GD21-2013

CHINA CLASSIFICATION SOCIETY

GUIDELINES FOR CONSTRUCTION MONITORING OF HULL STRUCTURES

2014

Implementation date: July 1, 2014

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CHAPTER 1 GENERAL

1.1 General provisions

1.1.1 The Guidelines are applied in addition to the requirements for survey of the critical locations within the ship structure, for the purpose of controls on alignment, fit-up, groove preparation and workmanship to the critical locations of the relevant hull structures, to ensure that the critical locations are built to both an acceptable quality standard and approved construction procedures.

1.1.2 The Construction Monitoring Plan (CMP) described in the Guidelines is also used for all parties concerned to focus the attention of knowledge of the critical locations during the service life of the ship.

1.1.3 Ships to which 1.2 of this Chapter applies and which have effectively implemented the procedure described in 1.5.1 are to be assigned with CM notation.

1.2 Scope of application

1.2.1 The Guidelines apply to new constructed oil tankers, bulk carriers and container ships of 150 m or over in length.

1.2.2 New constructed ships other than those mentioned in 1.2.1 may be referred to the guidelines.

1.3 Definitions

1.3.1 *Critical Areas* are those areas of the ship structure that have been shown by rules requirements, structural analysis and service experience to have a higher probability of failure than the surrounding ship structure.

1.3.2 *Critical Locations* are locations identified within the critical areas that experience high levels of stress or are prone to structural damages such as cracking, buckling and distortion.

1.3.3 A *Construction Monitoring Plan* for hull structures (hereinafter referred to as CMP) is a supplement to the Construction Quality Plan, which provides a specific quality standards and control procedures for the critical locations that have been identified.

1.4 General requirements

1.4.1 The designer is to, according to the requirements of 2.1.1 and 2.1.2, determine critical locations of the hull structure of a ship, and give due attention to the critical locations identified. Appropriate measures for improvement, such as weld bead appearance, grinding and preheating, etc., are to be taken as necessary in order to reduce the probability of structural damage at the locations. The critical locations identified and appropriate measures required are to be reflected in the design drawings and submitted to CCS for approval.

1.4.2 The following are to be done by the shipyard during the process of construction monitoring:

(1) establishment of requirements for critical location construction tolerances control for a specific ship in accordance with Construction Monitoring Standard (hereinafter referred to as CMS) for hull structures described in Appendix B;

(2) on the basis of design drawings approved by CCS in which critical locations are indicated, development of a CMP according to the practical conditions of the yard and submitting it to CCS for approval prior to steel cutting;

(3) establishment of quality assurance procedures and effective implementation of the approved CMP;

(4) the yard's quality control department/personnel are responsible for the inspection and recording of results during the construction of the ship and timely notifying the CCS site Surveyor(s) to confirm that the critical locations are constructed in compliance with the CMP; and

(5) remedial measures as specified by the CMS against locations not constructed in compliance with the CMS.

1.4.3 During the service life of the ship, the shipowner is responsible for regular inspection and maintenance of the determined critical locations in accordance with the approved CMP.

1.5 Basic procedure and class notation

1.5.1 A basic construction monitoring procedure for hull structures and the flow chart thereof (given in Figure 1.5.1) include:

(1) identification and confirmation of critical locations;
(2) development and approval of CMP;
(3) survey during construction;
(4) assignment of CM notation; and
(5) survey after construction.

Construction monitoring procedure for hull structures-flowchart

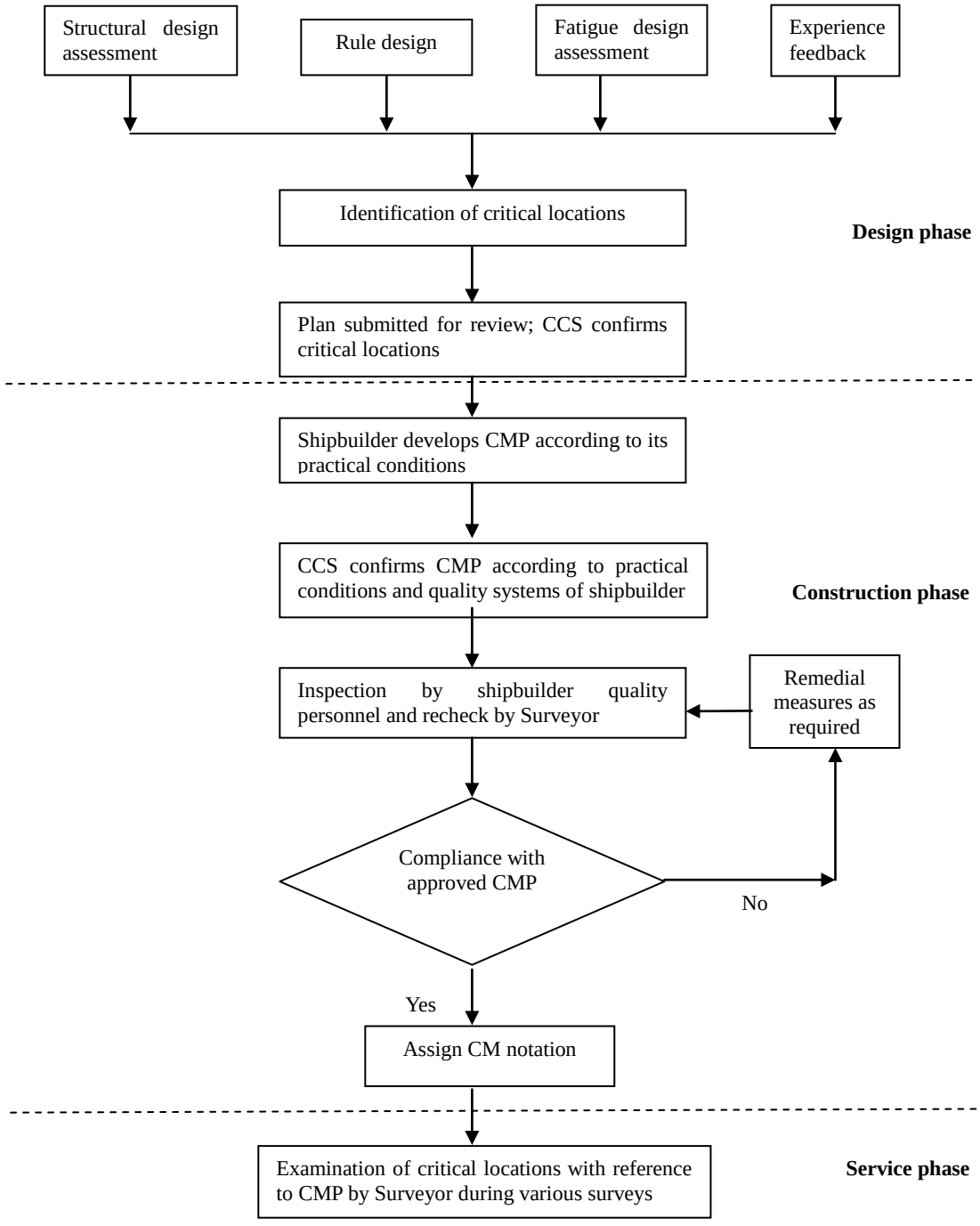


Figure 1.5.1

1.6 Construction Monitoring Standard(CMS) for hull structures

1.6.1 A CMS is a supplementary standard to ensure that the critical locations of hull structures meet relevant quality standards. It covers three aspects:

(1) fit-up and alignment of structural components;
(2) welding of structural components; and
(3) remedial measures for inappropriate fit-up, misalignment or poor welding.

1.6.2 Requirements for alignment of critical locations and remedial measures for misalignment are specified in Appendix B of the Guidelines. The construction standards and tolerances not indicated in Appendix B are to be at least equivalent to the industrial, national or international standards or the approved yard's ship construction standards.

CHAPTER 2 MONITORING PRIOR TO CONSTRUCTION

2.1 Identification and labeling of critical locations

2.1.1 Critical locations of hull structures are to be identified on the basis of the following:

(1) requirements of CCS Rules for Classification of Sea-going Steel Ships and relevant guidelines;

(2) finite element structural strength assessment (including yield and buckling strength)and fatigue strength assessment of hull structures; and

(3) analysis of similar or sister ships for areas prone to cracking, buckling and distortion that will damage hull structural integrity.

2.1.2 Typical critical locations of hull structures for bulk carriers, oil tankers and container ships are indicated in Appendix A as guidance for identification of critical locations of these three ship types.

2.1.3 Critical locations are to be labelled by means of a special labeling system on the structural design drawings relating to the CMP.

2.2 Development of CMP

2.2.1 The shipyard is to develop the CMP on the basis of the design drawings approved by CCS, including critical locations of hull structures. CCS may provide the format of CMP and relevant information where necessary.

2.2.2 A CMP is at least to contain the following information:

(1) construction monitoring standard appropriate for the ship;

(2) summary table (with figures) of all critical locations to be monitored, indicating alignment tolerances applied;

(3) detailed structural drawing for each critical location, indicating alignment tolerances and shapes and gaps of weld grooves;

(4) where fatigue life improvement measures have been specified at the critical locations, these are to be included on the detailed structural drawings;

(5) alignment verification methods used during fit-up, such as reference line marking;

(6) outline of quality control for fit-up of structural components of all critical locations during pre-assembly, block assembly and gross assembly phases; and

(7) form for recording of construction monitoring inspection results.

2.2.3 A sample CMP of a large bulk carrier is shown in Appendix C of the Guidelines.

2.3 Approval of CMP

2.3.1 The CMP is to be submitted to CCS for approval normally prior to steel cutting, in order that the findings of practical construction, structural analysis and fatigue analysis as well as experience of similar ships in service are fully reflected in the plan.

2.3.2 Once approval is given, the quality control department of the shipyard is to maintain efficient contact with CCS' site Surveyors and plan approval Surveyors to ensure that the requirements of the CMP are fully understood and are complied with by all interested parties.

2.3.3 A copy of the approved CMP is to be maintained on board either in electronic or hard copy format throughout the life of the ship for use during surveys after construction.

CHAPTER 3 MONITORING DURING CONSTRUCTION

3.1 Pre-assembly

3.1.1 The pre-assembly of each critical structural component is to be monitored in accordance with the approved CMP. The workmanship employed and material preparation during the pre-assembly stage is to conform to the relevant requirements defined in the CMP. Weld grooves and gaps of critical structural components required to be preassembled are to be inspected for compliance with CMS. Non-compliance, if any, is to be rectified.

3.1.2 In the process of assembly of critical structural components, appropriate methods are to be applied to ensure alignment of the components at joints. In general, two alignment verification methods may be used, i.e., profile gauge and offset marking. The method for inspection of alignment is to be to the satisfaction of the site Surveyor. The shipyard's quality personnel are to inspect the alignment of the critical structural components for compliance with CMS, using the method agreed by the site Surveyor. Non-compliance, if any, is to be rectified.

3.1.3 Upon completion of the above 3.1.1 and 3.1.2, the shipyard is to notify the site Surveyor to recheck.

3.2 Assembly of units and block assembly

3.2.1 During unit assembly, special attention is to be given to the alignment of critical structural components so as to ensure that each process is in compliance with the approved plan and construction tolerances. The plates and components are to be left loose as far as possible until such time that acceptable fit-up and alignment has been achieved so as to avoid great inner stress caused by forced assembly.

3.2.2 The shipyard's quality control personnel may use the method agreed by the site Surveyor as mentioned in 3.1.2 to inspect the alignment of critical structural components. If the alignment cannot comply with the specified tolerances, it is to be rectified and then re-inspected. For each critical structural component, the inspection of alignment, rectification of non-compliance and re-inspection are to be recorded.

3.2.3 After the positions of critical structural components have been fixed and satisfactorily inspected by the yard's quality control personnel and before welding is undertaken, the yard is to notify the site Surveyor. The Surveyor is to inspect the records provided by the yard's quality control department and do sample recheck.

3.2.4 Welding sequences are to enable to reduce residual stress as far as possible, i.e., welding started from the middle to both ends or back-step welding.

3.2.5 Surfaces intended to be welded are to be clean and dry. Measures of pre-heating and heat preservation for the weld areas are to be taken as necessary, with the aim to prevent cracks and other defects due to rapid cooling of welds. For any given welding method, the welding processes are to be in compliance with the welding procedures approved by CCS. All welders involved are to have qualifications approved by CCS.

3.2.6 Temporary components are normally not allowed at critical locations. Where such components as lifting lugs have to be welded at critical locations, the locations and their adjacent structures are to be inspected to ensure that no cracks or defects are present. When temporary components are removed, the Surveyor may request inspection of the surface for possible cracks, in order to eliminate defects and potential damage.

3.3 Inspection after welding

3.3.1 Upon completion of the welding of critical structural components, a visual inspection is to be carried out. Prior to the inspection, all rust, weld slag and coatings that may impair the inspection are to be removed. The inspection is to ensure that:

(1) all welds are in good shape, homogeneous and reasonably smooth, which are to comply with

class B of ISO 5817, and grinding is applied when necessary;
(2) all weld sizes meet the design requirements over their entire length;
(3) double continuous round welding is applied at the ends of structural components (e.g. brackets) or openings in way of their ends. The round welds are not less than 75 mm in length and the size of the weld leg may be increased as appropriate, thus avoiding cracks at points of stress concentration; and
(4) if repair welding has been undertaken, the repair welds are not to be less than 50 mm in length.

3.3.2 Welds may be examined using Ultrasonic, Magnetic Particle, Radiographic, Dye Penetrant or other approved NDT methods. The quality of a weld is often affected by factors such as heat input and the welding process, therefore, when specifying an NDT procedure, full consideration is to be given to the weld process employed to ensure that the method of NDT is suitable for the type of weld under consideration. At critical locations where full or deep penetration welding is employed, generally not less than one NDT is to be carried out at every 10 locations.

3.3.3 Where defects of welds are observed and are tended to be progressive, examination is to be expanded. Unacceptable weld defects detected by NDT are to be removed and re-welded using approved procedures.

3.3.4 At critical locations where repairs or re-welds have been undertaken, appropriate measures are to be taken to avoid distortion and stress concentration due to excessive welding. Re-inspection using the appropriate method of NDT is to be carried out for repairs where necessary, until no defects are discovered.

3.3.5 Additional welding inspection or NDT may be carried out if the site Surveyor considers necessary.

3.3.6 The site Surveyor is to recheck the inspection and repair records of welding of critical structural components made by the yard's quality control department.

3.4 Departure from the Approved Hull Structure

3.4.1 Where a ship has undergone departure from the approved hull structure, any location subsequently identified as being critical is to be constructed to the CMP.

3.4.2 All revised drawings and documents as well as the CMP involved in an alteration are to be submitted to CCS for approval as early as possible.

3.4.3 Locations not previously identified but subsequently found to be critical due to the structural alteration are to be examined in detail to ensure that no severe misalignment and weld imperfections exist.

CHAPTER 4 MONITORING AFTER CONSTRUCTION

4.1 Monitoring after construction

4.1.1 The Surveyor undertaking various surveys for ships in service is to, according to the scope of each survey, identify, from the CMP, those critical structural locations that will require special consideration and/or extended examination during survey.

4.1.2 During surveys, the Surveyor is to pay particular attention to possible defects of critical locations such as cracking, corrosion, local damage, severe distortion and local coating breakdown.

4.1.3 Repairs undertaken at the critical locations of ships with CM notation are also to be undertaken in accordance with CMP.

4.2 Structural conversion of ships in service

4.2.1 If a ship with CM notation in service is intended to undergo major conversion of its hull structure, the shipowner is to re-assess structural strength and fatigue strength of the hull structure, subsequently identify critical locations of the hull structure, and update the CMP. The revised drawings and updated CMP are to be submitted to CCS for re-approval in accordance with 3.4.2. During the conversion, alignment and welding of the subsequently identified critical structural components is to comply with the revised CMP approved.

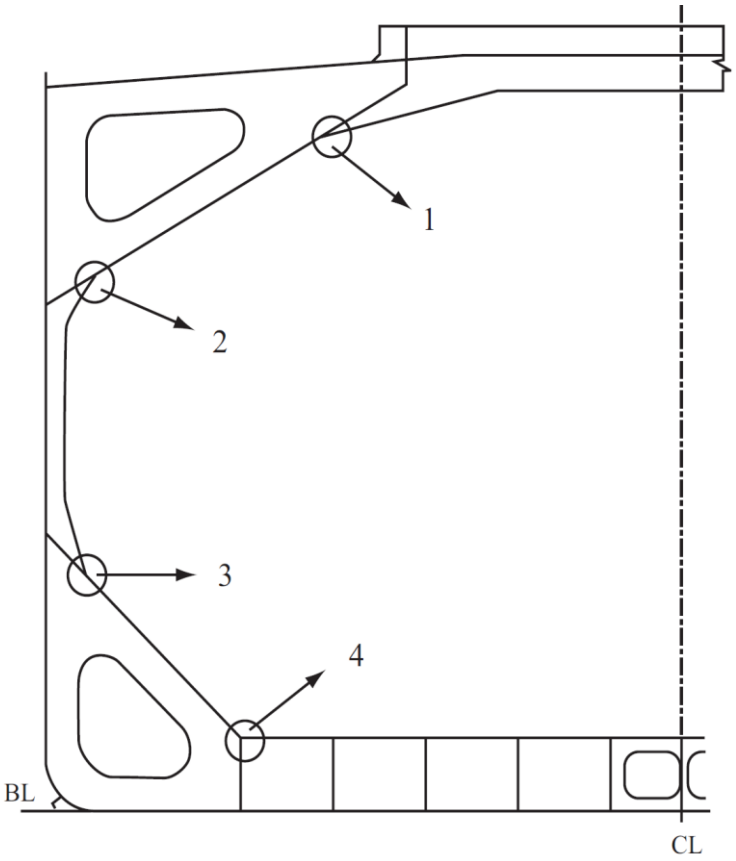
4.2.2 The structures at new critical locations not previously identified but subsequently found due to the conversion are to be examined closely to ensure that relevant structures meet the tolerances and welding quality required.

Appendix A

CRITICAL LOCATIONS OF HULL STRUCTURES

Critical Locations of Typical Bulk Carriers **Table A.1**

Structure	No.	**Critical location**	Figure
Deck	1	Hatch end beam toe in way of topside tank transverse ring web	Fig A.1(1), Position 1
	2	Connection of deck longitudinal to transverse bulkhead	Fig A.1(10), Position 1
	3	Scallops in way of block connections joints at cargo hold deck amidships	Fig A.1(8), Positions 1 and 2
Hatch coaming	1	Hatch coaming longitudinal end bracket toe	Fig A.1(2), Position 1
Hold main frame	1	Toe connection of hold main frame to topside tank sloping plating (in way of ring web)	Fig A.1(1), Position 2
	2	Toe connection of hold main frame to hopper tank sloping plating (in way of ring web)	Fig A.1(1), Position 3
Double side skin	1	Connection of topside tank sloping plating to side longitudinal bulkhead plating	Fig A.1(3), Position 1
	2	Connection of hopper tank sloping plating to side longitudinal bulkhead plating	Fig A.1(3), Position 2
Hopper tank	1	Connection of hopper tank sloping plating to inner bottom plating	Fig A.1(1), Position 4
Transverse bulkhead	1	Connection of lower stool side plating to inner bottom plating and hopper tank sloping plating in way of double bottom girders	Fig A.1(4), Position 1
	2	Connection of lower stool shelf plating to corrugated bulkhead in way of lower stool diaphragm	Fig A.1(4), Position 2
	3	Connection of upper stool to corrugated bulkhead and topside tank sloping plating	Fig A.1(6), Position 1
	4	Connection of transverse bulkhead to inner bottom plating in way of double bottom girders (if no lower stool is fitted)	Fig A.1(7), Position 1
Hatchway	1	Hatch corners of strength deck	Fig A.1(5), Position 1
Webs of primary members	1	Cut out for longitudinal stiffeners in web-frame without web stiffener connection	Fig A.1(9), Positions 1,2 and 3
Double bottom	1	Connection of inner bottom longitudinal stiffener to transverse bulkhead	Fig A.1(10), Position 2
	2	Connection of bottom longitudinal stiffener to transverse bulkhead	Fig A.1(10), Position 2



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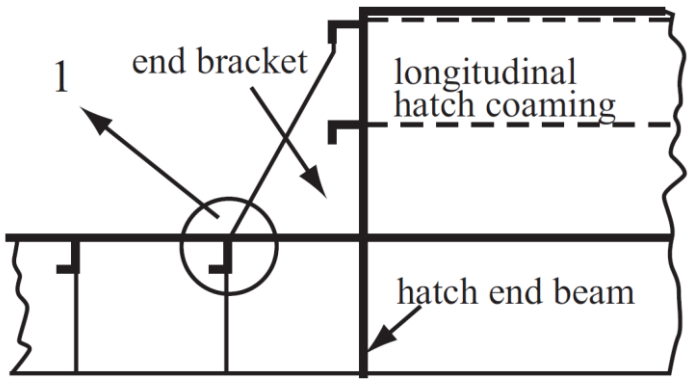

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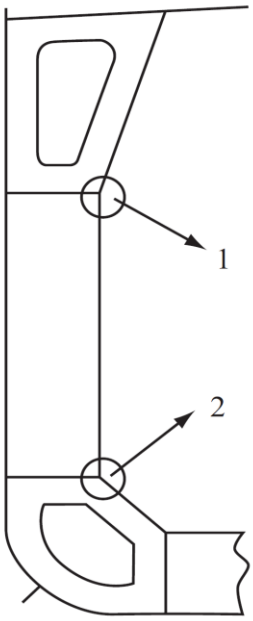

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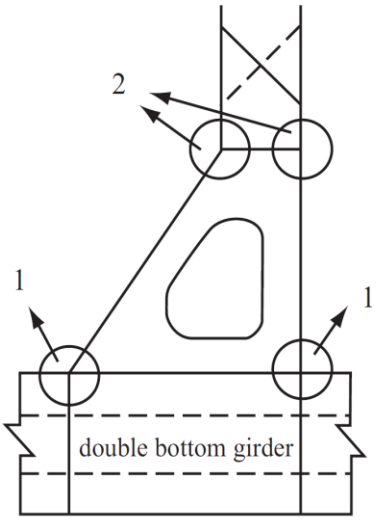

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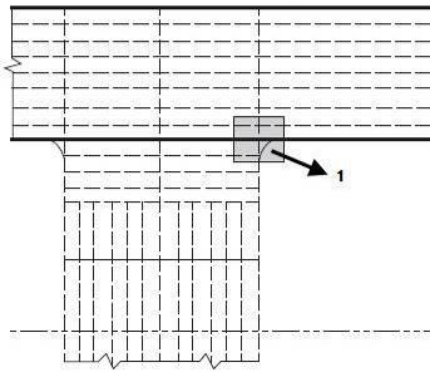

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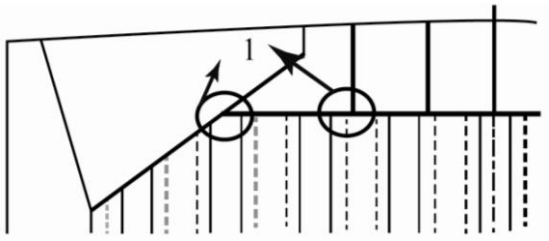

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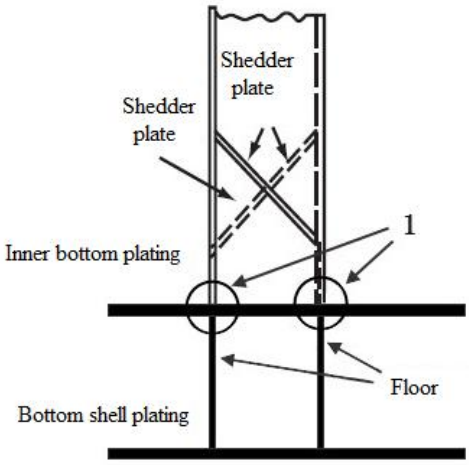

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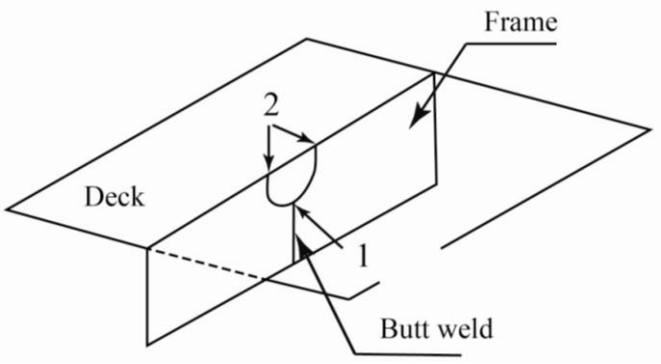

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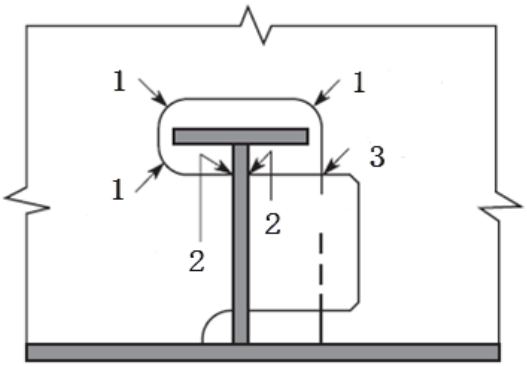

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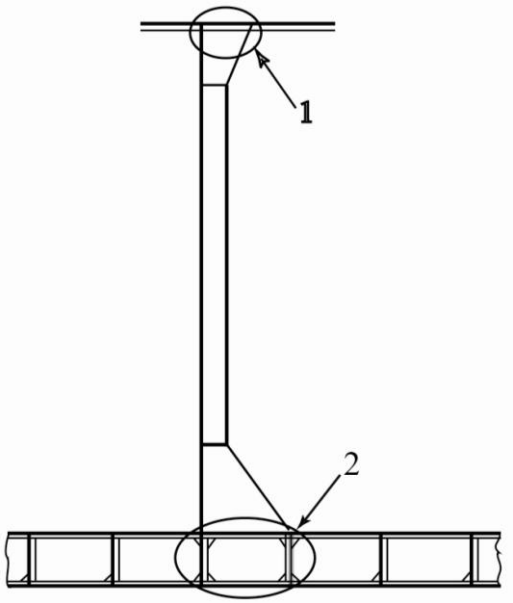
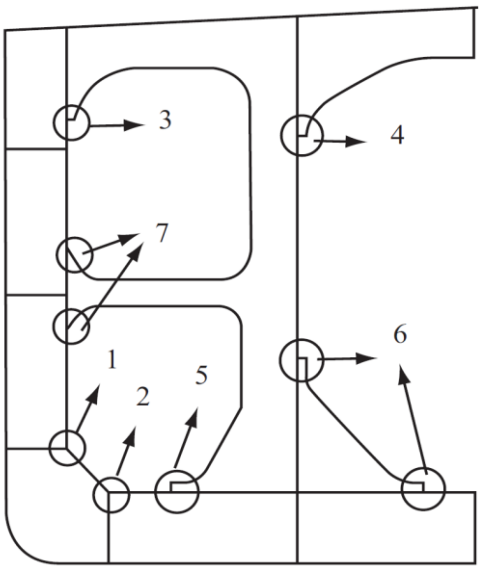


Figure A.1(10)

Critical Locations of Oil Tankers **Table A.2**

Structure	Area	No.	Critical location	Figure
Plate connections	Inner shell	1	Intersection of side longitudinal bulkhead, hopper tank sloping plating and side stringer in double side tank	Fig A.2(1) Position 1
		2	Intersection of hopper tank sloping plating, inner bottom plating and double bottom girder	Fig A.2(1) Position 2
		3	Intersection of side longitudinal bulkhead, topside tank sloping plating and side stringer in double side tank	Fig A.2(2) Position1
	Bulkhead	1	Intersection of longitudinal and transverse vertical corrugated bulkheads in way of lower stool	Fig A.2(2) Position 2
		2	Intersection of longitudinal and transverse vertical corrugated bulkheads in way of upper stool	Fig A.2(2) Position 3
		3	Intersection of lower stool side plating, inner bottom plating and floor	Fig A.2(3) Position 1
		4	Connection of lower stool shelf plating to corrugated bulkhead in way of lower stool diaphragm	Fig A.2(3) Position 2
Girder end	Deck	1	Connection of transverse end bracket to side longitudinal bulkhead	Fig A.2(1) Position 3
		2	Deck transverse end bracket toe in way of topside tank transverse web	Fig A.2(4) Position 1
		3	Connection of transverse end bracket to longitudinal bulkhead	Fig A.2(1) Position 4
		4	Connection of deck longitudinal stiffener to transverse bulkhead	Fig A.2(7) Position 1
		5	Scallops in way of block connections joints at cargo hold deck amidships	Fig A.2(8) Positions 1 and 2
	Longitudinal bulkhead	1	Connection of vertical web lower end bracket to inner bottom	Fig A.2(1) Position 5
	Transverse bulkhead	1	Connection of horizontal girder to longitudinal bulkhead	Fig A.2(5) Position 1
		2	Connection of horizontal girder to side longitudinal bulkhead	Fig A.2(5)

Structure	Area	No.	Critical location	Figure
				Position 2
		3	End of horizontal girder	Fig A.2(5) Position 3
Big bracket	Inner bottom	1	Toe of big bracket connecting inner bottom and longitudinal bulkhead	Fig A.2(1) Position 6
	Swash bulkhead (cargo oil tank)	1	Bracket connecting swash bulkhead and side longitudinal bulkhead	Fig A.2(6) Position 1
Cross-tie	Wing cargo oil tank	1	Toe connection of cross-tie to side longitudinal bulkhead	Fig A.2(1) Position 7
Longitudinals	Double bottom	1	Connection of inner bottom longitudinals to transverse bulkhead	Fig A.2(7) Position 2
		2	Connection of bottom longitudinals to transverse bulkhead	Fig A.2(7) Position 2
Webs of primary members		1	Cut out for longitudinal stiffeners in web-frame without web stiffener connection	Fig A.2(9) Positions 1,2 and 3



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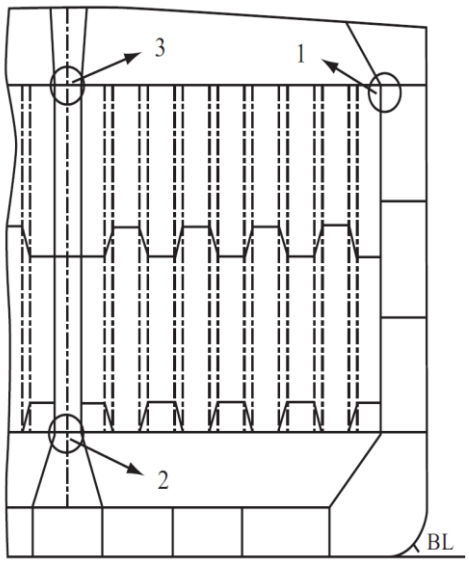

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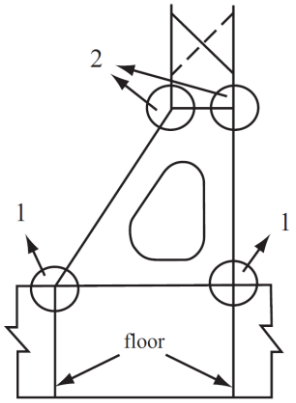

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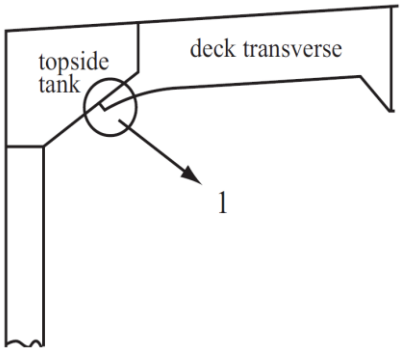

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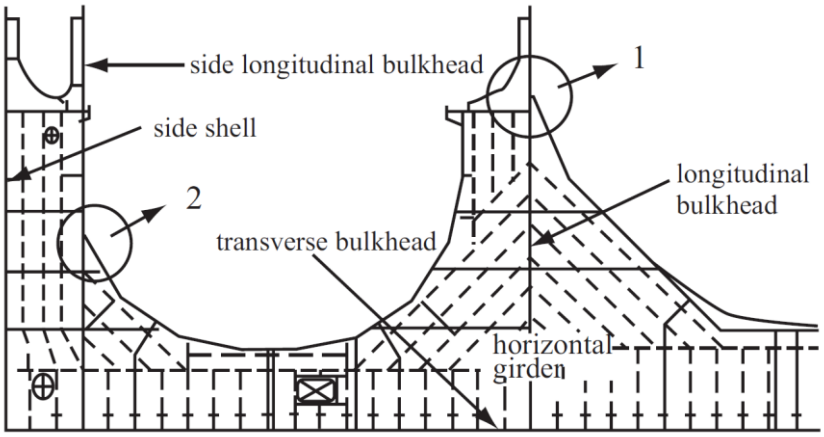

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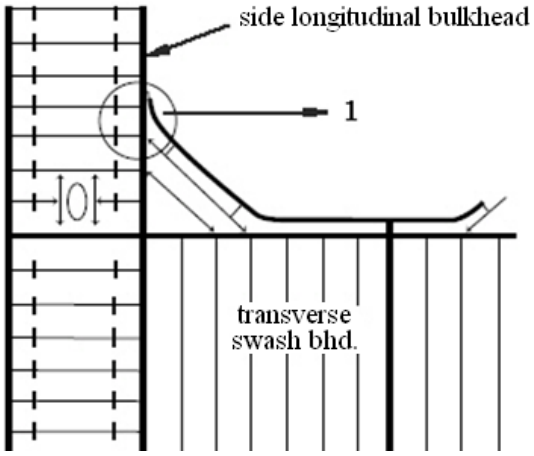

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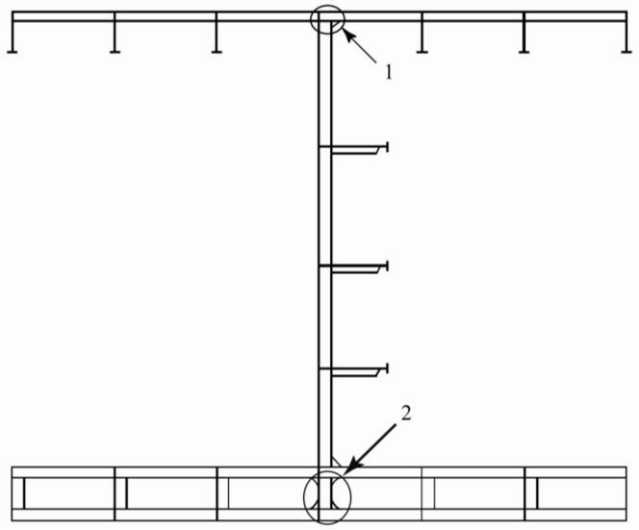

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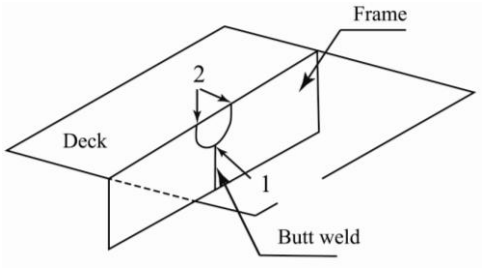

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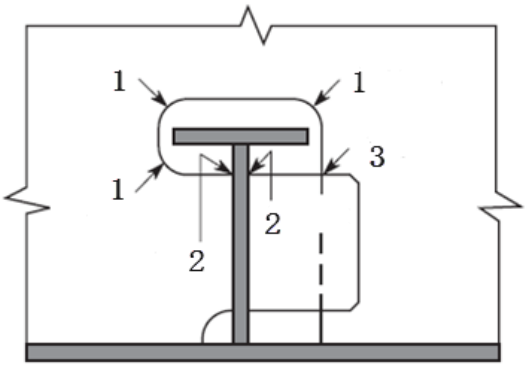
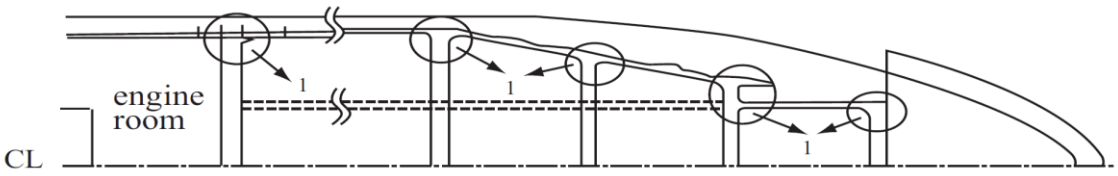


Figure A.2(9)

Critical Locations of Container Ships **Table A.3**

Structure	No.	Critical location	Figure
Deck	1	Deck plating in way of hatch corner of cargo hold, esp. where there is transition of sizes of engine room fore end and fore cargo hold hatch	Fig A.3(1) Position 1
Hatch coaming	1	Intersection of longitudinal hatch coaming with superstructure	Fig A.3(2) Position 1
	2	Toe connection of longitudinal hatch coaming transverse stay bracket to deck plating	Fig A.3(2) Position 2
	3	Connection between transverse and longitudinal top of coamings	Fig A.3(3) Position 1
	4	Longitudinal hatch coaming end bracket toe	Fig A.3(4) Position 1
Double side hold	1	Intersection of side longitudinal bulkhead, inner bottom plating and double bottom side girder in way of floor	Fig A.3(5) Position 1
	2	Intersection of side longitudinal bulkhead with bilge tank top plating in way of transverse web	Fig A.3(2) Position 3
Bilge tank	1	Intersection of bilge tank longitudinal bulkhead, inner bottom plating and double bottom side girder in way of floor	Fig A.3(2) Position 4
	2	Connections in way of bilge tank stepped longitudinal bulkhead	Fig A.3(6) Position 1
Watertight &non-watertight bulkheads	1	Connection of cargo hold hatch end beam to side longitudinal bulkhead (including 2nd deck)	Fig A.3(2) Position 5
	2	Toe connection of vertical web to inner bottom plating	Fig A.3(2) Position 6
	3	Intersection of transverse bulkhead plating or bulkhead bottom box side plating, floor, inner bottom plating and double bottom longitudinal girder	Fig A.3(7) Position 1



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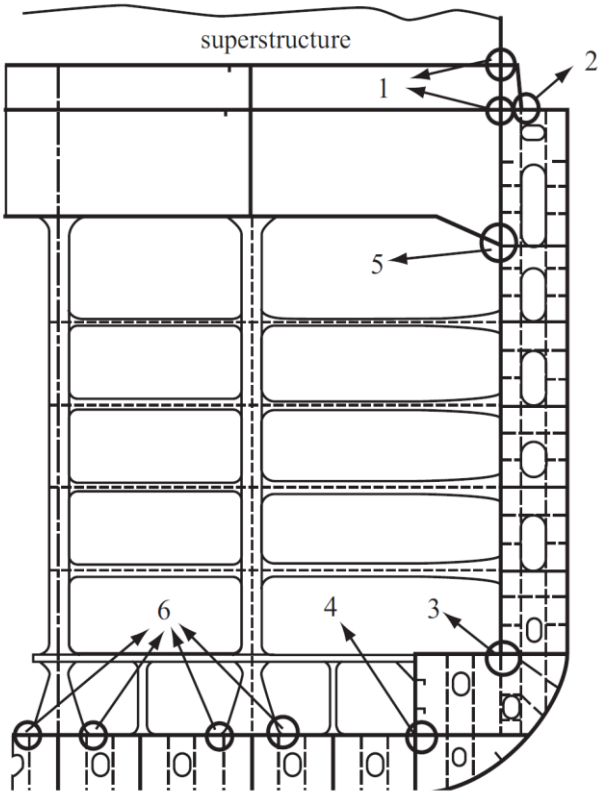
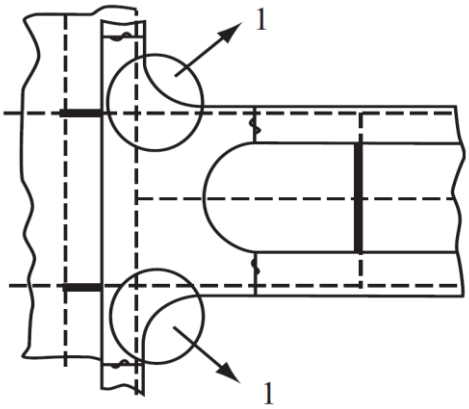


Figure A.3(2)



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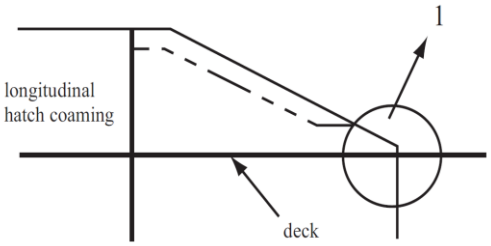

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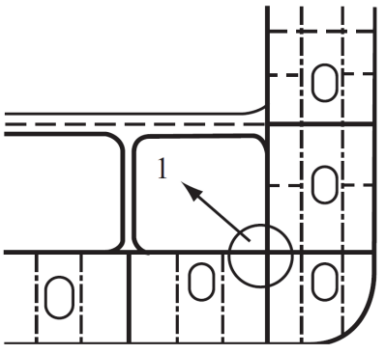

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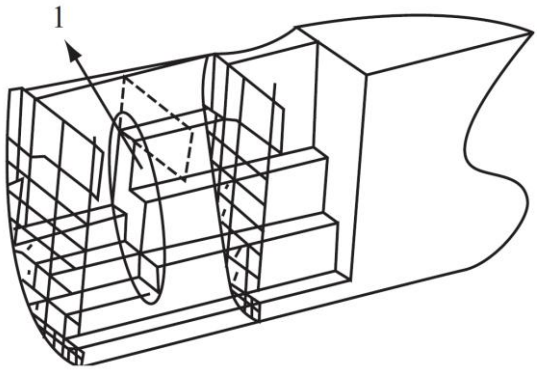


FigureA.3(6)

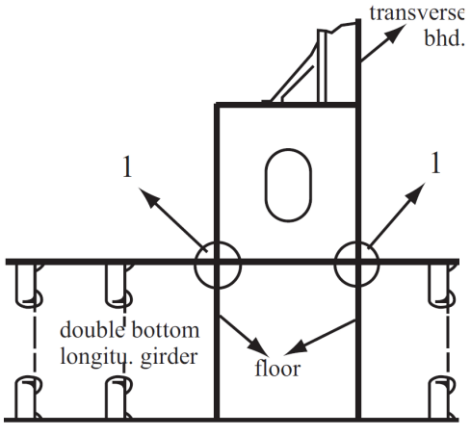


Figure A.3(7)

Appendix B

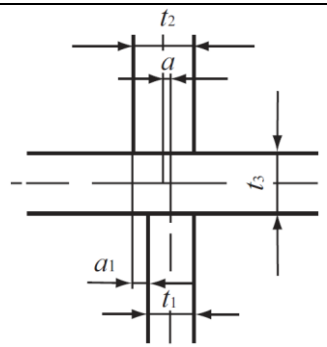
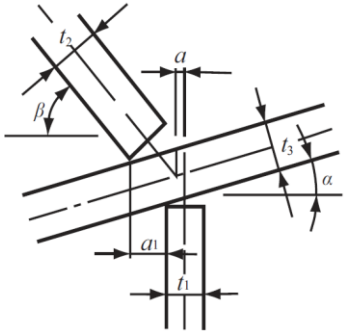
CONSTRUCTION MONITORING STANDARD (CMS) FOR HULL STRUCTURES

1 General requirements

1.1 This Appendix gives fit-up and alignment requirements as well as possible remedial measures for critical locations of key hull structures.

1.2 In addition to the requirements given in this Appendix, requirements for cutting, fit-up and repair are to comply with ship construction standards accepted by CCS.

Alignment Standard for Critical Hull Structural Components **Table B1**

Joint type		Standard	Limit	Remedial measures
Cross joint		Practical tolerance a_1: $\Delta t\text{-}a \le a_1 \le \Delta t + a$ where: $\Delta t = \frac{1}{2}(t_2 - t_1)$ a=theoretical alignment tolerance =t_{min}/4 t_{min}= t_1, t_2 or t_3, whichever is the smallest Note: Cross joint is a special case of oblique cross joint when α=0°, β=90°.	Practical tolerance a_1: $\Delta t\text{-}a \le a_1 \le \Delta t + a$ where: $\Delta t = \frac{1}{2}(t_2 - t_1)$ a=t_{min}/3 and not greater than 5mm t_{min}= t_1, t_2 or t_3, whichever is the smallest	Where tolerance is within the range below, weld leg may be increased by 10%~15%: $\Delta t\text{-}1.5a \le a_1 \le \Delta t\text{-}a$, or $\Delta t + a \le a_1 \le \Delta t + 1.5a$ where: $\Delta t = \frac{1}{2}(t_2 - t_1)$ a = t_{min}/3 and not greater than 5mm t_{min}= t_1, t_2 or t_3, whichever is the smallest Where a_1 goes beyond the above range, release and refit over a minimum 50 a to achieve compliance.
Oblique cross joint		Practical tolerance a_1: $\Delta t\text{-}a \le a_1 \le \Delta t + a$ where: $\Delta t = \frac{1}{2}\left(\frac{t_2 \cos\alpha}{\sin(\beta+\alpha)} + \frac{t_3 \cos\beta}{\sin(\beta+\alpha)} - t_1\right)$ a=theoretical alignment tolerance = t_{min}/4 t_{min}= t_1, t_2 or t_3, whichever is the smallest Note: Heel of sloping plate t_2 is to be measured using a surface of vertical plate $t_1$which intersects with plate t_3 as the baseline. If the tolerance a_1 is positive, heel is deemed on the outer side of the surface of the vertical plate t_1, if negative, inner side.	Practical tolerance a_1: $\Delta t\text{-}a \le a_1 \le \Delta t + a$ where: $\Delta t = \frac{1}{2}\left(\frac{t_2 \cos\alpha}{\sin(\beta+\alpha)} + \frac{t_3 \cos\beta}{\sin(\beta+\alpha)} - t_1\right)$ a=t_{min}/3 and not greater than 5mm t_{min}=t_1, t_2 or t_3, whichever is the smallest	Where tolerance is within the range below, weld leg may be increased by 10%~15%: $\Delta t\text{-}1.5a \le a_1 \le \Delta t\text{-}a$, or $\Delta t + a \le a_1 \le \Delta t + 1.5a$ where: $\Delta t = \frac{1}{2}\left(\frac{t_2 \cos\alpha}{\sin(\beta+\alpha)} + \frac{t_3 \cos\beta}{\sin(\beta+\alpha)} - t_1\right)$ a = t_{min}/3 and not greater than 5mm t_{min}=t_1, t_2 or t_3, whichever is the smallest Where a_1 goes beyond the above range, release and refit over a minimum 50 a to achieve compliance

Appendix C

SAMPLE CONSTRUCTION MONITORING PLAN (CMP)

Construction Monitoring Plan for XXX,XXX DWT Bulk Carrier

(This appendix only serves as reference for development of CMP and not all details are covered)

1. Objective

1.1 The objective of this procedure is for, throughout design and construction phases and the ship's whole lifetime of service, monitoring all the critical locations that are prone to high stress or fatigue damage on the ship, so as to ensure that construction and construction workmanship of all the critical locations comply with the Construction Monitoring Standard (CMS) attached in this CMP and attain the requirement for the assignment and maintenance of the CM notation.

2. Control monitoring

2.1 Indication of critical locations and relevant construction requirements

The critical locations identified are to be indicated in the summary table of all critical locations of the ship(see Annex 2).

In addition, structural design drawings for various critical locations are to contain all of the relevant information required for the accurate construction of the critical locations such as alignment tolerances, reference lines marking, welding details, fit-up information, etc. All critical locations are to be marked with Ⓒⓜ on the structural design drawings.

2.2 Alignment

Alignment tolerances for critical structural components are given in the summary table in Annex 3.

Reference lines required for the alignment of structural components during construction are to be clearly marked on both sides of the plate for examination prior to and after welding.

2.3 Welding

Prior to welding of all critical structural components, grooves and gaps are to be inspected in accordance with the CMS indicated in Annex 1 of this CMP.

2.4 Remedy of non-compliance

If misalignment or unacceptable welding is observed upon the examination of critical structural components during the process of construction, remedial measures are to be taken in compliance with the CMS given in Annex 1.

2.5 Monitoring of ships in service

The CMP is to be kept onboard for use in future surveys after the ship is delivered and put into service.

3. Monitoring during construction

3.1 Assembly of units

Prior to assembly of units at critical locations, the units are to be inspected for alignment and welding preparation to ensure that the CMS (see Annex 1) is complied with, and particularly to make sure that the reference lines are clearly and properly marked.

3.2 Block assembly

During block assembly phase, reference lines necessary for block construction are to be marked. Then the yard's quality control personnel are to inspect each critical location to ensure that they are fitted up in compliance with the CMP. Upon completion of the inspection, the yard is to notify the site Surveyor. The Surveyor is to inspect the records provided by the yard and do sample recheck. If the recheck results are satisfactory, welding will be carried out. Upon completion of welding, the yard's quality control personnel and site Surveyor are to inspect and recheck welding quality

respectively. If critical locations are not aligned and welded in compliance with the requirements in the CMS, the yard is to take remedial measures strictly in line with the CMS.

3.3 Reports and records

The yard's quality control personnel are to record the inspection results of alignment of each critical structural component prior to welding and of welding quality after welding. The site Surveyor is to record the sample recheck results of alignment and welding quality of the critical structural components.

4. Monitoring of ships in service

4.1 After the ship is delivered, the CMP is to be maintained on board as finished documents. The shipowner and Surveyor are to give special attention to critical structural components indicated in the CMP during the service life of the ship.

Annexes

1. Construction monitoring standard for hull structures (see Appendix B of the Guidelines) (omitted)
2. Summary table of critical locations and alignment tolerances (including figures)
3. Hold No.X Critical Location Cross Alignment Tolerances-- Summary and Node Figure (Example)
4. References Lines Marking for Alignment Inspection
5. Outline of Quality Control during Construction and Fit-up of Hull Structures
6. Records of Hull Structure Fit-up Monitoring Results

Annex 1

Construction Monitoring Standard for Hull Structures (CMS)

See Appendix B of the Guidelines (Omitted).

Annex 2

Summary Table of Critical Locations and Alignment Tolerances (including Figures)

Critical Locations of Holds No.3 to No.7

No.	Critical location	Fig	Key elements for control
S308-CX-101	Cargo hold hatch coaming longitudinal end bracket	Fig C2-1 CM001	Cutting (lines, fairness, edge chamfering), end round weld, toe grinding
S308-CX-102	Connection of cargo hold hatch end beam to topside tank transverse ring web	Fig C2-1 CM002	Fit-up (alignment, gap, groove angle), weld profile and quality
S308-CX-103	Connection of hatch coaming longitudinal end bracket to topside tank vertical plating	Fig C2-1 CM003	Fit-up (alignment, gap, groove angle), weld profile and quality
S308-FXXX-201	Connection of hold main frame to topside tank ring web (in way of topside tank sloping plating)	Fig C2-1 CM004	Fit-up (alignment, gap, groove angle), weld profile and quality
S308-FXXX-202	Connection of hold main frame to hopper tank ring web (in way of hopper tank sloping plating)	Fig C2-1 CM005	Fit-up (alignment, gap, groove angle), weld profile and quality, surface grinding
S308-FXXX-203	Connection of hopper tank sloping plating to double bottom longitudinal girder (in way of inner bottom)	Fig C2-1 CM006	Fit-up (alignment, gap, groove angle), weld profile and quality

Note: “CX” represents the serial number of cargo holds and “FXXX” the serial number of frames.

Critical Locations at Transverse Bulkheads of Frames No.150 to 198

No	Critical location	Fig	Key elements for control
S308-FXXX-301	Connection of lower stool side plating to corrugated bulkhead (in way of stool shelf plating)	FigC2-2 CM007	Fit-up (alignment, gap, groove angle), weld profile and quality
S308-FXXX-302	Connection of lower stool sloping plating to corrugated bulkhead (in way of stool shelf plating)	FigC2-2 CM008	Fit-up (alignment, gap, groove angle), weld profile and quality
S308-FXXX-303	Connection of double bottom floor and lower stool side plating (in way of inner bottom)	FigC2-2 CM009	Fit-up (alignment, gap, groove angle), weld profile and quality
S308-FXXX-304	Connection of double bottom floor and lower stool sloping plating (in way of inner bottom)	FigC2-2 CM010	Fit-up (alignment, gap, groove angle), weld profile and quality

Note: “XXX” represents the serial number of frames.

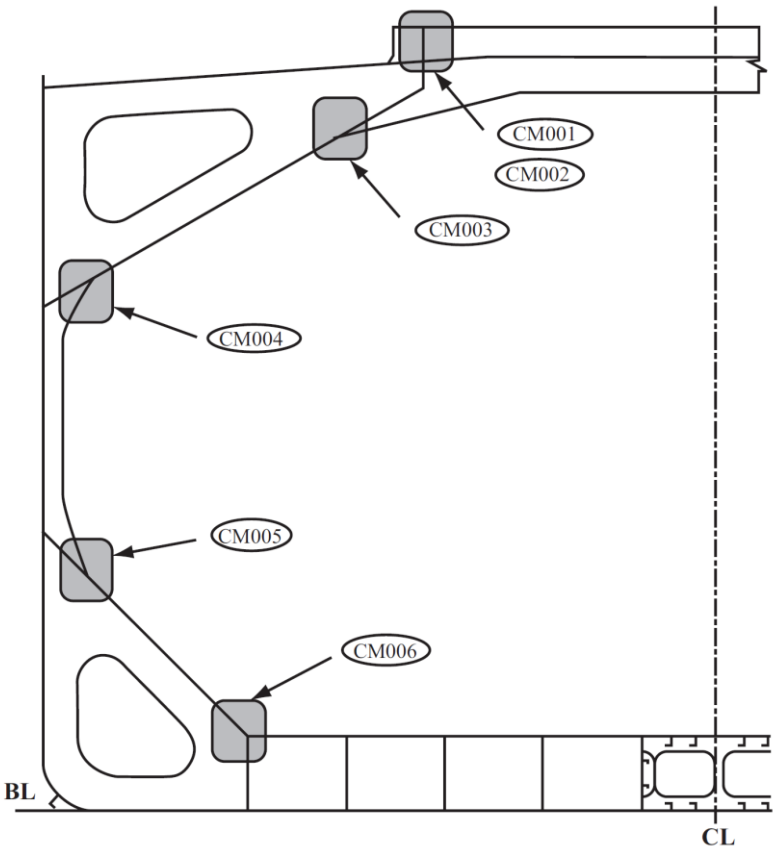


Figure C2-1 Critical Locations at Transverse Sections

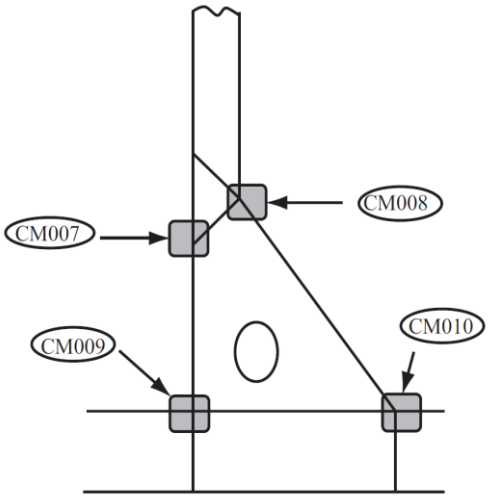
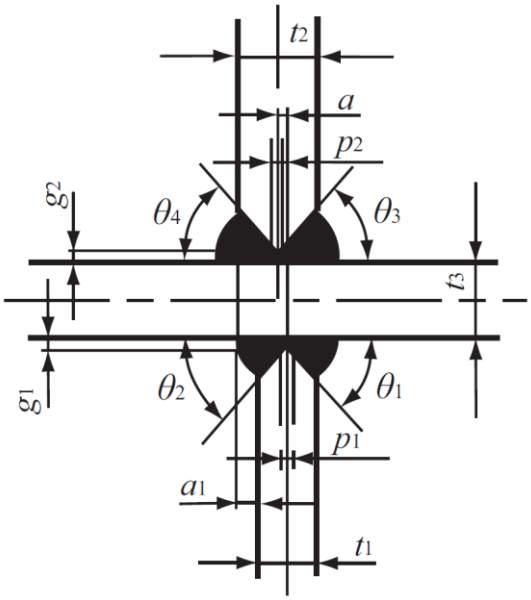


Figure C2-2 Critical Locations at Transverse Bulkheads

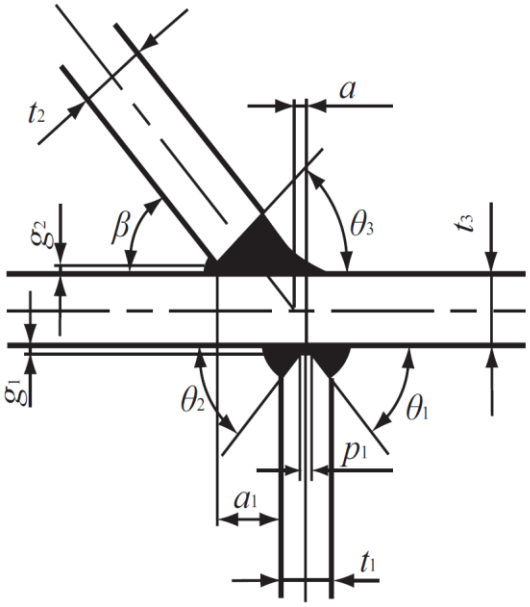
Annex 3

Hold No.X Critical Location Cross Alignment Tolerances—Summary and Node Figure (Example)

No.	Critical location	Data	Alignment tolerance (mm)	Node Fig
S308-CX-102	Connection of cargo hold hatch end beam to topside tank transverse ring web (in way of topside tank vertical plating)	t_1=14mm, t_2=18mm, t_3=26mm θ_1= θ_2= θ_3= θ_4=0 º p_1=t_1, p_2=t_2, g_1=g_2=0~2mm	a=±4.7, or a_1=-2.7~+6.7	Fig C3-1
S308-CX-103	Connection of hatch coaming longitudinal end bracket to topside tank vertical plating	t_1=14.5mm, t_2=13mm, t_3=26mm θ_1=50 º, θ_2=0 º, θ_3=50 º, θ_4=0 º p_1=p_2=0~3mm, g_1=g_2=0~2mm	a=±4.3, or a_1=-5.1~+3.5	Fig C3-1
S308-FXXX-201	Connection of hold main frame to topside tank ring web(in way of topside tank sloping plating)	t_1=13mm, t_2=16mm, t_3=16mm θ_1=θ_2=θ_3=θ_4=0 º p_1=t_1, p_2=t_2, g_1=g_2=0~2mm	a=±4.3, or a_1=-2.8~+5.8	Fig C3-1
S308-FXXX-202	Connection of hold main frame to hopper tank ring web(in way of hopper tank sloping plating)	t_1=14mm, t_2=18mm, t_3=20mm θ_1=θ_2=θ_3=θ_4=0 º p_1=t_1, p_2=t_2, g_1=g_2=0~2mm	a=±4.7, or a_1=-2.7~+6.7	Fig C3-1
S308-FXXX-203	Connection of hopper tank sloping plating to double bottom longitudinal girder (in way of inner bottom)	t_1=14mm, t_2=22.5mm, t_3=25.5mm θ_1=45 º, θ_2=45 º, θ_3=50 º, p_1=0~3mm β=45 º, g_1=g_2=0~2mm	a=±4.7, or a_1=+17.0~+26.3	Fig C3-2
S308-FXXX-301	Connection of lower stool side plating to corrugated bulkhead (in way of stool shelf plating)	t_1=23mm, t_2=23mm, t_3=23mm θ_1=θ_2=45 º, α=45 º g_1=g_2=0~2mm	a=±5.0, or a_1=-5.0~+5.0	Fig C3-3
S308-FXXX-302	Connection of lower stool sloping plating to corrugated bulkhead (in way of stool shelf plating)	t_1=23mm, t_2=23mm, t_3=23mm θ_1=50 º, θ_2=45 º, α=45 º, β=55 º, g_1=g_2=0~2mm	a=±5.0, or a_1=-1.5~+8.5	Fig C3-4
S308-FXXX-303	Connection of double bottom floor and lower stool side plating (in way of inner bottom)	t_1=18mm, t_2=16mm, t_3=22.5mm θ_1=θ_2=45 º, θ_3=θ_4=45 º, p_1=6mm, p_2=0~3mm, g_1=g_2=0~2mm	a=±5.0, or a_1=-6.0~+4.0	Fig C3-1
S308-FXXX-304	Connection of double bottom floor and lower stool sloping plating (in way of inner bottom)	t_1=18mm, t_2=21.5mm, t_3=22.5mm θ_1=θ_2=45 º, θ_3=50 º, p_1=6mm β=55 º, g_1=g_2=0~2mm	a=±5, or a_1=+7.0~17.0	Fig C3-2



FigureC3-1 Cross joint



FigureC3-2 Oblique cross joint

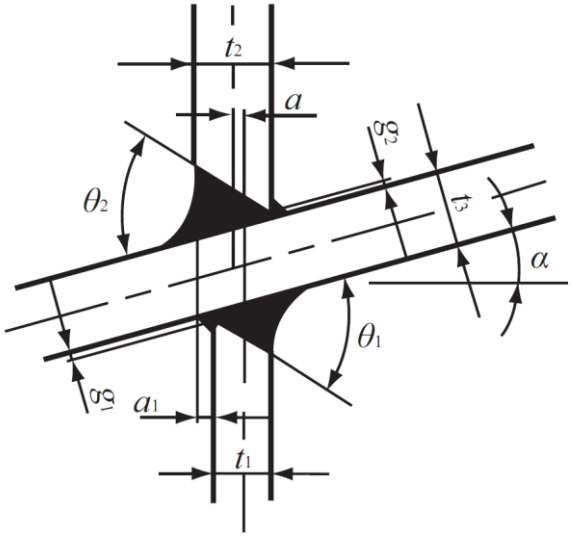


Figure C3-3 Cross joint with angled diaphragm

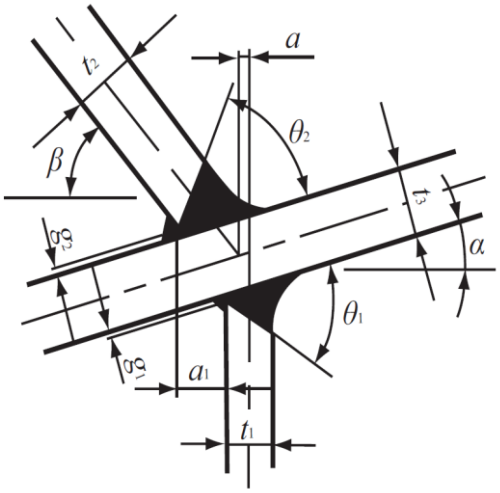


Figure C3-4 Oblique cross joint with angled diaphragm

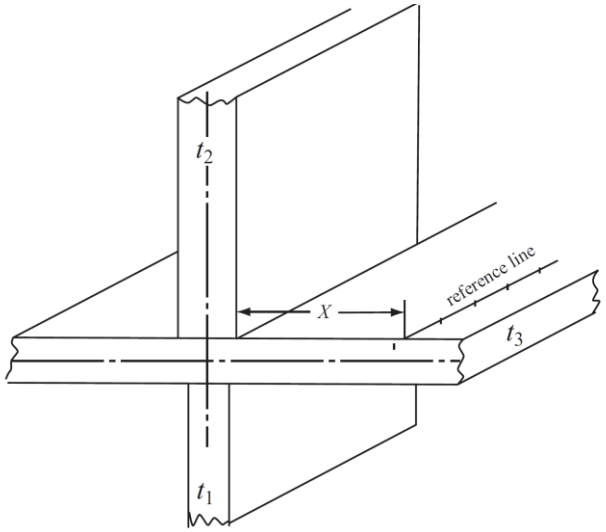
Annex 4

References Lines Marking for Alignment Inspection

For cross or oblique cross joints with diaphragms inbetween, references lines are to be marked on the diaphragm to ensure alignment. Location of reference lines are determined by the following formulae respective for three different types of joints:

It is assumed in the figure that the distance between the reference line and the intersection of the three plates is 50 mm. t_3 is the thickness of the diaphragm, t_1, the thickness of the plate pre-fitted to the diaphragm, and t_2, the thickness of the plate to be aligned and fixed.

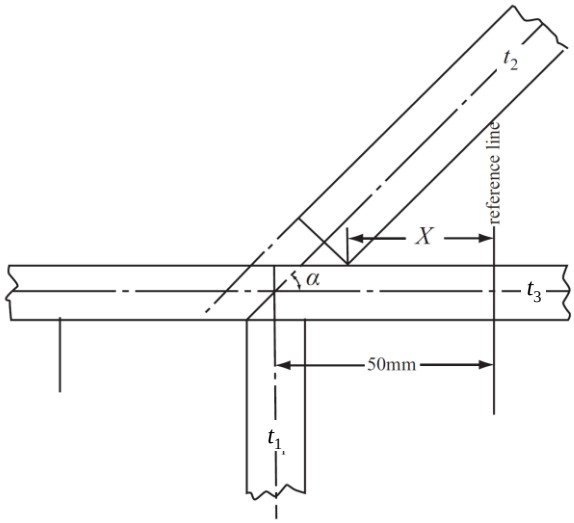
I Cross joint



Distance between the reference line and heel of Plate t_2 is: $\boldsymbol{X}=50-\frac{t_3}{2}$ mm

II Oblique cross joint

1. The diaphragm t_3 is horizontal:

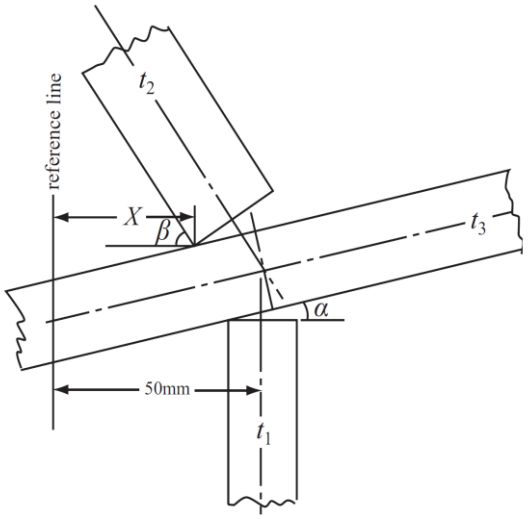


The reference line used for alignment of Plate t_2 is to be marked on the side of the acute angle as far as possible, then:

$$\boldsymbol{X}=50-\frac{1}{2}\left(\frac{t_2}{\sin\alpha}+\frac{t_3}{\tan\alpha}\right)\ \text{mm}$$

2. The diaphragm $t_3$is inclined in the angle α:

Angle of Plate t_2 to the horizontal is β, as shown in the figure below:



Horizontal distance between heel of Plate t_2 and the reference line marked on Plate t_3 on the side of the acute angle is:

$$\boldsymbol{X}=50-\frac{1}{2}\left[\frac{t_2\cos\alpha}{\sin(\alpha+\beta)}+\frac{t_3\cos\beta}{\sin(\alpha+\beta)}\right]\ \text{mm}$$

Annex 5

Outline of Quality Control during Construction and Fit-up of Hull Structures
(Including responsibilities of and coordination between yard's quality control personnel and CCS site Surveyor)

A. Pre-assembly

Shipyard's quality control personnel are to:
(1) inspect weld grooves and gaps of the critical structural components to be preassembled for compliance with CMS. Non-compliance, if any, is to be rectified;
(2) inspect the critical structural components which are required within certain alignment tolerances to see if the alignment is in compliance with that required in the CMS. Non-compliance, if any, is to be rectified. At the intersection of three plates (no matter cross joints or oblique cross joints), in order to ensure the alignment of components at both sides of the diaphragm, the quality personnel are to make sure that reference lines for inspection of alignment are marked on both faces of the diaphragm. The inspection result using reference lines should demonstrate that the alignment of the joints is in compliance with CMS; and
(3) inform the site Surveyor to recheck upon completion of the above two steps.
The site Surveyor is to verify and carry out sample recheck of the inspection records made by the quality control personnel to ensure they all comply with the CMP.

B. Block assembly

1. Prior to welding

Shipyard's quality control personnel are to:
(1) inspect weld grooves and gaps of critical structural components intended to be fit up during block assembly phase prior to welding to ensure that they comply with CMS;
(2) inspect the critical structural components which are required within certain alignment tolerances to see if the alignment is in compliance with that required in the CMS. Non-compliance, if any, is to be rectified. At the intersection of three plates (no matter cross joints or oblique cross joints), in order to ensure the alignment of components at both sides of the diaphragm, the quality personnel are to make sure that reference lines for inspection of alignment are marked on both faces of the diaphragm. The inspection result using reference lines should demonstrate that the alignment of joints is in compliance with CMS; and
(3) inform the site Surveyor to recheck upon completion of the above two steps.
The site Surveyor is to:

① carry out sample recheck for the above (1) (2) to ensure that they all comply with the CMP; and
② ensure that welding process used at the critical locations comply with the requirements of the welding procedures approved by CCS, including qualifications of welders and welding sequences, etc.

2. After welding

Shipyard's quality control personnel are responsible for cleaning after welding of critical locations, including cleaning weld slag and other residues as well as inspecting welds(including NDT) to ensure that welding quality meet relevant standards, and then to inform site Surveyor to recheck.
CCS site Surveyor is to:
(1) carry out sample inspection of welds, including visual inspection, inspection of weld sizes and NDT; and
(2) if upon sample inspection poor weld quality are observed, the inspection is to be expanded until

satisfactory results are attained. Any unacceptable weld observed is to be informed to the yard for re-welding or rectification until weld quality is satisfactory.

C. Erection

Same as B.

Annex 6

Records of Hull Structure Fit-up Monitoring Results

Ship name									
Phase of fit-up									
No. of critical locations	Align. tolerances	Align. inspection results	Groove & gap requirement	Groove & gaps inspection results	Yard's quality personnel (signature/date)	CCS Surveyor (signature/date)	Weld quality inspection results	Yard's quality personnel (signature/date)	CCS Surveyor (signature/date)