Base Load Power Hub (BLPH)

DIMENSIONAL CONTROL AND SURVEYING PROCEDURE

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Table of contents

1 INTRODUCTION 5

1.1 PROJECT OVERVIEW 5

1.1.1 Project Location 5

1.1.2 Project Concept 6

2 DOCUMENT PURPOSE AND SCOPE 8

2.1 REFERENCES 8

2.2 DEFINITIONS AND ABBREVIATIONS 8

3 RESPONSIBILITIES 9

3.1 PROJECT QUALITY MANAGER 9

3.2 QC INSPECTOR (QCI) / WELDING INSPECTOR (WI) 9

3.3 DIMENSIONAL CONTROL ENGINEER 9

4 FABRICATION TOLERANCES – DIMENSIONAL CONTROL 10

4.1 General 10

4.2 Local tolerances for structural components and sub-assemblies (EEMUA158) 11

4.2.1 Fabricated tubulars and cones 11

4.2.1.1 Circumference 11

4.2.1.2 Ovality 12

4.2.1.3 Out-of-roundness 12

4.2.1.4 Local straightness 13

4.2.1.5 End perpendicularity 13

4.2.2 Rectangular plated sections 14

4.2.2.1 Plate girders 14

4.2.2.2 Box girders 15

4.2.2.3 Girder nodes 19

4.2.2.4 Cruciform joints 20

4.2.2.5 Joint misalignment 20

4.3 Global tolerances for the completed structure (EEMUA 158 – ISO19902) 21

4.3.1 Deck node work points 21

4.3.2 Global vertical tolerances 23

4.3.3 Leg alignment and straightness tolerances 23

4.3.4 Padeyes, padears and lifting trunnions 24

4.3.5 Miscellaneous structural steelwork tolerances 24

4.3.5.1 Handrails 24

4.3.5.2 Deck plating, walkways, stairways and landings 24

5 REPORTS 25

5.1 Production Reports 25

5.2 Certification reports 26

Dimensional Control Certificate Cover Sheet 27

6 Safety 29

List of Figures

Figure 1 HOLLANDSE KUST NOORD WIND PARK Location Map 5

Figure 2 - Wind Park Details 6

Figure 3 – BLPH Concept 6

Figure 4 - Circunferential Tollerance 11

Figure 5 - Ovality 12

Figure 6 – Local Straightness 13

Figure 7 – End Perpandicularity 14

Figure 8 – Tolerances for plate girders 14

Figure 9 – Box girders 15

Figure 10 – Box girders 16

Figure 11 – Tolerances for plate girders stiffners 17

Figure 12 – box girders tolerances 19

Figure 13 – girder nodes 19

Figure 14 – Joint misalignment 20

Figure 15 – Deck node work point 21

Figure 16 – Leg's position 22

Figure 17 – Leg alignment 23

List of tables

Table 1 - Reference Documents 8

Table 2 - Definitions and Abbreviations 8

List of Attachments

Attachment 1

1 INTRODUCTION

1.1 PROJECT OVERVIEW

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

Offshore wind farms produce intermittent electricity and balancing these dips and peaks and integrating this electricity into the national energy system requires new technologies. For this reason, the offshore wind farm will include several new technologies that could be implemented at full-scale in the future. The new technologies being explored include a floating solar park, a short-duration battery storage as well as long-term storage via green hydrogen produced by water electrolysis and subsequently consumed in a fuel cell. The combination of these individual measures, herein referred to as the Base Load Power Hub (BLPH) will ensure a continuous power supply regardless of the wind situation.

1.1.1 Project Location

The Hollandse Kust Noord (HKN) wind farm is located 18.5km off the coast of the Netherlands near the town of Egmond aan Zee.

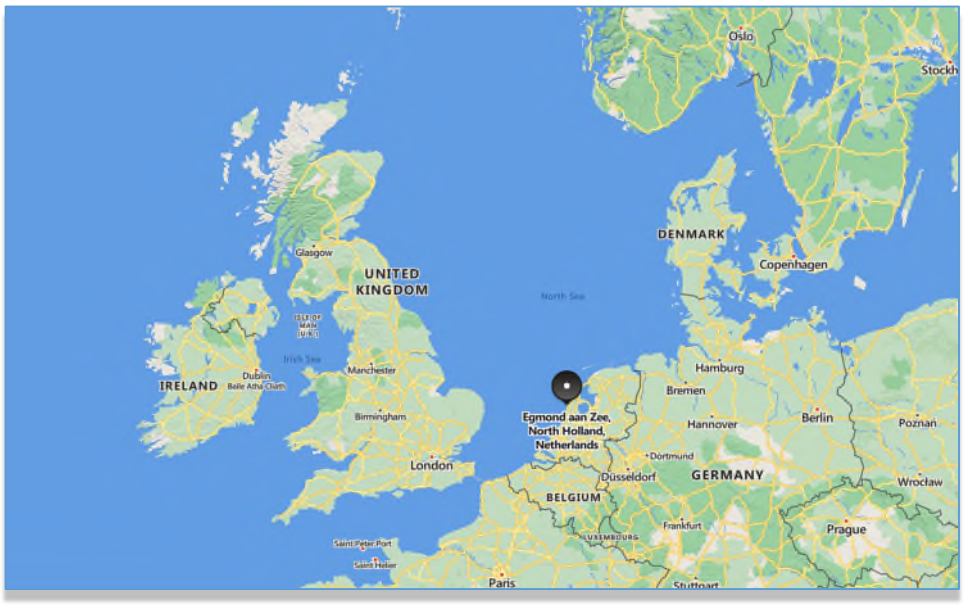


Figure 1 HOLLANDSE KUST NOORD WIND PARK Location Map

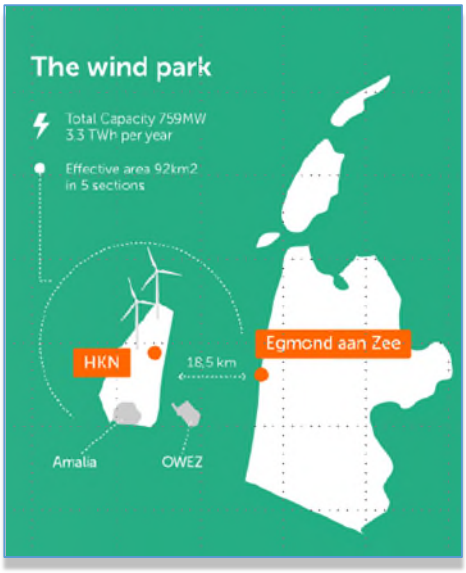


Figure 2 - Wind Park Details

The wind farm will consist of No. 69 x 11.5MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile located on coordinates E 590719.1, N 5841602.3 is reserved for installing the platform accommodating the BLPH. The monopile structure was designed and installed by Van Oord Offshore Wind (VooW) and therefore not part of the BLPH scope.

1.1.2 Project Concept

All components included in the BLPH will be integrated onshore on a topsides and installed in an offshore location within the boundaries of the HKN wind farm. At its simplest, the BLPH will store energy during periods of high electricity generation from renewable sources (a wind turbine generator and the floating solar PV farm) and release it during periods of low generation. In practice. It is expected that the energy stored will supplement generation from renewable sources to ensure that at least 1.0MW of power is exported to the electrical grid regardless of wind/solar availability.

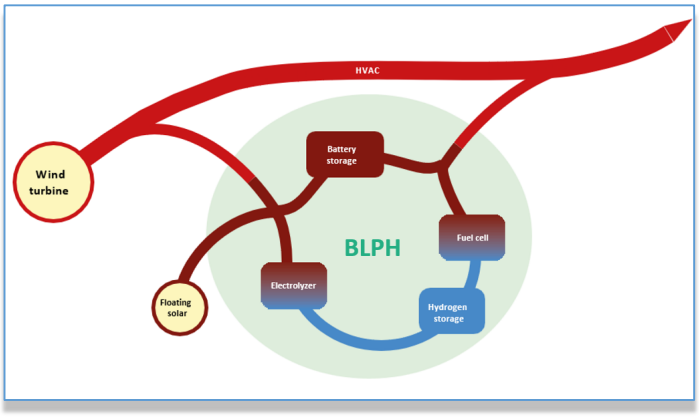


Figure 3 – BLPH Concept

Electricity in the BLPH will be stored in the form of electrons in a battery energy storage system (BESS) as well as converted into green hydrogen via water electrolysis. When the power output from the connecting wind turbine drops to below 1 MWe, the BLPH will return its stored energy to supplement the remaining power output. This will be by

discharging the BESS, while stored hydrogen will be converted back into electricity using a fuel cell to extend the discharge duration.

The purpose of the BLPH s to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have its own independent control room with the ability to communicate with Crosswind's control room.

2 DOCUMENT PURPOSE AND SCOPE

The purpose of this specification is to define the guidelines, tasks and responsibilities of the subcontractor who has been entrusted with the execution activities of the Dimensional Controls applicable to the construction of the STRUCTURES of the project 123A90.

This document shall be applied to structural fabrication and erection activities for Base Load Power Hub (BLPH), including sea fastening and grillage. Disciplines other than structural are covered by dedicated project ITPs.

2.1 REFERENCES

Doc. No.	Description
EEMUA Publication 158 Third Edition	Construction Specification for fixed offshore structures
ISO 19902:2020	Petroleum and natural gas industries – Fixed steel offshore structures

Table 1 - Reference Documents

2.2 DEFINITIONS AND ABBREVIATIONS

COMPANY or Client (CPY):	Crosswind
CONTRACTOR (CTR):	ROSETTI MARINO S.p.A.
PROJECT:	HOLLANDSE KUST NOORD WIND PARK Project
DS	Surveyor
DC	Dimensional Control
PQR	Procedure Qualification Record
QC	Quality Control Dept.
QCI	Quality Control Inspector
SC	Sub-contractor
CM	Construction Manager
ITP	Inspection Test Plan
Production Report	Internal document with evidence of the deviations detected

Table 2 - Definitions and Abbreviations

3 RESPONSIBILITIES

3.1 PROJECT QUALITY MANAGER

The PQM shall assure that:

- the project quality requirements are implemented through all phase of the project;
- project works are properly controlled, inspected, tested and documented.
- The required documentation for certification purpose is submitted to CPY for review and signature on continuous basis;
- fabrication facilities are properly maintained and/or calibrated according to contractors and project quality standards; all personnel holds required competence level and training in compliance with project specifications

3.2 QC INSPECTOR (QCI) / WELDING INSPECTOR (WI)

QCI / WI shall:

- perform the checks and tests as stated in responsibility column of this ITP;
- document the inspections issuing proper inspection reports;
- produce daily welding monitoring reports
- supervise and monitor the activities on site;
- interface with the CPY QA/QC site representative for the management of the inspection;
- notify the inspections to be attended to the CPY QA/QC site representative.
- coordinate all NDE activities;
- mark-up repairs area to be excavated in line with NDE report and control weld repairs (mark-up of areas to be repaired should be managed and independently performed by the NDE operator. Judgement of welds including characteristics of any repair shall be ensured the sole responsibility of the NDE operator).

3.3 DIMENSIONAL CONTROL ENGINEER

The dimensional control engineer shall:

- carry out dimensional check
- issue dimensional reports, including relevant mark-up drawing
- Surveys will be carried out for the following items and steps:
    - Upper grillage subassemblies as-built
    - Upper grillage assembly, positioning and as-built
    - Topside structure subassemblies, as-built
    - Topside structure assemblies (by level), as built
    - Primary nodes at fit-up stage
    - Primary nodes as-built
    - Overall structure, including interfaces, as-built

4 FABRICATION TOLERANCES – DIMENSIONAL CONTROL

4.1 GENERAL

The instruments used shall be in accurate adjustment and shall have current valid calibration certificates.

Tolerances shall be checked at each stage in accordance with the fabrication procedures, and the final survey shall meet the defined tolerances. The final survey shall be on complete sub-assemblies and on the completed structure after PWHT, if applicable, and shall be carried out by the contractor/sub-contractor.

Tolerances shall be based on theoretical setting-out points and centre lines of the structure referenced to permanent approved datum points (e.g. co-ordinated survey stations) and corrected to a temperature of +20°.

All setting out and fit-ups shall be subject to a tolerance measurement. Where local or global tolerances are not detailed in this Specification the item in question shall not deviate from the nominal design size, shape or position by more than ±15mm.

Fabrication and yard assembly supports shall be set to within 5mm of the appropriate position shown on the contractor/sub-contractor purchaser approved setting-out drawings. Where no such drawings exist, fabrication shall be carried out from a level plane to within 5mm.

As soon as field erection of the structure commences, the contractor/subcontractor shall monitor the position of the supports to ensure that they remain within tolerance. This shall be done on a monthly basis and on any other occasion when weld-out of a member will fix one support relative to another. All findings shall be passed to the purchaser. Where there is settlement of supports outside the tolerance given above, this should be immediately reported to the purchaser and remedial action undertaken. Where required to meet the tolerances of this Specification, e.g. for stab-in nodes (Section 6.3.1), such settlement shall be corrected by shimming and therefore fabrication and yard assembly supports shall be designed to allow such adjustment.

The required tolerances shall apply at all stages of fabrication and assembly.

The contractor shall ensure that components fabricated by sub-contractors meet, where applicable, all tolerances specified in this Specification.

Allowance shall be made for weld gap tolerances and weld shrinkage in all components, sub-assembly and global tolerance calculations.

4.2 LOCAL TOLERANCES FOR STRUCTURAL COMPONENTS AND SUB-ASSEMBLIES (EEMUA158)

4.2.1 Fabricated tubulars and cones

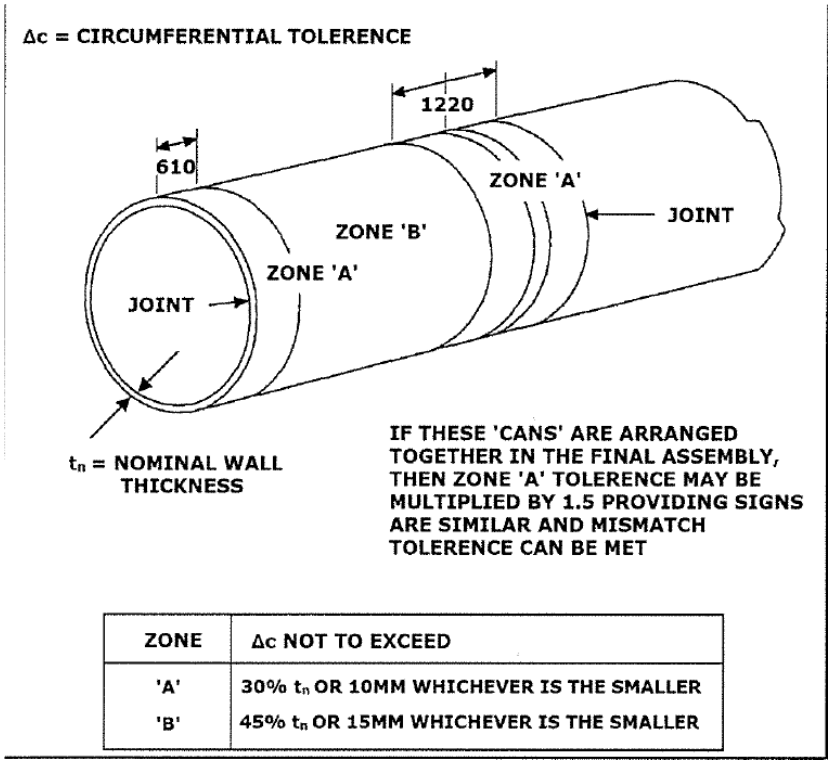
4.2.1.1 Circumference

The external circumference shall not differ from the nominal external circumference by more than the following limits:

(a) In Zone A (at joints or within 610mm from the joint), 30% of the nominal wall thickness or 10mm whichever is the smaller;

(b) In Zone B (the remaining length of the tubular), the tolerances in (a) may be multiplied by 1.5 (i.e. to 45%);

(c) Where it can be demonstrated to the satisfaction of the purchaser that particular tubulars will be butt welded together in the completed assembly, then the Zone A tolerance in (a) above may be multiplied by 1.5 provided the individual tolerances are of the same sign (i.e. both positive or both negative).



ZONE	Δc NOT TO EXCEED
'A'	30% t_n OR 10MM WHICHEVER IS THE SMALLER
'B'	45% t_n OR 15MM WHICHEVER IS THE SMALLER

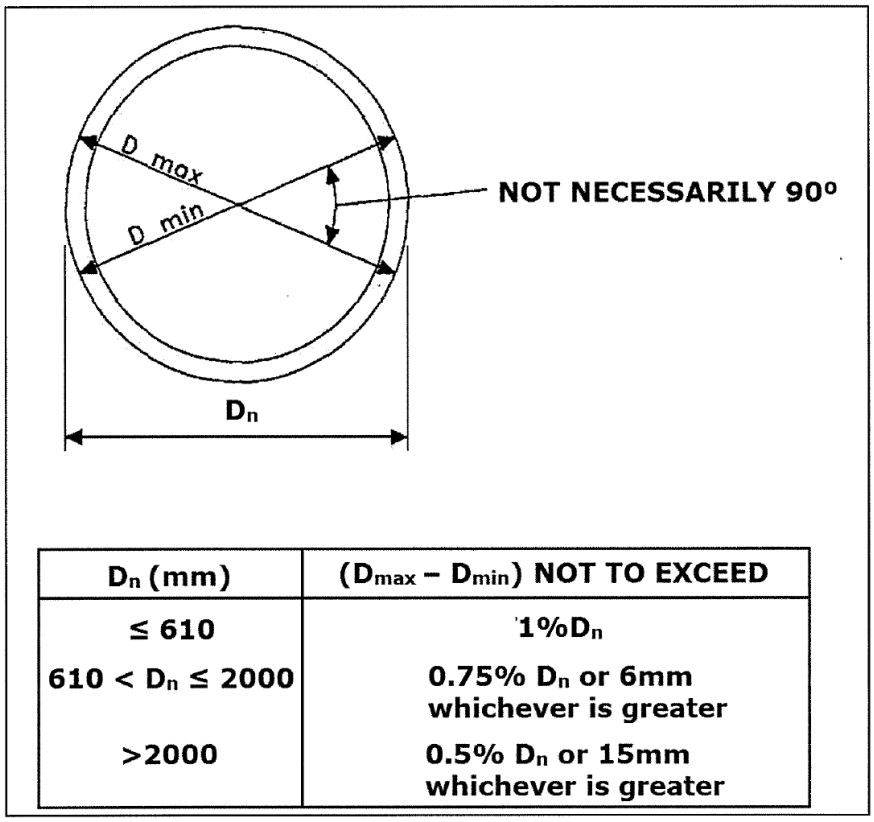
Figure 4 - Circunferential Tollerance

4.2.1.2 Ovality

Ovality of tubulars is defined as the difference between the measured maximum and minimum external (or internal) diameters:

Table 6 Allowable ovality

Nom. Dia. (mm)	Allowable ovality
≤ 610	1% of nominal diameter
>610≤2000	greater of 6mm or 0·75% of nom. dia.
>2000	greater of 15mm or 0·5% of nom. dia.



D_n (mm)	(D_{max} – D_{min}) NOT TO EXCEED
≤ 610	1%D_n
610 < D_n ≤ 2000	0.75% D_n or 6mm whichever is greater
>2000	0.5% D_n or 15mm whichever is greater

Figure 5 - Ovality

4.2.1.3 Out-of-roundness

Out-of-roundness is defined as the difference between the actual form and the ideal circular form of the section. This check is required to locate unacceptable flat or high spots.

Out-of-roundness shall not exceed 0·2% of the nominal external diameter or 25% of the nominal wall thickness, whichever is the smaller. This tolerance shall be checked on the inside or outside of tubulars subject to local buckling with a nominal external diameter greater than 2000mm or with a nominal external

diameter to nominal wall thickness ratio greater than 65.

These checks shall be carried out over a 360° sweep of the circumference at equal intervals of 20°.

4.2.1.4 Local straightness

Local straightness is defined as the deviation of the shell plate from a straight generator of length 'L' parallel to the true centre line of the tubular. This tolerance shall not exceed 20% of the wall thickness. Local straightness shall be checked on the inside or outside of tubulars subject to local buckling with a nominal external diameter greater than 2000mm or with a nominal external diameter to nominal wall thickness ratio greater than 65. These checks shall be carried out at the following locations:

Unstiffened tubular	: at 45º intervals of arc with L = 3000mm
Stiffened tubular	: at 20º intervals of arc with L = distance between stiffeners
At manways after welding	: at the centre and quarter points with L = 1000mm and with the straight generator centre on the transverse centre line of the manway
Node barrels	: at 20º intervals of arc with L = 1000mm

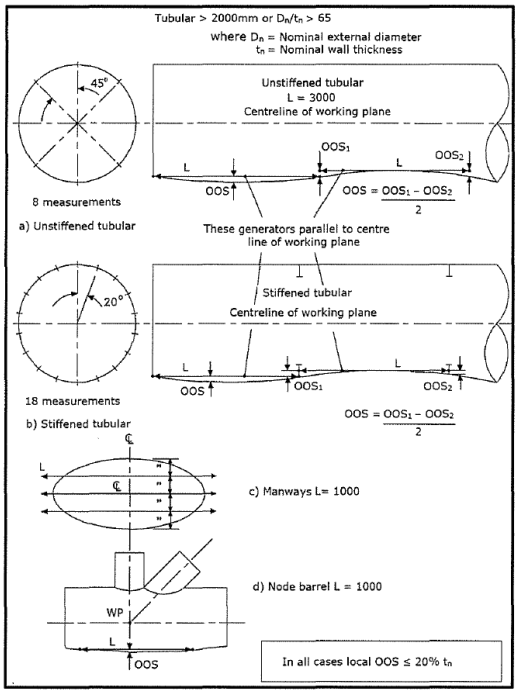


Figure 21 Local straightness tolerance for tubulars

Figure 6 – Local Straightness

The inspection will be conducted comprehensively, covering 100% of the items.

4.2.1.5 End perpendicularity

The ends of tubulars and cones shall be cut perpendicular to the longitudinal axis within the following tolerances:

• tubulars of nominal external diameter ≤ 2000 mm : 3 mm

• tubulars of nominal external diameter > 2000mm : 5 mm

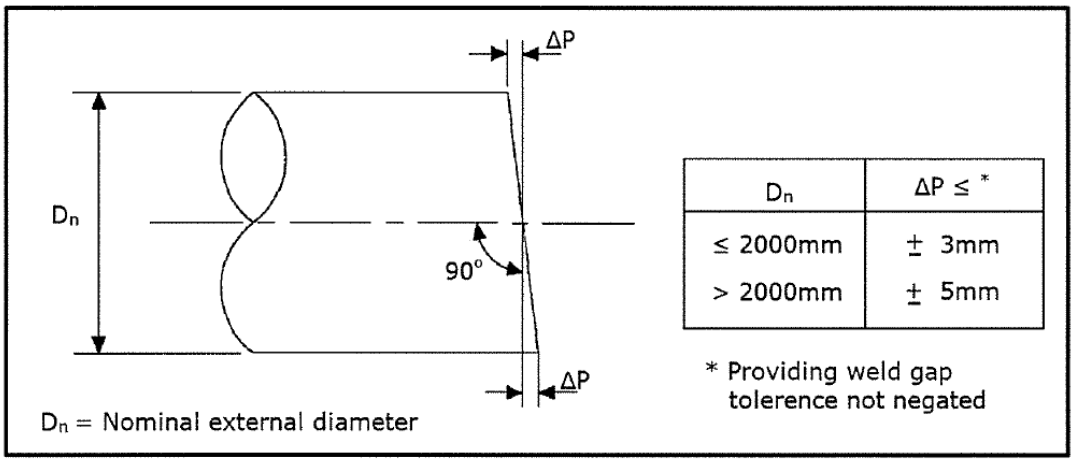


Figure 7 – End Perpandicularity

4.2.2 Rectangular plated sections

4.2.2.1 Plate girders

Table 10 Tolerances for plate girders

	Tolerance	Limiting value (mm)
Web depth	±0·12t	±5
Inclination of web and bow of web (Δw)	±0·008h	±10
Flange width	-	±3
Rotation of flange and bow of flange (Δf) (excluding skid beams)	±0·0125b	±10
Eccentricity of flange on web (Δe)	±0·015b	±5
End perpendicularity (Δp)	-	±3
Out-of-straightness (Δs): normal to web (sweep) and normal to flange (camber)	+0·001L, -0	+15, -0

Tolerances for plate girders shall comply with the following requirements:

Figure 8 – Tolerances for plate girders

The inspection will be conducted comprehensively, covering 100% of the items.

4.2.2.2 Box girders

Tolerances for box girders and box girder stiffeners shall comply with the following requirements:

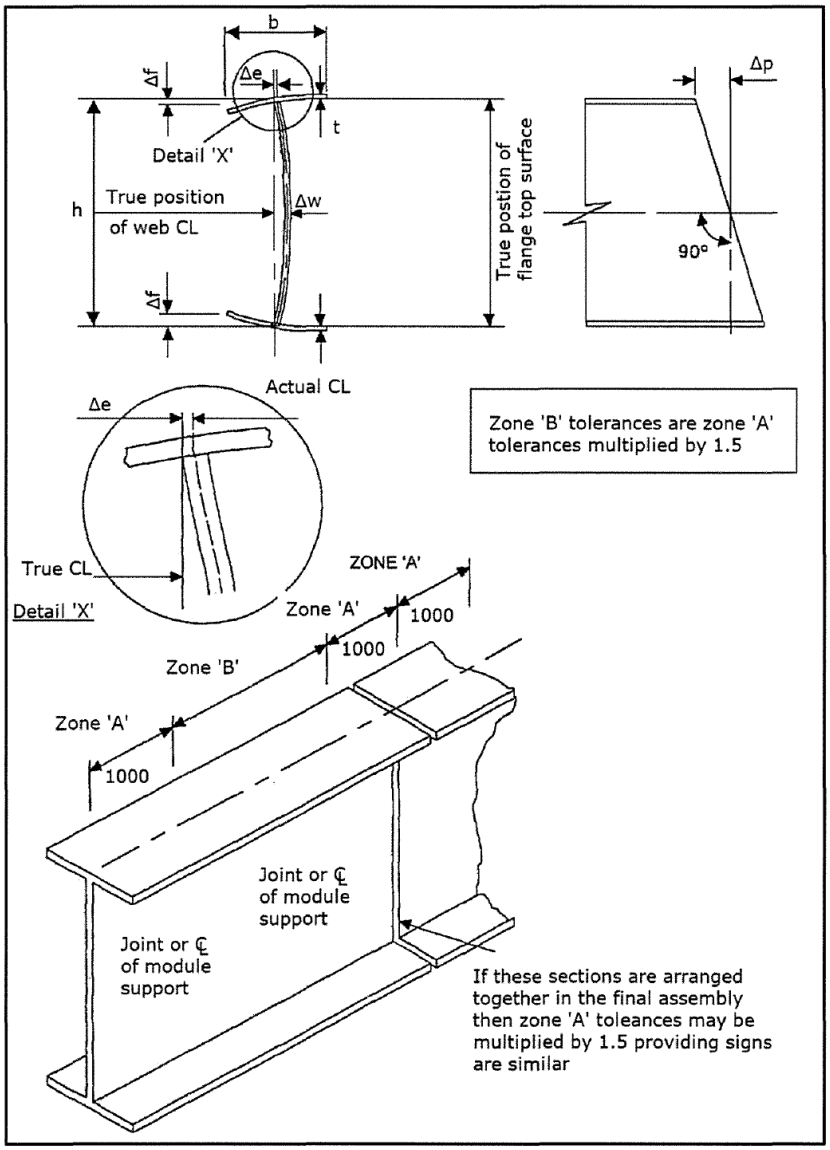


Figure 9 – Box girders

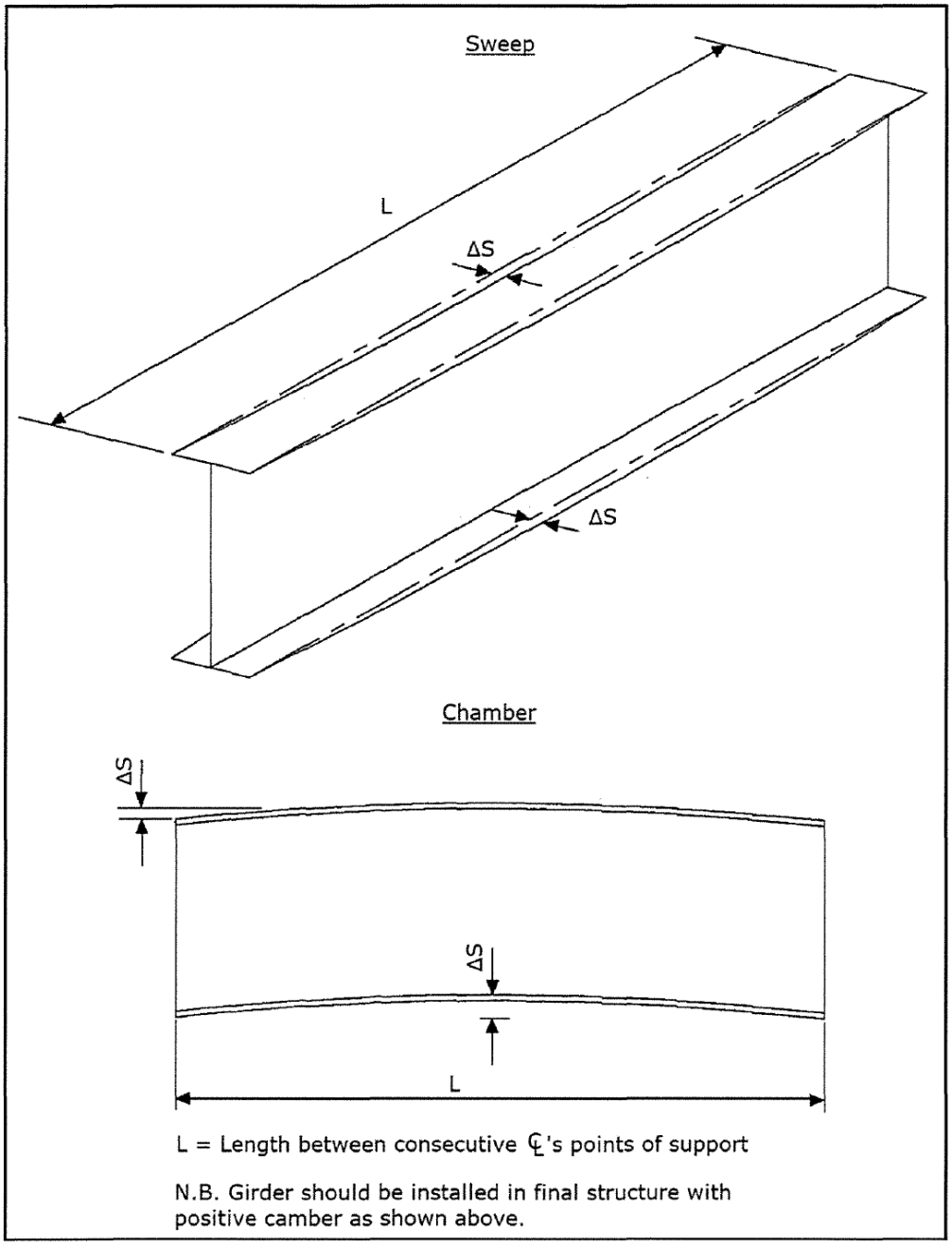


Figure 10 – Box girders

Table 11 Tolerances for plate girder stiffeners

	Tolerance	Limiting value (mm)
Positional deviation (Δp)	-	±5
Angular deviation and inclination (Δa)	±0·005h	±5
Out of straightness normal to girder web plane and normal to stiffener plane (Δs)	-	±5

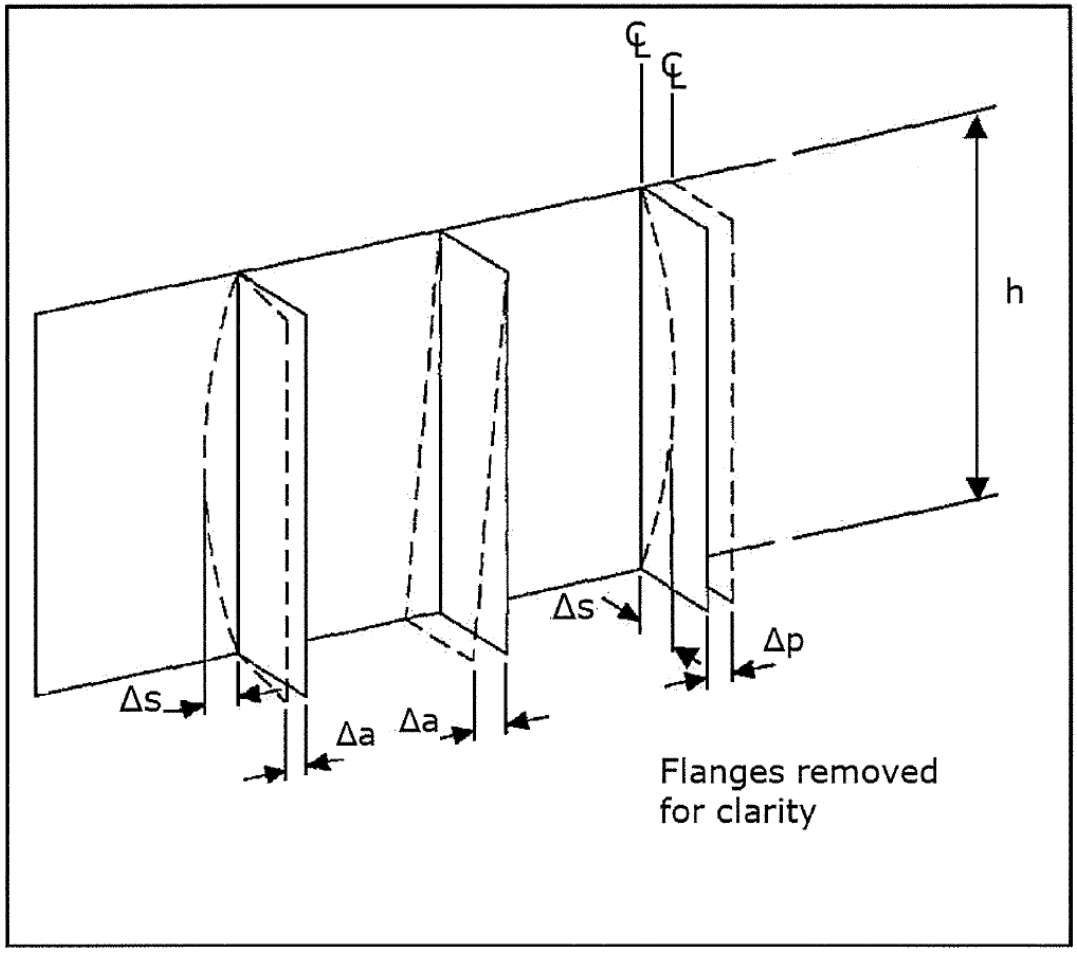


Figure 11 – Tolerances for plate girders stiffners

Table 12 Box girder tolerances

	Tolerance	Limiting value (mm)
Diagonal	±0·005g	±7
Twist offset between opposite ends	±0·008h	±10

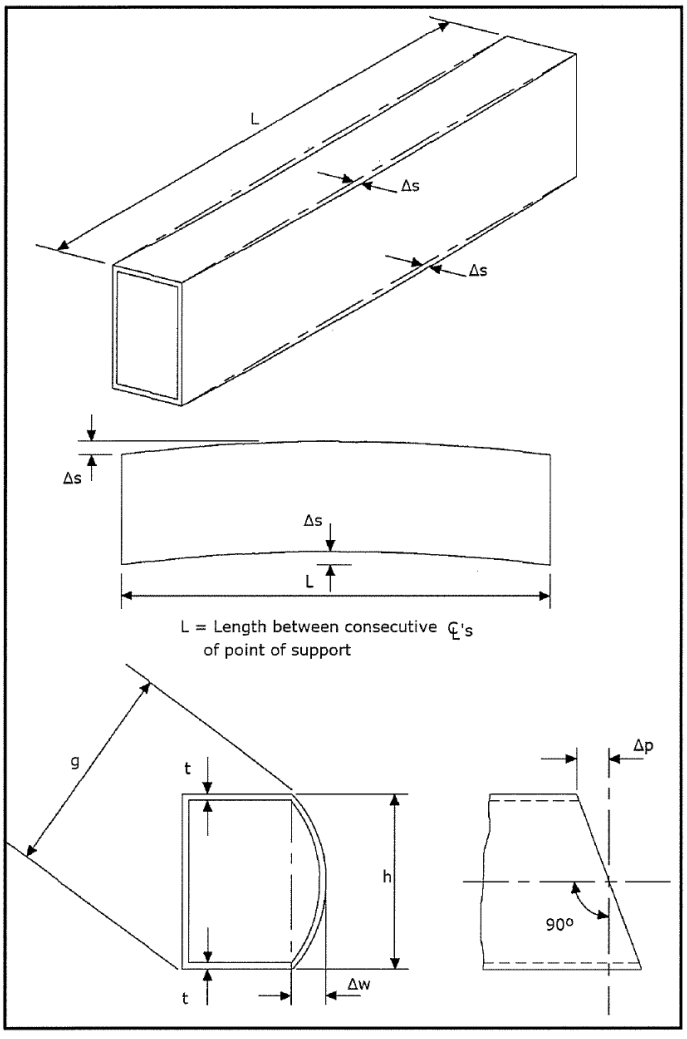


Figure 12 – box girders tolerances

4.2.2.3 Girder nodes

The length of a girder node measured from the central work point to either end shall be within 0 to +10mm of the length as specified in the purchaser approved drawings.

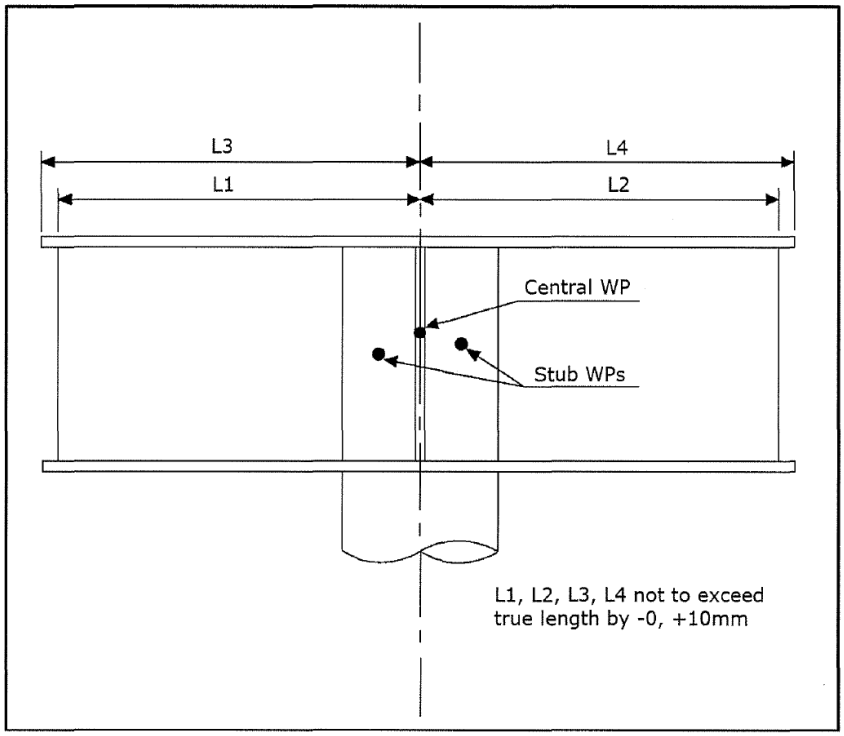


Figure 13 – girder nodes

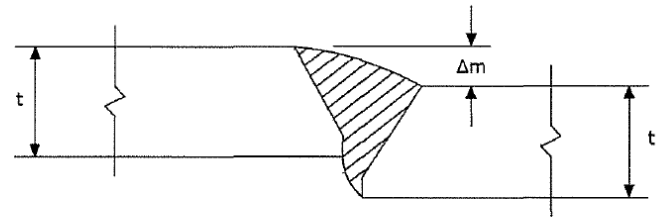
4.2.2.4 Cruciform joints

Where plates carrying in-plane loads are arranged to form a cruciform joint, the misalignment shall not exceed 0·5t, where t is the thickness of the thinnest noncontinuous member or 10mm, whichever is smaller.

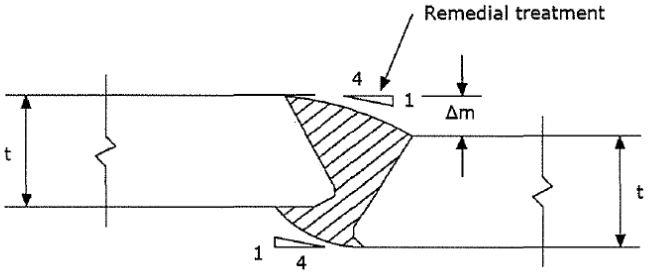
4.2.2.5 Joint misalignment

Joint misalignment in fabricated tubulars and rectangular beams shall be in accordance with fit-up dimensions applicable to the qualified welding procedures.

All misalignments greater than 2mm or 10% of the wall thickness, whichever is larger, in double-sided butt welds shall be built up with weld deposit to give a cross joint taper of 1 : 4.



A. Single sided butt



B. Double sided butt

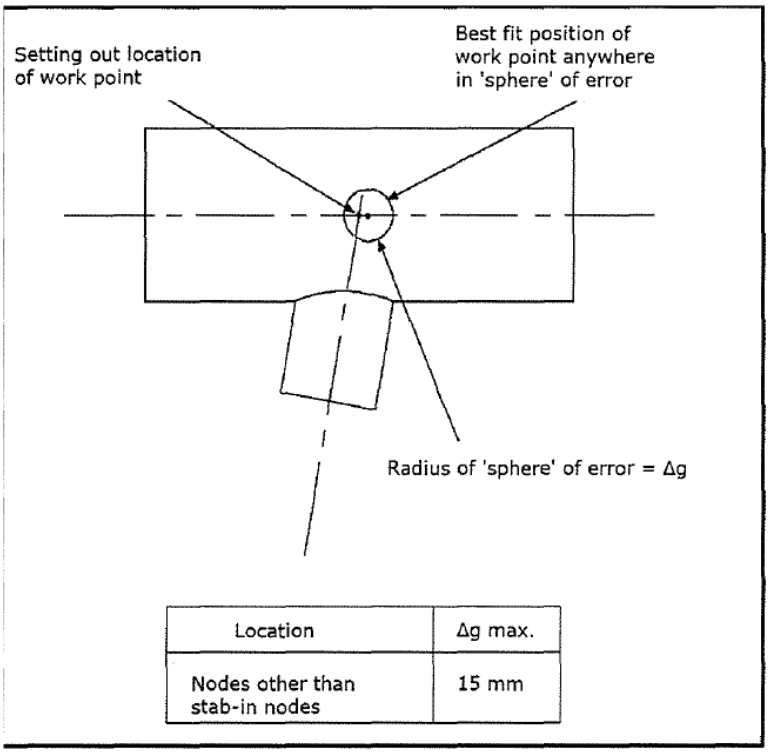
Types of section	Δm
Circular and longitudunal seams	Double sided welds: 10% t (but not > 6mm) Single sided welds: 10% t (but not > 3mm)
Rectangular (except skid beams) all thicknesses	12% t (but not > 5mm)

Figure 14 – Joint misalignment

4.3 GLOBAL TOLERANCES FOR THE COMPLETED STRUCTURE (EEMUA 158 – ISO19902)

4.3.1 Deck node work points

The best fit position of the achieved work point of deck node shall be within the tolerance given below in relation to the setting-out location of the work point as derived from the geometry of the structure shown in the purchaser approved drawings



Location	Δg max.
Nodes other than stab-in nodes	15 mm

Figure 15 – Deck node work point

In any plane critical to field assembly, such as the bottom of the deck legs, the horizontal distance from the best fit centre line of any leg to the best fit centre line of the leg adjacent in any direction shall be within a tolerance of 10 mm of the net drawing dimension.

The mating surfaces for stab-in nodes shall be within 3 mm of the best fit level plane between all mating legs providing the gap between the two mating surfaces is not more than 6 mm at any point .

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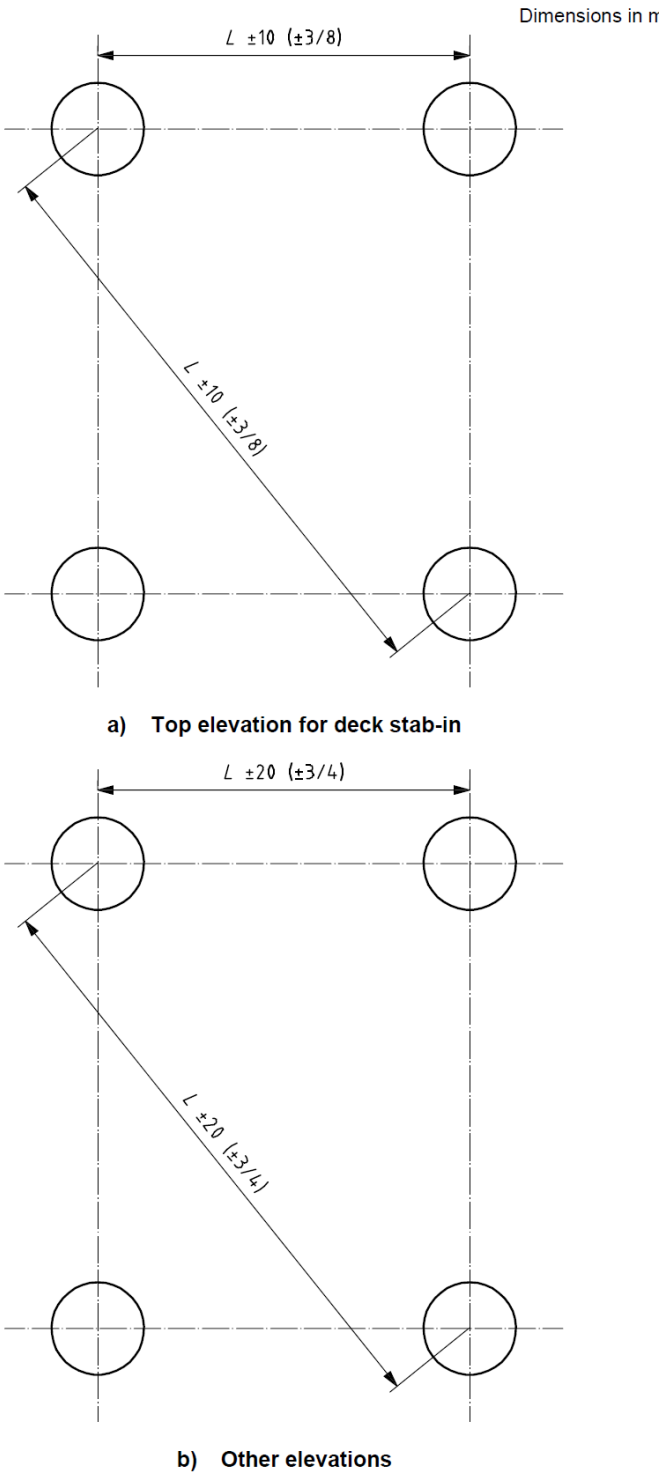


Figure 16 – Leg's position

4.3.2 Global vertical tolerances

The global tolerances for vertical levels of plan are detailed as follows:

b) the vertical level of braces within a horizontal plane shall be within 13 mm (1/2 in) of the design values;

c) the vertical distance between plan elevations shall be within 13 mm (1/2 in) of the design values**.**

4.3.3 Leg alignment and straightness tolerances

In addition to the tolerances for individual members, the tolerances for the alignment and straightness of legs shall be as shown in Figure G.7 and as follows:

– at each plan bracing level the legs shall be aligned horizontally within 10 mm (3/8 in) of the design location;

– each leg shall be straight to within 10 mm (3/8 in) over the entire length (see Figure G.2).

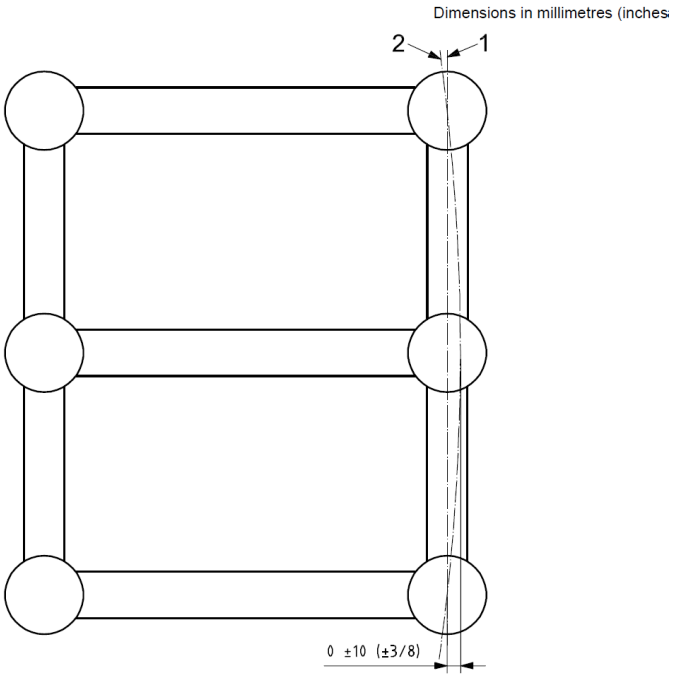


Figure 17 – Leg alignment

4.3.4 Padeyes, padears and lifting trunnions

The actual work points of padeyes, padears and lifting trunnions shall be located within a 15mm radius sphere of error and 0.5° of the final orientation marked in the purchaser approved drawings.

Where applicable, a trial fit-up to ensure correct tolerances shall be carried out prior to fixing.

4.3.5 Miscellaneous structural steelwork tolerances

4.3.5.1 Handrails

Handrails shall be erected so that the top rail is straight to within 5mm in any 3m length measured in either the vertical or horizontal planes. Stanchions and fencing shall be plumb to within 5mm.

4.3.5.2 Deck plating, walkways, stairways and landings

Deck plating, walkways, stairways and landings shall be positioned in accordance with the tolerances given below in relation to the theoretical position specified in the purchaser approved drawings:

- Best fit plane of an assembly within 12mm of its true elevation;
- Out-of-straightness normal to plate within 6mm in any 3m length; and
- Plan position within 12mm.

Plating or grating at joints shall be flat without visible warping. Mismatches greater than 2mm at deck plate and grating joints shall be ground out and recoated. Joints shall only occur at points of support. The vertical distance between stair treads shall not vary by more than 3mm.

4.3.5.3 Openings/penetrations

The centre point of any opening or penetration shall be within 10mm of the theoretical centre point. The true size of any opening shall be within 5mm of the theoretical dimension.

5 REPORTS

5.1 PRODUCTION REPORTS

These reports relate specifically to the construction phases of the project work.

Dimensional Control structural surveys will be undertaken at various stages of construction.

These stages will be as follows:

a) Fit-up with elements tack welded at assembly stage.

b) Post weld after final welding of all elements.

c) Post heat stress relief. (If applicable)

IMPORTANT NOTE: A component FIT-UP survey may prove that an items' position is outside the required dimensional tolerance. However, this situation may be acceptable as the effect of the welding process and the structural shrinkage will move the item to within the required dimensional tolerances.

A Production Survey Report sheet(s) will show in plan view a drawing of the component. Data results and other information shown on the reports will be as follows:

a) Actual dimensions.

b) Theoretical dimensions

c) The difference between the actual and theoretical dimensions in millimetres and indicated as a positive or negative value.

d) Structural Reference Points usually zeroed.

e) Work point vector arrows indicating the actual structural position of the item surveyed from its theoretical location with values in millimetres.
f) Grid or Row identification numbers.
g) Structural elevation references.
h) Welded or Fit-up positions stated.
i) Structural positions, out-of-tolerance, to be highlighted.
j) An indication of Conformity (OK) or Non-conformity (X) to the structural tolerances

The Non-Conformity Reports will be registered in a separate File.
The structural components will be checked at each stage of fabrication in accordance with the requirements of the Company's specification and this procedure.
All positional dimensional tolerances listed relate specifically to the components position after the welding process (Post Weld).
A referenced numbered Cover Report sheet will be attached to the survey report and will indicate the following details:

a) Project name and reference number
b) Date of survey
c) Report number
d) Surveyors name and signature
e) Item identification number
f) Drawing number reference

g) Applicable Procedure reference number
h) Construction phase
i) Number of Sheets
j) Measuring equipment used
k) Comments
l) Conforming or Not confirming

5.2 CERTIFICATION REPORTS

Final structural As Built certificates will be issued after the termination of welding and the removal of any structural restraints.
These certificates will be based on a final survey of the structure while it is still being supported in the horizontal position on its saddle supports and prior the Load-out onto the Transportation Barge.
The As Built certificates will show the positions for the following structural items:

a) Interface work point positions of the jacket legs at the connection elevation with the Deck structure
b) The main leg work point positions at each main elevation
c) The structural reference points will be ZEROED and all succeeding surveys shall be based on the same zeroed references
d) Primary nodes of deck
e) Sub-assembly of deck plan
f) Individual floors before lifting: lower, mezzanine, upper
g) The floors after lifting, such as lower + mezzanine
h) Pedestal crane
i) Final deck
j) All other surveyed locations shall be based on these ZEROED reference points
k) The structural work point positions at each intersection for each ROW

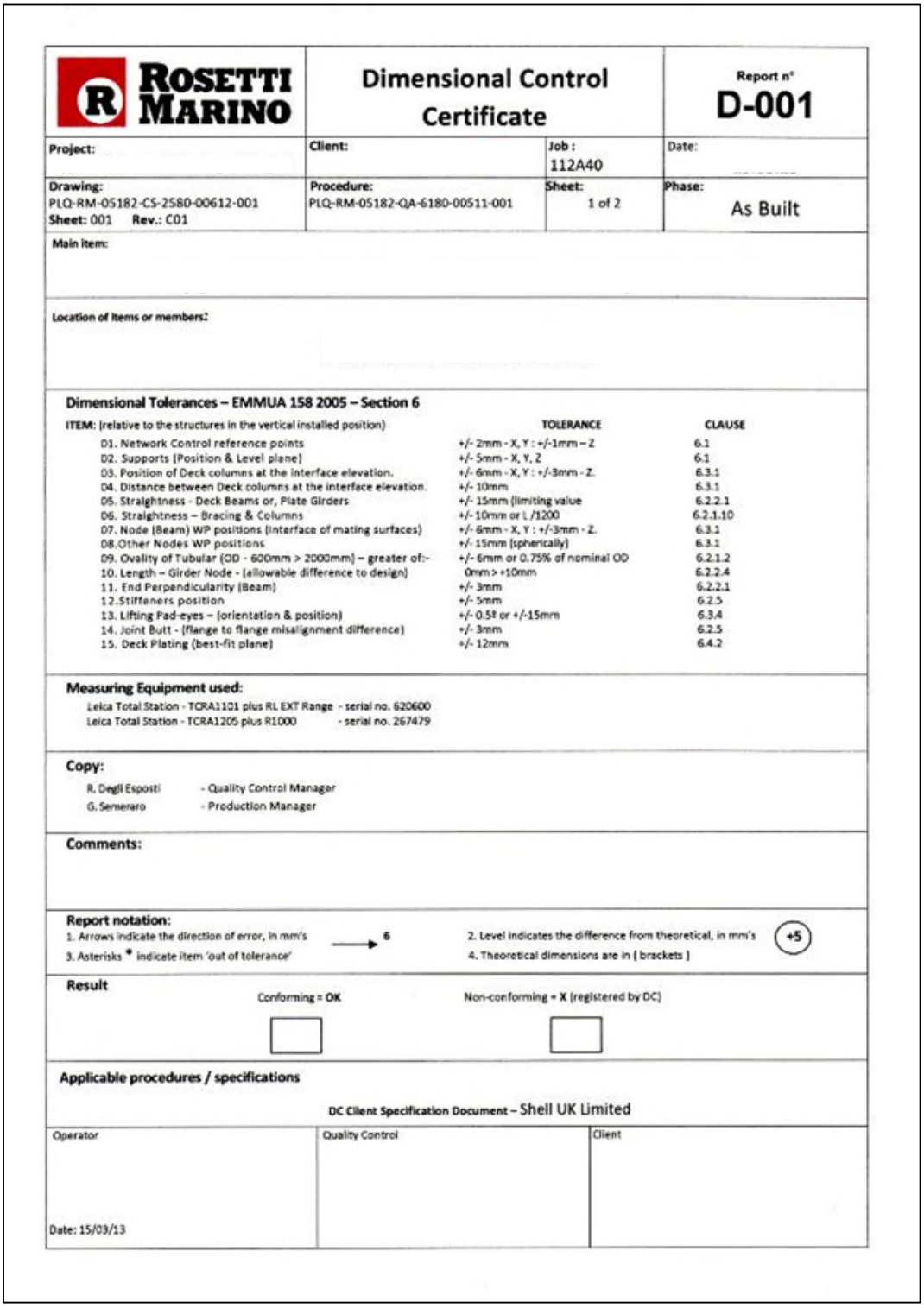
The certificates will show the structural Work Point positions by means of:

a) A vector arrow indicating the directional error from its required theoretical position
b) The measured displacement from its theoretical position in millimeters with any out-of- tolerance conditions highlighted
c) An elevation position indicating the elevation difference in millimetres from the theoretical elevation.

An NCR (Non-Conformance Report) is issued to record instances of non-compliance with the established acceptance criteria. The resolution proposed for the NCR, which will be submitted to the client (CPY) for approval, outlines the remedial actions for the problem, tailored according to its severity.

Dimensional Control Certificate Cover Sheet

Example:



ROSETTI MARINO

Dimensional Control Certificate

Report n° **D-001**

Project:	Client:	Job : 112A40	Date:
Drawing: PLQ-RM-05182-CS-2580-00612-001 Sheet: 001 Rev.: C01	Procedure: PLQ-RM-05182-QA-6180-00511-001	Sheet: 1 of 2	Phase: As Built

Main item:

Location of items or members:

Dimensional Tolerances – EMMUA 158 2005 – Section 6

ITEM: (relative to the structures in the vertical installed position)	TOLERANCE	CLAUSE
D1. Network Control reference points	+/- 2mm - X, Y : +/-1mm – Z	6.1
D2. Supports (Position & Level plane)	+/- 5mm - X, Y, Z	6.1
D3. Position of Deck columns at the interface elevation.	+/- 6mm - X, Y : +/-3mm - Z.	6.3.1
D4. Distance between Deck columns at the interface elevation.	+/- 10mm	6.3.1
D5. Straightness - Deck Beams or, Plate Girders	+/- 15mm (limiting value	6.2.2.1
D6. Straightness – Bracing & Columns	+/- 10mm or L /1200	6.2.1.10
D7. Node (Beam) WP positions (interface of mating surfaces)	+/- 6mm - X, Y : +/-3mm - Z.	6.3.1
D8.Other Nodes WP positions	+/- 15mm (spherically)	6.3.1
D9. Ovality of Tubular (OD - 600mm > 2000mm) – greater of:-	+/- 6mm or 0.75% of nominal OD	6.2.1.2
D10. Length – Girder Node - (allowable difference to design)	0mm > +10mm	6.2.2.4
D11. End Perpendicularity (Beam)	+/- 3mm	6.2.2.1
D12.Stiffeners position	+/- 5mm	6.2.5
D13. Lifting Pad-eyes – (orientation & position)	+/- 0.5° or +/-15mm	6.3.4
D14. Joint Butt - (flange to flange misalignment difference)	+/- 3mm	6.2.5
D15. Deck Plating (best-fit plane)	+/- 12mm	6.4.2

Measuring Equipment used:

Leica Total Station - TCRA1101 plus RL EXT Range - serial no. 620600
Leica Total Station - TCRA1205 plus R1000 - serial no. 267479

Copy:

R. Degli Esposti - Quality Control Manager
G. Semeraro - Production Manager

Comments:

Report notation:

1. Arrows indicate the direction of error, in mm's → 6
2. Level indicates the difference from theoretical, in mm's (+5)
3. Asterisks * indicate item 'out of tolerance'
4. Theoretical dimensions are in (brackets)

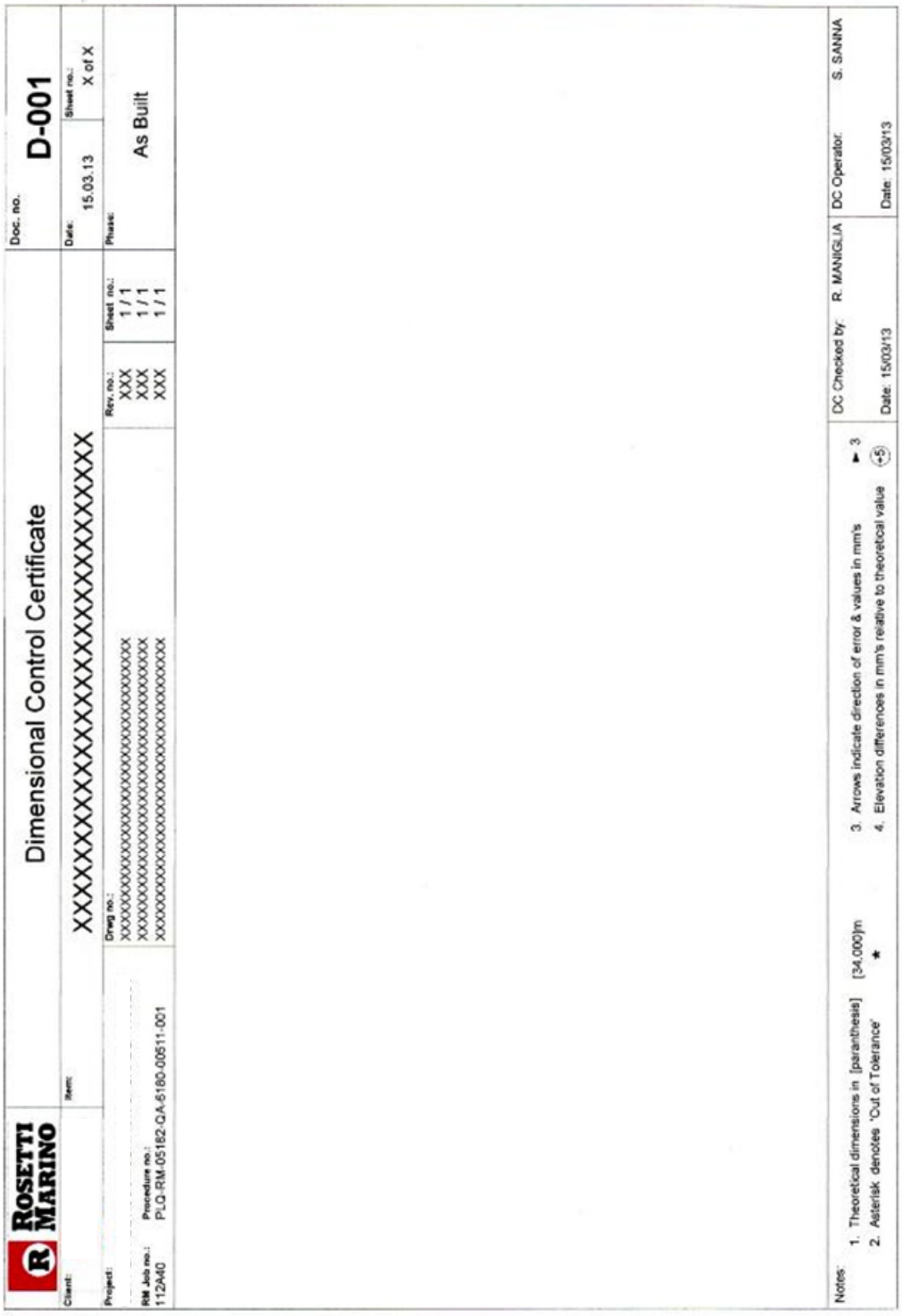
Result

Conforming = OK ☐ Non-conforming = X (registered by DC) ☐

Applicable procedures / specifications

DC Client Specification Document – Shell UK Limited

Operator	Quality Control	Client
Date: 15/03/13		


ROSETTI MARINO
Dimensional Control Certificate
Doc. no.
D-001
Client:
Item:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Date:
15.03.13
Sheet no.:
X of X
Project:
Drwg no.:
Rev. no.:
Sheet no.:
Phase:
As Built
RM Job no.:
112A40
Procedure no.:
PLQ-RM-05162-QA-6180-00511-001
Notes:
1. Theoretical dimensions in [parenthesis] [34.000]m
2. Asterisk denotes 'Out of Tolerance' *
3. Arrows indicate direction of error & values in mm's
4. Elevation differences in mm's relative to theoretical value
DC Checked by: R. MANIGLIA
Date: 15/03/13
DC Operator: S. SANNA
Date: 15/03/13

6 SAFETY

All project work must be carried out responsibly and within the HSE safety guidelines and regulations in force on the construction sites allocated for this project.
All personnel will undertake a 'Safety Induction Course' that will explain in detail the safety regulations and codes that are applicable and enforced within the confines of the construction yard.
All personnel will wear the following safety attire and equipment while working on site:

a) Work Overall (long sleeved)
b) Safety boots (steel toe capped)
c) Safety glasses
d) Safety helmet
e) Ear protectors

Dimensional Control personnel shall ensure that all daily measurement activities are carried out in full respect of the safety rules, without risking their own or other people's safety.
If there is a concern relating to safety then contact should be made immediately with the following personnel:

- HSE site management team or safety officer.
- Your company HSE representative or senior manager
- Project Construction Manager