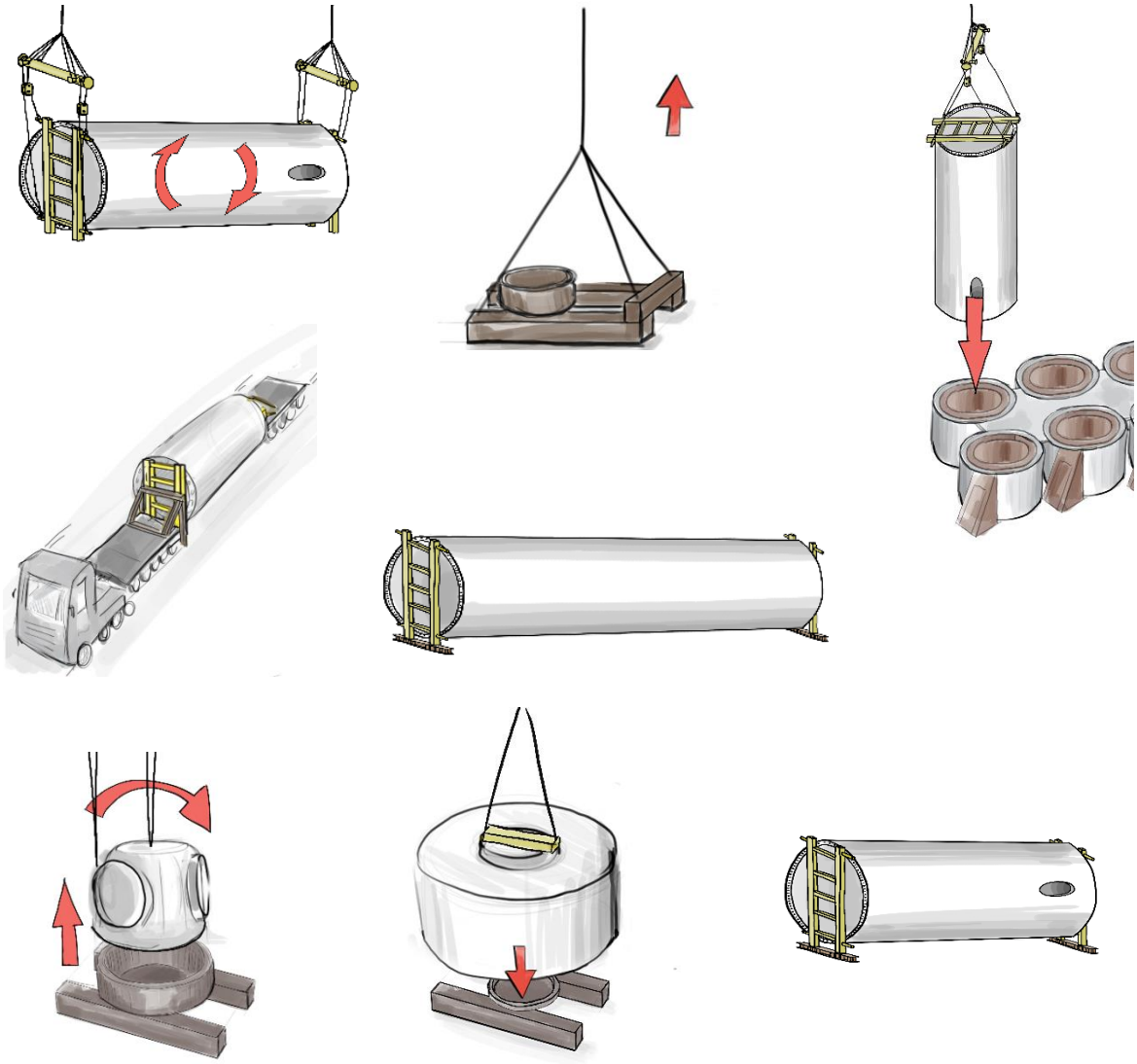
RECOMMENDED PRACTICE

OE–RP– 01

EDITION MARCH 2018

DESIGN OF LIFTING, TRANSPORT, STORAGE AND ACCESSORY EQUIPMENT



CHANGES – CURRENT

1.1 GENERAL

This is a new document

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1. INTRODUCTION, PURPOSE AND BACKGROUND

This is a recommended practice for design of lifting, transport, storage and handling equipment, the proposal is based on the references in each chapter. The recommended practice of this guidelines is the LRFD method.

The purpose of this document is to recommend one practice for the offshore wind industry regarding the design of lifting, transport, storage and handling equipment. This will reduce waste in the design process because of reduced need for clarification, in the designs themselves because they are only designed for what is necessary and as a result also in the manufacturing cost. In addition aligned industry guidelines is an important step towards enabling new designs that can be used regardless of who have manufactured the wind turbine generator components. The target group for the documents is buyers, designers and fabricators of the given types of equipment. The recommended practice does not aim to provide a full description of how to design, but to ensure that the right point of departure is chosen when making a given design.

1.2 BACKGROUND

The need for this recommended practice was discussed and confirmed at a workshop in December 2016, following this it was included as a project in the wind partnership originally formed by Siemens Wind Power, MHI Vestas Offshore Wind and Vestas Wind Systems, on Offshoreenergy.dk' s initiative.

During 2016 a project group consisting of DIS, LICengineering, MHI Vestas Offshore Wind, R&D, Semco Maritime and Siemens Gamesa Renewable Energy made this recommended practice based on their own accumulated knowledge of the field.

The process was facilitated by Offshoreenergy.dk and Service Platform, represented by Force Technology. The project was funded by the Danish Agency for Science and Higher Education as part of the SPIR funding scheme.

2 REFERENCES

[1] *DNVGL-ST-N001 Marine operations and marine warranty,* June 2016, Ammended November 2016.

[2] DNVGL-ST-0378 Standard for offshore and platform lifting May 2016.

[3] *EN 1993-1-1 Eurocode 3, Design of steel structures – General Rules and Rules for buildings,* July 2007 / AC2009.

[4] VDI 2230 blatt 1 and 2, 2015-11/2014-12.

[5] *DNVGL-OS-C101. Design of offshore Steel Structures, General, LRFD method,* July 2017.

[6] EN 1993-1-8 Eurocode 3: Design of steel structures - Part 1-8: Design of joints, AC2007.

[7] EN 1090, Execution of steel structures and aluminium structures, 2012+A1.

[8] DNVGL-OS-C401 Fabrication and testing of offshore structures, Jan 2018.

[9] *EN 13155+A2 Cranes - Safety - Non fixed load lifting attachments,* April 2009.

[10] Machinery Directive, 2006-42-EC.

[11] EN 1993-1-10+AC, *Eurocode 3: Design of steel structures - Part 1-10: Material toughness and through-thickness properties,* AC2009.

[12] EN 12195-1 Load restraining on road vehicle - safety - part 1 calculation fo securing forces, AC2014.

[13] *DNVGL-OS-C104 - Offshore standard, Structural design of self-elevating units - LRFD method,* July 2017.

[14] *DNVGL-RP-C203 Fatigue design of offshore steel structures,* April 2016.

[15] IMO CSS (lashing for sea transportation), 2011.

[16] EN 1990, Eurocode 0: Basis of structural design + Associated National Annexes, April 2007.

[17] EN 1991-1-4, Eurocode 1: Actions on structures – Part 1-4: General actions – Wind actions, DK NA 2010.

[18] EN 1992-1-1, Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings, DK NA 2017.

[19] EN 1995-1-1, Eurocode 5: Design of timber structures – Part 1-1: General – Common rules and rules for buildings, DK NA 2014.

[20] EN 1999-1-1, Eurocode 9: Design of aluminium structures – Part 1-1: General structural rules, DK NA 2013.

[21] EN 10025-1 Hot rolled products of structural steels - part 1: General technical delivery conditions, 2004, 2. edition.

[22] *DNVGL-RU-SHIP Part 3 Chapter 4 Loads,* Januar 2018.

[23] *DNV Classification notes No.30.7 Fatigue assesment of ship structures,* 2014.

[24] *ISO 19901-5:2016 Petroleum and natural gas industries " Specific requirements for offshore structures. Part 5: Weigth control during engineering and construction.*

[25] EN 1991-1-3, Eurocode 1 – Actions on structures – Part 1-3: General actions – Snow loads, July 2003.

[26] *AISC 360-10. Especification for structural steel buildings,* Juli 2016.

[27] DNV-RP-C205 Enviromental conditions and enviromental loads, August 2017.

[28] *DNVGL-RU-SHIP Part 3 Chapter 1,* January 2018.

3 DEFINITIONS, TERMINOLOGY AND ABBREVIATIONS

3.1 COMPONENTS AND EQUIPMENT

The relevant components for the design of transport, accessory and lifting equipment are shown on the figures below.

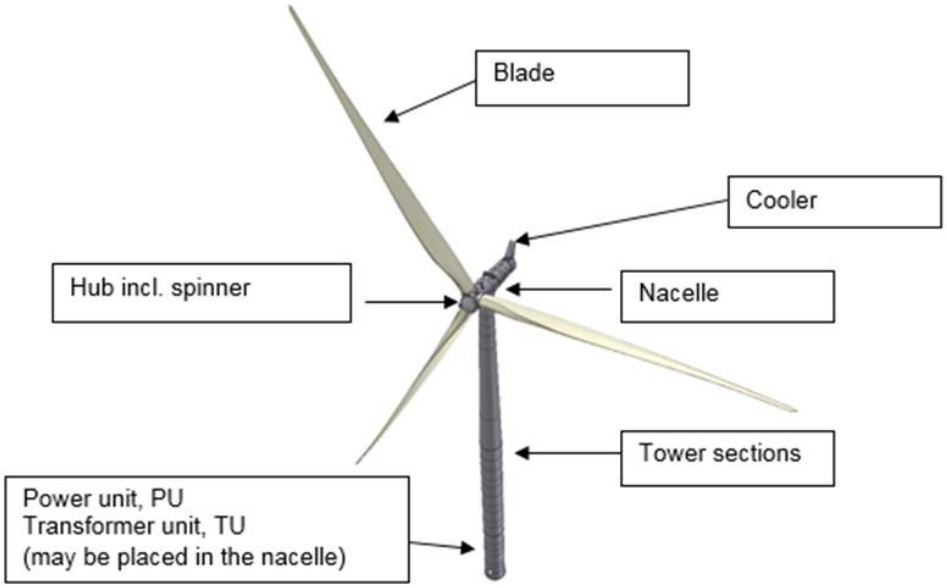


Figure 3-1 An example of the main components (modules) of a wind turbine

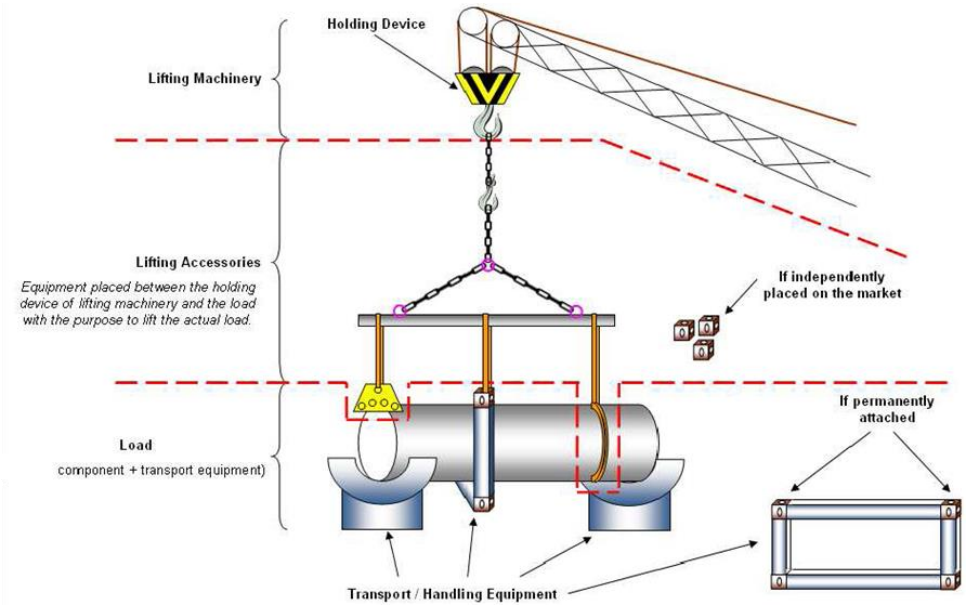


Figure 3-2 Different types of equipment

3.2 VERBAL FORMS

Regarding the definition of “must”, “shall”, “should” and/or “could”:

Term	*Definition*
Must/shall	verbal form used when describing mandatory requirements
Should or could	Verbal form used to denote optional or recommended requirements that may be replaced by equivalent or better/higher requirements.

Table 3-1 Verbal forms

3.3 TERMS

Term	*Definition*
Customer	The company, organization or department that orders the equipment
Equipment supplier	The company, organization or department that act as a supplier of the equipment to the customer

Table 3-2 Terms

3.4 ABBREVIATIONS

Short form	In full
ALS	Accidental limit state
ASD	Allowable stress design
Cog	Center of Gravity
DHL	Dynamic Hook Load
ELS	Expected load scenario
Fcog	Center of gravity factor
Fcont	Contingency factor
Fgrow	Weight grow factor
Fskl	Skew load factor
IACS	International association of classification societies
LFRD	Load & Resistance Factor Design
MWS	Marine Warranty Surveyor
S_{DL}	Weight of dead load
SLS	Serviceability load state
SWL	Safe Working Load
ULS	Ultimate Limit State
WLL	Working Load Limit
WSD	Working stress design
WTG	Wind Turbine Generator

Table 3-3 Abbreviations

4 CATEGORIZATION

When considering what section of the table to use, the primary function of the equipment should be considered first.

Having selected the primary function, it must first be verified as described in the matrix and the associated sections. If there is a secondary function or an additional primary function the equipment must be verified as described in the matrix and the associated section for the additional function. In case of tertiary functions etc., follow the same process.

As an example, a transport equipment can sometimes be used for lifting, resulting in three scenarios to be verified in addition to the primary function which is transport:

The component (black hexagon) is placed on a transport frame (blue bar) and the lift point (black circle) is connected to the transport frame. In this case the transport frame must also be verified for lifting.

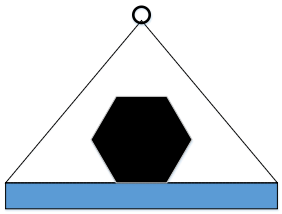


Figure 4-1 Scenario 1

The component (black hexagon) is directly connected to the lift point (black circle) and the transport frame (blue bar) is attached to the component. The lifting point(s) in the component and the connection between the component and transport frame must be verified.

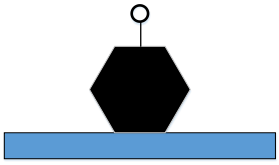


Figure 4-2 Scenario 2

An empty transport frame (blue bar) is connected to the lift point (black circle). The attachment points on the equipment must be verified.

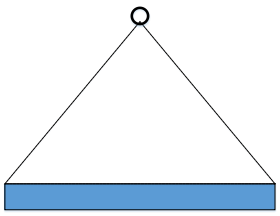


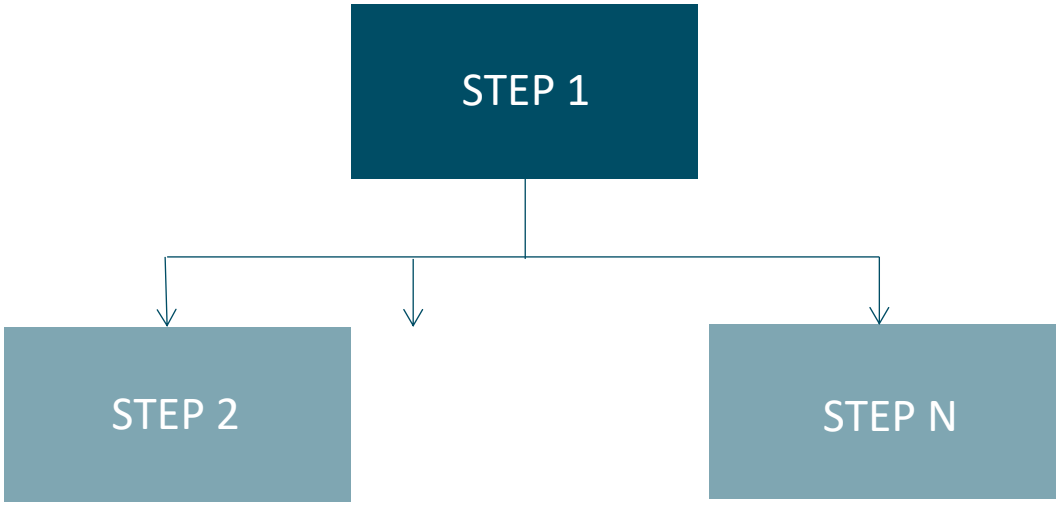
Figure 4-3 Scenario 3

Because of the variety in accessory equipment which cannot be categorized as one or a combination of the other categories, it is not included in the matrix. In this case see 9 **HANDLING EQUIPMENT AND OTHERS**.

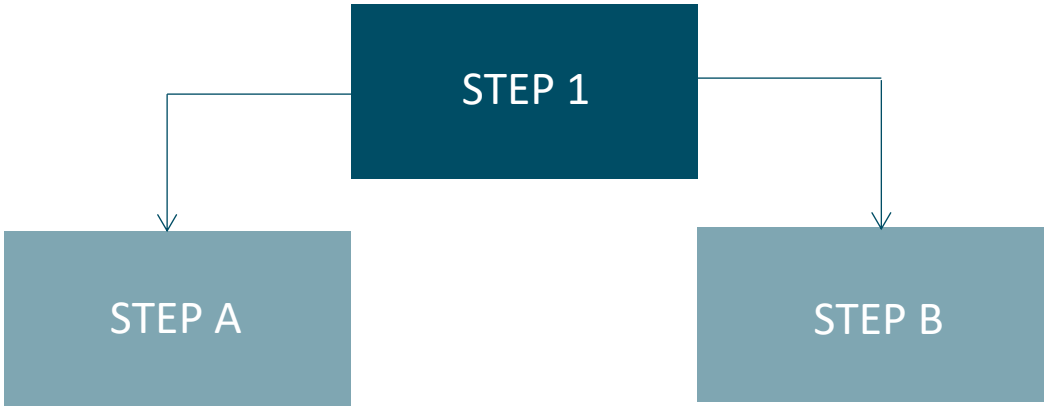
In addition it is important to check the interfaces of the equipment e.g. between equipment and vessel deck.

4.1 METHOD

The flowcharts in this document should be read as follows:



Means that step 2 to n needs to be done after step 1.



Means that only step A or only step B should be selected depending on step 1.

5 OVERVIEW CALCULATIONS CRITERIA AND STANDARDS

		Operation	Application Examples	Calculation approach	Loads	Load safety factors	Verification	Material safety factor	Fabrication	Aprovals
Lifting	Offshore	Rigging setup	Slings Shackles Chain set	DNVGL-ST-N001 [1]	DNVGL-ST-N001 [1]	DNVGL-ST-N001 [1]	DNV-GL-STN001 [1]	DNV-GL-STN001 [1]	Out of scope of this document	IACS, MWS
		Custom made lifting accessories	Lifting brackets Spreader beam Joints	DNVGL-ST-N001 [1] DNVGL-ST-0378 [2]	DNVGL-ST-N001 [1] DNVGL-ST-0378 [2]	DNVGL-ST-N001 [1] DNVGL-ST-0378 [2]	DNV-GL-ST- N001 [1] Buckling: EN 1993-1-1 [3] Bolts: VDI 2230 [4] / DNVGL-OS-C101 [5] / EN 1993-1-8 [6] Welds: DNVGL-OS-C101 [5]	DNVGL-STN001 [1] DNVGL-ST-0378 [2]	EN 1090 [7] or DNVGL-OS-C 401 [8] DNVGL-ST-0378 [2]	IACS, MWS and Certification
		Lifted object	Lifting points on lifted object	DNVGL-ST-N001 [1]	DNVGL-ST-N001 [1]	DNVGL-ST-N001 [1]		DNVGL-STN001 [1]	EN 1090 [7] or DNVGL-OS-C 401 [8]	
	Onshore	Rigging setup	Slings Shackles Chain set	DNVGL-ST-N001 [1]	DNVGL-ST-N001 [1]	DNVGL-ST-N001 [1] Verification acc. EN 13155 [9]	DNV-GL-ST- N001 [1]	Out of scope of this document	Out of scope of this document	CE Marking
		Custom made lifting accessories	Lifting brackets Spreader beam Joints	Machinery directive [10] EN 13155 [9]	EN 13155 [9]	Machinery directive [10] EN 13155 [9]	EN 13155 [9] Welds: EN 13155 [9] Basis material: EN 13155 [9] Bolts: VDI 2230 [4] / EN 1993-1-8 [6] Brittle Fracture: EN 1993-1-10 [11] Lamellar tearing: EN 1993-1-10 [11] Buckling: NL - Calc EN 1993-1-1 [3]	EN 13155 [9]	EN 1090 [7]	CE Marking
		Lifted object	Lifting points on lifted object							
Transport	Road	Supporting structures	Transport frames Joints	DNVGL-ST-N001 [1]	DNVGL-ST-N001 [1]	DNVGL-ST-N001 [1]	DNVGL-ST- N001 [1] Welds: EN 13155 [9] Basis material: EN 13155 [9] Bolts: VDI 2230 [4] / EN 1993-1-8 [6] Brittle Fracture: EN 1993-1-10 [11] Lamellar tearing: EN 1993-1-10 [11] Buckling NL – Calc: EN 1993-1-1 [3]	DNVGL-ST- N001 [1]	EN 1090 [7] or DNVGL-OS-C 401 [8]	None
		Lashing setup	Straps Chains, Schackles	EN 12195 [12]	EN 12195 [12]	EN 12195 [12]	EN 12195 [12]	EN 12195 [12]	Out of scope of this document	CE Marking
	Sea	Supporting Structures	Grillage/tower adapter frame Blade stacker Nacelle support frame	DNVGL-ST-N001 [1]	DNVGL-ST-N001 [1]	DNVGL-ST-N001 [1]	DNVGL-ST-N001 [1] DNVGL-OS-C104 [13] EN 1993-1-1 [3] DNVGL-RP-C203 [14]	DNVGL-ST-N001 [1]	EN 1090 [7] or DNVGL-OS-C 401 [8]	MWS
		Lashing setup	Bolts Corner casting pad eyes special node							
			Lashing seatransport vessel	IMO [15]	IMO [15]	IMO [15]	IMO [15]	IMO [15]	EN 1090 [7] or DNVGL-OS-C 401 [8]	MWS
			Lashing installation vessel	DNVGL-ST- N001 [1]	DNVGL-ST- N001 [1]	DNVGL-ST- N001 [1]	DNVGL-ST- N001 [1]	DNVGL-ST- N001 [1]	Out of scope of this document	IACS, MWS
Storage		Supporting structures	Temporary tower foundation Tower feet Blade support Nacelle support	EN1990 + NA (EC0) [16]	EN1991 + NA (EC1) [17]	EN1990 + NA (EC0)	EN 1992 + NA (EC2) [18] EN 1993 + NA (EC3) [11] EN 1995 + NA (EC5) [19] EN 1999 + NA (EC9) [20]	EN 1993 + NA (EC3) [11]	EN 1090 [7]	None

Table 5-1 Overview calculations criteria and standards

6 LIFTING

6.1 INTRODUCTION

This section list key procedures for the calculation of lifting operations in air. For subsea lifting operations please refer to [1].

Lifting operations are considered as onshore and offshore. Onshore lifting in this guide follows mainly EN standards in particular [9] while offshore liftings are following DNVGL rules [1]. For cases where onshore and offshore lifting occur it is indicated in section 6.5 to follow in general the offshore procedure but checks following the onshore procedure could be required.

In this guide it is considered that effects of position of CoG and effect of skew loading should be if possible calculated based on tolerances (still, it is allowed the use of CoG and SKL factors).

For the offshore lifting case, it is also defined a procedure flowchart in [1] Figure 16.1, the procedure indicated in section 6.4 for offshore lifting is compatible with the indicated flowchart.

6.2 DESIGN PROCEDURE LIFTING

6.2.1 MINIMUM INPUT FROM CUSTOMER

Input from the customer and equipment supplier level is indicated in the workflows using a dashed line. However, the extent of the customer and supplier level can be different depending on the project. The following information is required:

1. WTG component drawing and description.
2. WTG component weight and type of weight (calculated or weighted).
3. CoG envelope of WTG component.
4. Additional special conditions.

The following additional information should be given if available:

1. Weight envelope upper and lower boundary for the specific component.
2. CoG envelope. (Otherwise CoG factors will be used for design).
3. Lifting geometry, number of cranes and hooks. (Otherwise will be defined by the designer).

6.3 ONSHORE LIFTING

The general procedure is indicated in the following diagram. The diagram presents the approach for the design of a whole lifting system. Another approach is to design individual accessories in the lifting system, where operational/geometrical parameters are considered before the structural verification with respect to rated capacity (WLL).

Observe that the object to be lifted e.g. WTG component or equipment in principle is not covered by [9]. Therefore the object to be lifted should follow the Machinery Directive.

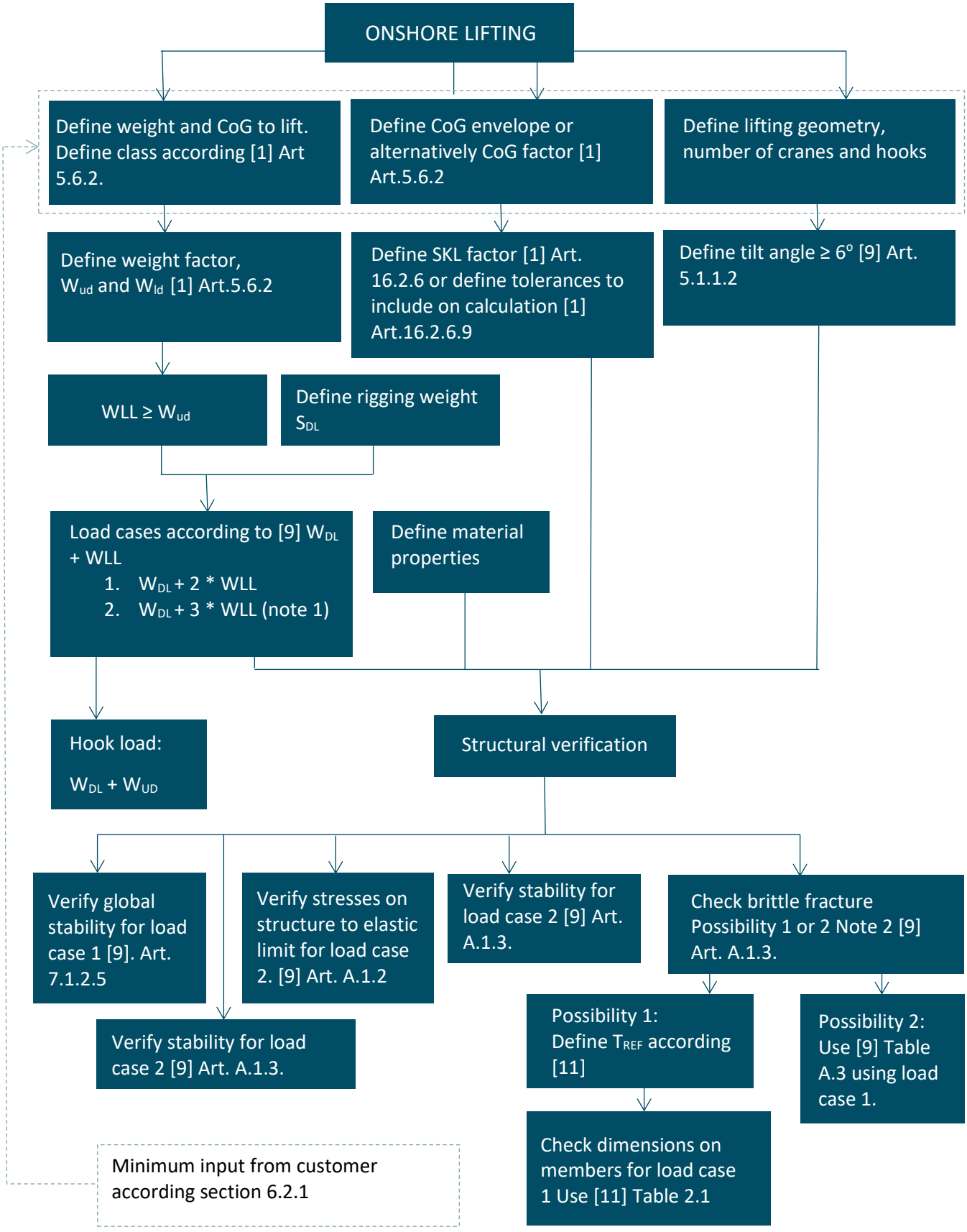


Figure 6-1 Onshore lifting flowchart

Note 1: no. 3 is not applicable to materials according to [21].

Note 2: Low design temperatures may reduce the capacity of the material significantly, see [11].

6.4 OFFSHORE LIFTING

The general procedure is indicated in the following diagram. The diagram below presents the approach for the design of a whole lifting system based on [1]. Another approach is to design individual accessories in the lifting system based on [2], where operational/geometrical parameters are considered before the structural verification with respect to rated capacity (WLL).

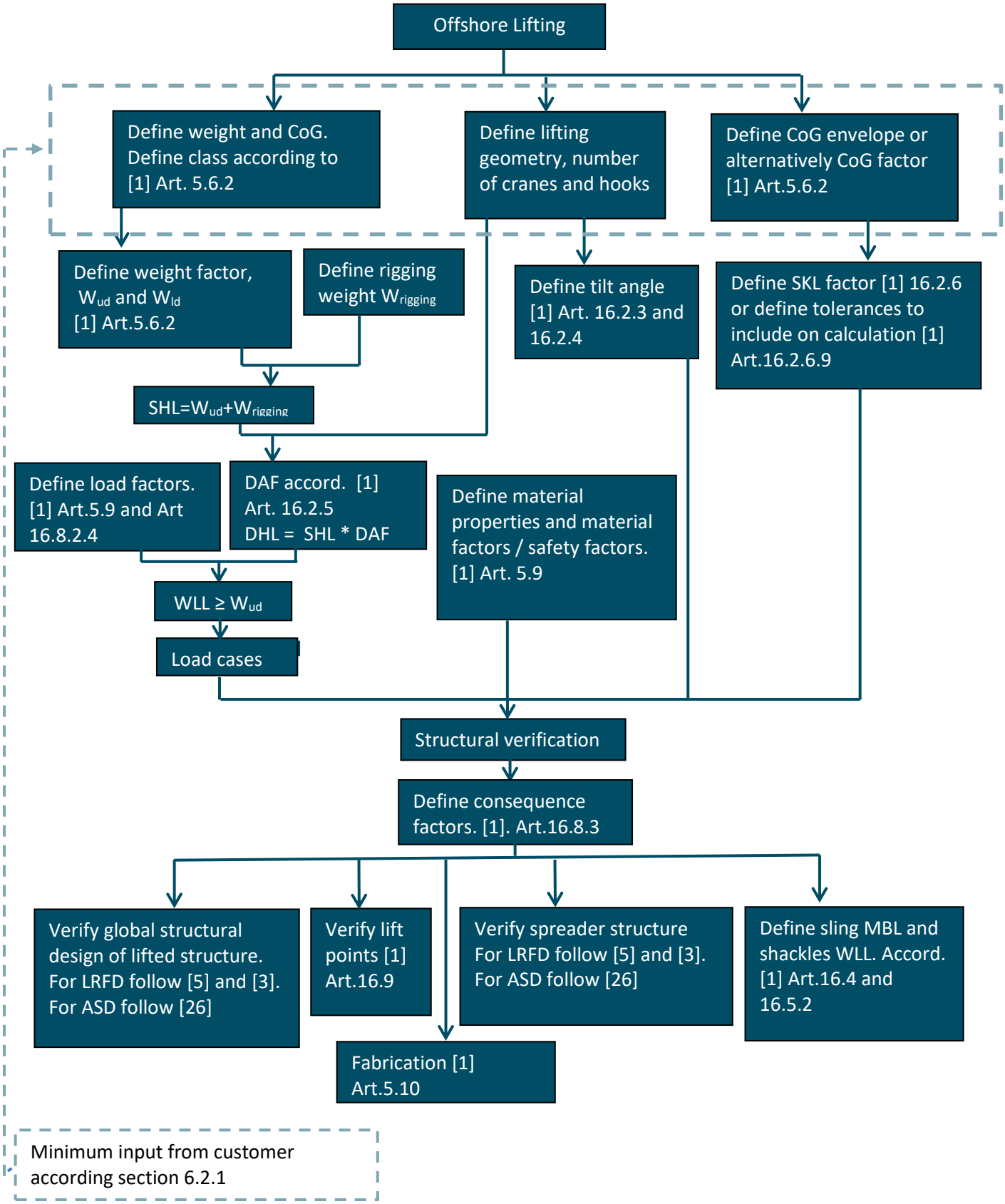


Figure 6-2 Offshore lifting flowchart

6.5 DISCUSSION: ONSHORE VS. OFFSHORE LIFTING

It is expected that normally spreader bars and lift points are designed for offshore lift because the global safety factor of 1.5 in DNVGL (consist of material factor and load factor) is multiplied by the DAF of 1.3, this is producing a value of 1.95.

Note however that the verification of stresses in the onshore case is purely elastic, while in the offshore case can be used the plastic capacity of the members. Therefore, check that components with larger utilization remains elastic using only the factor 2.0 could be required.

This means that in the majority of the cases the offshore design will be more conservative than the onshore design. Thus only offshore verification is required when the offshore case is more conservative.

If to be used offshore material selection must comply accordingly. E.g. brittle fracture has to be checked according to [1] for offshore use and according to [11] for onshore use. If used both offshore and onshore it must comply with both, as shown in the matrix. The same is true for the other standards referenced in the matrix.

7 TRANSPORT

7.1 ROAD TRANSPORT

7.1.1 INTRODUCTION

This section lists key parameters and considerations to include in a road transport analysis for typical WTG components. This basic approach is the recommended practice for road transport analyses. This section also includes other onshore transport scenarios on harbor areas etc.

The recommended practice presented covers typical WTG components, e.g. tower sections, blades, nacelle, rotor, etc.

Depending on the size and shape of the component transported, the item can be supported by use of a support structure and/or securing devices. When larger items are being transported, the equipment often requires special solutions in order to meet the restrictions from the road authorities and to achieve adequate support of the item on e.g. a truck. In this case, a reusable support structure will be a benefit.

Main considerations to include in a road transport:

- Speed of the truck
- Road and pavement
- Road curvature
- For the item – C.o.G and general stability

7.1.2 DESIGN PROCEDURE

A typical approach for carrying out structural verification of transport equipment and securing devices is presented below as a route diagram.

The route diagram specifies the basic information required from the level of customer and equipment supplier in order to be able to carry out a detailed onshore transport analysis. Furthermore, the diagram specifies the proposed design methodology to follow, depending on the choice of support design. Each method defines characteristic loads. However, the corresponding standard acceleration coefficients are very conservative, therefore recommended accelerations to be used are given in Section 7.1.4. The verification shall be combined with partial safety factors, see Section 7.1.6.1.

During road transport, components will be subjected to wind loads. However, these loads depend on the exposed surfaces of the components as well as the shape of the components. Wind load is relative to the driving direction and speed of the vehicle and shall be included if applicable.

7.1.3 MINIMUM INPUT FROM CUSTOMER

The typical customer and equipment supplier level is indicated in Figure 7-1 Road transport flowchart below, using a blue dashed box. The extent of the customer and equipment supplier level can be different depending on the project. The following basic information is required for a road transport analysis:

- WTG component drawing and description.
- WTG component weight.
- CoG of WTG component.
- Securing method, lashings or support structure
- Support condition.

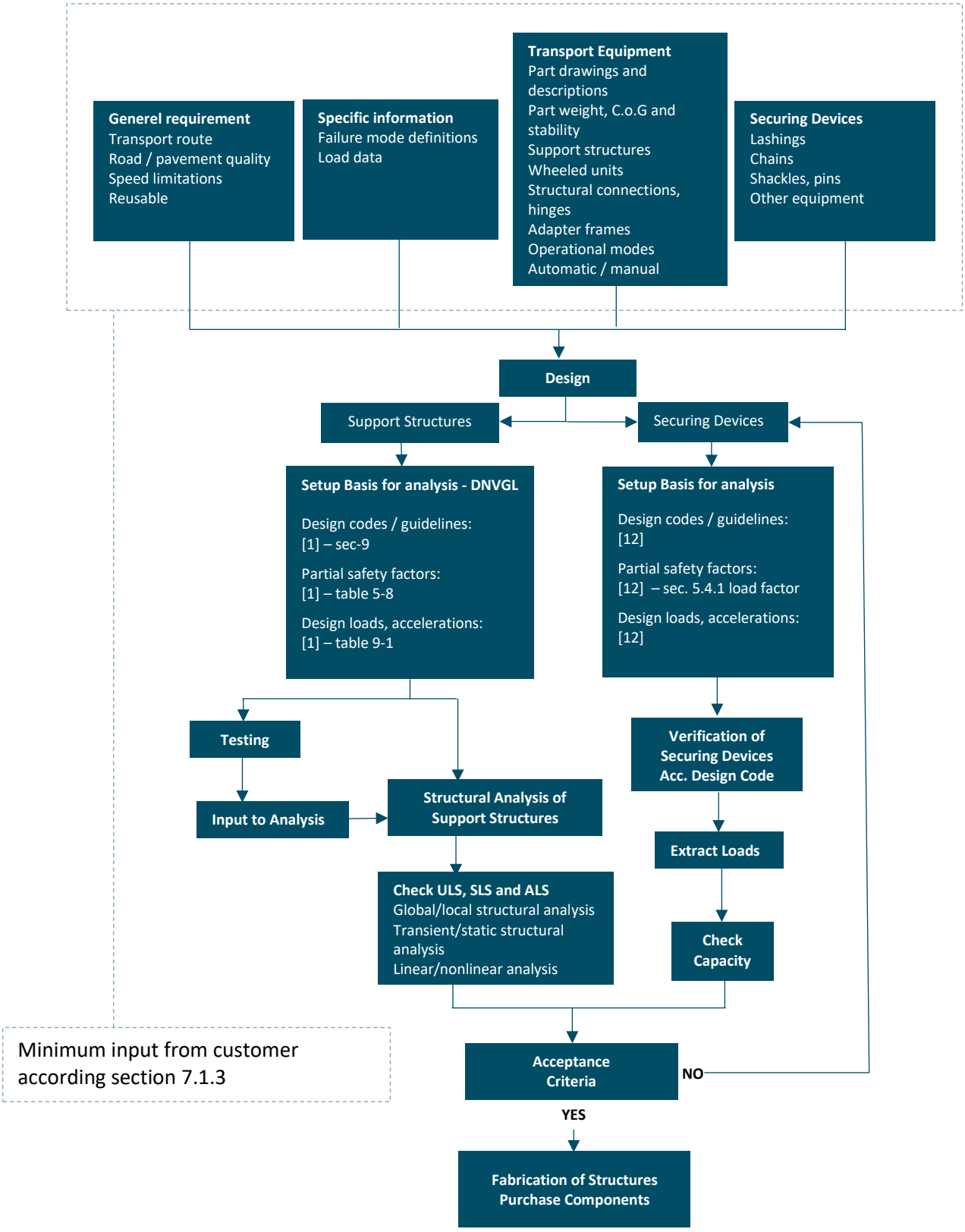


Figure 7-1 Road transport flowchart

7.1.4 ACCELERATION COEFFICIENTS

Lashing and securing:

The accelerations coefficient to use for lashing calculations during road transport are taken according to [12] and summarized in Table 7-1 below.

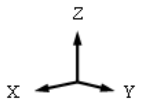
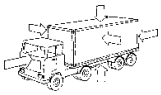
Accelerations for road transport. Acc. given as fraction of standard gravity (g_0 = 9.81 m/s²)							
GCS	Road	Securing in	Longitudinal a_x		Transverse a_y		Vertical a_z
			Forward	Rearward	Sliding	Tilting	
		Longitudinal direction	0.8	0.5	-	-	1.0
		Transverse direction	-	-	0.5	0.5/0.6[a]	1.0
[a] see section 5.1 of EN 12195-1 [12]							

Table 7-1 Road transport accelerations for lashing and securing verification

Supporting structure:

The acceleration coefficients to use when designing a support structure for a WTG component shall be taken from the guideline given in [1], see Table 7-2 below.

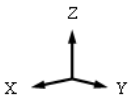
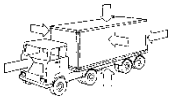
Accelerations for road transport. Acc. given as fraction of standard gravity (g_0 = 9.81 m/s²)						
GCS	Road	Securing in	Longitudinal a_x		Transverse a_y	Vertical a_z
			Forward	Rearward		
		Longitudinal direction	0.8	0.5	-	1.0 / 1.2
		Transverse direction	-	-	0.5	1.0 / 1.2

Table 7-2 Road transport accelerations for design of support structures

Note: The transverse acceleration is limited to the stability of the trailer; hence if the transverse acceleration results in overturning of the trailer, the transverse acceleration should be reduced to the acceleration value just before instability of the trailer occurs.

7.1.5 LOAD COMBINATIONS

Lashing and securing:

In the verification of the lashing and load securing, the stability of the trailer and truck is not taken into account and lashings are to be verified according to [12]. In Table 7-3, the minimum load cases to be considered in a road transport analysis are summarized. In general all unfavorable load cases shall be considered in the road transport analysis.

	Lashing and securing – load combinations for road transport		
Description	Accelerating	Breaking	Turning
Longitudinal	a_x (forward)	a_x (rearward)	-
Vertical acceleration	g_0	g_0	g_0
Transverse	-	-	a_y

Table 7-3 Example of road transport acceleration load combinations for lashing and securing

Supporting structure:

Similar to the minimum load combination given for the Lashing and securing equipment.

7.1.6 PARTIAL SAFETY FACTORS

7.1.6.1 RESISTANCE FACTORS

Lashing and securing:

Generally, the design load for any lashing, chain, etc. shall not exceed the certified working load limit (WLL).

The resistance factors for the different securing devices can be taken from [1] if no WLL is given. The material resistance factor for steel wire ropes and chains can be taken as 1.5. However, for fibre ropes the material resistance factor the following minimum factors apply:

- Polyester: 1.65
- HMPE and Aramid: 2.0
- Other fibre materials: 2.5

Support structure:

The resistance factor for steel support structures should be taken as minimum $\gamma_m = 1.15$ and $\gamma_{m_w} = 1.3$ for welds according to [1].

7.1.6.2 LOAD FACTORS

Lashing and securing:

Load factors shall be taken according to [12] Section 5.4.1.

Support structure:

Load factors based on the LRFD method shall be taken according to Table 5-8 of [1].

7.2 SEA TRANSPORT

7.2.1 INTRODUCTION

This section lists key parameters/considerations to include in a sea transport analysis for typical WTG equipment. This basic approach is the recommended practice for sea transport analyses.

The recommended practice presented covers typical WTG items, e.g. tower sections, blades, nacelle, rotor, etc.

The main considerations for designing the components are:

- Mass and mass distribution of WTG item.
- Position on vessel
- Type of vessel, duration of transport

The guide is based on reference [1], chapter 11. In particular sea fastening requirements are described in section 11.9.5.

7.2.2 DESIGN PROCEDURE

7.2.2.1 MINIMUM INPUT FROM CUSTOMER

Customer and equipment supplier level is indicated in the workflows using a dashed line. However, the extent of the customer and supplier level can be different depending on the project. The following information is required:

1. Component drawing and description.
2. Component weight envelope and type of weight (calculated or weighted).
3. CoG of component.
4. Components mass moment.
5. Vessel or type of vessel for the transport.
6. Transport route and/or T_{POP} and T_R.
7. Position of equipment on/in vessel. (Otherwise a worst position scenario shall be defined during design)

8. Additional special conditions.

The following additional information should be given if available:

1. Motion analysis for the vessel, indicating accelerations. (Otherwise default motion analysis should be used for calculation).

7.2.3 PROCEDURES

Design procedure is described below. The section in the blue dotted box is the information that can be defined by customer or equipment supplier according section 7.1.3.

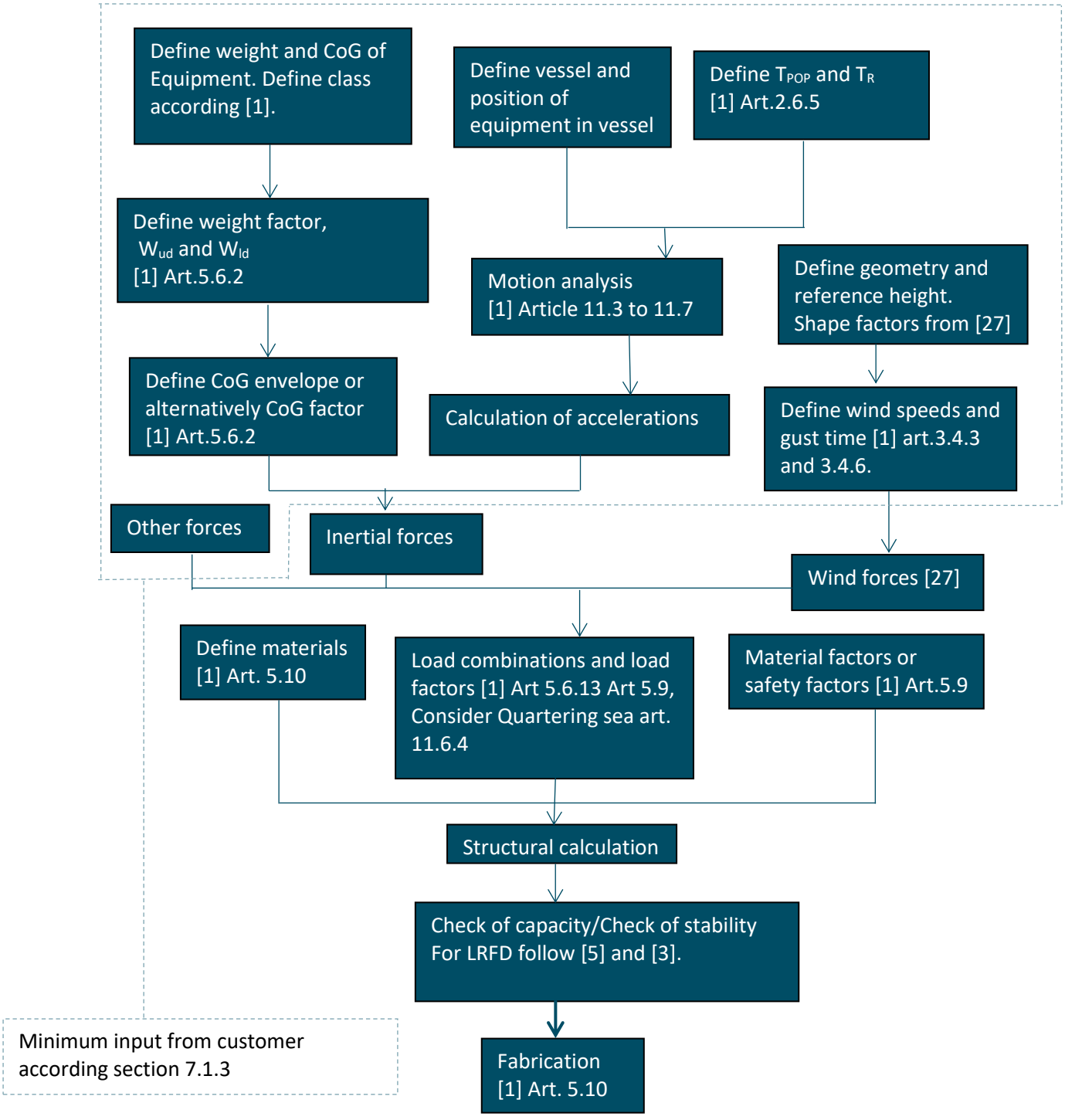


Figure 7-2 Sea transport flowchart

Motion analysis is detailed below

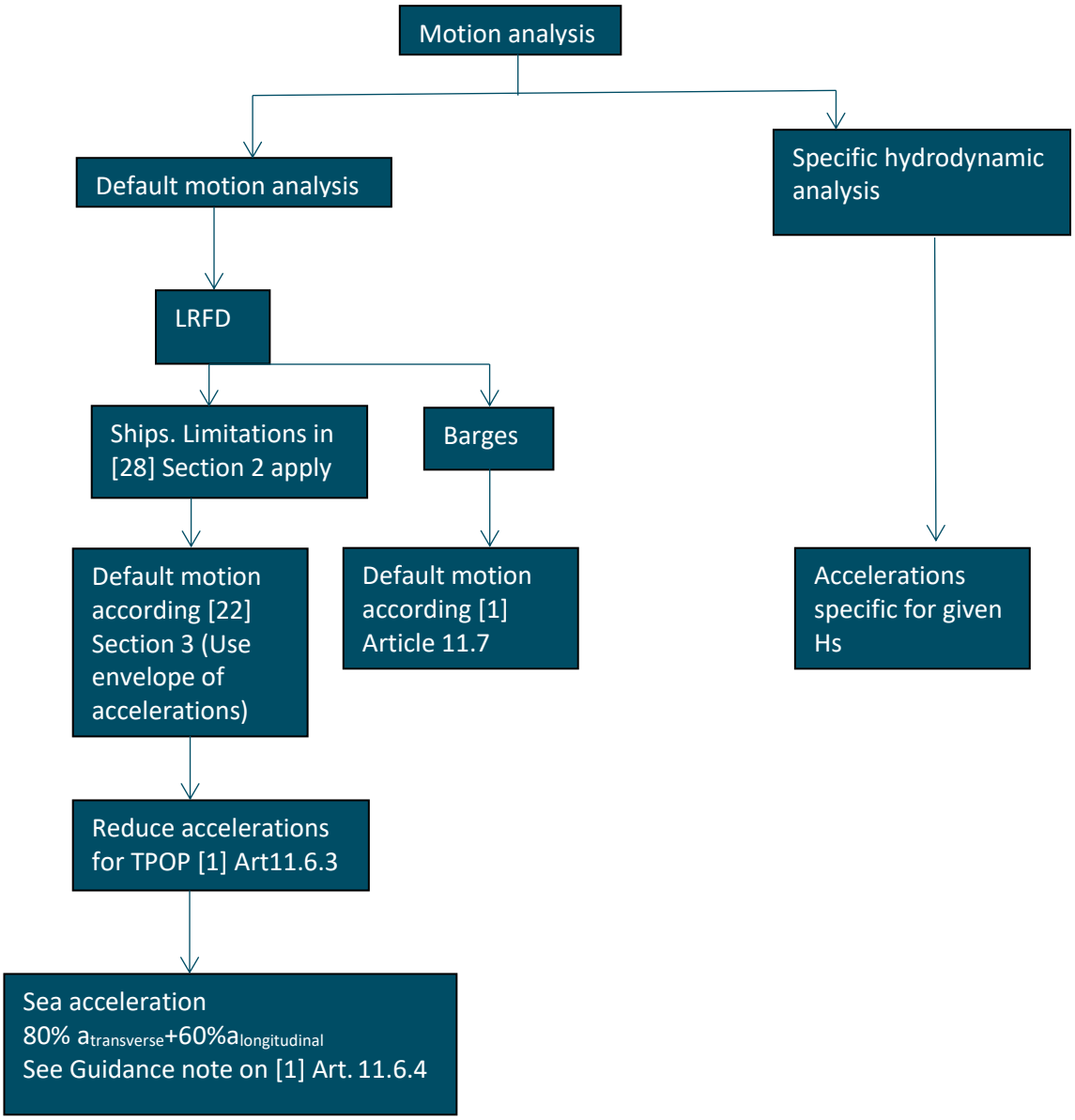


Figure 7-3 Motion analysis flowchart

Note 1: It is indicated in the standard that the forces calculated as envelope of accelerations in [22] have a probability of occurrence of 10^{-8}, the forces are conservative and could be reduced for T_{POP}. The reduced forces has a probability of occurrence of 10^{-4}.

Note 2: The forces calculated from the resulting accelerations should not be reduced for completing the design. The probability of occurrence of these forces should be 10^{-4}.

7.2.3.1 PROCEDURE FOR FATIGUE ASSESSMENT DURING TRANSPORTATION

Fatigue during sea transportation should be assessed by following one of the methods described in [14] and [23]. Limitations and bases for the different procedures are addressed in the referred standards. In all cases design fatigue factor shall be applied as indicated in [1] Art.5.9.4.2 Table 5-4.

7.2.4 LOAD CASES COMBINATION

Load combinations are indicated in [1] Article 5.9.1.5

7.2.4.1 LOAD FACTORS FOR LRFD CALCULATION

LRFD Load factors for ULS are indicated in [1] Art5.9.8.2
Load factors for FLS and SLS are all 1.0
Load factors for ALS are indicated in [1] Article 5.9.5.2

7.2.4.2 MATERIAL FACTORS FOR LRFD

For ULS load cases:

For steel according article 5.9.8.4, ropes, chain and bolts according Article 5.9.8.5.

For steel minimum use 1.15. For use of Eurocode 3, follow [5], Chapter 2 Section 4 for steel and Chapter 2 section 8 for welded connections.

For FLS the DFF is indicated in [1] Table 5.4.

For ALS material factors according [1] article 5.9.5.3.

For SLS, material factors are all 1.0.

8 STORAGE

8.1 INTRODUCTION

This section lists key parameters/considerations to include in an analysis of a equipment or tool used for storage of typical WTG component. This basic approach is the recommended practice for onshore conditions in a storage area or temporary waiting positions for instance at quayside.

The recommended practice presented covers typical WTG items, e.g. tower sections, blades, nacelle, rotor, etc.

This section applies to equipment where the functionality is to store a turbine component, but also, in cases where the is a combined functionality between storage and transport/handling.

The storage scenario could be the governing dimensioning factor in case of combined use.

In this case, a reusable support structure will be a benefit. For reusable equipment, a fatigue damage assessment/calculation is then recommended.

Main considerations to include in storage

- Geometric
- Weight and C.o.G envelope.
- Wind, snow and ice
- Storage location
- Ground pressure
- Ground level tolerance
    - E.g. height difference, slope

8.2 DESIGN PROCEDURE

8.2.1.1.1 8.2.1 PROCEDURES

Design procedure is described below:

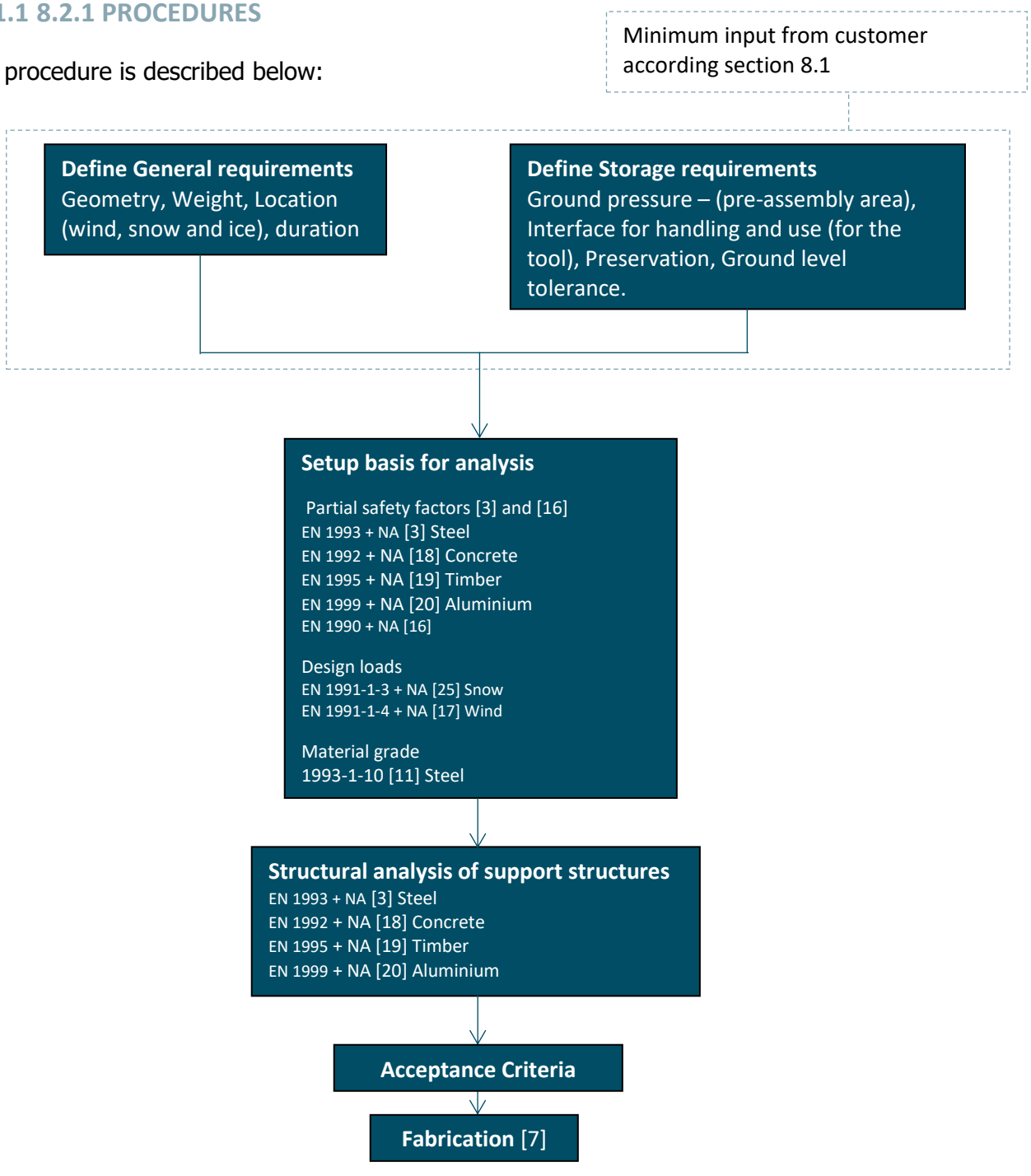


Figure 8-1 Storage flowchart

9 HANDLING EQUIPMENT AND OTHERS

When designing equipment which does not fit the categories listed above the use case must be considered and designed in compliance with the applicable standards.

Example one: a supporting equipment for a tower that will only be used for a very limited period of time where other operations limits the wind pressure. In this case it might not be necessary to calculate wind loads and fatigue loads. Other examples are:

- Guides
- Supporting bar not used for lifting
- Scaffolds
- Working platforms
- Stairs

10. REQUIREMENT SPECIFICATION

As a minimum the requirement specification should include the following:

- Introduction and general scope of work
- Function of the product/tool incl. area of use
- WTG component data
- Weight envelope, upper and lower boundary Technical requirements
    - Interface
    - Physical requirements (outer dimensions, weight, etc.)
    - Structural requirements
    - Design lifetime (user frequency)
    - Fabrication requirement
- Operational requirements/parameters
    - Environmental conditions, loads etc.
- Certification required
- Documentation requirements