirements
- All these structural designs have been reviewed, approved and classed by ABS
- All vessel classes have had unusual requirements and untypical structural features – **Structurally Complex**
- Programs experienced unanticipated challenges in achieving structural design maturity within the planned time frame – **Program Risk**

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Background

LMSR
1995-2000, 8 Ships



BP
2000-2005, 4 Ships



TOTE
2000-2003, 2 Ships



T-AKE
2001-2012, 14 Ships



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Background

Characteristic	Sealift LMSR	Trailer Ship	Tanker	Dry Cargo
Owner	Government	Commercial	Commercial	Government
Type	Vehicle Carrier	Trailer Carrier	Crude	Mixed Dry Stores & Bulk
Rules	ABS SVR Pt. 3	ABS SVR Pt. 3	ABS SVR Pt. 5	ABS SVR Pt. 3
Structural Notations	Yes	No	Yes	Yes
Steel Weight	27,000	24,000	34,000	11,000
Cargo Weight	20,000 Mixed Ro-Ro	16,000 Trailers and Autos	180,000 Crude	12,000 Mixed Dry Cargo/Liquid

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I Problem

➤ Structurally Complex Vessel

- Vessels such as tankers, containerships and bulk carriers are covered by well defined rule sets comprising design and validation methodologies - not considered to be structurally complex vessels
- Vessels with unusual and/or multiple operational requirements and tailored arrangements to accommodate operational requirements, not readily falling into an established rule sets
 - considered to be structurally complex vessels

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Problem

	Non-Complex Vessels	Complex Vessels
Ship Types	Crude Carrier Bulk Carrier Containership	General Cargo Vessel
Rule Sets	SVR Part 5 A, B, C 1-6	SVR Part 3

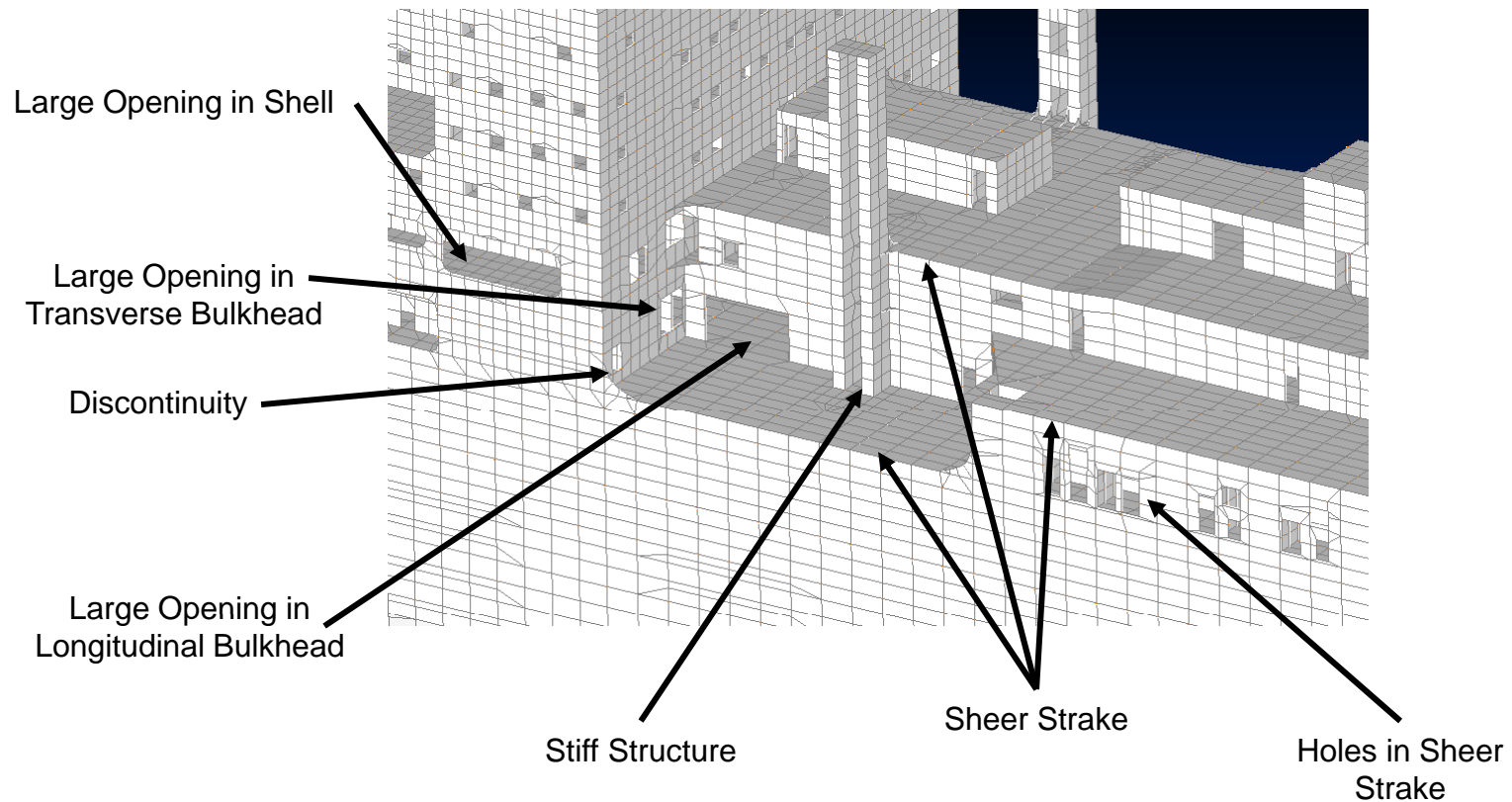
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I Problem

- **Characterizing complex structural features**
 - **Features tend to be extensive in scope**
 - **Large access openings in bulkheads, decks, and shell**
 - **Large penetrations in sheer strake and stringer plates**
 - **Open architecture deck supporting structures / long beam and girder spans**
 - **Major structural discontinuities in critical locations**
 - **Indeterminate sheer strake locations**
 - **High 'tween deck heights/ oversized bulkhead stiffeners**
 - **Large stiff structural fixtures integrated into relatively flexible ship structure**
 - **Etc, etc.....**

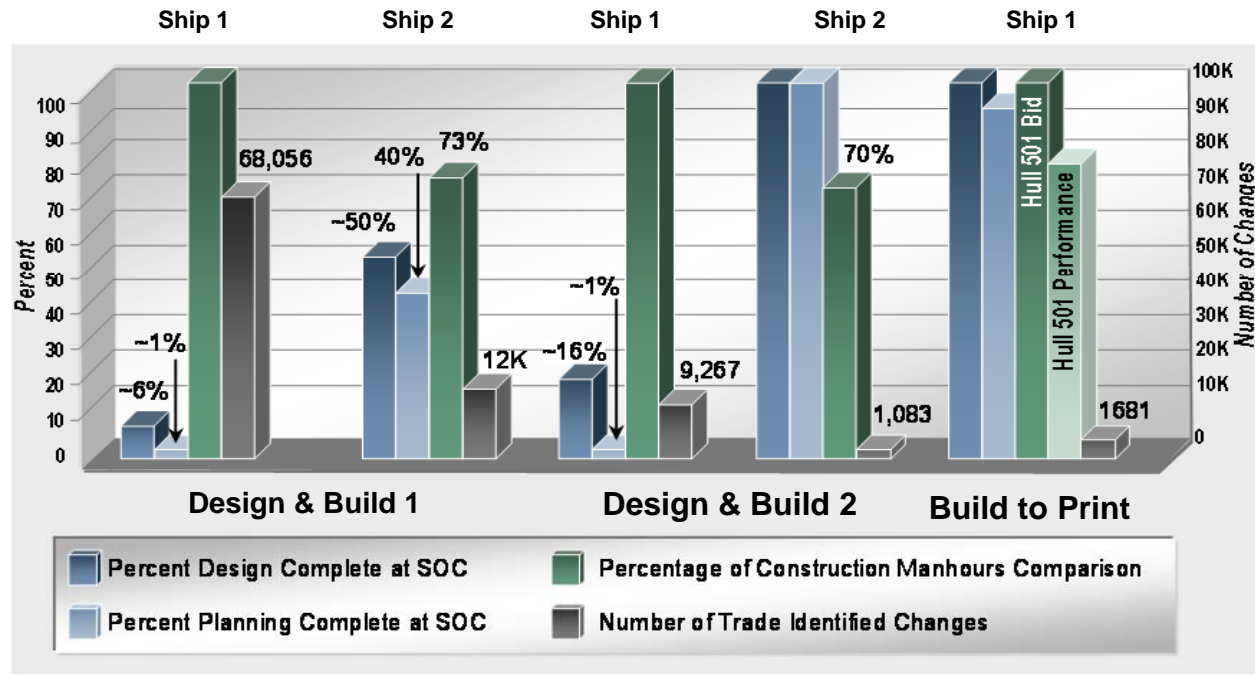
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I Problem



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Problem



More design and planning achieved by SOC → Fewer changes during construction

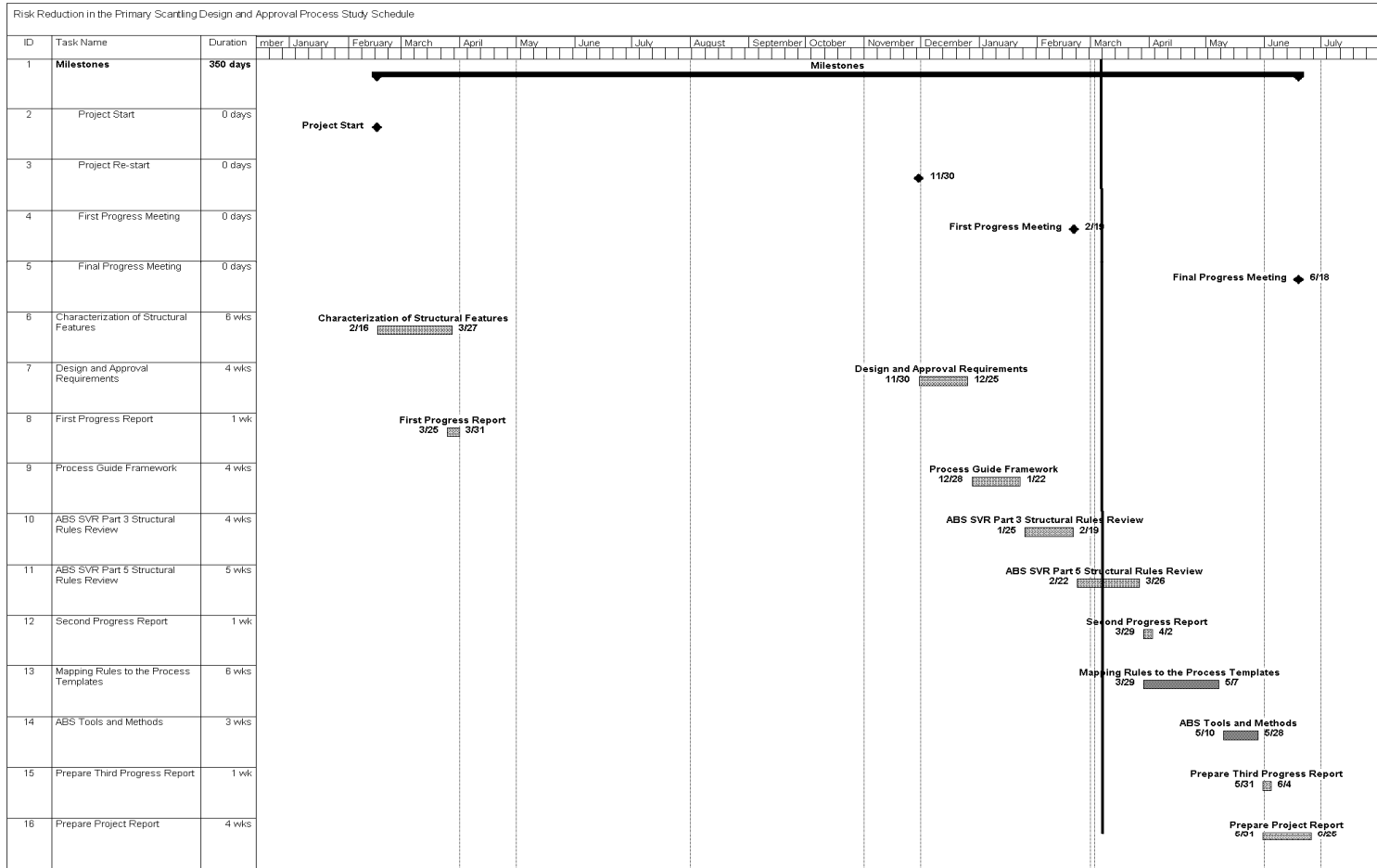
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Problem

- | **Need strategies and tools which enable the primary scantling definition to achieve stability and maturity in support of the vessel planning and construction schedule**
 - **Problem is not unique to NASSCO**
 - **What does this mean to the scantling design & approval process?**
 - **No heroes and villains**
 - **Share the experience**
- | **Goal**
 - **Develop process plan tools that will:**
 - **Facilitate the timely design and approval of complex vessel primary structures**
 - **Contain scantling change - minimize disruption to the ship planning and construction process.**

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Approach



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Approach

| Participants

GENERAL DYNAMICS



- **NASSCO Functional Engineering**
 - **Designed and submitted plans for approval**
 - **Project Participation**
 - **Develop process tools**
 - **Prepare report**



- **ABS Ship Engineering Department**
 - **Reviewed and approved plans**
 - **Project Participation**
 - **Contribute to process tool development**
 - **Review report**

GENERAL DYNAMICS



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I Approach

➤ Tasks

- **Characterization of complex structural features**
- **Design and approval process**
- **Process guide framework**
- **ABS SVR Pt 3**
- **ABS SVR PT5 and Guides**
- **Process templates**
- **Tools and Methods**

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Approach

Characterization of Structure

SHIP STRUCTURE CHARACTERIZATION TEMPLATES	
1.	Large access doors through watertight bulkheads –sliding and overhead
2.	Fixed access ramps penetrating through watertight decks and strength deck
3.	Side ports penetrating side shell
4.	Oversize vent intake and exhaust penetrations in the vicinity of sheer strake
5.	Integration of large kingposts into primary structure
6.	Extensive recesses into shell at sheer strake location
7.	Extensive discontinuities such as house endings
8.	Stanchions supporting cargo carrying decks
9.	Open arrangement of deck supports to facilitate vehicle and cargo movement
10.	Large openings in effective longitudinal structure
11.	Bow flare and bottom structure arrangement issues
12.	Excessive stiffener spans associated with deckhead heights (torsional buckling checks)
13.	Load paths through loaded decks into double bottoms
14.	Cargo decks and support arrangements at side shell and centerline
15.	Unusual stanchion configurations to suit cargo plan (trailer layout)
16.	"Anti-stanchions" (tension members) supporting deck girders from above
17.	Deep tank vertical stiffeners also carrying column loads

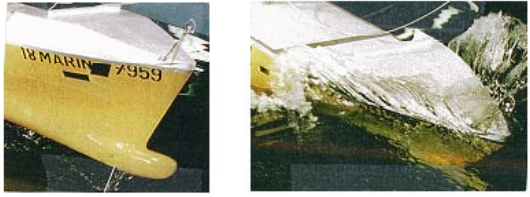
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Approach

Characterization of Structure Template

Structural Arrangements and Features
18. TBD
<u>CONFIGURATION:</u>
<u>RULE SET:</u>
<u>ISSUES:</u>
<u>APPROACH:</u>

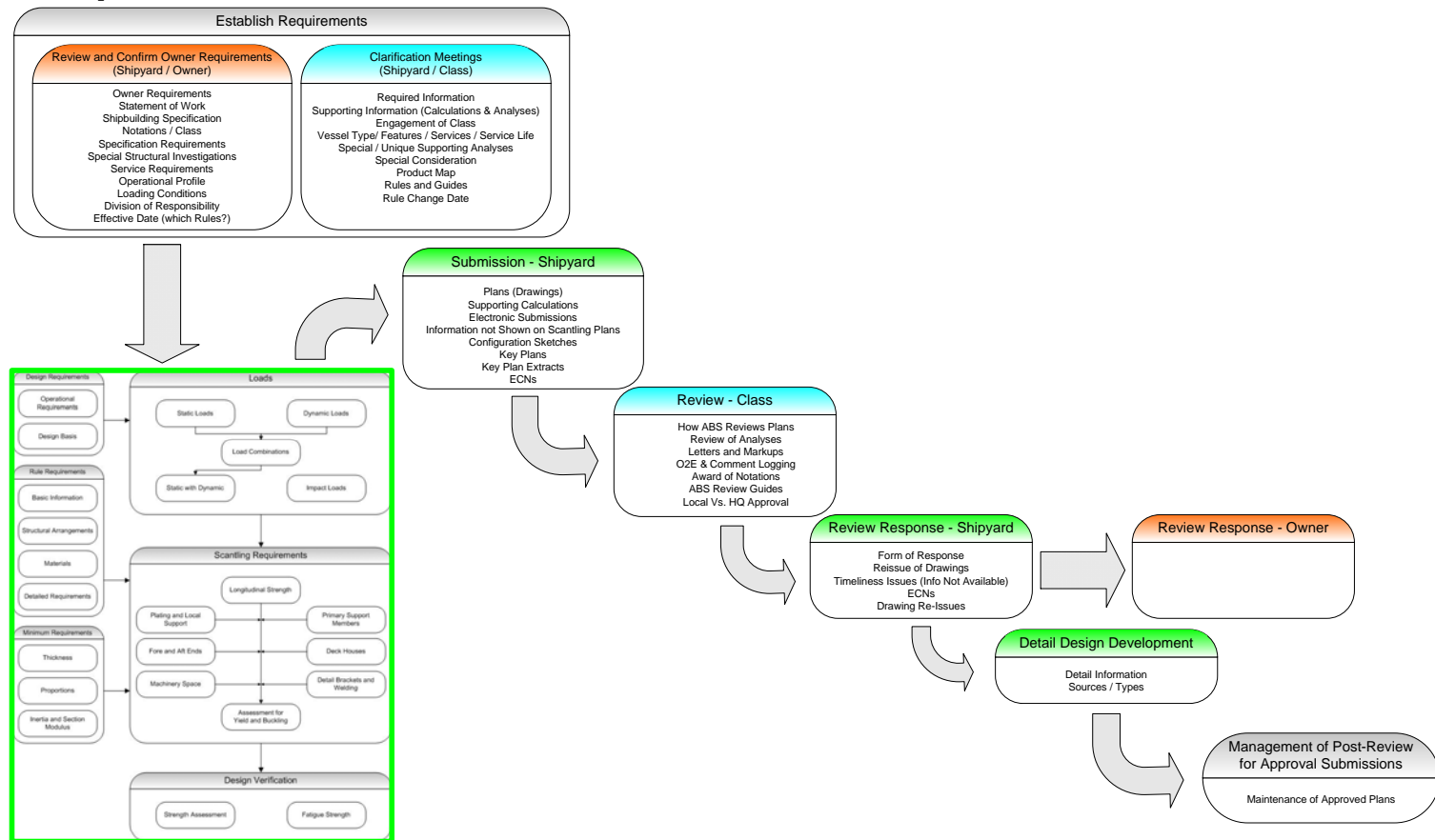


STRUCTURAL ARRANGEMENTS AND FEATURES
11. FORE END BOTTOM AND BOW FLARE STRUCTURES
<u>CONFIGURATION:</u>

<u>RULE SET:</u>
<ul style="list-style-type: none"> • 3-2-4/5 and 7 • 3-2-5/7.1 and 7.2 • 3-2-6/9.1 and 9.3 • 3-2-13/1
<u>ISSUES:</u>
Pt 3 provides generalized requirements which may not result in: <ul style="list-style-type: none"> • Efficient structure scantlings • Optimum Structural arrangement • Adequate scantlings for service
<u>APPROACH:</u>
Develop scantlings iaw <ul style="list-style-type: none"> • 5C-5-6/3, 5,7 etc • 5C-5-6/23 Verification by analysis not required

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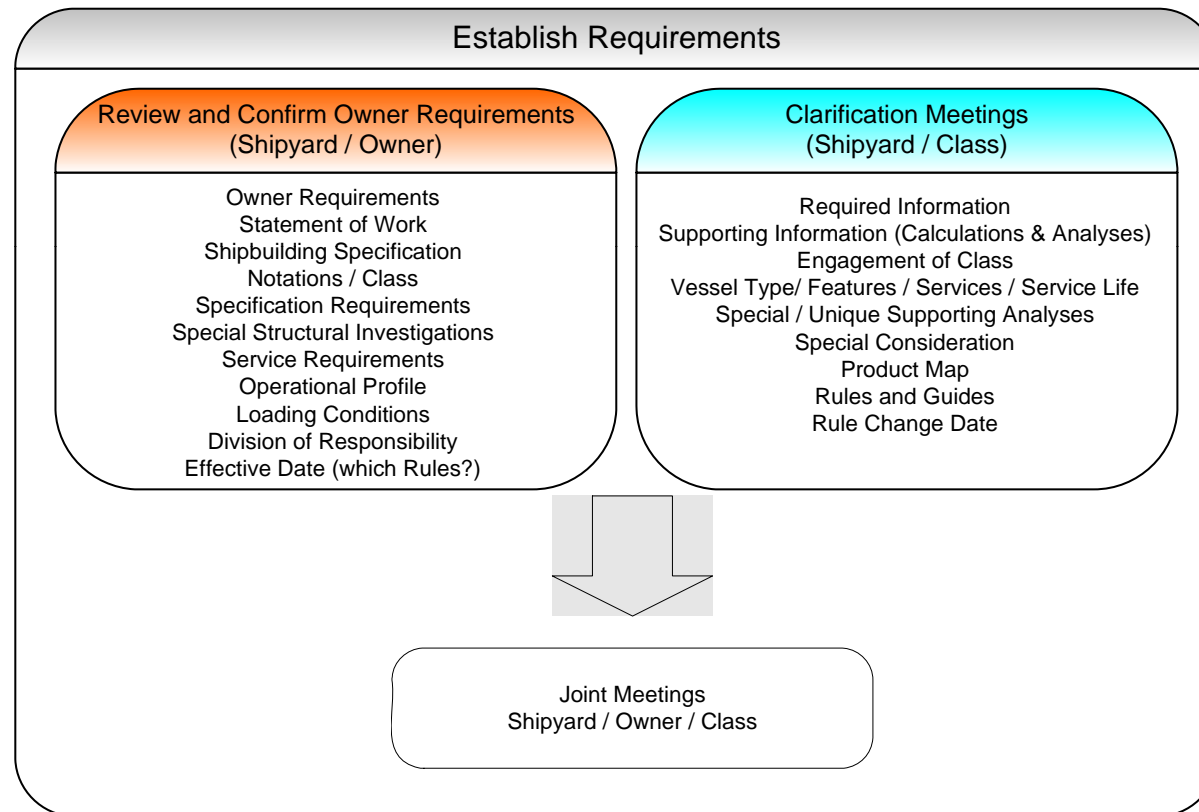
Approach

Process – Experience based review



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Approach Requirements



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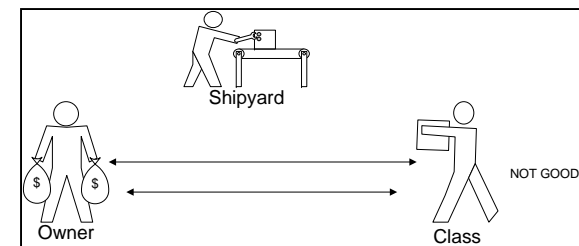
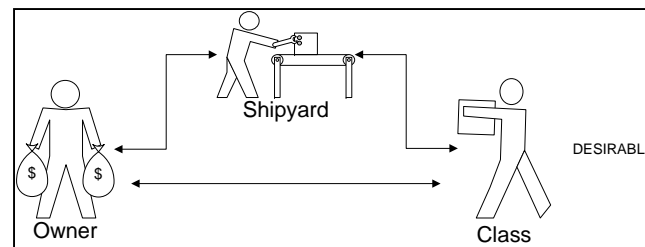
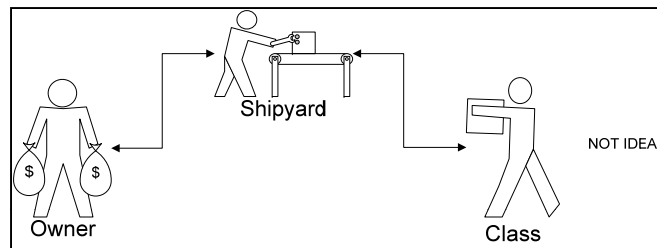
Approach Communication

Miscommunication	Issue	Outcome
Failure on the part of the Owner to identify all analysis cases "assumed" by the Owner	Upon completion of an extensive analysis the owner notes that a particular case has not been addressed. Class does not require the case	The shipyard agreed to run the case. In this particular situation no adverse findings resulted
Failure on the part of the shipyard to properly understand an Owner requirement which was incorrectly incorporated into the Specification	Upon completion of analysis Owner inquired about performance under dynamic loads.	Additional extensive analyses were undertaken which revealed non-compliance with specification
Failure of Shipyard to properly interpret Class "advice"	Shipyard had requested a pre-approval review of plans by Class with the objective of reducing the approval cycle time. The Shipyard chose to selectively incorporate Class "advice"	Increased plan approval cycle time and caused significant friction between Class and Shipyard
Failure to identify all requirements to achieve scantling approval of a complex mid-body structural design	The Shipyard engaged Class to undertake a pre-contract review and approval of a proposed design mid-ship section .6 months into the contract it was determined that a "direct calculation " approach analysis would be required to support plan approval	An unplanned extensive 3-D finite element analysis was undertaken to support plan approval resulting in significant stress to both Shipyard and Class

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Approach

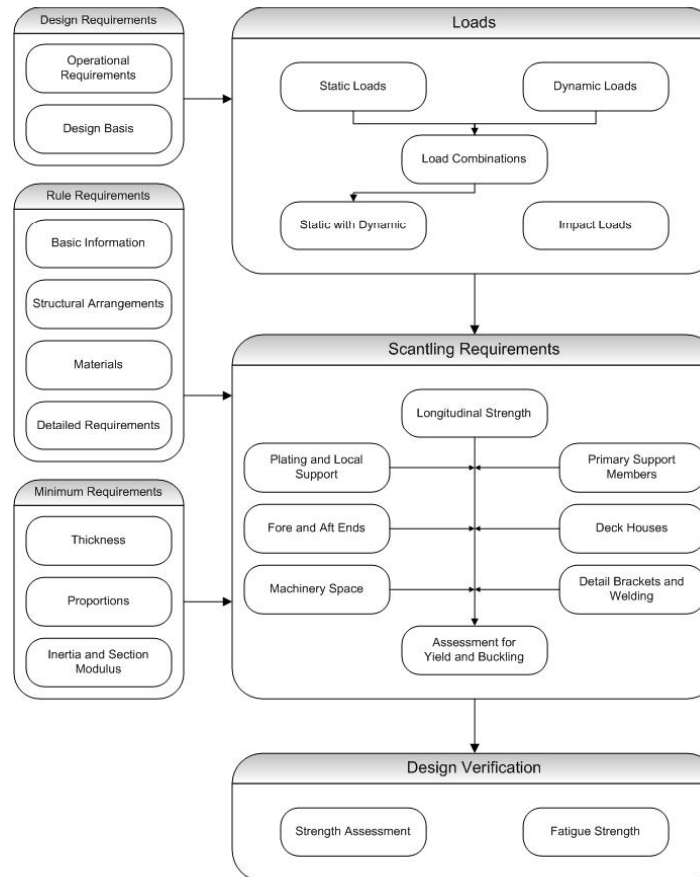
Communication Models



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Approach Simplified Structural Design Process

ABS SVR
Part 3



ABS SVR
Parts 5A and B
Part 5C 1-6
Part 5C 7-10

Guides

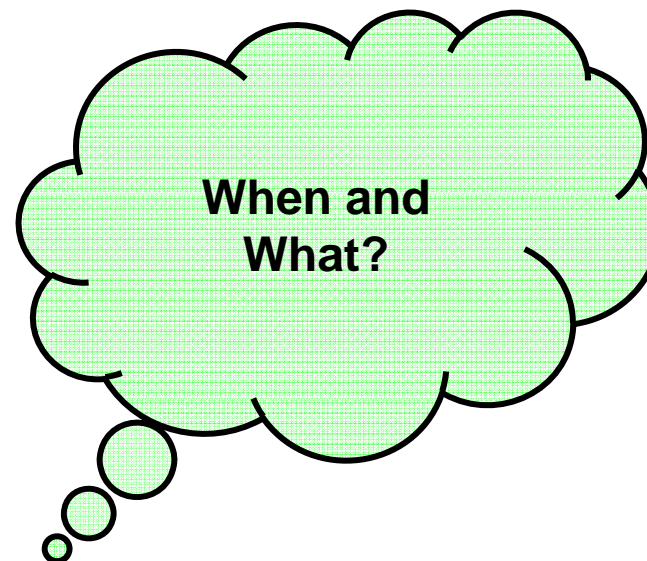
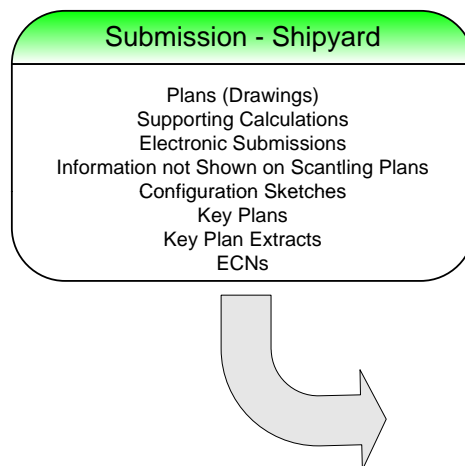
Scantling Design and Approval

Approach

- | **Design Process - SVR Part 3**
 - **Primary Scantlings**
 - **Global – Mid body effective longitudinal structure**
 - **Parts of Ship**
 - **Other**
 - **Welding**
 - **Key Phrases to Watch for:**
 - *Effectively connected*
 - *Special attention*
 - *Special consideration*
 - *Adequate buckling strength*
 - *Attention is drawn* (fatigue with high-strength steel)
 - *Give consideration to* (corrosion, proportions, stress concentrations)
 - *Provide proper margins*
 - *Acceptable to surveyor*
 - *It may be required to submit calculations*
 - *Etc.....*
 - **More to come on Part 5 and Guides**

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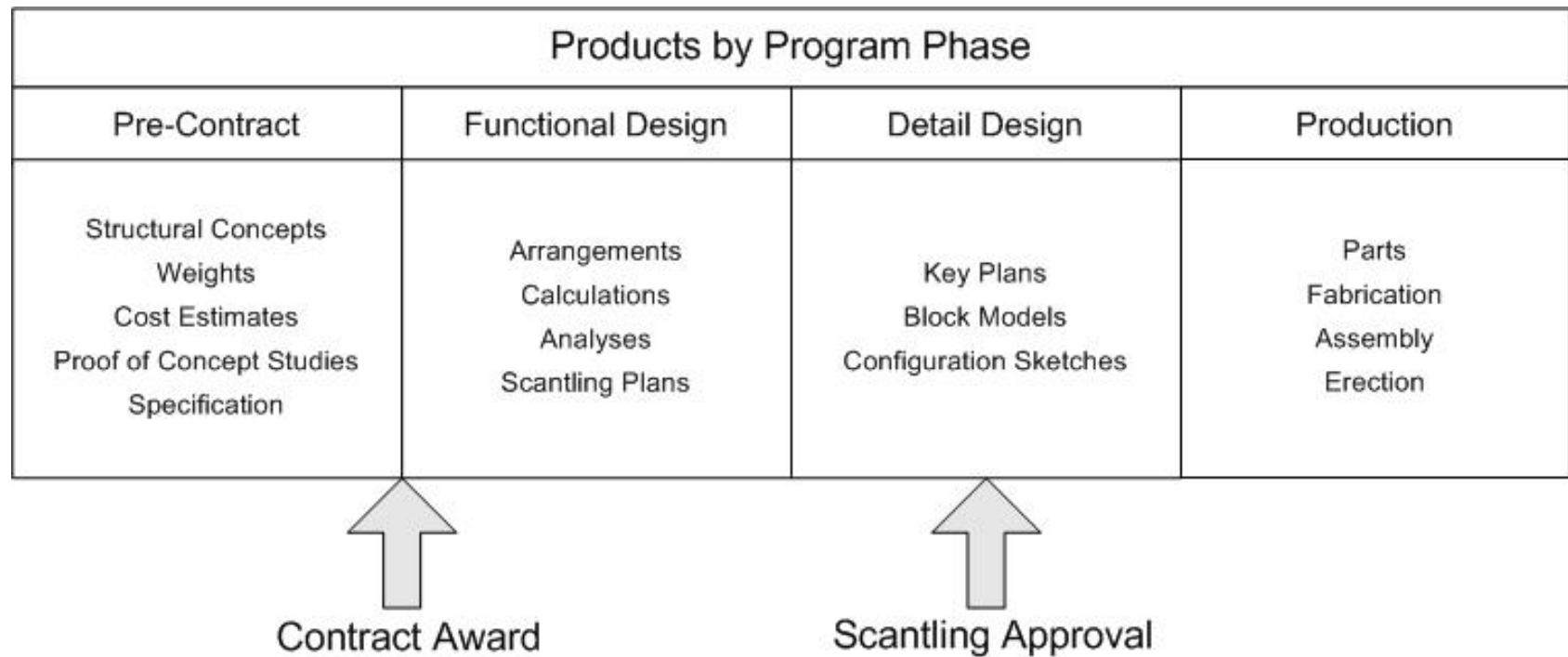
Approach Approval Process



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Approach

Products and Program Phase



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Approach

Approval Process Products

- | Anchor Handling Arrangement
- | Bow Framing
- | Framing Plan
- | Hull Port and Framing Details
- | Machinery Casings
- | Boiler, Engine, and Main Auxiliary Foundations
- | Miscellaneous Non-Tight Bulkheads Used as Structural Supports
- | Scantling Profile and Decks
- | Shaft Tunnels
- | Skeg Attachment Foundations
- | Stem
- | Stern Framing
- | Ventilation System on Weather Decks
- | Watertight Doors and Framing
- | Welding Schedule and Details
- | Bottom Construction, Floors, Girders, etc.
- | Deck Plans
- | Hatches and Hatch Closing Arrangements
- | Inner Bottom Plating
- | Midship Section
- | Pillars and Girders
- | Shaft Struts
- | Shell Expansion
- | Spectacle Frames and Bossing Details
- | Stern Frame and Rudder
- | Superstructures and Deckhouses (with Closing Arrangements)
- | Watertight and Deep-Tank Bulkheads
- | Weathertight Doors, Framing, and Sill Heights
- | Window and Framing Details

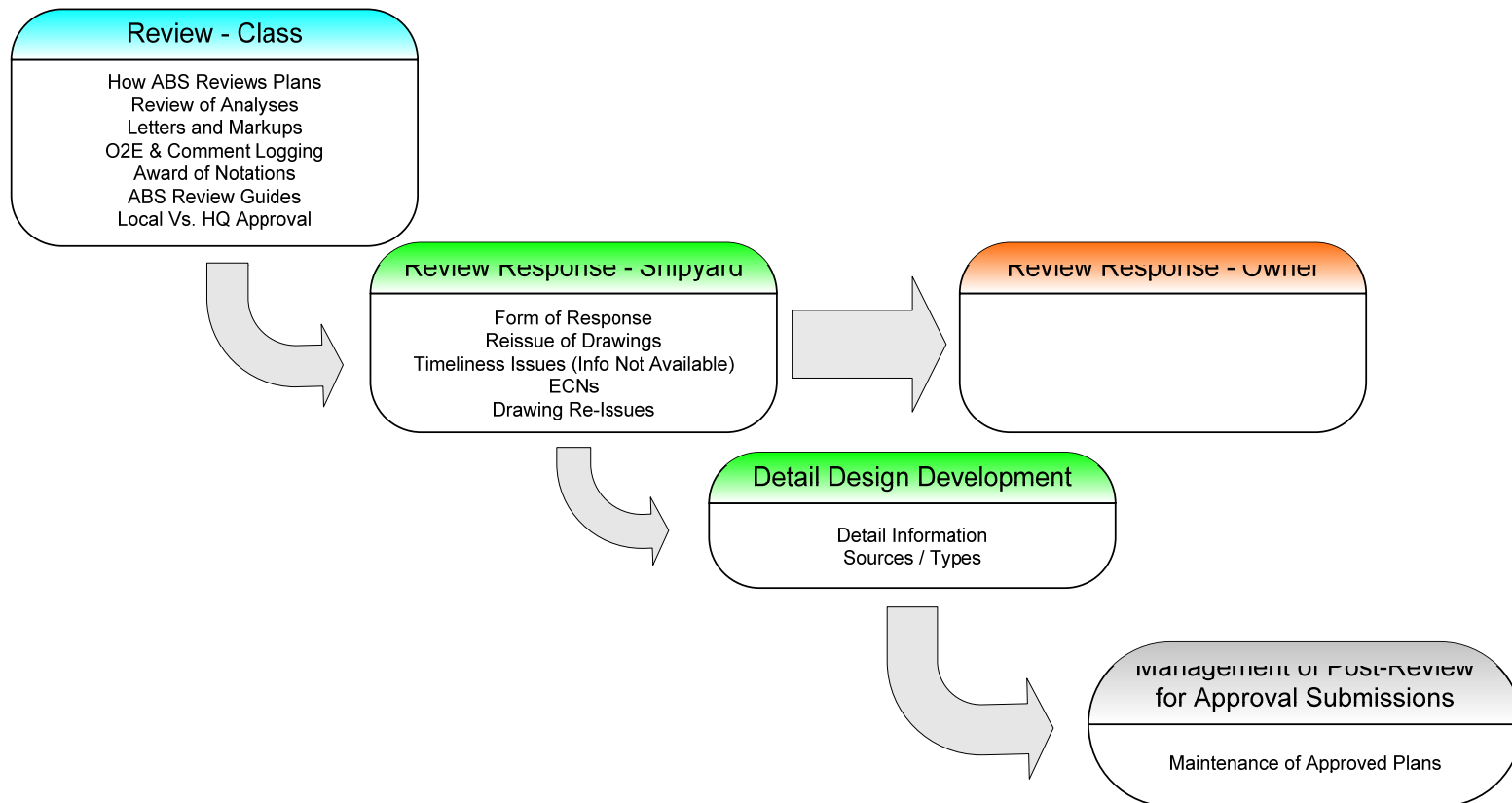
Product Map



- Scantling plans (80 – 100 sheets)
- Rule based design calculation reports (20 - 30)
- Finite element based global analyses of the vessel (1)
- Finite element based local analyses of vessel parts and features (5 -10)
- Major equipment foundation analyses (3 -10)
- Standard structural details (100 sheets)
- Structural welding details (1)
- Design zone structural key plans (800 – 1,000 sheets)

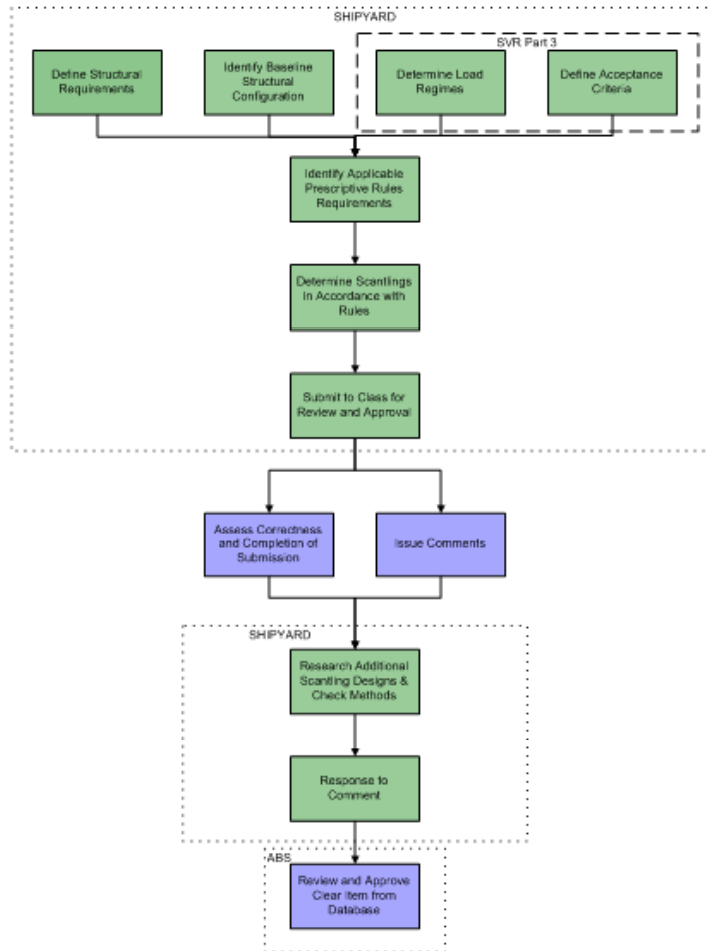
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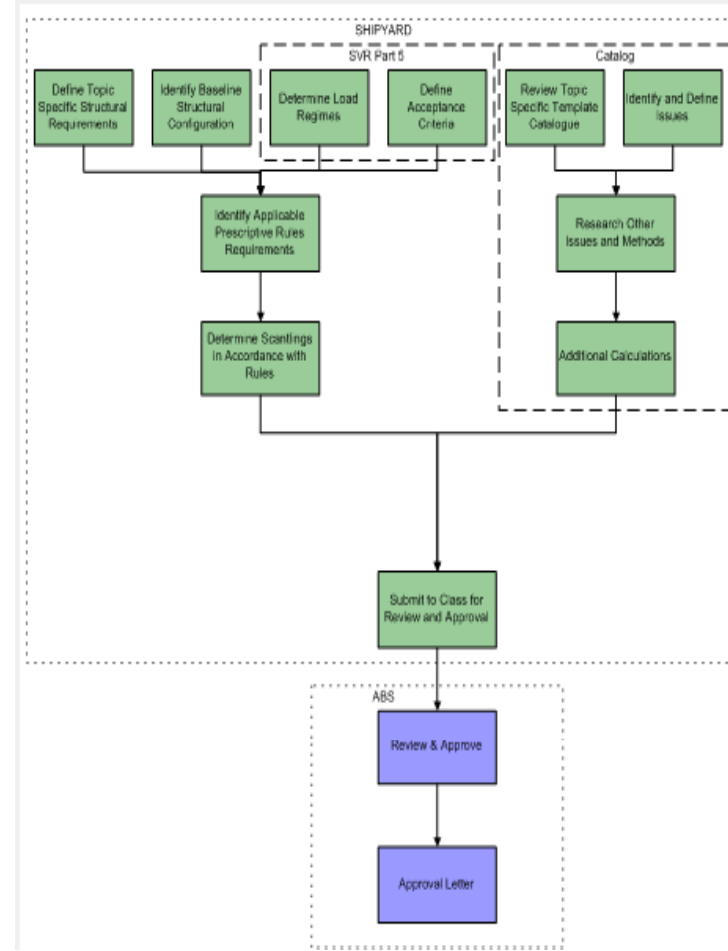


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WAS



IS



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Process Template

Process Template –			
Determination of Loads	Criteria	Method	Verification

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Process Template Example

Process Template – Fore End Bottom & Bow Flare Slamming			
Determination of Loads	Criteria	Method	Verification
5C-5-3 / 5.3.4a Bow Pressures	Bottom Slamming Plate f as defined in 5-5-4 / 11.3 and 5-5-6 / 23.1.1	Plate $t = (c)S(k_1 \frac{P_s}{f_1})^{1/2}$	Not Required
5C-5-3 / 11.1 Bottom Slamming Pressure	Longitudinals f _b as defined in 5-5-4 / 11.3 and 5-5-6 / 23.1.1	Longitudinals $SM = \frac{M}{f_b}$	
5C-5-2 / 11.3	Bow Flare Plate f as defined in 5-5-4 / 11.3 and 5-5-6 / 23.1.1		
	Side Longs and Frames f _b as defined in 5-5-6 / 23.3.2 and 5-5-4 / 11.3.1		
	Side Transverses and Stringers f _b as defined in 5-5-6 / 23.3.3 and 5-5-4 / 11.3.1		

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I Final Report

- Experience-based discussion of the review and approval process – *leading to process check sheets*
- Catalog comprising:
 - Complex structural arrangements
 - Process templates - *indentifying Class approved methods beyond SVR Pt 3*

I Project completion - June 2010