Accuracy Control

STANDARDS AND PROCEDURES

Foreword

Accuracy Control is our systematic approach to monitoring every stage of the shipbuilding process, from the initial cutting of raw plate to the final delivery of the vessel. Our goal is to ensure that each component is manufactured with the highest precision, adhering closely to design specifications for a seamless fit during final assembly on the dry-dock.

Through this continuous monitoring, our Accuracy Control team will be able to effectively identify the root causes of issues such as twisting, deformation, and dimensional discrepancies. This proactive approach not only helps us correct current deviations but also enables us to develop and refine procedures to prevent similar inaccuracies in future builds.

This manual outlines the general accuracy control standards adopted by [redacted]. It is based on the principles of the [redacted] Accuracy Control Manual, with further reference to IACS Recommendation No. 47 Rev.10 and the ABS Rules for Building and Classing Marine Vessels, Part 3. Please note that where project-specific requirements differ, those standards will take precedence.

We view this manual as a living document, designed to evolve with out work methods and as we achieve new improvements in construction standards. To that end, your feedback is invaluable. We welcome all suggestions and insights, as they are crucial to our continuous effort to ensure top-quality builds and enhance operational efficiency.

Chapter 1: General Accuracy Control

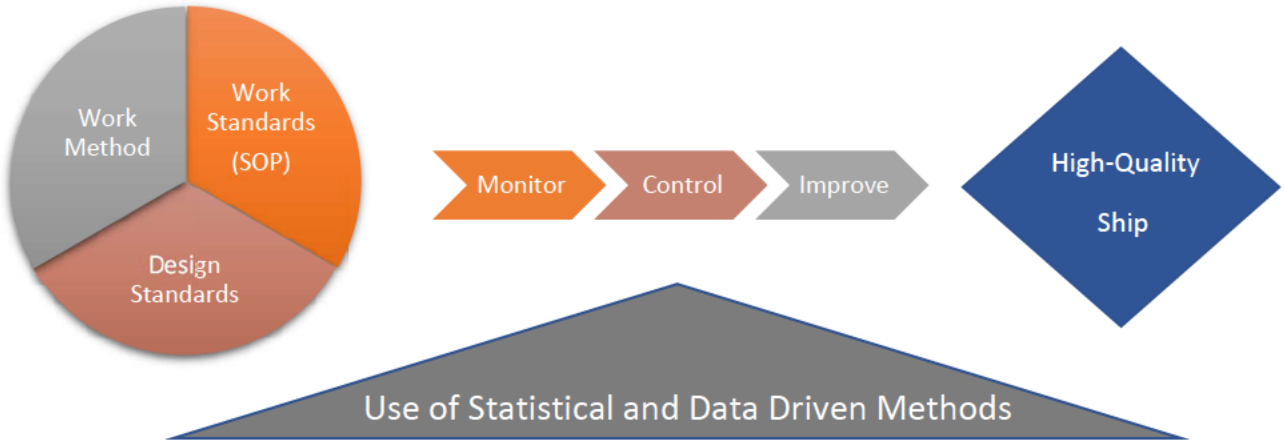
I. Overview of Accuracy Control

II. Accuracy Control Standards (Tolerance Table)

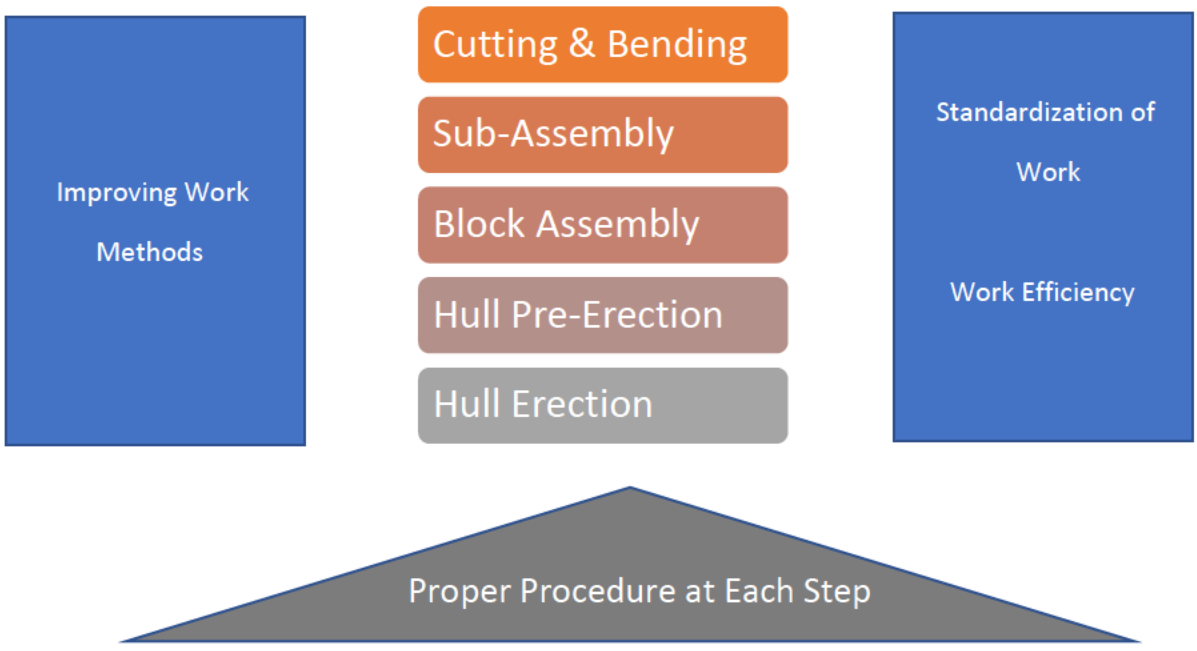
1. Overview of Accuracy Control

1. Definition of Accuracy Control

- **It is the process carried out at all stages of fabrication, assembly, and erection to satisfy the shape and dimensions required by the design; It's the foundation of technical management in production.**



2. Purpose of Accuracy Control

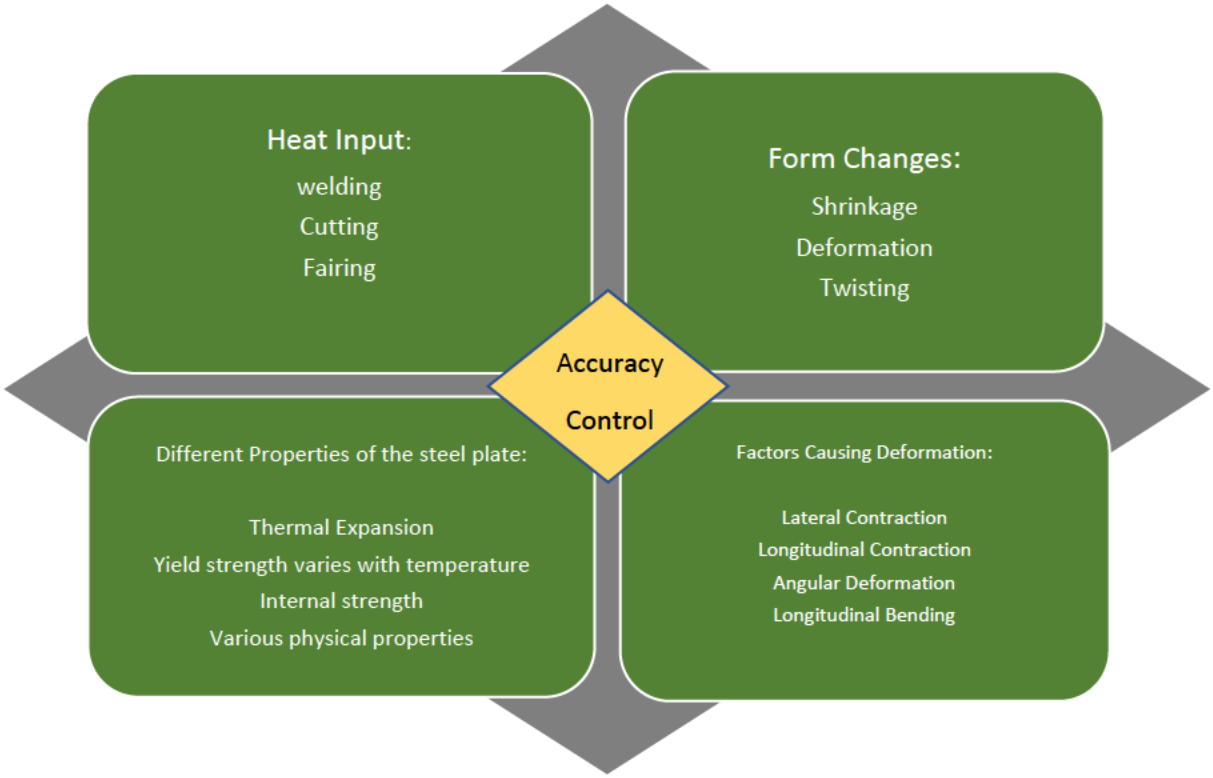


3 . Basic Principles of Accuracy Control

◐Right Way ◐Policy ◐Experience ◐Practice

◐Sacrifice ◐Challenge ◐Creation ◐Endless

4 . The Importance of Accuracy Control



5. The 3 Major Elements of Accuracy Control

Element	Control Item	Type of rework	Control Point
Dimension	LxBxD (Length x Breadth x depth)	Re-cutting, Trimming, Gap	Reference Line, Shrinkage Value
Twisting	Level, Perpendicularity	Re-cutting, Trimming, Gap	Restraint, Application of Reverse Deformation, Welding sequence
Deformation	Deformation Prevention	Fairing	Welding Sequence, Welding Method (Throat), Back Heating

6. Procedure of Accuracy Control

Initial Plan	Detailed Plan
Block Div **DWG** DAP **DEP** DOP	Work Method, **Control Standard,** Vital Point, **Key Outfitting,**
Accuracy Plan Shrinkage Drawing	

Preparation	Measurement
Check Sheet, Check Method, **Measurement Equip.,** Measurement Tools, **Safety Mgmt.**	Measurement Record, **Program Registration (database),** Info Sharing with preceding/succeeding processes
Dimension Control Sheet Measurement Equipment	

Evaluation	Improvement
Data Analysis Cause Analysis **Countermeasure Establishment,** Post-Mgmt. **Improvement Proposal**	Tolerance Standard, **Work Method,** Accuracy Control Program, **Measurement Equip.**
Accuracy Index Mgmt. Accuracy Improvements	

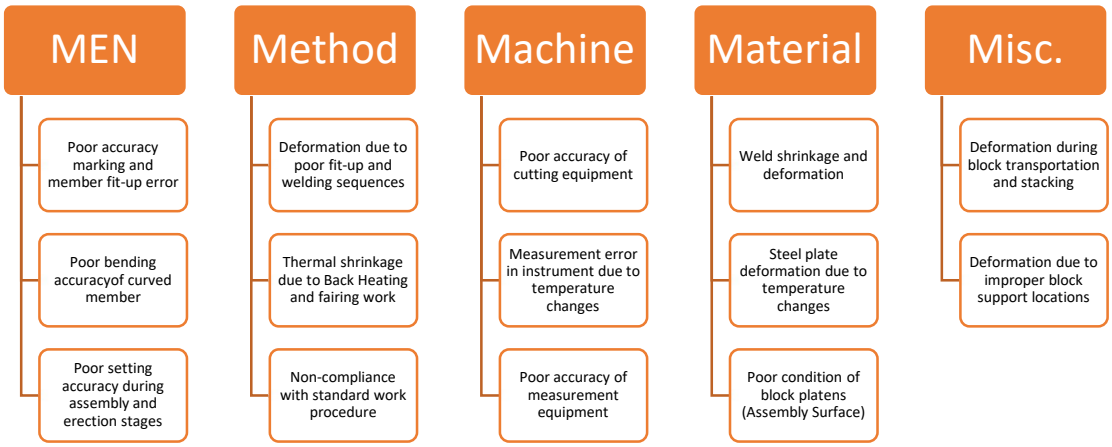
Key Checkpoints by Construction Stage

Fabrication	Assembly	Pre-Erection	Erection	Outfitting Fab.	Subsequent Outfitting
Plate cutting, **Bending,** **Internal** Member Cutting, **Ref. Line Marking,** Fabrication Equip.	Plate Joining, **Marking,** Internal Member Fit-up, **Sub-Assembly,** **Assembly,** Grand Assembly	Level, **Perpendicularity,** Edge Misalignment, **100M.K.,** Length/Breadth, **Straightness**	Absolute Position, **Setting,** Fit-up/Weld Sequence, **Shaft/Rudder Mgmt.,** Alignment, **Final Dimension**	Outfitting Fab., **Pipe Cutting,** Pipe Bending, **Steel Outfitting Fab.** Fittings, **Flange Fit-up,** Angle/Bolt Hole	Pipe Installation, **Various Seat Installation,** Unit Outfitting, **Large Gas Pipe/Duct Installation,** Accommodation GRP, **Pipe/Pump Room Area**

7. Causes for Accuracy Problems

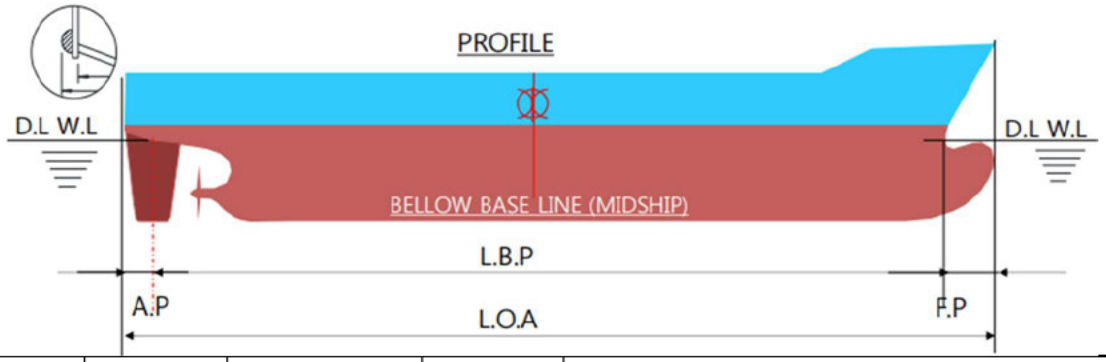
Causes of accuracy problems exist at every stage of the process, including fabrication, assembly, and erection.

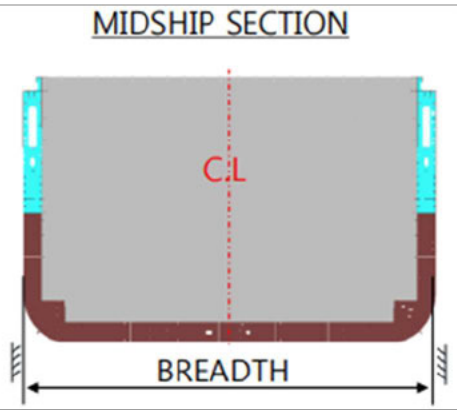
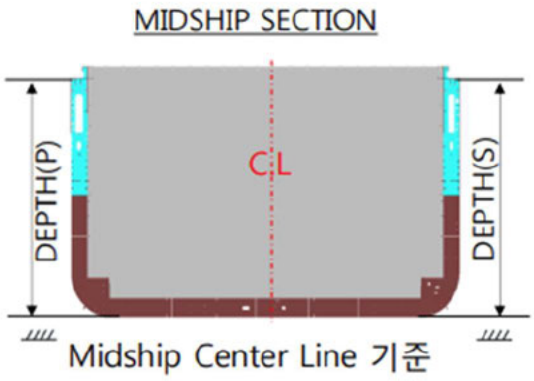
The goal is to predict accuracy in advance to eliminate the causes of accuracy problems beforehand.

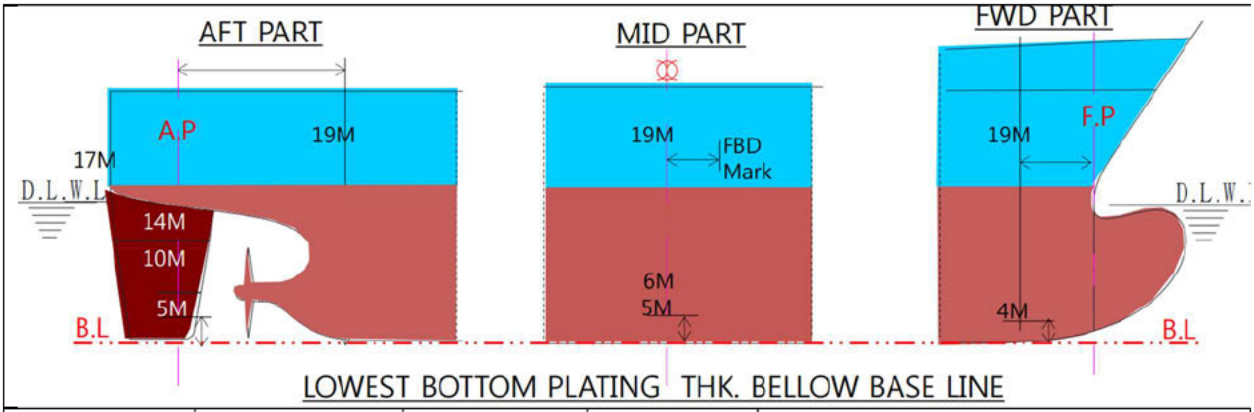


2. Accuracy Control Standards

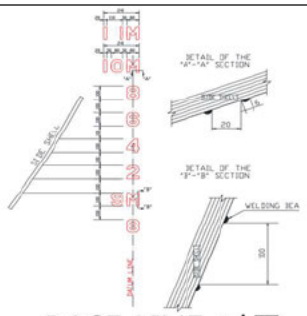
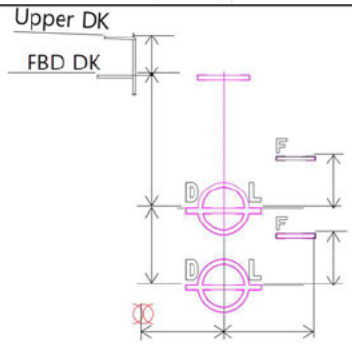
1. Principal Dimensions



Category	Detailed Item	Work Standard	Stage	Check Standard
Principal Dimension	L.O.A.	±L/1000mm L is in mm	Erection	Distance from the stern-most point to the bow's forward-most point
	L.B.P	±L/1000mm L is in mm	Erection	Distance from A.P. to F.P.
	Breadth	±B/1000mm B is in mm	Erection	
	Depth	±D/1000mm D is in mm	Erection	

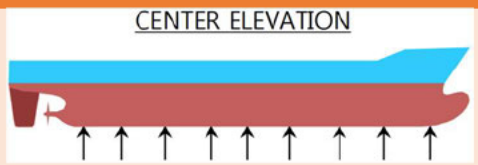
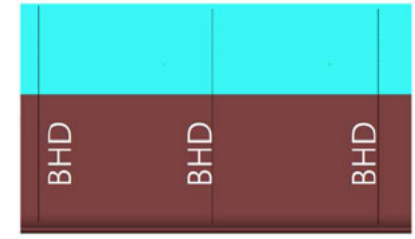
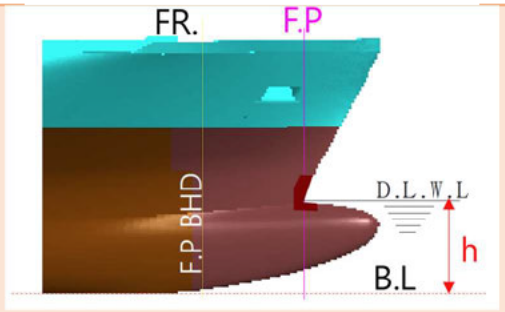
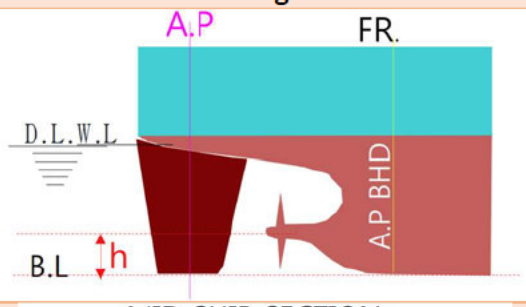
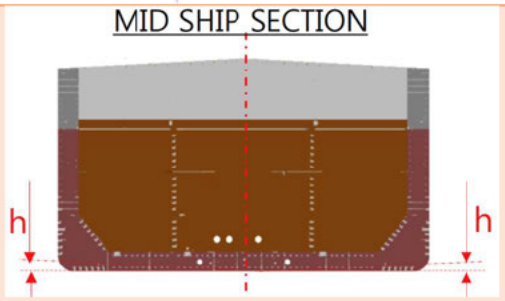


LOWEST BOTTOM PLATING THK. BELLOW BASE LINE

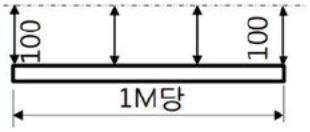
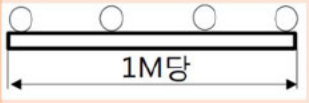
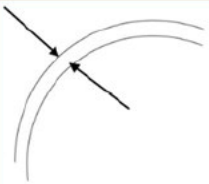
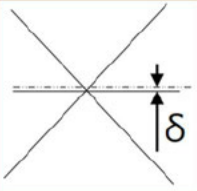
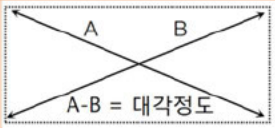
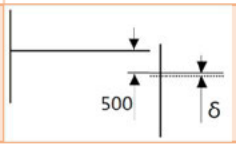
Category	Detailed Item	Work Standard	Stage	Check Standard
DRAFT MARK	Draft Marks	±2mm	Erection	 - BASE LINE 기준
	Air Draft	H ≤ Nominal	Erection	
FREE BOARD MARK	Freeboard Mark	±1mm	Erection	 - UPPER DECK LINE 기준

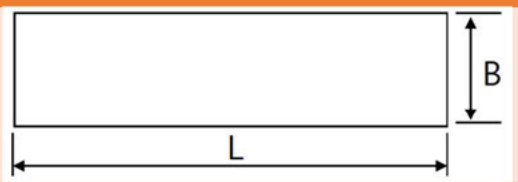
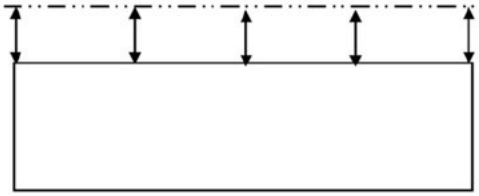
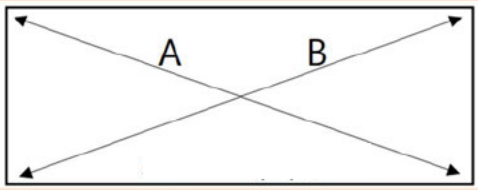
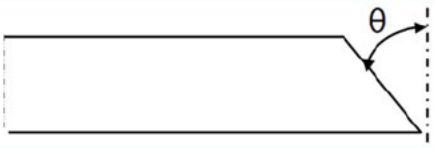
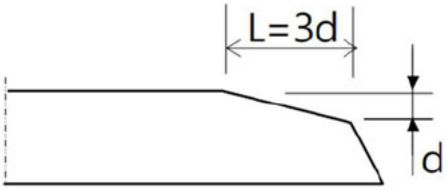
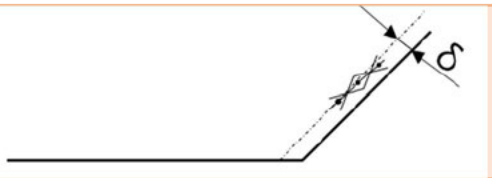
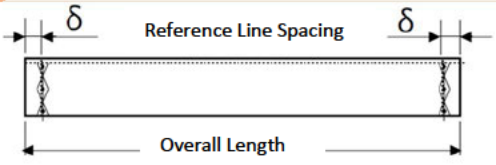
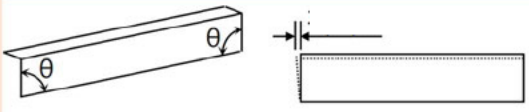
2. Draft and Freeboard

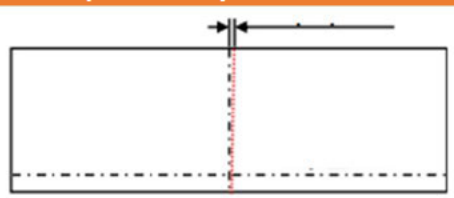
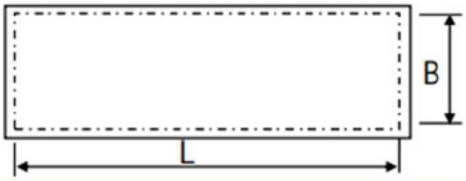
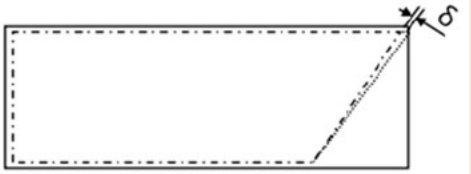
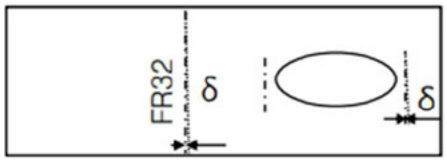
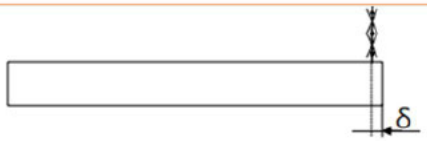
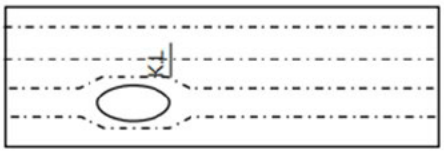
3. Major Deformations

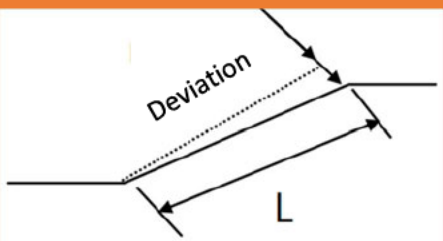
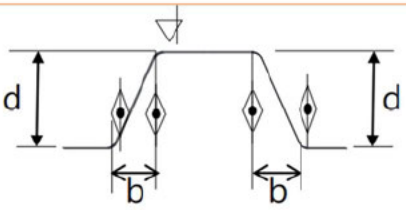
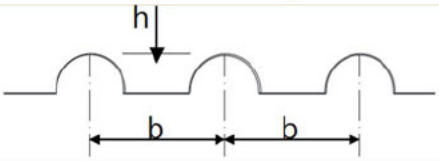
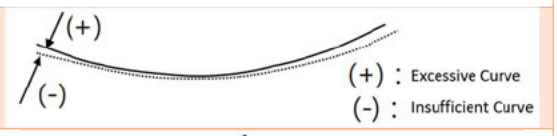
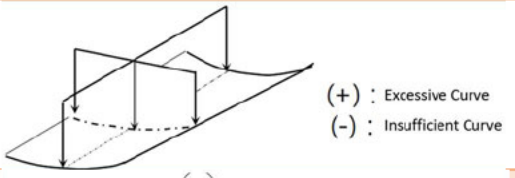
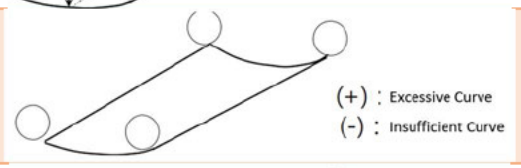
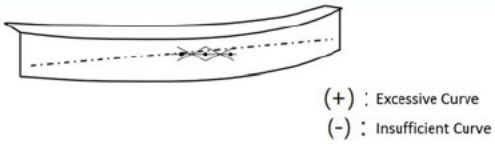
Category	Detailed Item	Work Standard	Shape and Key Control Points
Keel Flatness	Deformation for the whole Length	±50 mm	 Keel deformation is measured based on the keel sighting inspection line
	Deformation between two adjacent Bulkheads	±15 mm	
Cocking Up	Fore Body	±30 mm	 The deviation is to be measured from the design line
	Aft Body	±20 mm	
Rise of Floor Amidships	Rise of Floor Amidships	±15 mm	 The deviation is to be measured from the design line

4. Fabrication Stage Accuracy Control Standard

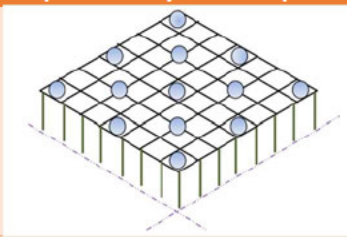
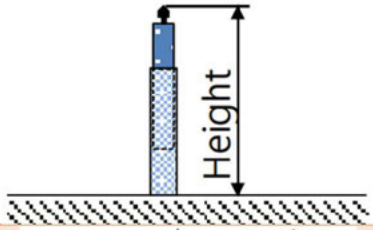
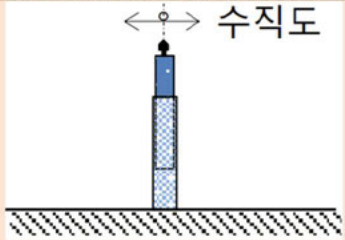
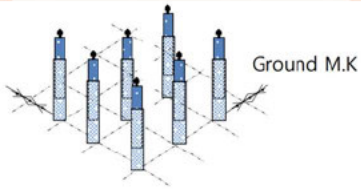
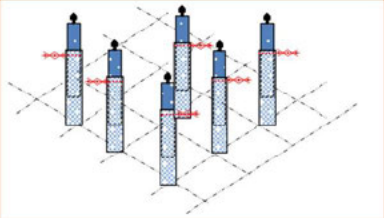
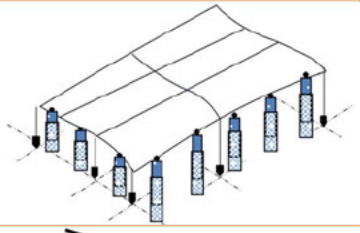
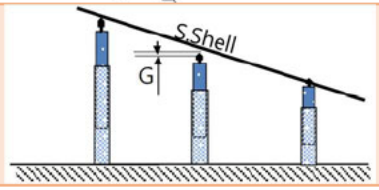
Category	Control Item	Work Standard	Shape and Key Control Points
Cutting Equipment	Cutting Equipment Precision (Precision between cutting start and end points)	±0.5mm	 -Precision is checked by moving the marking torch a set distance on the X-axis and returning to the start point. -Performed for both X and Y axes. -Performed once a month.
	Cutting Equipment Rail Straightness	±1mm / Full Length	 -Cutting equipment management is performed at 6-month intervals.
	Cutting Equipment Rail Level	±1mm / Full Length	 -Cutting equipment managements is performed at 6-month intervals.
	Marking Roundness	±1.5mm / Full Length	 -Precision is checked by drawing two circles on different diameters with the marking torch and verify the diameter accuracy. -Preformed once a month.
	Marking Intersection Error	±0.5mm	 -Precision is checked by drawing three intersecting straight lines with the marking torch and verify their alignment. -Performed once a month.
	Diagonal Error	±0.5mm	 -Squareness of 4 sides is checked by drawing a rectangle with the marking torch. -Performed once a month.
	Offset	±0.5mm	 -Movement precision is checked by moving the marking torch a set distance. -Performed once a month

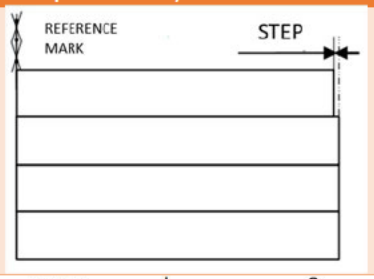
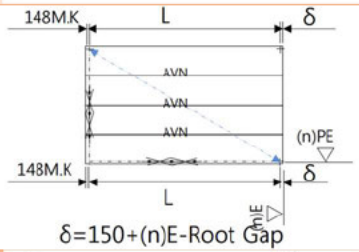
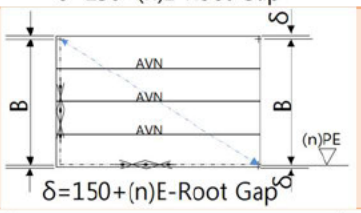
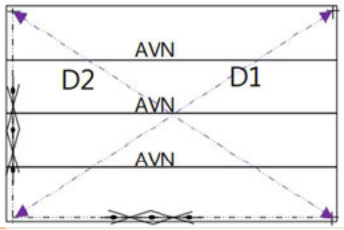
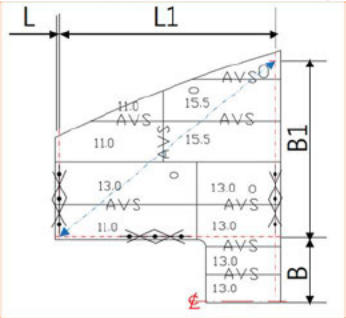
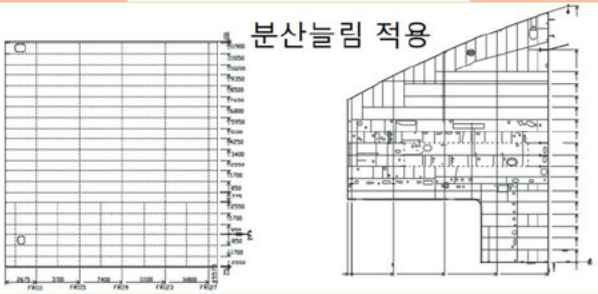
Category	Control Item	Work Standard	Shape and Key Control Points
Cut Member	Length, Width	±1 mm	
	Straightness	±1 mm	
	Diagonal	±1 mm	 A - B= Diagonal Accuracy
	Bevel Angle	θ ± 2.0°	
	Root Face	±1 mm	
	Chamfer Angle	± 1.0d	
	Plate Joining Reference Line	±1 mm	
	Longitudinal Cutting Length	Overall Length: ±1.0mm Ref. Line: ±1.0mm	
	Longitudinal Cutting Squareness	±1 mm	

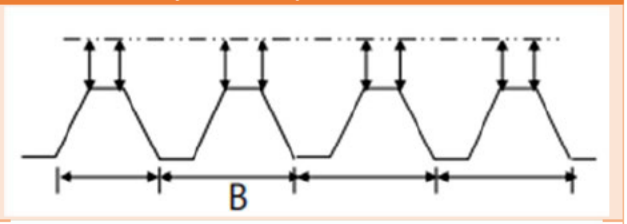
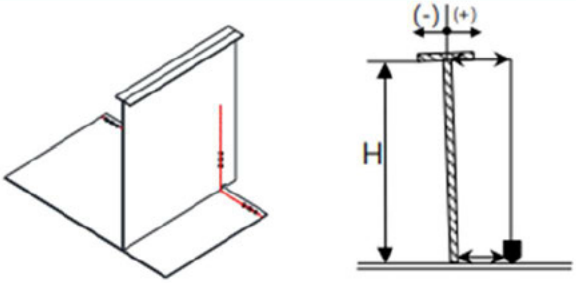
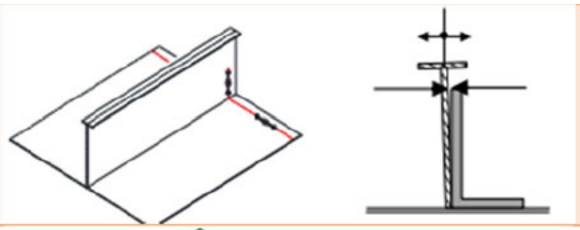
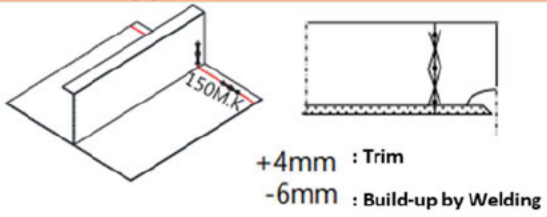
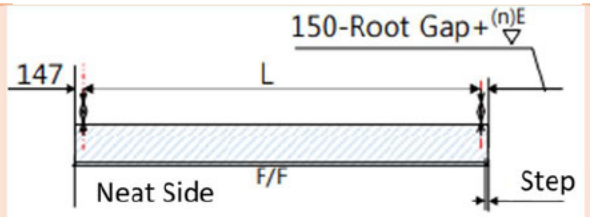
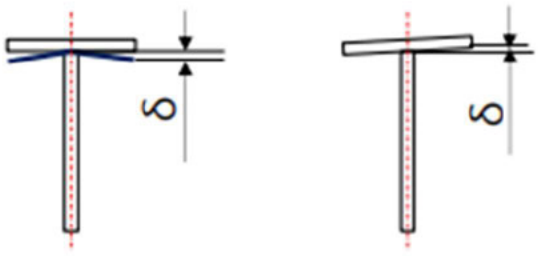
Category	Control Item	Work Standard	Shape and Key Control Points
Marking	Reference Line (W.P.)	Straightness: ±0.5mm Squareness: ±0.5mm	 -Straightness is measured with a piano wire
	General Member Width, Length	±1.0mm	
	Member Angle	±1.0mm	
	Reference Line (Internal Member, Frame)	±1.0mm	
	Member Fit-up Position (B/W)	±1.0mm	
	Fit-up Line (150MK)	±1.0mm	
	R-END or Knuckle Angle	±1.0mm	

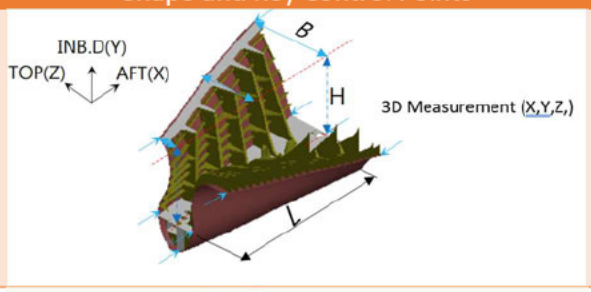
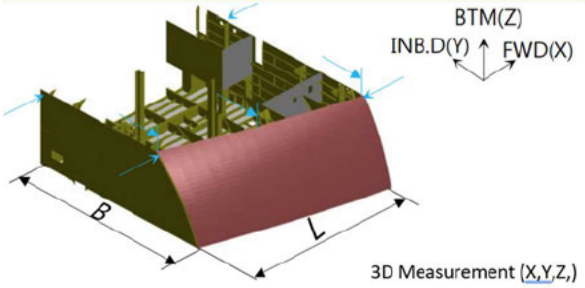
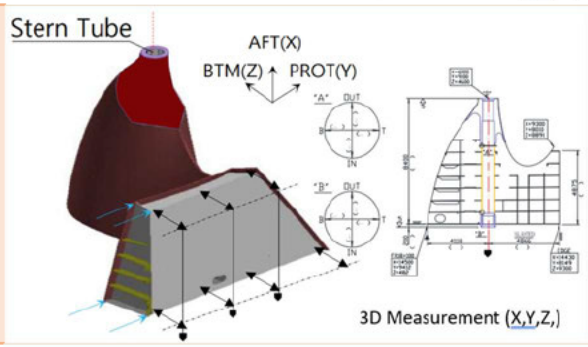
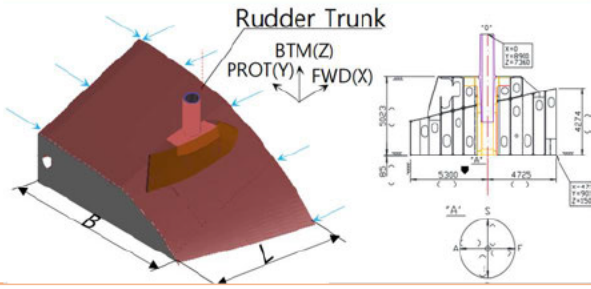
Category	Control Item	Work Standard	Shape and Key Control Points
Bending	Knuckle	±3.0mm	
	Corrugated Bulkhead	±3.0mm	
	Corrugated Wall	h: ±3.0mm b: ±3.0mm	
	Roll-Bending	0 ~ -5mm	
	Flange Bending	0 ~ -5mm	
	Shell Plate Transverse/Longitudinal Curve	0 ~ -5mm	
	Shell Plate Twist	±5.0mm	
	Longitudinal Curve Bending	±3.0mm	

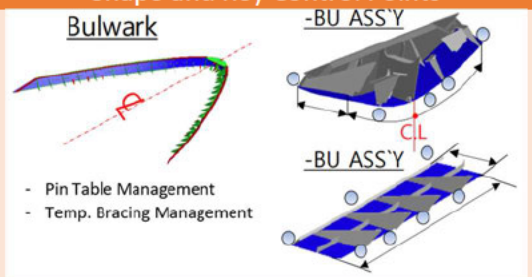
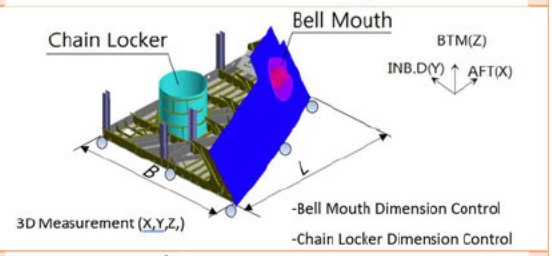
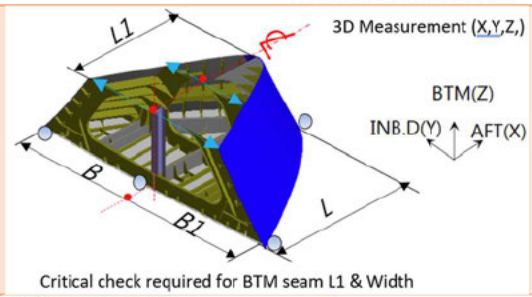
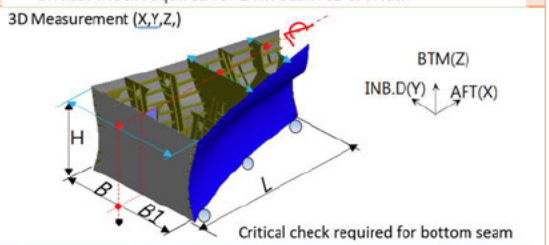
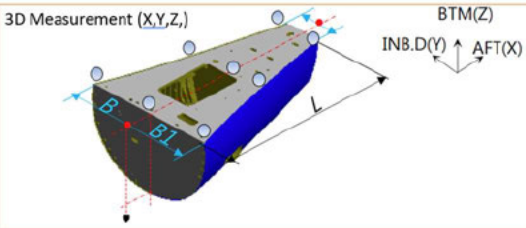
5. Assembly Stage Accuracy Control Standard

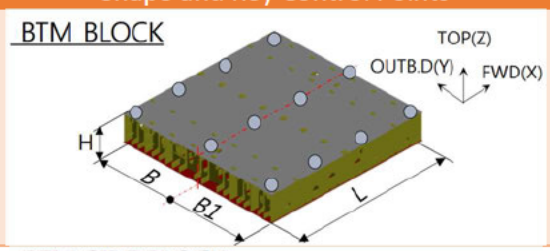
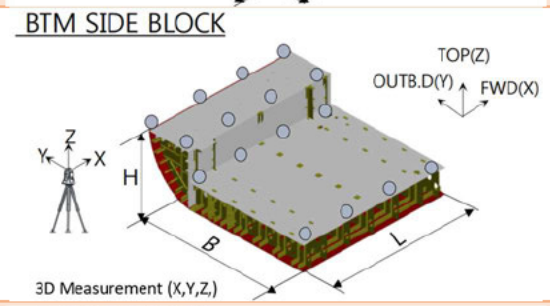
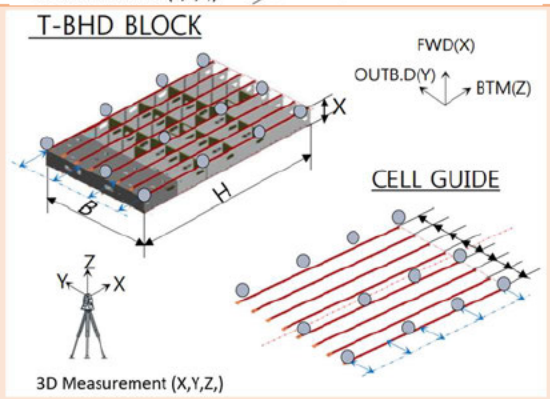
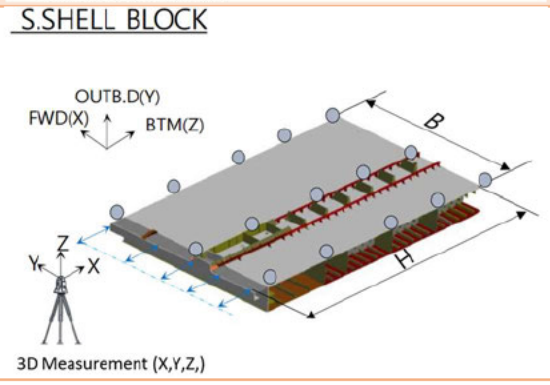
Category	Control Item	Tolerance	Shape and Key Control points
Pin Table	Pin Table Level	± 3.0 mm	
	Pin Height	± 3.0 mm	
	Pin Plumb	± 5.0 mm	
	Pin Table Ground Marking	± 1.0 mm	
	Pin Height Reference Mark	± 1.0 mm	
Curved Panel Assy	Ground Mark Alignment	± 3.0 mm	
	Pin Contact	G : ≤ 5	

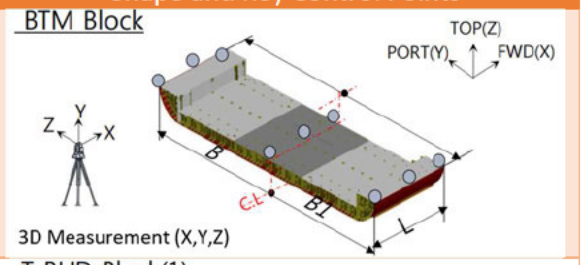
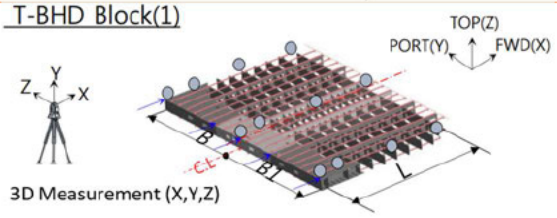
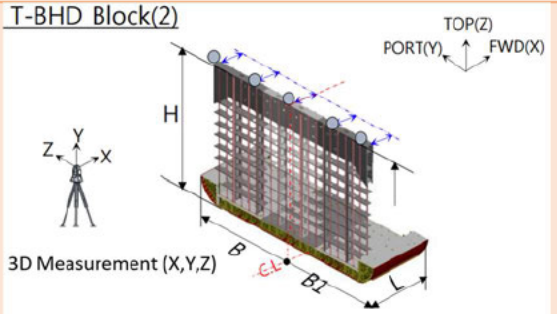
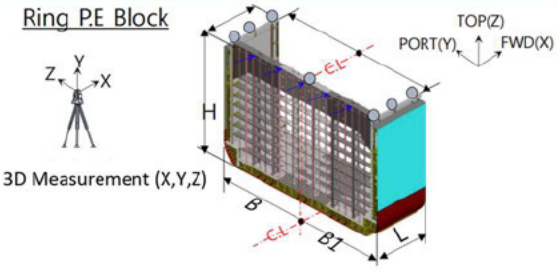
Category	Control Item	Tolerance	Shape and Key Control Points
Plate Joining (Flat Block)	Main Plate Misalignment	± 2.0 mm	
Marking	Main Plate Length	L: ± 1.0 mm	
	Main Plate Width	B: ± 1.0 mm	
	Main Plate Diagonal	D1-D2: ± 5.0 mm	
	Bow, Stern Block Deck	L1: ± 1.0 mm B1: ± 1.0 mm	
	Member Location Mark Line	± 1.0 mm	

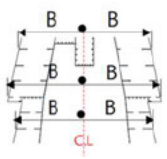
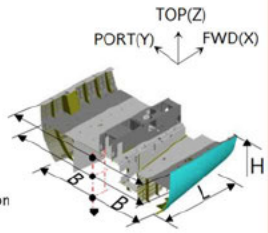
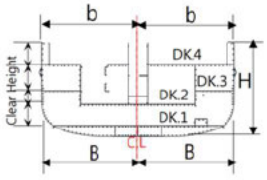
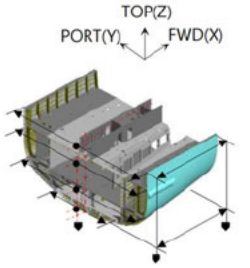
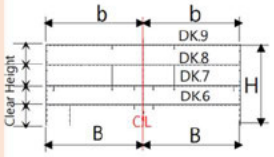
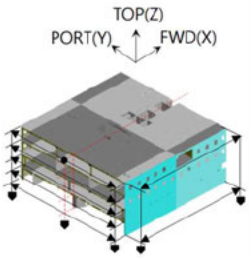
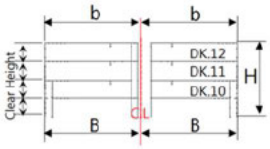
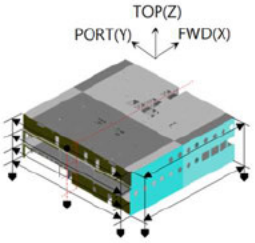
Category	Control Item	Tolerance	Shape and Key Control Points
Assembly	CORR. BHD Straightness and Width	Straightness: ± 5mm Width (B): ± 3mm	
	Fr. Girder Plumb H ≥ 5M H < 5M	± 3.0 mm ± 5.0 mm	
	Long (T-beam) Plumb	± 3.0 mm	
	Internal Member Misalignment	Reference Side: ±1mm Opposite Side: ±2mm	
	T-Beam Length	L: ± 1.0 mm	
	T-Beam Tolerance	±3.0 mm	

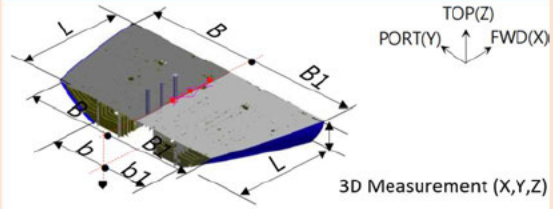
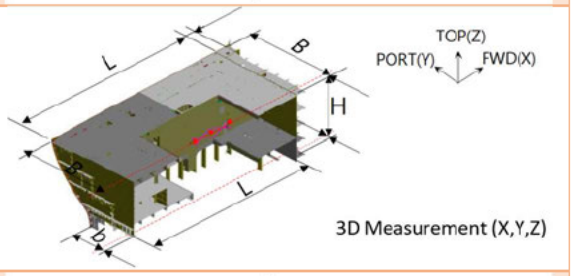
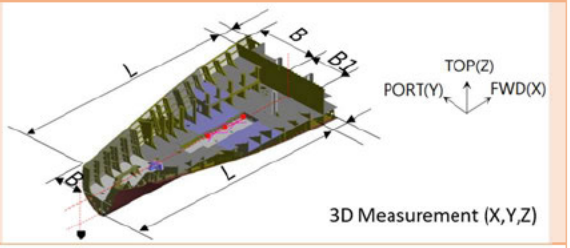
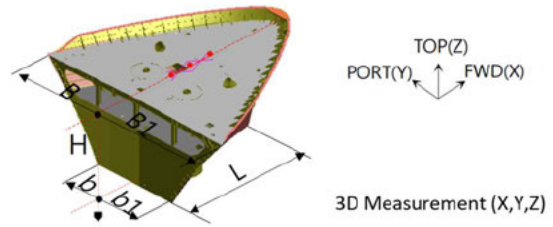
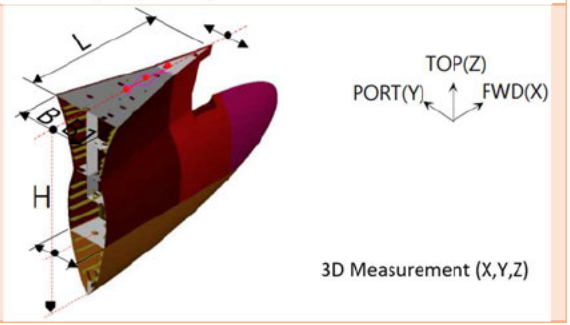
Category	Control Item	Tolerance	Shape and Key Control Points
Stern E/R Block (Engine Room)	Length (L) Half-Breadth (B) Height (H) Squareness	Length (X): ±5 Half Breadth (Y): ±5 Height (Z): ±5 Squareness: ±5	 
Shaft System Block (Boss)	Length (L) Half-Breadth (B) Height (H) Plumb Stern Tube Centerline	Length (X): ±5 Half Breadth (Y): ±5 Height (Z): ±5 Plumb: ±5 S.T. CL: ±3	
Rudder Block	Length (L) Half-Breadth (B) Height (H) Squareness Rudder Trunk Centerline	Length (X): ±5 Half Breadth (Y): ±5 Height (Z): ±5 Squareness: ±5 R.T. CL: ±3	

Category	Control Item	Tolerance	Shape and Key Control Points
Bow Section/ Fore Body	Length (L) Height (H) Level	Length (X): ±5 Height (Z): ±5 Level: ±5	
	Length (L) Half-Breadth (B) Height (H) Squareness	Length (X): ±5 Half-Breadth (Y): ±5 Height (Z): ±5 Squareness: ±5	
	Length (L) Half-Breadth (B) Height (H) Level	Length (X): ±5 Half-Breadth (Y): ±5 Height (Z): ±5 Level: ±5	
	Length (L) Half-Breadth (B) Height (H) Level	Length (X): ±5 Half-Breadth (Y): ±5 Height (Z): ±5 Level: ±5	
	Length (L) Half-Breadth (B) Height (H) Level	Length (X): ±5 Half-Breadth (Y): ±5 Height (Z): ±5 Level: ±5	

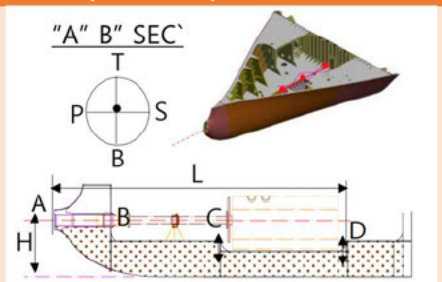
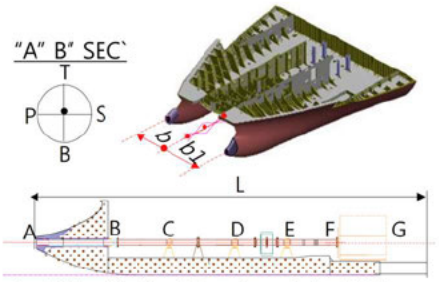
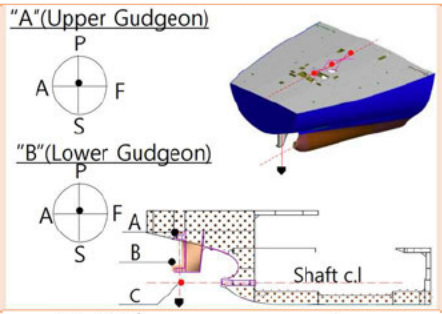
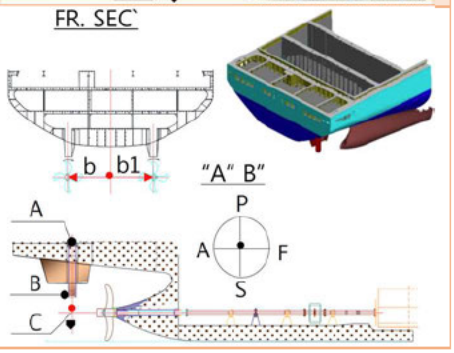
Category	Control Item	Tolerance	Shape and Key Control Points
Midship Section Container	Length (L) Half-Breadth (B) Height(H) Squareness Level	Length (X): ±5 Hale-Breadth (Y): ±5 Height (H): ±5 Squareness: ±5 Level: ±5	
	Length (L) Half-Breadth (B) Height(H) Squareness Level	Length (X): ±5 Hale-Breadth (Y): ±5 Height (H): ±5 Squareness: ±5 Level: ±5	
	Length (L) Half-Breadth (B) Height(H) Squareness Level Cell Guide	Length (X): ±5 Hale-Breadth (Y): ±5 Height (H): ±5 Squareness: ±5 Straightness: ±5 Level: ±5 Cell Guide Squareness: ±5 Width: ±5 Level: ±3	
	Length (L) Half-Breadth (B) Height(H) Squareness Level Plumb Cell Guide	Length (X): ±5 Hale-Breadth (Y): ±5 Height (H): ±5 Squareness: ±5 Level: ±5 Plumb: ±5 Cell Guide Straightness: ±3 Level: ±3	

Category	Control Item	Tolerance	Shape and Key Control Points
Midship Section Container	Length (L) Half-Breadth (B) Height (H) Squareness Level	Length (X): ±10 Half-Breadth(Y): ±10 Height (Z): ±10 Squareness: ±10 Level: ±10	BTM Block  3D Measurement (X,Y,Z)
	Length (L) Half-Breadth (B) Height (H) Squareness Level	Length (X): ±10 Half-Breadth (Y): ±10 Height (Z): ±10 Squareness: ±10 Level: ±10	T-BHD Block(1)  3D Measurement (X,Y,Z) -Apply Reverse Deformation to Coaming Top
	Length (L) Half-Breadth (B) Height (H) Squareness Level	Length (X): ±10 Half-Breadth (Y): ±10 Height (Z): ±10 Squareness: ±10 Level: ±10	T-BHD Block(2)  3D Measurement (X,Y,Z) -Focus on Coaming Top Straightness
	Length (L) Half-Breadth (B) Height (H) Squareness Level	Length (X): ±10 Half-Breadth (Y): ±10 Height (Z): ±10 Squareness: ±10 Level: ±10	Ring P.E Block  3D Measurement (X,Y,Z) -Focus on Coaming Top Straightness and Level

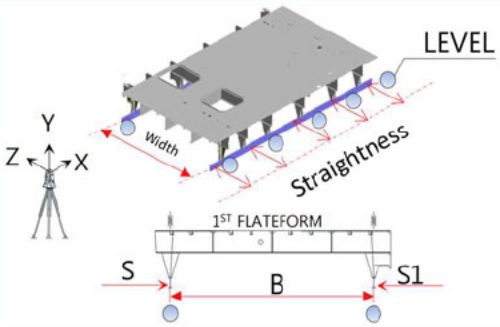
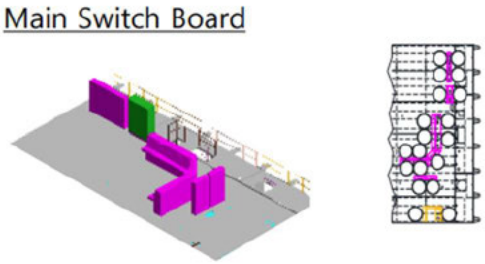
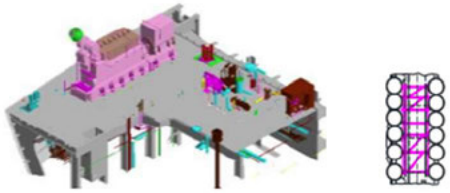
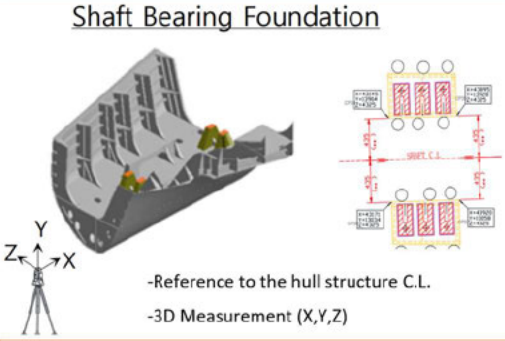
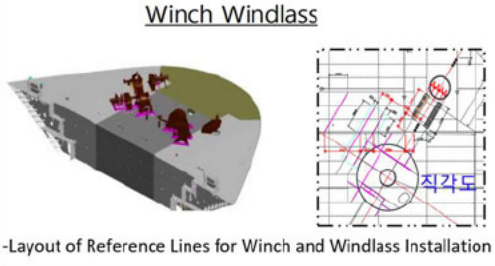
Category	Control Item	Tolerance	Shape and Key Control Points
Midship Section Passenger Ship	Length (L) Half-Breadth (B) Height (H) Squareness Deck Deformation Mgmt.	Length (X): ±10 Half-Breadth (Y): ±10 Height (Z): ±10 Squareness: ±10 DK Level: ±5 DK Height: ±5 DK Deformation: ≤5 Side Shell: ≤5	BTM Seam Plan  S.Shell Block  -Monitor for Deck and Side Shell Distortion -Manage Deck Heights
	Length (L) Half-Breadth (B) Height (H) Squareness Deck Deformation Mgmt.	Length (X): ±10 Half-Breadth (Y): ±10 Height (Z): ±10 Squareness: ±10 DK Level: ±5 DK Height: ±5 DK Deformation: ≤5 Side Shell: ≤5	FR. Section  Lower Ring P.E Block  -Monitor for Deck and Side Shell Distortion -Manage Deck Heights -M-Ramp Opening Dimension Control
	Length (L) Half-Breadth (B) Height (H) Squareness Deck Deformation Mgmt.	Length (X): ±10 Half-Breadth (Y): ±10 Height (Z): ±10 Squareness: ±10 DK Level: ±5 DK Height: ±5 DK Deformation: ≤5 Side Shell: ≤5	FR. Section  MID` Ring P.E Block  -Monitor for Deck Distortion -Manage Deck Heights -Cabin Location and Level Management
	Length (L) Half-Breadth (B) Height (H) Squareness Deck Deformation Mgmt.	Length (X): ±10 Half-Breadth (Y): ±10 Height (Z): ±10 Squareness: ±10 DK Level: ±5 DK Height: ±5 DK Deformation: ≤5 Side Shell: ≤5	FR. Section  Upper Ring P.E Block  -Monitor for Deck Distortion -Manage Deck Heights -Cabin Location and Level Management

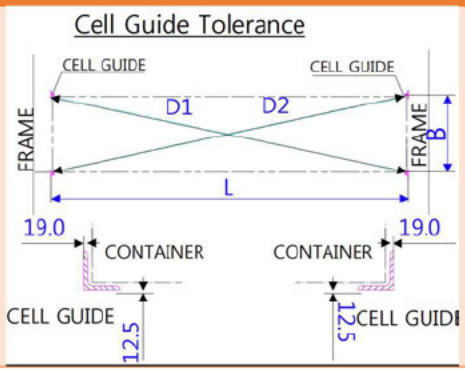
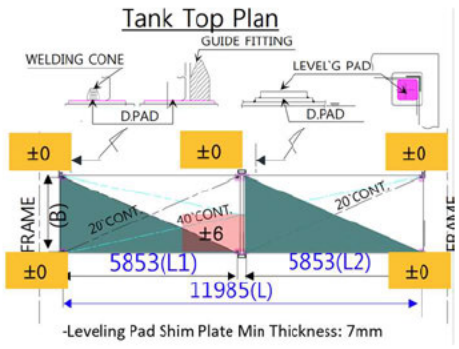
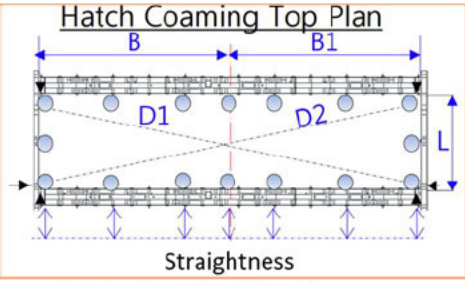
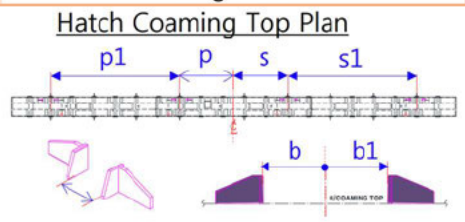
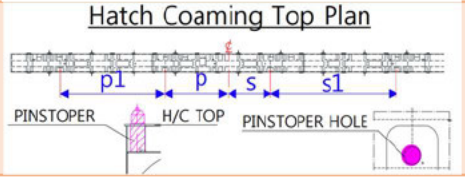
Category	Control Item	Tolerance	Shape and Key Control Points
Aft Body & Fore Body	Length (L) Half-Breadth (B) Height (H) Squareness Level	Length (X): ±10 Half-Breadth (Y): ±10 Height (Z): ±10 Squareness: ±10 Level: ±10	
	Length (L) Half-Breadth (B) Height (H) Squareness Level	Length (X): ±10 Half-Breadth (Y): ±10 Height (Z): ±10 Squareness: ±10 Level: ±10	
	Length (L) Half-Breadth (B) Height (H) Squareness Level	Length (X): ±10 Half-Breadth (Y): ±10 Height (Z): ±10 Squareness: ±10 Level: ±10	
	Length (L) Half-Breadth (B) Height (H) Squareness Level	Length (X): ±10 Half-Breadth (Y): ±10 Height (Z): ±10 Squareness: ±10 Level: ±10	
	Length (L) Half-Breadth (B) Height (H) Squareness Level	Length (X): ±10 Half-Breadth (Y): ±10 Height (Z): ±10 Squareness: ±10 Level: ±10	

6-1. Pre-Erection & Erection (Shaft, Rudder System) Accuracy Control Standard

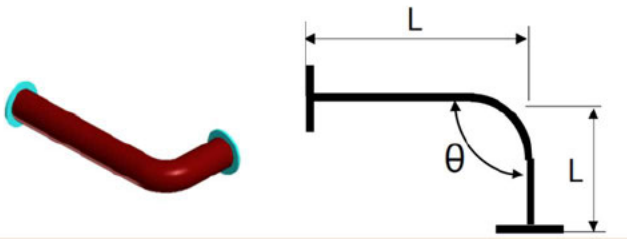
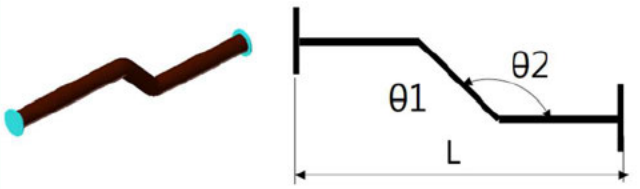
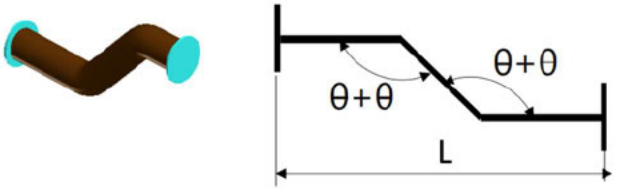
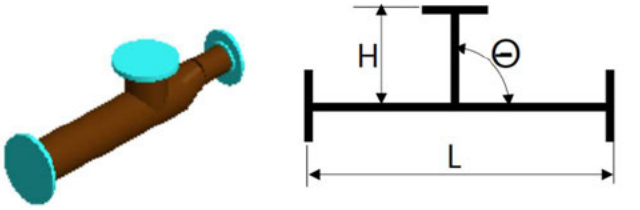
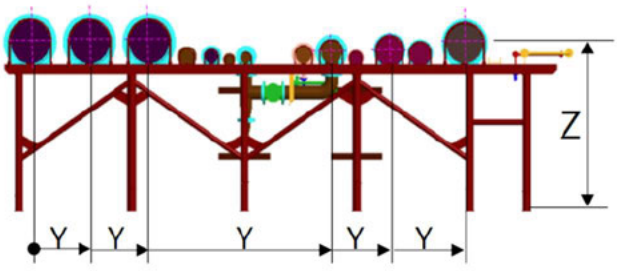
Category	Detailed Item	Tolerance	Stage	Shape and Key Control Points
Single Shaft Pre-Sighting	Shaft System Centering	-Centering Port, Stbd: ±5 mm -Height: Apply Slope (Based on the datum line from A to B, Point D should be ±15) -Shaft Length: ±10	P.E.	 - Pre-sighting of the Stern Tube, reference to the A.B. Datum.
Twin Shaft Pre-Sighting	Shaft System Centering	-Centering Port, Stbd: ±5mm -Height Apply Slope (Based on the datum line from A to B, Point G should be ±15) -Width (b): ±5 mm -Shaft Length: ±10	P.E.	 -Pre-sighting of the Stern Tube, reference to the A.B. Datum. -Transverse straightness of bearing foundation: ≤6mm
Single Shaft Final Sighting	Shaft/Rudder System	DWT ≥ 10,000: C ≤ 8 DWT ≤ 10,000: C ≤ 6 Deviation Between Points A & B: 3mm	Erection	
Twin Shaft Final Sighting	Shaft/Rudder System	DWT ≥ 10,000: C ≤ 8 DWT ≤ 10,000: C ≤ 6 Deviation Between Points A & B: 3mm Width (b): ±5 mm	Erection	

7. Accuracy Control Standard for Hull Outfitting Items

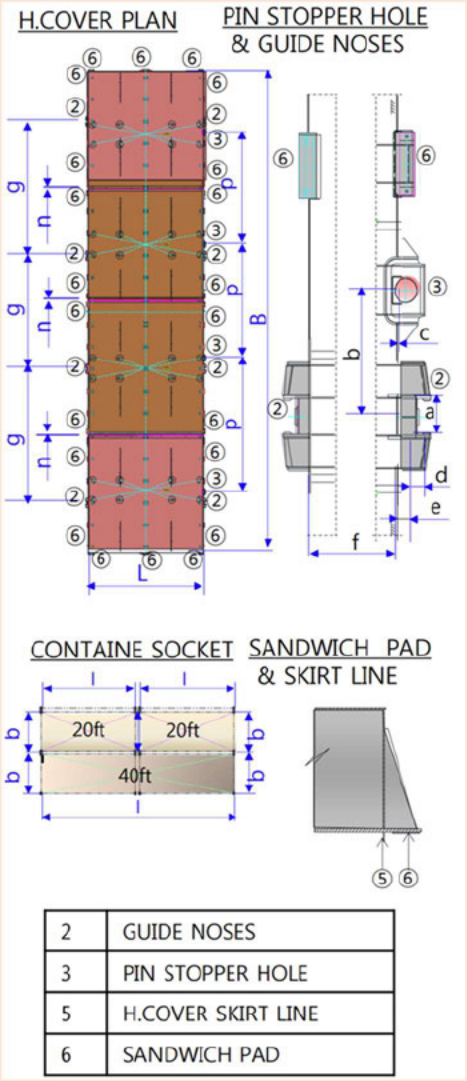
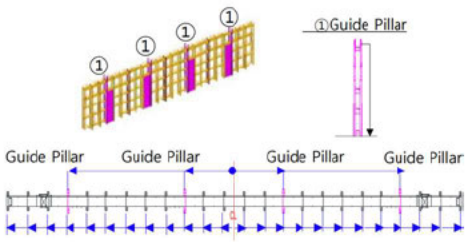
Category	Detailed Item	Tolerance	Stage	Shape and Key Control Points
Common	Engine Room Over Head Crane Rail	Straightness: ±3 Level: ±6 Rail Width: ±3	P.E.	
	Main Switch Board Dk Level	Level: ±3	P.E.	
	D/G Dk Level	Level: ±3	P.E.	
	Shaft Bearing Foundation	Length (X): ±6 Width (Y): ±6 Level (Z): ±5	P.E.	
	Winch Windlass	Squareness: ±0.5°	P.E.	

Category	Detailed Item	Tolerance	Stage	Shape and Key Control Points
Container Ship	Cell Guide	Width (B): ±5 Length (L): +6 ~ -12 Straightness: ±6 Diagonal Diff: ≤10	Assy, Erection	
	In Hold Double Pad	**Longitudinal Slope** 20ft : ±6 / 40 ft: ±9 **20 ft & 40 ft 3-Point Plane Level:** ±6 **Length Dimensions:** 20 ft: ±6 40 ft: +6 / -12	Assy, Erection	
	Hatch Coaming	Width (B,B1): ±6 Straightness: ±6 Level: ±6 Diagonal Diff (D1-D2): ≤10	Assy, Erection	
	FY-Stopper	Width (P, P1, S,S1): ±3 Spacing (b, b1): ±3	Assy, Erection	
	Pin Stopper	Width (P, P1, S, S1): ±3	Assy, Erection	

7-2. Hull Pipe Fabrication and Unit Accuracy Control Standard

Category	Control Item	Tolerance	Shape and Key Control Points
Piping	Straight Pipe	L: ±2	
	Bending Pipe	Θ ≤ 0.5° L: ±2	
		Θ1, Θ2 ≤ 2° L: ±2	
		Θ ≤ 0.5° L: ±2	
	Branch Pipe	Θ ≤ 0.5° L: ±2 H: ±2	
	Butt Joint Pipe End	Z: ±2 Y: ±2 Z: ±2	 -3D Measurement

7-3. Hull Outfitting Accuracy Control Standard

Category	Item	Tolerance	Stage	Shape and Key Control Points
Container Ship	Hatch Cover	**H. Cover-Single Panel** -Panel Length & Width: ±6 -Panel Diagonal Diff.: ±10 -Deformation: ≤4 -Skirt Line Straightness: ±3 -Skirt Line Level: ±3 -Sandwich Pad Level: ±3 Guide Noses: ±9 Pin Stopper Hole: ±3 Deformation: ≤ 4 **H. Cover-Mating Condition** -Skirt Line Straightness: ±6 -Skirt Line Level: ±6 -Sandwich Pad Level: ±6 -Guide Noses (g): ±6 -Pin Stopper Hole (p): ±3 -Mating Joint Gap (n): ±10 -Panel Length & Width: ±9 -Panel Diagonal Diff.: ±15 -Deformation: ≤ 4 **Container Socket Tolerances (20ft & 40ft)** -Transverse Spacing (b): ±5 -Longitudinal Spacing (l): ±6 -Diagonal Diff.: ≤10 -Deformation: ≤5 -Level reference to a 3-pointplane: Any single point must be within ±6	Assy.	 2 GUIDE NOSES 3 PIN STOPPER HOLE 5 H.COVER SKIRT LINE 6 SANDWICH PAD
	Lashing Bridge	Guide Pillars -Spacing: ±3mm -Level: ±6 -Spacing Between Normal Pillars: ± 6mm	Assy.	
		Guide Pillars -Spacing: ±3 -Perpendicularity: ±9 -Straightness: ±9	P.E.	

Chapter 2: Prevention of Welding Deformation

I. Welding Sequence
II. Welding Deformation
III. Back Heating Work Standard

I. Welding Sequence

1. Purpose

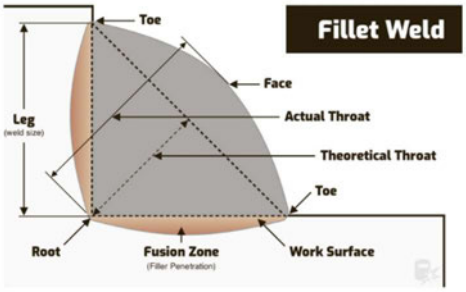
When creating welding structures, deformation, shrinkage, and the generation of internal stress are unavoidable dur to the properties of steel during the welding process. However, by selecting and applying an optimal welding sequence, these effects can be minimized.

This section provides the basic conditions and models for welding sequences. By adhering to these sequences, the goal is to minimize deformation, shrinkage, and internal stress caused by welding. With the recent expansion and adoption of CO2 welding, weld shrinkage at the joint has increased, making the importance and compliance with the welding sequence even greater. Furthermore, as the dimensional accuracy of blocks has improved, there is a pressing need to improve the control of block twisting caused by weld shrinkage, an issue that has been overlooked in the past.

2. Basic Conditions for Weld Sequence

2.1 Definition of Weld Leg Length and Throat Thickness

- **Weld Throat Thickness:** The shortest distance from the root of the weld to the face of the fillet weld.
- **Weld Leg Length:** The visual size of the weld (Weld Size).

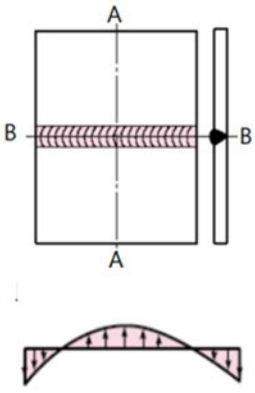


2.2 Minimization of Weld Heat Input

- Minimize weld throat (Maintain appropriate throat thickness)
- Minimize number of weld layers (Minimum layer method)
- Apply reverse deformation and restraint (Elastic, Plastic).
- Adhere to welding method (backstep, skip method). Use intermittent welding beads.

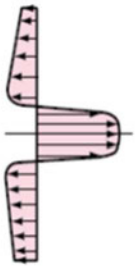
2.3 Reduction of Residual Welding Stress

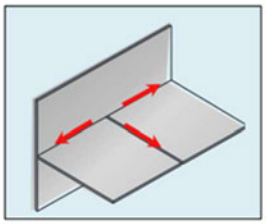
-Change the Welding Sequence ad deposition method; perform preheating (to equalize temperature distribution)



B-B Section Stress Distribution Diagram

A-A Section Stress Distribution Diagram

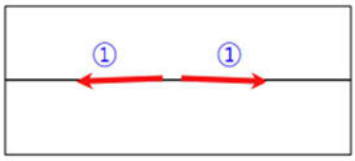


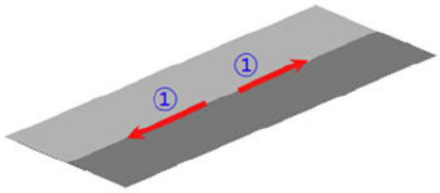


Welding Procedure

2.4. Welding Direction

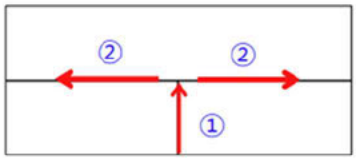
- From the center to both side

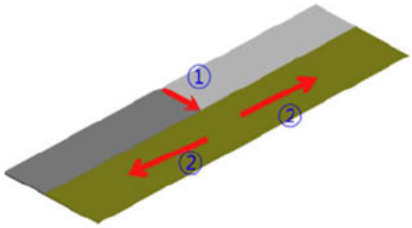




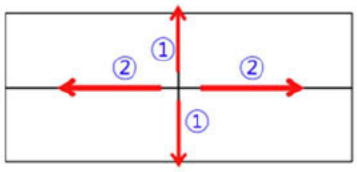
2.5. T-Intersection (BUTT)

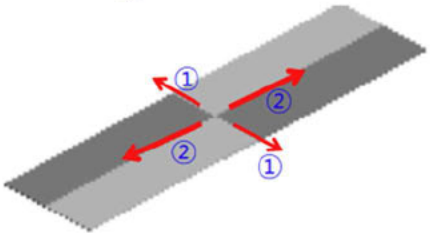
- Butt Weld, Fillet Weld



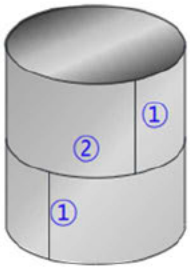


2.6. Cross-Intersection





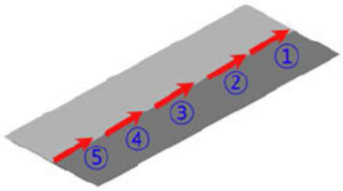
2.7. For **circumferential welding**, seam (Longitudinal) welding must be done before the circumference welding

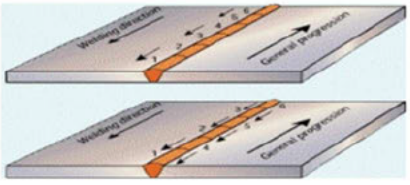


2.8. **Welding Stress**: If welding stress exists, weld the area under tensile stress before the area under compressive stress.

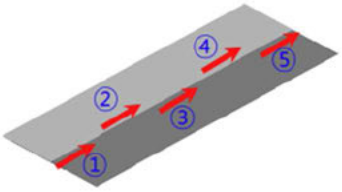
2.9. Apply Back Step or Skip Welding

Back Step 용접





Skip 용접



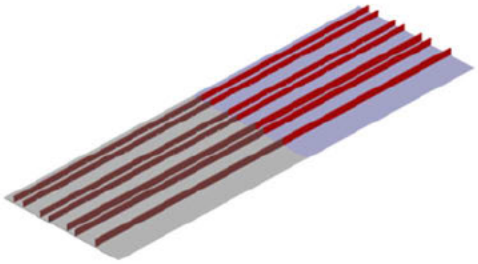
2.10. Butt (Widthwise) vs Seam (Lengthwise) Welding

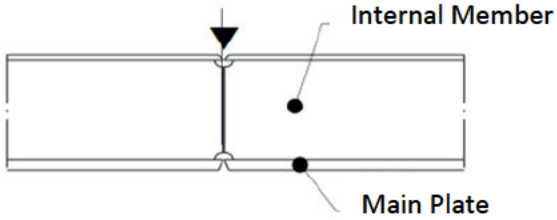
-When a Butt weld and a Seam weld meet, **Butt welding takes priority.**

2.10. Sequence for Main Plate and Internal Member Welding

-. Main Plate Thickness (THK) ≤ 15mm: Internal member welding takes priority

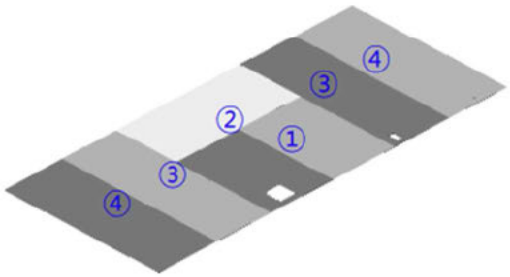
-. Main Plate Thickness (THK) ≥ 15mm: Main plate welding takes priority

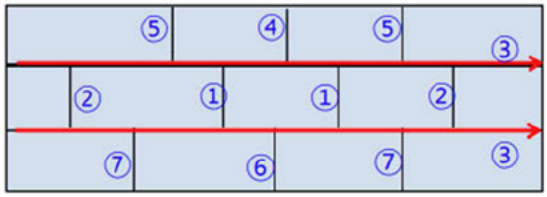




3. Application of Welding Sequence

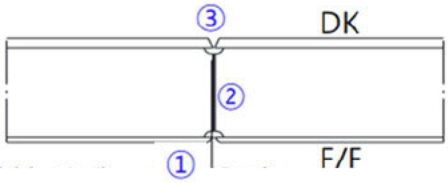
3.1 Main Plate Welding: Prioritize welding members that bear more stress and have shorter weld lines

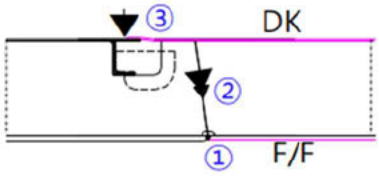




3.2 Main Plate Welding and Internal Member Welding Sequence

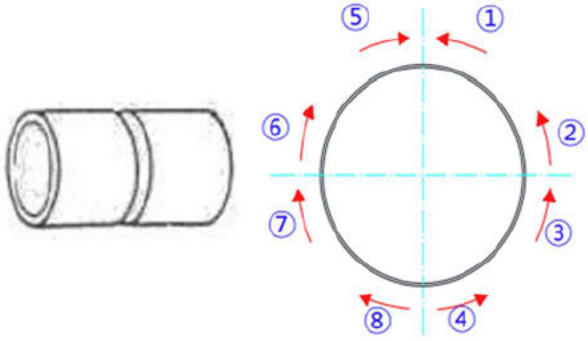
- Flange > Web > Deck Plate



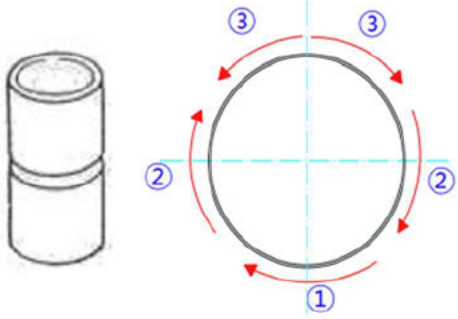


3.3 Circular Member: Use symmetrical Welding

Welding sequence for vertical member



Welding sequence for Horizontal

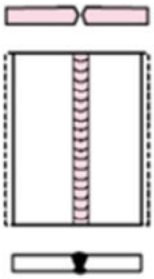


II. Weld Strain

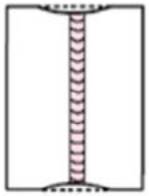
1. Welding Deformation

Welding deformation is caused by the expansion and shrinkage that occur during rapid heating and rapid cooling of weld metal and base metal due to welding heat. Types of deformation include transverse shrinkage, longitudinal shrinkage, longitudinal bending, deformation, and angular deformation.

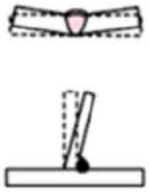
Transverse Shrinkage



Longitudinal Shrinkage

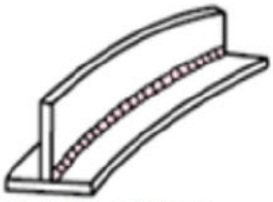


Transverse Bending Deformation

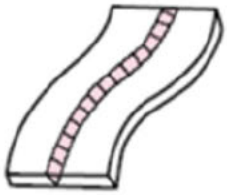


Rotational Deformation

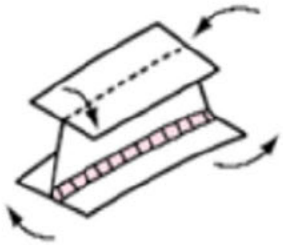
Longitudinal Bending Deformation



Longitudinal Bending Deformation

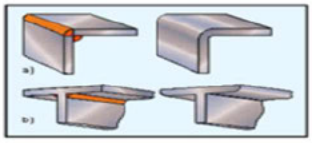


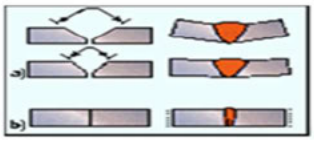
Twisting Deformation

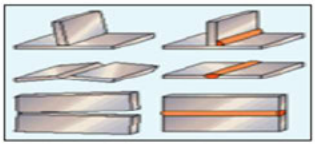


2. Welding Deformation Prevention Methods

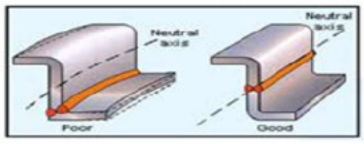
1. **Minimize the Welding Seam**

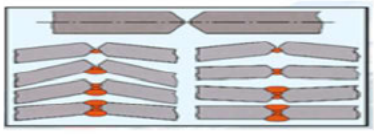


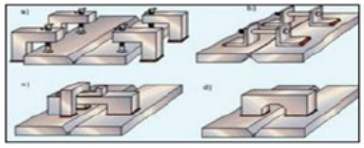




2. **Adjust the Welding Seam Location**

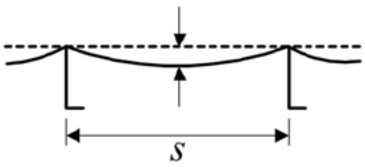






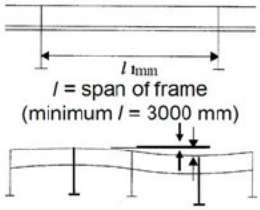
3. Deformation Between Longitudinals

Table 3-1. Standard for Deformation Between Longitudinals (Unit: mm)

Item		Standard	Limit	Remarks
Shell Plate	Parallel part (Side and Bottom Shell)	4mm	8mm	
	Fore and Aft Part	5mm		
Tank Top		4mm		
Bulkhead	Longl. Bulkhead Trans. Bulkhead Swash Bulkhead	6mm		
Strength Deck	Parallel Part	4mm		
	Fore and Aft Part	6mm	9mm	
	Covered Part	7mm		
Second Deck	Bare Part	6mm	8mm	
	Covered Part	7mm	9mm	
Forecastle and Poop Deck	Bare Part	4mm	8mm	
	Covered Part	6mm	9mm	
Super Structure Deck	Bare Part	4mm	6mm	
	Covered Part	7mm	9mm	
House Wall	Outside Wall	4mm	6mm	
	Inside Wall	6mm	8mm	
	Covered Part	7mm	9mm	
Interior Member (Web of Girder, etc.)		5mm	7mm	
Floor and Girder in Double Bottom		5mm	8mm	

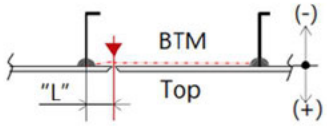
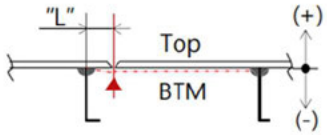
4. Deformation per Unit Length

Table 4-1. Deformation per Unit Length (Unit: mm)

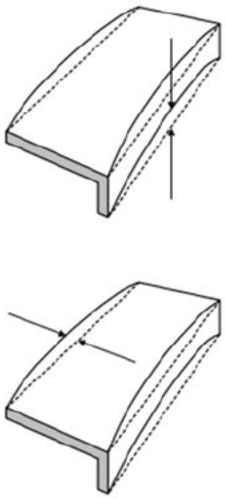
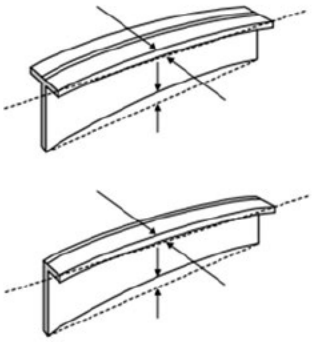
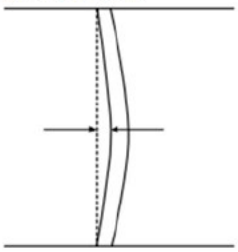
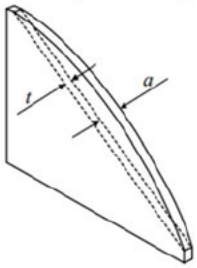
Item		Standard	Limit	Remarks
Shell Plate	Parallel Part	±2 / /1000 mm	±3 / /1000 mm	*L* = Span of frame (mm) To be measured between trans. Space (min. *l* = 3000 mm)
	Fore and Aft Part	±3 / /1000 mm	±4 / /1000 mm	
Strength Deck (Excluding cross deck) and top plate of double bottom		±3 / /1000 mm	±4 / /1000 mm	
Bulkhead			±5 / /1000 mm	
Accommodation above the strength deck and others		±5 / /1000 mm	±6 / /1000 mm	
 To be measured between one trans. space.				

5. Block Butt (Joint) Deformation

Table 5-1. Block Joint Deformation Control Standard

Ship Class	Block	Joint Location		Assembly Stage	P.E. / Dock	Remarks
		Location	L	Standard	Standard	
VLCC	T.TOP	Center	75	-2 ~ ±0	-4 mm	Assembly Stage  P.E & Dock 
		Side	100	-2 ~ ±0	-4 mm	
	M.DECK	Center	75	-2 ~ ±0	-4 mm	
	T.BHD	Center	150	+2 ~ +5	-3 mm	
		Side	450	-2 ~ ±0	0 mm	
COT	T.TOP	Center	100	-2 ~ ±0	-4 mm	
		Side	240	+2 ~ +5	0 mm	
	M.DECK	Center	65	-2 ~ ±0	-4 mm	
		Side	100	-2 ~ ±0	-4 mm	
	T.BHD	Center	410	+2 ~ +5	0 mm	
		Side	380	+2 ~ +5	0 mm	
LNGC	T.TOP	Center	100	-2 ~ ±0	-4 mm	
	T.DECK	Side	310	+2 ~ +5	0 mm	
CONT'	T.TOP	Side	100	-2 ~ ±0	-4 mm	

6. girder, stiffener, pillar

Detailed Item	Standard Range	Permissible Limit
Straightness in plane of flange and web 	±10 mm per 10 m	±25mm per 10 m
Distortion of built-up longitudinal, girder, and transverse at upper edge and flange 	±10 mm per 10 m	±25 mm per 10 m
Pillar (between decks) 	4 mm	6 mm
Tripping bracket and small stiffener, distortion at the part of free edge 	a ≤ t/2 mm	t

III. Back Heating

1. Purpose

The purpose of performing back heating work during sub-assembly, Assembly, and Grand Block Assembly stages is to remove deformations caused by welding. This is a critical step in the quality production process to ensure accurate accuracy control of the block and to prevent rework in subsequent stages.

2. Definition of Terms

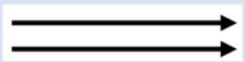
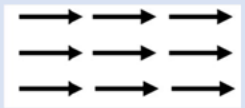
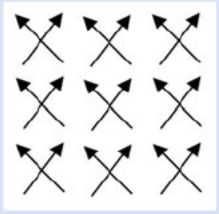
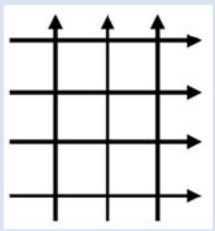
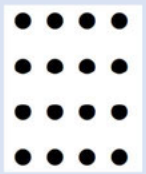
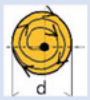
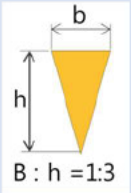
2-1. Heating: Any work that applies heat to a member's surface to create a required ship shape or to correct a deformed shape (applies to line heating or when applying reverse deformation).

2-2. Back Heating: The process of heating the backside (The opposite side) of a fillet welded joint to remove the deformation and residual stress that occurred after welding.

2-3. Line Heating: Heating work performed on the block's end (Joint Faces) to correct misalignment or warpage that is expected to occur after Pre-Erection (P.E.) or Erection due to assembly welding.

- **2.3.1 Fairing:** Work that corrects a deformed area, which exceeds the allowable tolerance, back within tolerance by applying heat to the plate and utilizing expansion and shrinkage (thermal forces).
- **2.3.2 Reverse Deformation:** The act of intentionally applying heat to deform a member in the opposite direction to counteract the deformation expected to occur after the welding process.

3. Back Heating Application Types

	Line Heating	Cross Heating	Grid Heating	Spot Heating	Triangle Heating
Pattern	Continuous  Intermittent 				
Features and Application	Basic patterns for Distortion Control	Allows for uniform shrinkage in every direction	For use on severe deformation	Applied to thin mild steel (≤ 10mm) and finishing work	Used to straighten shaped beams
	Spacing between heating lines: 50 – 100mm For intermittent pattern, heating length: 200 – 300mm	Heating line length: 100 – 300 mm		 For thin plates d ≤ 20	

4. Line Heating

Item		Standard
Conventional Process AH32-EH32 & AH36-EH36	Water Cooling just after heating	Under 650°C
	Air Cooling after heating	Under 900°C
TMCP type AH36-EH36 (Ceq. > 0.38%)	Air cooling and subsequent water cooling after heating	Under 900°C (starting temperature of water cooling to be under 500°C
TMCP type AH32-DH32 & AH36-DH36 (Ceq. ≤ 0.38%)	Water cooling just after heating or air cooling	Under 1000°C
TMCP type EH32-EH36 (Ceq. ≤ 0.38%)	Water cooling just after heating or air cooling	Under 900°C

Note:

$$Ceq = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}(\%)$$

5. Temperature Measurement

Workers should use a digital thermometer to monitor the surface temperature of the material. Care must be taken to not exceed the specified temperature.

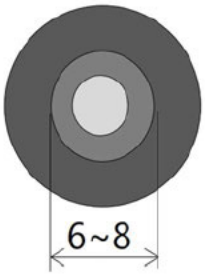
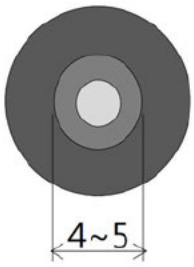
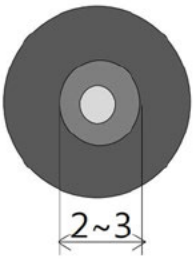
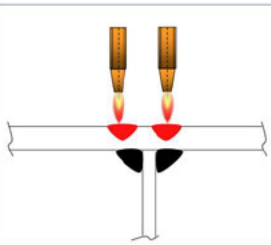
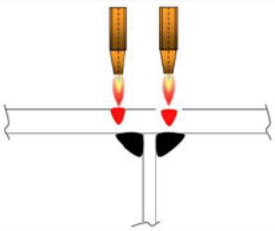
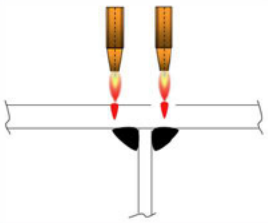
6. Line Heating Speed by Plate Thickness

Note: Flame distance refers to the distance from the white core of the flame to the surface of the plate.

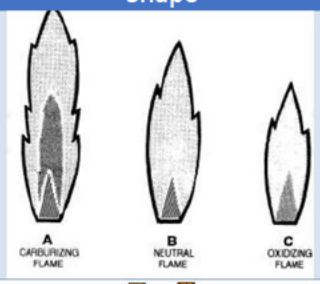
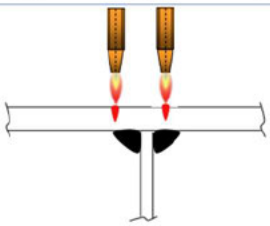
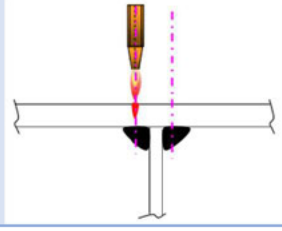
Plate Thickness (mm)	Heating Speed (mm/min)	Torch Tip (No.)	Flame Distance (mm)
5 – 8	700 – 800	1000 (L/HR)	0 – 3
9 – 12	500 – 1000	1600 (L/HR)	
13 – 16	400 – 800	2000 (L/HR)	3 – 4
17 – 22	350 – 800	2500 (L/HR)	
22 – 28	300 – 600	3150 (L/HR)	4 – 5
29 and Above	250 - 500	3500 (L/HR)	6 – 10

7. Heating Method

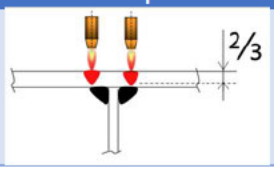
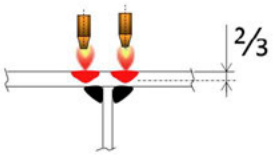
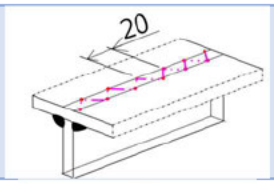
There are three basic flame types: Neutral (balanced), excess acetylene (carburizing), and excess oxygen (oxidizing) as shown below

	Carburizing Flame	Neutral Flame	Oxidizing Flame
Flame Shape	Thin and Long	A white light appears at the tip of the nozzle	White inner cone is short
Heat Marks			
Heat Distribution Pattern			
Effect	Greater Effect	Neutral	Smaller Effect

8. Basic Requirements

Shape	Compliance Requirement	Notes
	To be performed with a neutral flame	1. Fuel Types: Acetylene, Ethylene, Propane 2. Flame Types: Oxidizing Flame, Neutral Flame, Carburizing Flame 3. Heating Methods: Line Heating, Spot Heating, Triangle Heating, Other Methods 4. Magnitude of straightening power -Acetylene > Propane -High speed > Low speed -Water cooling > Air cooling
	Minimize the heat-affected zone	
	Flame Position: Center of the weld bead	

9. Heating Method

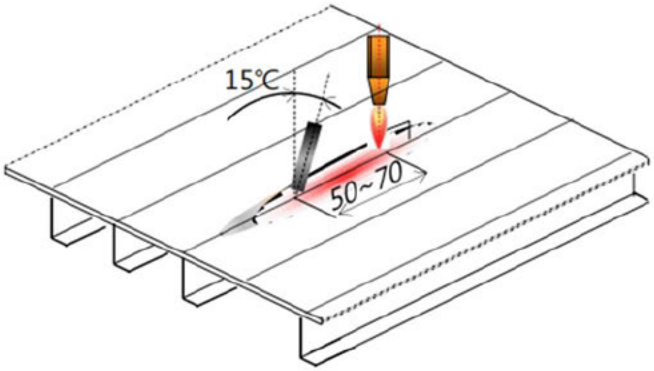
	Control Standard	Shape	Notes
1. Heating Location	Effective Heating Methods		-Appropriate Torch Height -Appropriate Torch Tip Size -Oxidizing Flame
	Ineffective Heating Methods		-Torch Tip Height Large, Small -Neutral Heat (White light appears at the torch tip)
2. Pitch	20 mm		Zig-Zag pitch spacing
3. Starting Temperature	Approximately 480°C		The moment the plate begins to change color
4. Back Heating Speed	700 – 800 mm/min		

10. Cooling Method

10.1 Air Cooling: This method uses natural cooling by air after heating. If correction is insufficient, the heating and cooling process is repeated.

10.2 Water Cooling: This method involves running water through a hose approximately 50 – 70 mm behind the heating center to cool the steel. This method provides a greater and more effective shrinkage rate than air cooling, but there is a higher potential for change, so caution is required.

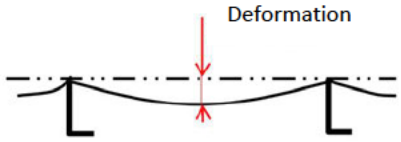
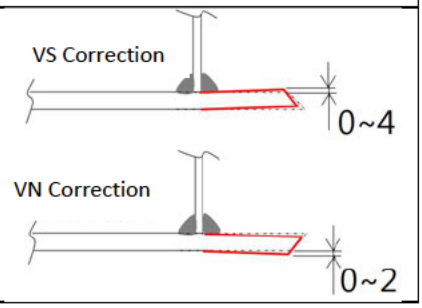
- A hose of 8 – 10 is typically used, and a nozzle is attached to the end with a water pressure of 4 – 5 kg/m².
- There are two techniques: surface water cooling and reverse-side water cooling.



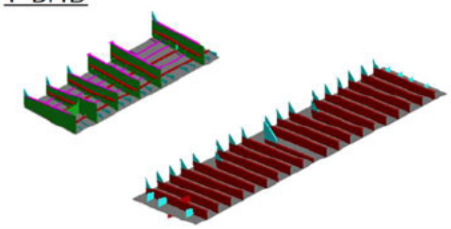
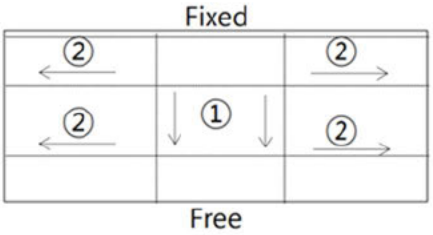
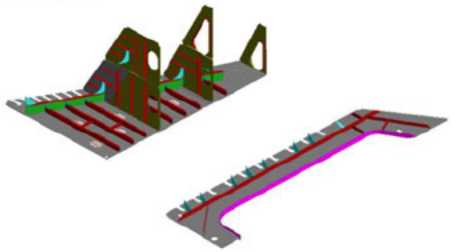
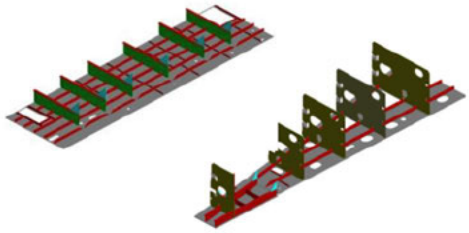
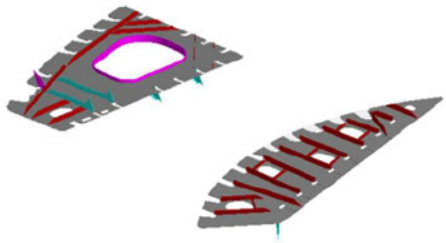
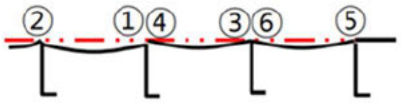
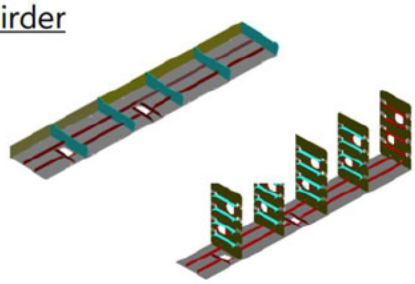
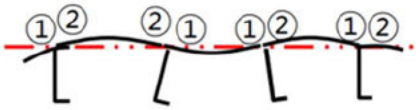
11. Back Heating Application Standard by Area

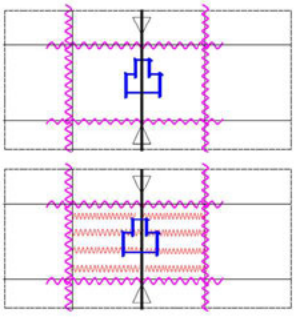
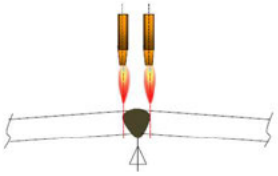
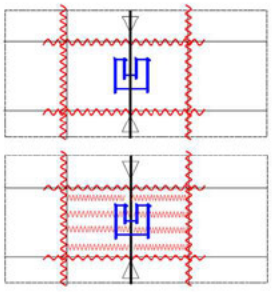
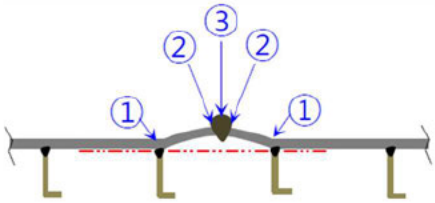
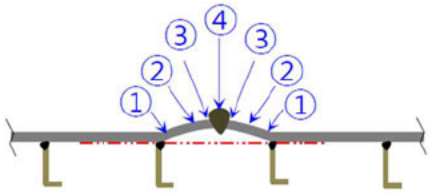
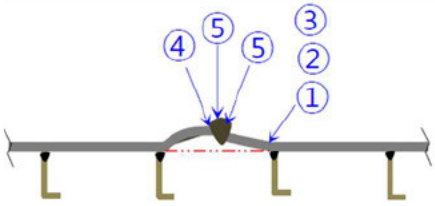
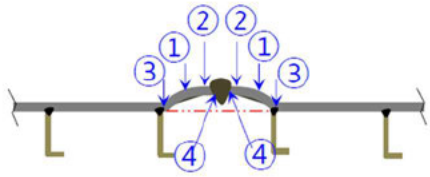
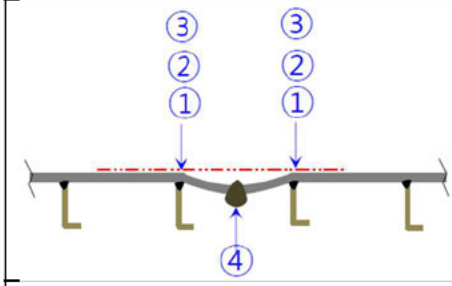
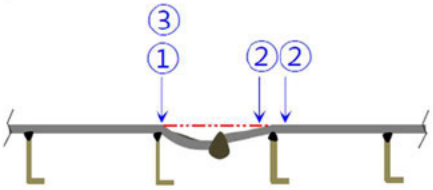
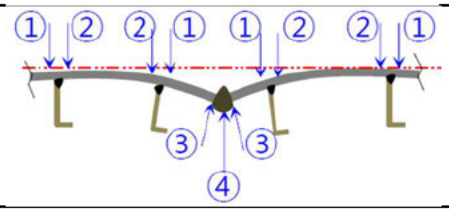
Area				Thickness	Control Standard		
					Assembly	P.E.	Erection
Aft Body	A.P. BHD, L-BHD, & Various Walls			t ≤ 12	4	6	8
	Deck, Stringer			t ≤ 14			
Engine Room	Engine Room BHD, Various walls			t ≤ 12	4	6	8
	Deck, Stringer			t ≤ 14			
Hold	Tank Top, Deck			t ≤ 12	4	6	8
	Stringer			t ≤ 14			
	L-BHD Main Plate (Ver. Stiff. struct.)			t ≤ 12	4	6	8
	TBHD Main Plate			t ≤ 14			
Super Structure	Deck House	Deck	Covered	t ≤ 12	4	9	9
			Bare	t ≤ 12	4	6	6
		Wall	Out-Side	t ≤ 12	4	6	6
			In-Side	t ≤ 12	4	6	8
	Funnel			t ≤ 12	4	6	8
	Wing Bridge			t ≤ 12	4	6	8
	Engine Casing			t ≤ 12	4	6	8
Internal Structure	Web, Gir, Floor			t ≤ 12	4	6	8

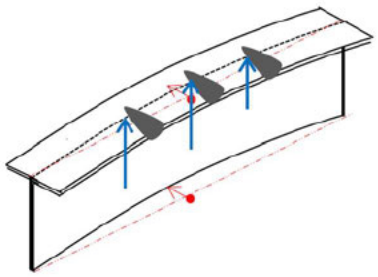
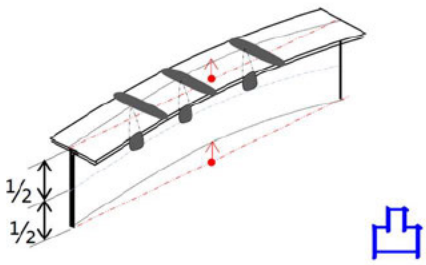
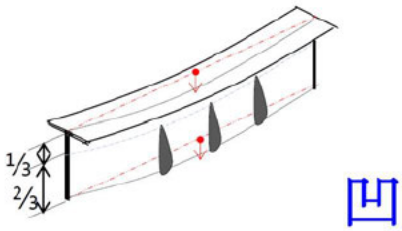
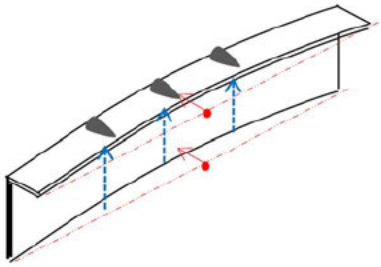
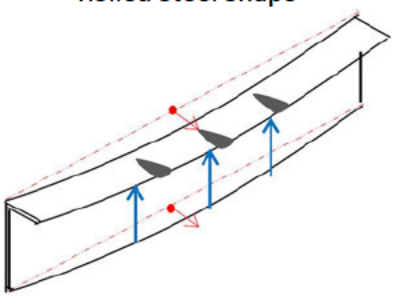
12. Deformation Control Standard

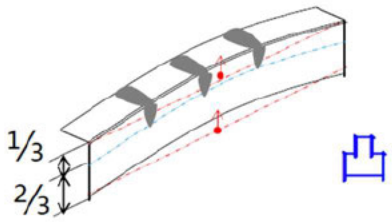
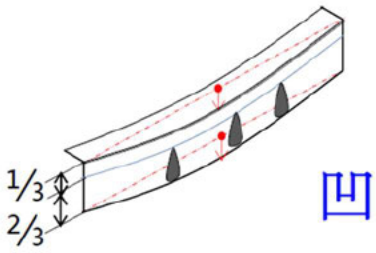
	Standard	Stage	Diagram
Back Heating	4	-Perform Back Heating during the Sub-Assembly, Assembly, and Grand Assembly stages -Hot work is to be performed in accordance to DSQS	
Line Heating (t ≤ 18)	VS Correction: 0 – 4 VN Correction: 0 – 2	-Perform Line Heating during the Assembly and Grand Assembly stages	

13. Correction Work Methods

Deformation	Assembly	Correction Work Method
Fillet Weld Deformation	T-BHD 	13.1 Basic Principles of Correction Work - Fixed → Free - Central Area → Edges 
	Stringer 	
	L-BHD 	13.2 Correction Work Sequence Type.1 
	Floor 	Type.2 
	Girder 	Type.3 

Butt Weld	Correction Work Method	Remarks
Plate plan  -Line heating perpendicular to the reinforcement of weld seam is highly effective Plate Heating Location  -Use a strong oxidation flame to heat the seam ede for local strengthening (straigtening from the underside is also possible). Plate plan  -Line heating perpendicular to the reinforcement or weld seam is highly effective.		-Apply work to areas 1 & 2 -Apply rapid cooling after each repetition. -Applicable to thin and thick plates.
		-After working areas 1 & 2, proceed to areas 3 & 4 -Apply rapid cooliing after each repetition -Applicable to thin and thick plates
		-Work areas 1, 2, & 3, then proceed to area 4. -Rapid cooling is required
		-Check status of areas 1, 2, & 3; if local distortion remains, work area 4. -Rapid cooling is required
		-Check status of areas 1, 2, & 3; if local distortion remains, work area 4. -Rapid cooling is required
		-Work area 1, the proceed to areas 2 & 3. -Rapid water cooling is necessary.
		-Work areas 1 & 2. -Rapid water cooling is necessary.

	Internal Member Distortion	Corrective Action
Internal member	Built Member 	-1 Apply line heating to the bottom face of the web. -2 Apply triangle heating to the face plate. -3 Ensure that the heat penetrates the entire thickness of the triangular heated area. -4 When applying triangle heating, do not heat more than 2/3 the depth of the member.
	Built Member 	-1 Start triangle heating at ½ the web depth. Directing the heat upward. -2 Apply water cooling only to the portions that were not heated -3 Heat the face plate -4 Apply water cooling sequentially in the order the heat was applied.
	Built Member 	-1 Start triangle heating at 2/3 the web depth, directing the heat upward. -2 Apply water cooling sequentially, delaying it slightly behind the heating.
	Rolled Steel Shape 	-1 Apply line heating to the side of the web intended for bending. -2 Apply triangle heating to the side of the flange intended for bending. -3 Omit line heating for small rolled steel shapes. -4 Apply water cooling immediately followinf the line heating area. -5 Pause riangle heating momentarily, allow it to heat fully, hen apply water cooling.
	Rolled Steel Shape 	

	Internal Member Distortion	Corrective Action
Internal member	Rolled Steel Shape 	-1 Start triangle heating at 2/3 the Web depth, directing the heat downwards.
	Rolled Steel Shape 	-1 Start triangle heating at 2/3 the Web depth, directing the heat downwards.

14. Precautions for Correction Work

1. If both the plate and the reinforcement (stiffeners) are distorted simultaneously, always correct the plate first.
2. Avoid applying excessive heat initially. Overheating can cause distortion to worsen or induce secondary distortion due to excessive shrinkage. Therefore, observe the entire area of distortion to determine the appropriate heating level.
3. The height of the triangle in the heating pattern should be maintained at 2/3 or less of the member's width. This is effective and helps prevent the induction of other types of distortion.
4. Be aware that beginning correction work without a pre-established plan is likely to result in failure.
5. Depending on the nature of the work, you must obtain approval from the relevant inspector before proceeding.
6. During the straightening process, heat should not be directly applied to the weld seam.
7. If heavy objects are used to modify the deformation during fairing, the approximate sketch of the heavy object's position and its weight must be recorded in the fairing work document.
8. When measuring temperature during the straightening process, verify it using an infrared temperature gun. Because the temperature may drop during the measurement process, perform the reading as quickly as possible.
9. The starting point of the next heating application must overlap the end of the previous heating area by at least 25mm.

Chapter 3: Various Accuracy Control Standards

Contents:

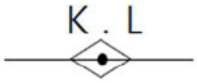
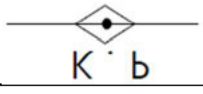
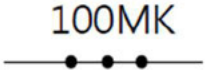
I. Accuracy Standards for Various Reference Lines

1. Reference Line Marking Standards

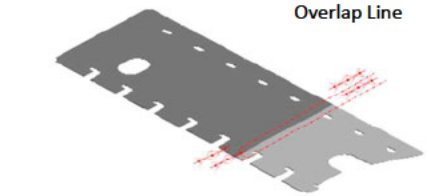
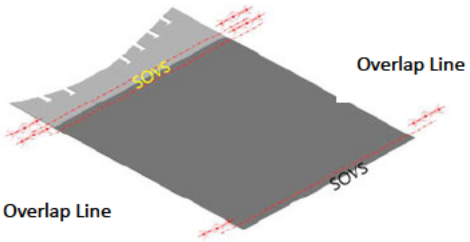
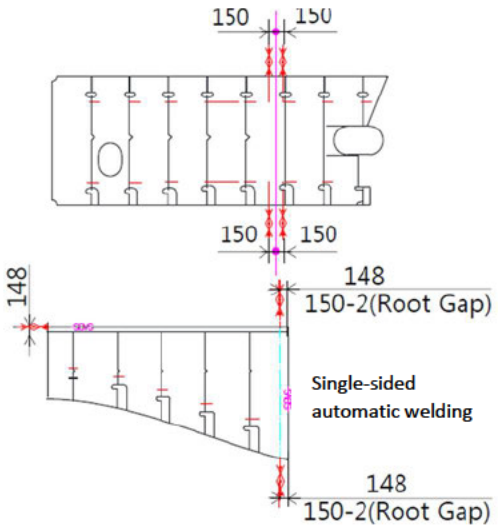
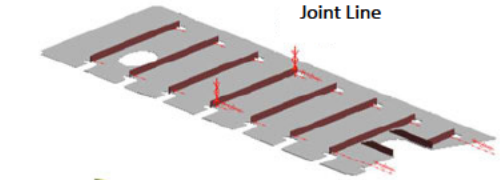
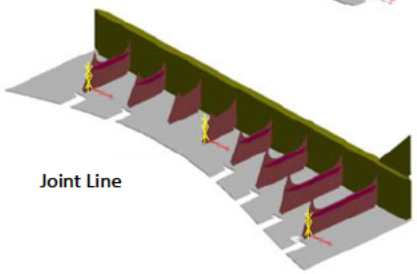
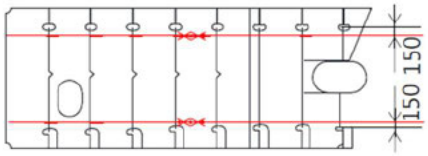
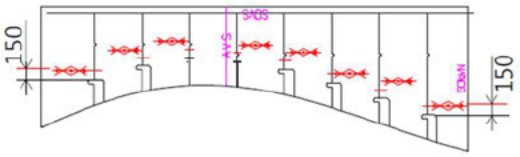
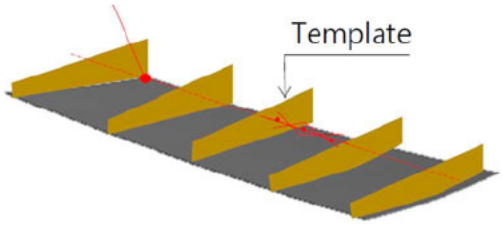
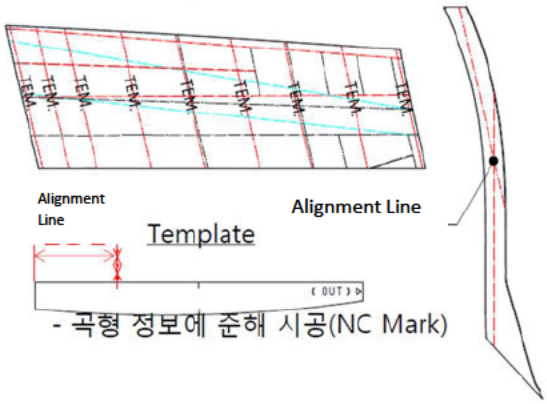
1.1 Objective of Reference Line Layout

The objective of establishing these reference lines is to define the standards for work processes across fabrication, assembly, pre-erection, and erection during ship construction. By marking these lines in each construction stage, they serve as a mandatory element for maintaining the precise dimensional accuracy of the block. The intent is to explicitly state the reference line symbols and application methods to ensure their accurate implementation at every stage of the process.

1.2 Marking Symbols and Application Procedures.

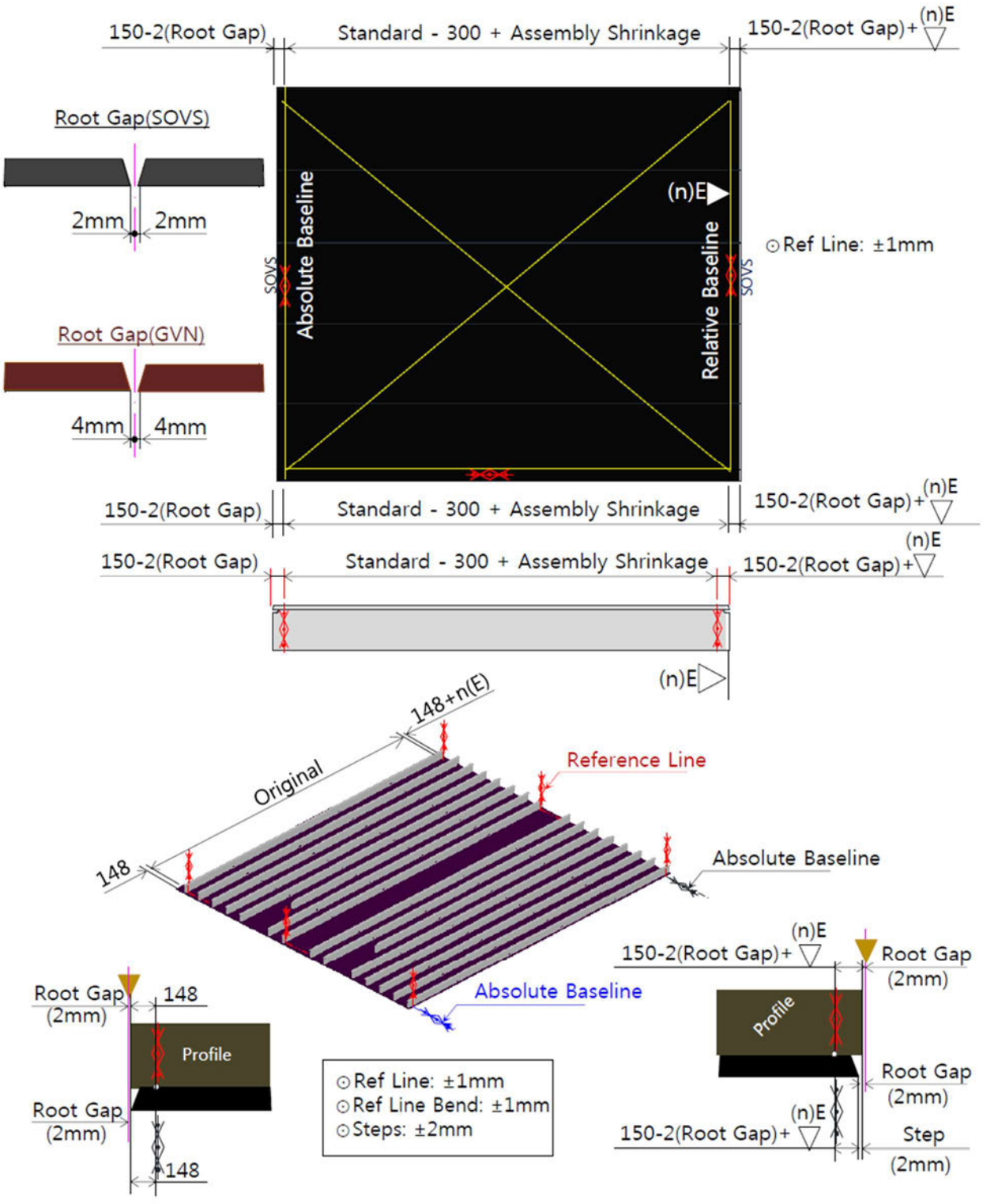
Item		Symbol	Description	Notes
Assembly Ref Line	Plate-to-Plate Ref Line		Plate to plate Ref line	Numerically Controlled Mark
	Alignment Line		Internal member attachment ref line	
	Template Ref Line		Curved member fabrication and assembly work ref line	
Erection Ref Line			Block Erection ref line	Punch mark applied after assy stage
Base Line (B.L)			Base Line	
Center Line (C.L)			Center Line	
Mould Line (ML)			Mould Line	Refer to Drawing
Knuckle Line (K.L)			Intersection of two different planes	
Knuckle Point (K.P)			Intersection of two different planes	
100 Marking Line (100M.K)			Reference line for the accuracy of reinforcement position of fillet joint	
Thee 100MK reference line must be marked according to the 100MK & Paint Hold Tape DWG construction standard set by the Accuracy & Engineering Departments. (They must be attached to the hull assembly drawing).				

2. Sub-Assembly and Unit Assembly Work Based on Reference Lines

Category	Form	Drawing
Overlap Line	In case of double-sided automatic welding  Overlap Line Single-sided automatic welding  Overlap Line Overlap Line	In case of double-sided automatic welding  150 150 150 150 148 148 150-2(Root Gap) Single-sided automatic welding 148 150-2(Root Gap)
Joint Line	Joint Line   Joint Line	 150 150 150mm from center of slot  150 150
Inspection Line	Alignment Line  Template	Shell Expansion Built-up 재  Alignment Line Alignment Line Template - 곡형 정보에 준해 시공(NC Mark)

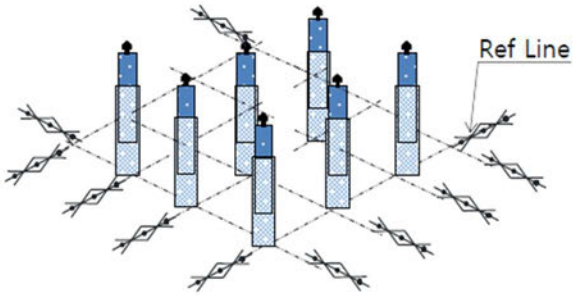
3. Flat Block Assembly Work Based on Reference Lines

3.1 SOVS/SOVN, SOVS/SOVN. SO1/2VS/SO1/2VN

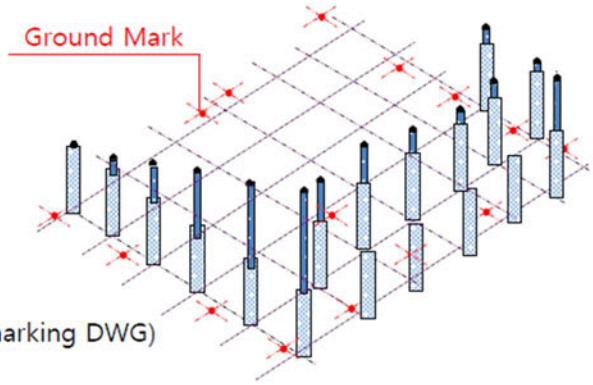


4. Curved Block Assembly Work Based on Reference Lines

▣ Reference Lines for Ground Marking

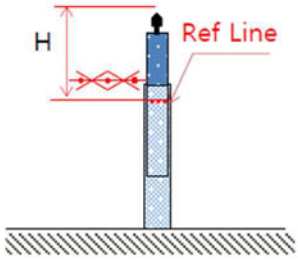


▣ Ref Line for Shell Plate Butt Welding Work

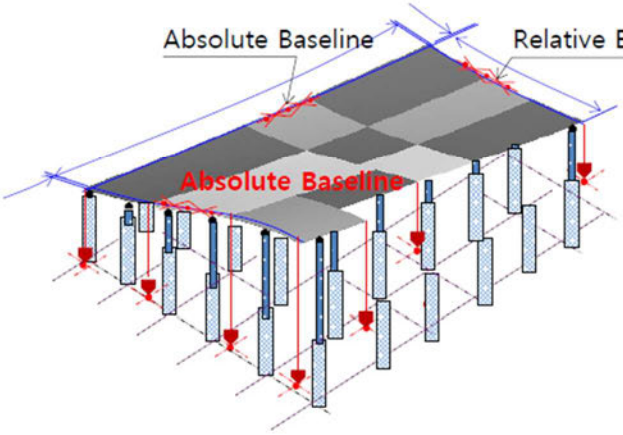


Ground M.K(re-marking DWG)

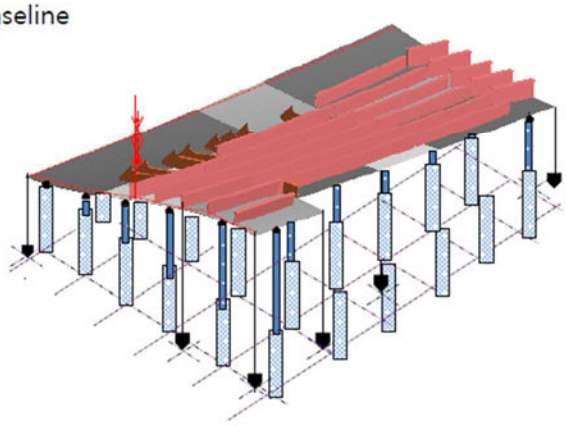
▣ Ref Line for Height Adjustment



▣ Absolute Baseline 148 Marking

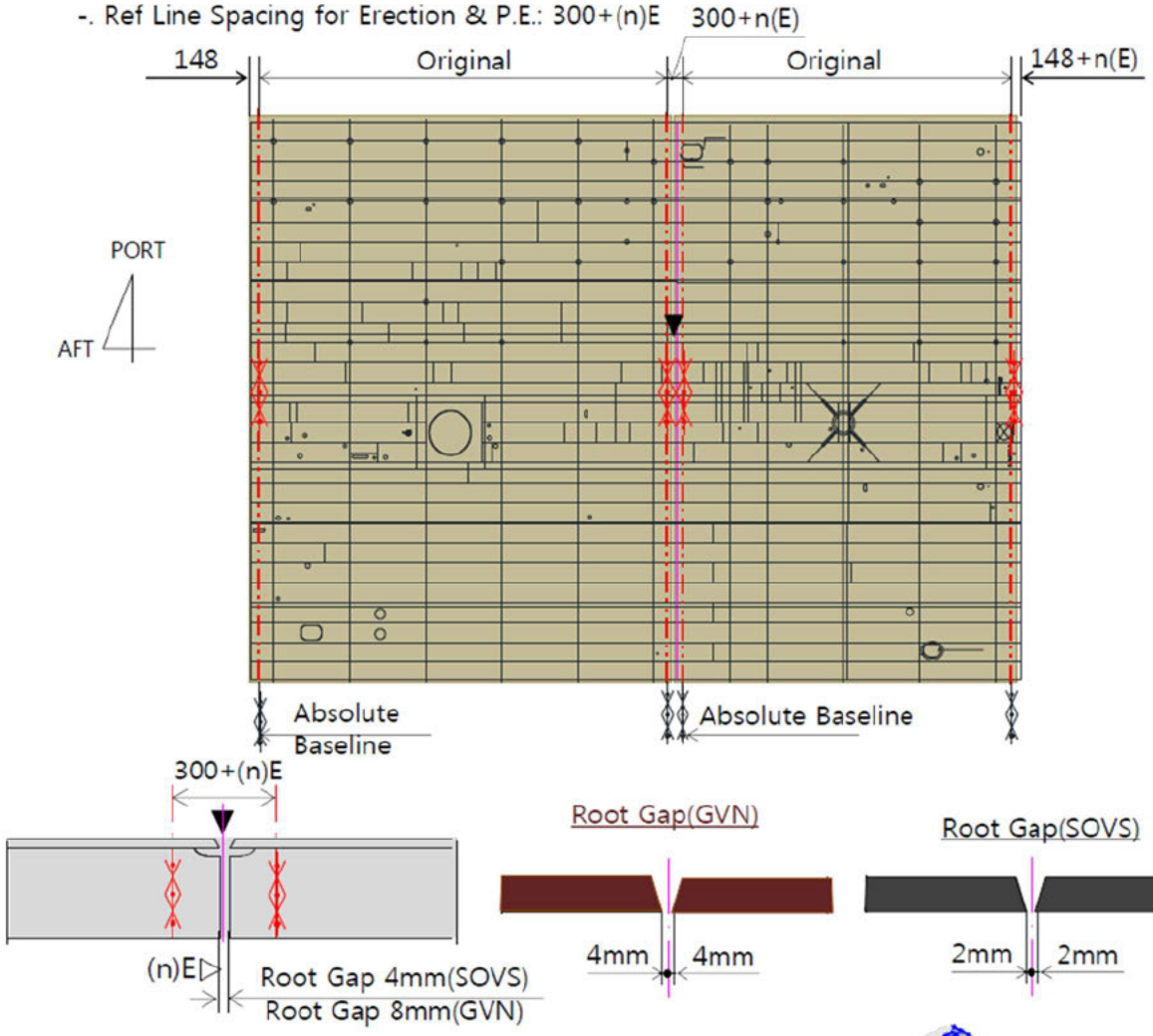


▣ Ref Line for Internal Member Installation



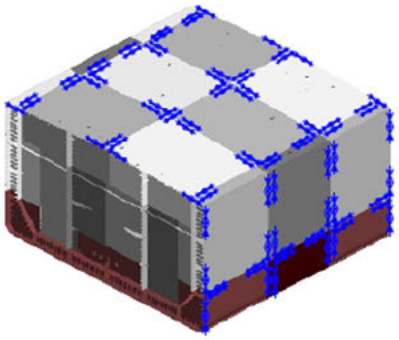
5. Pre- Outfitting & Erection Work Based on Ref Line

-. Ref Line Spacing for Erection & P.E.: 300+(n)E



6. Pre-Outfitting & Erection Shrinkage Allowance Application

-. The Absolute Baseline is on the Opposite Side of the Erection Shrinkage Application



Chapter II: Secondary Surface Preparation and Welding Shrinkage Allowance Application Standards.

1. Scope of Application

These standards shall apply when applying the shrinkage margin resulting from welding to the drawings prepared by the design department.

2. Purpose

The purpose of these standards is to establish criteria by consolidating all issues related to welding shrinkage occurring in hull construction during the ship's construction, thereby achieving a No-Margin process in fabrication, assembly, pre-outfitting, and erection work to improve productivity.

3. Definition of Terms

3.1 Welding Shrinkage Allowance:

Refers to providing an allowance on the base metal by anticipating the shrinkage caused by welding.

3.2 Butt Weld Transverse Shrinkage:

Refers to the shrinkage occurring perpendicular (transverse) to the weld line in Butt welding.

3.3 Taper Shrinkage Allowance:

Refers to the shrinkage allowance applied by considering the difference in welding shrinkage between the start and end points of the weld.

3.4 Two-Stage Preparation/Finishing:

Refers to applying allowances in the first and second stages (1st & 2nd Pass/Stage) to adjust step differences at the ends due to deviations in cutting and bending of the main plate, and to maintain accuracy; this allowance is then cut/beveled at the time of marking after plate joining in the assembly stage.

3.5 Fillet Weld Transverse Shrinkage:

Refers to the shrinkage occurring perpendicular (transverse) to the weld line in Fillet welding.

3.6 Fillet Weld Longitudinal Shrinkage:

Refers to the shrinkage occurring parallel (longitudinal) to the weld line in Fillet welding.

3.7 Assembly Distributed Extension Shrinkage Allowance:

Refers to the allowance applied by distributing the Fillet weld transverse shrinkage per member spacing at the design stage, ensuring the correct spacing of Slot Holes in assembled Girders and Web Frames, and internal members, to maintain accuracy without additional cutting work.

3.8 Pre-outfitting, Erection Shrinkage Allowance:

Refers to the welding shrinkage allowance applied during the pre-outfitting and erection stages, primarily applied to **Block Joints**.

4. Responsibilities and Authorities

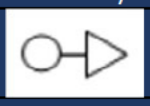
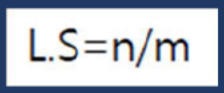
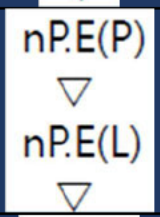
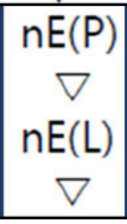
(1) The **Head of the Accuracy Technology Department** has the responsibility and authority for the establishment, revision, and enforcement of these standards.

(2) The **Structure Production Design Part Leader** has the responsibility and authority for the application of these standards to the drawings.

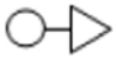
(3) The **Production Group Leader** has the responsibility and authority to analyze the cause of problems and provide **Feed Back** of the resulting data to prevent recurrence of issues based on these standards and their implementation.

5. Symbol Definition

5.1 Welding Shrinkage Allowance Application Symbols

Application Symbol	Name	Application Area	Work Stage
	Two-Stage Prep Allowance	Main Panel	Design Application, Assembly Cutting
	Assembly Distributed Extension Shrinkage Allowance	Main Panel and Inner Material	Design Application, Assembly Marking
	Assembly Shrinkage Allowance	Main Panel and BKT	Design Application
	Taper Shrinkage Allowance	Main Panel and Inner Material	Design Application
	Pre-outfitting Shrinkage Allowance	Main Panel and Inner Material	Design Application
	Erection Shrinkage Allowance	Main Panel and Inner Material	Design Application

5.2 Definitions for each Application Symbol

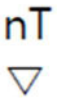


: For the 1st and 2nd finishing allowance, an additional 15mm allowance is given to the end of the main panel, excluding the shrinkage value.

L.S = n/m : **Assembly Distributed Elongation Shrinkage Allowance:** This shrinkage allowance is applied by distributing an amount of n for every m interval of the longitudinal space in the fillet welded area.

nA

Assembly Stage Shrinkage Allowance: A shrinkage allowance of n is applied to the end during the assembly stage.

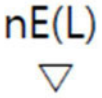


Taper Shrinkage Allowance: A shrinkage allowance of n is applied as a taper to the end.

Pre-Erection/Pre-Loading Shrinkage Allowance (Panel): A shrinkage allowance of n is applied to the main panel during the pre-erection/pre-loading stage.

Pre-Erection/Pre-Loading Shrinkage Allowance (L-Member/Internal): A shrinkage allowance of n is applied to the internal members during the pre-erection/pre-loading stage.

Erection/Loading Shrinkage Allowance (Panel): A shrinkage allowance of n is applied to the main panel during the erection stage.



Erection/Loading Shrinkage Allowance (L-member/Internal): A shrinkage allowance of n is applied to the internal members during the erection/loading stages.

6. Second Finishing

6.1 Application Standards

- **Flat Block**
  It is not applied except for special specifications (e.g., Hatch Cover, Fixed Ramp, Liftable Car Deck, etc.).

- **Curved Block**
  - Curved Shell Plates are subject to Second Finishing application in areas where the number of plates is 5 or more and where the hot working volume is high.
  - It is not applied, except for special specifications and the following for all ship types: Block 111, 101-SS Ass'y, and 824/34-SS Ass'y.

6.2 Directions for Applying Second Finishing by Structure

- **Midship Section**
  - Length Direction
    - It is applied toward the bow side, relative to the stern.
  - Width Direction
    - It is applied to the outboard side, relative to the centerline
  - Height Direction
    - It is applied to the lower part, relative to the upper part
- **Bow/Stern Section**

It is Generally applied toward the side with shorter cutting lengths and less curvature

- **Others**

It is generally not applied to the chamfer sections. If application is necessary, it should be applied to the opposite side of the chamfer.

7. Butt Welding Shrinkage Allowance Application Standards

7.1 Transverse Shrinkage Allowance for Butt Welds

- The transverse shrinkage allowance due to double-sided automatic welding shall be applied according to table 2 below.

  Table 2. Double-Sided Automatic Welding Transverse Shrinkage Allowance Application Standards.

Improved Shape	Shrinkage allowance per seam (mm)
I, DY, Y	0.5
V, X	2.0

- The shrinkage allowance for single-sided automatic welding (AOVS) and single-sided semi-automatic welding (SOVS) shall be applied as 2mm per seam.

7.2 Longitudinal Shrinkage Allowance for Butt Welds

- As a rule, it is not applied, except in special cases.

8. Fillet Welding Shrinkage Allowance Application Standards

8.1Transverse Shrinkage Allowance for Fillet Welds

The standards for applying the transverse shrinkage allowance based on the heat input for each fillet welding technique are as follows:

Table 3. Fillet Transverse Shrinkage Allowance Application Standards (Distributed Elongation per Member)

Angle / Thickness	3.5~4.0	4.5~5.0	5.5~6.0	6.5~7.0	7.5~8.0
6~8	0.6	0.7	0.8	0.9	1.0
9~10	0.5	0.6	0.7	0.8	0.9
11~12	0.4	0.5	0.6	0.7	0.8
12.5~15	0.3	0.4	0.5	0.6	0.7
15.5~20	0.2	0.3	0.4	0.5	0.6
20.5~25	0.1	0.2	0.3	0.4	0.5

8.2 Longitudinal Shrinkage Allowance Application for Fillet Welds

The longitudinal shrinkage allowance for fillet welds shall be applied at 0.2mm per meter (M), regardless of the welding angle or plate thickness. This value is applied by including it in the transverse shrinkage allowance caused by the fillet welding of the web frame.

8.3 Taper Shrinkage Allowance Application for Fillet Welds

This is applied to all web frames, stringers, and brackv et types that are fabricated with a triangular structural shape (T, L2, L3 types). The allowance is classified and applied according to the shape as follows:

Table 4. Taper Shrinkage Allowance Application Standards

F/F Welding Length (mm) / Thickness Factor			800~1999		2000~2999		3000~3999		4000~4999		5000~5999	
			45°	30°	45°	30°	45°	30°	45°	30°	45°	30°
t≤13	1.2	1.5	3	5	4	6	5	8	7	11	8	12
13<t≤23	1.0	1.3	3	4	4	5	5	7	6	8	7	9
23<t	0.8	1.2	2	3	3	4	4	5	4	6	5	6

9. Cutting/Stripping Shrinkage Allowance Application Standards

The standards for applying the cutting shrinkage allowance for stripping members are the following:

Table 5. Cutting Shrinkage Allowance Application Standards

Cutting Width / Plate Thickness	125 ~ 200	201 ~ 350	351 ~ 500	501 ~ 650	650 ~
10 ~ 16	0.3	0.2	0.1	0.1	0
17 ~ 25	0.3	0.2	0.2	0.1	0
26 ~ 49	0.3	0.2	0.2	0.1	0
50 ~	0.3	0.2	0.1	0.1	0

10. Erection/Loading Shrinkage Allowance Application Standards

10.1 Application Standards for Longitudinal Direction by Structure

The allowance is applied considering a 2mm step/offset by structure, according to the erection sequence. Since the internal members are welded before the main panel, they are applied 2mm longer than the main panel.

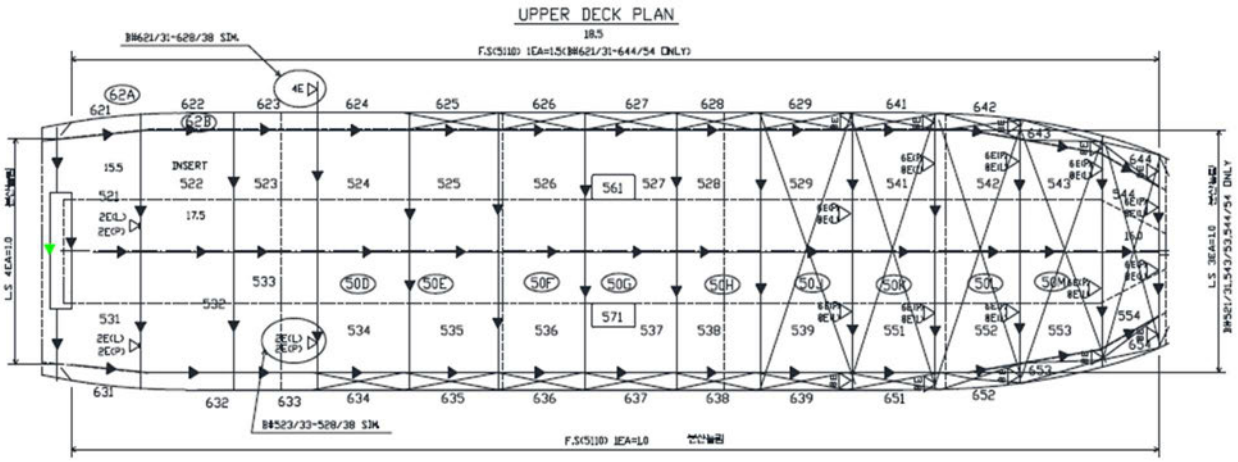
Table 5. Erection/Loading Shrinkage Allowance Longitudinal Direction Application Standards

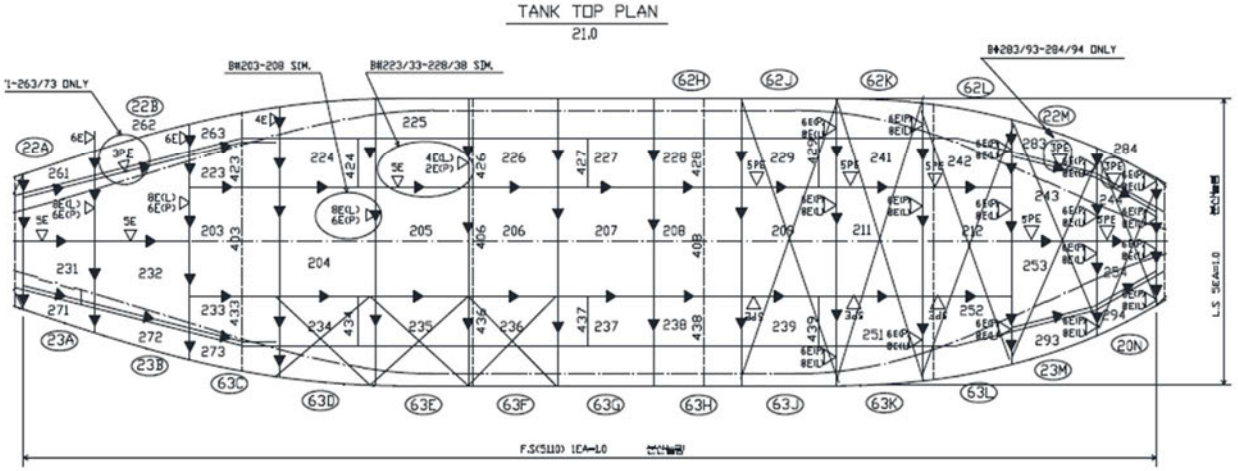
Ship Type / Structure	VLCC, COT		CONTAINER		B/C		RO/RO	
	Main Panel	Internal Member	Main Panel	Internal Member	Main Panel	Internal Member	Main Panel	Internal Member
M.DECK	0E	2E	2E	2E	2E	4E	3E	4E
S.SHELL	2E	4E	2E	4E	4E	6E	4E	6E
S.L.BHD	2E	E	2E	4E	-	-	-	-
C.L.BHD	4E	6E	-	-	-	-	-	-
D.BTM	6E	8E	6E	8E	6E	8E	6E	8E

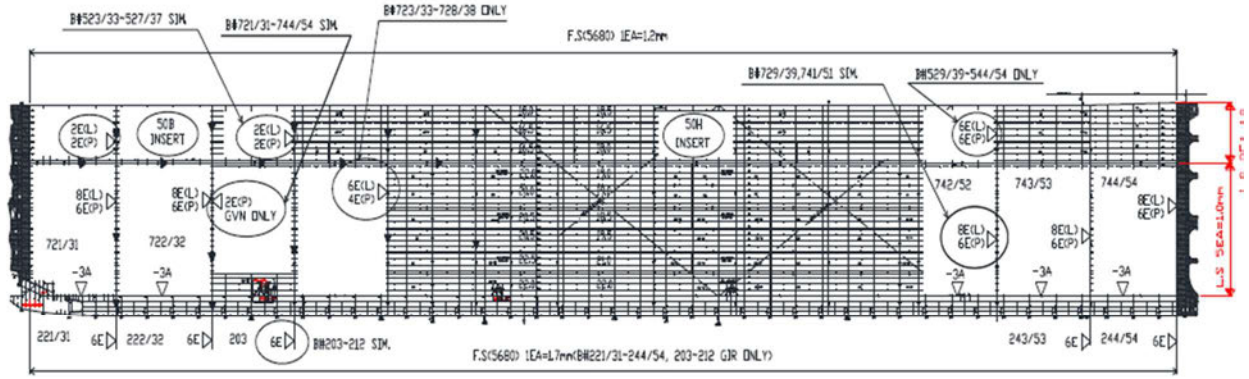
Adjustment is required according to joint configuration and work sequence.

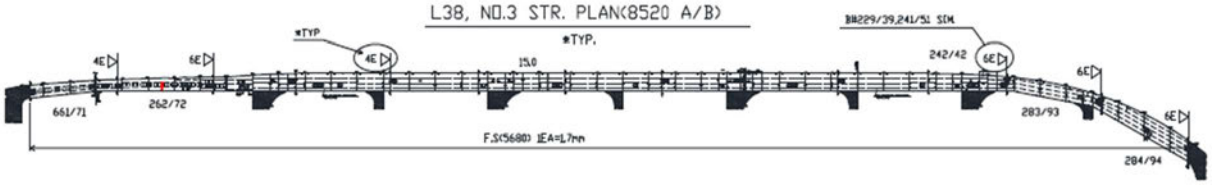
10.2 Application Standards for Width/Height Direction

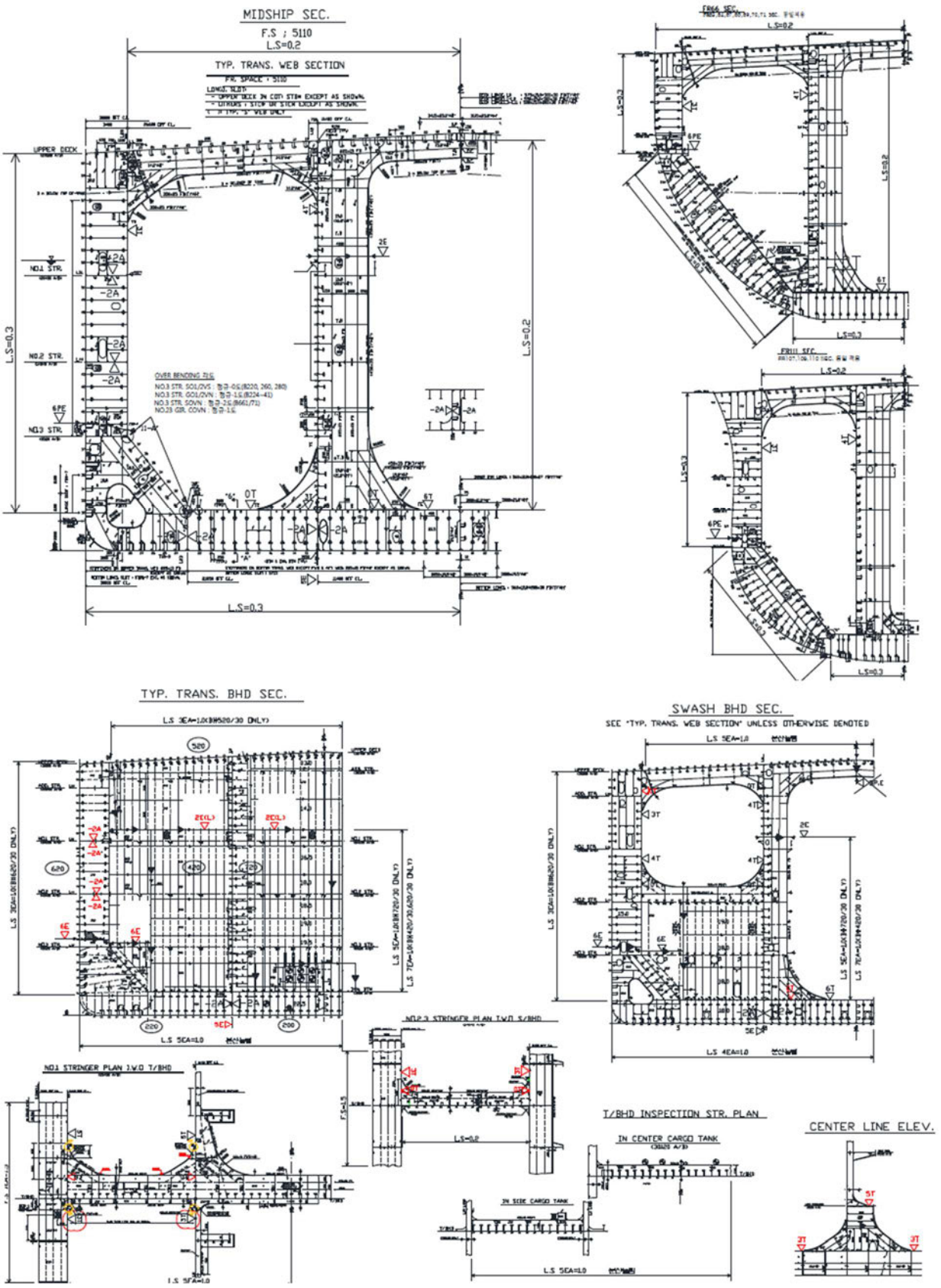
- The width direction shall be applied at 5mm as a rule, and adjusted according to the number of blocks.
- For the height direction, considering the load and welding sequence, if the main panel and internal members are a butt joint, the internal members are applied 4mm longer (Main Panel 2E, Internal Members 6E).


UPPER DECK PLAN
F.S(5110) 1EA=1.0

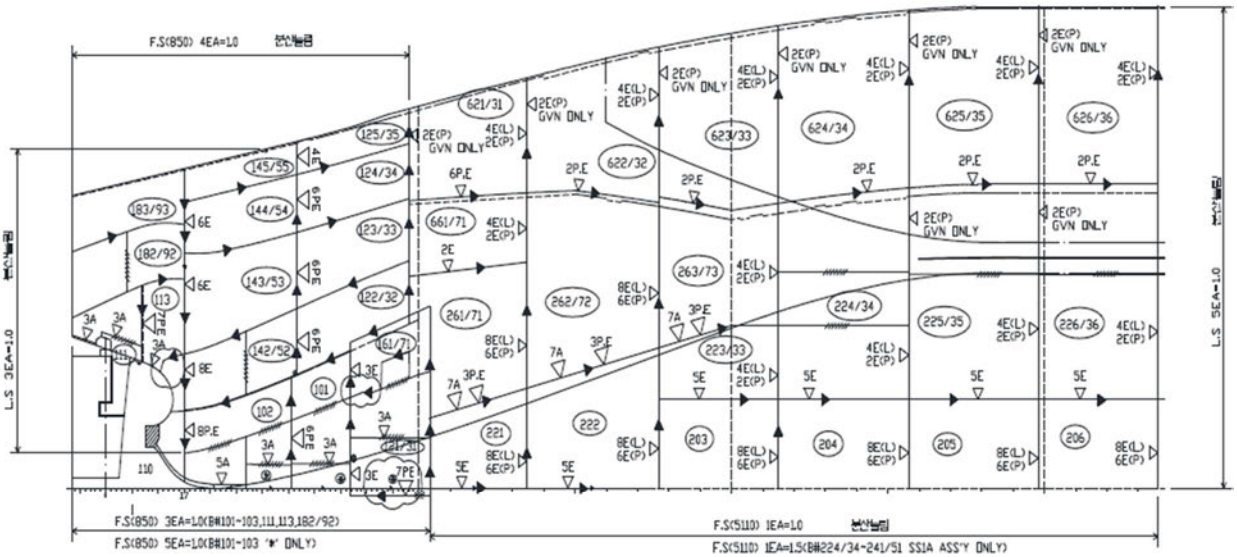

TANK TOP PLAN
21.0
F.S(5110) 1EA=1.0

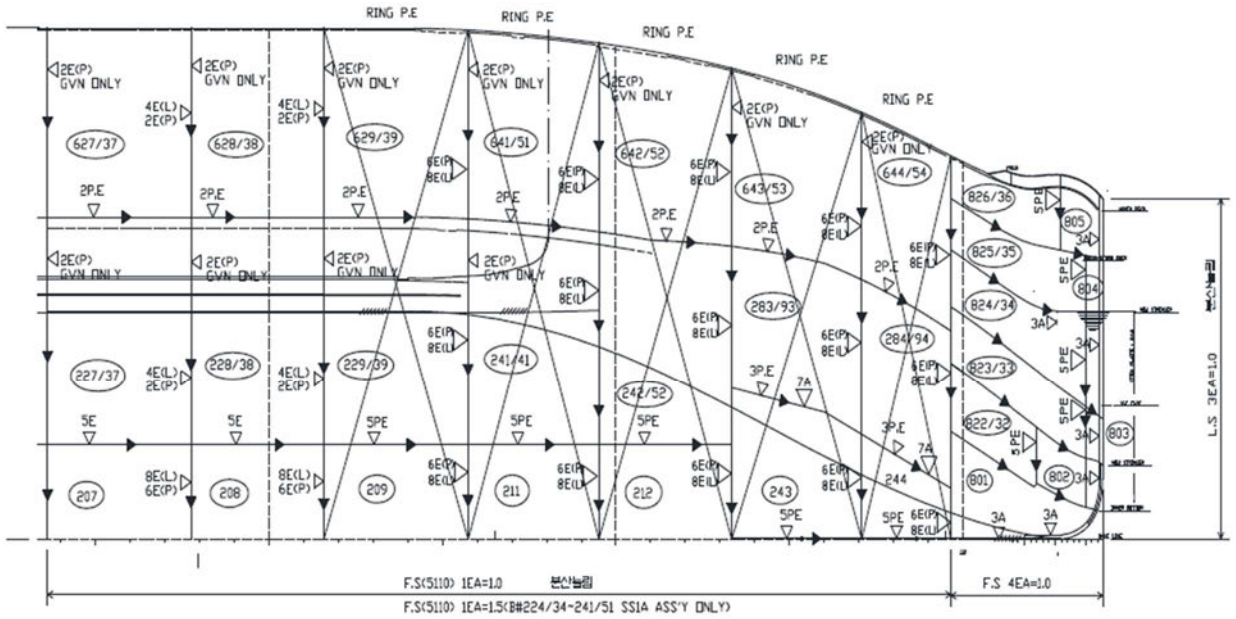

F.S(5680) 1EA=1.2mm
F.S(5680) 1EA=1.7mm(BH221/31-244/54, 203-212 GIR ONLY)


L38, NO.3 STR. PLAN(8520 A/B)
*TYP.
F.S(5680) 1EA=1.7mm

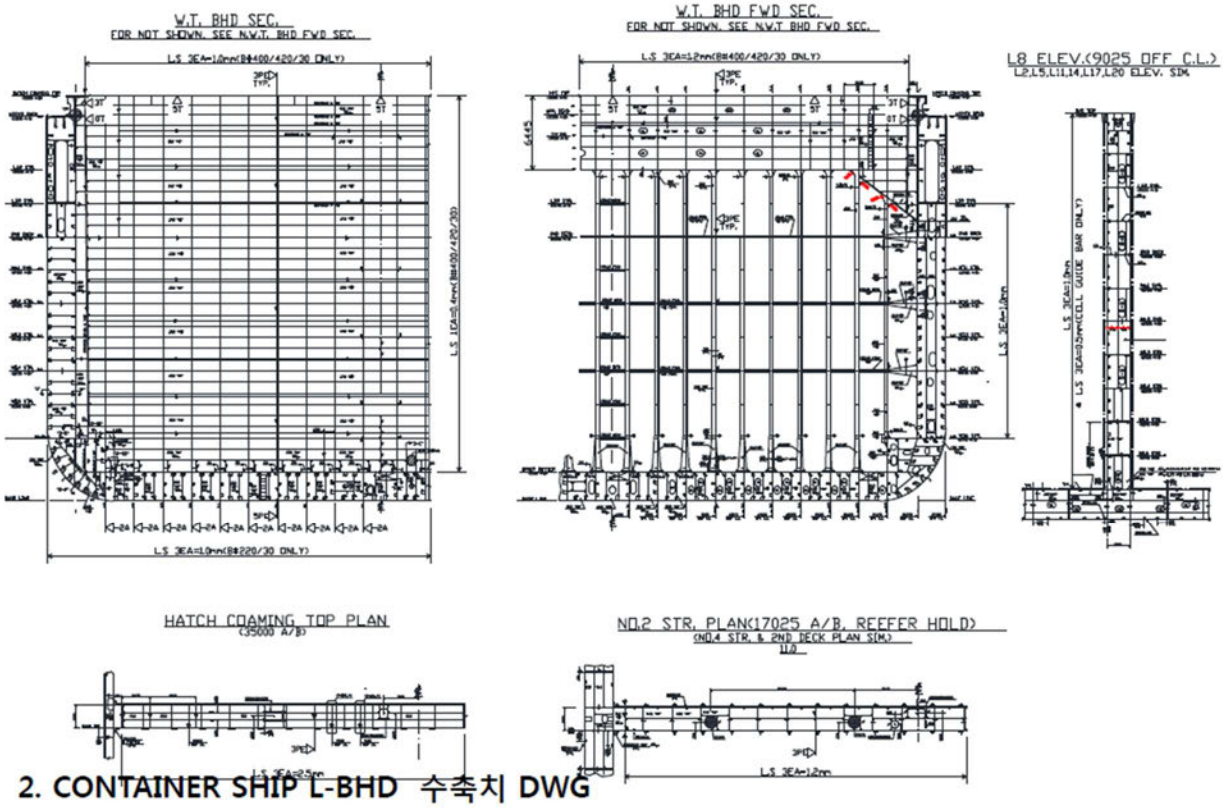

MIDSHIP SEC.
F.S ; 5110
L.S=0.2
TYP. TRANS. WEB SECTION
UPPER DECK
NO.1 STR.
NO.2 STR.
NO.3 STR.
L.S=0.3
L.S=0.2
TYP. TRANS. BHD SEC.
NO.1 STRINGER PLAN T.W.T. T/BHD
NO.2 STRINGER PLAN T.W.T. T/BHD
SWASH BHD SEC.
SEE "TYP. TRANS. WEB SECTION" UNLESS OTHERWISE DENOTED
T/BHD INSPECTION STR. PLAN
IN CENTER CARGO TANK
IN SIDE CARGO TANK
CENTER LINE ELEV.

SHELL EXPANSION

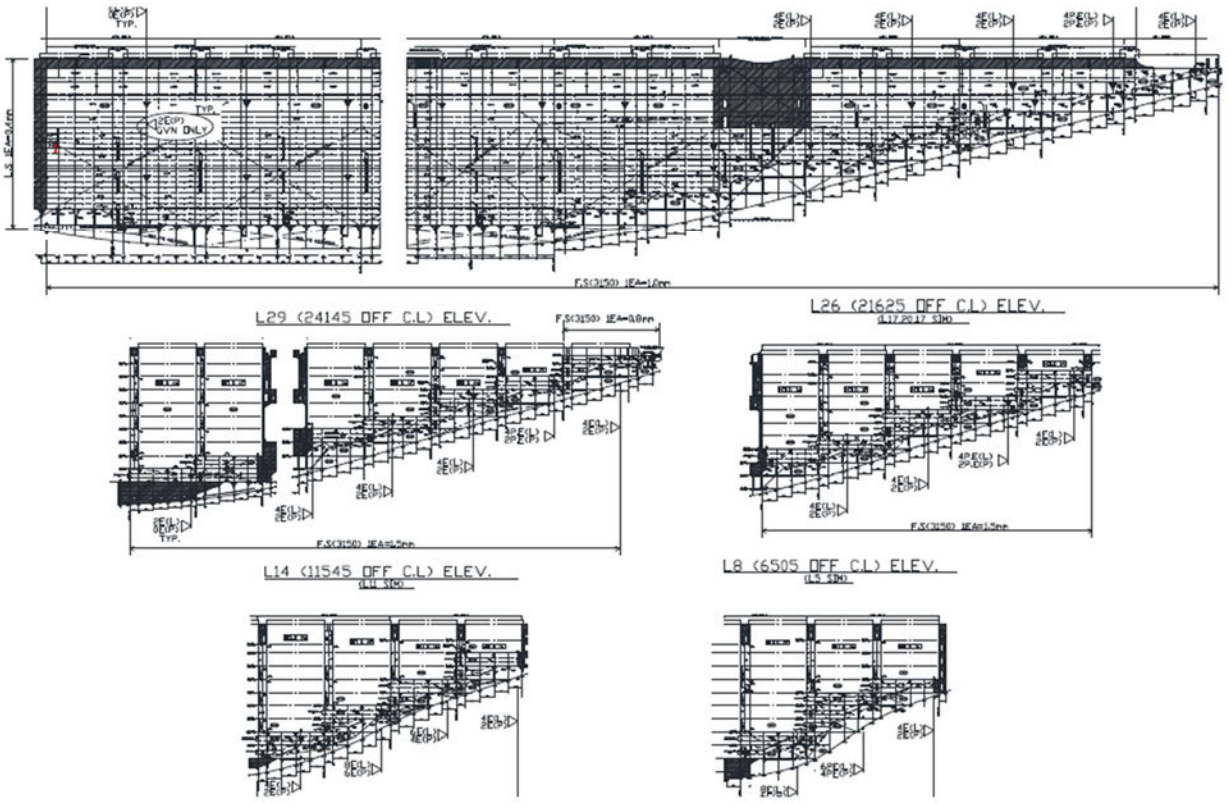




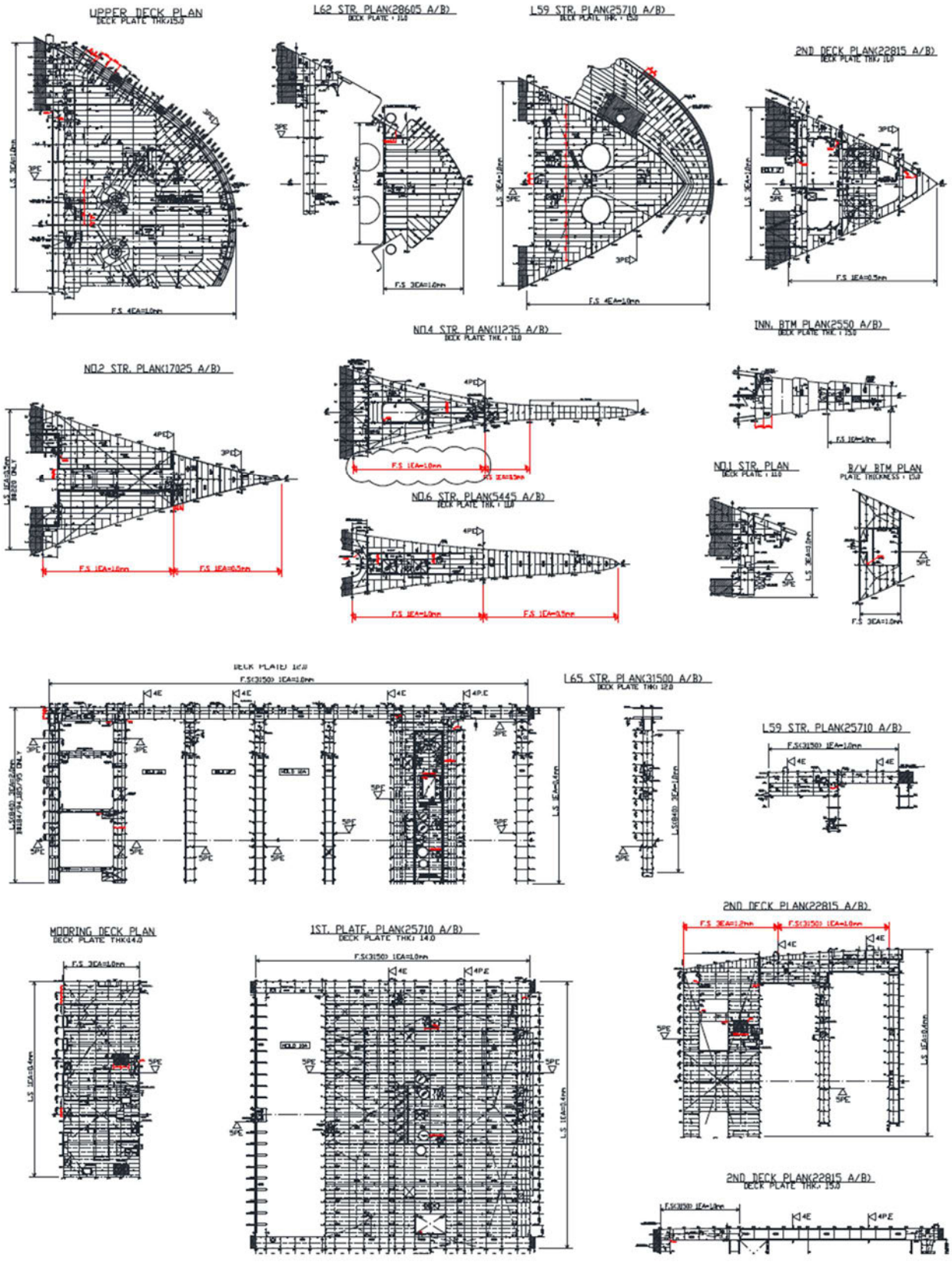
1. CONTAINER SHIP T-BHD 수축치 DWG



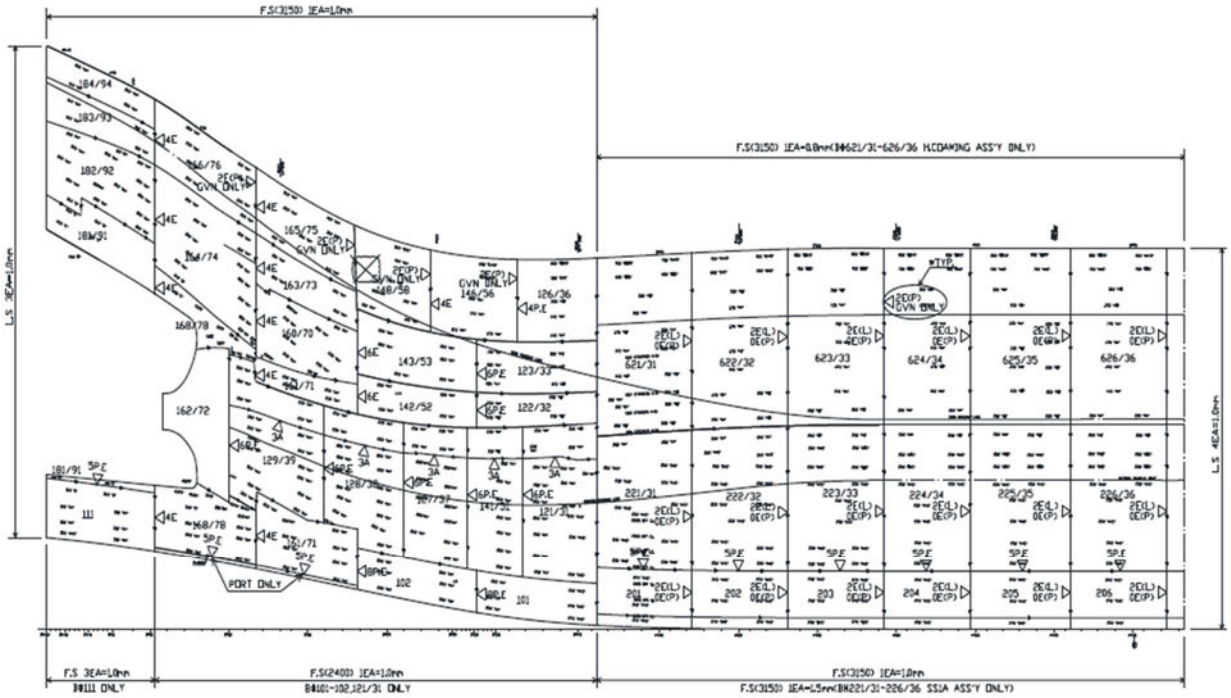
2. CONTAINER SHIP L-BHD 수축치 DWG

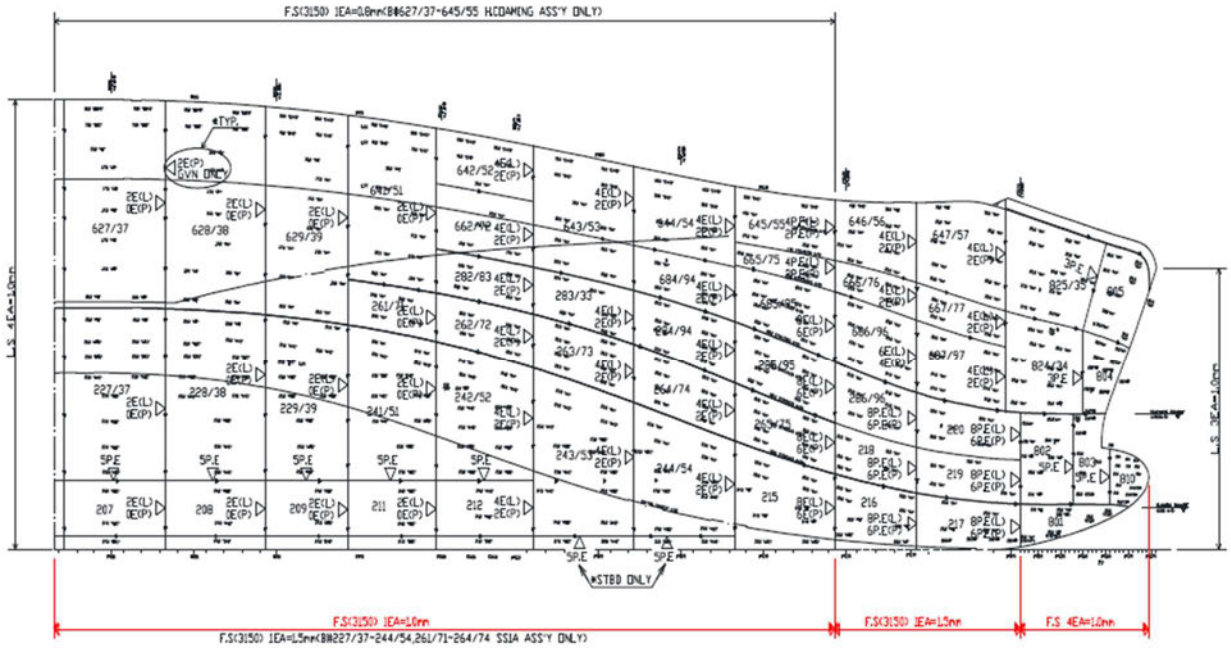


3. CONTAINER SHIP DECK PLAN 수축치 DWG



4. CONTAINER SHIP S.SHELL EXPANSION 수축치 DWG





1. SCOPE OF APPLICATION

This applies to the installation of 100M.K or 50M.K and the withholding of coating (taping) at joint locations where aggregate forms on the back side of steel structures.

2. PURPOSE

The purpose of this procedure is to establish the baseline installation method to prevent misalignment with the backside members at aggregate-accumulation areas, and to define the taping criteria for coating hold at welded joints.

3. TERMINOLOGY

100M.K (50M.K): This refers to the line marked (punched) at a point 100 mm (50 mm) away from the mould line of the grit/aggregate, or at (100(50) + t) to include the member thickness, in order to establish the backside-member location and prevent misalignment with the grit line.

4. RESPONSIBILITIES

(1) The Head of the Accuracy Control & Engineering Department has the responsibility and authority for establishing, revising, and abolishing this procedure.
(2) The heads of the Design and Production Departments are responsible for carrying out their duties in accordance with the contents of this procedure.

5. PREPARATION OF 100M.K (50M.K) DRAWING

The 100M.K (50M.K) drawings shall be prepared by the Accuracy Control & Engineering Department and distributed to the relevant departments (Design, Painting, and Erection) in accordance with the drawing-distribution procedure.

When preparing the drawings, the following information must be clearly indicated:

- Construction stage for 100M.K (50M.K) application
- Exact installation/marking location
- Required marking length
- Areas requiring marking on both sides
- Paint-hold zones on the reverse side
- Paint-hold boundary markings

Construction standards for the assembly stages shall be specified separately for:

- Sub-assembly
- Mid-assembly
- Grand/block assembly

6. 100M.K (50M.K) Construction Stage Standards

6.1 Assembly Stage – Application of 100M.K

During block assembly, **P.E (Pre-Erection) / Erection block joints** must have the **Mould Line** and **100M.K (50M.K) reference lines** applied exactly according to the construction stage specified in the drawings. These markings are mandatory and must not be omitted.

Applicable Structural Areas

100M.K (50M.K) must be applied to the following:

- A.P Bulkhead
- Engine Room (E/R) Bulkhead
- Center Girder
- Longitudinal Bulkhead
- Transverse Bulkhead
- Stringers and small structural members
- Cargo Hold Blocks

General Application Zones

For **Aft Body, Engine Room, Fore Body, and Cargo Hold Blocks**, 100M.K must be applied over **all areas except**:

- Structures that will face downward (non-accessible surfaces) during P.E or erection
- Areas noted as exceptions in the project specification

Special Ship Types

For special vessel types such as:

- TLP (Tension Leg Platform)
- Offshore rigs
  100M.K must be applied to **all areas** unless specifically excluded in the project specifications.

Marking Work Responsibility

For the **Fore Body Upper Deck**, all outfitting component marking (including **punch-marking**) shall be performed by the **Fabrication Team (in-house or subcontractor)** at the **plate-joining stage** during block fabrication.

6.1.1 Assembly Stage – 100M.K Construction Standards

- When the same work conditions exist for both the preceding and following processes, **the marking shall be performed in the earlier process** as a general rule.
- If the 100M.K construction height is **2,000 mm or higher**, the marking **must be reflected in the earlier process**.
- If the work location allows the task to be divided **half-and-half between two processes**, the work shall be split evenly, even if the marking height is high.
- For **100M.K at deck-top grand assembly joints**, marking shall be performed **only when the block is being dispatched in its normal attitude**.
    - (Marking may be done during waiting time.
    - For shell-base dispatch, grand assembly marking is permitted **only when the JIG angle is 15° or less**.)
- If a change to the 100M.K stage criteria is required contrary to the above rules, the matter must first be discussed with the **assembly accuracy-control group**, and then the final decision must be reported to the **100M.K coordinator**.
- When multiple stages occur, **each marking location must be emphasized clearly**.
  (e.g., Mid-assembly R1 marking, Mid-assembly H4 marking, Grand assembly marking, etc.)
- When applying upper-deck reference lines (offshore vessels), **auxiliary dimension lines must be added**.
- For blocks that include a **windlass foundation**, the paint-hold dimension line must be marked **entirely at the seam line**.
  (Same rule applies for upper outfitting areas.)

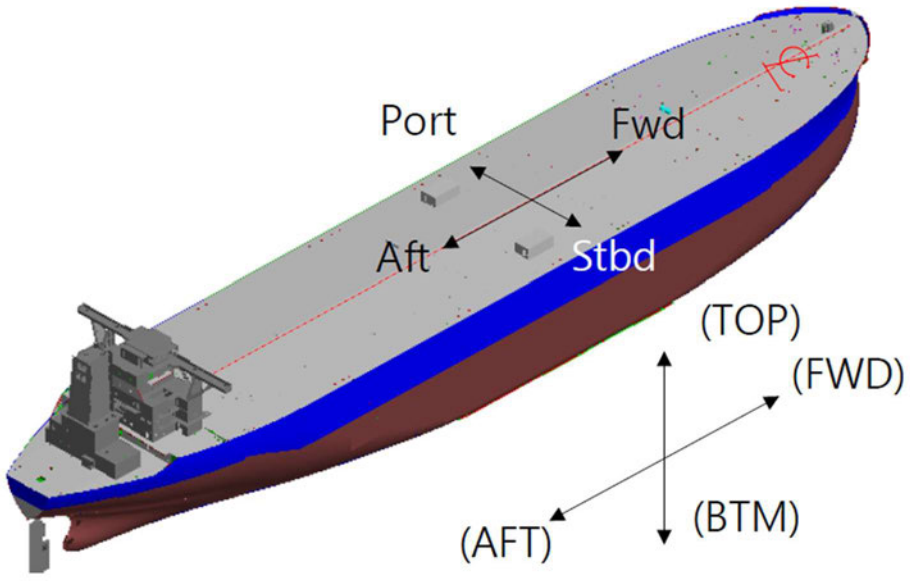
6.2 P.E Stage – Application of 100M.K (50M.K)

- For P.E / Erection block joints, 100M.K based on the **Mould Line** must be applied according to the drawing instructions designated for the **P.E stage**.
- For **deck base structures**, a temporary **marker-pen marking** is applied during assembly, and the final **Mould Line and 100M.K** are reapplied at the **P.E stage**.
- Applicable structural elements:
    - **Aft Body:** Deck / Stringer
    - **Engine Room:** Deck / Stringer
    - **Fore Body:** Deck / Stringer

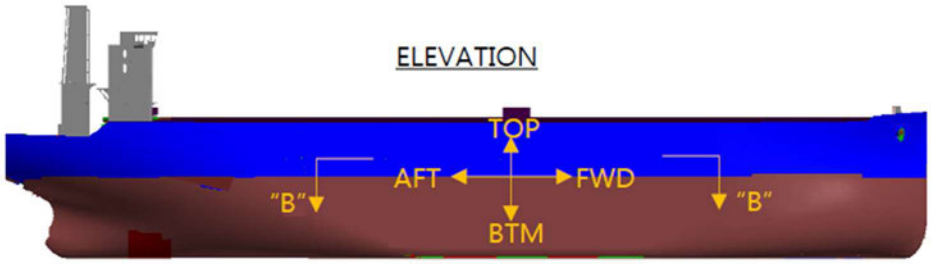
- For Aft Body, Engine Room, Fore Body, and Cargo Hold Blocks, **the assembly stage forms the base surface**, and at P.E or erection, **all structures that become visible upward (not underneath)** must have 100M.K applied across the entire applicable area.
- Special Vessels:
    - For units such as **TLPs, offshore rigs**, and other special ship types, apply 100M.K to **all required areas unless otherwise noted in the project specification**.

7. Criteria for Indicating 100M.K (50M.K) and Paint-Hold on Drawings

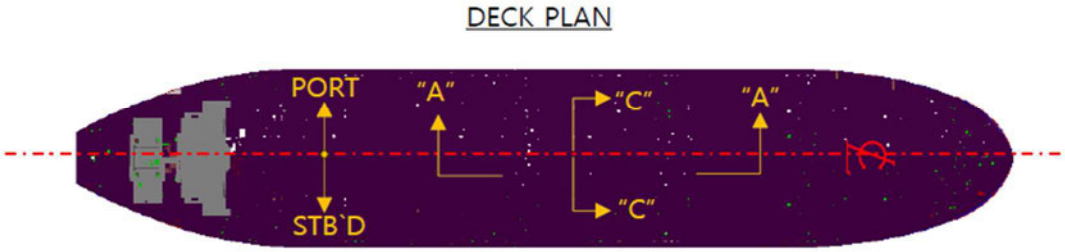
- On drawings, **fore / aft, port / starboard, upper / lower** always refer to the orientation of the vessel in its **normal upright condition**.
- If directional indications must be shown **other than the standard drawing orientation**, they shall be illustrated using:
    - **LOOKING STBD**
    - **LOOKING AFT**
    - **LOOKING UP**
      and the orientation must be **clearly marked** on the drawing.



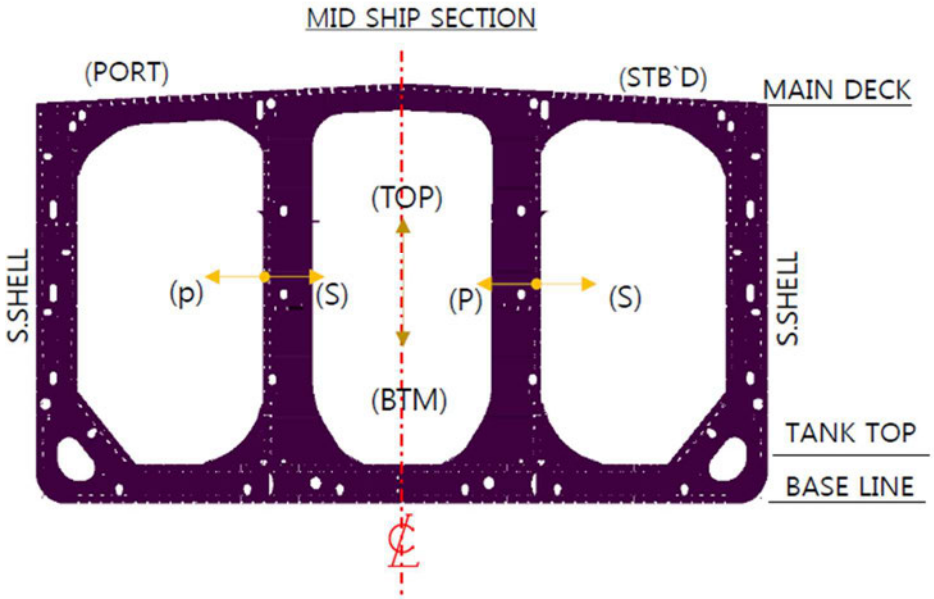
- LOOKING PORT : View in the "A" - "A" direction (ELEVATION).



- LOOKING DOWN : View in the "B" - "B" direction (PLAN)



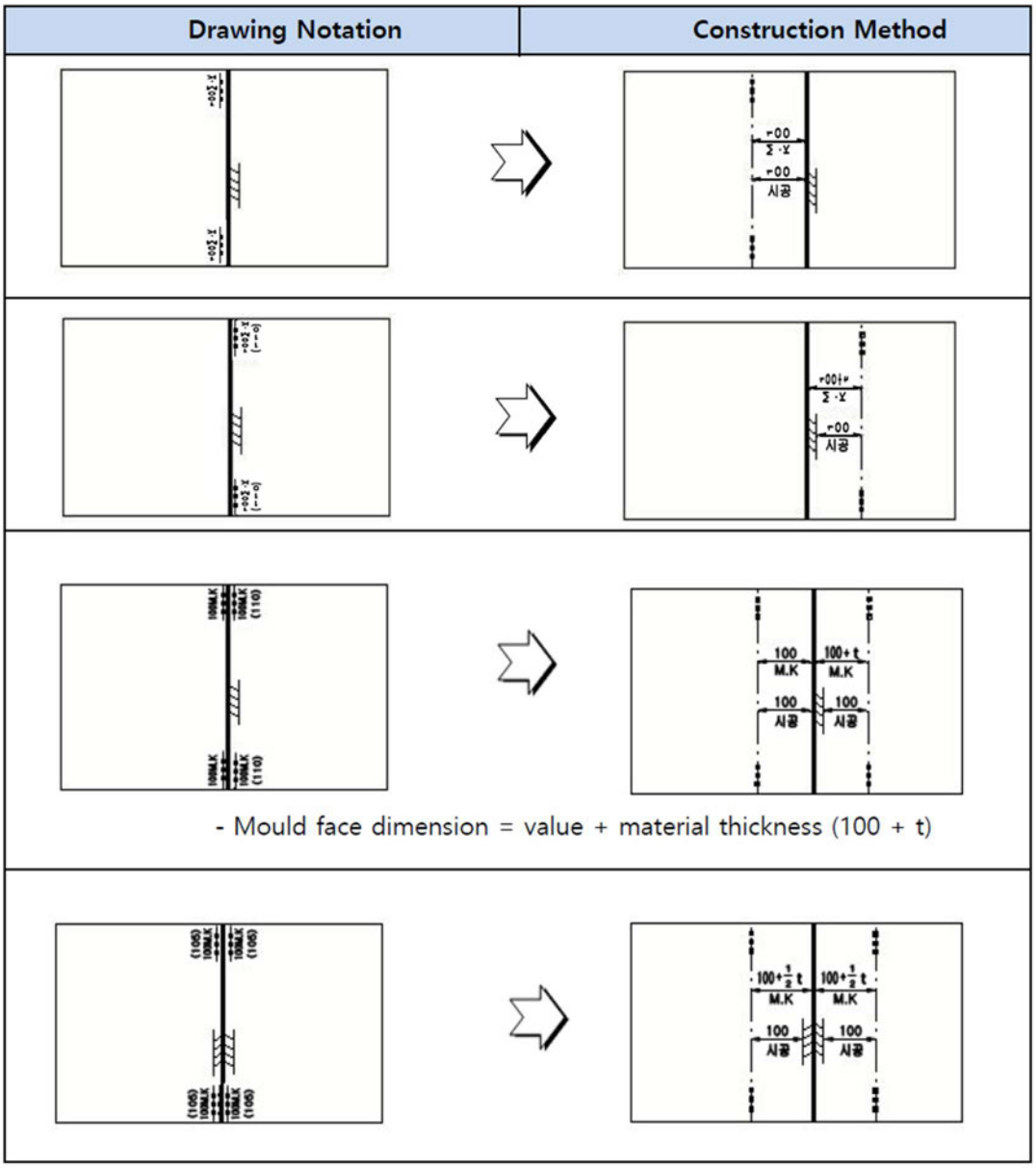
- LOOKING FWD(FORWARD) : View in the "C" - "C" direction (SECTION)



8. Drawing Notation and Construction Method

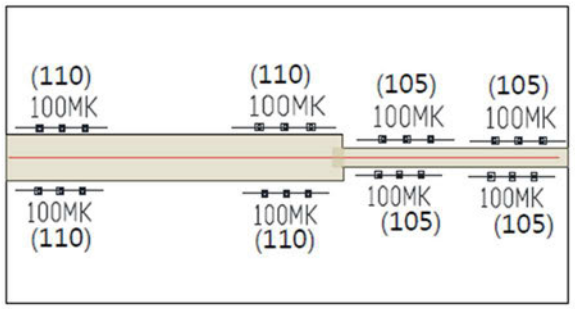
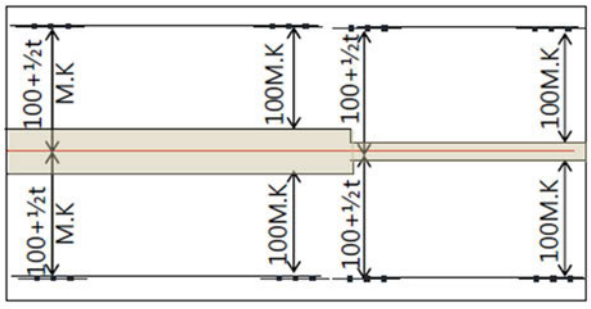
- Even if the drawing shows only **one** 100M.K point, the **actual marking (punching)** shall always be applied **as a pair**.
    - **Single-Side Application:** Marking is applied on the mould line side of the member with a fillet-weld joint.
    - **Double-Side Application:** Marking is applied simultaneously on both the mould line side and the thickness-direction side of the member with a fillet-welded joint.

- **Single-Side Application:** A pair of 100M.K. marks shall be applied on only one side, either on the mould line side or on the member thickness-direction side, depending on the required marking side.

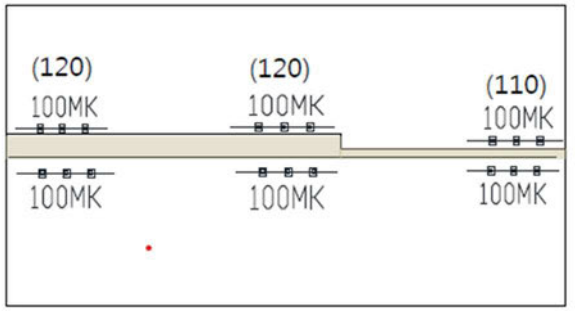
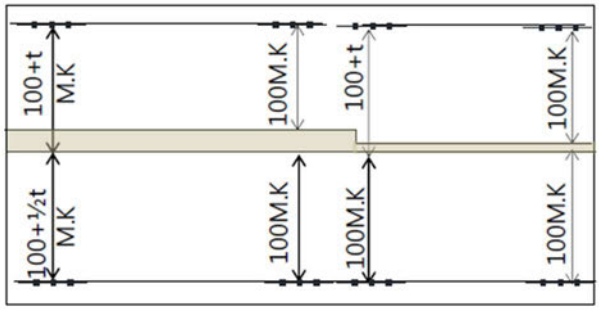


9. Structure With Thickness Differences at Single Joint

9.1 Center BHD Structure: (100 + ½t) where **t** is the plate thickness.

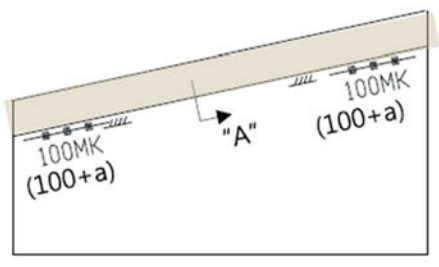
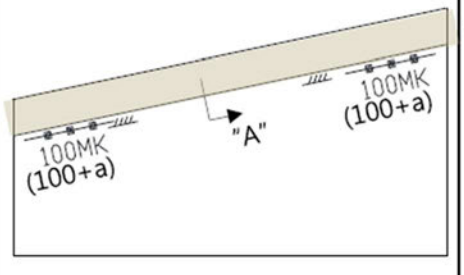
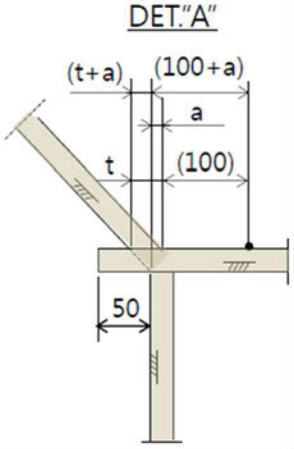
Drawing Notation	Construction Method
	

9.2 Trans. BHD Structures: Material side (100 + t) where **t** is the plate thickness

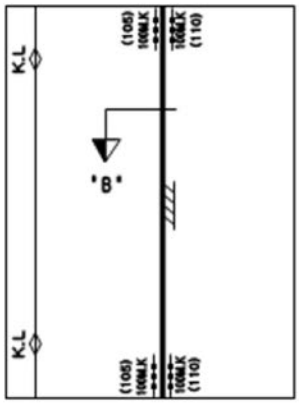
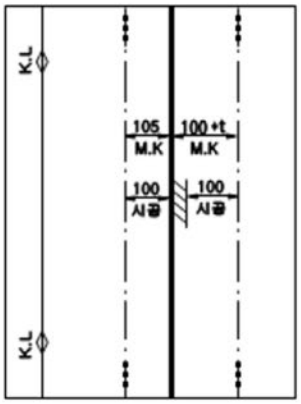
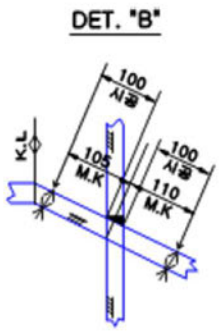
Drawing Notation	Construction Notation
	

10. Structures with Inclines (Sloped) Joints

10.1 Diagram for reference

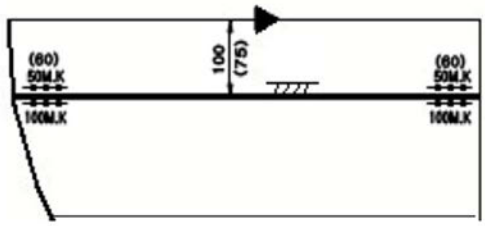
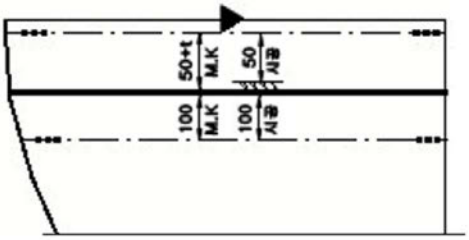
Drawing Notation	Construction Method	Remarks
		

10.2 100M.K on sloped sections should follow the surface

Drawing Notation	Construction Method	Remarks
		

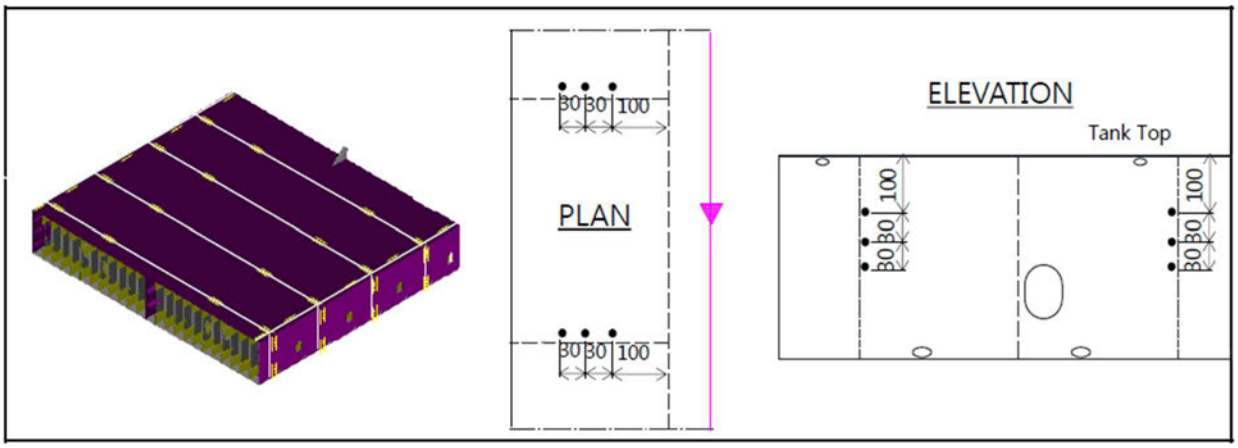
11. Structures With Members Located Adjacent to a Block Butt Joint

If a Butt Joint is located 75 – 100mm adjacent to a fillet-joint member, a 50M.K. mark shall be applied.

Drawing Notation	Construction Method
	

12. 100M.K Punch-Marking Construction Guidelines

Three points shall be applied at each end. The punching depth shall be less than 0.5-1 mm, and the spacing shall be 20-35 mm.



13. Outfitting-Related Work

- The drawings are prepared by the Accuracy Control Team and are used only for applying paint-hold tape.
- Drawings are prepared only for foundations that are configured as seats (SEAT-type foundations.)
- During the assembly stage, Marker Pen marking is applied in the deck bade condition.
    - FORE Windlass (Oil Coaming) Foundation
    - Cargo Hold Upper Deck Mooring Winch, Crane Pedestal
    - Engine Room Cargo Oil Pump, Ballast Pump, Stripping Pump
    - Engine Room Diesel Generator Foundation
    - Aft Steering Gear Foundation
    - Engine Room Air Compressor Foundation
    - Various Engine Room Boiler Foundations
    - Fore Bollard Foundation
    - Fore Chain Stopper
    - Fore Chain Compressor
    - Fore Mast, Stand Roller
    - Engine Room Upper Deck Crane Pedestal

14. Inspection (100M.K)

- During block inspection, the locations of the 100M.K marks specified on the assembly drawings must be checked to ensure that none are missing.
- The punch marks must be verified at the correct locations:
    - 100 mm from the mould line on the mould face of member.
    - 10 + t where t = plate thickness) in the thickness-direction location specified.
- All 100M.K marking work must be completed by the responsible department no later than one day prior to the scheduled block inspection.

15. Paint-Hold Taping Work

(1) During block taping work, the pre-painting team (or subcontractor) shall attach 100 mm wide paint-hold tape to all designated paint-hold areas before blasting, including:

- P.E / Erection fillet-joint member lines
- Block butt areas
- D/B pad top surfaces attached to Aft Body, Engine Room, Cargo Hold, Fore Body, and Deck.

After painting is completed, the same pre-painting team shall completely remove all applied tape.

(2) For ballast tank areas, paint-hold locations shall be separately indicated on the paint-hold drawing.

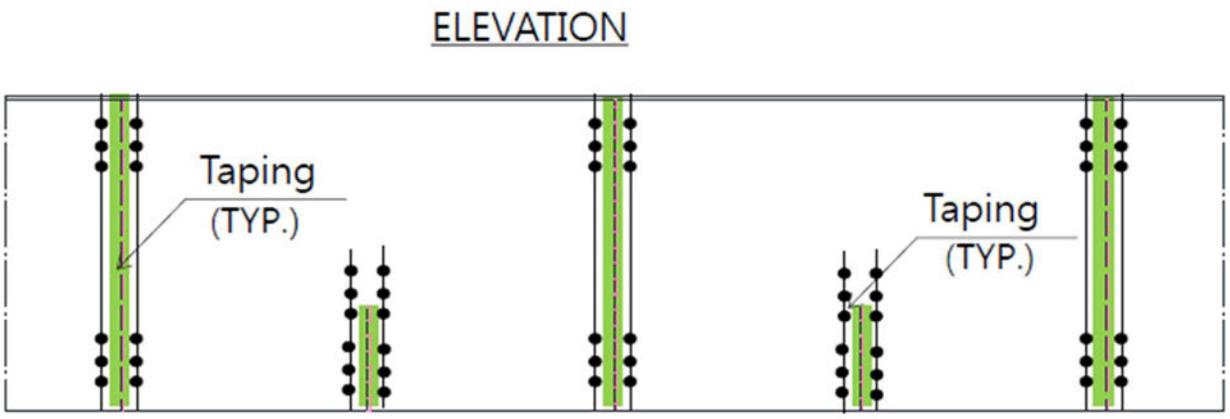
Tape must also be applied to reverse sides of structural members, and all tape shall be removed after painting.

(3) For assembly-stage 100M.K line application zones, paint-hold tape shall be attached and removed directly on the member marking line.

(4) For P.E.-stage 100M.k line zones:

- The assembly stage shall mark the location using a marker pen.
- The pre-painting team shall apply and remove the paint-hold tape.

(5) Paint-hold tape must be applied and removed at all outfitting installation locations that are indicated on the 100M.K drawings.



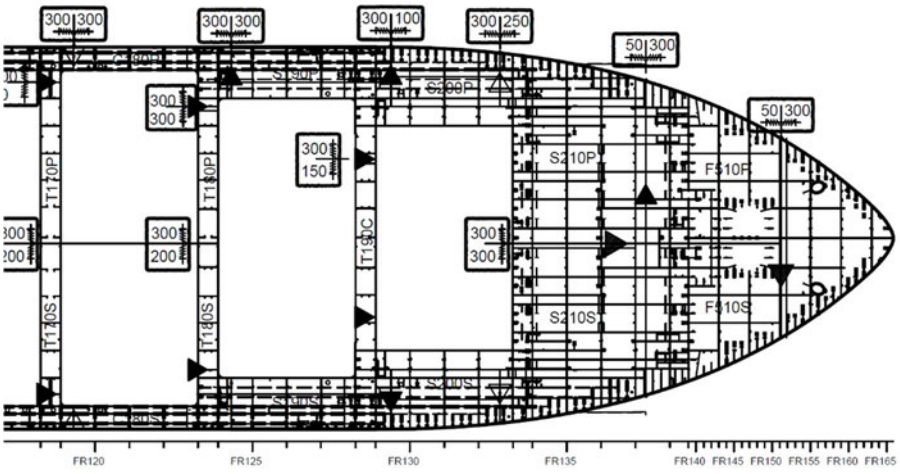
IV. Welding-Hold Application Standards (N.W)

1. Drawing Notation Method

1.1 Weld holds for each ship are defined in the ***Weld Hold Back Guide*** for that specific ship.

1.2 For locations where standard welding-hold amounts apply, the hold amount is not written numerically. Instead, it is indicated using the ⌇////— symbol.

1.3 For locations requiring a special welding-hold amount, both the symbol ⌇////— and the specific hold amount shall be indicated.

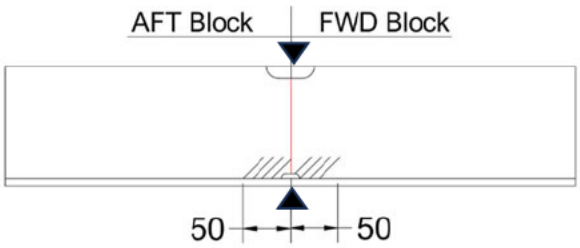


2. Welding-Hold Method

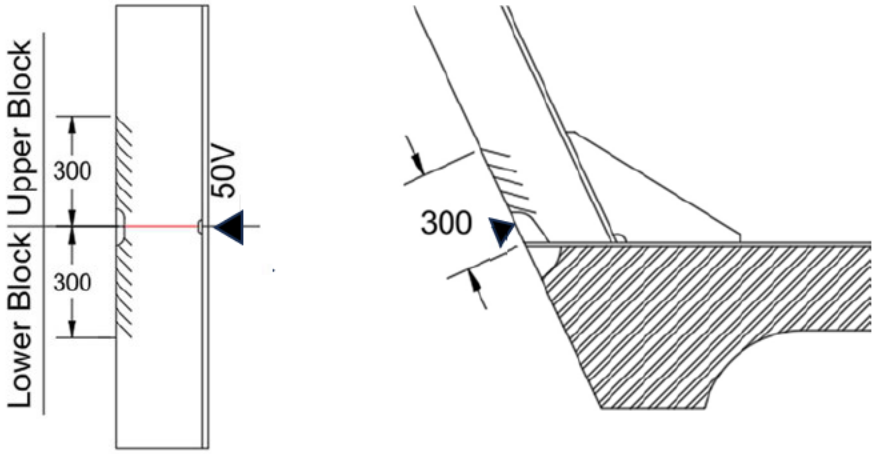
2.1 Welding-hold locations shall be applied as follows, based on the welding-hold indications shown on the *Weld Hold Back Guide.*

2.2 A standard 300 mm welding-hold shall be applied.

2.3 For built-up members, the face flat shall have a welding hold of 50 mm on each side, for a total of 100 mm.

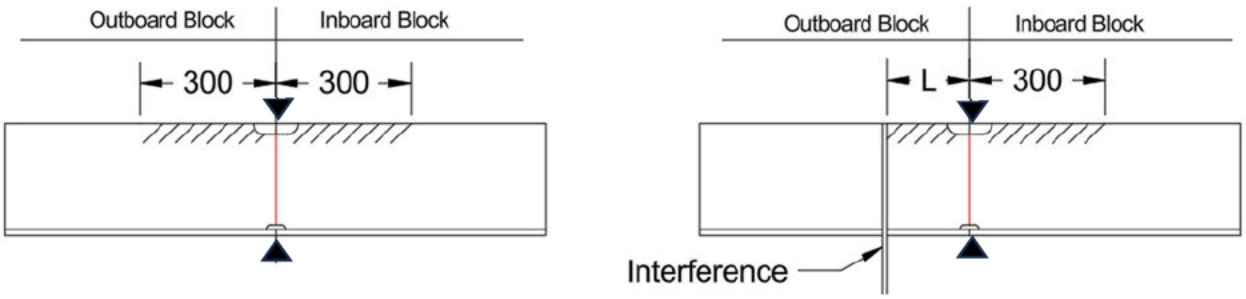


2.4 For members oriented in the vertical (up/down) direction, the welding hold shall be applied on both blocks.



2.5 For members oriented in the inboard/outboard direction, the welding hold shall be applied on both blocks.

2.6 However, if interfering members exist within the required hold length, the welding hold shall be the distance up to the interference.

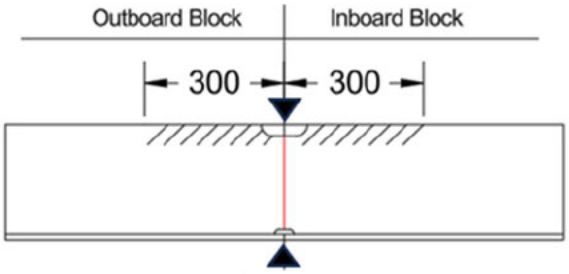


2.7 Welding Application Standards for W Within the Welding-Hold Zone.

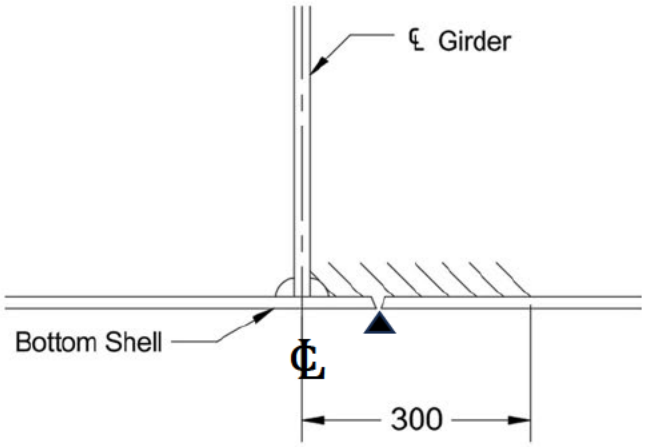
▣A tack-weld (50mm) should be applied at the end of the welding-hold zone.

2.10 Welding-Hold Length Indication Standards According to Member Shape.

Main plate and internal member aligned
(Including all internal members)



Main plate and internal member not aligned
(Including all internal members)



3. Welding-Hold Length

3.1 General Requirements

Chapter 4. Accuracy Control By Construction Stage

I. Key control Points at the Assembly Stage

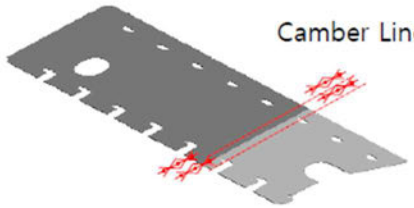
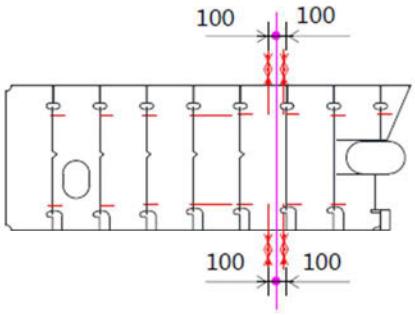
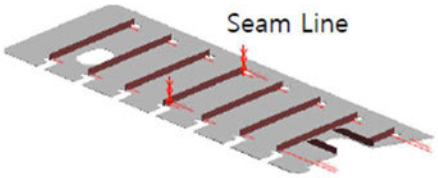
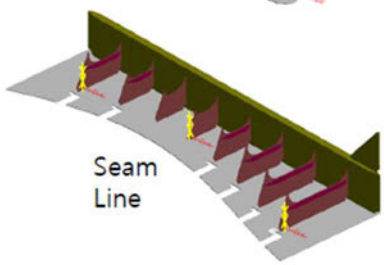
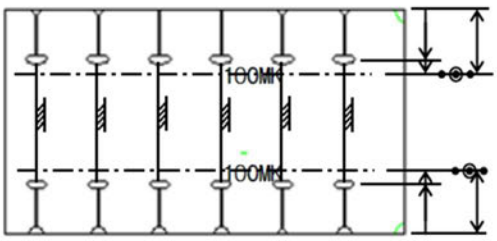
II. Key control Points at the Pre-Erection (P.E.) Stage

III. Key Control Points at the Erection (Dock) Stage

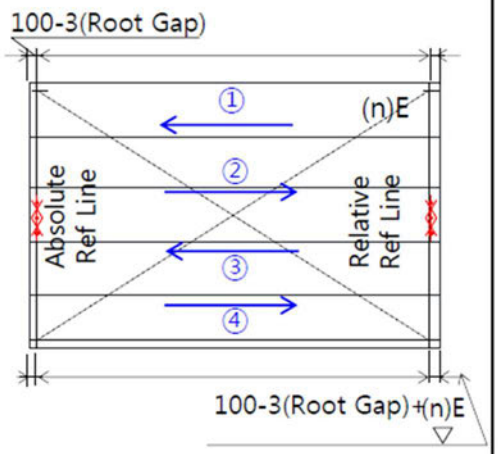
I. Key Control Points at the Assembly Stage

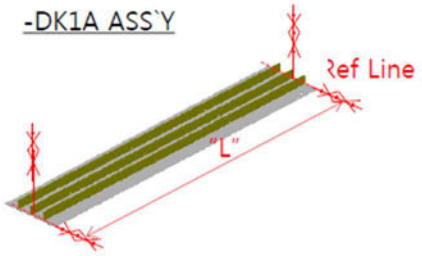
1. Flat Block Assembly Work Standard

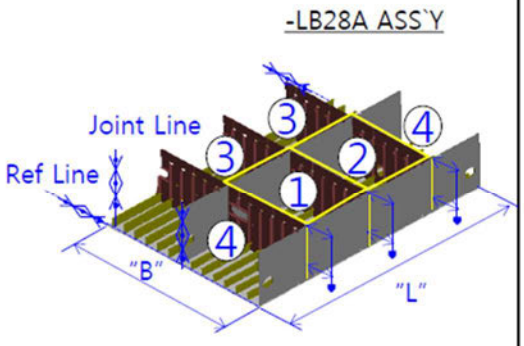
1.1 Sub-Assembly

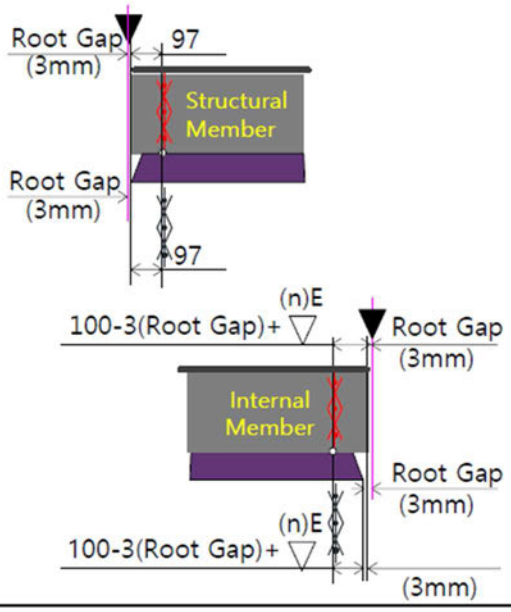
	Key Control Points	
Camber Line	 	-. Plate joining work based on camber line -. Measurement and as-built record of length, width and straightness. -. Deformation control (compliance with welding sequence) -. Angle measurement of bracket, T-bar, and angle-type members -. Back heating on reverse side of frames and girders. -. Installation of internal members to N/C marking -. Management of weld-hold according to standard -. Execution of 100M.K marking 
Joint Line	  	-. Installation of internal members after confirming joint-line and N/C markings -. Management of weld-holds according to standards -. As-built recording of the condition of step differences in internal structural members -. Deformation Control (Compliance with welding sequence) 

1.2 Mid-Assembly (Unit Assembly)

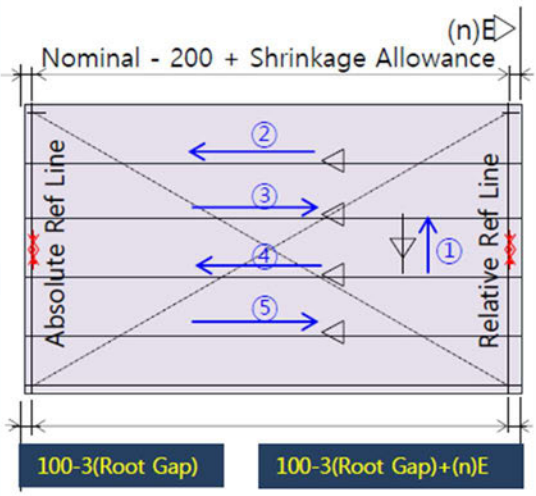
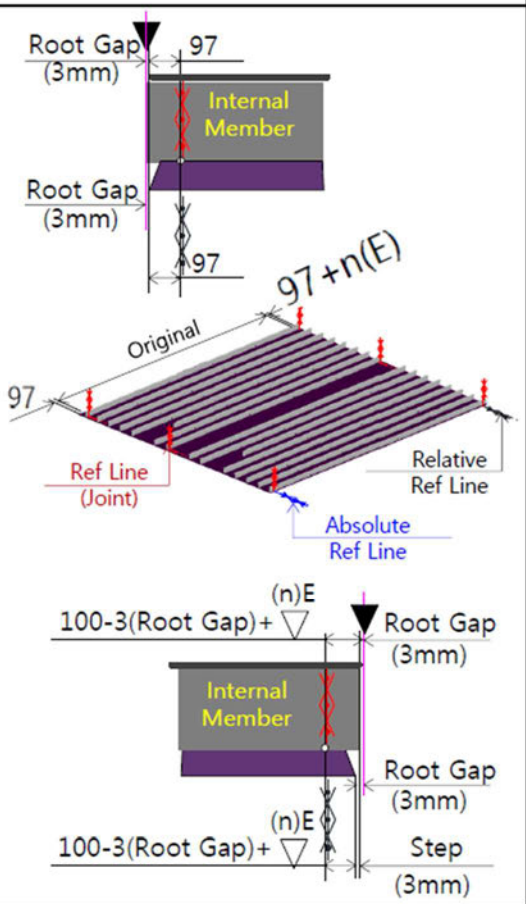
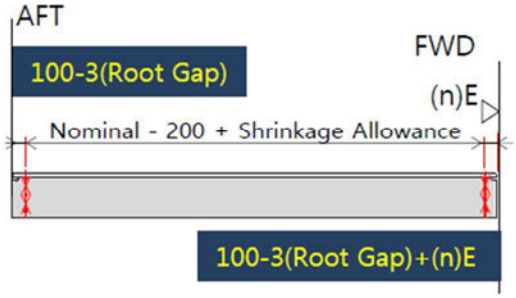
<table>
<tr><th></th><th>Key Control Points</th><th></th></tr>
<tr><td>Plate Layout Marking</td><td>Deck Plan
 

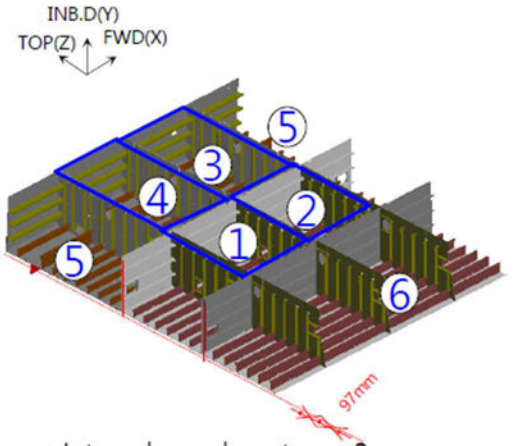
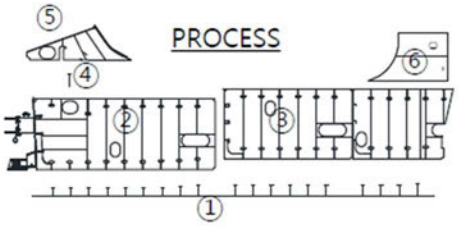
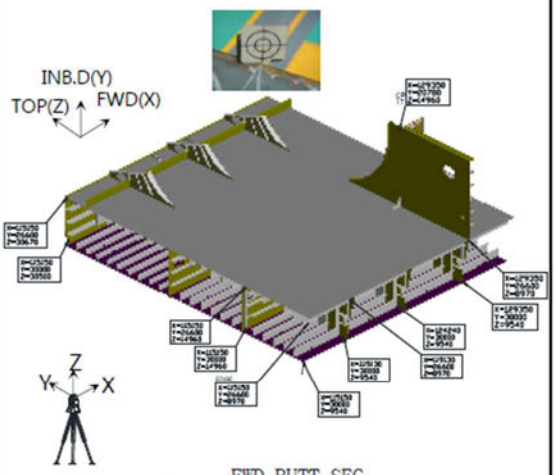
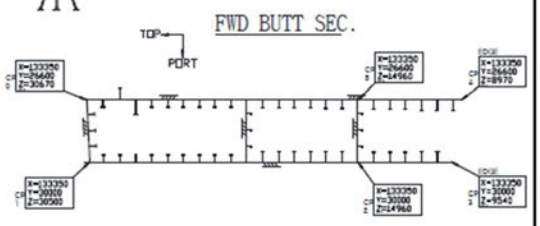
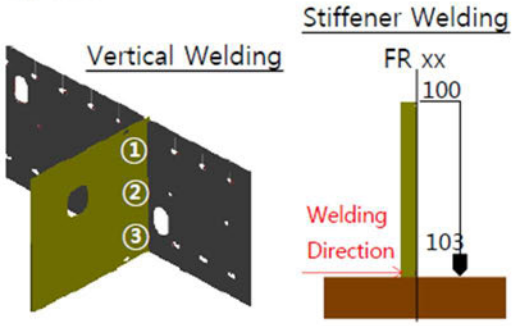
⊙Ref Line Layout: ±1mm
⊙Ref Line Joint (Seam) Alignment: ±1mm</td><td>- Plate Joining work based on camber line
- Measurement and recording of as-built dimensions and straightness
- Deformation control of main plates (compliance with welding sequence)
- Indication of welding-hold length and locations
- Execution of 100M.K marking
  </td></tr>
<tr><td>Internal Member Fitting & Welding</td><td> 



⊙Internal Member Step : ±2mm
⊙Main Plate Step: ±2mm</td><td>- Installation of internal members after confirming N/C markings
- Management of welding-holds to standard
- As-built recording of steps in internal members
- Deformation Control (compliance with sequence)
- Back heating the reverse side of frames and girders
- Angle measurement of bracket (BKT), T-bar, and angle-type members
- Layout of 100M.K marking
 
</td></tr>
</table>

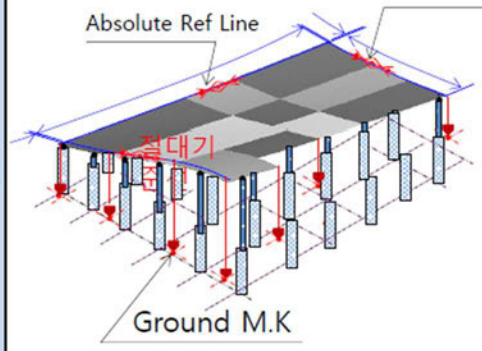
1.3 Grand Assembly

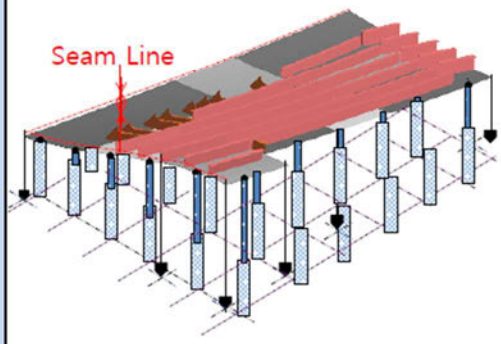
	Key Control Points	
Plate Layout Marking Work		Main Plate Layout ⊙Plate layout work based on the neat-side ref line - Use the opposite end to the excess or shrinkage allowance is applied (n)E or (n)P.E - If a step or misalignment occurs, readjust within allowable tolerance (±3mm) - Perform plate layout while checking the as-built dimensions - Comply with Welding sequence Marking Work - Apply reference-line markings - Measure and record as-built dimensions - Confirm N/C markings and mark internal member locations - Mark the weld-hold length ⊙Reference line layout: ±1mm ⊙Ref Line Seam (Joint) Alignment: ±1mm
Internal Member Install		Fitting Work - Install internal members to N/C markings. - Ensure member lines match; prevent gaps - Record the as-built condition - Use square to to adjust long angle - Use universal angle gauge if needed - Manage weld-hols according to standards - Comply with specified welding sequence  ⊙Internal Member Step: ±2mm ⊙Main Plate Step: ±2mm

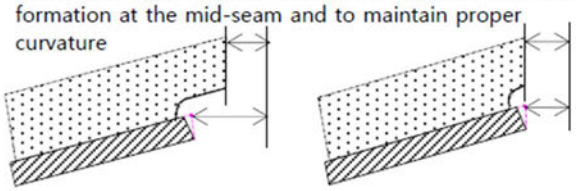
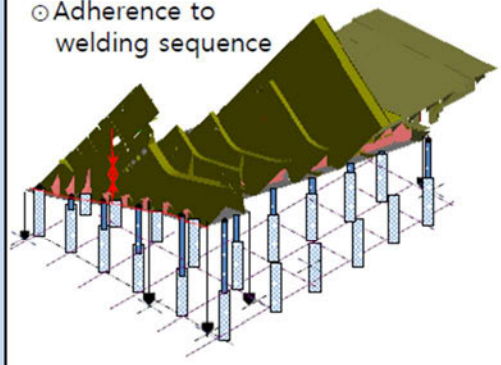
	Key Control Points	
Grand Assy	⊙Compliance with Welding Sequence  ⊙Internal member step: ±2mm ⊙Main Plate step: ±2mm    	- Install internal members to N/C marks - Manage Weld-holds according to standard - Record as-built steps in structural members - Comply with built method and welding sequence  - Perform and manage Block checks - Carry out assembly according to ref lines (Confirm all reference lines) - Verify and record dimensions of Assy as-built - Verify accuracy of fitting before proceeding - Frequently monitor block verticality and maintain as-built record  - Perform block accuracy inspection - Apply required markings according to drawings - Check for back heating condition - Mark reverse-side (100M.K, 50M.K) ⊙Level : ±6mm ⊙Dimension : ±6mm ⊙Vericality : ±6mm

2. Curved Block Assembly Work Standard

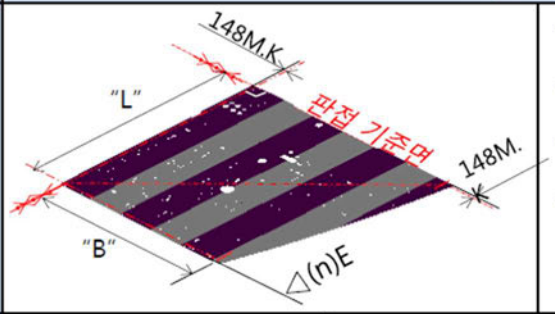
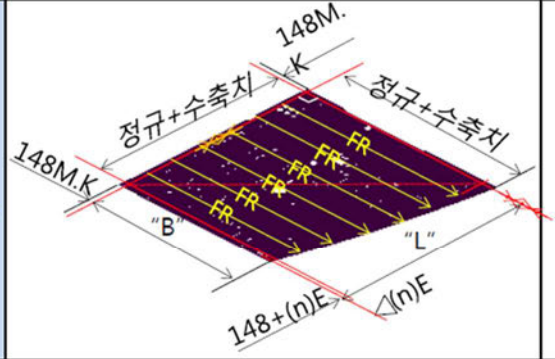
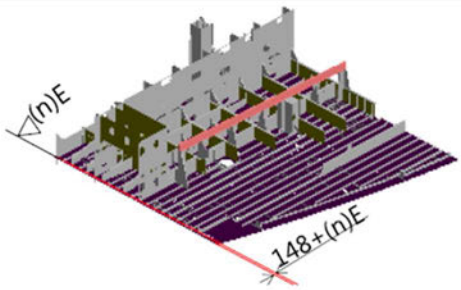
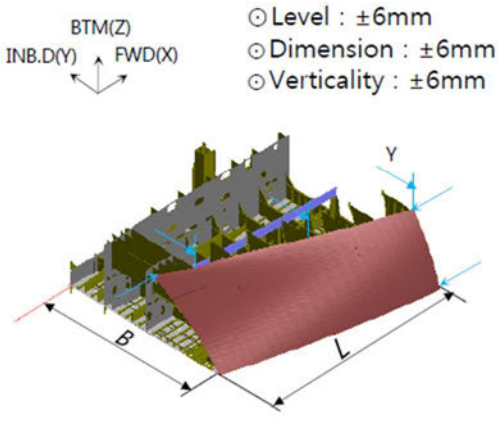
2.1 Unit Assembly

<table>
<tr><th></th><th>Key Control Points</th></tr>
<tr><td>Plate Alignment and Marking</td><td>⊙Baseline Marking
Relative Ref Line
Absolute Ref Line
 
</td><td><u>Plate Assembly Work</u>
- Layout Ground Marking
- Three (3) Ref points must be verified
- Fit-up once 3 points verified
- Lock inat a minimum of six (6) constraint points

<u>Structural Member Line Marking</u>
- After verifying the presence or absence of any abnormalities in the N/C marking, proceed with marking (absolute reference line and relative reference line marking).
- During marking work, clearly indicate the member number and include all relevant drawing information.</td></tr>
<tr><td rowspan="2">Internal Structure Fit-up Welding</td><td>⊙Internal Member Step Tol. ±2mm
 

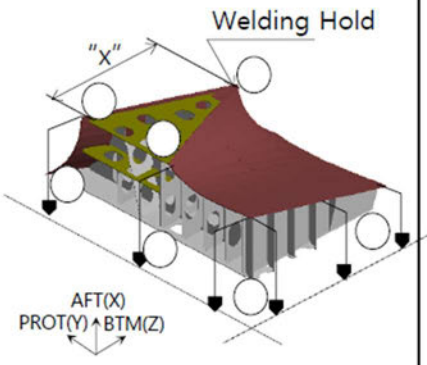
Transverse Angle=38.40
Frame Angle=14.29</td><td><u>Longitudinal Member</u> fit-up Welding
- Install Long according to N/C 150 MK Assembly Standard
- Verify Ref Line Alignment to maintain curvature
- Internal Member Step Tolerance ±3mm
- Tack Weld at Web and Face Flat where Long Sections meet.
- Secure the Face Flat on both sides using a clip.
- Install guide pieces at the seam area to prevent knuckle formation at the mid-seam and to maintain proper curvature
  </td></tr>
<tr><td>⊙Adherence to welding sequence
 
  </td><td><u>Frame and Girder Fit-up Welding</u>
- Level at Frames and Girder Locations
- Verify the T-angle and F-angle before installation
- Apply Reverse 100MK Construction
- Apply at least six constraint points before welding
  </td></tr>
</table>

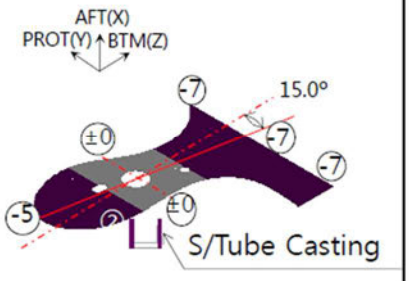
2.2 Grand Block Assembly

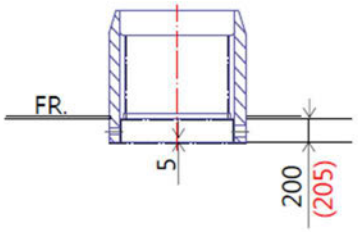
	Key Control Points	
Plate Alignment		- Plate Alignment Work Should be Based on the Bow Reference Plane. - Set the relative ref line from the long absolute ref line (148MK). - Set right-angle points in long and trans directions - Verify and record length, width, and diagonal measurements ⊙Ref Line Installation: ±1mm ⊙Ref Line Seam Alignment: ±1mm
Layout Marking		- Verify diagonal measurements for squareness. - Adjust the reference line as necessary - Readjust and remark ref lines according to values off CL. - Mark Long internal members in the transverse direction. - Mark lines for small components. - Record measurements for butt joint width and length by each frame line. ⊙ Length & Width : ±2mm ⊙ Diagonal (Squareness) : ±5mm
Internal Structure Installation		- Fit-up and Tack based on assy ref line. - Minimize gap with main plate. - Internal member step tolerace ±3mm. - Apply Weld Hold Standard ⊙Internal Member Step Tolerance: ±2mm ⊙Main Plate Step Tolerance: ±2mm
Side Shell Installation		- Attach targets to BTM area before Side Shell Assembly installation. - Ensure proper butt alignment (stern face to be aligned first) - Monitor mould line at butt weld-prep bevel. - Adjust levels of major structural members and apply reverse deformation if needed. - Measure verticality of bulkheads, girders, and box structures. - Measure width of bottom web framse - Follow the specified welding sequence - Apply Reverse 100MK construction - Layout all required markings.

3. Aft Body Block Assembly Work Standard

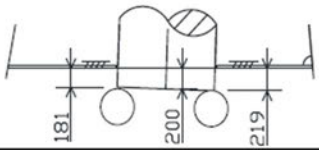
3.1 Stern Boss Block Assembly Stand

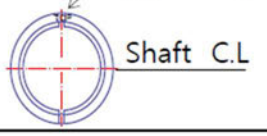
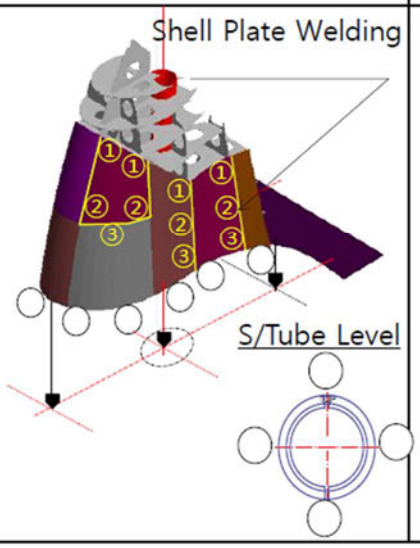
<table>
<tr><th></th><th>Key Control Points</th></tr>
<tr><td>Sub Assembly</td><td>-SRG9 ASS.Y
 
</td><td>FR & GIR. Fit-up and welding
⊙Ground Marking Layout
- Level at primary structural member locations.
- Hold with a minimum of 6 restraint points.

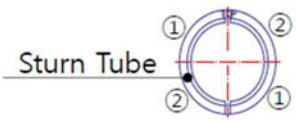
Shell Plate Standalone Installation
- AFT Shell Plate Level Tolerance ±5mm
- Control butt step difference during shell plate installation.
- 300mm welding hold at grand assembly joints.
- Grand Assembly joint "X" height within ±5mm.</td></tr>
<tr><td rowspan="2">Grand Block Assembly</td><td> 

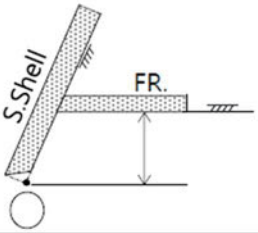
 
</td><td>FR. ASS`Y Plate fit-up and Marking
⊙Ground Marks Layout
- Mark Centerlines S/Tube, S/Boss C.L, S/Tube C.L
- Mark the 15° reference line

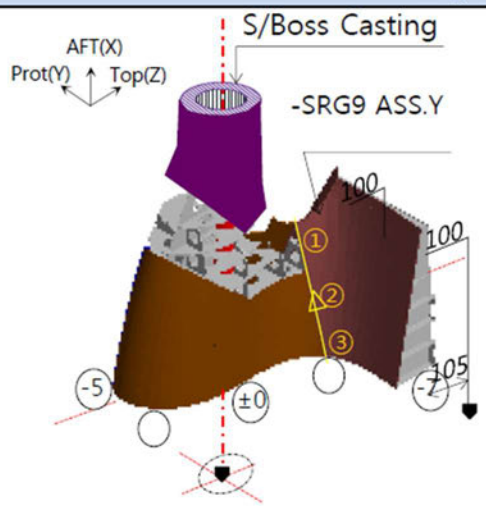
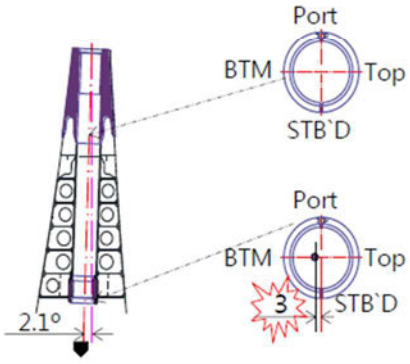
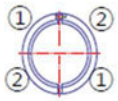
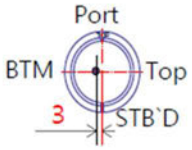
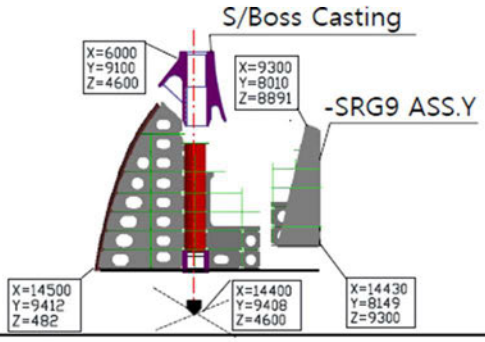
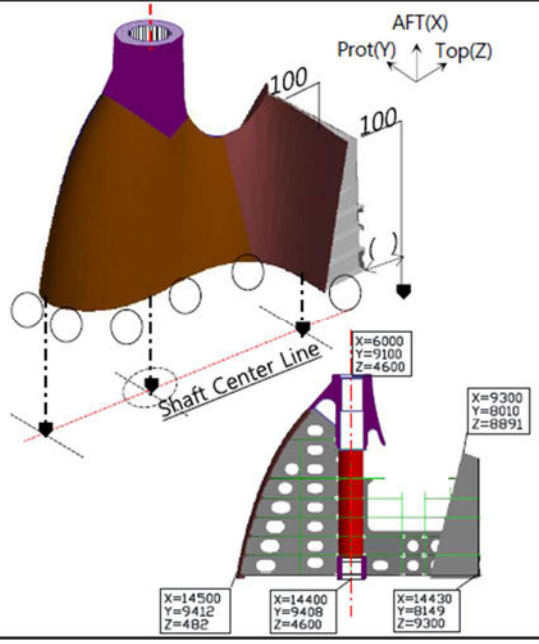
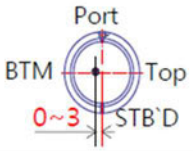
S/Tube Casting Installation
- Verify orientation during S/Tube installation.
- Consider Machining allowance of casting
- Verify Level condition

- Follow the specified welding sequence
Shaft Center Line ELEV.
 

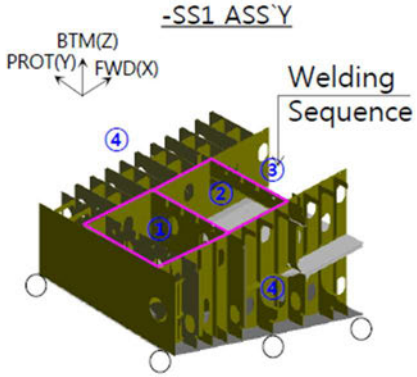
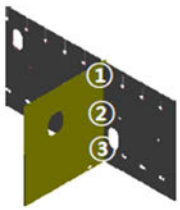
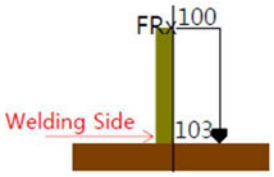
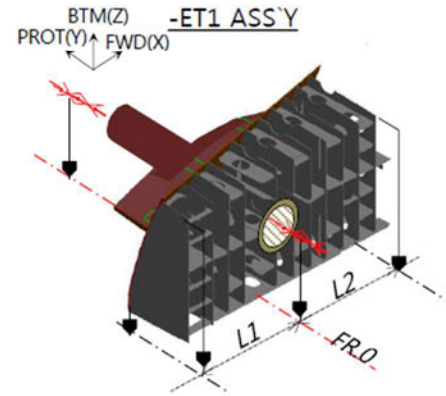
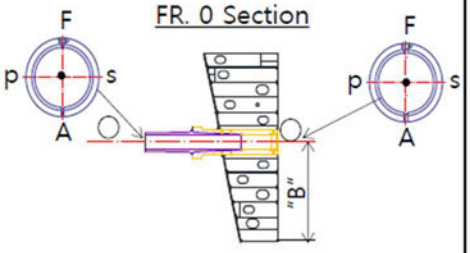
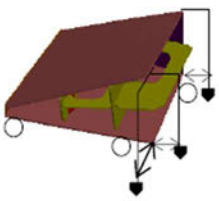
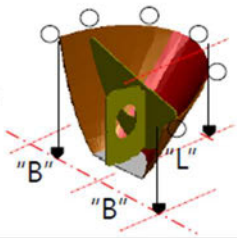
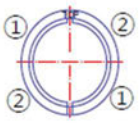
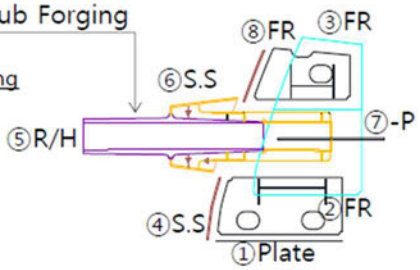
Top Marking (By Maker)
 
</td></tr>
<tr><td> 
</td><td>S/Tube Casting
- Follow the specified Welding sequence.
- Align casting CL with the shaft CL.

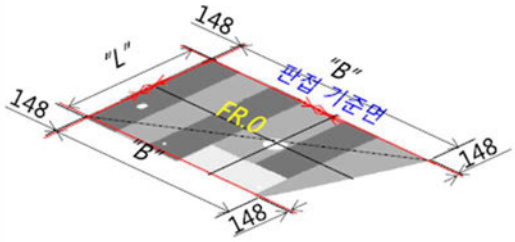
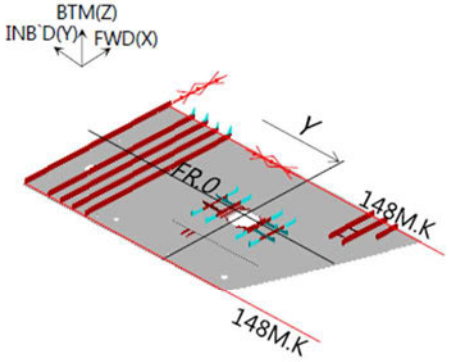
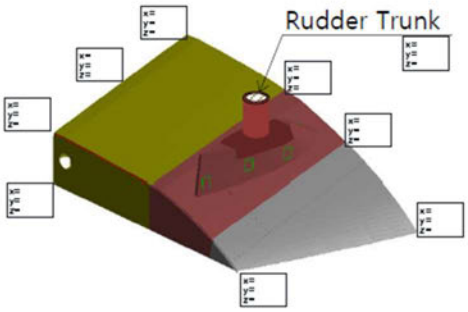
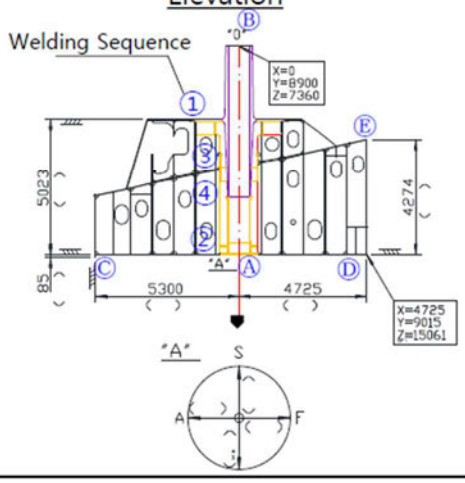
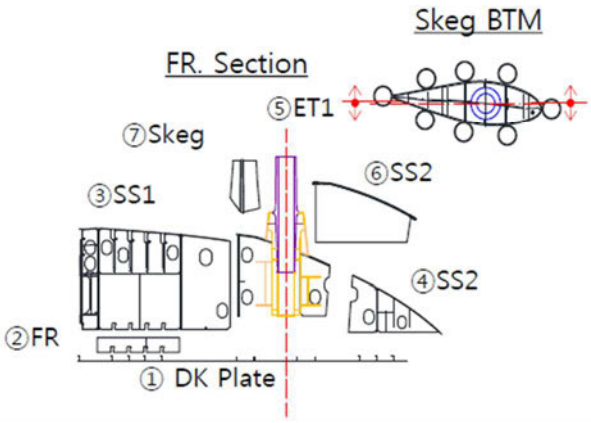
Shell Plate standalone installation
- AFT Shell Plate Level Tolerance: ±5mm
- Manage steps during shell plate Installation
- Follow the specified shell plate welding sequence.
Symmetrical Welding
 

 
</td></tr>
</table>

	Key Control Points	
Grand Block Assembly	 Shaft Center Line Plan 	SRG9 ASS.Y Installation - Apply reverse deformation to the verticality of top structural members. - Apply same in height direction (Btm: -5; Top:-7) - Follow the specified welding sequence. Stern Boss Casting Installation - Apply 3mm reverse deformation to shaft CL. - Align shaft CL after installing plumbobs. - Prevent shaft centerline deformation. Control  Apply Reverse Deformation  Shaft Center Line ELEV. 
		Shell Plate Standalone Installation - Monitor shaft CL plum bob movement during shell plate welding. - Follow shell plate welding sequence Shaft Center Line - Don't allow shaft CL plum bob movement toward Z. - Survey after restraint removal. - Apply required markings. - Apply reverse 100MK. - Confirm welding hold areas. Shaft C.L Plum bob 

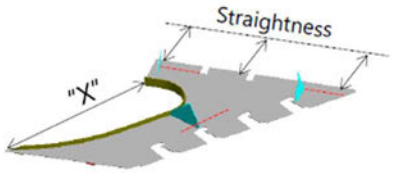
3.2 Rudder Trunk Block Assembly Standard

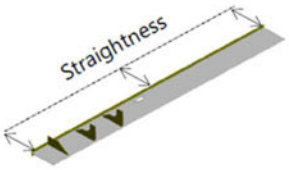
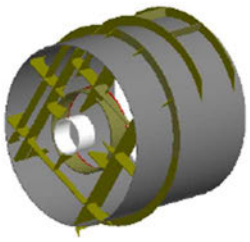
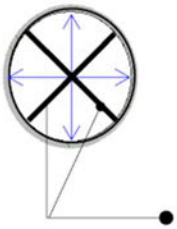
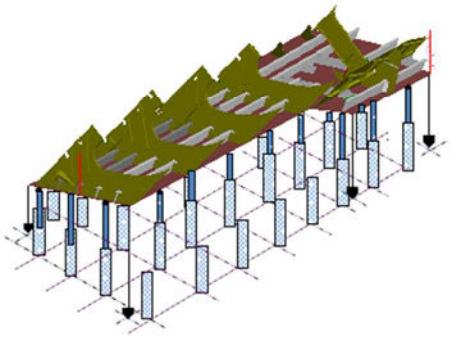
	Key Control Points	
중조립	-SS1 ASS`Y 	- Record key control items on the members. - Measure and record verticality of girders, bulkheads, and frames. - Measure and record steps. - Check babk-heating condition of frames and girders - Apply reverse 100MK. - Manage welding holds. BHD Welding Sequence  Stiffener Welding 
	-ET1 ASS`Y  FR. 0 Section  Skeg Assembly -ET11A  -ET13A 	ET1 ASS`Y - Ground Marking - Monitor rudder hub CL plumbob during install. - Align rudder hub CL (Trans. and Long. directions). - Maintain rudder hub CL position within ±6mm - Apply a minimum of 6 restraint points. - Keep verticality and steps within ±6mm - Follow Welding Sequence. Rudder Hub Forging Symmetrical Welding   Skeg Assembly ⊙ ET11A ASS`Y - Manage Steps - Control shell plate verticality (Steps) - Prevent welding deformation. - Follow the welding sequence. ⊙ ET11A ASS`Y - Ground Marking. - Manage internal member steps. - Verify shell plate level. - "B" & "L" Tolerance: ±6mm

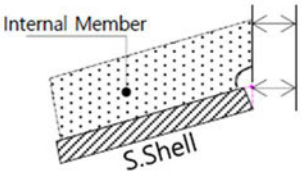
	Key Control Points	
Grand Block Assembly	 	Plate Fit-up Procedure - Follow the main plate welding sequence. - Base lae alignment on the bow ref. plane. - Set relative ref. line from the longitudinal absolute ref. line(148M.K) - After setting ref lines, establish right angle points in long and trans directions. - Verify and record length, width, and diagonal measurements. - Rudder hub CL X & Y Tolerance: ±3mm Member Line Marking - Verify N/C marking and confirm no abnormalities before marking. - Mark Member numbers and include relevant info. - Verify diagonal (squareness) - Confirm main plate end and adjust ref lines. - Verify deviations off CL and re-mark if needed. - Mark Long. and Trans. internal members. - Record butt width and length by frame line (as-built)
	 Elevation 	Sub-Assembly - Install R/H CL plumbob; verticality tolerance: ±2 - Verift alignment between R/H CL and hull structure off CL (Ⓐ – Ⓔ ±6mm). - Control skeg BTM level : ±6mm. - Maintain skeg CL alignment ±6mm. - Control block butt step difference: ±2mm. - Apply minimum of 6 restraint points pre-weld. - Follow the welding sequence. - Apply Reverse 100MK - Manage welding paint holds 

4. Fore Body Block Assembly Work Standard

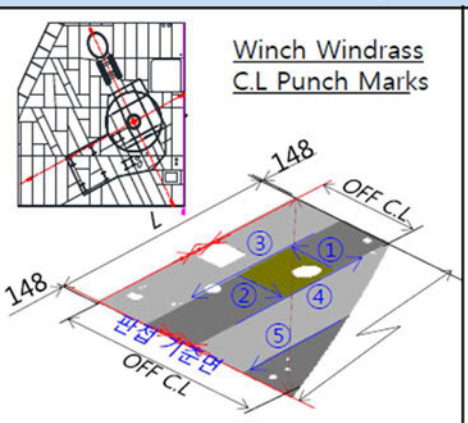
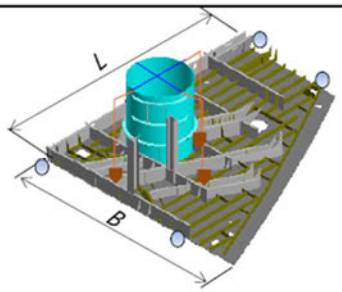
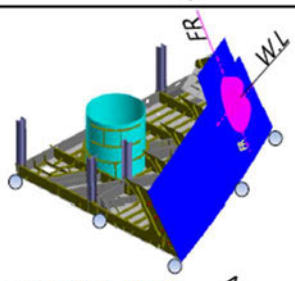
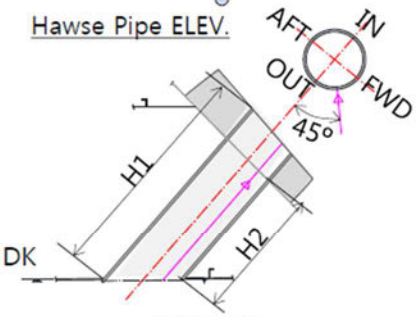
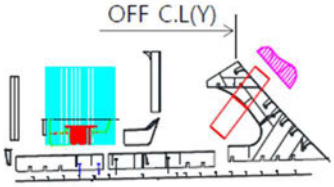
4.1 Bell Mouth Block Assembly Standard

<table>
<tr><th></th><th>Key Control Points</th></tr>
<tr><td>Detail Assembly</td><td> 


</td><td>- Verify Numerical Control markings for member locations and proceed with fit-up.
- After confirming seam N/C marking, install stiff bkt.
- Manage welding hold points according to Welding Hold Standard
- Record as-built condition of internal step difference.
- Check and correct deformation of small members.
- Follow weld sequence.
  </td></tr>
<tr><td>Sub Assembly</td><td>Chain Locker
 
I.D Check
 
-SS1 ASS`Y
  </td><td><u>Chain Locker</u>
- Maintain chain locker roundness before reinforcing.
- Follow Welding Sequence.

<u>Long. Fit-up Welding</u>
- Fit-up and tack Long according to Ass'y standard N/C 150MK.
- Check camber against ref line and maintain specified curvature
- Internal member step tolerance from plate: ±3mm
- Tack Web and face plate on midsection seams.
- Secure the face plate on both sides using clip.
- Install guide pieces at the mid-seam area to prevent knuckle formation and maintain curvature.
- Verify Weld holds.
 

<u>Frame & Girder fit-up and weld</u>
- For mid-assembly shell plate leveling, level at primary structural member locations.
- Verify T-angle and F-angle before installation.
- Control internal member step difference within ±3mm based on main plate.
- Set up a minimum of 6 restraint points.
- Verify internal member back-heating condition.
- Check weld-prep bevel surfaces and welding hol</td></tr>
</table>

	Key Control Points	
Plate Alignment & Marking		Plate Fit-up Work - Follow the main plate welding sequence. - Base plate alignment on the stern reference plane. - Set the relative reference line from the longitudinal absolute reference line (148MK) - After setting reference lines, establish right-angle points in the long. and trans. directions. - Record length, width, and diagonal dimensions. - Winch Windlass C.L Punch Mark. → No Marking Side
Internal Member Installation		Internal Member Fit-up - Fit-up and tack Long according to Assembly standard N/C 150MK. - Control internal member difference within ±3mm from main plate. - Chain locker verticality and roundness tol. ±6mm - Verify Welding holds
Side Shell & Bell Mouth	 Hawse Pipe ELEV.  	S. Shell Assembly Installation - Attach targets prior to installation - Control block butt step difference during sub-assembly installation. - Apply a minimum of 6 restraint points. - Adjust S.S Btm frame width (Y) within ±6mm. - Mark bell mouth installation ref lines (W.L, FR) - Apply reverse 100M.K. - Verify welding holds. Hawse Pipe - Mark hawse Pipe location based on the seam ref. - Verify pipe development condition and member lengths (L1,L2). - Measure hawse pipe position using total station. Bell Mouth - Align water line and frame line during installation. - Verify gap at the connection between the hawse pipe and bell mouth.  ⊙Frame & W.L Punch Marking → By Maker

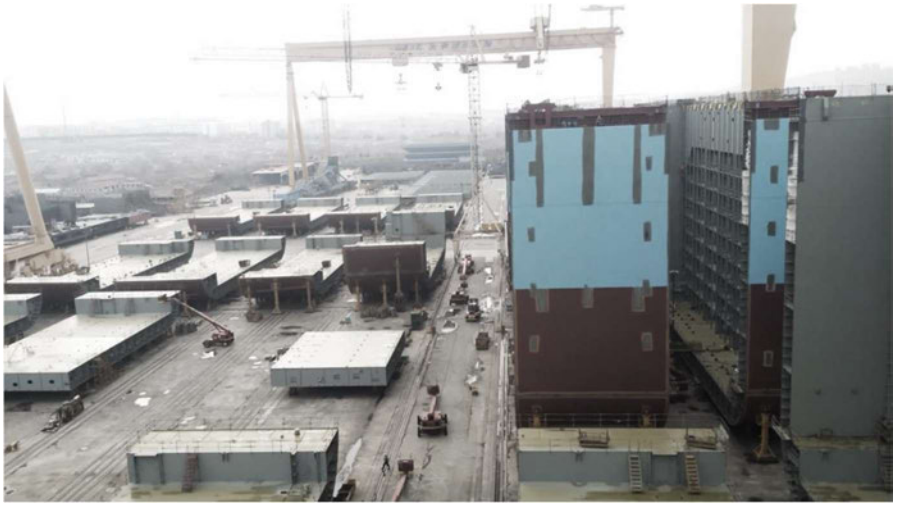
II. Key Control Points at the Pre-Erection (P.E) Stage

1. Pre-Erection (P.E)

Pre-Erection (P.E.) is a work process in which multiple small blocks are assembled into a large block prior to installation, after completing the small assembly, sub-assembly, and grand assembly stages.

By increasing block size before erection, the working time required in the dock (a facility where ship construction is carried out and which can be flooded to launch the vessel upon completion) can be significantly reduced.

Therefore, the pre-erection process is a critical part of shipbuilding, playing an important role in improving overall productivity.

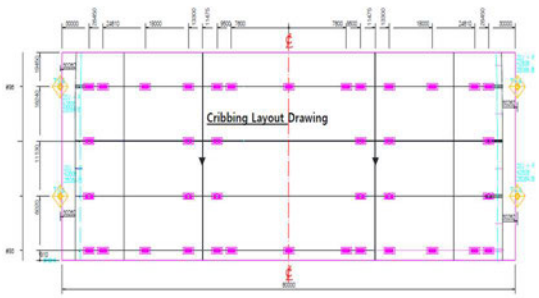


2. Pre-Erection (P.E) Dimensional Control Preparation

- Review potential issues in the erection sequence of unit block divisions in advance.
- Provide feedback for construction method and design improvements.
- Establish and improve restraint methods for P.E. (Technology and construction methods)
- Implement integrated dimensional control management between blocks.
- Promote P.E. block enlargement to reduce the number of blocks erected in the dock.
- Secure dock schedule by pre-installing outfitting items.
- Review, coordinate, and optimize WSD.

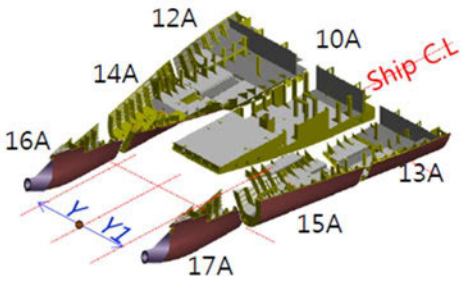
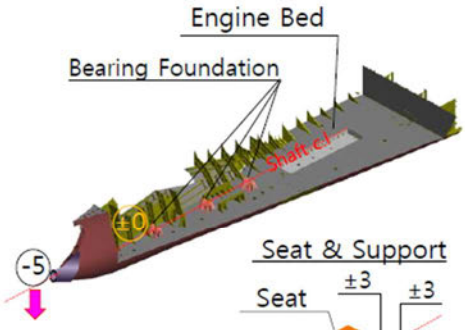
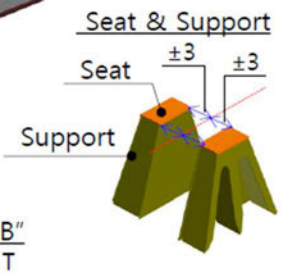
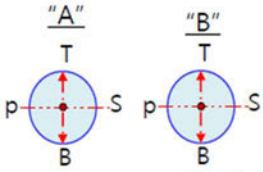
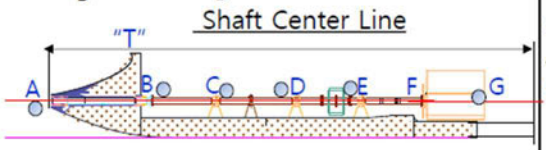
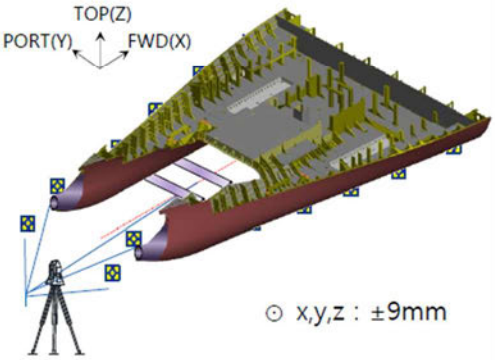
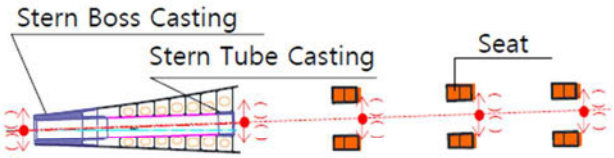
3. Pre-Erection (P.E.) Reference Line Marking

- Marking the center line (CL) and block butt lines.
- Mark locations of cribbing (blocking) and supports.
- Adjust levels of cribbing supports.

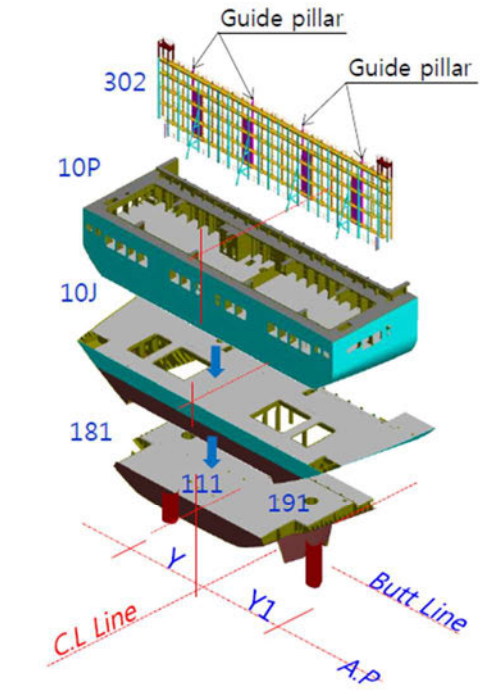
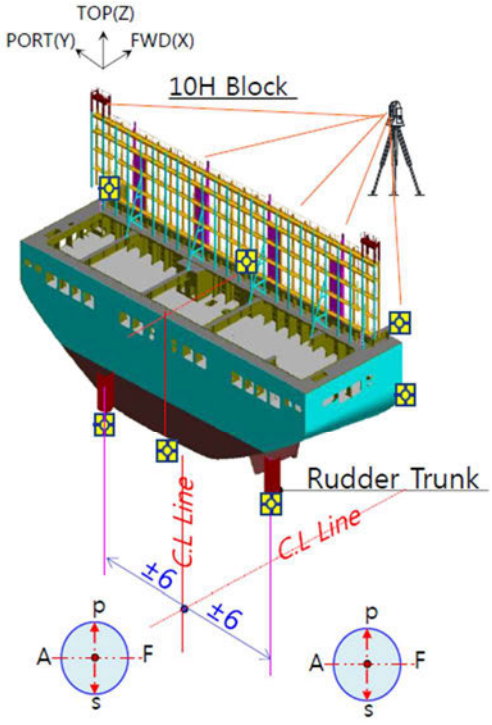


4. Supper Block Pre-Erection

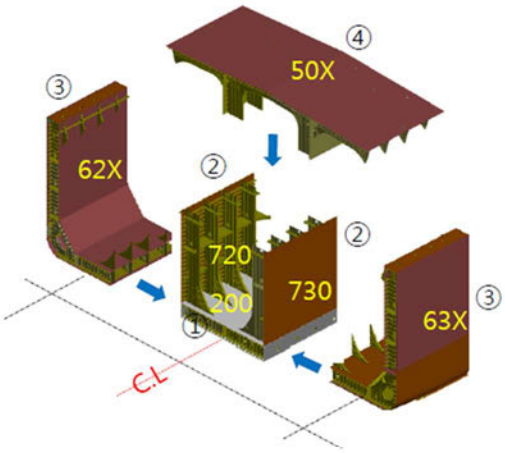
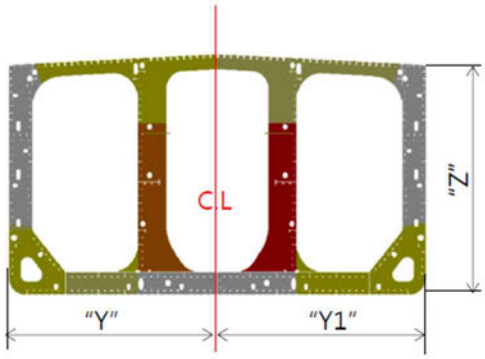
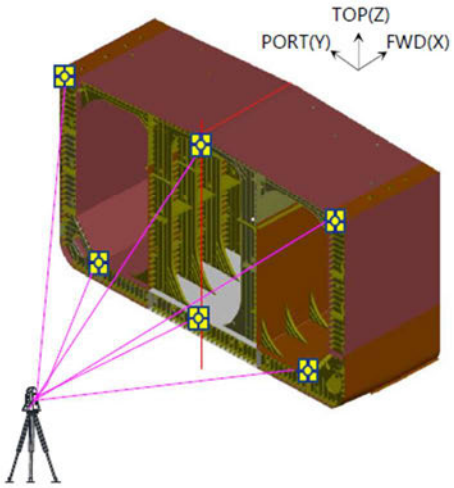
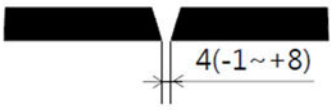
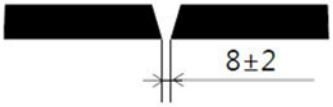
4.1 Shaft Boss Block

Block Configuration	Key Control Points
     	**Shafting (Boss) Block - P.E. Stage Inspection Items** 1. Review work drawings (Bevels, mould line, etc) 2. Ship C.L & Shaft C.L, Butt Line Ground Marking 3. Check keel blocks height, position, and inclination. → Shall be arranged to withstand localized loads 4. Reinforce to prevent shaft CL deformation. 5. Verify reverse 100MK 6. Place targets on top area prior to block erection. 7. Prepare block measurement using E.D.M. 8. After P.E. joint 300MK, securely restrain using cover plates 9. Determine fit-up and weld sequence considering dimesional condition. **10A, 12A/13A Block Pre-Erection** 1. Set blocks based on ship C/L. 2. Measure PORT & STBD engine bed CL "Y" values 3. Measure PORT & STBD engine bed level ("Z"). 4. Check P.E. joint gap and misalignment. **14A/15A Block Pre-Erection** 1. Set blocks based on shaft CL. - Align bearing foundation seat centerline (shaft CL) for Port & Stbd based on engine bed. - Verify bearing foundation seat half-width: ±3mm - Measure bearing foundation verticality & level:±3mm 2. Verify condition and alignment continuity of connected blocks. **16A/17A Block Pre-Erection** 1. Set the block based on the shaft centerline (CL) 2. Apply-5mm reverse deformation to the stern boss casting level, referenced to the stern tube casting. 3. Align the shaft centerline at points A-G ±6mm 4. Measure boss block top off CL "T" (X,Y,Z values) 5. Verify stern boss half-width(PORT & STBD): ±6mm  **Grand Block Final Measurement** - Install and record targets for erection reference points. - Perform final measurement after propeller fitting. - Release the block after completion of shaft alignment. - Verify reinforcement installation to prevent deformation during transportation. - Inspect the installation status of all markings.

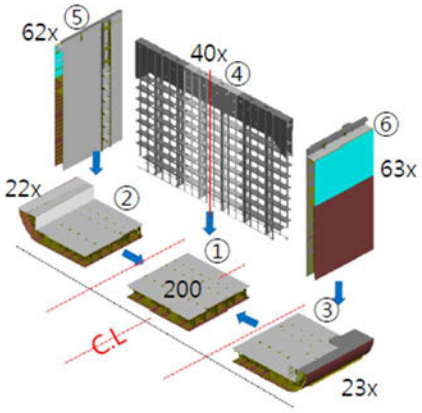
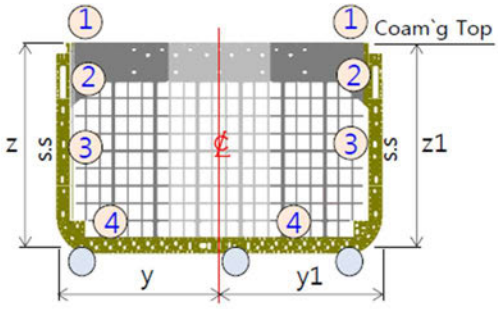
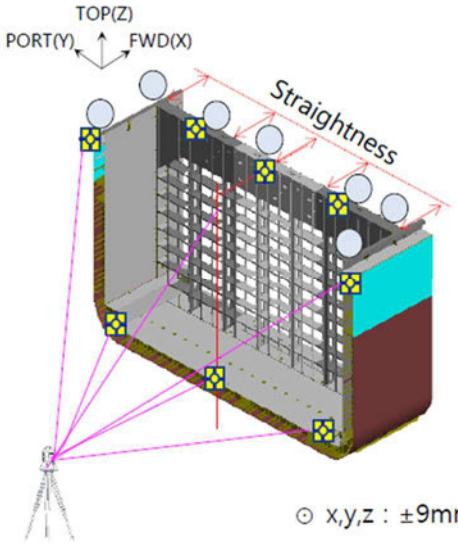
4.2 Rudder Block

Block 형상	주요 관리 점
Pre-Erection 순서   	111, 181, 191 Block Pre-Erection 1. Review work drawing (Frame value, mould line, etc.) 2. Layout of P.E. reference lines. - Block CL, AP line, rudder trunk (Y, Y1), Block Butt lines. 3. Install plum-bob on rudder trunk gudgeon. - Verify plumb at top and bottom of gudgeon - Check gudgeon half-width. 4. Attach top targets prior to block erection. 5. Align butt lines based on ship centerline CL. 6. Verify reverse 100MK application status. 7. Verify and coordinate width condition of Boss Block 10J Block Pre-Erection 1. Attach top targets prior to block erection. 2. Measure butt squareness (X) based on ship CL. 3. Check block joint step difference and misalignment 4. Align butt lines based on ship CL. 5. Monitor plum bob changes on low end of gudgeon. 6. Determine fit-up and welding sequence based on dimensional condition. 7. Verify reverse 100MK application status. 10P Block Pre-Erection 1. Measure butt squareness based on ship CL - Ensure upper and lower blocks align with ship CL 2. Check P.E. joint gap and misalignment. 3. Determine fit-up and welding sequence based on dimensional condition. 4. Measure hatch coaming top level (Z). 5. Verify reverse 100MK application status. 302 Block Pre-Erection 1. Install guide piece at lashing bridge location. 2. Mark Sq tube location on 10P block coaming top. 3. Verify verticality of 302 block guide pillars. 4. Verify centerline alignment of 302 block. 10H Grand Block Final Measurement 1. Release block after completion of shaft alignment. 2. Handover rudder trunk gudgeon half-width condition at erection. 3. Verify lower gudgeon plum bob condition 4. Inspect installation status of all markings.

4.3 Tanker Vessel

Block Configuration	Key Control Points
Pre-Erection Sequence 200*720/730*62X/63X*50X  FR.Section   	200 Block Pre-Erection - Review work drawings (bevels, mould line, etc.) - Attach top targets prior to block erection. - Verify reverse 100MK application status. 720/730 Block Pre-Erection - Apply reverse deformation considering overall condition of block. - Measure and adjust top web frame width. - Verify gap condition at bottom toe brackets. - Follow the wlding sequence and monitor. - Measure butt squareness to ship centerline CL. - Check block joint step difference. 62x/63x Block Pre-Erection - Measure butt squareness based on ship CL. - Verify upper deck and structural girder width (Y). - Determine fit-up and weld sequence based on dimensional condition. - Check P.E. joint gap and misalignment. - After P.E joint 300MK, secure with cover plates. - Install strong backs at P.E. joints. 50x Block Pre-Erection - Verify width condition before installation. - Measure butt squareness based on ship CL - After P.E joint 300MK secure with cover plates. - Determine fit-up and weld sequence based on dimensional condition. - Weld after installing strong backs at P.E joints. - Maintain proper P.E. joint gap. Supper Block Final Measurement - Release block after completion of shaft alignment - Inspect installation status of all markings. SOVS/SOVN  GVN 

4.4 Container Ship

Block Configuration	Key Control Points
Pre-Erection Work Sequence  Fit-up and Weld Sequence   ⊙ x,y,z : ±9mm	Pre- Erection Inspection Items - Ground marking of ship centerline and butt lines. - Review cribbing/support layout drawings. - Review workshop drawing. - Attach top targets prior to block erection. - Verify reverse 100MK application. - Inspect installation condition of guide and cylinder pieces. 200.220/230 Block Pre-Erection - Measure butt squareness based on ship centerline. - Apply reverse deformation to prevent side sagging. - Measure and adjust block half-width within ±6mm. - After P.E joint 300MK, secure with cover plates. - Determine fit-up and weld sequence considering dimensional condition. 400 .420/430Block Pre-Erection ※ T-BHD Coaming Top Straightness - Verify guide piece installation at T-BHD locations. - Adjust H. Coaming top level within ±5mm. - Measure and correct H. Coaming top straightness. - Verify verticality of T-BHD and cell guides. - Complete fit-up and welding after 620/630 block setting. - Check bottom misalignment and gap condition. - Correct fore-aft misalignments using power pump. Cutting prohibited to avoid cell guide deformation - Determine fit-up and weld sequences considering dimensional condition. 62x/63x Block Pre-Erection ※ T-BHD Coaming Top Level - Set blocks based on H.coaming top level (Z). - Verify P.E joint cell guide width within ±5mm. - Check T-BHD straightness to determine correction. - Measure butt squareness based on ship centerline. - Check P.E joint gap and misalignment. - After P.E joint 300MK, secure with cover plates. - Weld after installing strong backs at P.E joints. - Determine fit-up and welding sequence considering dimensional condition. Supper Block Final Measurement ※ Cell Guide Straightness and Verticality - Perform shaft alignment at butt joints considering hatch (cell guide) arrangement based on T-BHD. - Handover block after completion of shaft alignment.

3. Dock (Erection) Stage – Key Control Points

1. Erection

Erection is the process that follows Pre-Erection, in which multiple large and medium-sized blocks are connected inside the dock.

This stage precedes the launching operation, where the dock is flooded to float the completed vessel into the sea.

Because erection directly affects dock efficiency and throughput, it plays a critical role in determining a shipyard's overall construction capacity.

2. Erection – Dimensional Control Preparation

- Review potential issues in the erection sequence of unit block divisions in advance.
- Provide feedback for construction method and design improvements.
- Check for interference between structural members and pre-installed outfitting items.
- Implement integrated dimensional control management between blocks.
- Promote P.E. block enlargement to reduce the number of blocks erected in the dock.
- Review, coordinate, and optimize DEP.

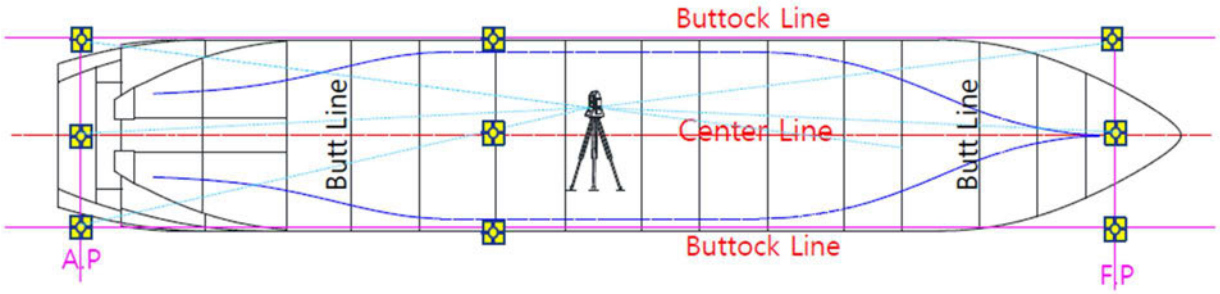
3. Erection Dock Ground Marking

Dock ground marking is a critical step in the hull construction process.

It involves accurately marking and managing the vessel's main reference (datum) lines on the dock ground to ensure precise dimensional control.

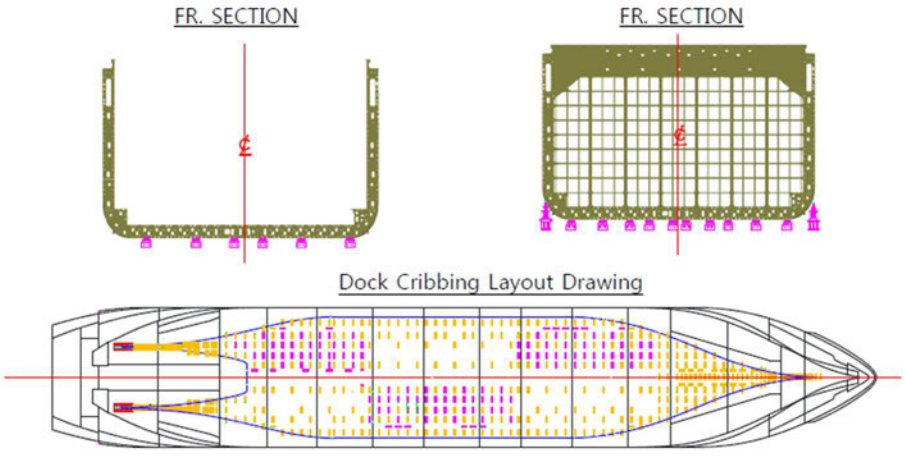
These markings serve as:

- Block setting reference lines
- Cribbing (blocking) layout references
- Dimensional inspection baselines



3.1 Dock Ground Marking Work Procedure

1. Relocate concrete cribbing and perform washing after floating (launching).
2. Review the dock cribbing layout drawing
3. Mark the centerline (buttock line) using E.D.M. (electronic distance measurement)
4. Mark perpendicular reference lines from the center line using E.D.M
5. Mark A.P. and F.P. points on the centerline.
6. From the A.P. point, cumulatively mark frame lines for cribbing installation.
7. Mark all block butt lines for the entire vessel (refer to block division).
8. Mark the maximum breadth and buttock lines
9. Paint key areas before marking and ensure markings are protected from erasure.
10. Establish auxiliary control points along the dock side and record measurement coordinates for full ship construction.



4. Dimensional Inspection Items During Hull Erection

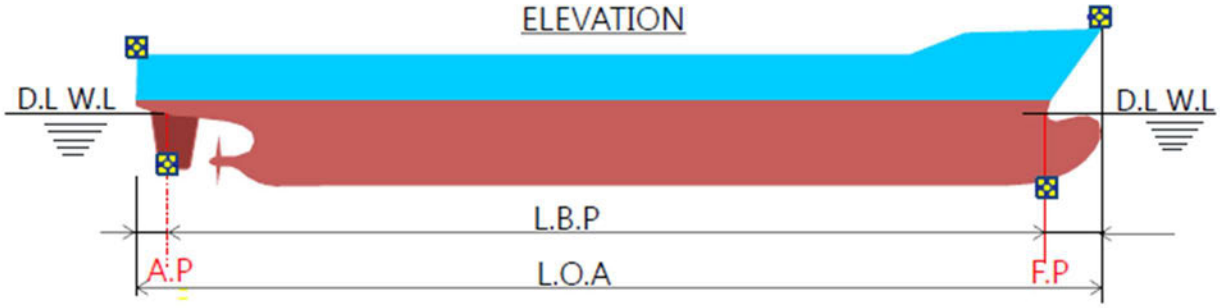
4.1 Principal Dimension Measurement

4.1.1 Length Between Perpendiculars (LBP)

The horizontal distance between the forward perpendicular (F.P.) and the aft perpendicular (A.P.).

4.1.2 Length Overall (LOA)

The horizontal distance from the extreme aft end of the hull to the extreme forward end, including all permanently installed protruding structures.

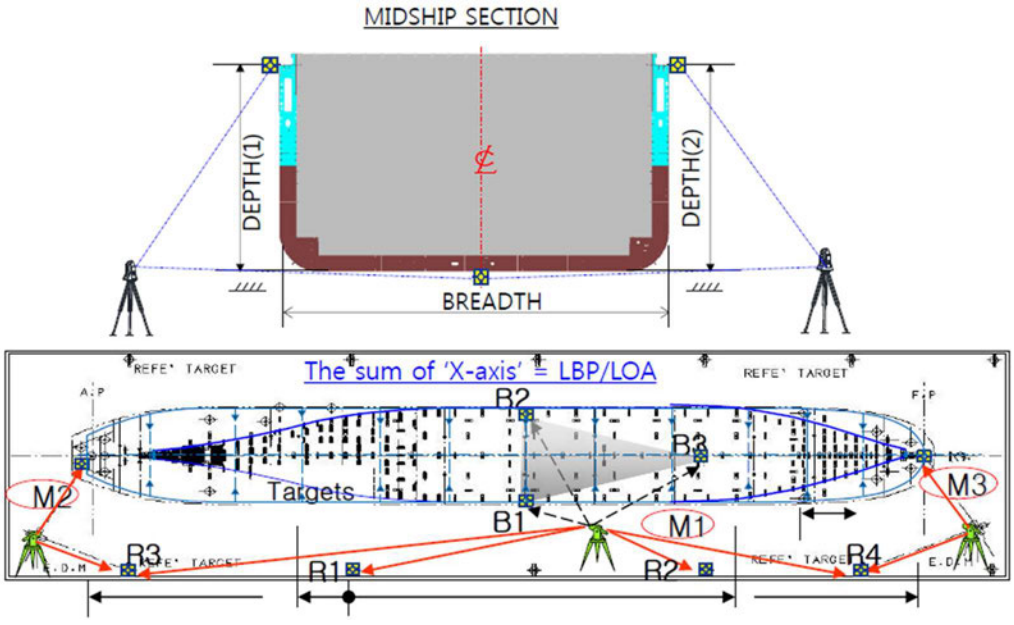


4.1.3 Breadth (Beam)

The horizontal distance between the outer surface of the shell plating at the widest part of the hull.

4.1.4 Depth

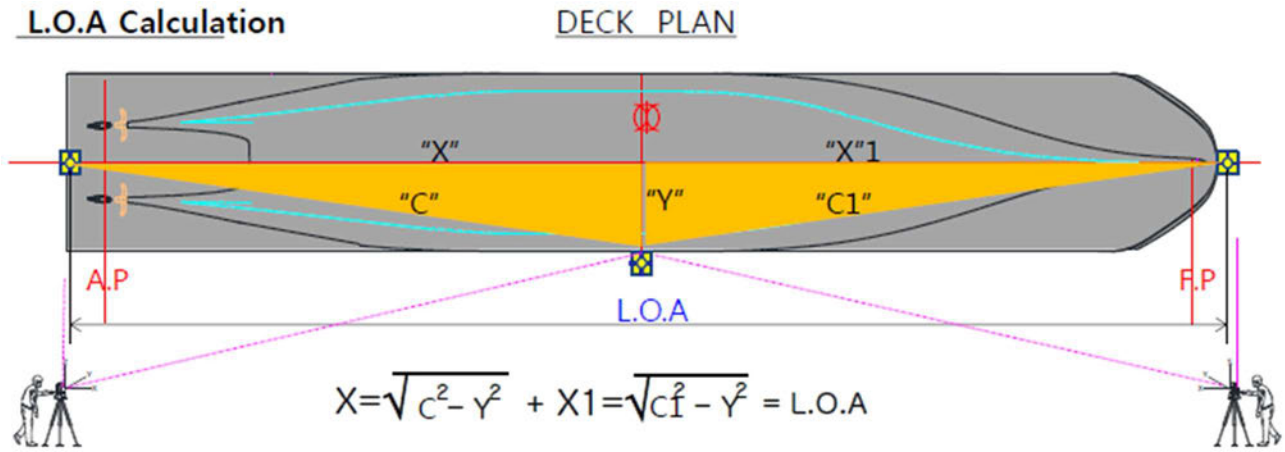
The vertical distance from the keel (bottom of the hull) to the uppermost watertight deck.

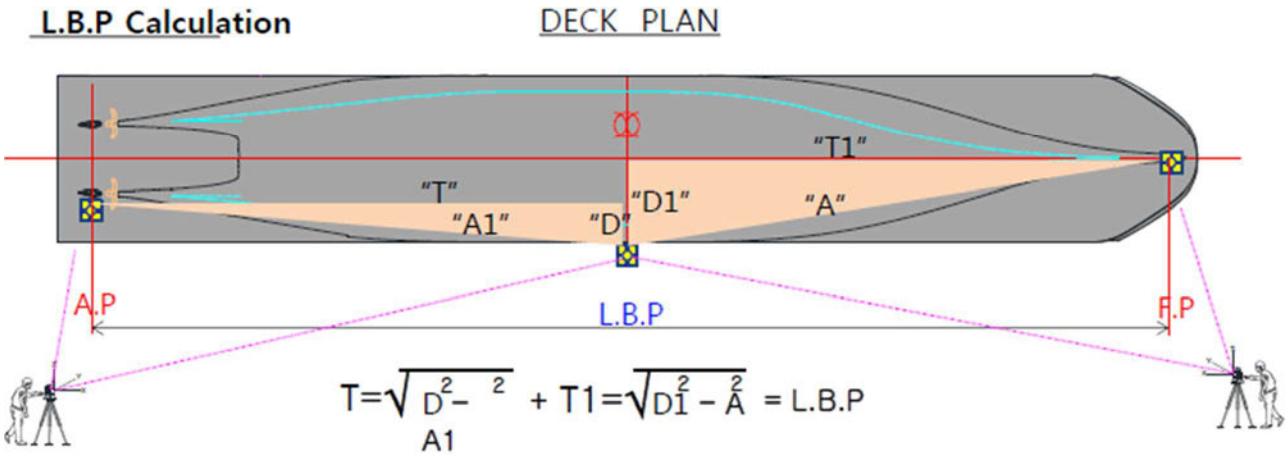


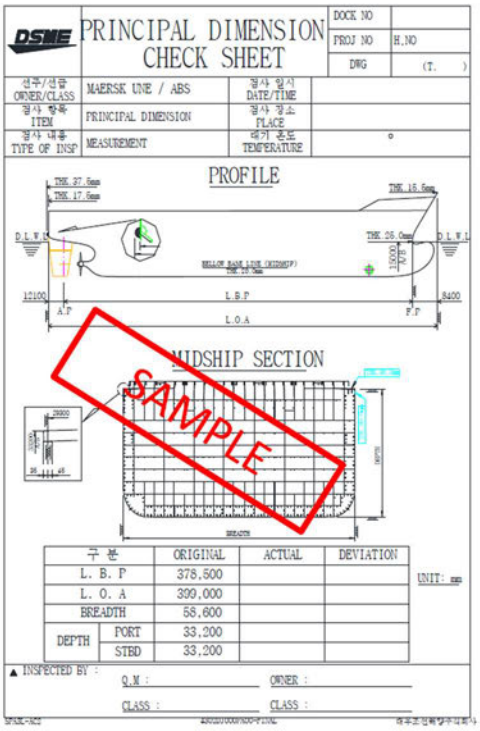
4.1.5 Floating Dock Measurement Method

- Install targets at midship bottom reference points (B1, B2, B3) and perform measurements
- After establishing reference points, measure Depth 1.
- After measuring reference points, install targets at auxiliary dock-side control points (R1, R2, R3, R4) and measure.
- Move the E.D.M. and measure the dock-side control points (R1-R4) at the forward section.
- Move the E.D.M. and measure the dock-side control points (R1-R4) at the aft section.
- Move the E.D.M. back to reference points (B1,B2,B3) and measure Depth 2.

4.2 L.O.A., L.B.P. Calculation Methods







PRINCIPAL DIMENSION CHECK SHEET

DOCK NO
PROJ NO H.NO
DWG (T.)

선주/선급 OWNER/CLASS	MAERSK LINE / ABS	검사 일시 DATE/TIME	
검사 항목 ITEM	PRINCIPAL DIMENSION	검사 장소 PLACE	
검사 내용 TYPE OF INSP	MEASUREMENT	대기 온도 TEMPERATURE	°

PROFILE

MIDSHIP SECTION

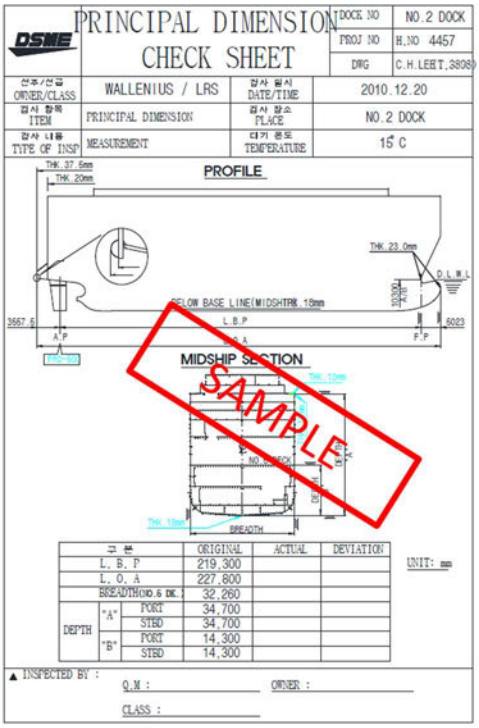
SAMPLE

구 분		ORIGINAL	ACTUAL	DEVIATION
L. B. P		378,500		
L. O. A		399,000		
BREADTH		58,600		
DEPTH	PORT	33,200		
	STBD	33,200		

UNIT: mm

▲ INSPECTED BY : Q.M : OWNER : CLASS : CLASS :

Check Sheet



PRINCIPAL DIMENSION CHECK SHEET

DOCK NO NO.2 DOCK
PROJ NO H.NO 4457
DWG C.H.LEET.3808

선주/선급 OWNER/CLASS	WALLENIUS / LRS	검사 일시 DATE/TIME	2010.12.20
검사 항목 ITEM	PRINCIPAL DIMENSION	검사 장소 PLACE	NO.2 DOCK
검사 내용 TYPE OF INSP	MEASUREMENT	대기 온도 TEMPERATURE	15°C

PROFILE

MIDSHIP SECTION

SAMPLE

구 분			ORIGINAL	ACTUAL	DEVIATION
L. B. P			219,300		
L. O. A			227,800		
BREADTH(MLD.S DK.)			32,260		
DEPTH	"A"	PORT	34,700		
		STBD	34,700		
	"B"	PORT	14,300		
		STBD	14,300		

UNIT: mm

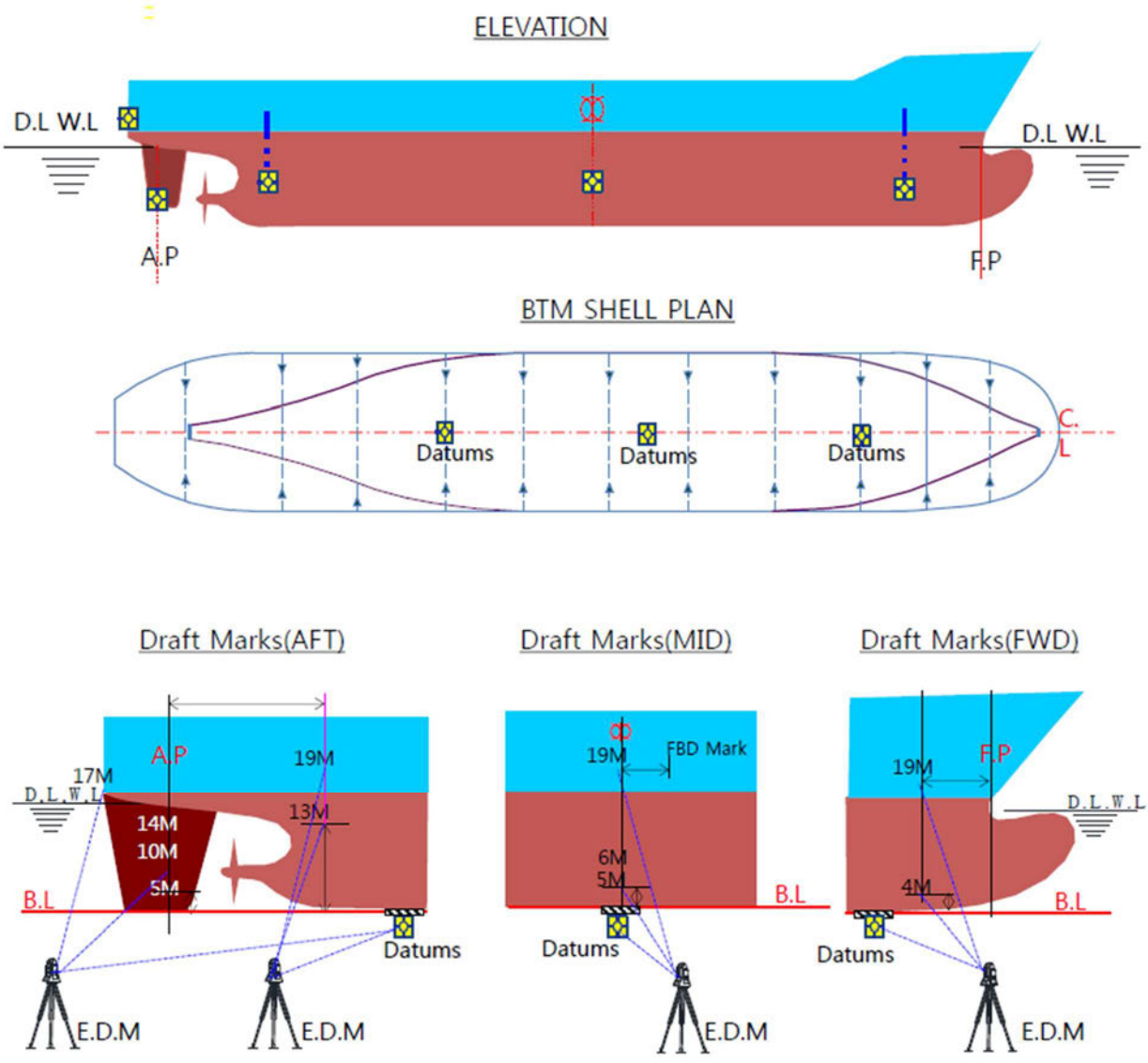
▲ INSPECTED BY : Q.M : OWNER : CLASS :

4.3 Draft Marks

Keel Draft

Keel draft is the vertical distance from the bottom surface of the keel to the waterline. It represents the depth to which the hull is submerged and is used to determine cargo loading condition and overall ship condition.

- Perform keel sighting (measure keel bottom levelness)
- Establish draft mark reference points at FWD, MIDSHIP, AFT, and transom keel bottom locations.
- Measure draft marks using separate reference points for FWD, MID, and AFT.
- Draft marks are installed by the midship assembly department; FWD and AFT are installed by the erection department.



5.4 Freeboard Mark

Freeboard Mark

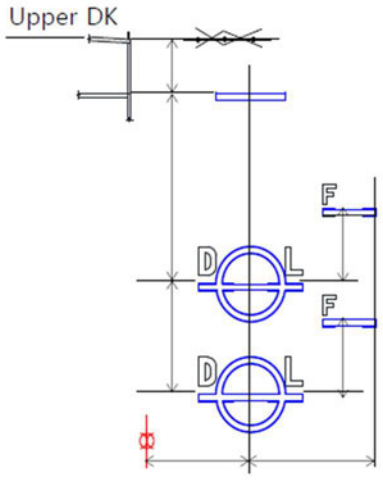
The freeboard mark is an indicator showing the maximum permissible loading limit when cargo is loaded onto the vessel.

It is also referred to as the load line mark and is applied to ensure safe navigation.

When the ship is in an upright condition, the maximum allowable draft in accordance with load line regulations is marked as the vertical distance from the upper deck at the midship section to the designated waterline.

These marks vary depending on the navigation area, season, and vessel type.

- Measurement is taken at the midship hull side based on the upper deck reference.

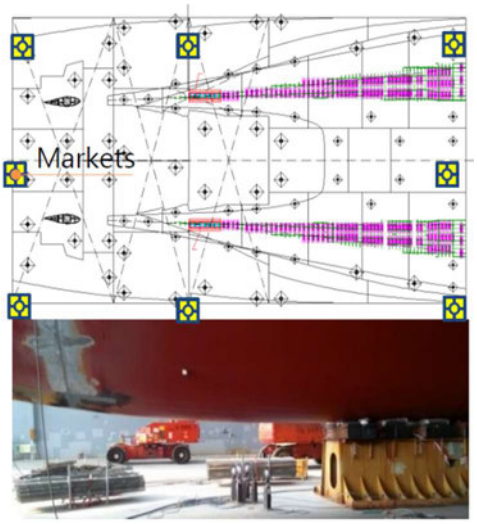


AB : ABS 선급명
TF : Tropical Fresh Water
F : Fresh Water
S : Summer
W : Winter
WNA : Winter North Atlantic

5.5 Air Draft

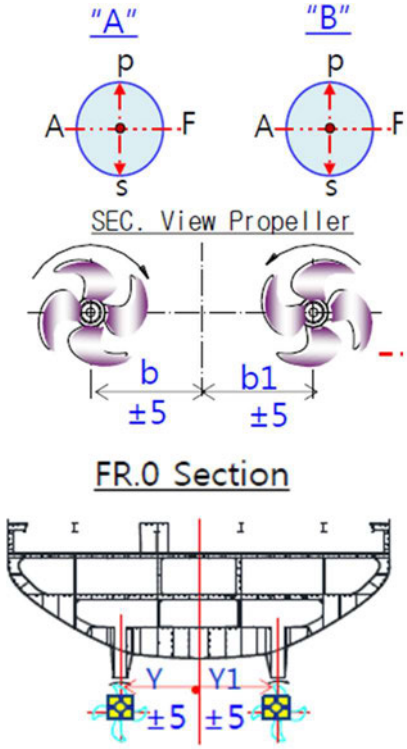
- The vertical distance from the baseline to the top of the vessel's highest structure (Radar mast top).
- This draft is used to verify clearance and potential interference when navigating under bridges.

5.6 Dimensional Control for Shaft and Rudder Blocks



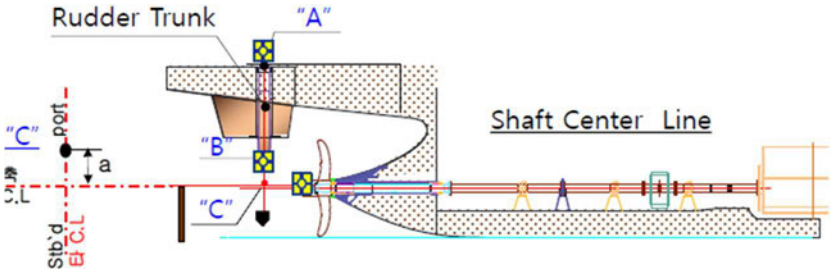
Erection Process Inspection Items

1. Ground marking of shaft CL and rudder trunk CL
2. Check cribbing height, position, and inclination.
   -Cribbing shall be arranged to withstand localized loads
3. Verify erection reference points (X, Y, Z) for installation of 11A (Boss) Block and 10H (Rudder) Block.
4. Receive shaft pre-sighting condition from machinery outfitting department.
   - Verify Installation of targets at shaft CL end points.
5. Prepare plum bob on piano wire for shaft and rudder CL alignment.
6. Measure block using E.D.M.



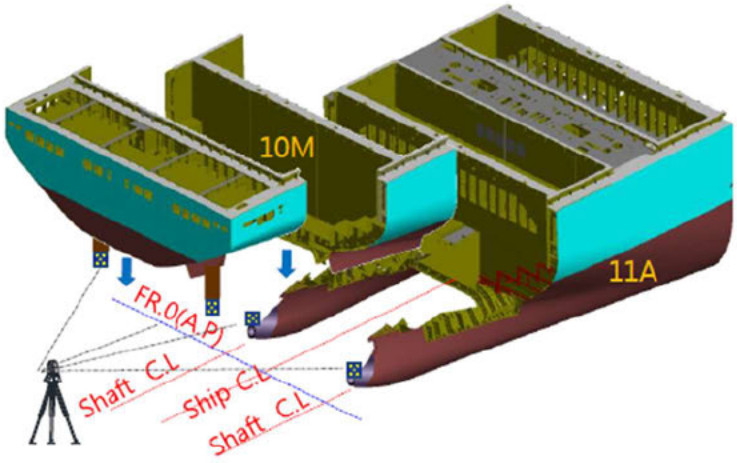
11A Block Erection

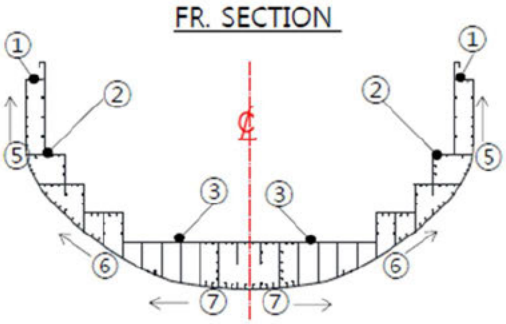
1. Set the 11A block using the erection reference points (X, Y, Z) established during P.E., based on the previously erected blocks.
2. Continuously monitor half-width changes during installation of shaft CL plum-bob
3. Verify boss half-width (b, b1) based on ship centerline CL.
4. Strictly follow the fit-up and welding sequence to control deformation.



10H Block Erection

1. Verify alignment of the lower gudgeon plum-bob based on the upper gudgeon reference.
2. Align the rudder trunk centerline CL with the shaft centerline piano wire
3. Continuously monitor the condition changes during fit-up and welding with plum-bobs installed.
4. Verify rudder trunk half-width (y, y1) based on ship centerline CL.
5. Strictly follow the fit-up and welding sequence to control deformation.
6. Apply reverse deformation in the fore-aft direction considering expected distortion.

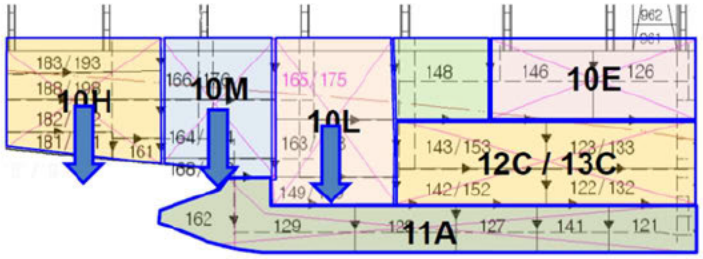


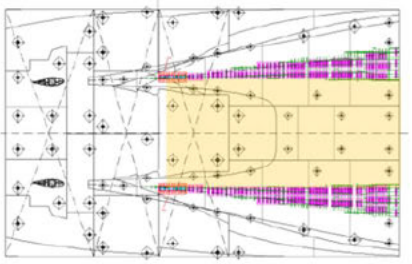


Fit-up and Welding Sequence Compliance

1. Perform deck fit-up and welding symmetrically (PORT & STBD), progressing from TOP to BTM
2. Perform side shell fit-up and welding from BTM to TOP
3. Continuously monitor plum-bob condition during fit-up and welding and take corrective action as required.

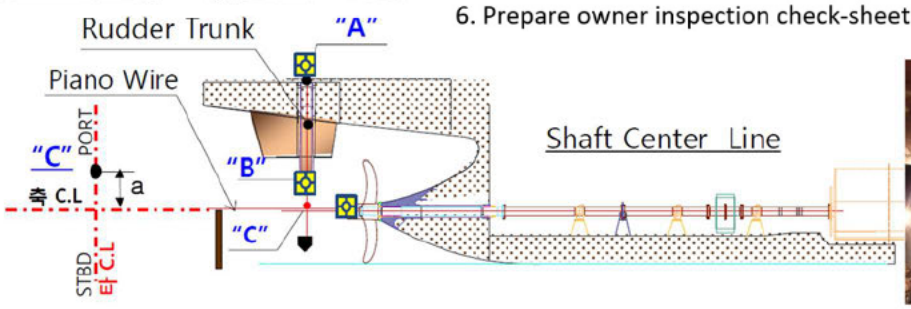
5. Final Sighting

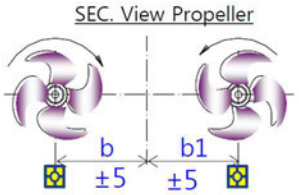


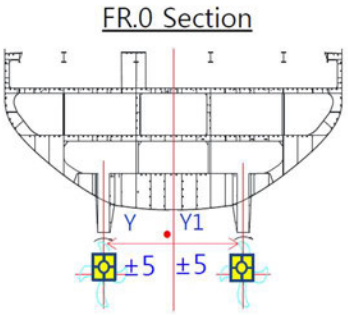


Final Sighting Inspection Items

1. Inspect welding condition of joints between 10H and 10L blocks.
2. Remove surrounding supports after welding completion
   - Remove inboard support immediately before final sighting.
3. Install shaft CL piano wires using E.D.M. (PORT & STBD).
4. Verify extension alignment of shaft CL piano wires.
5. Remove inboard supports immediately before final sighting.
6. Prepare owner inspection check-sheet.







Final Sighting Procedure

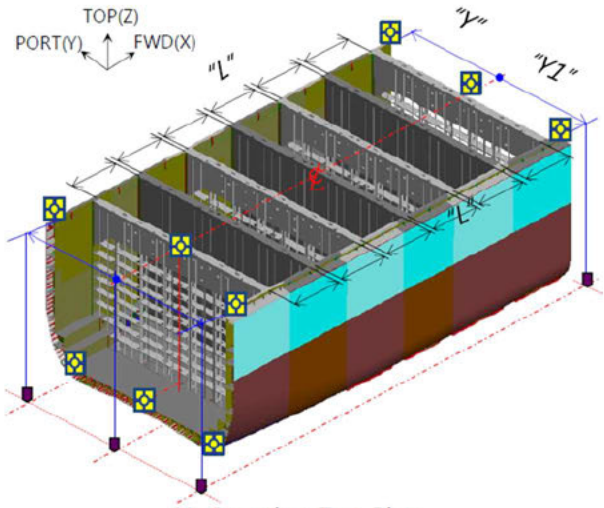
1. Remove cribbing considering boss width variation and perform final sighting at the specified timing.
2. Align rudder trunk centerline CL with shaft CL piano wire – Point C.
3. Measure centering of upper and lower gudgeons – Points A and B.
4. Based on ship centerline CL
   - Measure rudder trunk half-widths (PORT & STBD): y, y1
   - Measure stern boss half-widths (PORT & STBD): b, b1
5. Verify extension alignment of the shaft CL piano wire.
6. Submit owner inspection check-sheet

Final Sighting Acceptance Criteria

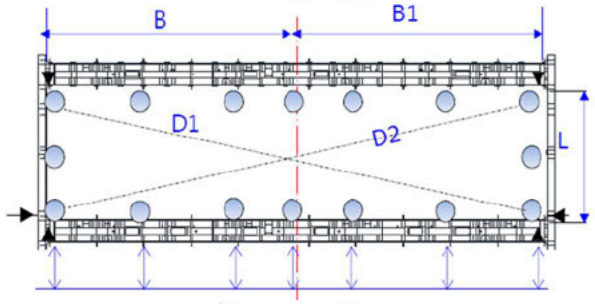
1. Piano wire diameter: 0.5 – 0.7 mm
2. Piano wire tension: 10 – 20 kg
3. Deviation of rudder center from shaft centerline (a):

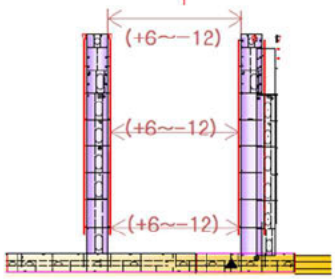
- Vessel displacement ≥ 100,000 tons: a ≤ 8 mm
- Vessel displacement < 100,000 tons: a ≤ 6 mm

Block Configuration

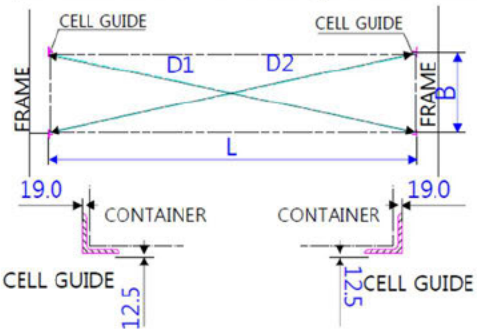


H. Coaming Top Plan





Cell Guide Width and Length Tolerances



Key Control Points

Erection Inspection Items

1. Ground marking of ship ℄ and butt lines.
2. Review cribbing/support layout drawings.
3. Review workshop drawings.
4. Attach top targets prior to block erection.
5. Verify Reverse 100MK application status.
6. Inspect installation condition of guide and cylinder pieces

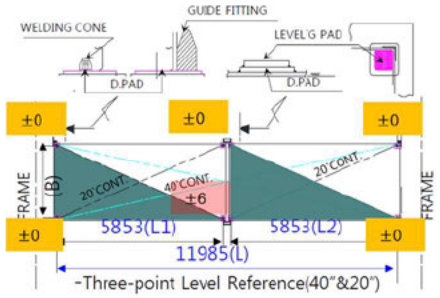
Ring P.E. 20x Block Erection

1. Set blocks based on H. Coaming top level (Z).
2. Verify hatch cell guide length
3. Check misalignment of main plates and internal members.
4. After PE joint 300MK, secure with cover plates.
5. Determine fit-up and welding sequence.

T-BHD 40F Block Insert

1. Focus control on hatch (cell guide) length.
2. Control H. Coaming top level.
3. Measure T-BHD straightness and verticality.
4. Follow the fit-up and welding sequence.

Double Pad Plan



Leveling pad & welding Cone Installation work

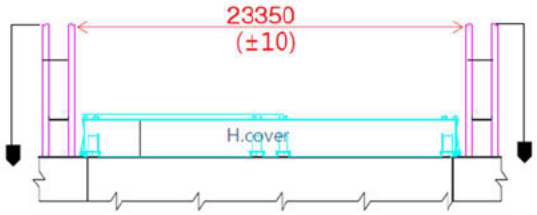
- Minimum leveling pad thickness: 7mm

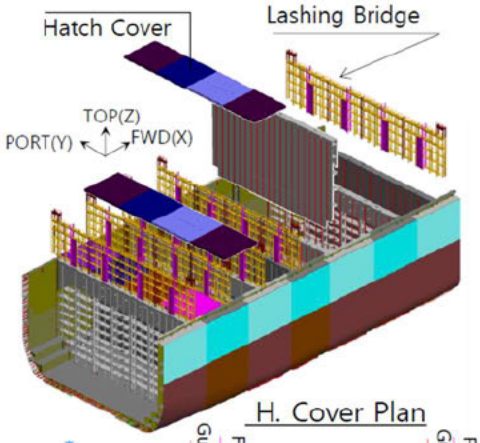
1. Check level at 20ft and 40ft pad locations.
2. Calculate level by each lower section.
3. When three-point level difference is ±0, install Leveling pads of 6 mm or more.
   - Longitudinal slope limits
     - 20 ft: ±6 mm
     - 40 ft: ±9 mm
4. Mark welding cone location
   - Set welding cone based on cell guide reference.
   - Verify welding cone width, length, and diagonal.
   - Mark and install guide fitting position.

3.2 Hatch Cover & Lashing Bridge

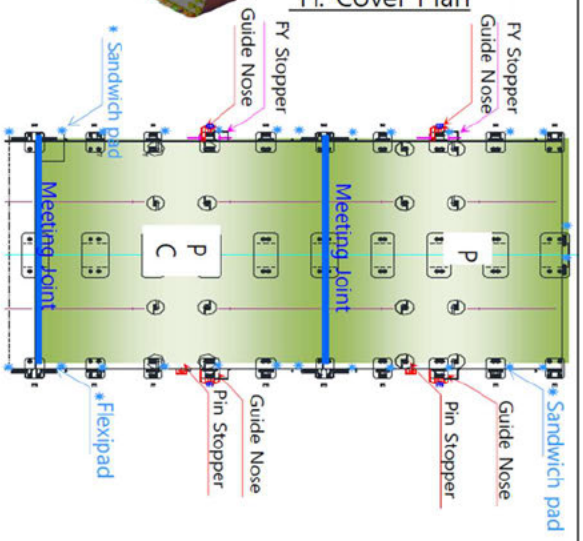
Block Configuration

Lashing Bridge Section

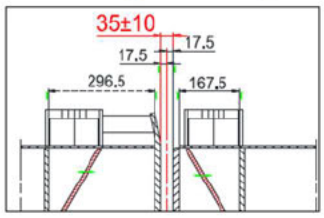




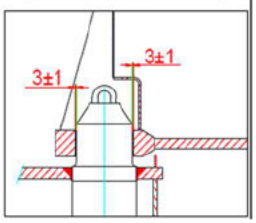
H. Cover Plan



Meeting Joint Gap



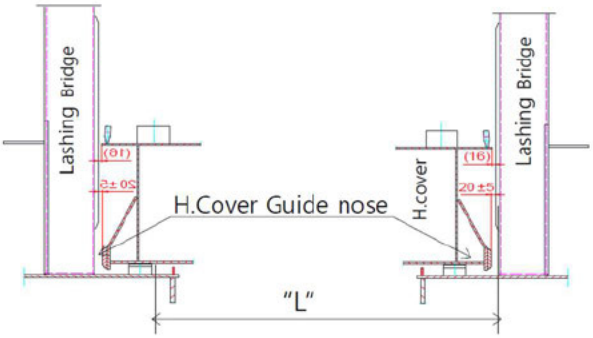
Hole Clearance



Key Control Points

Lashing Bridge (30x) Block Erection

1. Apply 100MK reference marking for lashing bridge location.
2. Install guide piece for lashing bridge erection.
3. Verify verticality of guide pillars.
4. Control longitudinal distance of guide pillars within ±5 mm.
5. Measure lashing bridge bottom length and install hatch cover.



Hatch Cover Block Erection

1. Measure and maintain proper meeting joint gap.
2. Verify pin stopper and hole clearance.
3. Check clearance between hatch cover guide nose and lashing bridge;
   - Determine D-pad thickness
4. Verify sandwich pad contact condition and determine shim plate thickness.
5. Measure hatch cover top container socket level.
6. Perform container demonstration (fit verification).

Skirt line Gap