GDV German Insurance Association

Publication by the German Insurers on loss prevention

VdS

International guideline on the risk management of offshore wind farms

# Offshore Code of Practice



© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

VdS 3549en : 2014-01 (01)

Use of and compliance with the present document is at your discretion. Neither the editor, nor the persons who have contributed to publishing, revision, and maintaining of the guideline guarantee that the contents meet the user's special requirements, that its application will be faultless, and that the contents are always complete, correct, up-to-date, and reliable.

The authors bestowed greatest care on drawing up the texts and figures. The authors gave and verified the references to the best of their knowledge. However, mistakes cannot be ruled out completely. Therefore, both, the authors and the publishing house, deny legal responsibility as well as guarantee for the information and figures - whether expressed or implied - regarding quality, realisation, or use to a particular purpose. Should particular references appear to be wrong despite due diligence, we kindly ask to notify us thereof.

The present publication has no binding force. In particular cases, the insurers may accept other precautions, or installers, or maintenance services under conditions at their discretion which do not correspond to these technical specifications or guidelines.

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

**Imprint**

Last revision: 12 September 2014
Published by: Gesamtverband der Deutschen Versicherungswirtschaft e. V. [German Insurance Association]

Edited by: Thorsten Land, Andreas Schindler, Frank Thyrolf
Layout/Graphik Design: Nicole Nikoleit

Gesamtverband der Deutschen Versicherungswirtschaft e.V.
Wilhelmstraße 43/43G
10117 Berlin
Phone +49/30/2020 -5343
Fax +49/30/2020 -6343
E-mail: a.schindler@gdv.de
www.gdv.de

**Photograph on the title page by the courtesy of © halberg Fotolia.com**

International guideline on the risk management of offshore wind farms

# Offshore Code of Practice
































































List of companies involved in the risk analysis

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## Contents

**Preface** ..... **7**

**1 Introduction** ..... **7**
1.1 Purpose ..... 7
1.2 Scope ..... 8

**2 Use of the guideline** ..... **9**
2.1 Compliance with legal requirements ..... 9
2.2 Structure of the guideline ..... 10

**3 Introduction to risk management** ..... **11**
3.1 Process of risk management ..... 11
3.2 Risk assessment techniques ..... 11
3.3 Documentation, verification, and monitoring of risks ..... 12

**4 Marine Warranty Surveyor (MWS): Possible tasks and responsibilities** ..... **12**

**5 Representation of significant risks when building offshore wind farms** ..... **14**
5.1 Cabling in wind farms ..... 14
5.1.1 List of process steps under review ..... 14
5.1.2 Representation of significant risks when installing the cables in wind farms ..... 14
5.2 Offshore transformer stations in wind farms ..... 15
5.2.1 List of process steps under review ..... 15
5.2.2 Representation of significant risks when building the offshore transformer stations in wind farms ..... 15
5.3 Offshore wind turbine ..... 17
5.3.1 List of process steps under review ..... 17
5.3.2 Representation of significant risks when building offshore wind turbines ..... 18

**6 Conclusion and prospects** ..... **20**

**7 Literature/references** ..... **21**
7.1 Suppliers ..... 21
7.2 Literature ..... 21

**8 Annex** ..... **21**
8.1 Glossary ..... 21
8.2 List of abbreviations ..... 23
8.3 List of companies involved in the risk analysis ..... 23
8.4 Explanations of the list of risks ..... 23

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

**9 Lists of risks ..... 26**
**9.1 Offshore transformer stations in wind farms ..... 26**
**9.2 Cabling in wind farms ..... 48**
**9.3 Engineering, transport of transformer station ..... 60**
9.3.1 Vessels, barges, tugboats, etc. ..... 60
9.3.2 Load-out ..... 66
9.3.3 Transport on own hull ..... 72
9.3.4 Route, ports of refuge, and refuges in general ..... 90
9.3.5 Sea-fastening, grillage, structure ..... 92
9.3.6 MWS weather criteria ..... 94
9.3.7 Operating manual complies with limitations ..... 98
9.3.8 Availability of MWS ..... 100
9.3.9 Emergency plans - person in charge ..... 102
9.3.10 Component of limited tipping angle ..... 106
9.3.11 Component of limited acceleration ..... 108
9.3.12 Approval by MWS ..... 110
9.3.13 Verification by certifier of the method statements ..... 112
9.3.14 Delay by bad weather / ship repair ..... 114
**9.4 Construction engineering of transformer station ..... 116**
9.4.1 Review of sea state and weather conditions ..... 116
9.4.2 Release of installation procedures by the person in charge of project certification ..... 118
9.4.3 Engineering of pre- & post-piling ..... 120
9.4.4 Soil investigation ..... 122
9.4.5 Positioning, bubble curtain, mooring, DP, and jacking ..... 124
**9.5 Erection of transformer station ..... 126**
9.5.1 Planning of ships, barges, etc. ..... 126
9.5.2 Setting down the base structure onto the seabed ..... 130
9.5.3 Piling, fixing ..... 132
9.5.4 Grouting the base structure piles ..... 134
9.5.5 Floating into position and alignment of topside ..... 136
9.5.6 Jacking up the topside ..... 142
9.5.7 Lifting the topside ..... 146
9.5.8 Grouting the topside ..... 148
**9.6 Foundations of offshore wind turbines ..... 150**
**9.7 Erection of tower, nacelle, and rotor ..... 200**
9.7.1 Planning of the erection of WTG ..... 200
9.7.2 Planning of loading and sea transport ..... 204
9.7.3 Transports to the port area assembling site ..... 206
9.7.4 Work, assembly work, fitting work in the port area / at the shipyard, preparations for offshore erection ..... 234
9.7.5 Loading for sea transport ..... 240
9.7.6 Sea transport to the wind farm ..... 244
9.7.7 Erection of tower, nacelle, and rotor ..... 248
9.7.8 Commissioning ..... 250

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## Core team

Harald Dimpflmaier (spokesman) ..... Swiss Re
Georg Englert ..... HDI Gerling Industrieversicherung AG
Michael Klug ..... Munich Re
Stefan Gumpp ..... Allianz

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## Preface

The European Wind Turbine Committee (EWTC) composed of European direct-writing insurers and reinsurers launched the initiative "Offshore Code of Practice" in 2010. The German insurance association GDV (Gesamtverband der Deutschen Versicherungswirtschaft e. V.) and the foundation Offshore Windenergie are supporters of this initiative. In spring/summer 2014 the GDV publishes the document Offshore Code of Practice (OCoP) named after this initiative for the first time. This is planned to be reviewed and edited regularly and upon important changes in technology and risk management processes to be up-to-date.

Motives for the OCoP have been that

- offshore wind farm projects are vast and complex,
- the experiences gained so far in the installation of offshore wind farms in specific areas, such as deep waters of the North Sea, are limited,
- this is a young business striving for immense growth.

The erection of offshore wind farms involves a multitude of the most different risks that should be dealt with proactively. Early detection allows reduction or prevention of such risks.

This initiative aims at establishment of a guideline dealing with the risk management for the erection of offshore wind farms. This guideline shall point out significant risks as well as the importance of a complementary risk management. Furthermore, the OCoP shall motivate any actor involved in the erection to implement risk management procedures.

A transparency of risks resulting therefrom can reduce the risk of damage and provide for long-term insurability of offshore wind farm projects. The OCoP shall represent the risks and proven methods of erection of offshore wind farms. However, as the possible designs of offshore wind farms are manifold it is neither reasonable nor possible to give general recommendations.

The risks and protection measures stated in the OCoP are intended to be an appropriate guidance in practice. The OCoP is not exhaustive. It should only point out the most important issues of the risk management for an installation of offshore wind farms.

The risk analysis made in the work groups is fundamental to the OCoP. This is the definition and assessment of risks and relevant protection measures for any important operation. The risk analysis shall cover the risks which can cause significant damage to deliveries and services, project delays due to property damage, as well as losses due to business interruption during the installation of an offshore wind farm. The knowledge documented in the lists of risks is based on the experiences of the experts involved. To ensure uniform structure, all participants got instructions on how to proceed. The work groups have been composed of experts in the offshore business proving knowledge in different fields. These have been representatives of

- direct-writing insurers and reinsurers, insurance brokers;
- manufacturers, operating parties, developing companies;
- investors, banks, consultants, certifiers, utility companies;
- shipping companies, technical experts, Marine Warranty Surveyors (MWS);
- as well as of the German insurance association GDV (Gesamtverband der Deutschen Versicherungswirtschaft e. V.) and the foundation **Offshore Windenergie**.

This is the opportunity to thank anyone involved in the development of the OCoP for his/her cooperation and commitment!

## 1 Introduction

### 1.1 Purpose

The guideline aims at pointing out how important the implementation of risk management procedures is. On the one hand, risk management procedures involve early detection of potential risks during the erection of offshore wind farms. On the other hand, they involve protection measures taken as a prevention to reduce or even prevent such risks. This should minimise the risk of damage to property and loss by delay or at least reduce this to an acceptable level and optimise security of supply.

Target groups of the OCoP are the risk bearers in the insurance business as well as any actor involved in the erection of offshore wind farms.

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

Use of and compliance with the present guideline is at your discretion.

Purpose of the OCoP is that the target groups will comprehend the processes taking place, potential risks, and possible protection measures to reduce or prevent risks or that they become sensitive to these. Thus, the guideline points out to primary risks and the target groups can use it as a reference work.

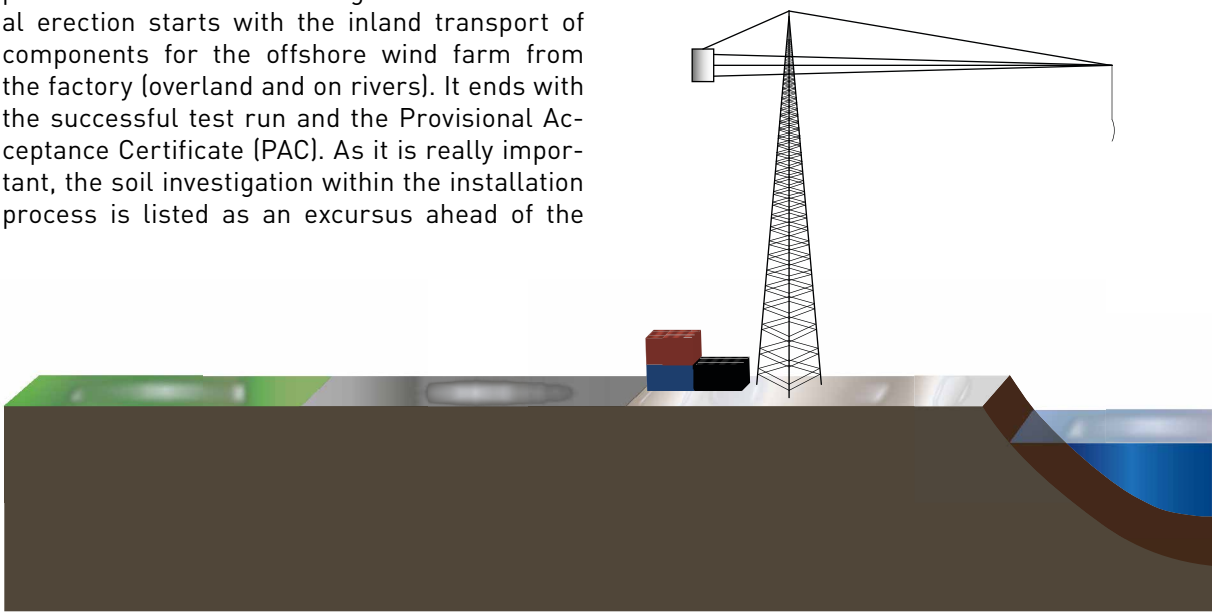
## 1.2 Scope

The scope of the OCoP is the erection of an offshore wind farm and the risk management procedures involved. In the guideline the actual erection starts with the inland transport of components for the offshore wind farm from the factory (overland and on rivers). It ends with the successful test run and the Provisional Acceptance Certificate (PAC). As it is really important, the soil investigation within the installation process is listed as an excursus ahead of the inland transport. Figure 1 shows the different process steps including main fields of activities being part of the erection.

The erection considered in the OCoP refers to the trades of cabling in wind farms, offshore transformer station in wind farms, and offshore wind turbine.

The guideline does not cover the design and development work, the manufacture of work items, and the operating stage following the installation. It should nevertheless be pointed out that any

**Figure 1:** Erection including the fields of activities



**Erection**

| Soil investigation | Inland transport | On-shore assembly and storage | Offshore transport |
|---|---|---|---|
| • Geophysical investigations<br>• Geotechnical preliminary exploration<br>• Geophysical final analysis (in consideration of the results of the geotechnical preliminary exploration)<br>• Geotechnical main investigations<br>• (...) | • Loading<br>• Inland transport (rivers and overland)<br>• Transshipment<br>• Intermediate storage<br>• Unloading<br>• (...) | • Identification of port/ port requirements<br>• Storage in offshore port<br>• Onshore assembly in offshore port<br>• Acceptance of onshore assembly<br>• Shipment to the quay edge (port transport)<br>• Preparations for offshore transport (packaging, tests, etc.)<br>• (...) | • Port cargo handling<br>• Stowing<br>• Sea-fastening<br>• Offshore transport<br>• Dynamic positioning, dropping of anchor, etc.<br>• Approval by MWS<br>• (...) |

MWS: Marine Warranty Surveyor; OWT: Offshore Wind Turbine; OTS: Offshore Transformer Station; OWF: Offshore Wind Farm

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

knowledge as to the design, manufacture, and operation resulting from the risk analysis shall be taken into consideration.

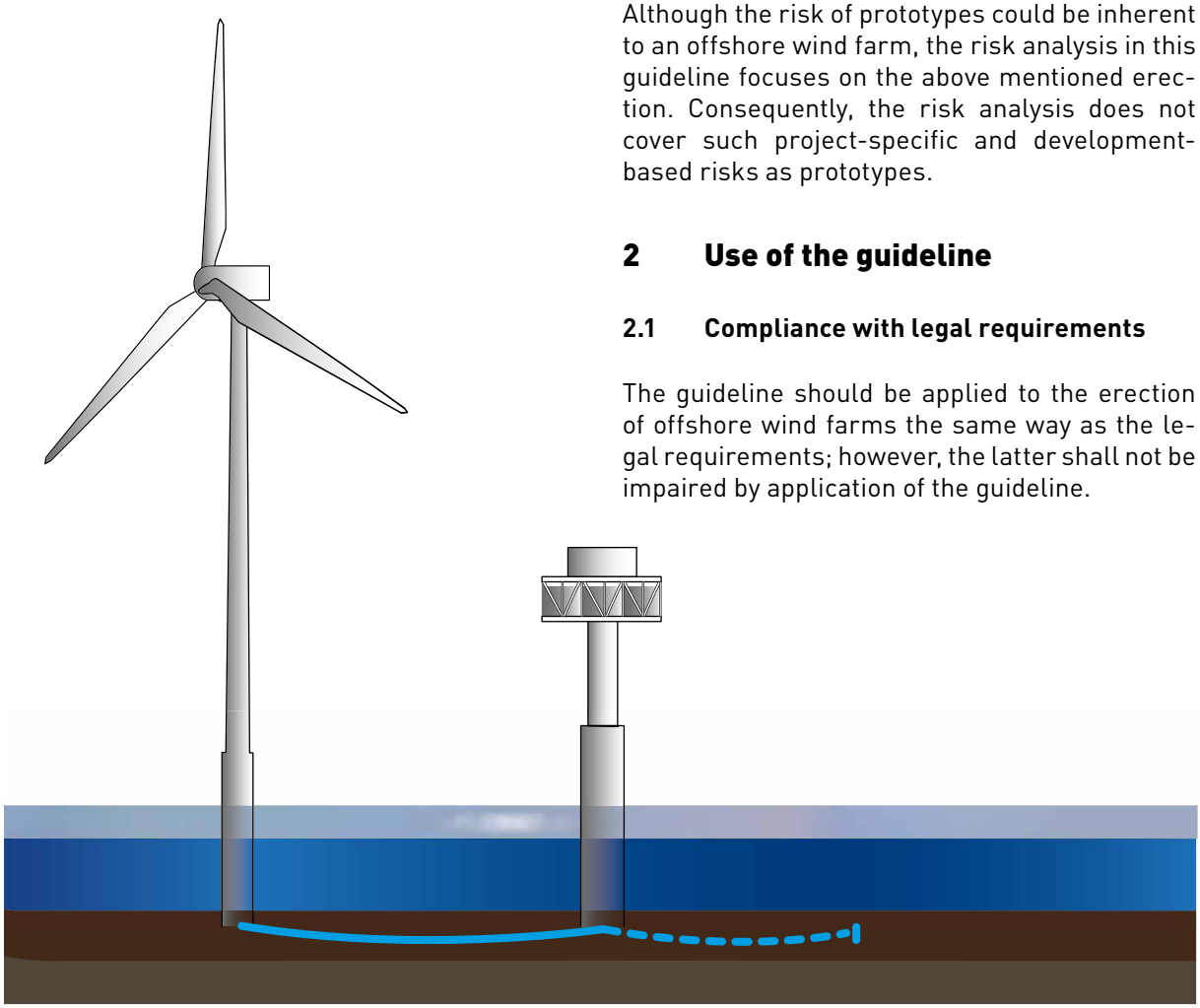
Purchase and the delivery of offshore wind farm components from places beyond Europe are not examined either.

Although the risk of prototypes could be inherent to an offshore wind farm, the risk analysis in this guideline focuses on the above mentioned erection. Consequently, the risk analysis does not cover such project-specific and development-based risks as prototypes.

## 2 Use of the guideline

### 2.1 Compliance with legal requirements

The guideline should be applied to the erection of offshore wind farms the same way as the legal requirements; however, the latter shall not be impaired by application of the guideline.



**Erection** | **Betrieb**

| Offshore erection | Residual assembly work offshore | Commissioning and test run |
|---|---|---|
| • Pre-/post-piling of footing structure<br>• Grouting<br>• Lifting and lowering<br>• Arresting<br>• Installation of the cable in the wind farm<br>• Pulling in of the cable in the wind farm and the sea cable<br>• Approval by MWS<br>• (...) | • Provision of the external power supply<br>• Connection of the cable in the wind farm and of the sea cable<br>• Approval by MWS<br>• (...) | • Tests<br>• Mains connection of the OWT to the OTS<br>• Mains connection to the OTS of the transmission grid operator<br>• Function tests<br>• Approval<br>• Approval by MWS<br>• Test runs of OWF<br>• (...) |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 2.2 Structure of the guideline

The guideline informs about the erection of offshore wind farms examined in the OCoP (see Chapter 1), the risk management in general (see Chapter 3), and the potential tasks and fields of responsibilities of the MWS (see Chapter 4). However, the main emphasis is on the significant potential risks that could occur during erection of the trades: cabling in wind farms, offshore transformer station in wind farms, and offshore wind turbines in an offshore wind farm (see Chapter 5). The significant risks are integral part of the knowledge resulting from the lists of risks drawn up to this end in the work groups. This means that the knowledge and the experiences of the more than 90 experts working in the offshore business found their way into the results.

The guideline delivers descriptions of operations for each process step defined for the trades of cabling in wind farms, offshore transformer station in wind farms, and offshore wind turbine. Moreover, it describes the hazards and protection measures for each operation and gives a general assessment. The risk assessment has been provided without and in consideration of the effects of a protection measure.

The risks have been assessed to fit in one of the four categories below, which reflect the potential risk:

- low risk,
- medium risk,
- high risk,
- very high risk.

Each risk listed for an operation is followed by an assessment of the extent of property damage and loss due to delay as well as of the probability of occurrence. As to the property damage and losses due to delay, the potential financial loss has been estimated.

The protection measures have been assessed to fit in one of the three categories below:

- very good,
- adequate,
- poor.

They inform on the potential effect of a protection measure.

The effect of a protection measure is very good if the risk resulting from a hazard (damage to property / loss due to delay) can almost be excluded as far as our experience goes. Thus, the protection measure provides for control of the risk.

The effect of a protection measure is adequate if taking the measure noticeably reduces the risk resulting from a hazard (damage to property / loss due to delay) as far as our experience goes. The protection measures noticeably cut down the risk.

The effect of a protection measure is poor if taking the measure hardly reduces the risk resulting from a hazard (damage to property / loss due to delay) or does not reduce it at all as far as our experience goes. Although a protection measure has been taken and met, the risk endures.

Based on the assessments of the risk and the protection measures, the risk is again classified in the four risk categories above. This underlines significant risks involved in an operation or process step. A risk is significant if the potential risk of the corresponding hazard connected to an operation is high to very high despite considering and taking of the protection measures. A precise description of how to proceed in risk analysis is given in the annex of the guideline (see Chapter 8.4). In addition, the lists of risks are enclosed with this document as an annex. As the information given in the lists of risks is not complete we ask for a sensitive use of this knowledge and the corresponding data. The examples given there shall only help you to orient yourself.

Selection of the operations, hazards, and protection measures included in the lists of risks as well as the risk assessments and the effects of the protection measures were effected in the work groups. Please mind that the assessments are estimates. To define the "correct" assessment has made greatest demands on the work groups. The estimates are based on experiences, which have been gained in particular fields and, consequently, are subject to uncertainty. This could be compensated for by a wide choice of experts and interdisciplinary work groups. Moreover, only those hazards have been included that could be considered involving a risk at the very moment of the risk analysis. Thus, the participants narrowed down the choice.

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

We additionally point out that the risk analysis in the work groups were made on conditions, which have to be connected to the results and taken into account. This means that the data may vary in a user-project as the general set-up differs. Thus, you may have to adapt the data to the project.

# 3 Introduction to risk management

## 3.1 Process of risk management

The risk management is part of the project management and can be described as a systematic and continuous process of identification, analysis, assessment, and treatment of risks. An early implementation of protection measures to delimit the risk optimises the process. The risk management procedure can generally be subdivided into the following activities:

a) establishing a context, in which the basic parameters, criteria, influencing variables, system limits, and objectives are defined;

b) assessing the risks by identifying, analysing, and appraising the hazards and the risks involved;

c) planning and taking proactive protection measures to prevent or reduce the risks;

d) implementing control mechanisms to continuously monitor and study the risk;

e) developing strong communication and documentation structures between the actors involved to link the different fields of knowledge and carefully consider the different interests and views;

f) assigning responsibilities in the risk management procedure to the actors involved so that the fields of responsibility are clearly defined regarding a reduction and prevention of risks.[1]

Activity b) through d) of the risk management procedure are iterative, one based upon another and with mutual effect. Activities e) and f) take place parallel to the other activities.

The risk assessment forms integral part of the risk management procedure as this delivers understanding of hazards, their causes, their consequences, their probabilities of occurence, and their extent of damage as well as the necessity to take protection measures.

This is subdivided into the three stages below, which take place in succession:[2]

- Risk identification
- Risk analysis
- Risk assessment (see Chapter 8.1)

Here, we would like to point out that the risk management procedure should be seen as continuous cyclical improvement process. It shall be repeated again and again to curtail potential risks to an acceptable level on the one hand and to take into account any project changes resulting in the course of time on the other hand.

Literature gives many possible definitions of a risk. The general risk definition (see Chapter 8.1) means for the OCoP that the risks occurring within the scope of erection of an offshore wind farm are (property) damage to all deliveries and services of relevance to the erection itself and delivered (onshore and offshore) as well as any project delays due to such damage.

Damage means any damage to or destruction of an object (property damage) whereas project delay means any delay in the (final) completion that is due to a compensable property damage (loss resulting from a delayed commissioning) of the offshore wind farm.

## 3.2 Risk assessment techniques

Risk assessment techniques should be applied to all life cycle steps of offshore wind farms, thus, to the erection, too. Each actor involved in the erection of offshore wind farms should be responsible for a realisation of risk assessment in his/her field of activities.[3]

There is a multitude of risk assessment techniques differing in the level of details and method (scope of examinations, number and complexity of the selected procedures, etc.) in the corresponding stage and/or field of and requirements for the system or the object under examination.

1 Risk management -- Risk assessment techniques (IEC/ ISO 31010:2009); German version EN 31010:2010, Page 7 et seq.

2 Risk management -- Risk assessment techniques (IEC/ ISO 31010:2009); German version EN 31010:2010, Page 9

3 Risk management -- Risk assessment techniques (IEC/ ISO 31010:2009); German version EN 31010:2010, Page 15

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

Some risk assessment techniques, for instance, only refer to the mere identification of risks whereas other ones cover identification, assessment, evaluation and point out additional protection measures to minimise or prevent the risks. Each person responsible should define the scope of examination with due consideration of the overall risk management as to the continuous cyclical improvement process.[4]

The guideline uses a simple list of risks as risk assessment technique. This gives a first survey of the process steps of erection and the risks involved. The list of risk is based on the risk analysis and, therefore, contains the process steps and operations examined in the OCoP, the determination of hazards, and the deduction of protection measures, as well as an assessment of the risks without and with protection measures.

### 3.3 Documentation, verification, and monitoring of risks

The different steps of the selected risk assessment technique should be adequately documented. To this end, you can draw up different lists, which show the main steps of the technique and determine and assign the responsibility for the risk. The lists should describe at least the hazards and risks of each operation as well as the protection measures required to reduce or prevent such risks. Moreover, they should provide for transparency and comprehensibility regarding the assessments and evaluations of risks and protection measures.

It shall be pointed out, as well, that the deeper the information on hazards, risks, and protection measures are, the less free the user of the lists is to interpret.[5]

In addition to the lists for risk assessment, measures to be taken for orientation and to remind of, establish, and verify the required protection measures should be listed, too. These could e.g. name the persons responsible and state the date of completion, the measures, and the hazards if any.

The documents created for the risk assessment technique should "live". This means that they are subject to regular reviews and - in case of changes in the project (facilities, work equipment, transport means, etc.) and, thus, in the risk assessment - to revision. The documents should be available at any time to ensure transparency regarding the risks and the corresponding measures for prevention and reduction taken during the erection of offshore wind farms.

The systems implemented for risk monitoring (e.g. determination of characteristics of considerable potential influence on the risk assessment and monitoring of them) should be implemented in all stages of erection to record any future context, change, etc.[6]

## 4 Marine Warranty Surveyor (MWS): Possible tasks and responsibilities

For the (erection) insurance of an offshore wind farm, hiring of an MWS as independent third party makes sense. The main job of an MWS is to ensure that the safety guidelines and goals are observed as well as to verify compliance with the procedures agreed upon in the Scope of Work. The MWS shall in particular verify the relevant use parameters (e.g. wind speed, wave height, etc.) with regard to the duration of operation (AdÜ) and the "weather slot".

The MWS makes a big contribution to the implementation of safe procedures during transport and installation of wind farm components and to their insurability. This way, s/he contributes to successful completion of projects.

The insurer and/or the insurance companies involved in the erection of offshore wind farms may propose several MWS to supervise the process. The insured should hire a competent MWS. The insurer and/or the insured should exercise due care when selecting the MWS. The MWS, above all, should prove long-time experience and adequate expertise.

The hired MWS and the loss expert charged upon a damage or loss should not be the same.[7]

If an MWS is hired, the scope of work as defined in the policy shall apply. If required, this can be defined in the kick-off meeting with all parties

4 Risk management -- Risk assessment techniques (IEC/ISO 31010:2009); German version EN 31010:2010, Page 16

5 Risk management -- Risk assessment techniques (IEC/ISO 31010:2009); German version EN 31010:2010, Page 14 et seq.

6 Risk management -- Risk assessment techniques (IEC/ISO 31010:2009); German version EN 31010:2010, Page 15

7 Renewable energies -- Overall survey of Engineering Insurers within the German Insurance Association (GDV) on the level of technological development and the technical hazard potential, Page 117

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

**Table 1:** Distribution of the potential risks of the operations required to install the cables in the wind farm examined in the OCoP (WITHOUT and IN consideration of protection measures)

| Potential risks | Potential risks of the examined operations w/o consideration of protection measures | | Potential risks of the examined operations in consideration of protection measures | |
|---|---|---|---|---|
| | [number] | [percent] | [number] | [percent] |
| low risk | 5 | 15 | 15 | 35 |
| medium risk | 5 | 15 | 13 | 30 |
| high risk | 10 | 29 | 5 | 12 |
| very high risk | 14 | 41 | 1 | 2 |

involved (leading insurance company, the insured, and the MWS). Should the project change fundamentally, the scope of activities shall be reviewed and adapted adequately. The MWS should accompany the erection of an offshore wind farm just from the beginning and be involved in the corresponding project meetings of the builders early.[8]

In addition to the above stated main task of the MWS, there are other activities that refer to surveillance and verification of the procedures during marine transport and installation.

These activities can be subdivided in the desktop analysis and the on-site inspection. In the desktop analysis, the documents, plans, calculations, etc. shall be looked through and reviewed. These documents contain among other things an analysis of the site conditions (e.g. ambient and soil conditions), job descriptions, as well as information on shipping, sea-fastening, transport, any installation procedure, and installation of undersea cables.

Furthermore, the MWS shall review whether the means for transport and installation as well as other equipment required for erection meet the technical requirements and prove corresponding approvals for the works they are intended for. During the on-site inspection, the MWS checks how the works have been put into practice and whether they correspond to the already approved plans resulting from the desktop analysis. This affects the ships and equipment used as well as the cargo handling, stowing, fastening of the shipment on the transport means, the transport itself, raising and setting upright the transported offshore wind farm components, the transformer station, as well as undersea cable assembly and laying. Upon completion of the corresponding works and having inspected them, the MWS signs the inspection certificates with a list of his/her activities and findings.[9]

If the parties involved have agreed upon hiring of MWS, normally the insurance is subject to the MWS approval of operations, equipment, etc. If the MWS does not approve an operation, an equipment, etc., s/he gives the insured recommendations how to get the approval / acceptance certificate.

The insured should implement the recommendations of the MWS to prevent withdrawal of insurance coverage for the corresponding activity. The recommendations and/or those implemented are noted down on an approval certificate and handed out to the insurer upon request.[10]

The entrusted MWS shall grant final approval of the activities. Starting of the work before having get this final approval may be a violation of the insurance contract; this depends on the actual wording. In such a case the insured shall bear the risk from this very moment. Should both, the insurer and the insured, have hired an MWS, it is recommendable - as experience has shown - to stipulate with binding force and in advance, the approval or refusal of whom shall be considered for which procedures.[11]

8 Renewable energies -- Overall survey of Engineering Insurers within the German Insurance Association (GDV) on the level of technological development and the technical hazard potential, Page 117

9 Marine Warranty Surveying, Page 25 et seq.

10 Renewable energies -- Overall survey of Engineering Insurers within the German Insurance Association (GDV) on the level of technological development and the technical hazard potential, Page 118

11 Renewable energies -- Overall survey of Engineering Insurers within the German Insurance Association (GDV) on the level of technological development and the technical hazard potential, Page 117

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

# 5 Representation of significant risks when building offshore wind farms

Please find in the paragraphs below the process steps of erection defined in the OCoP for the trades of cabling in wind farms, offshore transformer station in wind farms, and offshore wind turbine

Moreover, the significant risks remaining even after taking protection measures are stated for the corresponding process steps. The significant risks are based on the results of the risk analysis.

## 5.1 Cabling in wind farms

### 5.1.1 List of process steps under review

The cabling in wind farms considered in the OCoP is composed of the process steps below:

a) execution planning of the soil investigation for the installation of cables in the wind farm;

b) soil investigation for the installation of cables in the wind farm;

c) execution planning of the transport (inland and offshore transport) and of the installation of the cables in the wind farm;

d) execution planning of the connection of the cables in the wind farm;

e) execution planning of the commissioning and the test run until getting the PAC;

f) transport (inland and offshore transport) and of the installation of the cables in the wind farm;

g) connections (installation) of the cables in the wind farm;

h) commissioning and test run until getting the PAC.

### 5.1.2 Representation of significant risks when installing the cables in wind farms

There have been 34 risks identified and assessed throughout the installation process of cables in the wind farm. Most of them (about 70 %) are of high up to very high potential risk without consideration of protection measures, which can reduce or prevent the risks. The implementation of several protection measures mitigates the hazards of high to very high potential risk by about 56 %. Table 1 overviews the distribution of the potential risk in and without consideration of the protection measures.

The hazards showing a high to very high potential risk despite any protection measures are described below in detail with regard to the process steps. These are process step c) and process step f) because the other process steps have not shown any significant risks during installation of the cables in the wind farm.

**Process step c):**
**Execution planning of the transport (inland and offshore transport) and of the installation of the cables in the wind farm**

A high potential risk involves the resource planning, i.e. resources are unsuitable or not available at all. For instance, the personnel has not gained sufficient experience so far, the technical requirements for the ships and the installation equipment do not correspond to the task and the sea area (weather, soil, etc.).

The selection of the equipment for laying of cables involves a high potential risk; i.e. the selected equipment is unsuitable to the laying work.

The execution planning of laying work involves a high potential risk; i.e. alternative plans for possible interruptions of laying are not developed. Interruptions could occur, e.g. by short-term changes in weather, natural hazards, etc.

**Process step c):**
**Transport (inland and offshore transport) and of the installation of the cables in the wind farm**

Laying the cables in the offshore wind farm involves a high potential risk. During this process step, above all damage to the cable and equipment are possible.

Trenching and laying the cables in the wind warm into the soil involves a high potential risk; i.e. the trench depth and/or the thickness of the soil covering the cable is insufficient.

Ploughing of the cables in the wind farm involves a high potential risk; i.e. this method can cause damage to the cable.

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

**Table 2:** Distribution of the potential risks of the operations required to build the offshore transformer station examined in the OCoP (WITHOUT and IN consideration of protection measures)

| Potential risks | Potential risks of the examined operations w/o consideration of protection measures | | Potential risks of the examined operations in consideration of protection measures | |
|---|---|---|---|---|
| | [number] | [percent] | [number] | [percent] |
| low risk | 6 | 3 | 103 | 54 |
| medium risk | 32 | 17 | 74 | 39 |
| high risk | 100 | 53 | 13 | 7 |
| very high risk | 52 | 27 | 0 | 0 |

## 5.2 Offshore transformer stations in wind farms

### 5.2.1 List of process steps under review

The building of the offshore transformer station in wind farms considered in the OCoP is composed of the process steps below:

a) execution planning of the soil investigation for the site of the offshore transformer station in the wind farm;

a) soil investigation for the site of the offshore transformer station in the wind farm;

c) execution planning of the inland transport (overland and rivers) from the factory to the offshore port;

d) execution planning of the storage in the offshore port and the onshore assembly there;

e) execution planning of offshore transports;

f) execution planning of offshore erection;

g) execution planning of residual assembly work offshore;

h) execution planning of the commissioning and the test run until getting the PAC;

i) inland transport (overland and rivers) from the factory to the offshore port;

j) storage in the offshore port and the onshore assembly there;

k) offshore transports;

l) offshore erection;

m) residual assembly work offshore;

n) commissioning and test run until getting the PAC.

### 5.2.2 Representation of significant risks when building the offshore transformer stations in wind farms

There have been 190 risks identified and assessed throughout the installation process of the offshore transformer station in the wind farm. Most of them (about 80 %) are of high up to very high potential risk without consideration of protection measures, which can reduce or prevent the risks.

The implementation of several protection measures mitigates the hazards of high to very high potential risk by about 73 %. Table 2 overviews the distribution of the potential risk in and without consideration of the protection measures.

The hazards showing a high to very high potential risk despite any protection measures are described below in detail with regard to the process steps. These are process step b), process step j), process step k), process step l), and process step n). The other process steps required to build the offshore transformer station in the wind farm do not involve any significant risks.

**Process step b):**
**Soil investigation for the site of the offshore transformer station in the wind farm**

A high potential risk occurs in case the actual soil conditions significantly deviate from the geological, geophysical, and geotechnical investigation results. The consequences are as follows:

- insufficient stability of the installation points of the offshore transformer station in the wind farm;

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

- feasibility of driving and footing (piling) due to the conditions of the sea ground is not ensured;
- insufficient levelling due to variations in the thickness of bearing beds (ruggedness);
- search for ammunition (not considered separately in the OCoP);
- objects and/or obstacles at the pile positions (e.g. wrecks, undersea cable, etc.).

These potential hazards can cause different adverse effects on the erection of the offshore wind turbines; e.g.

- an installation of the offshore transformer station of the wind farm at the planned position is impossible so that the position has to be turned down;
- the ram piles cannot be rammed down to the planned depth;
- the ram piles can be subject to deformation;
- the ramming equipment can be damaged;
- the ram piles are unsuitable for the soil;
- the ram piles become stuck in the sea ground during ramming because they are blocked by objects;
- yet not discovered ammunition is found in the ramming area, so that explosion can cause damage to or loss of piles, installation work equipment, and transport means as well as injury to the personnel.

As a consequence, the pile positions have to be adjusted correspondingly to the changed and perhaps more unfavourable soil conditions so that the defined positions could have to be turned down, which could cause a project delay and considerable extra expenses.

**Process step j):**
**Storage in the offshore port and the onshore assembly there**

The provision of material and components for an onshore assembly in the offshore port involves a high potential risk; i.e. delivery of components is delayed.

The provision of material and components for an onshore assembly in the offshore port involves a high potential risk; i.e. the quality supplied by the suppliers is not reliable (not in compliance with product specifications, not on schedule).

The provision of material and components for an onshore assembly in the offshore port involves a high potential risk; i.e.unsuitable components and materials are installed, which - provided that this is revealed early - have to be dismounted and replaced.

Provision of personnel involves a high potential risk; i.e. the personnel recruited for onshore assembly in the offshore port is insufficiently trained and not skilled.

**Process step k):**
**Offshore transports**

The offshore transport "on own hull" involves a high potential risk regarding the buoyancy of the topside of the offshore transformer station in the wind farm. The topside can capsize and/or sink. This can cause damage to the topside and the equipment installed or even the total loss of the topside followed by delays throughout the entire project and damage to fixed and other floating objects and the environment.

Floating into position of the topside (separate and combined unit) involve another high potential risk; i.e. monitoring of the sea state and weather conditions shows a sudden change in the weather. This can entail too heavy wind and gusts, too rough sea(s), and too strong currents in the different depths of water.

This adversely affects installation of the anchor grid and connecting the mooring ropes to the anchor grid because this is impossible then. Moreover, it is possible that floating into position becomes impossible. This can cause a delay in positioning and installation.

**Process step l):**
**Offshore erection**

The jack-down procedure of the movable legs and alignment of the topside involve a high potential risk if this procedure is required. Here, the jack-up system can fail so that

- no jacking is possible at all,
- jack-up and installation become delayed.

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

**Table 3:** Distribution of the potential risks of the operations required to build the offshore wind turbines examined in the OCoP (WITHOUT and IN consideration of protection measures)

| Potential risks | Potential risks of the examined operations w/o consideration of protection measures | | Potential risks of the examined operations in consideration of protection measures | |
|---|---|---|---|---|
| | [number] | [percent] | [number] | [percent] |
| low risk | 15 | 5 | 126 | 43 |
| medium risk | 117 | 40 | 156 | 53 |
| high risk | 142 | 48 | 13 | 4 |
| very high risk | 21 | 7 | 0 | 0 |

The jack-up procedure (in up direction) involves a high potential risk if this procedure is required. Here, the jack-up system can fail so that

- no jacking is possible at all,
- damage to the topside and/or the legs occurs if the topside has not been jacked up out of the tidal limit or wave peak (this is called slamming);
- jack-up and installation become delayed.

The jack-up procedure involves a high potential risk if this procedure is required. The hazard occurs during monitoring of the sea state and weather conditions when a sudden change in weather becomes obvious. This can entail too heavy wind and gusts, too rough sea(s), and too strong currents in the different depths of water. This adversely affects the jack-up procedure; i.e. this becomes impossible and damage to the topside by slamming can occur. This can cause a delay in jack-up and installation.

Lifting (lifting and depositing) of the topside involves a high potential risk if the transformer platform is deposited directly onto the foundation. This is the case if it is composed of small, separate units and work is effected with crane vessels and/or jack-up barges/vessels. Here, the topside can swing, twist, and touch down as a result of an uneven distribution of loads (either the centre of gravity is far beyond the vertical axis of the topside or by touching down onto the base frame / pile or any other structure). This can cause:

- falling of the spreader from the hooks,
- damage to the topside, the footing structure (base structure), the crane vessel, the barge, and/or other structures due to collision with the topside,
- a delay in lifting and installing.

**Process step n):**
**Commissioning and test run until getting the PAC.**

Commissioning of the medium-voltage switchgear involves a high potential risk if a fire cause damage to the medium-voltage switchgears, the transformers, or the connected electrical components. Synchronising faults are possible, too.

Electrical connection to the offshore transformer station of the transmission grid operator involves a high potential risk. There is the risk that fires and damage to the low-voltage, medium-voltage, and high-voltage switchgears, the transformers, and connected electrical components occur.

## 5.3 Offshore wind turbine

### 5.3.1 List of process steps under review

The building of the offshore wind turbine considered in the OCoP is composed of the process steps below:

a) execution planning of the soil investigation for locations of offshore wind turbines;

a) soil investigation for locations of offshore wind turbines;

c) execution planning of the inland transport (overland and rivers) from the factory to the offshore port;

d) execution planning of the storage in the offshore port and the onshore assembly there;

e) execution planning of offshore transports;

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

f) execution planning of offshore erection;

f) execution planning of residual assembly work offshore;

h) execution planning of the commissioning and the test run until getting the PAC;

i) inland transport (overland and rivers) from the factory to the offshore port;

j) storage in the offshore port and the onshore assembly there;

k) offshore transports;

l) offshore erection;

m) residual assembly work offshore;

n) commissioning and test run until getting the PAC.

### 5.3.2 Representation of significant risks when building offshore wind turbines

There have been 295 risks identified and assessed throughout the installation process of the offshore wind turbines in the wind farm. Most of them (about 55 %) are of high up to very high potential risk without consideration of protection measures, which, however, can reduce or prevent the risks.

The implementation of several protection measures mitigates the hazards of high to very high potential risk by about 51 %. Table 3 overviews the distribution of the potential risk in and without consideration of the protection measures.

The hazards showing a high to very high potential risk despite any protection measures are described below in detail with regard to the process steps. These are process step b), process step c), process step i), process step j), process step l), and process step n) because the other process steps have not shown any significant risks during erection of the offshore transformer station in the wind farm.

**Process step b):**
**Soil investigation for locations of offshore wind turbines**

A high potential risk occurs in case the actual soil conditions significantly deviate from the geological, geophysical, and geotechnical investigation results. The consequences are as follows:

- the ground does not prove the characteristics required for the planned foundation method (e.g. due to soft sediment lenses);
- feasibility of driving and footing (piling) due to the conditions of the sea ground is not ensured;
- insufficient levelling due to variations in the thickness of bearing beds (ruggedness);
- search for ammunition (not considered separately in the OCoP);
- objects and/or obstacles at the pile positions (e.g. wrecks, undersea cables, etc.).

These potential hazards can cause different adverse effects on the erection of the offshore wind turbines; e.g.

- an installation of the footing structure at the planned position is impossible so that the position has to be turned down;
- the ram piles cannot be rammed down to the planned depth;
- the ram piles can be subject to deformation;
- the ramming equipment can be damaged;
- the ram piles are unsuitable for the soil;
- the ram piles become stuck in the sea ground during ramming because they are blocked by objects;
- the OCoP has not considered the search for ammunition;
- risks for stability and usability can occur if the soil investigation has been insufficient.

Therefore, e.g. the positions of piles, their design, or procedures have to be adapted to the most unfavourable soil conditions as the case may be. This can entail project delays and considerable increases in costs.

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

**Process step c):**
**Execution planning of the inland transport (overland and rivers) from the factory to the offshore port**

Reservation of human resource and equipment capacity required for the inland transport of offshore wind turbine involves a high potential risk; i.e. any reserves for their/its availability have not been allowed for. Thus, personnel and equipment are available at stated times, only.

Reservation of human resource and equipment capacity involves a high potential risk; i.e. any reserves for the human resource and equipment capacity have not been allowed for. The number of personnel is sufficient; however, it has been calculated without any allowance for deviations. Mounting equipment and means are sufficient as to their output capacity; however, they are insufficient as to their output capacity if the load increases and cannot be used then.

Reservation of resource and equipment capacity involves a high potential risk; i.e. any redundancies for potential faults have not been allowed for.

**Process step i):**
**Inland transport (overland and rivers) from the factory to the offshore port**

The inland transport of tower segments involve a high potential risk; i.e. the tower could be subject to deformation due to an uneven load distribution.

**Process step j):**
**Storage in the offshore port and the onshore assembly there**

The check of the ram piles upon the inland transport as operation to prepare the offshore transport involves a high potential risk; i.e. the checks are not carried out in a workmanlike manner and, as a consequence, damage (e.g. due to improper transport, loading, and storage) is not detected.

The onshore assembly of the footing structure and the transition piece involves a high potential risk. If damage due to improper inland transport or improper loading is not detected, there is a high risk that the onshore assembly of the footing structure and the transition piece becomes impossible.

The onshore assembly of the three rotor blades and the rotor hub to the rotor star involves a high potential risk. Improper lifting, loading, or improper inland transports could have caused damage.

**Process step l):**
**Offshore erection**

The jack-down procedure of the movable legs until getting stability carried out by the jack-up barge/vessel during installation of the base structure of offshore wind turbines involves a high potential risk; i.e.

- the jack-up system could fail,
- the movable legs could sink unevenly deep into the seabed,
- the soil is inhomogeneous or erratic blocks (monoliths) could be there,
- jack-up procedures have been carried out there already (old foot print).

These hazards can adversely affect the offshore erection of offshore wind turbines; i.e.

- jack-up becomes impossible,
- the movable legs and the jack-up mechanisms could be damaged.

This can cause delays during jack-up and/or installation and entail additional costs.

The jack-up procedure of the jack-up barge/vessel during installation of the tower and the turbine of the offshore wind turbines involves another high potential risk; i.e. under load the movable legs sink unevenly deep into the seabed.

**Process step n):**
**Commissioning and test run until getting the PAC.**

The installation work, tests, checks, etc. carried out during commissioning involve a high potential risk. During installation etc., heat intensive tasks (welding, abrasive cutting, etc.) or e.g. the test run of electric devices in connection with fire load can cause fire and explosions. Increased fire loads, such as stored fuel quantities to run emergency generators, cannot be excluded and present an increased danger compared to standard operation.

There is a high potential risk if the external power connection is not available for installation work, tests, inspections, etc.

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

# 6 Conclusion and prospects

Starting from the objective of the present guideline as set out in detail in the preface we can conclude as follows from the risk analysis effected.

On the basis of the lists of risks drawn up we could gain an impression of the process steps and operations during erection and the risks coming along with them. The descriptions of significant risks are to be considered exemplary and not to be equated with the project specific requirements of the user. The user's attention is drawn to certain risks; however, s/he shall be able to transfer the significant risks with regard to the actual requirements upon a specific consideration of the project.

Taking protection measures can considerably reduce the risks during erection of an offshore wind farm. This accentuates the need for a preventive implementation of the risk management procedure.

There are mostly significant risks for individual operations during erection. The relevant protection measures to reduce or prevent the risks mostly refer to activities of execution planning and preparation. Thus, planning and preparation is essential for erection of offshore wind farms, for the execution of operations finally shows how good planning and preparation had been. Please note here that the hazards and risks of a single process step should perhaps be taken into account already when drawing up the first concept provided that they can be changed, e.g. by selection of a different design option.

In the trades offshore transformer station in wind farms and offshore wind turbines recurring risks occur in the process steps "soil investigations", "offshore erection", and "commissioning and test run until getting the PAC".

The meeting of more than 90 representatives of the offshore and the insurance business started within the scope of the OCoP initiative a dialogue regarding the erection of offshore wind farms with its main focus on the exchange of information on risks and possible protection measures. Here, particularly those coming from the industry learned about the necessity that the risk analysis should be even more detailed. For the lists of risks presented in the OCoP already give a first impression of the processes run, potential risks, and protection measures.

To minimise the scope of interpretation of a risk analysis or even prevent any interpretation at all, deepest information on hazards, risks, and protection measures are supportive. Such supplementary information could possibly be gained and provide for a uniform view of things with a procedure which is quite usual in the industrial sector. A possible procedure is e.g. the failure mode and effect analysis (FMEA), which again can be supplemented with the failure mode, effects and criticality analysis (FMECA).

The FMEA is a procedure to determine the kind of a failure, malfunction, damage, or potential fault. An FMEA or FMECA, respectively, proves advantageous because e.g.

- this is preventive quality assurance with its focus on the prevention of failures instead of their removal;
- this is a continuous cyclical improvement process;
- this can be applied to any stage in the lifecycle of a system, product, process, etc.;
- this is a systematised method, the results of which are documented in an easily readable manner;
- the systematised method results in a high level of detail to investigate on the one hand into the potential failures, the failure causes, and consequences / effects of failures. On the other hand, these are analysed regarding the relevance of the sequence of failures / effect, the probability of existence of the failure cause, and the probability of discovery of the failure;
- this provides for detection of significant and/or critical failures in e.g. a process and for establishment of measures to reduce and prevent such;[12]
- the (AdÜ: groß?) mentioned process steps of high risk require thorough planning of execution with adequate appreciation of the risks and development of the protection measures to be taken, which are perfectly adjusted to the offshore wind farm project.

12 Risk management -- Risk assessment techniques (IEC/ISO 31010:2009); German version EN 31010:2010, Page 45 et seq.; Methoden der Risikoanalyse in der Technik [Methods of risk analysis in technology]; Systematische Analyse komplexer Systeme [Systematic analysis of complex systems], Page 30 et seq.; Gefährdungsanalyse mit FMEA [Risk analysis with FMEA]; DIN EN 60812:2006-11

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

Furthermore, it would be reasonable to create a uniform understanding of how to apply risk assessment techniques in practice. For erection and other processes throughout the lifecycle of an offshore wind farm are very complex and extensive processes involving different actors or companies, respectively. The present OCoP shall provide for a common understanding of the importance of cross-trade and cross-company risk transparency and places a guide for practical use at your disposal. The FMEA is one possibility to put the findings obtained in the OCoP into action.

# 7 Literature / references

## 7.1 Suppliers

[1] Standards
Beuth Verlag GmbH, Am DIN-Platz
Burggrafenstraße 6, D-10787 Berlin
www.beuth.de

[2] VDE standards
[German Association for Electrical, Electronic & Information Technologies]
VDE-Verlag GmbH
Bismarckstraße 33, D-10625 Berlin
www.vde.com

[3] Publications of GDV
[German Insurance Association]
Gesamtverband der Deutschen Versicherungswirtschaft e. V. (GDV)
Wilhelmstraße 43/43 G, D-10117 Berlin
www.gdv.de

## 7.2 Literature

Beuth: DIN EN 50126; Railway applications - The specification and demonstration of reliability, availability, maintainability and safety (RAMS); German version EN 50126:1999; 1999

Beuth: DIN EN 31010; Risk assessment techniques; German version EN 31010:2010; 2010
Bundesamt für Seeschifffahrt und Hydrographie (BSH - Federal Maritime and Hydrographic Agency): Standard - Design of Offshore Wind Turbines, http://www.bsh.de/en/Products/Books/Standard/7005eng.pdf; 2007
Bundesamt für Seeschifffahrt und Hydrographie (BSH - Federal Maritime and Hydrographic Agency): Ground Investigations for Offshore Wind Farms
http://www.bsh.de/en/Products/Books/Standard/7004eng.pdf; 2008

Eberhardt, O.: Gefährdungsanalysen mit FMEA [Risk analyses through FMEA];
DIN EN 60812:2006-11
Gasch, Prof. Dr.-Ing. R.; Twele, Dr.-Ing. J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb [Wind-power plants - basics, design, engineering, and operation] , 6th revised and corrected edition; Publishing house: Vieweg + Teubner; Wiesbaden; 2010

Overall survey of Engineering Insurers within the German Insurance Association (GDV) on the level of technological development and the technical hazard potential; 2013
http://www.gdv.de/wp-content/uploads/2013/04/GDV-Broschuere_Erneuerbare_Energien_2013.pdf

International Tunneling Insurance Group (ITIG): Richtlinien zum Risikomanagement von Tunnelprojekten [Guidelines on the risk management of tunnel projects]; 2006

Mähl, D.; Vogel, A.: Überwachung von Marine-Operationen; Sicherheit auf See in [supervision of marine operations, offshore safety in]: BWK, DAS ENERGIE-FACHMAGAZIN [a trade journal for power companies]; volume 64; No. 11; Erneuerbare Energien; Windenergie [renewable energy; wind power]; Pages 25 – 26; 2012

# 8 Annex

## 8.1 Glossary

**Erection:** The erection is one stage of the life cycle of products and/or offshore wind farms ranging from product development to recycling. The life cycle is subdivided into planning, external design, engineering and design, manufacture, erection, operation, repowering if required, dismantling, and recycling.

The erection in the OCoP chronologically refers to the inland transport (overland and rivers), the onshore assembly, the offshore transport, the offshore erection, the residual assembly work offshore, the commissioning, and the test run. As it is really important, the soil investigation within the installation process is listed as an excursus ahead of the inland transport.

**Hazard**: A hazard is an event, condition, or property presenting a potential source of damage and upon occurrence being of adverse effect on persons, material assets (buildings, operating

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

equipment, stocks, and plants), the environment - including costs and deadlines.[13]

**Cabling in wind farms:** Cabling in wind farms means laying the cables between the individual offshore wind turbines including their junction and connexion to the offshore transformer station in the wind farm.[14]

**Marine Warranty Surveyor:** The MWS is an independent expert. His/her main job is to ensure that the safety guidelines and goals are observed as well as to verify compliance with all procedures.

**Offshore wind farm:** Based on the definition of the the Federal Maritime and Hydrographic Agency - the BSH - offshore wind farms are composed of the main crafts below:

- Offshore wind turbine
- Cabling in wind farms
- Platforms (sub-stations), such as the offshore transformer station in wind farms, the offshore transformer stations (DC transformer station) normally operated by the grid operator, the living and working station, and other stations in the farm (met mast etc.)
- Undersea cable [15]

The OCoP covers the trades: offshore wind turbine, cabling in wind farms, and offshore transformer station in wind farms.

**Offshore wind turbine:** The offshore wind turbine includes the turbine itself and the support structure. The turbine is composed of the rotor and the nacelle. The support structure is composed of the tower and the base structure. Normally, the base structure is composed of the transition piece and the foundation including local fastening into the seabed (footing structure or pile).[16]

**Offshore transformer station in wind farms:** There are several constructions of offshore transformer station in wind farm. However, this stations is generally composed of a topside and a base structure (or base frame). In addition, the platform houses electrical components (transformers, medium- and low-voltage switchgears, etc.) technical safety equipment, ancillary equipment (cranes, helicopter deck, etc.). Normally, the base structure is composed of the foundation and the footing structure.

The offshore transformer station in wind farms may be designed in two different ways. These are the separate and the combined design. In separate design, the base structure and the topside are separate, i.e. transport and assembly can be effected separately. In combined design, the base structure and the topside are connected already before starting the offshore transport.

**Project delays:** Project delays result from a delayed completion (of the entire project) that is due to a compensable property damage (loss resulting from a delayed start-up) of the offshore wind farm and the following delay in getting the PAC.

**Provisional Acceptance Certificate:** The PAC is a formal procedure, at the end of which a certificate is issued attesting delivery of the works from the contractor to the customer. Thereupon the test run of the offshore wind farm ends.

**Risk:** A risk is the combination of probability of occurrence of a hazard causing a damage and the extent of damage.[17]

Risk in general means:

**Risk = probability of occurrence x extent of damage**[18]

**Risk analysis:** The risk analysis includes at least the estimation of the extent of damage and the probability of occurrence of the hazards determined through the risk identification. As a rule, this takes the existence and effectiveness of already existing protection measures into account.[19]

**Risk assessment:** The risk assessment compares the results from the risk analysis to the set targets, criteria, etc., which have been defined in AdÜ? This helps to make decisions regarding

13 Methoden der Risikoanalyse in der Technik [Methods of risk analysis in technology]; Systematische Analyse komplexer Systeme [Systematic analysis of complex systems], Page 8

14 Standard - Design of Offshore Wind Turbines, Page 5

15 Standard - Design of Offshore Wind Turbines, Page 5

16 Standard - Design of Offshore Wind Turbines, Page 11

17 ISO/IEC Guide 73 - Risk Management

18 Methoden der Risikoanalyse in der Technik [Methods of risk analysis in technology]; Systematische Analyse komplexer Systeme [Systematic analysis of complex systems], Page 8 et seq.

19 Risk management -- Risk assessment techniques (IEC/ISO 31010:2009); German version EN 31010:2010, Page 11 et seq.

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

the necessity and implementation of protection measures to reduce and prevent the risk.[20]

**Risk identification:** The risk identification means searching for, detection, and recording of hazards with regard to their causes and effects.[21]

**Risk management:** Based on DIN EN 31010, risk management means rating and control of risks so as to be able to cope with the risks inherent to an organisation, a process, etc. The risk management is a systematic, cyclical, continuous improvement process. This should be repeated again and again until the potential risks will have reached acceptable levels on the one hand and to take into account any project changes resulting in the course of time on the other hand. Thus, this is repeated again and again until the potential risks will have reached acceptable levels on the one hand and to take into account any project changes resulting in the course of time.[22] (AdÜ: Überflüssig - siehe 1 Satz weiter oben?)

**Property damage:** Property damage results from the damage to or destruction of an object.

**Protection measures:** These are preventive measures taken to reduce or prevent a risk. This means, that the protection measures can both, reduce the probability of occurrence of a hazard and cut down the extent of damage.

### 8.2 List of abbreviations

**BSH** Bundesamt für Seeschifffahrt und Hydrographie [Federal Maritime and Hydrographic Agency]

**DC** direct current

**EWTC** European Wind Turbine Committee

**FMEA** Failure Mode and Effect Analysis

**FMECA** Failure Mode, Effects, and Criticality Analysis

**GDV** Gesamtverband der Deutschen Versicherungswirtschaft e. V. [German Insurance Association]

**MWS** Marine Warranty Surveyor

**OCoP** Offshore Code of Practice

**PAC** Provisional Acceptance Certificate

### 8.3 List of companies involved in the risk analysis

This is the opportunity to thank anyone involved in the development of the OCoP for his/her cooperation and commitment!

On Page 3 of the OCoP, you will find a list of the companies involved in the risk analysis

### 8.4 Explanatory notes on the lists of risks

The risk analysis made together with representatives of the offshore wind power industry is fundamental to the guideline. This is the definition and assessment of risks and relevant protection measures for any important operation. Documentation was effected into corresponding lists of risks revealing the significant risks.

The instructions on how to proceed (see Table 4) inform on how to analyse the risk and draw up a corresponding list. These were used among other things as a guide in the meetings of the work groups to perform the analysis and note down the results.

20 Risk management -- Risk assessment techniques (IEC/ISO 31010:2009); German version EN 31010:2010, Page 14

21 Risk management -- Risk assessment techniques (IEC/ISO 31010:2009); German version EN 31010:2010, Page 10

22 Risk management -- Risk assessment techniques (IEC/ISO 31010:2009); German version EN 31010:2010, Page 5 et seq.

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

**Table 4:** Instructions on how to proceed in the risk analysis and drawing up the lists of risks.

| Column header | Explanatory notes on how to fill the cells of the list of risk |
|---|---|
| **Id**<br>(manual entry) | A common identification code is assigned to the process steps and, thus, to the corresponding operations so that later selection of an entire process step will be possible.<br>The identification code of the process step is composed of letters. This has been defined for each process step and cannot be changed by the user. |
| **Name of the process step**<br>(manual entry) | This is a catchy header describing the process step. The process steps have been selected so that they can be differentiated from each other. Those corresponds to the differentiations of work groups 1 through 3 so as to allow corresponding allocation of the packages.<br>The descriptions of the different process steps have been defined for each trade and cannot be changed by the user.<br>*Example: Execution planning of offshore transports* |
| **Short description of operations**<br>(manual entry) | Each process step can be followed by any number of operations and their descriptions. Each operation gets an own line.<br>*Example: Planning of necessary barges / tugboats; planning of necessary sea-fastening; manpower planning MWS; etc.* |
| **Description of hazards**<br>(manual entry) | Detailed description of any important hazard, which could occur during the corresponding operation. Several hazards per operation are possible. Each hazard described gets an own line.<br>*Example: Barge unsuitable for mass of footing structure; loss of footing structure due to unfavourable wind conditions / sea state; loss of footing structure due to poor sea-fastening; etc.* |
| **Assessment: risk**<br>(manual entry) | Assessment of the risk without consideration of the protection measures listed below. The assessment classifies into 4 categories:<br>■ low risk<br>■ medium risk<br>■ high risk<br>■ very high risk<br>The assessment is made in view of the extent of property damage and loss due to delay as well as of the probability of occurrence based on the experiences the participants of the work group have gained. As to the property damage and losses due to delay, the potential financial loss has been estimated. |
| **Description of protection measures**<br>(manual entry) | For each listed hazard, possible protection measures are named, which can reduce the probability of occurrence and/or cut down the extent of damage. It is possible that a sufficient protective effect can be reached only with a combination of several protection measures. Point to this in the field for comments. Each protection measure described gets an own line.<br>Even if in practice further protection measures are possible, the number of protection measures for the risk analysis ought to be limited to 5.<br>*Examples: Defining max. wind speeds and/or wave heights for transport of the footing structure; approval of sea-fastening by MWS; defining the minimum weather slot when transport and depositing in the target area shall be complete; etc.* |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Column header | Explanatory notes on how to fill the cells of the list of risk |
|---|---|
| **Assessment of protection measure**<br>(manual entry) | How effective is the protection measure and can it reduce the risk? The assessment classifies into 3 categories:<br>■ very good<br>■ adequate<br>■ poor<br>The effect of a protection measure is very good if taking the measure almost excludes the risk resulting from a hazard (damage to property / loss due to delay) as far as our experience goes; i.e. if the risk can be controlled.<br>The effect of a protection measure is adequate if taking the measure noticeably reduces the risk resulting from a hazard (damage to property / loss due to delay) as far as our experience goes. The protection measures noticeably cut down the risk.<br>The effect of a protection measure is poor if taking the measure hardly reduces the risk resulting from a hazard (damage to property / loss due to delay) or does not reduce it at all as far as our experience goes, i.e. the risk will persist although the protection measure is taken.<br>The assessment of the effectiveness of protection measures is also based on the experiences the participants of the work group have gained. |
| **Relevance**<br>(automatic entry - calculation field) | The risk relevance is automatically calculated from the risk assessment and the assessment of the effectiveness of a protection measure and classified into 12 grades. The higher the relevance, the larger the damage to be expected or the delay when the risk come true. |
| **Risk status**<br>(automatic entry - calculation field) | The risk status informs about the potential risk in consideration of the aforementioned protection measures. The assessment automatically classifies into 4 categories:<br>■ low risk<br>■ medium risk<br>■ high risk<br>■ very high risk.<br>The automatic calculation of the risk status uses the relevance grade.<br>If the desired protection objective can be reached only by taking several protection measures to compensate for a risk, any of the protection measures involved are to be classified "low risk". However, in such a case a comment on the common establishment of the protection measures has to be given in all comment fields. |
| **Comments**<br>(manual entry) | Supplementary description of the risk or the protection measures so that any third person not being involved (fundamentals in the field assumed) is able to understand the statements. Upon completion and evaluation of the risk analysis, these comments shall be of assistance when writing out the OCoP in full. |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

# 9 Lists of risks

## 9.1 Offshore transformer stations in wind farms

9.1

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| c) | Planning of transport | No planning of individual transport stages | high |
| c) | Notification of insurer<br>Designation of warranty surveyor | Notification of insurers / warranty surveyors too late<br>Present risk analysis only applies to first transport stage (e.g. until unloading in seaport)<br>Required transport eyes or necessary protection against environmental impact offshore missing<br>Once the cargo is ready, the expenditure for an optimum adjustment to the necessary changes is often inacceptable - from the economic point of view<br>Thus, acceptance of compromises resulting in cutbacks of safety standards<br>Unplanned delays result<br>Already rented transport means and hoists could be lacking then | medium |
| c) | Determination of final transport route | Impracticability and/or considerable delays due to missing or poor planning of the entire transport route | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.1 |
|---|---|---|---|---|---|
| Draw up a transport manual for all stages, start with the manufacturer and end up with the final destination<br>Risk analysis with protection measures per stage<br>Emergency planning / emergency locations per stage | very good | 3 | low risk | Avoid organisation blindness by old hands | |
| As soon as the insurer has received a request for coverage:<br>▪ Entrust inspector with preliminary examination of the transport concept<br>▪ Require method statements just being developed for the different handling and lifting procedures<br>▪ Request submission of rough calculations of the fastening points for lifting and securing of cargo<br>▪ Request submission of the specific criteria for transport of the cargo | very good | 3 | low risk | Very often the insured hires several sub-contractors with even more sub-contractors<br>It takes a lot of time until the chain of suppliers and their responsibilities will be clear and the surveyor will have the necessary documents on hand<br>Beyond doubt, each sub-contractor / forwarding agent is an expert in its field<br>But this does not inevitably mean that the particularity of the following stage is recognised<br>Therefore, an inspection company shall examine the issues of the entire transport chain | |
| On the basis of the scheduled transport date:<br>Entire transport route / transport chain shall be on hand<br>The inspector examines any method statement for any single route and any single lifting procedure<br>The inspector verifies the risk analysis and the protection measures for any single stage including the planned emergency locations and emergency measures<br>Verification of the calculations of the fastening points for lifting and securing of cargo and examination of the sling gear to lift and of the securing of cargo<br>The inspector checks for potential compliance with the specific criteria of the cargo for transport under the planned conditions | very good | 3 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.1

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| c) | Pre-check of trans-port route | Unpracticability of transport due to hindrances on the transport route | high |
| c) | Selection of transport means per stage | Insufficient stability of the transport means with cargo<br>Unsuitable for selected transport route | high |
| c) | Preparations for transport of the cargo | Insufficient protection by packaging<br>Changing environmental impact on different stages and transport means (road, inland waterways, open sea) not taken into account when preparing for the transport<br>The shipping inserts, the external packaging of cargo, and the securing of cargo on the corresponding transport means and per stage not always proper | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.1 |
|---|---|---|---|---|---|
| Proof for checks of route sections (maximum allowed load on roads, bridges, etc. as well as turning radii of bends)<br>Locations where temporary dismounting of obstacles is required and corresponding permits on hand?<br>Appropriate companies hired for such dismounting?<br>List of measures to be taken in case of too high or too low water levels<br>Corresponding weather forecast on hand?<br>Sufficient crane capacities at the planned transhipment points, passageways under bridges, etc. provided for? | very good | 3 | low risk | | |
| Calculation of stability of the transport means with cargo<br>Check whether the transport means with cargo is able to move on the transport route proving the actual stability | very good | 3 | low risk | | |
| Check whether packaging suits the transport<br>Check whether weather conditions and mechanical load could affect transport and the properties of the cargo<br>Packaging shall be adequate to the required protection grades of the cargo and meet the highest requirements of weather impact and mechanical load during the entire transport from the manufacturer to the final destination<br>The inspector shall check the corresponding stage and the critical influences of other stages on this<br>If for reasons of logistics and/or practicability, the packaging as well as the shipping inserts and/or the external securing of cargo is made per stage, only, corresponding logistic, technical, and organisational measures shall be taken between the stages I.e.:<br>▪ Storage sites of sufficient ground load-carrying capacity<br>▪ Crane capacities and the required lashings and packaging material shall be available | very good | 3 | low risk | Existing standards to be checked for their applicability to the respective cargo<br>Packaging shall suit sea transport to prevent repackaging prior to this<br>As a rule, the sea transport is the decisive element for preparation of the cargo for transport | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.1

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| c) | Check of weather criteria and other restrictions for any stage | Missing description of the external influencing factors on the cargo to be avoided | high |
| c) | Definition of inter-faces regarding the transfer of risk | Responsibilities of the actors (companies, persons on site) insufficient-ly depicted | high |
| i) | Cargo subject to handling several times during the transport<br>(e.g. from road to train, to river boat, to road, and so on) | Different risk potentials depending on the transport means and route not taken into account for preparations | high |
| i) | Cargo subject to handling several times during the transport<br>(e.g. from road to train, to river boat, to road, and so on) | Mounting and dismounting the securing of cargo several times may weaken the securing arrangements | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.1 |
|---|---|---|---|---|---|
| The manufacturer shall state definite maximum and minimum values for: temperature, air humidity, purity of ambient air, susceptibility to shock, angle of inclination, acceleration, sensitivity in contact with other substances<br><br>Which goods of which hazard classes shall not be stored in the same room or near the cargo?<br><br>Where are emergency and alternative locations to provide for sufficient protection when the weather gets worse? | very good | 3 | low risk | Information by manufacturers are taken as a basis to draw up a transport manual<br><br>Information by manufacturers widely influence the planning of transport<br><br>Consequently, the transport route better should be roughly defined in the design stage already<br><br>This includes definition of the optimum season for transport<br><br>Reliability of weather forecasts etc. depends on the season, too | |
| Clear definition of the transfer of risk and, consequently, clear definition of the responsibilities by naming the responsible companies and persons<br><br>Check of standard handling procedures, e.g. from the workshop to first transport means with object-related adjustment | very good | 3 | low risk | For such transports, the manufacturers should be involved as they know the characteristics of the cargo very well<br><br>In particular if the manufacturer modified the cargo compared to the previous one<br><br>An inspector should accept the transport concept and securing in advance and on site | |
| Compulsory elaboration of an independent procedure incl. risk analysis in accordance with the standards for transport on roads and inland waterways for each transport means and each handling of cargo<br><br>An inspector should verify the procedures very early<br><br>If required, the inspector should accompany on the spot the execution of transport and handling | very good | 3 | low risk | Any handling of cargo involves a risk as the cargo is handled and/or moved against its purpose | |
| Check of condition of the materials used prior to any use and check of the guaranteed lifetime of materials<br><br>As an alternative, use of a new one-way material | very good | 3 | low risk | Already when designing the cargo, the possible fastening points for securing attachments shall be calculated and designed<br><br>For an optimum design of the fastening points, also the material for securing of cargo should already be defined | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.1

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| i) | Loading of cargo | Improper sling gear and lifting equipment | high |
| i) | Execution of trans-port | Unforeseeable changes during transport | high |
| i) | Execution of trans-port | Interruption of transport due to malfunctions of the transport means and/or road damage or accidents of other vehicles | high |
| i) | Execution of inland and river transport | Inappropriate use of transport means, e.g. for salvage of third parties | medium |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.1 |
|---|---|---|---|---|---|
| TÜV and/or the class have provided standards for calculation of the required sling gear and lifting equipment<br>Inspection of the lifting equipment and sling gears by an inspector as required in the applicable standards by DIN and VDI<br>The inspector verifies whether all criteria with influence on the dimensions of a sling gear have been taken into account when calculating such dimensions<br>Visual inspection of sling gears and lifting equipment on site | very good | 3 | low risk | The documents are of limited validity<br>The equipment and sling gears shall be subject to regular inspections by the TÜV / class<br>The inspector should carry out a visual inspection immediately before any use | |
| The inspector is immediately notified of any deviation from the planned route and/or procedure according to the transport manual<br>If required, the inspector shall immediately travel to the site to inspect the required deviations | very good | 3 | low risk | Impossible to allow in a concept for any incalculability<br>In exceptional cases, the customer often decides on the costs only and not on the aspect to meet the insurers' requirements | |
| Immediate notification of the inspector who looks in the transport manual for an emergency plan provided for the very situation<br>The inspector shall be consulted about the conditions for continuing transportation<br>If the stacking area / the emergency site has not been inspected so far, this shall be done immediately (protection against damage, ground load, crane capacities, protection against environmental effects, etc.)<br>Perhaps allow for alternative transport means | very good | 3 | low risk | If the following transport means is not available for a short period, intermediate storage shall take place<br>If a mobile crane has been planned for cargo handling, this crane shall also be available later | |
| The transport means cannot be used for rescue operations when being loaded<br>Should there be threat to life, think over an alternative first<br>Implement a corresponding provision in the transport agreement | very good | 2 | low risk | It is quite usual that river boats help each other without posing questions<br>Sometimes this is done to get free way on the river | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.1

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| i) | Loading of inland ship | Insufficient stability of the transport means with cargo | small |
| i) | Loading of inland ship | Dangerous goods transport on the river boat in the same cargo compartment<br>Based on certain classes of hazard this increases the danger for the entire transport means including the cargo | high |
| i) | Execution of trans-port | Interruption of transport due to malfunctions of the transport means and/or insufficient water depth | small |
| c) | Preparations for loading | Particular transport means and loading itself depends on the weather<br>In case of unfavourable weather conditions (storm, ice, flood or low water), transport cannot be realised as planned<br>Pursuant to the agreement the required lifting equipment is available for a certain time only | small |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.1 |
|---|---|---|---|---|---|
| Determine the centres of gravity and the lever arms affecting stability<br>Check and prove loaded condition of the ship<br>Deliver evidence for sufficient water depth along the entire waterway | very good | 1 | low risk | The calculation of stability is not as detailed as for sea vessels<br>For loading of river boats, only the Plimsoll mark is decisive<br>However, if the centre of gravity of the cargo is too high, a larger inclination of the river boat can cause a list with hazardous water inrush into the cargo compartment<br>This problem is not well known in the inland water transport industry<br>Only since containers have been transported on river boats and two large accidents on the Rhine were due to instability, this issue has received attention | |
| Prior definition, which dangerous goods are allowed by their class of hazard to be transported together with the transformer | very good | 3 | low risk | Rather hypothetic risk | |
| Calling at stacking area / emergency sites as defined in the transport manual<br>If impossible to call at the planned emergency areas / sites, an alternative shall be found in cooperation with the inspector | very good | 1 | low risk | Rather low risk<br>Problematic in case of collisions<br>However, a reasonable emergency concept for such a case cannot be established<br>But there are enough boats and emergency sites on the river to start rescue measures immediately | |
| This problem is part of the transport manual, the risk analysis, and the protection measure<br>Inform the inspector who shall see to a realisation in accordance with the transport manual | very good | 1 | low risk | The transport manual also covers provision of time-critical lifting equipement depending on the season<br>The corresponding protection measure of the transport manual should provide for a variant, for the realisation of which the required lifting equipment will be available at once<br>There are reliable weather statistics that are adequate for overland transport | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.1

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| j) | Planned storage | The storage site does not correspond to the required protection measures | small |
| j) | Execution of assem-bly | Fault of equipment and devices required for assembly | very high |
| j) | Provision of material and components | No specialists | very high |
| j) | Provision of material | Failure of basic supply for operation (e.g. power supply, working media) | very high |
| j) | Execution of assem-bly | Fire | very high |
| j) | Execution of assem-bly | Natural hazards (lightning, storm, heavy rain, ...) | very high |
| j) | Execution of assem-bly | Lightning | very high |
| j) | Execution of assem-bly | Storm | very high |
| j) | Execution of assem-bly | Sabotage | very high |
| j) | Provision of material and components | Delivery of components delayed | very high |
| d) | Selection of assem-bling site, equip-ment, and devices | Planning basis not subject to standards | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.1 |
|---|---|---|---|---|---|
| The transport manual specifies appropriate locations / sites for planned intermediate stops that have been verified in advance<br>This shall also apply to unplanned stops corresponding to the protection measures defined in the transport manual<br>If other sites have to be used nevertheless, the inspector shall be informed immediately<br>Then, corresponding measures will be taken on site | very good | 1 | low risk | | |
| Provision of redundant equipment and devices, regular maintenance | very good | 4 | medium risk | | |
| Contingency personnel planning | very good | 4 | medium risk | | |
| Provision of emergency supply according to the emergency plan | very good | 4 | medium risk | | |
| Fire protection concept and measures for the assembling workshop and assembling site including the partially assembled platform | very good | 4 | medium risk | Generally required and of higher level | |
| Protection measures for work involving fire risk (fire permit procedure / process manual) | | | | Only regarding the prevention of an outbreak of fire during welding | |
| Fire protection during building - depending on design and project | | | | In the construction stage, only | |
| Protection measures against events to be expected, incl. drawing up an emergency plan and keeping this up-to-date | very good | 4 | medium risk | | |
| Lightning protection for assembling workshop and outdoor assembling site with any partially assembled platforms | very good | 4 | medium risk | | |
| Additional protection measures when a storm approaches, e.g. protection of scaffolds and cranes | very good | 4 | medium risk | | |
| Intrusion protection (fences, illumination, monitoring with cameras, safety service and security personnel, etc.) | very good | 4 | medium risk | | |
| Find possible alternative suppliers during planning already<br>Include necessary time allowance in scheduling | adequate | 8 | high risk | | |
| Standardise planning basis | very good | 3 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.1

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| d) | Construction engineering<br>(method statements, material, person-nel, components, lcoation) | Poor construction engineering | very high |
| j) | Execution of assem-bly | Poor compliance with set dates | very high |
| j) | Execution of assem-bly | Quality problems entailing time-consuming reworking | very high |
| d) | Draw up emergency plans | Preparations for emergencies missing although such emergency entails considerable delays (e.g. because of instructions by authori-ties) | high |
| j) | Execution of assem-bly | Insufficient co-ordination leading to mutual impediment of the diffe-rent trades and, consequently, to delays and quality problems | very high |
| j) | Execution of assem-bly | Delay due to open interfaces between the involved parties | very high |
| j) | Provision of material and components | Installation of unsuitable components and materials that could have to be dismounted and replaced | very high |
| j) | Provision of material and components | Suppliers are not reliable | very high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.1 |
|---|---|---|---|---|---|
| Possibility of preassembling depending on the shipyard capacities and the transport option (onshore if possible, offshore in exceptional cases, only)<br>Make sections / modules depending on the transport/lifting options<br>Allow for and co-ordinate all required operations and stages and processes<br>Allow for the working spaces required as a function of the assembling progress | very good | 4 | medium risk | | |
| Careful and prudent scheduling in consideration of the typical assembling conditions (e.g. weather conditions for work, e.g. coating not outdoor, potential fluctuation of capacities by other companies)<br>Schedule supervision | very good | 4 | medium risk | Prerequisite for schedule supervision | |
| Quality control along with assembling (e.g. weld seams, steel sections, etc.)<br>Partial acceptances acc. to ITP (installation and test plan, already drawn up in the design stage) | very good | 4 | medium risk | Self-checks and partial acceptance to be co-ordinated and complementary | |
| Emergency plan<br>(shipyard and companies involved, logging of present persons for safe evacuation) | very good | 3 | low risk | | |
| Designation of a competent chief of assembling to co-ordinate assembling with construction managers, suppliers, and customers and checks going along with assembling<br>(QA, QC, teamwork of the involved trades and companies, deadline, quality, and documentation)<br>Clearly stipulate by contract the responsibilities<br>Clearly stipulate by contract the transfer of risk | very good | 4 | medium risk | | |
| Designate a competent project controller<br>Where possible, design, manufacture, transport, and assembling, as well as installation from one single source<br>Place order for main components promptly so that early co-ordination is ensured | very good | 4 | medium risk | | |
| Receipt control of materials and components regarding their fitness for the particular purpose "offshore" (manufacturer's declaration) | very good | 4 | medium risk | | |
| Traceability of material and components (e.g. steel) | adequate | 8 | high risk | Does not take effect immediately, but educational effect | |
| Select appropriate suppliers<br>(QA, QC, deadlines, references, assessment reg. solvency, too) | adequate | 8 | high risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.1

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| j) | Provision of personnel | Work done by unsuitable personnel | very high |
| g) | Scheduling as well as provision of plan "B" with changed time schedule for the residual assembly work offshore | Corresponding scheduling of the assembly work onshore in compliance with the corresponding time slot<br>Depending on time slot, season, weather forecast the transformer platform is transported earlier into the wind field and, therefore, the residual assembly work is more extensive than scheduled or deviates from the time schedule | high |
| g) | Scheduling of residual assembly work after erection in wind farm<br>(following arresting and grouting of the platform) | Poor planning of residual assembly work with possible damage to the transformer platform | high |
| m) | Hand-over<br>(removal of equipment and new set-up) of transport / installation to following trades / companies | Non-compliance involves the risk that necessary equipment, such as temporary fire protection, or other necessary equipment or protections are not available | high |
| m) | Residual assembling of the platform in the wind farm | Upon transport / installation and prior to starting the residual work it is not clarified whether rooms have been sealed hermetically<br>Rooms not sealed hermetically | medium |
| m) | Cable connection<br>Connection to corresponding component (socket) | Dirty and humid connections / plug-type connections | medium |
| n) | Cold commissioning of transformer platform in the shipyard (onshore)<br>What to be done offshore? | Damage to transformer platform | medium |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.1 |
|---|---|---|---|---|---|
| Select appropriate assembling personnel (e.g. personnel by the manufacturer, potential criterions: professional training, experience, instruction / briefing) | adequate | 8 | high risk | | |
| Early draw up plan "B" in advance (when foreseeable that the planned deadline will not be observed - approx. 6 months before scheduled time of shipping) incl. a risk analysis (e.g. deviating fire protection, logistics, materials, storage, etc.)<br>Identify any work that can only be done onshore so as to effect them onshore | adequate | 6 | medium risk | | |
| Draw up process flow scheme with any work to be done (incl. responsibilities, required personnel and material, safety regulations) as well as its effect on other trades | adequate | 6 | medium risk | | |
| Comply with HSE rules and regulations (customer, authorities, etc.), e.g. welding only after compliance with all rules and regulations | very good | 3 | low risk | | |
| Temporary measures correspond to the manufacturer's requirements; they shall be taken to ensure the required protection at any time | very good | 2 | low risk | | |
| Compliance with instructions for erection | very good | 2 | low risk | | |
| HAC (Harbour Acceptance Test, with MWS) onshore and prerequisite for transport; SAC (Sea Acceptance Certificate) offshore and prerequisite for commissioning of transformer platform | very good | 2 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.1

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| m) | Pumping over of transformer oil from the drums for transport into the transformer in the wind farm and other filling of systems (e.g. fuel) | Escaping oil:<br>▪ Hazard class<br>▪ Ecological hazard<br>▪ Spillage of or damage to other components<br>▪ Cleaning expenditure on transformer platform | high |
| m) | Removing all devices securing the equipment on the platform | Damage to single components during the test run | high |
| m) | Offshore welding on platform | Fire hazard and damage | high |
| m) | Coating<br>Corrosion protection | Fire hazard and environmental damage | medium |
| m) | Installation of equipment, such as pumps, ladders, etc. without welding | Damage to transformer platform | small |
| n) | Activation of fire detection / fire alarm and extingu-ishing equipment | Release of extinguishing equipment | small |
| n) | Installation and check of earthing system | Damage to all electrotechnical components and life safety at risk | high |
| n) | Activation of power supply systems | Fire hazard and damage to cabling and power supply units | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.1 |
|---|---|---|---|---|---|
| Comply with requested procedures and check the corresponding work equipment for any damage<br>Make available and install any precaution for handling of oil (e.g. oil binder, collection tray, etc.) before starting it<br>Observe the requirements and standards issued by the erecting party<br>Measures requested in national and international rules and regulations regarding pollution with oil shall be taken | adequate | 6 | medium risk | | |
| Execute item per item on the check list to remove the securing devices (as required by manufacturer where specified) | very good | 3 | low risk | | |
| Comply with process flow scheme for welding and defined regulations (fire protection etc.) | adequate | 6 | medium risk | | |
| Comply with process flow scheme for coating and defined regulations as amended (fire protection etc.) | very good | 2 | low risk | Active cathode protection<br>Check connection with group 3 (activity to be done by group 3?) | |
| Comply with process flow scheme for installation and defined regulations | very good | 1 | low risk | | |
| Lock the extinguishing medium prior to connection | very good | 1 | low risk | | |
| Comply with process flow scheme for installation and defined regulations | very good | 3 | low risk | | |
| Comply with process flow scheme for installation and defined regulations<br>Specialists for power supply systems and medium-voltage switchgears with corresponding permission (adÜ) required<br>Visual inspection and check of insulation of the units and cabling Check of the load switch in the outgoing panel to the medium-voltage switchgear (opened and filled with SF6)<br>Connect power supply of single units at no load down to the outgoing panel to the bus bar | adequate | 6 | medium risk | Checking and ensuring functions (network stability, fire protection, safety cut-off) | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.1

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| n) | Commissioning of medium-voltage switchgear | Fire, damage to medium-voltage switchgears, transformers, as well as electrical components connected<br>Synchronising faults possible | very high |
| n) | Commissioning of low-voltage switch-gear | Fire hazard and damage | medium |
| n) | Commissioning of transformers | Fire hazard and damage | very high |
| n) | Commissioning of high-voltage switch-gear | Fire hazard and damage | very high |
| n) | Electrical connec-tion to the "North Sea outlet" | Fire, damage to low-, medium-, high-voltage switchgears, transfor-mers, as well as electrical components connected | very high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.1 |
|---|---|---|---|---|---|
| Comply with process flow scheme for installation and defined regulations<br>Specialists for power supply systems and medium-voltage switchgears with corresponding permission (adÜ) required<br>Visual inspection and check of insulation of the medium-voltage switchgear and cabling<br>All outgoing panels of medium-voltage switchgear in open condition and filled with SF6<br>Connect power supply of single units at no load to the bus bar<br>Check monitoring of bus bar system protection<br>Synchronise power supplies through medium-voltage bus bars | adequate | 8 | high risk | | |
| Comply with process flow scheme for installation and defined regulations<br>Visual inspection and check of insulation of the low-voltage switchgear and cabling<br>All outgoing panels of low-voltage switchgear in open condition<br>Successive connection of single loads with function test | adequate | 4 | medium risk | | |
| Comply with process flow scheme for installation and defined regulations<br>Analysis of the shock recorders<br>Check of insulating oil (oil level, reading of breakdown voltage, reading of humidity content)<br>Visual inspection and check of insulation of the transformer and cabling as well as check of corresponding protection of power system<br>Check of the load switch in the outgoing panel to the high-voltage switchgear (opened and filled with SF6)<br>If it is possible to connect through (no other consumer) to the transformer to be started up for the first time with the emergency generator, it is recommended to energise the emergency generator slowly until the transformer will have reached the nominal voltage | very good | 4 | medium risk | | |
| | very good | 4 | medium risk | | |
| | adequate | 8 | high risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.1

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| n) | Lacing (electrical connection of cables in the wind farm) and connection of first cluster | Fire hazard and damage | high |
| n) | Lacing (electrical connection of cables in the wind farm) and connection of following clusters | Fire hazard and damage | high |
| n) | Test run of single main components prior to overall test | Fire hazard and damage | high |

**Legend**
a) Execution planning of the soil investigation for the site of the offshore transformer station in the wind farm
b) Soil investigation for the site of the offshore transformer station in the wind farm
c) Execution planning of the inland transport (overland and rivers) from the factory to the offshore port
d) Execution planning of the storage in the offshore port and the onshore assembly there
e) Execution planning of offshore transports
f) Execution planning of offshore erection
g) Execution planning of residual assembly work offshore
h) Execution planning of the commissioning and the test run until getting the PAC
i) Inland transport (overland and rivers) from the factory to the offshore port
j) Storage in the offshore port and the onshore assembly there
k) Offshore transports
l) Offshore erection
m) Residual assembly work offshore
n) Commissioning and test run until getting the PAC

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.1 |
|---|---|---|---|---|---|
| | adequate | 6 | medium risk | | |
| | adequate | 6 | medium risk | | |
| | adequate | 6 | medium risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.2 Cabling in wind farms



| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| b) | Route survey | Crossings and adjacent media | very high |
| b) | Route survey | Danger from soil and ground | high |
| c) | Planning of resour-ces | Inappropriate resources<br>Resources not available | very high |
| c) | Planning of cable protection systems<br>Scour protection | Damage to cable | high |
| c) | Release of cable installation by the person in charge of project certification | Standstill<br>No permit | medium |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.2 |
|---|---|---|---|---|---|
| Identification of crossed media (cable, pipeline, ...)<br>Complying with recommendations (e.g. ICPC)<br>Determination of position of the crossing media (cable, pipeline, ...)<br>Entering into crossing agreements<br>Transfer into execution planning | very good | 4 | medium risk | Improper execution planning for cable crossings involves the risk of damage to the installed cable and/or to the medium to be crossed<br>The mentioned protection measures prevent meeting with unknown media during execution, that an execution is not possible at all, or that a damage occurs<br>The cable installer should be involved (AdÜ: DE unvollständig) when drawing up execution planning | |
| Select and execute of soil surveys and route survey in accordance with the BSH guideline "Ground Investigations for Offshore Wind Farms" latest edition (AdÜ: In DE gibt es eine Version von 2014, in EN nur von 2008?!)<br>Analysis of the survey together with any information by third parties (e.g. areas with ammunition; description of nature protection, cable maps, wreck maps, archaeology)<br>Analysis of the survey as to the suitable installation methods, installation equipment, and the appropriate installation depth (e.g. burial assessment, sediment shift) | very good | 3 | low risk | The BSH standard is under review at the moment to become more detailed; publishing date not yet known<br>Selection of the installation equipment should be based on the results of the survey and not only depend on availability of the equipement. | |
| Enquire the installer about corresponding experiences<br>Check the ship and the installation equipment for technical suitability for the tasks and the sea area (weather, soil)<br>Experience of the personnel with the installation equipment<br>Examine and assess complications of the past<br>Check relevant certificates against the corresponding purpose of use / the corresponding area of use<br>Provide for sea trials | adequate | 8 | high risk | Changes of equipment and personnel are rather normal, not an exception<br>Duty to obtain consent from employer when equipment changes (equivalent)<br>Ensuring protection measures even in the project execution stage | |
| Design and length of cable protection system in consideration of the calculation results of scour dimensioning | very good | 3 | low risk | Consider that enough free space for assembling of the cable protection system is available on the deck of the cable layer<br>Reference to group 2: Erection of wind turbine / scour protection | |
| Always submit method statements / procedures early to the person in charge of project certification for verification and release | very good | 2 | low risk | Execution planning<br>3. release by BSH | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.2

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| f) | Option: onshore inspection (after transport to offshore port) | Damaged cable | small |
| f) | Storage of ready-made cable | Damaged cable | small |
| f) | Storage of ready-made cable | Fire | small |
| f) | Storage of ready-made cable | Theft<br>Vandalism | medium |
| f) | Loading of cables | Damaged cable | medium |
| b) | Soil preparation (geotechnical investi-gation) | UXO (unexploded ordnance) | very high |
| b) | Soil preparation (geotechnical investi-gation) | Wreck<br>Large obstacle | small |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.2 |
|---|---|---|---|---|---|
| Inspect in accordance with concerted inspection schedule<br>(e.g. high-voltage inspection, visual inspection)<br>Quality check before and after each re-reeling after Factory Acceptance Test<br>Observe how many times re-reeling may take place<br>Turntables matched | very good | 1 | low risk | | |
| Proper storage according to applicable Cable Handling Guidelines and any arrangements<br>End-cap the cables<br>Cover the stacks of cables | very good | 1 | low risk | Normally, sea cable provide an external layer made of PP yarn<br>Long storage of this yarn can lead to aging and/or porosity due to direct sunlight (UV radiation)<br>But this does not affect the integrity of the cable system | |
| No source of fire and fire load around the stored cable<br>Complex separation | very good | 1 | low risk | | |
| No storage in public areas<br>Video surveillance, fencing, patrolling, and intruder alarm system for storage outside the plant site | very good | 1 | low risk | | |
| Inspect in accordance with concerted inspection schedule<br>(e.g. visual inspection, conduction test, OTDR reading)<br>Quality check before and after each re-reeling after Factory Acceptance Test<br>Observe how many times re-reeling may take place<br>Match turntables, cable machines, and personnel | very good | 2 | low risk | Observe how many times re-reeling takes place | |
| Based on the pre-lay survey results and the requirements by authorities an UXO survey of the planned cable routes is required and where necessary explosive ordnance disposal (EOD) in a correspondingly wide corridor (determined by the installation equipment) | very good | 4 | medium risk | | |
| Execute a PLGR while permanently monitoring the tractive forces, shortly before installation<br>Reroute the cable where required | very good | 1 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.2

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| c) | Selection of equip-ment for laying of cables | Unsuitable | very high |
| c) | Emergency planning for perhaps required interruption of laying<br>Contingency planning | Effect by natural hazards | very high |
| c) | Emergency planning for perhaps required interruption of laying<br>Contingency planning | Malfunction of equipment for laying of cables | medium |
| f) | Watertight end caps for laying the cable into the sea<br>Wet storage | Permeability<br>Water penetrates into the single wires of the sea cable | high |
| f) | Cable installation in the wind field | Standstill of laying spread (AdÜ? - marine spread: means the marine part of the Survey Equipment, with all appurtenances thereof, together with captain, full crew and technical team to be mobilised and used on site upon repair of the cable due to a damage | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.2 |
|---|---|---|---|---|---|
| Enquire the installer about corresponding experiences<br>Check the ship for technical suitability for the tasks and the sea area (weather)<br>Experience of the key personnel with the installation equipment<br>Examine and assess complications of the past<br>Check relevant certificates against the corresponding purpose of use / the corresponding area of use<br>Provide for sea trials<br>Check the cable installation method / cable laying equipment regarding the structure of the ground | adequate | 8 | high risk | For the time being not enough suitable cable layers available in the market<br>Only the provision of references does not prove quality - this is insufficient and does not replace the protection measures<br>The risk status only applies if all listed protection measures have been taken to 100 %<br>Cable installation methods:<br>▪ Post lay burial<br>▪ Simultaneous lay and<br>▪ burial or pre-trenching | |
| Define and select stopping criteria and suitable weather slots for all stages of cable installation<br>Select an appropriate port of refuge (e.g. little distance)<br>Select and provide appropriate, local weather reports and forecast<br>Procedure for laying the cable down onto the seabed<br>Provide for end caps and fittings<br>Safety measures for cable ends (e.g. buoys, guard vessel) | adequate | 8 | high risk | The restrictions due to weather must be so that securing of cargo and ship is possible<br>But any delay due to bad weather often increases the overall project costs and, therefore, the risk remains a "medium risk" | |
| Design systems redundantly<br>Procedure for laying the cable down onto the seabed<br>Provide for end caps and fittings<br>Safety measures for cable ends (e.g. buoys, guard vessel) | very good | 2 | low risk | | |
| Development, design, and construction of a high-quality seal for the particular cable type (laydown head) according to the assembly instructions on hand by trained and skilled personnel | very good | 3 | low risk | Penetrating water causes damage or accelerates ageing of the cable insulation<br>Later drying of an already installed and damp cable is impossible | |
| Analysis of known damage and early development and certification of appropriate procedures aiming at securing of the cable during any offshore repair work<br>Provide for adequate resources | very good | 3 | low risk | The aim shall be quick and persistent repair of potential damage | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.2

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| f) | Cable installation in the wind field | Loss of transmission possibilities due to a damaged cable and its repair | very high |
| f) | Release of cable laying procedures by MWS | Standstill<br>Damage<br>Possible effects on the design of insurance coverage | high |
| c) | Drawing up procedures for cable and pipeline crossings as well as adjacent media<br>(emergency plans) | Crossings and adjacent media | very high |
| c) | Planning that installation work is accompanied and checked by the MWS | Standstill<br>Damage<br>Possible effects on the design of insurance coverage | high |
| f) | Cable logistics<br>(loading of cable & transport) | Damage to cable<br>Standstill<br>Loss | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.2 |
|---|---|---|---|---|---|
| Analysis of known damage and early development and certification of appropriate procedures aiming at securing of the cable during any offshore repair work<br>Provide for adequate resources | very good | 4 | medium risk | The aim shall be quick and persistent repair of potential damage<br>Possible exchange of short lengths instead of repair<br>Redundant park layouts reduce the effects of a defective cable | |
| Always submit procedures to the MWS on time to be checked against a previously stipulated standard and released by the MWS | adequate | 6 | medium risk | Experiences from many cable laying operations are bundled through the MWS to be used<br>Consideration of the allowed sea and weather conditions during installation procedures | |
| Availability and implementation of execution planning<br>Check execution planning for recency<br>Suitable mounting equipment for planned execution<br>Preparation of crossing structures<br>Avoid "fly over" procedures (pulling devices over the structure)<br>Highly-topical documentation within the scope of the laying accuracy laid down for the project | very good | 4 | medium risk | We urgently recommend an offshore co-ordinator / site co-ordinator for the project who shall promptly match the execution of different crafts | |
| Early co-ordination with MWS<br>Installation work to be accompanied by the MWS who shall check it against a stipulated standard<br>Recurring work can later be done without the MWS being present; this requires close co-ordination of the parties involved | adequate | 6 | medium risk | The MWS shall check and release any project-relevant procedure in advance | |
| Load in accordance with the "Cable Handling Guidelines" and loading procedures agreed upon<br>Redundant communication between land and ship<br>Observe how many times re-reeling may take place<br>Match / synchronise turntables and linear machines<br>Securing of cargo complies with international standards<br>Cable inspections complies with test schedule agreed upon | adequate | 6 | medium risk | "Cable Handling Guidelines":<br>▪ Document to be supplied by the cable manufacturer how to handle the cable | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.2

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| f) | Cable installation in the wind field | Damage to cable<br>Damage to equipment | very high |
| f) | Pulling cable into the wind turbine founda-tion and/or the wind turbine | Damage to cable | very high |
| f) | Pulling cable into the transformer platform | Damage to cable | very high |
| f) | Mechanical, electric, and fibre-optics termination | Damage to cable<br>Damage to offshore structure | high |
| f) | Trenching | Insufficient bury depth<br>Covering | very high |
| f) | Jetting | Damage to cable | very high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.2 |
|---|---|---|---|---|---|
| Use a suitable installation software (e.g. WinFrog, Makai-Lay) to plan and control cable installation<br>Make the laying parameters available to all ship stations (e.g. "Cable Handling Guidelines", laying angle, tractive force, etc.)<br>Synchronise the cable machines, the speed of the installation equipment, and the ship speed | adequate | 8 | high risk | The installation software is designed to visualise and document any installation-relevant data (e.g. cable position, normally X, Y, and Z) | |
| Cable pull-in according to procedures agreed upon in consideration of the park layout<br>Onshore trials of the pull-in procedure including cable protection system<br>Permanent monitoring of pull-in forces<br>Cable handling in compliance with the "Cable Handling Guidelines" | very good | 4 | medium risk | The 2nd pull-in operation is the most critical cable operation offshore<br>This shall be taken into special consideration when selecting the installation equipment, establishing the procedures and the corresponding risk assessments | |
| Cable pull-in according to procedures agreed upon in consideration of the park layout<br>Onshore trials of the pull-in procedure including cable protection system<br>Permanent monitoring of pull-in forces<br>Cable handling in compliance with the "Cable Handling Guidelines"<br>Monitoring of cable on the seabed during the pull-in operation (e.g. observation with ROV)<br>Take into account any adjacent cables under voltage | very good | 4 | medium risk | The 2nd pull-in operation is the most critical cable operation offshore<br>This shall be taken into special consideration when selecting the installation equipment, establishing the procedures and the corresponding risk assessments | |
| Training and instruction of fitters in the field of connectors<br>Thorough planning and development of a temporary as well as of a final hang-off (AdÜ?) according to the "Cable Handling Guidelines"<br>Documentation of assembly work<br>Selection of the corresponding tools for assembly and covering of critical components around (e.g. coating or cable)<br>Thorough planning of any overlengths of cables to be pulled in as well as suitable fittings (e.g. transition sleeve) | very good | 3 | low risk | Provide for overlength reserve for new termination<br>Offshore structures:<br>▪ Foundations<br>▪ Transformer substations<br>▪ Converter platforms<br>▪ Wind turbines etc. | |
| Use of appropriate installation equipment for submarine power cables<br>Where required pre-trench the cable routes<br>Planning and execution of more jetting in consideration of the reasonable endeavour | adequate | 8 | high risk | | |
| | very good | 4 | medium risk | Where possible, cable installation without any external draw and shear force exerted on the cable | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.2

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| f) | Rock cutting | Damage to cable | very high |
| f) | Ploughing | Damage to cable | very high |
| f) | Additional protection measures<br>(e.g. rock dumping, mattressing, URADUCTs, grout bags, etc.) | Damage to cable | high |
| g) | Cable inspection when connection finished | Damage to cable and connected fittings | small |
| h) | Cold commissioning | Damage to cable, fibre optic cable, and connected fittings (switchgear connector) | medium |
| h) | Hot commissioning | Damage to components in the entire electrical system (switchgear, transformer, cable, connector) | high |

**Legend**
a) Execution planning of the soil investigation for the installation of cables in the wind farm
b) Soil investigation for the installation of cables in the wind farm
c) Execution planning of the transport (inland and offshore transport) and of the installation of the cables in the wind farm
d) Execution planning of the connection of the cables in the wind farm
e) Execution planning of the commissioning and the test run until getting the PAC
f) Transport (inland and offshore transport) and of the installation of the cables in the wind farm
g) Connections (installation) of the cables in the wind farm
h) Commissioning and test run until getting the PAC

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.2 |
|---|---|---|---|---|---|
| | very good | 4 | medium risk | To date only the vertical injector and only a few trenching ROVs have reached a burial depth of more than 1.5 m for submarine power cables | |
| | poor | 12 | very high risk | Ploughing the cable into the seabed with existing equipment results in almost uncontrollable draw and shear forces, which can lead to destruction or premature ageing due to almost not detectable damage to the cables | |
| | adequate | 6 | medium risk | The use of a cable protection system also serves the protection of the cable from falling objects as well as rocks or perhaps mattresses | |
| | very good | 1 | low risk | Electricity and fibre-optics tests in combination with cold commissioning shall be carried out (e.g. insulation, VLF, OTDR) | |
| | very good | 2 | low risk | Electricity and fibre-optics tests in combination with cold commissioning shall be carried out (e.g. insulation, VLF, OTDR) | |
| | adequate | 6 | medium risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.1 Ships, barges, tugboats, etc.

| 9.3.1 | Process steps | Short description of operation | Requirements for the operation | Marine Spread | Requirements | Risks |
|---|---|---|---|---|---|---|
| | Execution planning of offshore transports | Planning / assessment of necessary ships, barges, ...<br>(proof of class) | Identification / calculation of the ship, tugboat, barge capacities required<br>Tugging equipment (marine spread) based on industrial standards (DNV, GL Noble Denton, London Offshore, etc.) | | | Crane ships, tugboats, AHT, barges, supply vessels, jack-up barges / vessels etc., and equipment |
| | Execution planning of offshore transports | Planning / assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified requirements<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | Crane ship | Lifting capacities<br>Positioning conditions (DP, 4-point mooring)<br>Navigation restrictions | |
| | Execution planning of offshore transports | Planning / assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified requirements<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | Tugboat | Static pull<br>Machine output<br>Operating radius<br>Positioning conditions (DP, 4-point mooring)<br>Navigation restrictions | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Events | Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.3.1 |
|---|---|---|---|---|---|---|---|
| Inappropriate crane ships, tugboats, AHT, barges, supply vessels, jack-up barges / vessels etc., and equipment (as to project requirements or technical condition) | Failure of units used and corresponding delay for entire project | high risk | Select well-respected, experienced, and certi-fied shipping companies with crane ships, jack-up barges / vessels, tugboat and the corresponding managers (ISO, ISM, IMCA)<br><br>Select appropriate vehicles, barges, etc. according to the corresponding project requirements<br><br>Check the class documents and other certificates (e.g. equip-ment)<br><br>Early draw up a condition survey of the units and equipment used to find adequate replacement where necessary<br><br>Permanent supervision of the requirements for maritime units, e.g. weight | very good | 3 | low risk | |

**General remark:**
- Determination of the most risky stage of travel
- Check of dimensions (length, width, draught) of the waterways to be passed (emergency ports, too)
- Undocking space (adverse effects on near sea lanes)
- Damage to towing equipment and connection, perhaps very long time in tow
- Availability of special ships very bad
- High daily rate and high technicization of the ship
- Issue of repair capacities and facilities
- Availability of spare parts and shipyard capacity
- Areas where the chartered ships may cruise and compliance with (inter)national conditions (operation, crew, classification)

**1st scenario "floating platform"**
- **H**ighest risk during undocking
- **L**ess tugboats required thereupon
- Tugboats shall feature corresponding static pull; this shall be available
- Fixture of towing equipment to the platform shall be calculated and welded on
- Classification Society and experience on tugboats
- Guidelines published in 2006 for the first time

**2nd scenario "Transport of platform and base frame on barge"**
- Check of capacities and availability of barges (alternatives: semisubmersible floating platform or floating dock)
- Costs for off-hire lay days when waiting for better weather
- Classification Society and equipment of barges (retrofitting for additional lashings with calculation of loading capacity), manoeuvrability (dynamic position, speed)

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.3.1 | Process steps | Short description of operation | Requirements for the operation | Marine Spread | Requirements | Risks |
|---|---|---|---|---|---|---|
| | Execution planning of offshore transports | Planning / assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified requirements<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | | Towing gear | |
| | Execution planning of offshore transports | Planning / assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified requirements<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | AHT | Anchor handling capacity<br>Static pull<br>Positioning conditions (DP, 4-point mooring)<br>Navigation restrictions | |
| | Execution planning of offshore transports | Planning / assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified requirements<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | Barges | Navigation restrictions<br>Dimensions<br>Load bearing capacity<br>Submergible | |
| | Execution planning of offshore transports | Planning / assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified requirements<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | | Towing gear | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Events | Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.3.1 |
|---|---|---|---|---|---|---|---|

**General remark:**
- Determination of the most risky stage of travel
- Check of dimensions (length, width, draught) of the waterways to be passed (emergency ports, too)
- Undocking space (adverse effects on near sea lanes)
- Damage to towing equipment and connection, perhaps very long time in tow
- Availability of special ships very bad
- High daily rate and high technicization of the ship
- Issue of repair capacities and facilities
- Availability of spare parts and shipyard capacity
- Areas where the chartered ships may cruise and compliance with (inter)national conditions (operation, crew, classification)

**1st scenario "floating platform"**
- **H**ighest risk during undocking
- **L**ess tugboats required thereupon
- Tugboats shall feature corresponding static pull; this shall be available
- Fixture of towing equipment to the platform shall be calculated and welded on
- Classification Society and experience on tugboats
- Guidelines published in 2006 for the first time

**2nd scenario "Transport of platform and base frame on barge"**
- Check of capacities and availability of barges (alternatives: semisubmersible floating platform or floating dock)
- Costs for off-hire lay days when waiting for better weather
- Classification Society and equipment of barges (retrofitting for additional lashings with calculation of loading capacity), manoeuvrability (dynamic position, speed)

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.3.1 | Process steps | Short description of operation | Requirements for the operation | Marine Spread | Requirements | Risks |
|---|---|---|---|---|---|---|
| | Execution planning of offshore transports | Planning / assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified require-ments<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | Supply vessel | Deck surface area<br>Deck capacities<br>Crane capacity<br>Tank capacities, e.g. navigation restrictions | |
| | Execution planning of offshore transports | Planning / assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified require-ments<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | Jack-up barge / vessel | Operation - water depths<br>Deck surface area<br>Crane capacities<br>Positioning conditions<br>Accommodation<br>Navigation restrictions | |
| | Execution planning of offshore transports | Planning / assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified require-ments<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | Cable layer | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Events | Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.3.1 |
|---|---|---|---|---|---|---|---|

**General remark:**
- Determination of the most risky stage of travel
- Check of dimensions (length, width, draught) of the waterways to be passed (emergency ports, too)
- Undocking space (adverse effects on near sea lanes)
- Damage to towing equipment and connection, perhaps very long time in tow
- Availability of special ships very bad
- High daily rate and high technicization of the ship
- Issue of repair capacities and facilities
- Availability of spare parts and shipyard capacity
- Areas where the chartered ships may cruise and compliance with (inter)national conditions (operation, crew, classification)

**1st scenario "floating platform"**
- **H**ighest risk during undocking
- **L**ess tugboats required thereupon
- Tugboats shall feature corresponding static pull; this shall be available
- Fixture of towing equipment to the platform shall be calculated and welded on
- Classification Society and experience on tugboats
- Guidelines published in 2006 for the first time

**2nd scenario "Transport of platform and base frame on barge"**
- Check of capacities and availability of barges (alternatives: semisubmersible floating platform or floating dock)
- Costs for off-hire lay days when waiting for better weather
- Classification Society and equipment of barges (retrofitting for additional lashings with calculation of loading capacity), manoeuvrability (dynamic position, speed)

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.2 Load-out

| 9.3.2 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| e) | Load-in/out | Identification of load-in/out objects | Weights<br>Dimensions | Loaded object | Wrong weight information (no weight check during assembly)<br>Wrong dimensions (no final object dimensons taken) | |
| e) | Load-in/out | Identification of load-in/out method | Lift-on/off<br>Slide-on/off<br>Roll-on/off<br>Float-in/off<br>Skidding | Load-in/out method | Wrong load-in/out method selected | |
| e) | Load-in/out | Identification of load-in/out equipment | Crane<br>Trailer / SPMT<br>Sliding system<br>Skidding system<br>Slings<br>Upending tool<br>Spreader beam<br>Required class / certificate | Load-in/out equipment | Selection of improper load-in/out equipment because of wrong load-in/out method<br>Selection of improper load-in/out equipment because of wrong weights and/or dimensions<br>Non-compliance with requirements for class / certificates | |
| e) | Load-in/out | Identification of appropriate port / water terminal | Access possibilities<br>Mooring capacities<br>Possibilities to manoeuvre<br>Heavy cargo pier<br>Storage capacities<br>Position compared to installation site<br>Jack-up possibilities in the port (soil conditions)<br>Cargo handling capacities | Port / water terminal | Large transport distance between manufacturers<br>Port of shipment / installation area<br>Not enough moorings<br>Poor manoeuvrability during loading, e.g. with floating crane<br>Insufficient storage capacities<br>Bad soil conditions to jack-up for corresponding barges / ships | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.2 |
|---|---|---|---|---|---|---|---|
| Load-in/out impossible; thus, delayed load-in/ out as well as entire installation | medium risk | Weight monitoring<br>Dimensions to be taken upon completion by certi-fied company<br>Draught survey<br>Make certifier / MWS verify this | adequate | 4 | medium risk | | |
| Load-in/out impossible; thus, delayed load-in/ out as well as entire installation | medium risk | Verify basic design / detailed design<br>Define appropriate load-in/out method<br>Make certifier / MWS verify this | adequate | 4 | medium risk | | |
| Load-in/out impossible; thus, delayed load-in/ out as well as entire installation | medium risk | Verify basic design / detailed design<br>Define appropriate load-in/out equipment<br>Select appropriate suppliers / check of/by (AdÜ?) suppliers<br>Make certifier / MWS verify this | adequate | 4 | medium risk | | |
| Load-in/out impossible; thus, delayed load-in/ out as well as entire installation | high risk | Thoroughly analyse / plan the requirements for the ports of loading/ unloading<br>On-site inspection of the ports according to the requirements<br>Early book by contracts the port capacities | very good | 3 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.3.2 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | e) | Load-in/out | Identification of the requirements for the load on the areas / piers for handling and storage | Surface load | Port, pier of loading/unloading, storage area | No use of port as not suitable for heavy cargo<br>Damage to pier and access ways |
| | e) | Load-in/out | Identification of requirements for transport unit<br>(barge, ship, tugboat, jack-up barge, etc.) | Loading capacity<br>Deck surface area<br>Stability<br>Load on decks<br>Ballasting<br>Manoeuvrability | Barge<br>Ship<br>Jack-up barge<br>etc. | Poor selection of transport unit due to wrong information on the object to be transported<br>Invalid documents on class/certification<br>Wrong and/or inappropriate manoeuvring properties |
| | k) | Load-in/out | Loading and ballasting | Stowing plan | Loading and ballasting | Wrong or poor loading / ballasting during load-in/out<br>Malfunction of ballasting system<br>Damage to ballasting system |
| | e) | Load-in/out | Verification of class documents / certificates regarding project requirements | | Barge<br>Ship<br>Jack-up barge<br>etc. | No valid class documents / certificates |
| | k) | Load-in/out | Verification of class documents / certificates regarding project requirements | | Barge<br>Ship<br>Jack-up barge<br>etc. | No valid class documents / certificates |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.2 |
|---|---|---|---|---|---|---|---|
| Load-in/out impossible; thus, delayed load-in/ out as well as entire installation | high risk | Thoroughly analyse / plan the requirements for the ports and piers of loading/unloading, access ways<br>On-site inspection of the ports according to the requirements | very good | 3 | low risk | | |
| Use of transport units impossible<br>Damage to transport unit and cargo<br>Capsizing of transport unit due to insufficient stability and/or poor sequences of ballasting / dropping ballast<br>Entire project delayed | medium risk | Thoroughly analyse / plan the loading and transport sections<br>Thoroughly analyse the requirements for the ports of loading/unloa-ding<br>Thoroughly plan the loading and transport units<br>Prepare loading plans / method statements for each load-in/out | adequate | 4 | medium risk | | |
| Transport unit will capsize<br>Damage to transport unit and object<br>Damage to fix and floating objects and environment<br>Load-in/out impossible and/or entire project delayed | very high risk | Draw up a stowage and ballast plan for load-in/ out - process / sequen-ces<br>Check and test the ballasting system prior to load-in/out<br>Monitor the loading and ballasting sequences | very good | 4 | medium risk | | |
| Loading in/out impos-sible<br>Thus, loading in/out and entire project delayed | medium risk | Verify the class documents / certificates prior to any use of the units<br>Ensure that the class documents / certificates will be valid for the entire mission or apply for new ones | adequate | 4 | medium risk | | |
| Loading in/out impos-sible<br>Thus, loading in/out and entire project delayed | medium risk | Verify the class documents / certificates prior to any use of the units<br>Ensure that the class documents / certificates will be valid for the entire mission or apply for new ones | adequate | 4 | medium risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.3.2 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | e) | Load-in/out | Verification of class documents / certificates regarding the personnel | Crane driver<br>Trainers / marshalling personnel (AdÜ? oder einweisen im Sinne von Platz zuweisen?)<br>Operating personnel<br>Maritime crews | Personnel | Insufficient experience how to carry out loading/ unloading processes - heavy lift / offshore<br>Lack of / insufficient communication during loading / unloading |
| | k) | Load-in/out | Verification of class documents / certificates regarding the personnel | Crane driver<br>Trainers / marshalling personnel (AdÜ? oder einweisen im Sinne von Platz zuweisen?)<br>Operating personnel<br>Maritime crews | Personnel | Insufficient experience how to carry out loading/ unloading processes, heavy lift / offshore<br>Lack of / insufficient communication during loading / unloading |
| | k) | Load-in/out | Permanent observation / verification of the weather conditions | | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Tide |

**Legend**
a) Execution planning of the soil investigation for the site of the offshore transformer station in the wind farm
b) Soil investigation for the site of the offshore transformer station in the wind farm
c) Execution planning of the inland transport (overland and rivers) from the factory to the offshore port
d) Execution planning of the storage in the offshore port and the onshore assembly there
e) Execution planning of offshore transports
f) Execution planning of offshore erection
g) Execution planning of residual assembly work offshore
e) Execution planning of the commissioning and the test run until getting the PAC
i) Inland transport (overland and rivers) from the factory to the offshore port
j) Storage in the offshore port and the onshore assembly there
k) Offshore transports
l) Offshore erection
m) Residual assembly work offshore
n) Commissioning and test run until getting the PAC

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.2 |
|---|---|---|---|---|---|---|---|
| Transport unit will capsize<br>Damage to transport unit and object<br>Damage to fixed or floating objects and environment, e.g. pier<br>Load-in/out impossible and/or entire project delayed | high risk | Verify qualification and experience of the person-nel for crane and AdÜ s.o.<br>Draw up a loading plan with responsibilities / communication<br>Kick-off meeting with the persons in charge for the project<br>Toolbox meetings prior to load-in/out | very good | 3 | low risk | | |
| Transport unit will capsize<br>Damage to transport unit and object<br>Damage to fixed or floating objects and environment, e.g. pier<br>Load-in/out impossible and/or entire project delayed | high risk | Verify qualification and experience of the person-nel for crane and AdÜ s.o.<br>Draw up a loading plan with responsibilities / communication<br>Kick-off meeting with the persons in charge for the project<br>Toolbox meeting prior to load-in/out | very good | 3 | low risk | | |
| Loading / unloading impossible due to the weather criteria<br>Loading / unloading delayed<br>Loss of cargo and/or damage to cargo<br>Entire project delayed | high risk | Check wether the weather reports meet the weather criteria<br>Toolbox meeting with all persons involved in the process before starting the corresponding process step; talk about stop criteria<br>Monitor present weather conditions | adequate | 6 | medium risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.3 Transport on own hull

| 9.3.3 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore transports | Transport on own hull | Towability | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Floatability of the topside | Topside will capsize and/ or sink |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.3 |
|---|---|---|---|---|---|---|---|
| Damage to the topside and the equipment installed or loss of topside<br><br>Entire project delayed<br><br>Damage to fix and floating objects and environment | very high risk | Calculate floatability, stability, trim - according to international rules and regulation (e.g. MODU code)<br><br>Calculate the max. values for acceleration and heeling and check against the permitted values<br><br>Make certifier / MWS verify this<br><br>Monitor the current acceleration and heeling values during transport and installation<br><br>Carry out towing tests in the towing tank / simulations | adequate | 8 | high risk | **General:**<br>▪ Floating device and towing gear of platform<br>▪ Towing approval<br><br>**1st scenario "out of the dock":**<br>▪ Damage to dock, tugboat, or third-party property<br>▪ Adverse effect on adjacent sea lanes<br>▪ Personal injury and environmental damage<br>▪ Physical damage to the substance of the platform, perhaps disposal of wreck<br>▪ Calculation and approval of towing gears<br>▪ Damage to towing connection (prepared emergency connec-tion)<br>▪ Lighting<br><br>**2nd scenario "on the base frame":**<br>▪ Delay due to weather<br>▪ Additional tugboats as support<br>▪ Problems with assembly | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.3.3 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore transports | Transport on own hull | Towability | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Water tightness of the topside | Water inrush, topside will capsize and/or sink |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.3 |
|---|---|---|---|---|---|---|---|
| Damage to the topside and the equipment installed or loss of topside<br><br>Entire project delayed<br><br>Damage to fix and floating objects and environment | high risk | Draw up a plan to establish water tight-ness:<br>▪ Determine number of openings<br>▪ Define method to establish water tight-ness<br>▪ Test procedure<br>▪ Verify<br>▪ water tightness during transport / installati-on by floaters (alarm equipment), draught marks on topside<br>▪ Install crew on topside (if required) and stand watch<br>▪ Install pump system if water enters into the topside<br><br>Establish and test water alarm and pump systems<br><br>Make MWS effect an acceptance inspection of the platform by MWS upon establishment of water tightness / seal<br><br>Monitor for water inrush into the topside, alarm system / watches | very good | 3 | low risk | **General:**<br>▪ Floating device and towing gear of platform<br>▪ Towing approval<br><br>**1st scenario "out of the dock":**<br>▪ Damage to dock, tugboat, or third-party property<br>▪ Adverse effect on adjacent sea lanes<br>▪ Personal injury and environmental damage<br>▪ Physical damage to the substance of the platform, perhaps disposal of wreck<br>▪ Calculation and approval of towing gears<br>▪ Damage to towing connection (prepared emergency connec-tion)<br>▪ Lighting<br><br>**2nd scenario "on the base frame":**<br>▪ Delay due to weather<br>▪ Additional tugboats as support<br>▪ Problems with assembly | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.3.3 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore transports | Transport on own hull | Towability | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Towability of topside | Resistance to towing too high<br>Towing speed too slow<br>Poor towing behaviour (e.g. swinging) |
| | Offshore transports | Transport on own hull | Towability | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | "Strong points" | Improper "strong points" |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.3 |
|---|---|---|---|---|---|---|---|
| The required towing speed is not reached; therefore, towing actually impossible<br>Poor towing behavi-our (e.g. too much swinging) makes towing impossible<br>Entire project delayed | high risk | Calculate towing behavi-our in theory<br>Carry out towing tests in the towing tank<br>Re-design if required<br>Calculate required towing capacities | adequate | 6 | medium risk | **General:**<br>▪ Floating device and towing gear of platform<br>▪ Towing approval<br>**1st scenario "out of the dock":**<br>▪ Damage to dock, tugboat, or third-party property<br>▪ Adverse effect on adjacent sea lanes<br>▪ Personal injury and environmental damage<br>▪ Physical damage to the substance of the platform, perhaps disposal of wreck<br>▪ Calculation and approval of towing gears<br>▪ Damage to towing connection (prepared emergency connec-tion)<br>▪ Lighting<br>**2nd scenario "on the base frame":**<br>▪ Delay due to weather<br>▪ Additional tugboats as support<br>▪ Problems with assembly | |
| As the "strong points" are improper, towing and/or positioning of the topside is impos-sible<br>Drifting off, grounding, collision, capsizing, or loss possible<br>Damage to topside<br>Water inrush<br>Entire project delayed | high risk | Based on the calculations of the required towing capacities, the strong points are designed according to applicable standards (DNV, GL ND)<br>Requirements and number of strong points are designed according to the use (towing, mooring, positioning)<br>Correspondingly mark the "strong points"<br>Position and SWL | very good | 3 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.3.3 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore transports | Transport on own hull | Towability | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | "Push" zones | Improper "push zones" |
| | Offshore transports | Transport on own hull | Towage | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Route | Inappropriate route<br>Ports of refuge<br>Protected areas due to limited navigational towing possibilities (AdÜ: INhalt?)<br>(draughts, widths of canals, narrows, lengths of locks, overhead clearances under bridges) |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.3 |
|---|---|---|---|---|---|---|---|
| As the "push zones" are improper, towing and/ or positioning of the topside is impossible Drifting off, grounding, collision, capsizing, or loss possible<br>Damage to topside<br>Water inrush<br>Entire project delayed | high risk | Requirements and number of "push zones" are designed according to the use (towing, mooring, positioning)<br>Correspondingly mark the "push zones" on the top side (position and SWL) so that the tugboats know where and at which level they have to push | very good | 3 | low risk | **General:**<br>▪ Floating device and towing gear of platform<br>▪ Towing approval<br>**1st scenario "out of the dock":**<br>▪ Damage to dock, tugboat, or third-party property<br>▪ Adverse effect on adjacent sea lanes<br>▪ Personal injury and environmental damage<br>▪ Physical damage to the substance of the platform, perhaps disposal of wreck<br>▪ Calculation and approval of towing gears<br>▪ Damage to towing connection (prepared emergency connec-tion)<br>▪ Lighting<br>**2nd scenario "on the base frame":**<br>▪ Delay due to weather<br>▪ Additional tugboats as support<br>▪ Problems with assembly | |
| Towing impossible or longer towing route (distance, time)<br>Entire project delayed | very high risk | Check the navigational towability of the objects to be transporteds and use of the planned towing/lifting capaci-ties prior to opting for a shipyard (draughts, widths of canals, narrows, lengths of locks, overhead clearances under bridges, interna-tional and national rules and regulations, etc.)<br>Plan exact route, protection areas, ports of refuge, use of canals in compliance with national and international rules and regulations | very good | 4 | medium risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.3.3 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore transports | Transport on own hull | Towage | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Tugboat | Damage to tugboat |
| | Offshore transports | Transport on own hull | Towage | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Tugboat | Collision with other ships or other fixed or floating objects |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.3 |
|---|---|---|---|---|---|---|---|
| No tugboat, drifting off, grounding, collision, capsizing, sinking, or loss possible<br><br>Tugboat to be replaced<br><br>Towage and entire project delayed | medium risk | Select well-respected, experienced, and certi-fied shipping companies (ISO, ISM, IMCA)<br><br>Early draw up a condition survey of the units and equipment used to find adequate replacement when necessary<br><br>Permanently monitor towing / installation by means of a tow master (AdÜ: Mensch oder Gerät?)<br><br>Contingency plan for lack of tugboats (ISM)<br><br>Access to stand-by tugboats | very good | 2 | low risk | **General:**<br>▪ Floating device and towing gear of platform<br>▪ Towing approval<br><br>**1st scenario "out of the dock":**<br>▪ Damage to dock, tugboat, or third-party property<br>▪ Adverse effect on adjacent sea lanes<br>▪ Personal injury and environmental damage<br>▪ Physical damage to the substance of the platform, perhaps disposal of wreck<br>▪ Calculation and approval of towing gears<br>▪ Damage to towing connection (prepared emergency connec-tion)<br>▪ Lighting<br><br>**2nd scenario "on the base frame":**<br>▪ Delay due to weather<br>▪ Additional tugboats as support<br>▪ Problems with assembly | |
| Structural damage to tugboat<br><br>Water inrush, capsi-zing, sinking, or loss of tugboat<br><br>Damage to fix and floating objects and environment<br><br>Towage and entire project delayed | medium risk | Plan and supervise exact route<br><br>Comply with COLREGs (e.g. day and night signals for towing trains)<br><br>Use a guard-boat<br><br>Warn other ships of exceptional towing train<br><br>Emergency plans<br><br>Access to stand-by tugboats | very good | 2 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.3.3 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore transports | Transport on own hull | Towage | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Tugboat | Taking the ground |
| | Offshore transports | Transport on own hull | Towage | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Tugboat | Fire |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.3 |
|---|---|---|---|---|---|---|---|
| Water inrush, capsi-zing, sinking, or loss of tugboat<br>Damage to tugboat<br>Damage to fix and floating objects and environment<br>Towage and entire project delayed | medium risk | Plan and supervise exact route<br>Emergency plan and emergency measures according to SMS / ISM<br>If required, transfer of the mission to other tugboats | very good | 2 | low risk | **General:**<br>▪ Floating device and towing gear of platform<br>▪ Towing approval<br>**1st scenario "out of the dock":**<br>▪ Damage to dock, tugboat, or third-party property<br>▪ Adverse effect on adjacent sea lanes<br>▪ Personal injury and environmental damage<br>▪ Physical damage to the substance of the platform, perhaps disposal of wreck<br>▪ Calculation and approval of towing gears<br>▪ Damage to towing connection (prepared emergency connec-tion)<br>▪ Lighting<br>**2nd scenario "on the base frame":**<br>▪ Delay due to weather<br>▪ Additional tugboats as support<br>▪ Problems with assembly | |
| Structural damage to tugboat<br>Water inrush, capsi-zing, sinking, or loss of tugboat<br>Damage to fix and floating objects and environment<br>Towage and entire project delayed | medium risk | Structural and mobile fire alarm and fire extinguishing systems according to SOLAS<br>Permanent monitoring of the fire alarm systems<br>Emergency plans accor-ding to SMS / ISM | very good | 2 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.3.3 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore transports | Transport on own hull | Towage | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Towrope | Towrope damaged / broken |
| | Offshore transports | Transport on own hull | Towage | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Barge/ topside | Collision with other ships or other fixed or floating objects |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.3 |
|---|---|---|---|---|---|---|---|
| Drifting off, grounding, capsizing, sinking, or loss of topside possible<br>Damage to fix and floating objects and environment<br>Towage and entire project delayed | medium risk | Use adequate towrope according to correspon-ding standards (DNV, GL ND) on the basis of the calculated capacities to be towed<br>Redundant towing equip-ment | very good | 2 | low risk | **General:**<br>▪ Floating device and towing gear of platform<br>▪ Towing approval<br>**1st scenario "out of the dock":**<br>▪ Damage to dock, tugboat, or third-party property<br>▪ Adverse effect on adjacent sea lanes<br>▪ Personal injury and environmental damage<br>▪ Physical damage to the substance of the platform, perhaps disposal of wreck<br>▪ Calculation and approval of towing gears<br>▪ Damage to towing connection (prepared emergency connec-tion)<br>▪ Lighting<br>**2nd scenario "on the base frame":**<br>▪ Delay due to weather<br>▪ Additional tugboats as support<br>▪ Problems with assembly | |
| Capsizing, sinking, or loss of barge / topside possible<br>Heavy damage to topside<br>Damage to fix and floating objects and environment<br>Towage and entire project delayed | very high risk | Plan and supervise exact route<br>Comply with COLREGs (e.g. day and night signals for towing trains)<br>Use a guard-boat<br>Warn other ships of exceptional towing train<br>Emergency plans | very good | 4 | medium risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.3.3 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore transports | Transport on own hull | Towage | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Barge/ topside | Taking the ground |
| | Offshore transports | Transport on own hull | Towage | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Barge/ topside | Fire |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.3 |
|---|---|---|---|---|---|---|---|
| Capsizing, sinking, or loss of barge / topside possible<br>Heavy damage to tugboat<br>Damage to fix and floating objects and environment | medium risk | Plan and supervise exact route<br>Emergency plan and emergency measures according to SMS / ISM<br>Secure the tugboat<br>Lighter the barge or topside, respectively, if possible | very good | 2 | low risk | **General:**<br>▪ Floating device and towing gear of platform<br>▪ Towing approval<br>**1st scenario "out of the dock":**<br>▪ Damage to dock, tugboat, or third-party property<br>▪ Adverse effect on adjacent sea lanes<br>▪ Personal injury and environmental damage<br>▪ Physical damage to the substance of the platform, perhaps disposal of wreck<br>▪ Calculation and approval of towing gears<br>▪ Damage to towing connection (prepared emergency connec-tion)<br>▪ Lighting<br>**2nd scenario "on the base frame":**<br>▪ Delay due to weather<br>▪ Additional tugboats as support<br>▪ Problems with assembly | |
| Structural damage to barge / topside<br>Capsizing, sinking, or loss of barge / topside possible<br>Damage to fix and floating objects and environment | medium risk | Structural and mobile fire alarm and fire extin-guishing systems<br>Permanent monitoring of the fire alarm systems<br>Emergency plans accor-ding to SMS / ISM | very good | 2 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.3.3 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore transports | Transport on own hull | Towage | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Barge/ topside<br>(towage on proper keel) | Damage<br>Towing gear broken |
| | Offshore transports | Transport on own hull | Towage | Floatability - stability / trim<br>Max. acceleration<br>Max. angle of heeling<br>Water tightness<br>Towing behaviour (speed, resistance, following properties)<br>Towing gear / equipment (strong points)<br>"Push" zones:<br>▪ Route<br>▪ Tugboat<br>▪ Barge<br>▪ Topside<br>▪ Weather criteria | Weather conditions | Adverse weather conditions |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.3 |
|---|---|---|---|---|---|---|---|
| Drifting off, grounding, capsizing, sinking, or loss of barge / topside possible<br><br>Damage to fix and floating objects and environment<br><br>Towage and entire project delayed | medium risk | Use adequate towing gear according to corre-sponding standards (DNV, GL ND) on the basis of the calculated capacities to be towed<br><br>Install redundant towing gear (emergency gear) | very good | 2 | low risk | **General:**<br>▪ Floating device and towing gear of platform<br>▪ Towing approval<br><br>**1st scenario "out of the dock":**<br>▪ Damage to dock, tugboat, or third-party property<br>▪ Adverse effect on adjacent sea lanes<br>▪ Personal injury and environmental damage<br>▪ Physical damage to the substance of the platform, perhaps disposal of wreck<br>▪ Calculation and approval of towing gears<br>▪ Damage to towing connection (prepared emergency connec-tion)<br>▪ Lighting<br><br>**2nd scenario "on the base frame":**<br>▪ Delay due to weather<br>▪ Additional tugboats as support<br>▪ Problems with assembly |
| Damage to tugboat, barge, topside<br><br>Towage and entire project delayed | very high risk | Definition of the weather criteria based on the design of the topside (design, equipment, max. values for acceleration / heeling, sea-fastening, etc.)<br><br>Check wether the weather reports meet the weather criteria<br><br>Monitor present weather conditions | very good | 4 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.4 Route, ports of refuge, and refuges in general

| 9.3.4 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Execution planning of offshore transports | Planning of the route, ports of refuge, and protection areas | Identification of appropriate routes for towing | Navigation restrictions due to length, width, draught, and overhead clearances of the towing object and the object to be towed in locks, canals, narrows, under bridges, etc.<br>International and national rules and regulations for shipping | Route<br>(ports of refuge and protection areas) | Inappropriate route, ports of refuge, protected areas due to limited navigational towing possibilities (draughts, widths of canals, narrows, lengths of locks, overhead clearances under bridges) |
| | Execution planning of offshore transports and offshore erection | Planning of the route, ports of refuge, and protection areas | Definition of weather criteria for transport and installation | Definition of weather, sea state, and flow criteria to provide for safe transport and installation on the basis of weather, sea state, and flow statistics for the respective area of transportation and installation | Weather<br>Flows<br>Sea state<br>Tides | Area of installation cannot be reached and/ or project delayed |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.3.4 |
|---|---|---|---|---|---|---|
| Towing impossible or longer towing route (distance, time)<br>Towage and entire project delayed | high risk | Exactly plan where the platform is to be erected on the basis of the towability from the shipyard to the installation area.<br>Exactly plan the routes on the basis of:<br>▪ the given dimensions of the towing units and those to be towed<br>▪ the applicable national and international regulations and laws | very good | 3 | low risk | |
| Project infeasible<br>Towing and/or installation delayed<br>Damage to towed object | high risk | Define realistic weather criteria for towing, the area where towing will take place, and the time when towing will take place<br>Check wether the weather reports meet the weather criteria<br>Monitor present weather conditions | adequate | 6 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.5 Sea-fastening, grillage, structure

| 9.3.5 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Execution planning of offshore transports | Sea-fastening and grillage<br>Deck structure integrity | Planning and calculation of sea-fastening | Object to be transported<br>Transport equipment<br>Lashing methods / system<br>Loads on deck<br>Strong points / attachment points | Sea-fastening | Wrong or poor sea-fastening<br>Safe releasing of the sea-fastening impossible when being offshore<br>Wrong releasing of sea-fastening<br>Damage to lashing equipment used<br>Failure of sea-fastening |
| | Execution planning of offshore transports | Sea-fastening and grillage<br>Deck structure integrity | Planning and calculation of grillage | Object to be transported<br>Transport equipment<br>Lashing methods / system<br>Loads on deck<br>Strong points / attachment points | Grillage | Damage to installed grillage<br>Failure of grillage |
| | Execution planning of offshore transports | Sea-fastening and grillage<br>Deck structure integrity | Planning and calculation of deck structure integrity | Object to be transported<br>Transport equipment<br>Lashing methods / system<br>Loads on deck<br>Strong points / attachment points | Deck structure integrity | Damage to deck structure<br>Failure of deck structure |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.5 |
|---|---|---|---|---|---|---|---|
| Damage to cargo and transport means<br>Loss of cargo or splitting of cargo and transport means<br>Damage to fix and floating objects and environment<br>Transport unit will capsize<br>Towage and entire project delayed | high risk | Plan and calculate the sea-fastening on the basis of the weather conditions defined for the object to be trans-ported and the transport equipment<br>Implement the planning in construction<br>Supervise the execution of construction work<br>Prepare method state-ments to establish / release sea-fastening<br>Make MWS verify and approve this | very good | 3 | low risk | Evidence of allowed load on decks for barges (deck slab size, size of longitudinal structures and trans-verse structures, shell, tanks, bollards, etc.)<br>Evidence of additional lashings as required by regulations (quantity, position)<br>Condition, approval, certification of lashing material | |
| Damage to cargo and transport means<br>Loss of cargo / trans-port means<br>Damage to fix and floating objects and environment<br>Towage and entire project delayed | high risk | Plan and calculate the grillage on the basis of the weather conditions defined for the object to be transported and the transport equipment<br>Implement the planning in construction<br>Make MWS verify and approve this | very good | 3 | low risk | | |
| Damage to cargo and transport means<br>Loss of cargo / trans-port means<br>Damage to fix and floating objects and environment<br>Towage and entire project delayed | very high risk | Evidence of allowed loads on deck, structures, lashing points accor-ding to SOLAS (Cargo Securing Manual)<br>Proof by calculation of the loads resulting from cargo, grillage, and sea-fastening<br>Verification and approval on site by MWS | very good | 4 | medium risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.6 MWS weather criteria

9.3.6

| Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|
| Execution planning of offshore transports | Clearing up allowed sea state and weather conditions with MWS / certifier | Structural design and implementation of requirements for objects to be transported and sea-fastening on the basis of defined sea state and weather conditions | Weather conditions | Design faults<br>Faults when installing the transport equipment onto the object to be transported |
| Execution planning of offshore erection | Clearing up allowed sea state and weather conditions with MWS / certifier | Structural design and implementation of requirements for objects to be transported and sea-fastening on the basis of defined sea state and weather conditions | Weather conditions | Design faults<br>Faults when installing the installation equipment (AdÜ: Was ist damit gemeint?) onto the object to be transported |
| Execution planning of offshore transports | Clearing up allowed sea state and weather conditions with MWS / certifier | Planning of different transport sections | Weather conditions | Wrong verification of transport sections |
| Execution planning of offshore erection | Clearing up allowed sea state and weather conditions with MWS / certifier | Planning of different installation stages | Weather conditions | Wrong verification of the installation stages |
| Execution planning of offshore transports | Clearing up allowed sea state and weather conditions with MWS / certifier | Definition of weather, sea state, and flow criteria to provide for safe transport on the basis of weather, sea state, and flow statistics for the respective area of transportation | Weather conditions | Wrong basis of statistical data for the area and period of transportation |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.3.6 |
|---|---|---|---|---|---|---|
| Wrong definition of maximum weather and sea state criteria<br>Damage to topside and other objects to be transported<br>Damage to fix and floating objects and environment<br>Transport and/or lifting operations and entire project delayed | high risk | Define the design requirements by exact planning of the transport sections<br>Make MWS verify this | very good | 3 | low risk | |
| Wrong definition of maximum weather and sea state criteria<br>Damage to topside and other objects to be transported<br>Damage to fix and floating objects and environment<br>Transport and/or lifting operations and entire project delayed | high risk | Define the design requirements by exact planning of the installation stages<br>Make MWS verify this | very good | 3 | low risk | |
| Wrong definition of maximum weather and sea state criteria<br>Damage to topside and other objects to be transported<br>Damage to fix and floating objects and environment<br>Transport and/or lifting operations and entire project delayed | high risk | Exactly plan the individual transport sections<br>Make certifier / MWS verify this | very good | 3 | low risk | |
| Wrong definition of maximum weather and sea state criteria<br>Damage to topside and other objects to be transported<br>Damage to fix and floating objects and environment<br>Transport and/or lifting operations and entire project delayed | high risk | Exactly plan the individual transport stages<br>Make certifier / MWS verify this | very good | 3 | low risk | |
| Wrong definition of maximum weather and sea state criteria<br>Damage to topside and other objects to be transported<br>Damage to fix and floating objects and environment<br>Transport and/or lifting operations and entire project delayed | high risk | Select the relevant statistical data on the basis of an exact plan of the area of operation<br>Make certifier / MWS verify this | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.3.6 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Execution planning of offshore erection | Clearing up allowed sea state and weather conditions with MWS / certifier | Definition of weather, sea state, and flow criteria to provide for safe installation on the basis of weather, sea state, and flow statistics for the respective area of installation | Weather conditions | Wrong basis of statistical data for the area and period of installation |

Definition of weather, sea state, and flow criteria to provide for safe transport and installation on the basis of weather, sea state, and flow statistics for the respective area of transportation and installation

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.3.6 |
|---|---|---|---|---|---|---|
| Wrong definition of maximum weather and sea state criteria<br><br>Damage to topside and other objects to be transported<br><br>Damage to fix and floating objects and environment<br><br>Transport and/or lifting opera-tions and entire project delayed | high risk | Select the relevant statistical data on the basis of an exact plan of the area of operation<br><br>Make certifier / MWS verify this | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.7 Operating manual complies with limitations

| 9.3.7 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Execution planning of offshore transports | Operating manual complies with limitations | Preparing operating manuals / method statements | Method statements<br>Operating manuals | Wrong / poor information about restrictions for transport<br>(e.g. weight, acceleration, weather and sea state criteria) |
| | Execution planning of offshore erection | Operating manual complies with limitations | Preparing operating manuals / method statements | Method statements<br>Operating manuals | Wrong / poor information about restrictions for installation<br>(e.g. weight, acceleration, weather and sea state criteria) |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.3.7 |
|---|---|---|---|---|---|---|
| Wrong reproduction of restrictions leads to transmission of wrong information to the transport contractors / sub-contractors<br><br>This entails damage or loss of the object to be transported and the transport and/or installation equipment, damage to fix and floating objects, and environmental damage | high risk | Peruse and verify the operating manuals / method statements following the six-eyes principle<br><br>Discuss and verify the restriction criteria with the transport contractors / sub-contractors<br><br>Make certifier / MWS verify this | very good | 3 | low risk | |
| Wrong reproduction of restrictions leads to transmission of wrong information to the installation contractors / sub-contractors<br><br>This entails damage or loss of the object to be installed and the installation equipment, damage to fix and floating objects, and environmental damage | high risk | Peruse and verify the operating manuals / method statements following the six-eyes principle<br><br>Discuss and verify the restriction criteria with the installation contractors / sub-contractors<br><br>Make certifier / MWS verify this | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.8 Availability of MWS

| 9.3.8 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Execution planning of offshore transports | Clear up whether MWS will be available during transport | Verification of MWS availability during transport | MWS | No MWS available<br>No MWS available who is familiar with this transport section |
| | Execution planning of offshore erection | Clearing up whether MWS will be available during offshore installation | Verification of MWS availability during installation | MWS | No MWS available<br>No MWS available who is familiar with this installation stage |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.8 |
|---|---|---|---|---|---|---|---|
| No general approval / approval of the individu-al transport section<br>Execution of the indivi-dual transport sections delayed<br>Loss of weather slot for this transport section | medium risk | Contact insurance companies to ask for recommended MWS companies<br>Check 24/7-availability of MWS prior to entering into an agreement<br>Verify references as to sufficient experience during approval / general approval of the transport section in question | very good | 2 | low risk | Limited number of MWS skilled in this field<br>In case of delays perhaps not available anymore | |
| No general approval / approval of the individu-al installation stage<br>Execution of the indivi-dual installation stages delayed<br>Loss of weather slot for this installation stage | medium risk | Contact insurance companies to ask for recommended MWS companies<br>Check 24/7-availability of MWS prior to entering into an agreement<br>Verify references as to sufficient experience during approval / general approval of the installation stages in question | very good | 2 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.9 Emergency plans - person in charge

9.3.9

| Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|
| Execution planning of offshore transports | Draw up emergency plans<br>Designation of responsible persons in consideration of the German Construction Site Ordinance (AdÜ: hier ist das deutsche Gesetz gemeint?) | Execution of HAZID / HAZOP | HAZID / HAZOP | No HAZID / HAZOP take place<br>Process- and/or design-relevant dangers not recognised |
| Execution planning of offshore erection | Draw up emergency plans<br>Designation of responsible persons in consideration of the German Construction Site Ordinance (AdÜ: hier ist das deutsche Gesetz gemeint?) | Execution of HAZID / HAZOP | HAZID / HAZOP | No HAZID / HAZOP take place<br>Process- and/or design-relevant dangers not recognised |
| Execution planning of offshore transports | Draw up emergency plans<br>Designation of responsible persons in consideration of the German Construction Site Ordinance (AdÜ: hier ist das deutsche Gesetz gemeint?) | Execution of risk assessment | Risk assessment | No risk assessment take place<br>Risks are not detected and/or not analysed or wrongly assessed |
| Execution planning of offshore erection | Draw up emergency plans<br>Designation of responsible persons in consideration of the German Construction Site Ordinance (AdÜ: hier ist das deutsche Gesetz gemeint?) | Execution of risk assessment | Risk assessment | No risk assessment takes place<br>Risks are not detected and/or not analysed or wrongly assessed |
| Execution planning of offshore transports | Draw up emergency plans<br>Designation of responsible persons in consideration of the German Construction Site Ordinance (AdÜ: hier ist das deutsche Gesetz gemeint?) | Drawing up emergency plans for all transport sections | Emergency plan | No or insufficient emergency plans drawn up |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.3.9 |
|---|---|---|---|---|---|---|
| Cargo / transport equipment, process execution, and the personnel involved at risk<br>Damage to the cargo of equip-ment used (AdÜ: oder "und der eingesetzten Ausrüstung"?<br>Transportation impossible | high risk | Execution of HAZID / HAZOP<br>Comply with national standards and requirements<br>Analyse the risks and if required change the process and/or the design | very good | 3 | low risk | |
| Cargo / transport equipment, process execution, and the personnel involved at risk<br>Damage to the cargo of equip-ment used (AdÜ: oder "und der eingesetzten Ausrüstung"?<br>Installation impossible | high risk | Execution of HAZID / HAZOP<br>Comply with national standards and requirements<br>Analyse the risks and if required change the process and/or the design | very good | 3 | low risk | |
| No conclusions to avoid risks / hazards<br>Consequence: damage and accidents | high risk | Establish risk assessment for all trans-port procedures<br>Identify correction and/or protection measures<br>Implement correction and/or protection measures into the design, method state-ments, process sequences, QHSE proce-dures, training programmes, instructions for PPE, emergency concepts, etc.<br>Complement / draw up a register of risks | very good | 3 | low risk | |
| No conclusions to avoid risks / hazards<br>Consequence: damage and accidents | high risk | Establish risk assessment for all installa-tion procedures<br>Identify correction and/or protection measures<br>Implement correction and/or protection measures into the design, method state-ments, process sequences, QHSE proce-dures, training programmes, instructions for PPE, emergency concepts, etc.<br>Complement / draw up a register of risks | very good | 3 | low risk | |
| As risk assessment is missing, hazards, risks, and any conse-quences are not detected and, therefore, no emergency measures are planned to be taken should the case occur<br>Insufficient preparation for the handling / averting of hazardous situations | high risk | Prepare emergency plans for all transport procedures on the basis of the HAZID, HAZOP, and risk assessments carried out | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.3.9

| Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|
| Execution planning of offshore erection | Draw up emergency plans<br>Designation of responsible persons in consideration of the German Construction Site Ordinance (AdÜ: hier ist das deutsche Gesetz gemeint?) | Drawing up emergency plans for all installation stages | Emergency plan | No or insufficient emergency plans drawn up |
| Execution planning of offshore transports | Draw up emergency plans<br>Designation of responsible persons in consideration of the German Construction Site Ordinance (AdÜ: hier ist das deutsche Gesetz gemeint?) | Execution of emergency practices | Emergency practices | No or insufficient training and emergency practices |
| Execution planning of offshore erection | Draw up emergency plans<br>Designation of responsible persons in consideration of the German Construction Site Ordinance (AdÜ: hier ist das deutsche Gesetz gemeint?) | Execution of emergency practices | Emergency practices | No or insufficient training and emergency practices |
| Execution planning of offshore transports | Draw up emergency plans<br>Designation of responsible persons in consideration of the German Construction Site Ordinance (AdÜ: hier ist das deutsche Gesetz gemeint?) | Definition of responsibilities and alerting methods and/or channels of communication | Emergency response team | Responsibilities, alerting methods, and channels of communication insufficient or not defined at all |
| Execution planning of offshore erection | Draw up emergency plans<br>Designation of responsible persons in consideration of the German Construction Site Ordinance (AdÜ: hier ist das deutsche Gesetz gemeint?) | Definition of responsibilities and alerting methods and/or channels of communication | Emergency response team | Responsibilities, alerting methods, and channels of communication insufficient or not defined at all |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.3.9 |
|---|---|---|---|---|---|---|
| As risk assessment is missing, hazards, risks, and any conse-quences are not detected and, therefore, no emergency measures are planned to be taken should the case occur<br>Insufficient preparation for the handling / averting of hazardous situations | high risk | Prepare emergency plans for all installa-tion procedures on the basis of the HAZID, HAZOP, and risk assessments carried out | very good | 3 | low risk | |
| Insufficient preparation and training for potential cases of emergency<br>Staff and crews cannot cope with the situation | high risk | Prepare training plans on the basis of the emergency plans<br>Carry out training and emergency practices on the basis of the training plans to be prepared for the case of emergency | very good | 3 | low risk | |
| Insufficient preparation and training for potential cases of emergency<br>Staff and crews cannot cope with the situation | high risk | Prepare training plans on the basis of the emergency plans<br>Carry out training and emergency practices on the basis of the training plans to be prepared for the case of emergency | very good | 3 | low risk | |
| Missing or insufficient decision structures<br>Missing or insufficient informati-on management<br>Chaotic and/or insufficient co-ordination of emergency measures | high risk | Provide for competent specialists for the different processes<br>Prepare training plans on the basis of the emergency plans<br>Carry out training and emergency practices on the basis of the training plans to be prepared for the case of emergency<br>Carry out table-top training<br>Communication channels tested | very good | 3 | low risk | |
| Missing or insufficient decision structures<br>Missing or insufficient informati-on management<br>Chaotic and/or insufficient co-ordination of emergency measures | high risk | Provide for competent specialists for the different processes<br>Prepare training plans on the basis of the emergency plans<br>Carry out training and emergency practices on the basis of the training plans to be prepared for the case of emergency<br>Carry out table-top training<br>Communication channels tested | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.10 Component of limited tipping angle

9.3.10

| Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|
| Execution planning of offshore transports | Registration of components of limited tipping angle | Checking all components for a limit of heeling/tipping angle | Tipping angle | Insufficient information about permitted angle of heeling/tipping |
| Execution planning of offshore erection | Registration of components of limited tipping angle | Checking all components for a limit of heeling/tipping angle | Tipping angle | Insufficient information about permitted angle of heeling/tipping |
| Offshore transports | Registration of components of limited tipping angle | Checking all components for a limit of heeling/tipping angle | Tipping angle | Exceeding of angle of heeling/tipping |
| Offshore erection | Registration of components of limited tipping angle | Checking all components for a limit of heeling/tipping angle | Tipping angle | Exceeding of angle of heeling/tipping |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.10 |
|---|---|---|---|---|---|---|---|
| Damage to and/or loss of object to be transported / transport equipment<br>Damage to fix and floating objects and environment | high risk | Check all components of the object to be trans-ported for max. angle of heeling/tipping<br>Calculate max. allowed weather/sea state condi-tions for max. allowed angle of heeling/tipping | very good | 3 | low risk | Susceptibility of components' heeling to waves and wind<br>Enlarged surface exposed to the wind<br>Vibrations | |
| Damage to and/or loss of object to be transported / transport equipment<br>Damage to fix and floating objects and environment | high risk | Check all components of the object to be trans-ported for max. angle of heeling/tipping<br>Calculate max. allowed weather/sea state condi-tions for max. allowed angle of heeling/tipping | very good | 3 | low risk | | |
| Damage to and/or loss of object to be transported / transport equipment<br>Damage to fix and floating objects and environment | high risk | Observe the weather criteria for transport and installation<br>Monitor the angle of heeling/tipping by means of appropriate measuring and recording instru-ments during transport and installation | very good | 3 | low risk | | |
| Damage to and/or loss of object to be transported / transport equipment<br>Damage to fix and floating objects and environment | high risk | Observe the weather criteria for transport and installation<br>Monitor the angle of heeling/tipping by means of appropriate measuring and recording instru-ments during transport and installation | very good | 3 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.11 Component of limited acceleration

9.3.11

| Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|
| Execution planning of offshore transports | Registration of components of limited acceleration | Checking all components for a limit of acceleration | Acceleration | Insufficient information about permitted acceleration values |
| Execution planning of offshore erection | Registration of components of limited acceleration | Checking all components for a limit of acceleration | Acceleration | Insufficient information about permitted acceleration values |
| Offshore transports | Registration of components of limited acceleration | Checking all components for a limit of acceleration | Acceleration | Exceeding of acceleration values |
| Offshore erection | Registration of components of limited acceleration | Checking all components for a limit of acceleration | Acceleration | Exceeding of acceleration values |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assessment | Protection measure | Assessment of protection measures | Relevance | Status | 9.3.11 |
|---|---|---|---|---|---|---|
| Damage to object to be transported and transport equipment<br>Damage to fix and floating objects and environment | very high risk | Check all components of the object to be transported for max. acceleration values<br>Calculate max. allowed weather and sea state conditions for max. allowed acceleration | very good | 4 | medium risk | |
| Damage to object to be transported and transport equipment<br>Damage to fix and floating objects and environment | very high risk | Check all components of the object to be transported for max. acceleration values<br>Calculate max. allowed weather and sea state conditions for max. allowed acceleration | very good | 4 | medium risk | |
| Damage to object to be transported and transport equipment<br>Damage to fix and floating objects and environment | very high risk | Observe the weather criteria for transport<br>Monitor the acceleration values by means of appropriate measuring and recording instruments during transport<br>If necessary, modify course and speed during transport | very good | 4 | medium risk | |
| Damage to object to be transported and transport equipment<br>Damage to fix and floating objects and environment | very high risk | Observe the weather criteria for installation<br>Monitor the acceleration values by means of appropriate measuring and recording instruments during installation<br>If necessary, modify course and speed during installation | very good | 4 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.12 Approval by MWS

| 9.3.12 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Execution planning of offshore transports | Approval by MWS | Execution of a transport-relevant approval | Approval | Error during approval due to insufficient knowledge of MWS<br>Error during approval due to insufficient information by client |
| | Execution planning of offshore erection | Approval by MWS | Execution of an installation-relevant approval | Approval | Error during approval due to insufficient knowledge of MWS<br>Error during approval due to insufficient information by client |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.3.12 |
|---|---|---|---|---|---|---|
| Damage to or loss of objects to be trans-ported<br><br>Damage to fix and floating objects and environment | high risk | Look for appropriate MWS companies<br><br>Verify references as to sufficient experience during approval / general approval of the transport section in question<br><br>Draw up a catalogue of the documents to be verified<br><br>Verify certified documents, only<br><br>Verify compliance with certified measures including on-site implementation<br><br>In case of discrepancies, stop the approval and verify the information / measures | very good | 3 | low risk | |
| Damage to or loss of objects to be trans-ported<br><br>Damage to fix and floating objects and environment | high risk | Look for appropriate MWS companies<br><br>Verify references as to sufficient experience during approval / general approval of the installation stages in question<br><br>Draw up a catalogue of the documents to be verified<br><br>Verify certified documents, only<br><br>Verify compliance with certified measures including on-site implementation<br><br>In case of discrepancies, stop the approval and verify the information / measures | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.13 Verification by certifier of the method statements

| 9.3.13 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Execution planning of offshore transports | Verification by certifier of the method statements | Verification of method statements | Method statements<br>(method statements) | Wrong documents that do not reproduce the processes<br>Missing or insufficient documents |
| | Execution planning of offshore erection | Verification by certifier of the method statements | Verification of method statements | Method statements<br>(method statements) | Wrong documents that do not reproduce the processes<br>Missing or insufficient documents |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.3.13 |
|---|---|---|---|---|---|---|
| Faulty certification<br>No homologation or refusal of homologation<br>Homologation delayed<br>Project delayed | high risk | Select appropriate and experienced certifier<br>Early and direct contact to the certifier to clear sequences and procedures of certification<br>Document management to reproduce and establish the process and corresponding documentation in its entirety<br>Make certifier carry out certification audits to ensure and verify the procedures<br>Check process sequences on-site during transport | very good | 3 | low risk | |
| Faulty certification<br>No homologation or refusal of homologation<br>Homologation delayed<br>Project delayed | high risk | Select appropriate and experienced certifier<br>Early and direct contact to the certifier to clear sequences and procedures of certification<br>Document management to reproduce and establish the process and corresponding documentation in its entirety<br>Make certifier carry out certification audits to ensure and verify the procedures<br>Check process sequences on-site during installa-tion | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.3 Engineering, transport of transformer station

### 9.3.14 Delay due to bad weather / vessel repair

| 9.3.14 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Execution planning of offshore transports and offshore erection | Delay due to bad weather and repairs of special ships | Planning of weather and sea state conditions for the use of transport and installation capacities | Weather and sea state | Conditions of weather and sea state beyond weather criteria |
| | Execution planning of offshore transports and offshore erection | Delay due to bad weather and repairs of special ships | Outage due to repair of special ships | Special ships | Technical breakdown of the special ships |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.3.14 |
|---|---|---|---|---|---|---|---|
| Long-term delays and/ or failure of trans-port and installation activities | high risk | Exactly plan the project start (winter or summer) on the basis of weather statistics and weather criteria to adhere to<br><br>Define as high weather and sea state criteria as technically possible and reasonable and observe them in the design and the chain of transport and installation<br><br>Plan the use of units on a daily basis and use the current weather condi-tions and development as well as possible criteria of use as a basis, too | adequate | 6 | medium risk | Observance of weather conditions<br><br>Development of a detailed weather and meteo-ocean plan of the installation site to well comprehend the weather there<br><br>Inclusion of delay costs in CAPEX<br><br>Weather insurance to be effected | |
| Due to the limited availability of special ships, delivery of spare parts, repair capaci-ties: long-term delays, or stop of transport and installation activities<br><br>Damage to and/or loss of objects to be trans-ported and installed<br><br>Damage to fix and floating objects and environment | high risk | Select well-respected shipping companies<br><br>Select ships classified in an IACS class<br><br>Condition survey prior to chartering and/or use of a ship<br><br>Ships belonging to shipyards and component manufacturers with a world-wide supporting network and reaction times of 24/7<br><br>Redundancy of ships | very good | 3 | low risk | Weather conditions to be met<br><br>High technicization of the ships and daily rates<br><br>Availability of spare parts and shipyard capacities and/or facilities<br><br>Available for construc-tions on certain days, only<br><br>Potential penalties due when electrical current is not delivered on-time | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.4 Construction engineering of transformer station

### 9.4.1 Review of sea state and weather conditions

| 9.4.1 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Execution planning of offshore erection | Clearing up allowed sea state and weather conditions with MWS / certifier | Planning of different assembling stages | Weather conditions | Wrong verification of assembling |
| | Execution planning of offshore erection | Clearing up allowed sea state and weather conditions with MWS / certifier | Definition of weather, sea state, and flow criteria to provide for safe transport and installation on the basis of weather, sea state, and flow statistics for the respective area and period of assembling | Weather conditions | Wrong basis of statistical data for the area and period of assembling |
| | Execution planning of offshore erection | Clearing up allowed sea state and weather conditions with MWS / certifier | Structural implementation of the requirements for the installation objects and the sea-fastening on the basis of weather / sea state statistics | Weather conditions | Wrong construction of installation objects and sea-fastening |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.4.1 |
|---|---|---|---|---|---|---|---|
| Wrong definition of maximum weather and sea state criteria<br>Damage to topside and other prefabricated sections<br>Assembling delayed | high risk | Exactly plan the individual assembling stages<br>Close co-ordination with design engineers and the contractors for transport and installation<br>Make certifier / MWS clear up and verify | very good | 3 | low risk | Professional indemnity<br>Hull & machinery<br>P&I<br>Charterer's liability | |
| Wrong definition of maximum weather and sea state criteria<br>Damage to topside and other prefabricated sections<br>Assembling delayed | high risk | Select the relevant statistical data on the basis of the exact schedule for area and period of assembling<br>Opt for weather providers experienced in the offshore area to deliver weather statistics<br>Make certifier / MWS verify this | very good | 3 | low risk | Professional indemnity<br>Hull & machinery<br>P&I<br>Charterer's liability | |
| Damage to topside and other installation sections<br>Installation delayed | high risk | Define the structural requirements by exact planning of the installation stages<br>Closely co-ordinate with design engineers and the shipyard<br>Make certifier / MWS verify this | very good | 3 | low risk | Professional indemnity<br>Hull & machinery<br>P&I<br>Charterer's liability | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.4 Construction engineering of transformer station

### 9.4.2 Release of installation procedures by the person in charge of project certification

| 9.4.2 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Execution planning of offshore erection | Release of installation procedures by the person in charge of project certification | Verification and release of installation procedures<br>(method statements) | Installation procedures<br>(method statements) | Missing or incomplete documents<br>Faulty installation procedures that do not reflect the actual steps and sequences<br>Wrong assumptions for design and execution |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.4.2 |
|---|---|---|---|---|---|---|
| Delay in verification / release of the installati-on procedures<br><br>Damage / accidents during transport and installation<br><br>Installation infeasible due to wrong assump-tions | high risk | Select experienced certifier<br><br>Co-ordinate with certifiers the certifying procedure<br><br>Furnish proof of all valid documents (document management)<br><br>Kick-off meeting on the execution of the individual transport and installation stages and check against the intended methods<br><br>Check when processes are running | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.4 Construction engineering of transformer station

### 9.4.3 Engineering of pre- & post-piling

| 9.4.3 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Execution planning of offshore erection | Planning complete: pre- / post-piling | Selection of piling method | Technology | The installation steps are appropriate for the piling technology<br>(e.g. no pile driving template, wrong installation equipment, etc.) |
| | Execution planning of offshore erection | Planning complete: pre- / post-piling | Pre-piling | Pile driving template | Wrong pile driving template<br>Does not correspond to the actually required distance between piles and pile sizes for the jacket |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.4.3 |
|---|---|---|---|---|---|---|
| Piling and installation impossible | high risk | Exactly define the piling technology and the individual steps<br>Make external surveyors verify this | very good | 3 | low risk | |
| The jacket cannot be installed<br>Position to be rejected<br>Ready-made and/or installed cables to be rejected<br>Entire installation delayed | high risk | Use only one pile driving template<br>Exactly mark the pile driving templates if several | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.4 Construction engineering of transformer station

### 9.4.4 Soil investigation

| 9.4.4 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Soil investigation | Soil investigation | Geotechnical and geophysical investigations of the building ground | Soil | Insufficient stability at the installation position<br>Impossible to drive piles into the hard subsoil<br>Insufficient levelling due to variations in the thickness of bearing beds (ruggedness);<br>Objects on the positions of piles (ammunition) |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.4.4 |
|---|---|---|---|---|---|---|---|
| Installation of the topside / baseframe at the planned position is impossible; position has to be turned down<br><br>Impossible to drive the piles down to the planned depth<br><br>Piles not designed for this soil<br><br>Piles have become stuck in the ground and are blocked by an object<br><br>Ammunition in the pile driving field, explosion followed by damage to / loss of pile, installation units, personnel<br><br>Position perhaps to be rejected | very high risk | Geotechnical and geophysical investigations to rate the soil quality<br><br>Ground scans to determine any stratification and to locate any objects in the installation area<br><br>Logs per pile position as well as CPTs to determine the geophysical characteristics of stratification and use them to draw up a feasibility study for pile-driving<br><br>Survey the bearing stratum and the ground levels and examine the resulting measures (excavation to adjust the level)<br><br>Apply conservative approach (high safety)<br><br>Verify the soil investigations and their consequences / results through independent expert opinions<br><br>Design and carry out construction on the basis of such investigations (e.g. pile sizes, ADÜ?)<br><br>Use appropriate equipment, such as vibro hammer, pile hammer<br><br>Levelling devices<br><br>Remove any ammunition and other objects in the installation area | adequate | 8 | high risk | Detailed geotechnical and geophysical investigation during development<br><br>Detailed platform design to detect sensitive areas and design margins<br><br>Design should be verified by a third party<br><br>Design should be proven and realised by experienced design engineers | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.4 Construction engineering of transformer station

### 9.4.5 Positioning, bubble curtain, mooring, DP, and jacking

9.4.5

| Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|
| l) | Positioning<br>Bubble curtain<br>Mooring<br>DP and jacking | Use of bubble curtain system to reduce the propagation of hammering sound<br>(relieved foundation systems / monopiles) | Bubble curtain systems | Failure and loss of the system |
| k) | Positioning<br>Bubble curtain<br>Mooring<br>DP and jacking | Use of bubble curtain system to reduce the propagation of hammering sound<br>(relieved foundation systems / monopiles) | Tugboat<br>Supply vessel | Failure of installation units:<br>▪ Technical failure<br>▪ Improper use<br>▪ Use beyond limitation of use |
| l) | Positioning<br>Bubble curtain<br>Mooring<br>DP and jacking | Use of bubble curtain system to reduce the propagation of hammering sound<br>(relieved foundation systems / monopiles) | Weather conditions and sea state | Heavy wind, gusts<br>Sea too rough<br>Tide |
| k) | Positioning<br>Bubble curtain<br>Mooring<br>DP and jacking | Dynamic positioning of crane ship / tugboat | Crane vessel<br>Tugboat<br>AHT<br>Supply vessel<br>Jack-up vessel | Malfunction of DP system during installation:<br>▪ no DP trail<br>▪ load distribution on the ship<br>▪ non-observance of limitation of use<br>▪ malfunction of sensors / measuring error<br>▪ Technical failure |
| k) | Positioning<br>Bubble curtain<br>Mooring<br>DP and jacking | Dynamic positioning of crane ship / tugboat | Weather conditions and sea state | Heavy wind, gusts<br>Sea too rough<br>Tide |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.4.5 |
|---|---|---|---|---|---|---|
| No sound-reducing measures possible<br>Pile installation work delayed<br>Entire project delayed | medium risk | Maintain and inspect the system prior to any use<br>Redundant system<br>Spare parts<br>Skilled and trained personnel | adequate | 4 | medium risk | |
| Impossible to lower into water / install the system<br>Pile installation work delayed<br>Entire project delayed | medium risk | Select well-respected, experienced, and certified shipping companies (ISO, ISM, IMCA)<br>Early draw up a condition survey of the units and equipment used to find adequate replacement where necessary<br>Qualified and trained crew<br>Contingency plan for lack of tugboats / supply vessels (ISM)<br>Access to stand-by tugboats / supply vessels | adequate | 4 | medium risk | |
| Impossible to build up bubble curtain and, consequently, the latter is ineffective<br>Pile installation work delayed<br>Entire project delayed | medium risk | Define appropriate weather criteria<br>Check the weather reports<br>Carry out operations under defined weather conditions only | adequate | 4 | medium risk | |
| Maritime units drifting during installation<br>Collision with fixed and floating objects / items<br>Damage to objects / items<br>Delay during installation | medium risk | Carry out maintenance work as required by the manufacturer<br>Check all units for their use in the field<br>DP trail prior to starting any work<br>Use qualified and trained personnel for operation and maintenance | very good | 2 | low risk | |
| Impossible to reach or keep position | high risk | Define appropriate weather criteria<br>Check the weather reports<br>Carry out operations under defined weather conditions and in the corresponding weather slot, only | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.5 Erection of transformer station

### 9.5.1 Planning of vessels, barges, etc.

| 9.5.1 | Process steps | Short description of operation | Requirements for the operation | Marine spread | Requirements | Risks |
|---|---|---|---|---|---|---|
| | Execution planning of offshore transports | Planning and assessment of necessary ships, barges, ...<br>(proof of class) | Identification / calculation of the ship, tugboat, barge capacities required<br>Tugging equipment (marine spread) based on industrial standards (DNV, GL Noble Denton, London Offshore, etc.) | Crane ship | | Crane ships<br>Tugboat<br>AHT<br>Barges<br>Supply vessels<br>Jack up barges / vessels etc.<br>Equipment |
| | Execution planning of offshore transports | Planning and assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified requirements<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | | Lifting capacities<br>Positioning conditions (DP, 4 points mooring)<br>Navigational restrictions | |
| | Execution planning of offshore transports | Planning and assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified requirements<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | Tugboat | Machine output<br>Operating radius<br>Positioning conditions (DP, 4 points mooring)<br>Navigation restrictions | |
| | Execution planning of offshore transports | Planning and assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified requirements<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | AHT | Anchor handling capacity<br>Static pull<br>Positioning conditions (DP, 4 points mooring)<br>Navigation restrictions | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Events | Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.5.1 |
|---|---|---|---|---|---|---|---|
| Unsuitable<br>tugboats<br>AHT<br>barges<br>supply vessels<br>jack up barges / vessels etc.<br>equipment | Failure of units used and corresponding delay for project | medium risk | Select well-respected, experienced, and certi-fied shipping companies (ISO, ISM, IMCA)<br>Early draw up a condition survey of the units and equipment used to find adequate replacement (where necessary) | adequate | 4 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.5.1 | Process steps | Short description of operation | Requirements for the operation | Marine spread | Requirements | Risks |
|---|---|---|---|---|---|---|
| | Execution planning of offshore transports | Planning and assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified requirements<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | Barges | Dimensions<br>Load bearing capacity<br>Submergible | |
| | Execution planning of offshore transports | Planning and assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified requirements<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | Supply vessel | Deck surface area<br>Deck capacities<br>Crane capacity<br>Navigation restrictions | |
| | Execution planning of offshore transports | Planning and assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified requirements<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | Jack-up barge<br>Vessel | Operation - water depths, survival conditions<br>Deck surface area<br>Crane capacities<br>Positioning conditions (DP, 4-point mooring)<br>Accommodation<br>Navigation restrictions | |
| | Execution planning of offshore transports | Planning and assessment of necessary ships, barges, ...<br>(proof of class) | Market analysis on the basis of the identified requirements<br>Availability of marine spread<br>Inspection of the condition of planned ship units, barges, tugboats<br>Check of the shipping companies<br>Check of the crews | Cable layer | ??? | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Events | Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.5.1 |
|---|---|---|---|---|---|---|---|

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.5 Erection of transformer station

### 9.5.2 Setting down the base structure onto the seabed

| 9.5.2 | Process steps | Short description of operation | Requirements for the operation | Require-ments in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore erection | Setting down the base structure onto the seabed | Positioning of base frame / topside on the seabed<br>(pre-piling) | | Pile position | Wrong setting down<br>Impossible to positi-on the base frame due to wrong piling |
| | Offshore erection | Setting down the base structure onto the seabed | Positioning of base frame / topside on the seabed<br>(post-piling) | Tolerances | Final position | Final position not within required limits |
| | Offshore erection | Setting down the base structure onto the seabed | Horizontal and vertical alignment of the base frame | | Alignment | Seabed not levelled out (even) within the required limits<br>Base frame not aligned within the required limits<br>(horizontal and quarter) |
| | Offshore erection | Setting down the base structure onto the seabed | Weather and sea state criteria | | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Too strong currents in the different depths of water |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.5.2 |
|---|---|---|---|---|---|---|
| Re-lifting/jacking of the base frame and new attempt to position it within limits: possible damage to base frame or piles<br>Due to wrong piling installation position to be turned down<br>Installation and entire project delayed | high risk | Take exact dimensions of pile positions for installation of the base frame<br>Develop a method to set down and exactly position the base frame<br>Select suitable measuring instruments and monitoring equipment<br>Monitor setting down of the base frame and permanently check the actual against the desired position<br>If required, lift the base frame again and restart positioning | adequate | 6 | medium risk | |
| Re-lifting/jacking of the base frame and new attempt to position it within limits: possible damage to base frame or piles<br>Installation and entire project delayed | high risk | Develop a method to set down and exactly position the base frame<br>Select suitable measuring instruments and monitoring equipment<br>Monitor setting down of the base frame and permanently check the actual against the desired position<br>If required, lift the base frame again and restart positioning | adequate | 6 | medium risk | |
| The base frame is out of limits<br>Re-lifting/-jacking of the base frame and new attempt to position it within limits: possible damage to base frame or piles<br>Seabed to be levelled out<br>Installation and entire project delayed | high risk | Have soil surveys drawn up<br>Where required and possible take improving measures (excavation, levelling layers) and/or use levelling technology<br>Take reading of alignment after setting down of the base frame on the seabed<br>Level by application of corresponding pile method | very good | 3 | low risk | |
| Exact positioning impossible | high risk | Check wether the weather reports meet the weather criteria<br>Plan positioning exactly<br>Monitor present weather conditions | adequate | 6 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.5 Erection of transformer station

### 9.5.3 Piling, fixing

| 9.5.3 | Process steps | Short description of operation | Requirements for the operation | Require-ments in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore erection | Piling to fix the base structure onto the seabed | Driving-in of piles | Pre-piling<br>Post-piling | Piles | Piles' bearing capacity not as required |
| | Offshore erection | Piling to fix the base structure onto the seabed | Driving-in of piles | Vibro hammer<br>Hydraulic hammer | Equipment | Failure due to technical fault of vibro/ hydraulic hammer |
| | Offshore erection | Piling to fix the base structure onto the seabed | Driving-in of piles | | Sea ground | Unexpected seabed conditions, rocks and other objects |
| | Offshore erection | Piling to fix the base structure onto the seabed | Driving-in of piles | | Sound / noise | The sound under water exceeds the BSH limits |
| | Offshore erection | Piling to fix the base structure onto the seabed | Weather and sea state criteria | | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Too strong currents in the different depths of water |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.5.3 |
|---|---|---|---|---|---|---|
| Impossible to drive in the pile at all or down to the planned depth<br>Pile to be rejected as not useful anymore<br>Loss of pile as stuck in the seabed; to be cut<br>Possibly, position to be rejected | high risk | Soil investigations / expert opinions on geophysical characteristics<br>Make expert in geophysics verify the results Driving study to be drawn up<br>Define the driving force and use this to define the vibro/hydraulic hammer<br>Design the piles corresponding to the results of the soil survey and driving study<br>Use the piles required for the corresponding pile position and the corresponding vibro/hydraulic hammer<br>Carry out and supervise the piling work by personnel experienced in this field | very good | 3 | low risk | |
| Installation and driving work delayed<br>Damage to piles or the pile driving template | high risk | Redundancy of hammers<br>Engineer(s) and spare parts on site | very good | 3 | low risk | |
| Impossible to reach the required depth of penetration<br>Driving impossible<br>Pile position to be rejected<br>Project delayed | high risk | Soil investigations / soil survey (borehole logs, core penetration tests, soil scans) | adequate | 6 | medium risk | |
| Damage to marine animals | high risk | Take sound-reducing measures (box dam, bubble curtain, etc.)<br>Frighten marine mammals away of the installation area<br>Take readings proving compliance with allowed sound level and that marine mammals have been frightened away (e.g. POD) | adequate | 6 | medium risk | |
| Piling of base frame impossible<br>Project delayed | high risk | Check wether the weather reports meet the weather criteria<br>Exactly plan piling<br>Monitor present weather conditions | adequate | 6 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.5 Erection of transformer station

### 9.5.4 Grouting the base structure piles

| 9.5.4 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | f) | Grouting of the base structure piles | Selection of grouting material | Grouting material | Wrong grouting material selected; physical properties do not suit the planned use |
| | l) | Grouting of the base structure piles | Use and manipulation of grouting material | Grouting material | Too short hardening times before exerting any stress onto the grouted structure<br>Non-observance of operating temperatures<br>Wrong composition of grout components |
| | l) | Grouting of the base structure piles | Use of grouting equipment | Grouting equipment | Fault of grouting equipment<br>Blocking and choking of grout pipes and hoses |
| | l) | Grouting of the base structure piles | Check and release of grouted structure | Grouted structure | Grouted structure released too early and without any check |
| | l) | Grouting of the base structure piles | Weather and sea state criteria | Weather conditions and sea state | Heavy wind, gusts<br>Sea too rough<br>Too strong currents in the different depths of water<br>Temperatures too low |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.5.4 |
|---|---|---|---|---|---|---|
| Grouted structure does not prove sufficient strength and, thus, its durability is insufficient<br>Damage to grouted structure and total strength of structures<br>Grouting and installation delayed | very high risk | Select experienced and certified grouting companies<br>Select and use certified grouting material according to the specifications<br>Monitor grouting and examine grout samples | very good | 4 | medium risk | |
| Grouted structure does not prove sufficient strength and, thus, its durability is insufficient<br>Damage to grouted structure and total strength of structures<br>Grouting and installation delayed | high risk | Select experienced and certified grouting companies<br>Select and use certified grouting material according to the specifications<br>Monitor manipulation of the grout under the required ambient conditions and examine ground samples | very good | 3 | low risk | |
| Grouted structure does not prove sufficient strength and, thus, its durability is insufficient<br>Damage to grouted structure and total strength of structures<br>Grouting and installation delayed | high risk | Select experienced and certified grouting companies<br>Select and use reliable grouting equipment<br>Redundancy<br>Make engineer(s) of the grouting company operate the equipment<br>Engineer(s) and spare parts on site<br>Toolbox meeting before operation<br>Monitor the grouting process<br>Immediately clean equipment / pipes and hoses prior to longer downtimes | adequate | 6 | medium risk | |
| Grouted structure does not prove sufficient strength and, thus, its durability is insufficient<br>Damage to grouted structure and total strength of structures<br>Grouting and installation delayed | medium risk | Select experienced and certified grouting companies<br>Select and use certified grouting material according to the specifications<br>Monitor manipulation of the grout under the required ambient conditions and examine ground samples | very good | 2 | low risk | |
| Grouting of base frame impossible<br>Project delayed | high risk | Check wether the weather reports meet the weather criteria<br>Exactly plan grouting<br>Monitor present weather conditions | adequate | 6 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.5 Erection of transformer station

### 9.5.5 Floating into position and alignment of topside

| 9.5.5 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore transports | Floating into position and alignment of topside<br>(separate and combined design) | Design of anchor grid | Base frame under water level<br>Base frame and topside combined | Anchor grid | Anchor does not hold, shifting<br>Too low holding load of anchors |
| | Offshore transports | Floating into position and alignment of topside<br>(separate and combined design) | Connection of anchor grid to mooring/positioning equipment | Base frame under water level<br>Base frame and topside combined | Anchor grid<br>Mooring/ positioning system | Windlasses fail<br>Broken mooring/ towing wire<br>Tugboats fail |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.5.5 |
|---|---|---|---|---|---|---|---|
| Loss of control of topside<br><br>Contact / collision with other floating or fixed structures and/or units leads to property damage or damage to third objects<br><br>Positioning / instal-lation and the entire project delayed | high risk | Exactly plan the installati-on of the anchor grid<br><br>Scan the seabed to get current data regarding the position of already existing underwater objects (e.g. sea cable).<br><br>Observe distances from existing sea cables required by industrial standards (e.g. GL Nobel Denton) and install floats / marker beacons where anchor or the mooring gear crosses sea cables<br><br>Exactly define the positions and installation of the anchors on the positions<br><br>Make independent expert verify this<br><br>Pre-tension and check corresponding holding load of anchor handling tug<br><br>Stand-by tugboats, which can rapidly take control of the topside<br><br>Weigh the anchor and drop it again | very good | 3 | low risk | Potential damage to already existing sea cables or other under-water structures | |
| Loss of control of topside<br><br>Contact / collision with other floating or fixed structures and/or units leads to property damage or damage to third objects<br><br>Positioning / instal-lation and the entire project delayed | high risk | Exactly plan, calculate, and design the mooring and positioning system (windlasses, wire, tugboats, etc.)<br><br>Let only experienced personnel operate the windlasses and/or tugboats<br><br>So-called towmaster shall supervise floating in and positioning<br><br>Toolbox meeting before taking action<br><br>Test prior to using<br><br>Redundancy (where possible)<br><br>Engineers and spare parts on site / repair<br><br>Stand-by tugboat | very good | 3 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.5.5 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore transports | Floating into position and alignment of topside<br>(separate and combined design) | Floating in and positioning with mooring/ positioning system | Base frame under water level<br>Base frame and topside combined | Mooring/ positioning system | Windlasses fail<br>Broken mooring/ towing wire<br>Tugboats fail |
| | Offshore transports | Floating into position and alignment of topside<br>(separate and combined design) | | Base frame under water level<br>Base frame and topside combined | Electronic positioning/ measuring system | Failure of positioning/measuring system<br>(computer, GPS, etc.) |
| | Offshore transports | Floating into position and alignment of topside<br>(separate and combined design) | | Structures of the base frame are above water level and designed as floating-in aids | Base frame | Contact and collision with the base frame |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.5.5 |
|---|---|---|---|---|---|---|---|
| Loss of control of topside<br>Contact / collision with other floating or fixed structures and/or units leads to property damage to the topside or damage to fixed and floating objects<br>Positioning / installati-on delayed | high risk | Exactly plan, calculate, and design the mooring and positioning system (windlasses, wire, tugboats, etc.)<br>Let only experienced personnel operate the windlasses and/or tugboats<br>So-called towmaster shall supervise floating in and positioning<br>Toolbox meeting before taking action<br>Test prior to using<br>Redundancy (where possible)<br>Engineers and spare parts on site / repair<br>Stand-by tugboat | very good | 3 | low risk | | |
| No exact positioning of the topside above base frame<br>Contact / collision with other floating or fixed structures and/or units leads to property damage or damage to third objects<br>Towage and entire project delayed | high risk | Use different measuring systems<br>Redundancy of systems<br>Engineers on site who know the systems | very good | 3 | low risk | | |
| Loss of control of base frame<br>Contact / collision with other floating or fixed structures and/or units leads to property damage or damage to third objects<br>Positioning / instal-lation and the entire project delayed | high risk | Exactly plan how to carry out floating into the base frame<br>Let only experienced personnel operate the windlasses and/or tugboats<br>So-called towmaster shall supervise floating in and positioning<br>Toolbox meeting before taking action | very good | 3 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.5.5 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore transports | Floating into position and alignment of topside<br>(separate and combined design) | Observance of weather and sea state criteria | | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Too strong currents in the different depths of water |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | Comments | 9.5.5 |
|---|---|---|---|---|---|---|---|
| Impossible to lay the anchor grid and connect the mooring ropes to the anchor grid; positioning / installation delayed<br><br>Impossible to floating in on the position; positioning / installati-on delayed | very high risk | Check wether the weather reports meet the weather criteria<br><br>Exactly plan loading out and piling<br><br>Monitor present weather conditions | adequate | 8 | high risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.5 Erection of transformer station

### 9.5.6 Jacking up the topside

| 9.5.6 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore erection | Jacking procedure, topside<br>(if any) | Check of trimming/ heeling level for jacking | | Trimming/ heeling level | Too much trimming/ heeling of topside |
| | Offshore erection | Jacking procedure, topside<br>(if any) | Jacking down of legs | | Jack-up system | Fault of jack-up system |
| | Offshore erection | Jacking procedure, topside<br>(if any) | Guiding of the legs into the structure | | Topside | Collision of the topside legs with the base frame / piles |
| | Offshore erection | Jacking procedure, topside<br>(if any) | | Cameras<br>ROV<br>Shock absorber | Underwater guiding / positioning aids | Failure of and/or damage to the guiding / positioning aids |
| | Offshore erection | Jacking procedure, topside<br>(if any) | | | Electronic positioning system | Failure of positioning system<br>(computer, GPS, etc.) |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.5.6 |
|---|---|---|---|---|---|---|
| Jacking impossible<br>Jacking and installation process delayed | high risk | Exactly plan, calculate, and execute the process<br>Design accordingly to minimise ballasting<br>Take required ballast into account when designing the jacking system<br>Ballast in the shipyard for towing and jacking of the topside<br>Use pump systems for ballasting (if required) | very good | 3 | low risk | |
| Jacking impossible<br>Jack-up and installation delayed | very high risk | Use of certified systems and experienced compa-nies, only<br>Exactly plan, calculate, and design the jacking system (e.g. sufficient safety margins, suitable for offshore use)<br>Make qualified personnel of the supplier of the jacking system operate the system<br>Redundancy of jacking system components as far as possible | adequate | 8 | high risk | |
| Damage to the legs of the topside and to the base frame / piles<br>Installation and entire project delayed | very high risk | Exactly plan how to insert the legs<br>Observe distances, tidal range, etc.<br>Prior to operation toolbox meeting of anyone invol-ved in the process with stop criteria and responsi-bilities<br>Make only qualified personnel of the supplier of the jacking system operate the system<br>Use visual underwater monitoring systems for position and distance control (e.g. ROV, diver, camera, distance marks on the legs and the base frame / pile)<br>Surface markings to determine the distance of legs and base frame / piles | very good | 4 | medium risk | |
| Impossible to insert the legs into the base frame / piles as a consequence of the failure of and/or damage to the guiding/ positioning aids<br>Jacking and installation process delayed | high risk | Exactly plan how to insert the legs and use appro-priate guiding and positioning aids (suitable for underwater use, shock-resistant, etc.)<br>Redundancy of systems (where possible)<br>Make only qualified personnel operate the system<br>Prior to operation toolbox meeting of anyone invol-ved in the process with stop criteria and responsi-bilities | very good | 3 | low risk | |
| Impossible to exactly position the topside above the base frame and, therefore, impossi-ble to insert the legs<br>Positioning / installati-on delayed | high risk | Use different measuring systems<br>Redundancy of systems<br>Engineers on site who know the systems | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.5.6 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore erection | Jacking procedure, topside<br>(if any) | Jacking up the topside | | Jack-up system | Fault of jack-up system |
| | Offshore erection | Jacking procedure, topside<br>(if any) | Observance of weather and sea state criteria | | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Too strong currents in the different depths of water |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.5.6 |
|---|---|---|---|---|---|---|
| Jacking impossible<br>Damage to the topside and/or the legs occurs if the topside has not been jacked up out of the tidal limit or wave peak (slamming)<br>Jack-up and installation delayed | very high risk | Use of certified systems and experienced compa-nies, only<br>Exactly plan, calculate, and design the jacking system (e.g. sufficient safety margins, suitable for offshore use)<br>Make only qualified personnel of the supplier of the jacking system operate the system<br>Redundancy of jacking system components as far as possible<br>Exactly plan and execute the process<br>Prior to operation toolbox meeting of anyone invol-ved in the process with stop criteria and responsi-bilities | adequate | 8 | high risk | |
| Jacking impossible<br>Damage to topside by slamming<br>Jack-up and installation delayed | very high risk | Check wether the weather reports meet the weather criteria<br>Exactly plan jacking<br>Monitor present weather conditions | adequate | 8 | high risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.5 Erection of transformer station

### 9.5.7 Lifting the topside

| 9.5.7 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore erection | Lifting the topside<br>(if any) | Fastening the spreader | Slings<br>Shackles etc. | Load-in/out equipment | Selection of improper load-out equipment because of wrong load-out method<br>Selection of improper load-out equipment because of wrong weights and/or dimensions<br>Load-out equipment defective<br>No appropriate fastening points |
| | Offshore erection | Lifting the topside<br>(if any) | Releasing of sea-fastening | | Sea-fastening | Lifting of the topside to completely release the sea-fastening<br>Sea-fastening under load (AdÜ?), thus sea-fastening becomes released before it will be completely disconnected |
| | Offshore erection | Lifting the topside<br>(if any) | Lifting procedure | | Crane ship | Damage to crane ship<br>(e.g. damage to the windscreen of the crane, twisting of the crane rope, damage to the crane rope as it runs over sharp edges, damage to the boom due to contact with the topside, etc.) |
| | Offshore erection | Lifting the topside<br>(if any) | Lifting procedure<br>(lifting and depositing) | | Lifting | Swinging, twisting, and slamming of topside (slamming = Aufschlagen des Schiffsbodens auf die Wasseroberfläche bei Seegang AdÜ?)<br>Loads unevenly distributed (centre of gravity far beyond vertical axis of the topside) |
| | Offshore erection | Lifting the topside<br>(if any) | Observance of weather and sea state criteria | | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Too strong currents in the different depths of water |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.5.7 |
|---|---|---|---|---|---|---|
| Impossible to load out<br>Touch up the design<br>Lifting and entire installation of topside delayed | medium risk | Exactly plan lifting<br>Calculate and design the topside so as to suit lifting<br>Provide the topside with suitable, certified fastening points<br>Select suitable spreader with certifications<br>Select appropriate suppliers / check of/by (AdÜ?) suppliers<br>Make certifier / MWS verify this<br>Visually inspect the spreader prior to any use | very good | 2 | low risk | |
| Damage to and/or loss of topside, crane ship, barge, spreader | medium risk | Exactly plan disconnection of sea-fastening<br>Draw up corresponding plan (exact releasing sequence for sea-fastening, use of tools, safety measures to be taken, etc.)<br>Toolbox meeting before taking action<br>Use of experienced personnel<br>Use of appropriate tools<br>Protect the topside against damage and/or loss (e.g. fasten the crane before disconnection of the sea-fastening)<br>Monitor disconnection | very good | 2 | low risk | |
| Damage to and/or loss of topside<br>Lifting and, conse-quently, installation of topside delayed due to failure of the crane ship | high risk | Select a suitable crane ship for lifting<br>Check the class and other certificates<br>(among other things: crane certificates of class and test reports)<br>Check whether maintenance and test intervals have been observed<br>Carry out visual inspection and function test prior to any use | adequate | 6 | medium risk | |
| Falling of the spreader from the hooks<br>Damage to the topside, the crane ship, the barge, and/or other structures due to contact / collision with the topside, | very high risk | Use experienced and qualified crane drivers<br>Toolbox meeting before taking action to define (AdÜ) stop criteria<br>Take safety measures to prevent swinging, rotating of the topside (e.g. tug ropes and tug winches)<br>Take safety measures on the hook to prevent falling of the spreader from the hooks<br>Make the supervisor monitor the lifting procedure | adequate | 8 | high risk | |
| Lifting impossible<br>Lifting and, thus, entire installation delayed | high risk | Check wether the weather reports meet the weather criteria<br>Exactly plan lifting<br>Monitor present weather conditions | adequate | 6 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.5 Erection of transformer station

### 9.5.8 Grouting the topside

9.5.8

| Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|
| Execution planning of offshore erection | Grouting the topside | Selection of grouting material | Grouting material | Wrong selection of grouting material<br>Physical properties do not suit the planned use |
| Offshore erection | Grouting the topside | Use and manipulation of grouting material | Grouting material | Too short hardening times before exerting any stress onto the grouted structure<br>Non-observance of operating temperatures |
| Offshore erection | Grouting the topside | Use of grouting equipment | Grouting equipment | Fault of grouting equipment<br>Blocking and choking of grout pipes and hoses |
| Offshore erection | Grouting the topside | Examine and release grouted structure | Grouted structure | Grouted structure released too early and without any check |
| Offshore erection | Grouting the topside | Weather and sea state criteria | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Too strong currents in the different depths of water<br>Temperatures too low |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.5.8 |
|---|---|---|---|---|---|---|
| Grouted structure does not prove sufficient strength and, thus, its durability is insufficient<br>Damage to grouted structure and total strength of structures<br>Grouting and installation delayed | very high risk | Select experienced and certified grouting companies<br>Select and use certified grouting material according to the specifications<br>Monitor grouting and examine grout samples | very good | 4 | medium risk | |
| Grouted structure does not prove sufficient strength and, thus, its durability is insufficient<br>Damage to grouted structure and total strength of structures<br>Grouting and installation delayed | high risk | Select experienced and certified grouting companies<br>Select and use certified grouting material according to the specifications<br>Monitor manipulation of the grout under the required ambient conditions and examine ground samples | very good | 3 | low risk | |
| Damage to grouted structures or grouting equipment and total strength of structures<br>Grouting and installation delayed | high risk | Select experienced and certified grouting companies<br>Select and use reliable grouting equipment<br>Redundancy<br>Make engineer(s) of the grouting company operate the equipment<br>Engineer(s) and spare parts on site<br>Toolbox meeting before taking action<br>Monitoring of grouting process<br>Immediately clean equipment / pipes and hoses prior to longer downtimes | adequate | 6 | medium risk | |
| Grouted structure does not prove sufficient strength and, thus, its durability is insufficient<br>Damage to grouted structure and total strength of structures | medium risk | Select experienced and certified grouting companies<br>Select and use certified grouting material according to the specifications<br>Monitor manipulation of the grout under the required ambient conditions and examine ground samples | adequate | 2 | low risk | |
| Impossible to carry out grouting<br>Grouting and installation delayed | high risk | Check wether the weather reports meet the weather criteria<br>Exactly plan grouting<br>Monitor present weather conditions | adequate | 6 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.6 Foundations of offshore wind turbines

| 9.6 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | b) | Soil investigation | Geological, geotechnical, and geophysical investigations of the building ground | | Soil | Insufficient stability at the installation position<br>Impossible to drive piles into the hard subsoil<br>Insufficient levelling due to variations in the thickness of bearing beds (ruggedness)<br>Objects on the positions of piles (ammunition)<br>Unfavourable soil conditions (e.g. soft sediments)<br>Insufficient soil investigation (e.g. inappropriate geophysical methods) |
| | a) | Soil investigation | Preliminary soil investigation | | Representative locations | Locations do not represent (10 %) the soil predominant for installation<br>Soil changes are not detected<br>e.g. couloirs, Elbe Urstromtal |
| | b) | Soil investigation | Analysis | | Unfavourable perhaps only local strata not detected<br>Considerable covered risks resulting therefrom, which could occur even later during the operation of the wind farm | Poor / insufficient investigation and/or investigation method<br>Poor analysis/interpretation of data |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Impossible to install the footing structure at the planned position so that the position has to be turned down<br><br>Impossible to drive the piles down to the planned depth<br><br>Piles not designed for this soil<br><br>Piles have become stuck in the ground and are blocked by an object<br><br>Ammunition in the pile driving field, explosion followed by damage to / loss of pile, installation units, personnel<br><br>Foundations have to be adjusted to unfavou-rable soil conditions (e.g. lengthening); this causes delay, consi-derable increase in costs<br><br>Insufficient soil investigation: risks for stability and usability can occur (even later when the wind farm will be in operation) | very high risk | Geotechnical and geophysical investigations to rate the soil quality<br><br>Ground scans to determine any stratification and to locate any objects in the installation area<br><br>Logs per pile position as well as CPTs to determine the geophysical characteristics of stratification and use them to draw up a feasibility study for pile-driving<br><br>Survey the bearing stratum and the ground levels and examine the resulting measures (excavation to adjust the level)<br><br>Apply conservative approach (high safety)<br><br>Verify the soil investigations and their consequences / results through independent expert opinions<br><br>Design and carry out construction on the basis of such investigations (e.g. larger pile size)<br><br>Use appropriate equipment, such as vibro hammer, pile hammer, levelling devices<br><br>Remove any ammunition and other objects in the installation area | adequate | 8 | high risk | |
| Footing structure impossible, new plans<br><br>Layout of the farm to be revised | medium risk | Extensive desktop study to select locations<br><br>Analyse the structure of strata with geophysical methods<br><br>Early carry out the main soil investigation | adequate | 4 | medium risk | |
| Footing structure impossible, new plans<br><br>Location to be rejected<br><br>Project delay, which could entail high conse-quential costs<br><br>Risks of liability | high risk | Soil investigations of highest possible quality (state of the art)<br><br>Good geophysics give a comprehensive overview over the entire area and help to identify potential fields of risk<br><br>Work done by qualified personnel | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.6 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | b) | Soil investigation | Execution | | Geotechnical conditions worse than expected<br>Foundation / pile design to be revised | Stability of the structure not ensured<br>Settlement / inclination<br>Scouring |
| | a) | Soil investigation | Preliminary soil investigation<br>(investigation of the soil to prove its suitability) | | Archaeological finds<br>Contamination<br>Ammunition<br>Wrecks<br>Monolithes<br>Containers | Poor or no investigation at all<br>New contaminations |
| | b) | Load-bearing stratum | Determination of load-bearing bed | | Stability<br>Excavation depth | Poor analysis of the structure of strata<br>Poor interpretation of the results of investigation<br>Unexpected run of the strata in the area of footing |
| | b) | Structure of strata | Feasibility of installation | | Feasibility of installation | Existence of spot objects (e.g. erratic blocks)<br>Clay band and/or stratification too dense<br>These are difficult to find (geological and geotechnical investigation could be misleading) |
| | e) | Basic installation concept | Draw up an installation concept | Co-ordination of the procedures and installation sequences | Construction time<br>Weather risks | Time shifting<br>e.g. damage to ships, technical delays, etc.<br>Weather conditions |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Footing structure impossible / unsuitable, new plans required<br>Footing structure to be revised (stability, inclination) | high risk | Detailed geotechnical, geological, and geophysical investigation during development Design should be verified by a third party Design should be proven and realised by experienced design engineers | very good | 3 | low risk | |
| Construction delayed due to additional measures of investiga-tion and site clearing<br>Installations impossible | medium risk | Geophysical investigations of the projected area (seismics, magnetics)<br>Early desktop study<br>Soil investigation prior to any installation | adequate | 4 | medium risk | |
| Insufficient stability<br>Inclination of the wind turbines<br>Supplementary excava-tion required | medium risk | Detailed soil investigation (preliminary soil investi-gation and main soil investigation)<br>Quality management for analysis of investigation results (experienced employees)<br>Analyse the structure of strata with geophysical and geotechnical methods<br>Desktop study | very good | 2 | low risk | |
| Impossible to install the suction bucket<br>Suction bucket becomes stuck during installation<br>Damage to suction bucket (e.g. buckling); even loss of footing structure possible | medium risk | Sufficient geological and geotechnical investigations<br>Make appropriate geophysical investigations to exclude such objects (erratic blocks) for the whole area<br>Sturdy design of suction bucket (buckling, flushing devices) | very good | 2 | low risk | |
| Non-linear project delay due to the concept (effect of weather conditions)<br>Too short / long charter periods<br>Interaction of sub-projects (mains connection vs. installa-tion of wind turbines) | very high risk | Consider the offshore weather conditions in detail for planning of the installation concept (locally / globally)<br>Analyse different scenarios of the interaction of sub-projects<br>Check the project plans for their sensivity to changes in the project start / to project or sub-project delays | very good | 4 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| e) | Basic installation concept | Sequence / principle of the installations of wind farm components | | Limitations of use of equipment<br>Duration of offshore activities | Project delayed |
| e) | Planning / assessment of necessary ships, barges, etc.<br>(proof of class) | Identification / calculation of the required capacities of ships, tugboats, barges, of the tugging equipment (marine spread) based on industrial standards (DNV, GL Noble Denton, London Offshore, etc.) | Crane ship: lifting capacities, positioning conditions (DP, 4-point mooring), navigational restrictions<br>Tugboat: machine output, operating radius, positioning conditions (DP, 4-points mooring), navigational restrictions<br>AHT: Anchor handling<br>Capacity: static pull, positioning conditions (DP, 4-points mooring), navigational restrictions<br>Barges: dimensions, load-bearing capacity, submersible | Crane ships<br>Tugboats<br>AHT<br>Barges<br>Supply vessels<br>Jack up barges / vessels<br>Equipment etc. | Unsuitable (project requirements or technical condition):<br>Crane ships<br>Tugboats<br>AHT<br>Barges<br>Supply vessels<br>Jack up barges / vessels<br>Equipment etc. |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Due to a delay the execution times considerably change as the weather becomes worse<br>e.g. cable installation shifted from summer to autumn | high risk | Use of sturdy equipment<br>Check the weather slot in detail<br>Analyse different scenarios<br>Check the project plans for their sensivity to changes in the project start / to project or sub-project delays | very good | 3 | low risk | |
| Failure of units used and corresponding delay for project<br>Damage to cargo and ships<br>Damage in the field of HSE | medium risk | Select well-respected, experienced, and certified shipping companies (ISO, ISM, IMCA)<br>Early draw up a condition survey of the units and equipment used to find adequate replacement (where necessary)<br>Adhere to classification restrictions for operation of vessels | adequate | 4 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| e) | Clearing up allowed sea state and weather conditions with MWS / certifier | Planning of the individual steps of transport and installation incl. definition of weather, sea state, and flow criteria on the basis of weather, sea state, and flow statistics for the respective area and period of assembling | Definition of weather, sea state, and flow criteria to provide for safe transport and installation on the basis of weather, sea state, and flow statistics for the respective area of transportation and installation | Weather conditions; e.g. wind, sea state, flow | Wrong basis of statistical data for the area and period of assembling<br>Application of statistical data not allowed<br>Wrong verification of transport and installation stages |
| e) | Clearing up allowed sea state and weather conditions with MWS / certifier | Consideration of theoretical values for statics, dynamics, acceleration and fatigue of the foundations | | Weather conditions | Wrong dimensioning or consideration of criteria or consideration in the T&I planning (AdÜ Abk. EN? s.u.) but not for implementation<br>Poor communication between the design engineers of the foundation and the T&I planners |
| e) | Clearing up allowed sea state and weather conditions with MWS / certifier | Structural design and implementation of requirements for objects to be transported and sea-fastening on the basis of defined sea state and weather conditions | | Weather conditions | Design faults<br>Faults when installing the transport and installation equipment onto the object to be transported |
| e) | Registration of components of limited tipping angle | Checking all components for a limit of heeling/tipping angle | | Tipping angle | Insufficient information about permitted angle of heeling/tipping |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Wrong definition of maximum weather and sea state criteria<br>Damage to foundation and other prefabricated sections<br>Assembling and/or entire project delayed<br>Damage to fix and floating objects and environment | very high risk | Exactly plan the individual assembling stages<br>Close co-ordination with design engineers<br>Select the relevant statistical data on the basis of the exact schedule for area and period of assem-bling<br>Use other methods of weather analysis, e.g. direct simulation<br>Consider extreme years (best case / worst case consideration)<br>Define realistic weather criteria for processes and the project area and the time when towing will take place<br>Check wether the weather reports meet the weather criteria<br>Opt for weather providers experienced in the offshore area to deliver weather statistics<br>Make certifier / MWS verify this | very good | 4 | medium risk | |
| Wrong definition of maximum weather and sea state criteria<br>Damage to foundation and other prefabricated sections (e.g. initial damages)<br>Stability problems (e.g. as-constructed condi-tions)<br>Assembling delayed | high risk | Closely interlock the design and the concept of transport / logistics<br>Select design engineers experienced in offshore projects<br>Make certifier / MWS verify this | very good | 3 | low risk | |
| Wrong definition of maximum weather and sea state criteria<br>Damage to foundation and other objects to be transported<br>Damage to fix and floating objects and environment<br>Transport and/or lifting operations and entire project delayed | high risk | Define the design requirements by exact planning of the transport sections and installation stages<br>Close co-ordinate with design engineers and the manufacturer<br>Make certifier / MWS verify this | very good | 3 | low risk | |
| Damage to and/or loss of object to be transported / transport equipment<br>Damage to fix and floating objects and environment | high risk | Check all components of the object to be trans-ported for max. angle of heeling/tipping<br>Calculate max. allowed weather/sea state condi-tions for max. allowed angle of heeling/tipping | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| f) | Registration of components of limited tipping angle | Checking all components for a limit of heeling/tipping angle | | Tipping angle | Insufficient information about permitted angle of heeling/tipping |
| k) | Registration of components of limited tipping angle | Checking all components for a limit of heeling/tipping angle | | Tipping angle | Exceeding of angle of heeling/tipping |
| l) | Registration of components of limited tipping angle | Checking all components for a limit of heeling/tipping angle | | Tipping angle | Exceeding of angle of heeling/tipping |
| e) | Registration of components of limited tipping angle | | | Susceptibility of components<br>Heeling to waves and wind<br>(enlarged surface exposed to the wind)<br>Vibrations | Prevailing weather conditions<br>Poor weather forecast<br>Design of dynamic loads |
| e) | Registration of components of limited acceleration | Checking of all components for limited acceleration | | Acceleration | Insufficient information about permitted acceleration values |
| f) | Registration of components of limited acceleration | Checking all components for a limit of acceleration | | Acceleration | Insufficient information about permitted acceleration values |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Damage to and/or loss of object to be transported / transport equipment<br>Damage to fix and floating objects and environment | high risk | Check all components of the object to be transported for max. angle of heeling/tipping<br>Calculate max. allowed weather/sea state conditions for max. allowed angle of heeling/tipping | very good | 3 | low risk | |
| Damage to and/or loss of object to be transported / transport equipment<br>Damage to fix and floating objects and environment | high risk | Observe the weather criteria for transport and installation<br>Monitor the angle of heeling/tipping by means of appropriate measuring and recording instruments during transport and installation | very good | 3 | low risk | |
| Damage to and/or loss of object to be transported / transport equipment<br>Damage to fix and floating objects and environment | high risk | Observe the weather criteria for transport and installation<br>Monitor the angle of heeling/tipping by means of appropriate measuring and recording instruments during transport and installation | very good | 3 | low risk | |
| Damage to the foundation structure<br>Transport and installation procedures delayed | high risk | Sturdy design of the foundation structure (dynamic loads, as-constructed conditions)<br>Define and observe the corresponding weather criteria required for transport and installation<br>Monitor the heeling/tipping angle | very good | 3 | low risk | |
| Damage to object to be transported / transport equipment<br>Damage to fix and floating objects and environment | high risk | Check all components of the object to be transported for max. acceleration values<br>Calculate max. allowed weather and sea state conditions for max. allowed acceleration | very good | 3 | low risk | |
| Damage to object to be transported / transport equipment<br>Damage to fix and floating objects and environment | high risk | Check all components of the object to be transported for max. acceleration values<br>Calculate max. allowed weather and sea state conditions for max. allowed acceleration | adequate | 6 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.6 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | k) | Registration of components of limited acceleration | Checking of all components for limited acceleration | | Acceleration | Exceeding of acceleration values |
| | l) | Registration of components of limited acceleration | Checking of all components for limited acceleration | | Acceleration | Exceeding of acceleration values |
| | e) | Ports and routes | Identification of appropriate routes for the transport of foundations<br>(incl. port conditions) | Navigation restrictions due to length, width, draught, and overhead clearances of the transport vehicle and/ or the cargo in locks, canals, narrows, under bridges, etc.<br>International and national regulations for shipping | Route<br>(ports of refuge and protection areas) | Inappropriate route, ports of refuge, protected areas due to limited navigational transport possibilities (draughts, widths of canals, narrows, lengths of locks, overhead clearances under bridges)<br>Insufficient knowledge of the conditions / transport route<br>Poor deck layout<br>Poor knowledge of the port and the conditions prevailing there |
| | e) | Clearing up whether MWS will be available during offshore transport | Verification of MWS availability during transport | | MWS | No MWS available<br>No MWS available who is familiar with this transport section |
| | f) | Clearing up whether MWS will be available during offshore installation | Verification of MWS availability during installation | | MWS | No MWS available<br>No MWS available who is familiar with this transport section |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Damage to object to be transported / transport equipment<br>Damage to fix and floating objects and environment | high risk | Observe the weather criteria for transport<br>Monitor the acceleration values by means of appro-priate measuring/recording instruments during transport<br>If necessary, modify course and speed during transport | very good | 3 | low risk | |
| Damage to object to be transported / transport equipment<br>Damage to fix and floating objects and environment | high risk | Observe the weather criteria for installation<br>Monitor the acceleration values by means of appro-priate measuring/recording instruments during installation<br>If necessary, modify course and speed during installation | adequate | 6 | medium risk | |
| Transport impossible or longer transport route (distance, time)<br>Transport and entire project delayed<br>Damage to transport vehicle and/or the foundations, e.g. by taking the ground, collision with corresponding structures<br>Loading impossible | high risk | Exactly plan the location of manufacture / base port<br>Exactly plan the routes on the basis of:<br>a) the given dimensions of the units to be trans-ported incl. cargo<br>b) the applicable national and international regulati-ons and laws<br>Plan in detail the route incl. ports, protection areas, ports of refuge Use canals<br>Take the dimensions of the deck of the transport unit | very good | 3 | low risk | |
| No general approval / approval of the individu-al transport section<br>Execution of the indivi-dual transport sections delayed<br>Loss of weather slot for this transport section | medium risk | Contact insurance companies to ask for recommen-ded MWS companies<br>Check 24/7-availability of MWS prior to entering into an agreement<br>Verify references as to sufficient experience during approval / general approval of the transport section in question | very good | 2 | low risk | |
| No general approval / approval of the individu-al transport section<br>Execution of the indivi-dual transport sections delayed<br>Loss of weather slot for this installation stage | medium risk | Contact insurance companies to ask for recommen-ded MWS companies<br>Check 24/7-availability of MWS prior to entering into an agreement<br>Verify references as to sufficient experience during approval / general approval of the installation stages in question | very good | 2 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| e) | Project engineering | Planning of transport concept | | Deadlines missed | Poor / optimistic scheduling<br>Poor / optimistic reserve times<br>Weather conditions<br>Unknown framework conditions (e.g. permits, conditions, failures, etc.) |
| f) | Project engineering | Planning of installation concept | | Deadlines missed | Poor / optimistic scheduling<br>Poor / optimistic reserve times<br>Weather conditions<br>Unknown framework conditions (e.g. permits, conditions, failures, etc.) |
| e) | Drawing up emergency plans / designation of responsible persons | Execution of HAZID / HAZOP | | HAZID / HAZOP | No HAZID / HAZOP take place<br>Process- and/or design-relevant dangers not recognised |
| f) | Drawing up emergency plans / designation of responsible persons | Execution of HAZID / HAZOP | | HAZID / HAZOP | No HAZID / HAZOP take place<br>Process- and/or design-relevant dangers not recognised |
| e) | Drawing up emergency plans / designation of responsible persons | Execution of risk assessment | | Risk assessment | No or poor risk assessment take place |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Transport processes / commissioning delayed<br>Vehicles missing | high risk | Solid project engineering<br>Extensive analyses of the weather slots<br>Concept of reserve times | adequate | 6 | medium risk | |
| Transport processes / commissioning delayed<br>Vehicles missing | high risk | Solid project engineering<br>Extensive analyses of the weather slots<br>Concept of reserve times | adequate | 6 | medium risk | |
| Cargo and transport equipment, process execution, and the personnel involved at risk<br>Damage to the cargo of equipment used (AdÜ: oder "und der einge-setzten Ausrüstung"?<br>Transportation impos-sible | high risk | Execution of HAZID / HAZOP<br>Analyse the risks and if required change the process and/or the design | very good | 3 | low risk | |
| Cargo and transport equipment, process execution, and the personnel involved at risk<br>Damage to the cargo of equipment used (AdÜ: oder "und der einge-setzten Ausrüstung"?<br>Installation impossible | high risk | Execution of HAZID / HAZOP<br>Analyse the risks and if required change the process and/or the design | very good | 3 | low risk | |
| Risks are not detected and/or not analysed or wrongly assessed<br>No conclusions to avoid risks / hazards<br>Consequence: damage and accidents | high risk | Establish risk assessment for all transport proce-dures<br>Identify correction and/or protection measures<br>Implement correction and/or protection measures into the design, method statements, process sequences, QHSE procedures, training programmes, instructions for PPE, emergency concepts, etc.<br>Complement or draw up a register of risks | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.6 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | f) | Drawing up emergency plans / designation of responsible persons | Execution of risk assessment | | Risk assessment | No or poor risk assessment take place |
| | e) | Drawing up emergency plans / designation of responsible persons | Drawing up emergency plans for all transport sections | | Emergency plan | No or insufficient emergency plans drawn up |
| | f) | Drawing up emergency plans / designation of responsible persons | Drawing up emergency plans for all installation stages | | Emergency plan | No or insufficient emergency plans drawn up |
| | e) | Drawing up emergency plans / designation of responsible persons | Execution of emergency practices | | Emergency practices | No or insufficient training and emergency practices |
| | f) | Drawing up emergency plans / designation of responsible persons | Execution of emergency practices | | Emergency practices | No or insufficient training and emergency practices |
| | f) | Planning complete: pre- / post-piling | Selection of piling method | | Technology | The installation steps are appropriate for the piling technology<br>(e.g. driving template, wrong installation equipment, etc.) |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Risks are not detected and/or not analysed or wrongly assessed<br>No conclusions to avoid risks / hazards<br>Consequence: damage and accidents | high risk | Establish risk assessment for all installation procedures<br>Identify correction and/or protection measures<br>Implement correction and/or protection measures into the design, method statements, process sequences, QHSE procedures, training programmes, instructions for PPE, emergency concepts, etc.<br>Complement / draw up a register of risks | very good | 3 | low risk | |
| As risk assessment is missing, hazards, risks, and any consequences are not detected and, therefore, no emergency measures are planned to be taken should the case occur<br>Insufficient preparation for the handling / averting of hazardous situations | high risk | Prepare emergency plans for all transport procedures on the basis of the HAZID / HAZOP, and risk assessments carried out | very good | 3 | low risk | |
| As risk assessment is missing, hazards, risks, and any consequences are not detected and, therefore, no emergency measures are planned to be taken should the case occur<br>Insufficient preparation for the handling / averting of hazardous situations | high risk | Prepare emergency plans for all transport procedures on the basis of the HAZID / HAZOP, and risk assessments carried out | very good | 3 | low risk | |
| Insufficient preparation and training for potential cases of emergency<br>Staff and crews cannot cope with the situation | high risk | Prepare training plans on the basis of the emergency plans<br>Carry out training and emergency practices on the basis of the training plans to be prepared for the case of emergency | very good | 3 | low risk | |
| Insufficient preparation and training for potential cases of emergency<br>Staff and crews cannot cope with the situation | high risk | Prepare training plans on the basis of the emergency plans<br>Carry out training and emergency practices on the basis of the training plans to be prepared for the case of emergency | very good | 3 | low risk | |
| Piling and installation impossible | high risk | Exactly define the piling technology and the individual steps<br>Make external surveyors verify this | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.6 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | f) | Planning complete: pre- / post-piling | Pre-piling | | Pile driving template | Wrong pile driving template; does not correspond to the actually required distance between piles and pile sizes for the jacket |
| | f) | Planning complete: pre- / post-piling | Pre-piling | | Tolerances | Tolerances for installation of jacket<br>(installation, pile driving template, pile) |
| | f) | Release of installation procedures by the person in charge of project certification | Check of and release of installation procedures (method statements) | | Installation procedures<br>(method statements) | Missing or incomplete documents<br>Faulty installation procedures that do not reflect the actual steps and sequences<br>Wrong assumptions for design and execution |
| | e) | Operating manual complies with limitations | Preparing operating manuals / method statements | | | Wrong / poor information about restrictions for transport<br>(e.g. weight, acceleration, weather and sea state criteria) |
| | f) | Operating manual complies with limitations | Preparing operating manuals / method statements | | Method statements<br>Operating manuals | Wrong / poor information about restrictions for installation<br>(e.g. weight, acceleration, weather and sea state criteria) |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| The jacket cannot be installed<br>Position to be rejected<br>Ready-made / installed cables to be rejected<br>Entire installation delayed | high risk | Use only one pile driving template<br>Exactly mark the pile driving templates if several | very good | 3 | low risk | |
| The jacket cannot be installed<br>Position to be rejected<br>Entire installation delayed | high risk | Concept of limits in planning and execution | very good | 3 | low risk | |
| Delay in verification / release of the installati-on procedures<br>Damage / accidents during transport and installation<br>Installation infeasible due to wrong assump-tions | high risk | Select experienced certifier<br>a) Co-ordinate the certifying process with certifier<br>b) Early involve the certifier / MWS in the planning process<br>Furnish proof of all valid documents (document management)<br>Kick-off meeting on the execution of the individual transport and installation stages and check against the intended methods<br>Check when processes are running | very good | 3 | low risk | |
| Wrong reproduction of restrictions leads to transmission of wrong information to the transport contractors / sub-contractors<br>This entails damage or loss of the object to be transported and the transport and/or installation equipment, damage to fix and floating objects, and environmental damage | high risk | Peruse and verify the operating manuals / method statements following the six-eyes principle<br>Discuss and verify the restriction criteria with the transport contractors / sub-contractors<br>Make certifier / MWS verify this | very good | 3 | low risk | |
| Wrong reproduction of restrictions leads to transmission of wrong information to the installation contractors / sub-contractors<br>This entails damage or loss of the object to be installed and the installation equipment, damage to fix and floating objects, and environmental damage | high risk | Peruse and verify the operating manuals / method statements following the six-eyes principle<br>Discuss and verify the restriction criteria with the installation contractors / sub-contractors<br>Make certifier / MWS verify this | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| e) | Approval by MWS | Execution of a transport-relevant approval | | Approval | Wrong / poor information about restrictions for installation<br>(e.g. weight, acceleration, weather and sea state criteria) |
| f) | Approval by MWS | Execution of a installation-relevant approval | | Approval | Wrong / poor information about restrictions for installation<br>(e.g. weight, acceleration, weather and sea state criteria) |
| e) | Load-in/out | Identification of load-in/out method | Lift-on/off<br>Slide on/off<br>Roll-on/off<br>Float-in/off<br>Skidding | Load-in/out method | Wrong load-in/out method selected |
| e) | Load-in/out | Identification of load-in/out equipment | Crane<br>Trailer / SPMT<br>Sliding system<br>Skidding system<br>Slings<br>Upending tool<br>Spreader beam<br>Required class / certificate | Load-in/out equipment | Selection of improper load-in/out equipment because of wrong load-in/out method<br>Selection of improper load-in/out equipment because of wrong weights and/or dimensions<br>Non-compliance with requirements for class / certificates |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Damage to or loss of objects to be trans-ported<br><br>Damage to fix and floating objects and environment | high risk | Contact insurance companies to ask for recommen-ded MWS companies<br><br>Verify references as to sufficient experience during approval / general approval of the transport section in question<br><br>Draw up a catalogue of the documents to be verified<br><br>Verify certified documents, only<br><br>Verify compliance with certified measures including on-site implementation<br><br>In case of discrepancies, stop the approval and verify the information / measures | very good | 3 | low risk | |
| Damage to or loss of installation objects<br><br>Damage to fix and floating objects and environment | high risk | Contact insurance companies to ask for recommen-ded MWS companies<br><br>Verify references as to sufficient experience during approval / general approval of the installation stages in question<br><br>Draw up a catalogue of the documents to be verified<br><br>Verify certified documents, only<br><br>Verify compliance with certified measures including on-site implementation<br><br>In case of discrepancies, stop the approval and verify the information / measures | very good | 3 | low risk | |
| Loading in/out impos-sible<br><br>Thus, loading in/out and entire installation delayed | medium risk | Verify basic design / detailed design<br><br>Define appropriate load-in/out method<br><br>Make certifier / MWS verify this | adequate | 4 | medium risk | |
| Loading in/out impos-sible<br><br>Thus, loading in/out and entire installation delayed | medium risk | Verify basic design / detailed design<br><br>Define appropriate load-in/out equipment<br><br>Select appropriate suppliers / check of/by (AdÜ?) suppliers<br><br>Make certifier / MWS verify this | adequate | 4 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| e) | Load-in/out | Identification of appropriate port / water terminal | Access possibilities<br>Mooring capacities<br>Possibilities to manoeuvre<br>Heavy cargo pier<br>Storage capacities<br>Position compared to installation site<br>Jack-up possibilities in the port (soil conditions)<br>Cargo handling capacities | Port<br>Water terminal | Large transport distance between manufacturer and the port of shipment / installation area<br>Not enough moorings<br>Poor manoeuvrability during loading, e.g. with floating crane<br>Insufficient storage capacities<br>Bad soil conditions to jack-up for corresponding barges / ships |
| e) | Load-in/out | Identification of the requirements for the load on the pier areas for handling and storage | Surface load | Port pier of loading/ unloading<br>Storage area | No use of port as not suitable for heavy cargo<br>Damage to pier and access ways |
| e) | Load-in/out | Identification of requirements for transport unit<br>(barge, ship, tugboat, jack-up barge, etc.) | Loading capacity<br>Deck surface area<br>Stability<br>Load on decks<br>Ballasting<br>Manoeuvrability | Barge<br>Ship<br>Tugboat<br>Jack-up barge<br>etc. | Poor selection of transport unit due to wrong information on the object to be transported<br>Invalid documents on class/certification<br>Wrong and/or inappropriate manoeuvring properties |
| k) | Load-in/out | Loading and ballasting | Stowing plan | Loading and ballasting | Wrong or poor loading / ballasting during load-in/out<br>Malfunction of ballasting system<br>Damage to ballasting system |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Loading in/out impos-sible<br>Thus, loading in/out and entire installation delayed | high risk | Thoroughly analyse / plan the requirements for the ports of loading/unloading<br>On-site inspection of the ports according to the requirements<br>Early book by contracts the port capacities | very good | 3 | low risk | |
| Loading in/out impos-sible<br>Thus, loading in/out and entire installation delayed | high risk | Thoroughly analyse / plan the requirements for the ports and piers of loading/unloading, access ways<br>On-site inspection of the ports according to the requirements | very good | 3 | low risk | |
| Use of transport units impossible<br>Damage to transport unit and cargo<br>Capsizing of transport unit due to insufficient stability and/or poor sequences of ballasting / dropping ballast<br>Entire project delayed | medium risk | Thoroughly analyse / plan the loading and transport sections<br>Thoroughly analyse the requirements for the ports of loading/unloading<br>Thoroughly plan loading and transport units<br>Prepare loading plans / method statements for each load-in/out | adequate | 4 | medium risk | |
| Transport unit will capsize<br>Damage to transport unit and object<br>Damage to fix and floating objects and environment<br>Load-in/out impossible and/or entire project delayed | very high risk | Draw up a stowage and ballast plan for load-in/out - process / sequences<br>Check and test the ballasting system prior to load-in/out<br>Monitor the loading and ballasting sequences<br>On-site inspection and/or take dimensions of the loading deck | very good | 4 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| e) | Load-in/out | Verification of class documents / certificates regarding project requirements | | Barge<br>Ship<br>Jack-up barge<br>etc. | No valid class documents / certificates |
| e) | Load-in/out | Verification of class documents / certificates regarding the personnel | Crane driver<br>Trainers / marshalling personnel (AdÜ? oder einweisen im Sinne von Platz zuweisen?)<br>Operating personnel<br>Maritime crews | Personnel | Insufficient experience how to carry out loading/unloading processes, heavy lift / offshore<br>Lack of / insufficient communication during loading / unloading |
| k) | Load-in/out | Permanent observation<br>Verification of the weather conditions | | Weather and sea state conditions | Poor weather forecast<br>Sudden change in weather:<br>▪ Heavy wind, gusts<br>▪ Sea too rough<br>▪ Tide |
| e) | Load-in/out | Planning and calculation of sea-fastening | Object to be transported<br>Transport equipment<br>Lashing methods<br>Lashing system<br>Loads on deck<br>Strong points | Sea-fastening | Wrong or poor sea-fastening<br>Safe releasing of the sea-fastening impossible when being offshore<br>Wrong releasing of sea-fastening<br>Damage to lashing equipment used<br>Failure of sea-fastening |
| e) | Load-in/out | Planning and calculation of grillage | Object to be transported<br>Transport equipment<br>Lashing methods<br>Lashing system<br>Loads on deck<br>Strong points | Grillage | Damage to installed grillage<br>Failure of grillage |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Loading in/out impos-sible<br>Thus, loading in/out and entire project delayed | medium risk | Verify the class documents / certificates prior to any use of the units<br>Ensure that the class documents / certificates will be valid for the entire mission or apply for new ones | adequate | 4 | medium risk | |
| Transport unit will capsize<br>Damage to transport unit and object<br>Damage to fixed or floating objects and environment, e.g. pier<br>Load-in/out impossible and/or entire project delayed | high risk | Verify qualification and experience of the personnel for crane and AdÜ s.o.<br>Draw up a loading plan with responsibilities / communication<br>Toolbox talk prior to loading in/out | very good | 3 | low risk | |
| Loading / unloading impossible due to the weather criteria<br>Loading / unloading delayed<br>Loss of cargo and/ or damage to cargo / transport unit<br>Entire project delayed | high risk | Check wether the weather reports meet the weather criteria<br>Toolbox talk with all persons involved in the process before the respective stage starts and talk about stop criteria<br>Monitor present weather conditions | adequate | 6 | medium risk | |
| Damage to cargo and transport means<br>Loss of cargo or splitting of cargo and transport means<br>Damage to fix and floating objects and environment<br>Transport unit will capsize<br>Towage and entire project delayed | high risk | Plan and calculate the sea-fastening on the basis of the weather conditions defined for the object to be transported and the transport equipment<br>Implement the planning in construction<br>Supervise the execution of construction work<br>Prepare method statements to establish / release sea-fastening<br>Make MWS verify and approve this | very good | 3 | low risk | |
| Damage to cargo and transport means<br>Loss of cargo / trans-port means<br>Damage to fix and floating objects and environment<br>Towage and entire project delayed | high risk | Plan and calculate the grillage on the basis of the weather conditions defined for the object to be transported and the transport equipment<br>Implement the planning in construction<br>Make MWS verify and approve this | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| e) | Load-in/out | Planning and calculation of deck structure integrity | Object to be transported<br>Transport equipment<br>Lashing methods<br>Lashing system<br>Loads on deck<br>Strong points | Deck structure integrity | Damage to deck structure<br>Failure of deck structure |
| k) | Execution of offshore transport | Planning and calculation of deck structure integrity | | Weather risk:<br>Sudden change in weather (emergency ports and/or emergency anchoring grounds)<br>Inaccurate forecast of wave height and wind (allowed heeling)<br>Delay due to currents in tidal water<br>Suddenly poor visibility | Wrong planning (safe-to-safe periods, duration of procedures, speeds)<br>Wrong / inaccurate weather forecast<br>Poor site investigations of emergency ports / emergency anchoring grounds |
| l) | Execution of offshore installation | Planning and calculation of deck structure integrity | | Weather risk:<br>Sudden change in weather (emergency ports and/or emergency anchoring grounds)<br>Inaccurate forecast of wave height and wind (allowed heeling)<br>Delay due to currents in tidal water<br>Suddenly poor visibility | Wrong planning (safe-to-safe periods, duration of procedures, speeds)<br>Wrong / inaccurate weather forecast<br>Poor site investigations of emergency ports / emergency anchoring grounds |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Damage to cargo and transport means<br>Loss of cargo / trans-port means<br>Damage to fix and floating objects and environment<br>Towage and entire project delayed | very high risk | Evidence of allowed loads on deck, structures, lashing points according to SOLAS (Cargo Securing Manual)<br>Proof by calculation of the loads resulting from cargo, grillage, and sea-fastening<br>Verification and approval on site by MWS | very good | 4 | medium risk | |
| Damage to ship and/or cargo (foundation)<br>Risk of life and limb (HSE)<br>Transport processes delayed | high risk | Weather forecast from two independent forecasting services<br>Thoroughly plan the emergency concept (incl. safe-to-safe periods) and make an independent surveyor or certifier verify this early<br>Plan the logistics (transport processes) to comply with industrial standards (e.g. DNV-OSH101, GL, ISO 19901-6, LOC) | very good | 3 | low risk | |
| Damage to ship and/or cargo (foundation)<br>Risk of life and limb (HSE)<br>Installation procedures delayed | high risk | Weather forecast from two independent forecasting services<br>Thoroughly plan the emergency concept (incl. safe-to-safe periods) and make an independent surveyor or certifier verify this early<br>Plan the logistics (installation processes) to comply with industrial standards (e.g. DNV-OSH101, GL, ISO 19901-6, LOC) | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| k) | Execution of offshore transport | Planning and calculation of deck structure integrity | | Technical failure of a transport unit | Technical damage to transport unit |
| l) | Execution of offshore installation | Planning and calculation of deck structure integrity | | Technical failure of an installation unit | Technical damage to installation unit |
| k) | Execution of offshore installation | Planning and calculation of deck structure integrity | | Collision with other ships or other fixed or floating objects | Collision with other ships or other fixed or floating objects<br>▪ Technical failures<br>▪ Poor co-ordination, e.g. collision of heavy equipment vehicles<br>▪ Poor navigation, e.g. a ship not involved in the construction runs into the construction site<br>▪ 4) Human failure |
| l) | Execution of offshore installation | Planning and calculation of deck structure integrity | | Collision with other ships or other fixed or floating objects | Collision with other ships or other fixed or floating objects<br>▪ Technical failures<br>▪ Poor co-ordination, e.g. collision of heavy equipment vehicles<br>▪ Poor navigation, e.g. a ship not involved in the construction runs into the construction site<br>▪ Human failure |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| No transport units, incl. drifting off, grounding, capsizing, sinking or loss possible<br>Unit to be replaced<br>Transport and entire project delayed | medium risk | Select well-respected, experienced, and certified transport companies (ISO, ISM, IMCA)<br>Early draw up a condition survey of the units and equipment used to find adequate replacement where necessary<br>Permanent monitoring<br>Contingency plans for failures<br>Access to stand-by tugboats<br>Toolbox meetings | adequate | 4 | medium risk | |
| No installation units, incl. drifting off, grounding, capsizing, sinking or loss possible<br>Unit to be replaced<br>Installation and the entire project delayed | medium risk | Select well-respected, experienced, and certified installation companies (ISO, ISM, IMCA)<br>Early draw up a condition survey of the units and equipment used to find adequate replacement where necessary<br>Permanent monitoring<br>Contingency plans for failures<br>Access to stand-by tugboats<br>Toolbox meetings | adequate | 4 | medium risk | |
| Structural damage to transport unit<br>Water inrush, capsizing, sinking, or loss of transport unit<br>Damage to fix and floating objects and environment and persons (HSE)<br>Transport and entire project delayed<br>Damage to foundations | medium risk | Plan and supervise processes and exact route<br>Comply with COLREGs (e.g. day and night signals)<br>Use a guard-boat<br>Warn other ships that there are exceptional transports<br>Emergency plans<br>Access to stand-by tugboats<br>Use the Sea Surveillance<br>Marking / buoyage of the construction field<br>Where required, use DP systems<br>Work done by qualified personnel | adequate | 4 | medium risk | |
| Structural damage to installation unit<br>Water inrush, capsizing, sinking, or loss of installation unit<br>Damage to fix and floating objects and environment and persons (HSE)<br>Installation and the entire project delayed<br>Damage to foundations | medium risk | Plan and supervise processes and exact route<br>Comply with COLREGs (e.g. day and night signals)<br>Use a guard-boat<br>Warn other ships that there are exceptional installation procedures<br>Emergency plans<br>Access to stand-by tugboats<br>Use the Sea Surveillance<br>Marking / buoyage of the construction field<br>Where required, use DP systems<br>Work done by qualified personnel | adequate | 4 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| k) | Execution of offshore transport | Planning and calculation of deck structure integrity | | Taking the ground | Taking the ground:<br>▪ Technical failures<br>▪ Poor co-ordination<br>▪ Poor navigation<br>▪ Human failure<br>▪ Poor knowledge of under-keel clearance / draught and/or cargo |
| l) | Execution of offshore installation | Planning and calculation of deck structure integrity | | Taking the ground | Taking the ground:<br>▪ Technical failures<br>▪ Poor co-ordination<br>▪ Poor navigation<br>▪ Human failure<br>▪ Poor knowledge of under-keel clearance / draught and/or cargo |
| k) | "Execution of offshore transport" | Planning and calculation of deck structure integrity | | Fire | Fire:<br>▪ Technical failures / defects<br>▪ Collision<br>▪ Improper execution of activities (e.g. welding)<br>▪ Human failure<br>▪ Handling of open fire |
| l) | Execution of offshore installation | Planning and calculation of deck structure integrity | | Fire | Fire:<br>▪ Technical failures / defects<br>▪ Collision<br>▪ Improper execution of activities (e.g. welding)<br>▪ Human failure<br>▪ Handling of open fire |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Water inrush, capsi-zing, sinking, or loss of transport unit<br>Damage to transport unit<br>Damage to fix and floating objects and environment<br>Transport and entire project delayed<br>Damage to footing structures | medium risk | Plan and supervise exact route<br>Emergency plan and emergency measures accor-ding to SMS / ISM | adequate | 4 | medium risk | |
| Water inrush, capsi-zing, sinking, or loss of transport unit<br>Damage to transport unit<br>Damage to fix and floating objects and environment<br>Transport and entire project delayed<br>Damage to footing structures | medium risk | Plan and supervise exact route<br>Emergency plan and emergency measures accor-ding to SMS / ISM | adequate | 4 | medium risk | |
| Structural damage to installation unit<br>Water inrush, capsi-zing, sinking, or loss of installation unit<br>Damage to fix and floating objects and environment<br>Installation and the entire project delayed<br>Damage to / loss of foundation | medium risk | Structural and mobile fire alarm and fire extingu-ishing systems according to SOLAS<br>Permanent monitoring of the fire alarm systems<br>Emergency plans according to SMS / ISM | adequate | 4 | medium risk | |
| Structural damage to installation unit<br>Water inrush, capsi-zing, sinking, or loss of installation unit<br>Damage to fix and floating objects and environment<br>Installation and the entire project delayed<br>Damage to / loss of foundation | medium risk | Structural and mobile fire alarm and fire extingu-ishing systems according to SOLAS<br>Permanent monitoring of the fire alarm systems<br>Emergency plans according to SMS / ISM | adequate | 4 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| k) | Execution of offshore transport | Equipment for loading | | Unsuitable cranes / equipment | Equipment changed<br>Not in the plans |
| e) | Execution of offshore transport | Identification of load-in/out objects | Weights dimensions | Loaded object | Wrong weight information<br>(no weight check during assembly)<br>Wrong dimensions<br>(no final object dimensions taken) |
| k) | Execution of offshore transport | Suitability of the port for jacking | | Jacking | Inadequate building ground<br>Poor investigation<br>Considerable preload (previous jacking) |
| k) | Execution of offshore transport | Verification of class documents / certificates regarding project requirements | | Barge<br>Ship<br>Jack-up barge<br>etc. | No valid class documents / certificates |
| k) | Execution of offshore transport | Verification of class documents / certificates regarding the personnel | Crane driver<br>Trainers / marshalling personnel (AdÜ? oder einweisen im Sinne von Platz zuweisen?)<br>Operating personnel<br>Maritime crews | Personnel | Insufficient experience how to carry out loading/unloading processes, heavy lift / offshore<br>Lack of / insufficient communication during loading / unloading |
| k) | Execution of offshore transport | Sea-fastening | | Sufficient sea-fastening | Poor planning<br>Poor ship, barge, etc.<br>Poor execution |
| k) | Execution of offshore transport | Sea-fastening | | Towrope | Towrope damaged / broken |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Loading impossible or delayed | high risk | Verify the class documents / certificates prior to any use of the units<br>Closely co-ordinate planning and execution | very good | 3 | low risk | |
| Load-in/out impossible; thus, delayed load-in/ out as well as entire installation | medium risk | Weight monitoring<br>Dimensions to be taken upon completion by certi-fied company<br>Draught survey<br>Make certifier / MWS verify this | adequate | 4 | medium risk | |
| Damage to transport unit (e.g. punch through etc.)<br>Load-in/out impossible and/or entire project delayed<br>Damage to port (wharf) | high risk | Soil investigation<br>Where required, take actions to improve the ground<br>Jacking tests | very good | 3 | low risk | |
| Load-in/out impossible; thus, load-in/out and entire project delayed | medium risk | Verify the class documents / certificates prior to any use of the units<br>Ensure that the class documents / certificates will be valid for the entire mission or apply for new ones | adequate | 4 | medium risk | |
| Transport unit will capsize<br>Damage to transport unit and object<br>Damage to fixed or floating objects and environment, e.g. pier<br>Load-in/out impossible and/or entire project delayed | high risk | Verify qualification and experience of the personnel for crane and AdÜ s.o.<br>Draw up a loading plan with responsibilities / communication<br>Toolbox talk prior to loading in/out | very good | 3 | low risk | |
| Loss of or damage to barge / ship or founda-tion structure | high risk | Verify the class documents / certificates prior to any use of the units<br>Certification of sea-fastening<br>Acceptance / inspection of sea-fastening | very good | 3 | low risk | |
| Drifting off, grounding, capsizing, sinking, or loss of barge possible<br>Damage to fix and floating objects and environment<br>Towage and entire project delayed | medium risk | Use adequate towing gear according to correspon-ding standards (DNV, GL ND) on the basis of the calculated capacities to be towed<br>Install redundant towing gear (emergency gear) | adequate | 4 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| k) | Execution of offshore transport | Sea-fastening | | Duration | Selection of route<br>Tide currents or weather conditions<br>Towing speed<br>Conditions by public law (AdÜ: ?)<br>Poor planning |
| l) | Execution of offshore installation | Sea-fastening | | Co-ordination | Work stopped, completion uncertain:<br>- Poor co-ordination of activities left to be done<br>- Poor or missing emergency plans<br>- Obscure procedure, missing responsibilities<br>- Poor definition of limitations of use<br>- Decision by master / MWS<br>- Technical failures |
| l) | Execution of offshore installation | Stability during construction | Installation of footing structure not yet complete whilst the weather is changing | Weather risk | Technical failures / failures during installation<br>Poor weather forecast<br>Planned time too short<br>Poor planning |
| k) | Positioning<br>Mooring<br>DP | Stability during construction | | DP system fails | Technical failure<br>Improper use<br>Use beyond limitation of use |
| k) | Positioning<br>Mooring<br>DP | Dynamic positioning of:<br>▪ crane vessel<br>▪ tugboat<br>▪ AHT<br>▪ supply vessel<br>▪ jack-up vessel | | Malfunction of DP system during installation: | no DP trail<br>load distribution on the ship<br>non-observance of limitations of use<br>malfunction of sensors / measuring error<br>Technical failure |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Transport and instal-lation and/or entire project delayed<br>Change in weather<br>Co-ordination of activities | high risk | Make experienced experts establish a solid planning<br>Early notify / involve the traffic control centre<br>Use two independent weather services<br>Deeply analyse the transport procedure | very good | 3 | low risk | |
| Structural damage to tugboat / transport and/ or installation unit<br>Damage to foundations<br>Installation / entire project delayed<br>Risk of life and limb<br>Obscure procedures and/or responsibilities unclear | high risk | Planning: HAZOP study and risk analysis incl. development of corresponding emergency plans<br>Work done by qualified personnel<br>Prior to operation toolbox meeting of anyone invol-ved in the process with stop criteria and responsi-bilities | very good | 3 | low risk | |
| Stability of the footing structure not given<br>Damage to footing structure<br>Damage to equipment | high risk | Solid planning of offshore operations<br>Weather report from two independent services<br>Analyse the conditions on-site<br>Have the plannings and procedures certified | very good | 3 | low risk | |
| Impossible to lower into water / install the system<br>Pile installation work and entire project delayed | medium risk | Select well-respected, experienced, and certified tugboat companies (ISO, ISM, IMCA)<br>Early draw up a condition survey of the units and equipment used to find adequate replacement where necessary<br>Qualified and trained crew<br>Contingency plan for lack of tugboats / supply vessels (ISM)<br>Access to stand-by tugboats / supply vessels | adequate | 4 | medium risk | |
| Maritime units drifting during installation<br>Collision with fixed and floating objects / items<br>Damage to objects / items<br>Installation delayed | medium risk | Carry out maintenance work as required by the manufacturer<br>Check all units for their use in the field<br>DP trail prior to starting any work<br>Use qualified and trained personnel for operation and maintenance | very good | 2 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| k) | Positioning<br>Mooring<br>DP | Dynamic positioning of:<br>▪ Crane vessel<br>▪ Tugboat<br>▪ AHT<br>▪ Supply vessel<br>▪ Jack-up vessel | | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Tide |
| l) | Bubble curtain to reduce the propagation of hammering sound<br>(relieved foundation systems / monopiles) | Use of bubble curtain system | | Bubble curtain system | Failure and loss of the system |
| l) | Bubble curtain to reduce the propagation of hammering sound<br>(relieved foundation systems / monopiles) | Use of bubble curtain system | | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Tide |
| l) | Jacking | Check of trimming/ heeling level for jacking | | Trimming/ heeling level | Too much trimming/ heeling of installation vessel |
| l) | Jacking | Jacking down and make the legs stable | | Missing stability | Fault of jack-up system<br>Varying depth of penetration of the legs<br>Inhomogeneous soil<br>Monolithes<br>Already several jacking procedures at this location |
| l) | Jacking | Enough distance between the bottom platform edge and maximum wave height | | Sufficient jacking capacity | Loading of jack-up vessel/barge<br>Soil / penetration of legs<br>Poor analysis of max. wave height |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Impossible to reach or keep position | high risk | Define appropriate weather criteria<br>Verify the weather report (two independent weather services)<br>Carry out operations under defined weather conditions / in defined weather slot, only | very good | 3 | low risk | |
| No sound-reducing measures possible<br>Pile installation work and entire project delayed | medium risk | Maintain and inspect the system prior to any use<br>Redundant system<br>Spare parts<br>Skilled and trained personnel | adequate | 4 | medium risk | |
| Impossible to build up bubble curtain and, consequently, the latter is ineffective<br>Pile installation work and entire project delayed | medium risk | Define appropriate weather criteria<br>Check the weather reports<br>Carry out operations under defined weather conditions only | adequate | 4 | medium risk | |
| Jacking impossible<br>Jacking and installation process delayed | high risk | Exactly plan, calculate, and execute the process<br>Design accordingly to minimise ballasting<br>Take required ballast into account when designing the jacking system<br>Use pump systems for ballasting (if required) | very good | 3 | low risk | |
| Jacking impossible<br>Damage to legs<br>Jacking and installation process delayed | very high risk | Use of certified systems and experienced companies, only<br>Exactly plan, calculate, and design the jacking system (e.g. sufficient safety margins, suitable for offshore use)<br>Make qualified personnel of the supplier of the jacking system operate the system<br>Redundancy of jacking system components as far as possible<br>Tests<br>Geotechnical investigations<br>Prior to operation toolbox meeting of anyone involved in the process with stop criteria and responsibilities | adequate | 8 | high risk | |
| Jacking impossible<br>Damage to barge by slamming<br>Damage to legs<br>Jack-up and installation delayed | high risk | Geotechnical investigations<br>Verify the weather report<br>Exactly plan jacking | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| l) | Jacking | Observance of weather and sea state criteria | | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Too strong currents in the different depths of water |
| l) | Lifting procedure | Fastening the spreader | Slings<br>Shackles<br>etc. | Load-in/out equipment | Selection of improper load-out equipment because of wrong load-out method<br>Selection of improper load-out equipment because of wrong weights and/or dimensions<br>Load-out equipment defective<br>No appropriate fastening points |
| l) | Lifting procedure | Release of sea-fastening | | Sea-fastening | Lifting of the foundations to completely release the sea-fastening<br>Sea-fastening under load (AdÜ?)<br>Thus, sea-fastening becomes released before it will be completely disconnected |
| l) | Lifting procedure | Lifting procedure | | Crane ship<br>Installation unit | Damage to crane ship<br>(e.g. damage to the windscreen of the crane, twisting of the crane rope, damage to the crane rope as it runs over sharp edges, damage to the boom due to contact with the foundation, etc.) |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Jacking impossible<br>Damage to barge by slamming<br>Damage to legs<br>Jack-up and installation delayed | high risk | Check wether the weather reports meet the weather criteria<br>Exactly plan jacking<br>Monitor present weather conditions | very good | 3 | low risk | |
| Impossible to load out<br>Touch up the design<br>Lifting and installation of topside delayed | medium risk | Exactly plan lifting<br>Calculate and design the foundations so as to suit lifting<br>Provide the foundations with suitable, certified fastening points<br>Select suitable spreader with certifications<br>Select appropriate suppliers / check of/by (AdÜ?) suppliers<br>Make certifier / MWS verify this<br>Visually inspect the spreader prior to any use | very good | 2 | low risk | |
| Damage to and/or loss of foundations, crane ship, barge, spreader | medium risk | Exactly plan disconnection of sea-fastening<br>Draw up corresponding plan (exact releasing sequence for sea-fastening, use of tools, safety measures to be taken, etc.)<br>Toolbox meeting before taking action<br>Use of experienced personnel<br>Use of appropriate tools<br>Protect the foundations against damage and/or loss (e.g. fasten the crane before disconnection of the sea-fastening)<br>Monitor disconnection | very good | 2 | low risk | |
| Damage to and/or loss of foundation<br>Lifting and, conse-quently, installation of foundations delayed due to failure of the crane ship | high risk | Select a suitable crane ship for lifting<br>Check the class and other certificates (among other things crane certificates of class and test reports)<br>Check whether maintenance and test intervals have been observed<br>Carry out visual inspection and function test prior to any use | adequate | 6 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| l) | Lifting procedure | Lifting procedure<br>(lifting and depositing) | | Lifting | Swinging, twisting, and slamming of foundations (slamming = Aufschlagen des Schiffsbodens auf die Wasseroberfläche bei Seegang AdÜ?)<br>Uneven load distribution:<br>▪ Lifting: (centre of gravity far beyond vertical axis of foundation)<br>▪ Depositing: touching down onto the foundation / pile or other structures |
| l) | Lifting procedure | Observance of weather and sea state criteria | | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Too strong currents in the different depths of water |
| l) | Setting down the base structure onto the seabed | Positioning of foundation on the seabed (pre-piling)<br>(under water) | | Pile position | Wrong setting down<br>Impossible to position the foundation due to wrong piling<br>Accuracy of piles / distances<br>Damage to piles (e.g. by ships, sanding up, due to installation)<br>Failure of positioning system (computer, GPS, etc.) |
| l) | Setting down the base structure onto the seabed | Positioning of foundation on the seabed (post-piling)<br>(under water) | Tolerances | Final position | Final position not within required limits<br>Failure of positioning system<br>(computer, GPS, etc.) |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Falling of the spreader from the hooks<br>Damage to the founda-tions, the crane ship, the barge, and/or other structures due to contact / collision with the topside, | high risk | Use experienced and qualified crane drivers<br>Toolbox meeting before taking action to define (AdÜ) stop criteria<br>Take safety measures to prevent swinging, rotating of the foundations (e.g. tug ropes and tug winches)<br>Take safety measures on the hook to prevent falling of the spreader from the hooks<br>Make the supervisor monitor the lifting procedure | adequate | 6 | medium risk | |
| Lifting impossible<br>Lifting and, thus, entire installation delayed | high risk | Check wether the weather reports meet the weather criteria<br>Exactly plan lifting<br>Monitor present weather conditions | adequate | 6 | medium risk | |
| Re-lifting/-jacking of the foundation and new attempt to position it within limits<br>Possible damage to foundation or piles<br>Due to wrong piling installation position to be turned down<br>Required repair actions on the piles<br>Installation and entire project delayed | medium risk | Take exact dimensions of pile positions for installa-tion of the foundation (after piling, before installa-tion)<br>Develop a method to set down and exactly position the foundation<br>Select suitable measuring instruments and monito-ring equipment<br>Monitor setting down of the foundation and perma-nently check the actual against the desired position<br>If required, lift the foundation again and restart positioning<br>Redundancy of systems | very good | 2 | low risk | |
| Re-lifting/-jacking of the foundation and new attempt to position it within limits<br>Installation and entire project delayed<br>No exact positioning of the foundation above piles<br>Damage to piles / foundation<br>Installation and the entire project delayed | medium risk | Develop a method to set down and exactly position the foundation<br>Select suitable measuring instruments and monito-ring equipment<br>Monitor setting down of the foundation and perma-nently check the actual against the desired position<br>If required, lift the foundation again and restart positioning<br>Use different measuring systems<br>Redundancy of systems<br>Engineers on site who know the systems | very good | 2 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| l) | Alignment of footing structure | Alignment of the foundation during installation<br>(under water) | Defined alignment of the foundation<br>Subsoil expertise (foundation type: gravity structure, suction bucket)<br>Marking<br>Pull-in of cable<br>Alignment of landing | Final position | Wrong alignment of the structure during installation<br>Poor surveying of the structure |
| l) | Alignment of footing structure | Alignment of transition piece (monopile)<br>(surface) | | Alignment | Seabed / piles not levelled out (even) within the required limits<br>Foundation not aligned within the required limits (horizontal and quarter)<br>Alignment mechanisms of insufficient dimensions<br>Poor concept of allowable variations |
| l) | Alignment of footing structure | | Cameras<br>ROV<br>Shock absorber | Underwater guiding / positioning aids | Failure of and/or damage to the guiding / positioning aids |
| l) | Alignment of footing structure | Weather and sea state criteria | | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Too strong currents in the different depths of water |
| l) | Floating installation unit | Heaving<br>Shock load | | | Vertical movement due to sea state |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Stability or installation problems possible<br>Marking to be changed<br>Additional expenditure for cable connection<br>Reduced accessibility<br>Damage due to diffe-rent soil<br>Access system mislo-cated<br>Cable pull-in misaligned<br>Marking misaligned | medium risk | Thoroughly plan installation / installation position<br>Toolbox meeting<br>Take exact dimensions of pile position<br>Quality control during installation<br>Work with experienced personnel<br>Mark clearly and check the alignment | very good | 2 | low risk | |
| The foundation is out of limits<br>Re-lifting and new attempt to position it within limits<br>Seabed to be evened out / height adjustment of foundations<br>Installation and entire project delayed | high risk | Have soil surveys drawn up<br>Where required and possible take improving measures (excavation, levelling layers) and/or use levelling technology<br>Take reading of alignment after setting down of the foundation on the seabed<br>Level by application of corresponding pile method | very good | 3 | low risk | |
| Impossible to insert the legs into the foundation as a consequence of the failure of and/or damage to the guiding/ positioning aids<br>Jacking and installation process delayed | medium risk | Exactly plan how to insert the legs and use appro-priate guiding and positioning aids (suitable for underwater use, shock-resistant, etc.)<br>Redundancy of systems (where possible)<br>Make only qualified personnel operate the system<br>Prior to operation toolbox meeting of anyone invol-ved in the process with stop criteria and responsi-bilities | very good | 2 | low risk | |
| Exact positioning impossible | high risk | Check wether the weather reports meet the weather criteria<br>Plan positioning exactly<br>Monitor present weather conditions | adequate | 6 | medium risk | |
| Uncontrolled impact of the foundation onto the seabed / piles | medium risk | Observe the weather criteria<br>Work with qualified personnel | very good | 2 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| l) | Pulling in | Pulling cable into the foundation | Pull-in cable | Pull-in cable not ready for operation or breaking | Pull-in cable breaking<br>Pull-in cable not pulled into J-tube or get lost during pulling in |
| l) | Connection to wind turbine | Fastening of the cable in the foundation<br>Connection to wind turbine | Permanent cable fastening | Cable insufficiently fastened | Cable becomes loose or damaged<br>Suspension damaged<br>Poor fastening |
| l) | Connection to wind turbine | Cable connection | | Not enough space<br>Bending radius insufficiently considered | Pulling in and fastening |
| l) | Foundations on seabed | Driving-in of piles | Pre-piling<br>Post-piling | Piles | Piles' bearing capacity not as required |
| l) | Foundations on seabed | Driving-in of piles | Vibro/hydraulic hammer | Equipment | Failure due to technical fault of vibro/hydraulic hammer |
| l) | Foundations on seabed | Driving-in of piles | | Sea ground | Unexpected seabed conditions, rocks and other objects |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Problems in the following<br>Cable perhaps to be salvaged<br>Damage to cable<br>Pull-in cable to be installed, to be pulled in again | very high risk | Thoroughly plan pulling in of cables<br>Quality control during manufacture<br>Co-operate with experience offshore companies | very good | 4 | medium risk | |
| Damage to cable and/or suspension<br>Connection / commissi-oning delayed | medium risk | Sufficiently dimension the cable suspension<br>Work with experienced personnel when pulling in / fastening the cable | very good | 2 | low risk | |
| Damage to cable<br>Impossible to install the cable<br>Pulling in of cable / mains connection delayed | medium risk | Sufficiently plan / dimension the cable basement<br>Co-operate with experience offshore companies | very good | 2 | low risk | |
| Impossible to drive in the pile at all or down to the planned depth<br>Damage to / destruc-tion of pile<br>(Pile to be rejected as not useful anymore)<br>Loss of pile as stuck in the seabed; to be cut<br>Possibly, position to be rejected | high risk | Soil investigations / expert opinions on geophysical characteristics<br>Make expert in geophysics verify the results<br>Draw up a driving study<br>Define the driving force and use this to define the vibro/hydraulic hammer<br>Design the piles corresponding to the results of the soil survey and driving study<br>Use the piles required for the corresponding pile position and the corresponding vibro/hydraulic hammer<br>Carry out and supervise the piling work by person-nel experienced in this field | very good | 3 | low risk | |
| Installation and driving work delayed<br>Damage to piles or the pile driving template<br>Premature refusal | high risk | Redundancy of hammers<br>Engineer(s) and spare parts on site | very good | 3 | low risk | |
| Impossible to reach the required depth of penetration<br>Driving impossible<br>Pile position to be rejected<br>Project delayed | high risk | Soil investigations / soil survey (borehole logs, core penetration tests, soil scans)<br>Geophysical and geotechnical investigations | adequate | 6 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| l) | Foundations on seabed | Driving-in of piles | | Sound<br>Noise | The sound under water exceeds the BSH limits |
| l) | Foundations on seabed | Weather and sea state criteria | | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Too strong currents in the different depths of water |
| f) | Grouting monopiles<br>Transition piece and pile<br>Relieved structure | Selection of grouting material | | Grouting material | Wrong selection of grouting material<br>Physical properties do not suit the planned use |
| l) | Grouting monopiles<br>Transition piece and pile<br>Relieved structure | Use and manipulation of grouting material | | Grouting material | Too short hardening times before exerting any stress onto the grouted structure<br>Non-observance of operating temperatures |
| l) | Grouting monopiles<br>Transition piece and pile<br>Relieved structure | Use of grouting equipment | | Grouting equipment | Fault of grouting equipment<br>Blocking and choking of grout pipes/hoses |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Damage to marine animals | high risk | Take sound-reducing measures (box dam, bubble curtain, etc.)<br>Frighten marine mammals away of the installation area<br>Take readings proving compliance with allowed sound level and that marine mammals have been frightened away (e.g. POD) | adequate | 6 | medium risk | |
| Piling of foundation impossible<br>Project delayed | high risk | Check wether the weather reports meet the weather criteria<br>Exactly plan piling<br>Monitor present weather conditions<br>Sturdy equipment | adequate | 6 | medium risk | |
| Grouted structure does not prove sufficient strength and, thus, its durability is insufficient<br>Damage to grouted structure and total strength of structures<br>Grouting and installati-on delayed | very high risk | Select experienced and certified grouting compa-nies<br>Select and use certified grouting material according to the specifications<br>Monitor grouting and examine grout samples<br>Consent by BSH | very good | 4 | medium risk | |
| Grouted structure does not prove sufficient strength and, thus, its durability is insufficient<br>Damage to grouted structure and total strength of structures<br>Grouting and installati-on delayed | high risk | Select experienced and certified grouting compa-nies<br>Select and use certified grouting material according to the specifications<br>Monitor manipulation of the grout under the required ambient conditions and examine ground samples | very good | 3 | low risk | |
| Damage to grouted structures or grouting equipment and total strength of structures<br>Grouting and installati-on delayed | high risk | Select experienced and certified grouting compa-nies<br>Select and use of reliable grouting equipment<br>Redundancy<br>Make engineer(s) of the grouting company operate the equipment<br>Engineer(s) and spare parts on site<br>Toolbox meeting before taking action<br>Monitoring of grouting process<br>Immediately clean equipment / pipes and hoses prior to longer downtimes | adequate | 6 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| l) | Grouting monopiles<br>Transition piece and pile<br>Relieved structure | Examine and release grouted structure | | Grouted structure | Grouted structure released too early and without any check |
| l) | Alignment of structure<br>(Transition piece, relieved structure) | Verticality of wind turbine | | Alignment | Poor alignment and fastening<br>Poor tolerances<br>Poor grouting procedure |
| l) | Alignment of structure<br>(Transition piece, relieved structure) | Weather and sea state criteria | | Weather and sea state conditions | Heavy wind, gusts<br>Sea too rough<br>Too strong currents in the different depths of water<br>Temperatures too low |
| l) | Admitting of scouring | Admitted scouring | Defined scouring admitted | Strong scouring | Scouring underestimated<br>Poor consideration in planning<br>Poor dimensioning |
| l) | Installation | Installation of scour protection | Prompt installation | Missing scour protection | Sequences delayed<br>Weather restrictions<br>Machine failures |
| l) | Installation | Installation of scour protection | Method | Damage to foundation | Improper installation<br>Unsuitable scour protection |
| l) | Installation | Installation of scour protection | | Incomplete scour protection | Improper installation |
| l) | Execution of offshore installation | Integrity of scour protection | | Damage to scour protection | Laying of cables<br>Anchor<br>Jacking |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Grouted structure does not prove sufficient strength and, thus, its durability is insufficient<br>Damage to grouted structures and total strength of structures | medium risk | Select experienced and certified grouting compa-nies<br>Select and use certified grouting material according to the specifications<br>Monitor manipulation of the grout under the required ambient conditions and examine ground samples | very good | 2 | low risk | |
| Wind turbine not vertical<br>Damage to wind turbine<br>Subsequent work<br>Re-alignment<br>Construction / project delayed | high risk | Work with experienced personnel<br>Prepare solid concept of allowable variations<br>Monitor the verticality | very good | 3 | low risk | |
| Impossible to carry out grouting<br>Grouting and installati-on delayed<br>Premature load onto grouted structure | high risk | Check wether the weather reports meet the weather criteria<br>Exactly plan grouting<br>Monitor present weather conditions<br>Sturdy equipment | adequate | 6 | medium risk | |
| Inadmissible scouring / not planned<br>Perhaps additional scour protection<br>Stability at risk | high risk | Take admissible scouring sufficiently into account for the design<br>Make random checks how scouring develops<br>Detailed site survey<br>Simulate the flow conditions | adequate | 6 | medium risk | |
| Risk of not planned scouring<br>Perhaps touch-up work required | high risk | Use two independent weather services<br>Sufficiently analyse the initial scouring<br>Promptly install a scour protection | very good | 3 | low risk | |
| Damage to foundation structure<br>(e.g. the surfaces) | medium risk | Select a suitable scour protection<br>Select an appropriate procedure to install the scour protection | adequate | 4 | medium risk | |
| Inadmissible scouring<br>Damage to foundation<br>Project delayed due to touch-up work | medium risk | Check the scour protection after installation<br>Work with experienced offshore company | adequate | 4 | medium risk | |
| Damage to scour protection<br>Stability at risk | medium risk | Work with a co-ordinator of vehicles<br>Work with experienced personnel<br>Thoroughly plan laying of cables | adequate | 4 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| l) | Execution of offshore installation | Integrity of scour protection | | Drive | Tools do not work properly<br>(functionality of tools not given)<br>Driving forces exceed designed capacity<br>Unsuitable tools<br>Failure of ILT / gripper vs. connection of monopiles |
| k) | Transport | Integrity of scour protection | | | Floating monopiles: faulty design of plugs<br>Barge: damage to corrosion protection by sea-fastening<br>(e.g. corrosion protection at welds of transition pieces) |

**Legend**
a) Execution planning of soil investigation for locations of offshore wind turbines
b) Soil investigation for locations of offshore wind turbines
c) Execution planning of the inland transport (overland and rivers) from the factory to the offshore port
d) Execution planning of the storage in the offshore port and the onshore assembly there
e) Execution planning of offshore transports
f) Execution planning of offshore erection
g) Execution planning of residual assembly work offshore
h) Execution planning of the commissioning and the test run until getting the PAC
i) Inland transport (overland and rivers) from the factory to the offshore port
j) Storage in the offshore port and the onshore assembly there
k) Offshore transports
l) Offshore erection
m) Residual assembly work offshore
n) Commissioning and test run until getting the PAC

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.6 |
|---|---|---|---|---|---|---|
| Damage to monopi-le / equipment (e.g. hammer, sleeve, vessel)<br>Works delayed<br>Damage to pile tip | medium risk | Use higher rated hammer/spare capacity<br>Have spare parts on field or redundant equipment (2. hammer)<br>Work with skilled personnel | very good | 2 | low risk | |
| Damage to or loss of monopile<br>Damage to corrosion protection | high risk | QM in design, preparation, and procedure of the plugs<br>Exactly define operating procedures for sea-faste-ning | adequate | 6 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.7 Erection of tower, nacelle, and rotor

### 9.7.1 Planning of the erection of WTG

| 9.7.1 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Execution planning of offshore transports | Planning of offshore erection of wind turbine | Planning and assignment of the transports of the wind turbine offshore | Load-out | Availability / suitability of quayside for storage of WTGs<br>Availability / suitability of quayside to moor a vessel / barge alongside |
| | Execution planning of offshore erection | Planning of offshore erection of wind turbine | Planning and reservation of reserve capacities for offshore erection<br>Personnel | Inexperience | Lack of experienced personnel endangers the workability and safety for the performance of the work<br>(Due to shortage, there is a lack of experienced personnel) |
| | Execution planning of offshore erection | Planning of offshore erection of wind turbine | Planning and reservation of reserve capacities for offshore erection<br>Personnel | Availability | Lack of engineering workforce |
| | Execution planning of offshore erection | Planning of offshore erection of wind turbine | Planning and reservation of reserve capacities for offshore erection<br>Ships | Inexperience | Lack of experience of contractor / ship<br>(there is a number of new contractors on the market with limited experience) |
| | Execution planning of offshore erection | Planning of offshore erection of wind turbine | Planning and reservation of reserve capacities for offshore erection<br>Ships | Availability | Not enough ships for planned number of projects<br>Offshore oil and gas is picking up the coming years, putting more pressure on the vessel availability |
| | Execution planning of offshore erection | Planning of offshore erection of wind turbine | Planning and reservation of reserve capacities for offshore erection<br>Ships | Weight | Lift limitations of vessels |
| | Execution planning of offshore erection | Planning of offshore erection of wind turbine | Planning and reservation of reserve capacities for offshore erection<br>General | Planning | If the planning is too tight (just-in-time planning), a delay to one operation causes a huge impact on the remaining / other operations |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.7.1 |
|---|---|---|---|---|---|---|
| Delays<br>Cost overrun<br>Schedule impact | medium risk | Work with skilled personnel<br>Feasibility study of quayside / storage location<br>Ensure early involvement of potential contractors (make sure you allow for alternatives at the early stage) | very good | 2 | low risk | |
| Danger to the safety performance of the project resulting in damage to or loss of structures, or injury or death of personnel | high risk | Involve expertise of contractors and 3rd party agencies<br>Where possible, try to use known successful technologies and systems<br>Use standardisation on a project | adequate | 6 | medium risk | |
| Schedule, safety, and damage risk | high risk | | adequate | 6 | medium risk | |
| Danger to the safety performance of the project resulting in damage to or loss of structures, or injury or death of personnel | high risk | Use certified vessels<br>Contractors without a successful track-record have to do a test run first<br>Use of multiple contractors (split the work)<br>Implement long term relationships (strategic partners) | adequate | 6 | medium risk | |
| Delays due to lack of vessels and prices for ships are increasing | medium risk | Plan ahead and start reserving / contracting vessels at an early stage<br>Implement / use of additional contingency budget for vessel cost overruns if you do not secure them at an early stage | very good | 2 | low risk | |
| The higher the weight, the less number of ships can perform the work, the more pressu-re is on availability | medium risk | Account for alternative installation methods early in order not to run into difficulties with the BSH approvals<br>Perform feasibility study on the vessel<br>Ensure reserve capacity in the installation tolerances of the vessels used | very good | 2 | low risk | |
| Schedule, consequen-tial standby costs, availability of vessels after a prolonged delay, additional "recovering" cost | high risk | Create a gap between fabrication and installation time to build up sufficient spare capacity to allow for delays<br>Early start of offshore operations in order to also create gaps between linked offshore construction works (i.e. foundation installation versus cables, etc.) - from a holistic point of view on all processes<br>Set the liabilities to the contractor such that on time delivery is key and encouraged<br>Set-up interface communication within the whole supply chain | adequate | 6 | medium risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.1 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Execution planning of offshore erection | Planning of offshore erection of wind turbine | Planning and reservation of reserve capacities for offshore erection<br>Devices | On-shore assembly | In case of floating crane concept, the mast, the nacelle, and potentially the blades are assembled on-shore<br>The cranes and foundation(s) required for this approach in combination with a suitable yard need to be assured |
| | Execution planning of offshore erection | Planning of offshore erection of wind turbine | Planning and reservation of reserve capacities for offshore erection<br>Devices | | Turbines getting bigger and heavier |
| | Execution planning of offshore erection | Planning of offshore erection of wind turbine | Involve the project certifier and MWS for offshore erection and make them check it | Delay | No availability of (experienced/qualified) MWS |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.7.1 |
|---|---|---|---|---|---|---|
| Delays due to unavai-lability of equipment or yard capacity | medium risk | Involve the contractor at an early stage<br>Feasibility study / site surveys | very good | 2 | low risk | |
| Errors in calculating quayside requirements (having greater impact due to size and weight increase) | medium risk | Full engineering checks and suitability surveys | very good | 2 | low risk | |
| | medium risk | Start contracting these services at an early stage<br>Work together with other wind developers to train MWS on other projects (working together with experienced MWS) | very good | 2 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.7 Erection of tower, nacelle, and rotor

### 9.7.2 Planning of loading and sea transport

| 9.7.2 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Execution planning of inland transport | Planning of loading and sea transport | Route planning incl. alternative ports | Load-out | Availability / suitability of quayside for storage of WTGs (alternative ports)<br>Availability / suitability of quayside to moor a vessel / barge alongside and the route, including accessibility (like bridges, logs, etc.)<br>Lack of engineering input for transport and installation<br>Damage to components during load-out and transportation |
| | Execution planning of inland transport | Planning of loading and sea transport | Planning of emergency ports<br>(shelter) | Inefficiency | Having close-by sheltered area to use for standby during weather downtime |
| | Execution planning of inland transport | Planning of loading and sea transport | Clear up allowed sea state and weather conditions with MWS / certifier<br>Make the MWS check, accept, and permit the transport planning | Timing | MWS / certification body does not approve the documents<br>Realistic requirements to allow practical installation methods, whilst maintaining strength and warranty of the WTGs |
| | Execution planning of inland transport | Planning of loading and sea transport | Clear up whether MWS will be available during transport | Timing | MWS / certification body does not approve the documents<br>Realistic requirements to allow practical installation methods, whilst maintaining strength and warranty of the WTGs |
| | Execution planning of inland transport | Planning of loading and sea transport | Vessel requirements | Unsuitability | Offshore requirements not met<br>Turbines getting bigger and heavier<br>Man overboard procedures inadequate |
| | Execution planning of inland transport | Planning of loading and sea transport | Draw up emergency plans<br>Designate responsible persons | Damage / injury | No clarity on emergency procedures or unaligned procedures between the several contractors |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.7.2 |
|---|---|---|---|---|---|---|
| Delays, cost overruns<br>Incorrect rigging<br>Sea-fastening design of load-out equipment inadequate | medium risk | Feasibility study<br>Allow for alternatives from the beginning<br>Experienced offshore engineers to be recruited at an early stage and/or early involvement of the installation contractor | very good | 2 | low risk | |
| HSE risk or large distance sailing delaying the work | medium risk | If no sheltered area is close-by, include sufficient budget and time for consequence | very good | 2 | low risk | |
| Delays as changing these types of documents absorbs a lot of time<br>Errors in these documents may result in damage and consequential delays | high risk | Early involvement of both MWS and experienced contractors<br>Use certified vessels<br>Detailed planning of installation procedures<br>Interface management between designer, manufacturer, and installation companies | very good | 3 | low risk | |
| Delays as changing these types of documents absorbs a lot of time<br>Errors in these documents may result in damage and consequential delays | high risk | Early involvement of both MWS and experienced contractors<br>Use certified vessels<br>Detailed planning of installation procedures<br>Interface management between designer, manufacturer, and installation companies | very good | 3 | low risk | |
| Requirements not met and engineering errors may result in the use of unsuitable vessels, causing delays and potentially damage | medium risk | Involve personnel with offshore experience<br>Full (engineering) checks and suitability surveys<br>Experienced HSE engineers to be recruited, standby and guard vessels to be adequately equipped with rescue facilities (to be checked in combination with installation vessel facilities) | very good | 2 | low risk | |
| Inefficiency and lack of clarity may lead to unnecessary damage / injury | medium risk | Set-up clear emergency procedures and onshore organisation<br>Organisation preferably done by developer to ensure an overall cover on all activities in the same manner (clarity) | very good | 2 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.7 Erection of tower, nacelle, and rotor

### 9.7.3 Transports to the port area assembling site

| 9.7.3 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | c) | Planning of transports of the wind turbine components<br>Ex work to the offshore delivery point<br>(port or shipyard) | Planning starts only upon completion, i.e. at a later time | medium |
| | c) | Planning of transports of the wind turbine components<br>Ex work to the offshore delivery point<br>(port or shipyard) | Inappropriate transport routes<br>(dimensions, passageways, heights, load-bearing capacities) | high |
| | c) | Planning of transports of the wind turbine components<br>Ex work to the offshore delivery point<br>(port or shipyard) | Planning does not allow for availability of transport means and capacities of the forwarding company | high |
| | c) | Planning of transports of the wind turbine components<br>Ex work to the offshore delivery point<br>(port or shipyard) | Use of transport routes subject to time limitations<br>(e.g. rivers) | high |
| | c) | Planning of transports of the wind turbine components<br>Ex work to the offshore delivery point<br>(port or shipyard) | No time buffer but transports delayed | high |
| | c) | Planning of transports of the wind turbine components<br>Ex work to the offshore delivery point<br>(port or shipyard) | Wrong selection of the transport unit; transport means of insufficient dimensions, e.g. because of wrong information on the object to be transported | medium |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| Implement the transport plan in the schedule for the entire project<br>Transport planning and design planning in parallel<br>Co-ordinate with manufacturers and logistics | adequate | 4 | medium risk | Scheduling of the transports should be part of the overall schedule | |
| Simulate the transport with real cargo data together with the forwarder and select experienced forwarder | very good | 3 | low risk | Particularly for riverboats, the allowed heights shall be observed. | |
| Early clear up availability and capacities of the forwarder, make booking, and stipulate this by contract | adequate | 6 | medium risk | | |
| Schedule a time buffer<br>Get hold of / verify alternative routes<br>Verify empirical data<br>Provide for alternative date(s) | adequate | 6 | medium risk | AdÜ | |
| Schedule time buffers<br>Close co-ordination with customer / producer and the authorising body regarding the time schedule<br>Provide for alternative date(s) | adequate | 6 | medium risk | On-time provision of wind turbine assemblies for erection | |
| Thoroughly analyse / plan the loading and transport sections<br>Thoroughly plan loading and transport units<br>Draw up stowing plans / method statements<br>Specification of the cargo and transport means and co-ordination, validation, tracking by all partners involved<br>Involve in design, project planning, etc. to provide for complete information | adequate | 4 | medium risk | You should aim at co-ordination and acceptance of all plans and schedules (technical plans, time schedules, logistic plans) as well as specifications with and by anyone involved and corresponding implementation | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.7.3

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| c) | Planning of transports of the wind turbine components<br>Ex work to the offshore delivery point<br>(port or shipyard) | Wrong selection of the transport unit; transport means of insufficient dimensions, e.g. because of wrong information on the object to be transported | high |
| c) | Planning, transport, and storage of nacelle | Sealing incomplete | high |
| c) | Planning, transport, and storage of nacelle | High number of loading and reloading procedures | high |
| c) | Planning, transport, and storage of nacelle | No / wrong equipment for reloading<br>(e.g. from the lorry onto the river boat or the like) | high |
| c) | Planning, transport, and storage of nacelle | No / wrong equipment for reloading<br>(e.g. from the lorry onto the river boat or the like) | high |
| c) | Planning, transport, and storage of nacelle | Planning includes form faults, such as undersized transport means, wrong / old schedules, etc. | medium |
| c) | Planning, transport, and storage of nacelle | Invalid documents on class / certification<br>Certifier not commissioned on time | medium |
| c) | Planning, transport, and storage of nacelle | Permits not asked for early | medium |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| Check, whether the transport unit, means, box, packaging suits the exposures to be expected such as:<br>▪ mechanical load,<br>▪ load by weather,<br>▪ ageing (very important), etc. | adequate | 6 | medium risk | | |
| Check and/or plan sealing<br>This should be designed for a use between -10 °C and 35 °C | adequate | 6 | medium risk | | |
| Generally, minimise the number of loading and reloading procedures | adequate | 6 | medium risk | Loading and reloading procedures increase the risk of damage and, therefore, have to be minimised to those times that cannot be avoided | |
| Integrate the loading procedures in the planning<br>Provide for information exchange on the occasion of regular project meetings<br>Establish appropriate platforms to make available currently applicable specifications<br>Allow for sufficient capacity reserves for weight<br>Keep ready and plan handling aids and if required, e.g. special lift fixtures | adequate | 6 | medium risk | | |
| Ask the hired forwarder / logistic company for proof that the adequate equipment will be available at the date<br>Inspect the site and the transport means in advance | adequate | 6 | medium risk | | |
| Independent second verification of transport plans (e.g. together with manufacturer) | adequate | 4 | medium risk | Verification of transport and logistics plans by a third person on the basis of the "four-eye principle" | |
| Thoroughly analyse / plan the loading and transport sections<br>Thoroughly plan loading and transport units<br>Prepare loading plans / method statements<br>Early place the order and involve the certifier, in particular for an on-time verification of documents<br>Certifier should go in parallel with planning<br>The resources of the certifying companies should be taken into account, too | very good | 2 | low risk | Certifying processes can take a long time and be suddenly prolonged when corrections are required<br>Therefore, the documents for any permit should be on hand early and the certifier should early be involved in planning | |
| Early place the order and involve the certifier, in particular for prompt verification of documents | very good | 2 | low risk | As already explained for the certifying processes, the procedure to issue a permit could take a long time and even much more time when corrections are required | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.7.3

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| c) | Planning, trans-port, and storage of nacelle | No "emergency plans" | medium |
| d) | Identification of appropriate port | Large transport distance between manufacturer and the port of shipment | medium |
| d) | Identification of appropriate port | Not enough moorings | medium |
| d) | Identification of appropriate port | Poor manoeuvrability during loading, e.g. with floating crane | medium |
| d) | Identification of appropriate port | Insufficient storage capacities | medium |
| d) | Identification of the requirements for the load on the handling/ storage/ pier areas | Port does not meet the requirements, e.g. port not suitable for heavy cargo | high |
| d) | Identification of the requirements for the load on the handling/ storage/ pier areas | Damage to pier, storage area, and access ways | small |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| Draw up emergency plans together with the manufacturer and the operating party<br>Alternatives, e.g. alternative transport routes<br>Alternatives, e.g. lifting equipment by a second company | very good | 2 | low risk | For the case that any transport means, lifting equipment, route become unusable due to accidents / averages, etc., alternative plans should already be on hand, e.g. alternative routes / capacities of other forwarders should have been considered, etc. | |
| Thoroughly analyse / plan the requirements for the ports of loading/unloading, e.g. examination, simulation, and shakedown cruises to the port<br>Check whether the ports meet the requirements - on-site inspection<br>Request that any delay, occupancy, reserve is allowed for in the planning | adequate | 4 | medium risk | | |
| Thoroughly analyse / plan the requirements for the ports of loading/unloading, e.g. examination, simulation, and shakedown cruises to the port<br>Check whether the ports meet the requirements - on-site inspection<br>Request that any delay, occupancy, reserve is allowed for in the planning | adequate | 4 | medium risk | Delays, unplanned occupancy of mooring due to delayed offshore installation should be allowed for in the planning | |
| Thoroughly analyse / plan the requirements for the ports of loading/unloading, e.g. examination, simulation, and shakedown cruises to the port<br>Check whether the ports meet the requirements - on-site inspection<br>Request that any delay, occupancy, reserve is allowed for in the planning | adequate | 4 | medium risk | | |
| Thoroughly analyse / plan the requirements for the ports of loading/unloading, e.g. examination, simulation, and shakedown cruises to the port<br>Check whether the ports meet the requirements - on-site inspection<br>Request that any delay, occupancy, reserve is allowed for in the planning | adequate | 4 | medium risk | Delays, unplanned occupancy of storage area due to delayed offshore installation should be allowed for in the planning | |
| Thoroughly analyse / plan the requirements for the ports of loading/unloading<br>Check whether ports meet the requirements - early on-site inspection together with the port operator in advance | adequate | 6 | medium risk | | |
| Thoroughly analyse / plan the requirements for the ports of loading/unloading<br>Check whether ports meet the requirements - early on-site inspection together with the port operator in advance | very good | 1 | low risk | Damage to pier etc. can occur in the meantime until loading will actually take place | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.3 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | d) | Identification of the requirements for the load on the handling/ storage/ pier areas | Damage to pier, storage area, and access ways occur during loading | small |
| | d) | Planning of local transports and storage of the nacelles | Sealing incomplete | high |
| | d) | Planning of local transports and storage of the nacelles | High number of loading and reloading procedures | high |
| | d) | Planning of local transports and storage of the nacelles | No / wrong equipment for reloading<br>(e.g. from the lorry onto the river boat or the like) | high |
| | d) | Planning of local transports and storage of the nacelles | No / wrong equipment for reloading<br>(e.g. from the lorry onto the river boat or the like) | high |
| | d) | Planning of local transports and storage of the nacelles | Planning includes form faults, such as undersized transport means, wrong / old schedules, etc. | medium |
| | d) | Planning of local transports and storage of the nacelles | Invalid documents on class / certification<br>Certifier not commissioned on time | medium |
| | d) | Planning of local transports and storage of the nacelles | Permits not asked for early | medium |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| Thoroughly analyse / plan the requirements for the ports of loading/unloading<br>Check whether ports meet the requirements - early on-site inspection together with the port operator in advance and if required, make available alternatives and/or emergency plans | very good | 1 | low risk | For the case of unusable loading edges, alternatives or emergency plans should already be drawn up in advance | |
| Check and/or plan sealing<br>This should be designed for a use between -10 °C and 35 °C | adequate | 6 | medium risk | | |
| Generally, minimise the number of loading and reloading procedures | adequate | 6 | medium risk | Loading and reloading procedures increase the risk of damage and, therefore, have to be minimised to those times that cannot be avoided | |
| Integrate the loading procedures in the planning<br>Provide for information exchange on the occasion of regular project meetings<br>Establish appropriate platforms to make available currently applicable specifications<br>Allow for sufficient capacity reserves for weight Keep ready and plan handling aids and if required, e.g. special lift fixtures | adequate | 6 | medium risk | | |
| Ask the hired forwarder / logistic company for proof that the adequate equipment will be available at the date<br>Inspect the site and the transport means in advance | adequate | 6 | medium risk | | |
| Independent second verification of transport plans (e.g. together with manufacturer) | adequate | 4 | medium risk | Verification of transport and logistics plans by a third person on the basis of the "four-eye principle" | |
| Thoroughly analyse / plan the loading and transport sections<br>Thoroughly plan loading and transport units<br>Prepare loading plans / method statements<br>Early place the order and<br>involve the certifier, in particular for an on-time verification of documents<br>Certifier should go in parallel with planning<br>The resources of the certifying companies should be taken into account, too | very good | 2 | low risk | Certifying processes can take a long time and be suddenly prolonged when corrections are required<br>Therefore, the documents for any permit should be on hand early and the certifier should early be involved in planning | |
| Early apply for any permit in consideration of potential deferments; plan time buffers in the overall project plan | very good | 2 | low risk | As already explained for the certifying processes, the procedure to issue a permit could take a long time and even much more time when corrections are required | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.3 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | d) | Planning of local transports and storage of the nacelles | No "emergency plans" | medium |
| | c) | Reserving capaci-ties, personnel, and equipment for transports | No time buffer for availability, i.e. personnel and equipment are availa-ble at stated times, only. | very high |
| | c) | Reserving capaci-ties, personnel, and equipment for transports | No reserves for personnel and equipment capacities (number of persons large enough but no allowance for deviations)<br>Equipment is sufficient, too, regarding its output capacity but insuffici-ent (unusable) for higher loads | very high |
| | c) | Reserving capaci-ties, personnel, and equipment for transports | No redundancies for any failure | very high |
| | c) | Reserving capaci-ties, personnel, and equipment for transports | Contractor's ability to supply, references, experiences not verified | medium |
| | i) | Supervision and approval of loading procedures and transports by certi-fier | Inadequate information policy | high |
| | i) | Supervision and approval of loading procedures and transports by certi-fier | No co-ordination with the other parties involved | high |
| | j) | Supervision and approval of loading procedures and transports by certi-fier | Inadequate information policy | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| Draw up emergency plans together with the manufacturer and the operating party<br>Alternatives, e.g. alternative transport routes<br>Alternatives, e.g. lifting equipment by a second company | very good | 2 | low risk | For the case that any transport means, lifting equipment, route become unusable due to accidents and averages, etc., alternative plans should already be on hand, e.g. alternative routes / capacities of other forwarders should have been considered, etc. | |
| Schedule time buffers over the entire transport chain<br>Track the production process closely as to deferments<br>The overall project schedule should already include resources of personnel, equipment, etc. with sufficient time buffers | adequate | 8 | high risk | It is supposed that detailed project schedules (incl. exactly planned teams) are on hand already and that they include time buffers | |
| Plan quantity reserves for personnel and quality reserves for the transport equipment (dimensions, max. weights, etc.)<br>Enough capacity reserves, personnel and equipment | adequate | 8 | high risk | It is supposed that detailed project schedules (incl. exactly planned teams) are on hand already<br>Capacity reserves should also be planned in advance, e.g. they should be callable | |
| Identify strategic bottlenecks and, if required, provide for redundancies on call<br>In this effect spare capacities (personnel, equipment) are to be developed in advance depending on their accessibility; also see the items above | adequate | 8 | high risk | Analyse and identify strategic bottlenecks and derive adequate redundancies | |
| Select contractors on the following criteria:<br>▪ capacity,<br>▪ experience gained in similar projects,<br>▪ good access to sub-contractors,<br>▪ creditworthiness assumed | very good | 2 | low risk | E.g. ship owners with experience in offshore wind energy and access to small shipping companies<br>Tugboat crew with experience is very important to cope with the particularities of big wind turbine components | |
| Transparent information policy | adequate | 6 | medium risk | | |
| Early co-ordinate with anyone involved, integrate the certifier in the project teams and relevant project meetings | adequate | 6 | medium risk | Involving the certifier, designation of certifier and substitute | |
| Transparent information policy | adequate | 6 | medium risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.3 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | j) | Supervision and approval of loading procedures and transports by certi-fier | No co-ordination with the other parties involved | high |
| | i) | Overland transport footing structure<br>Footing structure: This applies to any type of footing structures, such as monopiles, gravitati-on foundation, etc. | Ignoring / handling of process descriptions, such as method state-ments, transport specifications, instructions for actions, etc. by e.g. manufacturers / operating parties | high |
| | i) | Overland transport footing structure<br>Footing structure: This applies to any type of footing structures, such as monopiles, gravitati-on foundation, etc. | Ignoring / handling of control mechanisms by e.g. manufacturers / operating parties | very high |
| | i) | Overland transport footing structure<br>Footing structure: This applies to any type of footing structures, such as monopiles, gravitati-on foundation, etc. | Planning is not adapted to any changing requirement and consequently changing specifications regarding time, capacities, and technical requi-rements of the cargo | very high |
| | i) | Overland transport footing structure<br>Footing structure: This applies to any type of footing structures, such as monopiles, gravitati-on foundation, etc. | Wrong and/or inadequate manoeuvring during loading | medium |
| | i) | Unloading footing structure | Intermediate storage unsuitable for weight, size, etc. | medium |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| Early co-ordinate with anyone involved, integrate the certifier in the project teams and relevant project meetings | adequate | 6 | medium risk | Involving the certifier, designation of certifier and substitute | |
| Strictly adhere to the procedure instructions<br>Brief sub-contractors etc.<br>Deviate only upon consultation of manufacturers and/or authorised persons | very good | 3 | low risk | The manufacturer's specifications are based on experience and any non-observance could entail e.g. damage to components<br>Example: Wrong fixing of the lifting devices resulting in deformation of components | |
| Strictly adhere to the sequences of approval and release with the quality assurance department and certifiers etc. | very good | 4 | medium risk | The quality assurance department should supervise in principle all components in all process steps including commissioning ending up with the approval inspection / acceptance<br>Any deviation is allowed only upon technical clarification and positive result by QA and with their consent | |
| Immediately adapt the plans upon getting to know of changes as well as inform in detail any involved partner in project meetings and on information platforms (servers etc.) | very good | 4 | medium risk | We assume that the overall project schedules are subject to continuous updates and changes are announced in the corresponding groups and committees | |
| Supervision by QA and if required by the certifier | very good | 2 | low risk | | |
| Verify suitability within the scope of planning and immediately prior to execution | very good | 2 | low risk | Examples:<br>▪ Transport of rotor blades<br>▪ Intermediate stop on parking area<br>▪ Risk of grazing (AdÜ: schrammen KFZ-unfall oder ist starting gemeint?)<br>▪ Inappropriate storage of gear units and generators; beyond allowed angle of inclination | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.3 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | i) | Unloading footing structure | Intermediate storage unsuitable for weight, size, etc. | medium |
| | i) | Unloading footing structure | Unloading equipment unsuitable | medium |
| | i) | Unloading footing structure | Unloading equipment unsuitable | high |
| | i) | Unloading footing structure | Wrong and/or inadequate manoeuvring during loading | medium |
| | i) | Overland transport<br>▪ Transition piece (transition piece depends on type of construction)<br>▪ Tower / tower segments<br>▪ Nacelles / drive train<br>▪ Rotor blades<br>▪ Hub | See footing structure | medium |
| | i) | Transport of tower segments | Deformation of the tower due to uneven load distribution during trans-port | very high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| See identification of appropriate ports:<br>Thoroughly analyse / plan the requirements for the ports of loading/unloading and the storage capacities, e.g. examination, simulation, and shakedown cruises to the port<br>Check whether the ports meet the requirements - on-site inspection<br>Request that any delay, occupancy, reserve is allowed for in the planning | adequate | 4 | medium risk | See identification of appropriate ports:<br>▪ Delays<br>▪ Unplanned occupancy of storage area due to delayed offshore installation should be allowed for in the planning | |
| Verify suitability within the scope of planning and immediately prior to execution | very good | 2 | low risk | Basically, any equipment / auxiliary means used should be exclusively designed for this purpose<br>Provisional solutions are inacceptable and only allowed upon prior consent of the manufacturer | |
| Integrate the loading procedures in the planning<br>Provide for information exchange on the occasion of regular project meetings<br>Establish appropriate platforms to make available currently applicable specifications<br>Allow for sufficient capacity reserves for weight<br>Keep ready and plan handling aids and if required, e.g. special lift fixtures | adequate | 6 | medium risk | | |
| Supervision by QA and if required by the certifier | very good | 2 | low risk | | |
| | adequate | 4 | medium risk | The aforementioned risks and protection measures for footing structures also apply to the overland transport of other main components of the wind turbines, such as the transition piece (if type of construction includes such), tower / tower segments, nacelles / drive train, rotor blades, and hub | |
| Pay attention to even load distribution during transportation | adequate | 8 | high risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.3 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | i) | Unloading:<br>▪ Transition piece (transition piece depends on type of construction)<br>▪ Tower / tower segments<br>▪ Nacelles / drive train<br>▪ Rotor blades<br>▪ Hub | See footing structure | medium |
| | i) | Loading procedures - blades | Rotating blades when wind is springing up | high |
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | Incomplete planning of sequences of erection<br>Single steps missing | high |
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| | adequate | 4 | medium risk | The aforementioned risks and protection measures for footing structures also apply to the overland transport of other main components of the wind turbines, such as the transition piece (if type of construction includes such), tower / tower segments, nacelles / drive train, rotor blades, and hub | |
| Always use two cranes for loading | adequate | 6 | medium risk | | |
| Use experience by involving experienced colleagues<br>The majority of the project team - e.g. 80 % - should be skilled colleagues with experience in erection | adequate | 6 | medium risk | Experience is imparted within the team from an experienced person to a person with less experience | |
| Use of:<br>▪ simulation<br>▪ trying out<br>▪ feasibility studies<br>▪ FMEAs<br>together by the departments for design, assembling, logistics, and process design / work scheduling<br>Regular project meetings | adequate | 6 | medium risk | Experience gained from previous erections of prototypes, simulations is used | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.3 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | | high |
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | | high |
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | Planning rigid regarding project changes and delays | medium |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| Documentation of the results from the following:<br>▪ experiences gained in the assembly of onshore prototypes<br>▪ experiences of the assembly personnel<br>▪ simulations<br>▪ trying out | adequate | 6 | medium risk | Availability of results and information to anyone involved in the project by regular documentation | |
| Make the QA and certifier verify this | adequate | 6 | medium risk | Continuous supervision, testing, and approval inspections by QA, even in the sense of duplication checks | |
| Allow for sufficient resources | adequate | 4 | medium risk | Planning of sufficient resource capacities in the teams, for the equipment, etc. | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.3 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | | medium |
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | Planning per item refers to only one supplier / service provider | medium |
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | Current changes of standards and regulations or the legislation<br>Planning still as things were before, not up-to-date | small |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| Allow for reserves in the overall project plan already | adequate | 4 | medium risk | Allow for reserves in time, personnel, and finances and draw up emergency plans | |
| Provide for emergency plan<br>Early develop an alternative to change the service providers | adequate | 4 | medium risk | E.g. in case of insolvency of a service provider of erection work, a competent alternative should have been identified before | |
| Regularly check applicable standards, regulations, laws | adequate | 2 | low risk | Project team or one designated member of this permanently reads up on standards and regulations | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.3 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | Planned sequences of erection not possible / practicable | high |
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | | high |
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| Use of:<br>▪ simulation<br>▪ trying out<br>▪ feasibility studies<br>▪ FMEAs<br>together by the departments for design, assembling, logistics, and process design / work scheduling<br>Regular project meetings | adequate | 6 | medium risk | | |
| Use experience by involving experienced colleagues<br>The majority of the project team - e.g. 80 % - should be skilled colleagues with experience in erection<br>Use experiences by verification of sequencs and/or the aforementioned simulation in co-operation with experienced colleagues | adequate | 6 | medium risk | Experience is imparted within the team from an experienced person to a person with less experience | |
| Use following experiences:<br>▪ Experiences gained in the assembly of onshore prototypes<br>▪ Experiences of the assembly personnel | adequate | 6 | medium risk | Experience gained from previous erections of prototypes, simulations is used | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.3 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | | high |
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | Times<br>Time required for a sequence of erection underestimated | high |
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| Documentation of the results from the following:<br>▪ Experiences gained in the assembly of onshore prototypes<br>▪ Experiences of the assembly personnel<br>▪ Simulations<br>▪ trying out | adequate | 6 | medium risk | Availability of results and information to anyone involved in the project by regular documentation | |
| Take the times<br>Simulate / try out<br>Feasibility studies | adequate | 6 | medium risk | | |
| Use following experiences:<br>▪ Experiences gained in the assembly of onshore prototypes<br>▪ Experiences of the assembly personnel | adequate | 6 | medium risk | Experience gained from previous erections of prototypes, simulations is used | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.3 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | | high |
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | Effects of the weather insufficiently considered or not considered at all | medium |
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | | medium |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| Training of erection teams; in the manufacturer's work, too | adequate | 6 | medium risk | | |
| Allow for enough time buffer, allow for the effects of weather and season in planning | poor | 6 | medium risk | It is supposed that detailed project schedules (incl. exactly planned teams) are on hand already<br>Where possible, scheduling should provide for time buffers | |
| Allow for reserves (personnel and equipment), perhaps reserve them to compensate for adverse weather during erection with close supervision and check by QA | adequate | 4 | medium risk | Planning of additional erection capacities; e.g. in the form of third skilled and experienced co-operation partners, that have reserved the capacities (personnel and equipment) | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.3 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | Resources:<br>Quantity and time planned for resources of personnel / equipment are insufficient | high |
| | d) | Planning, work, assembly work, fitting work in the port area / at the shipyard, etc. as to the main compo-nents:<br>▪ Footing structure<br>▪ Transition piece (if any)<br>▪ Tower / tower segments<br>▪ Nacelle / drive train<br>▪ Rotor blades<br>▪ Hub | | high |

**Legend**
a) Execution planning of soil investigation for locations of offshore wind turbines
b) Soil investigation for locations of offshore wind turbines
c) Execution planning of the inland transport (overland and rivers) from the factory to the offshore port
d) Execution planning of the storage in the offshore port and the onshore assembly there
e) Execution planning of offshore transports
f) Execution planning of offshore erection
g) Execution planning of residual assembly work offshore
e) Execution planning of the commissioning and the test run until getting the PAC
i) Inland transport (overland and rivers) from the factory to the offshore port
j) Storage in the offshore port and the onshore assembly there
k) Offshore transports
l) Offshore erection
m) Residual assembly work offshore
n) Commissioning and test run until getting the PAC

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.3 |
|---|---|---|---|---|---|
| Make experienced personnel verify this as mentioned above for the construction engineering:<br>▪ Experiences gained in the assembly of onshore prototypes<br>▪ Experiences of the assembly personnel etc. | adequate | 6 | medium risk | | |
| Make third external experts etc. verify the planning - as mentioned above | adequate | 6 | medium risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.7 Erection of tower, nacelle, and rotor

### 9.7.4 Work, assembly work, fitting work in the port area / at the shipyard, preparations for offshore erection

| 9.7.4 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | j) | Inspection of ram piles after transport as one step to prepa-re offshore erection | Damage due to improper transport, loading, and storage | high |
| | j) | Inspection of ram piles after transport as one step to prepa-re offshore erection | | high |
| | j) | Inspection of ram piles after transport as one step to prepa-re offshore erection | | high |
| | j) | Inspection of ram piles after transport as one step to prepa-re offshore erection | Single components not operational (transport damage) | small |
| | j) | Erection of footing structure and transi-tion piece | Improper transport and loading | very high |
| | j) | | | very high |
| | j) | | Single components incl. corrosion protection not operational<br>(transport damage) | medium |
| | j) | Tests<br>Certifications<br>Footing structure | Compliance with structural requirements and the specifications laid down<br>(types of material, sizes of walls, etc.) | medium |
| | j) | | Pressure of time<br>Compliance with set dates | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.4 |
|---|---|---|---|---|---|
| Use a check sheet for transport and loading; make MWS verify this | poor | 9 | high risk | (if the type of construction includes ram piles) | |
| Make the stress analyst verify the method statements and execute approval inspection of the loaded piles prior to any onshore transport | adequate | 6 | medium risk | Correct static and constructional design of the transport is decisive | |
| Enough own qualified and experienced personnel incl. the MWS<br>Supervise loading | poor | 9 | high risk | Also see project stage 2, highly assessed for experiences<br>One decisive factor is the work with experienced personnel | |
| Quality assurance:<br>▪ Visual inspection | adequate | 2 | low risk | Also see project stage 2, inspections prior to any further use of poor components - here the ram piles | |
| Use a check sheet for transport and loading | adequate | 8 | high risk | Also see project stage 2 | |
| Enough own qualified and experienced personnel incl. the MWS<br>Supervise loading | very good | 4 | medium risk | Also see project stage 2, highly assessed for experiences<br>One decisive factor is the work with experienced personnel | |
| Quality assurance<br>▪ Visual inspection | adequate | 4 | medium risk | Also see project stage 2<br>Inspections incl. passive corrosion protection and if there is active corrosion protection, check of this, too | |
| Quality assurance:<br>▪ Visual inspection<br>▪ Inspection of joints / weld seams<br>▪ Check whether compliance with specifications | adequate | 4 | medium risk | The inspections / checks mentioned here are meant to be duplication checks<br>Generally, only approved and accepted components should leave the factories<br>The main inspections should be made in the factory | |
| Time and mounting schedule<br>Allow for time buffers | adequate | 6 | medium risk | As mentioned above:<br>It is supposed that detailed project schedules (incl. exactly planned teams) are on hand already Where possible, scheduling should provide for time buffers | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.4 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | j) | | Certifier does not detect deficiencies | high |
| | j) | | | high |
| | j) | Erection of footing structure if gravitati-on foundations | Compliance with structural requirements and the specifications laid down (types of material, sizes of walls, etc.) | high |
| | j) | Any onshore prepa-ration, assembly, installation, test, check, etc. | During mounting, installation, etc. heat intensive tasks (welding, abrasive cutting, etc.) or e.g. the test run of electric devices in connec-tion with fire load can cause fire and explosions | medium |
| | j) | Preparation of tower or assembly of tower segments | Single components not operational<br>(transport damage) | medium |
| | j) | Preparation nacelle / drive train | Single components not operational (transport damage), perhaps the last onshore function tests of a single component not carried out | medium |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.4 |
|---|---|---|---|---|---|
| Select and book only those certifiers who can prove their experience | adequate | 6 | medium risk | As only a limited number of certifiers is available in the market, book them early | |
| Involve the manufacturer's quality assurance in parallel to and independent of the certifier | adequate | 6 | medium risk | Complementary checks by QA to improve detection of deficiencies | |
| Quality assurance:<br>▪ Approval inspection of the reinforcement prior to pouring of concrete<br>▪ Check of the concrete quality<br>▪ Sampling of concrete<br>▪ Check whether compliance with specifications etc. | adequate | 6 | medium risk | Example, concrete quality certificates, approval inspections of reinforcement by inspecting structural engineer / engineering office | |
| Prepare risk analyses for all commissioning sequences<br>Take steps against risks (such as permit procedure for heat intensive tasks, fire guards after heat intensive tasks, provision of corresponding fire detectors, provision of fire extinguishing agent, personnel training and practice, emergency plans, etc.) | adequate | 4 | medium risk | Fire protection is to be integrated in all sequences and the safety officers are to be involved in all sequences, e.g. using risk analyses and by participation in project meetings, on-site inspections, etc. | |
| Quality assurance:<br>▪ Execution of corresponding checks | adequate | 4 | medium risk | As mentioned above:<br>The checks mentioned here are meant to be duplication checks<br>Generally, only approved and accepted components should leave the factories<br>The main inspections should be made in the factory | |
| Quality assurance:<br>▪ Check list whether the function test prior to shipment took place, all o.k. | adequate | 4 | medium risk | As mentioned above:<br>The checks mentioned here are meant to be duplication checks<br>Generally, only approved and accepted components should leave the factories<br>The main inspections should be made in the factory | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.4 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | j) | | Insufficient sealing of openings against effects by weather and seastate | medium |
| | j) | Assembly of rotor blades, hub, or star (one variant) | Improper lifting, transport, and loading | very high |

**Legend**
a) Execution planning of soil investigation for locations of offshore wind turbines
b) Soil investigation for locations of offshore wind turbines
c) Execution planning of the inland transport (overland and rivers) from the factory to the offshore port
d) Execution planning of the storage in the offshore port and the onshore assembly there
e) Execution planning of offshore transports
f) Execution planning of offshore erection
g) Execution planning of residual assembly work offshore
e) Execution planning of the commissioning and the test run until getting the PAC
i) Inland transport (overland and rivers) from the factory to the offshore port
j) Storage in the offshore port and the onshore assembly there
k) Offshore transports
l) Offshore erection
m) Residual assembly work offshore
n) Commissioning and test run until getting the PAC

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.4 |
|---|---|---|---|---|---|
| Quality assurance:<br>▪ Supervision of works<br>▪ Checks, e.g. visual inspections and<br>▪ check lists for all critical seals | adequate | 4 | medium risk | Adequate weather protection (against rain, frost, air humidity, lightning, etc.) to be ensured onshore during preassembly, as well, especially when carried out on an area that is not housed<br>As e.g. seals could have to be removed for access, here attention shall be paid to safe locking | |
| Compliance with assembly procedures:<br>▪ Check sheets<br>▪ Cover blade bearings<br>▪ Protect stud bolts | adequate | 8 | high risk | Compliance with procedure instructions and sequences to ensure proper and perfect assembly | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.7 Erection of tower, nacelle, and rotor

### 9.7.5 Loading for sea transport

| 9.7.5 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Offshore transports | Loading for sea transport | Loading of tower | Load-out | Grillage and/or sea-fastening incorrect<br>Soil risk on locations where jacks are used<br>Accessibility of the structures for loading<br>Accessibility of the quayside<br>Availability of required onshore equipment such as cranes<br>Weather conditions (wind)<br>Weight control<br>MWS approval |
| | Offshore transports | Loading for sea transport | Loading of nacelle | Load-out | Grillage and/or sea-fastening incorrect<br>Soil risk on locations where jacks are used<br>Accessibility of the structures for loading<br>Accessibility of the quayside<br>Availability of required onshore equipment such as cranes<br>Weather conditions (wind)<br>Weight control<br>MWS approval |
| | Offshore transports | Loading for sea transport | Loading of rotor | Load-out | Grillage and/or sea-fastening incorrect<br>Soil risk on locations where jacks are used<br>Accessibility of the structures for loading<br>Accessibility of the quayside<br>Availability of required onshore equipment such as cranes<br>Weather conditions (wind)<br>Weight control<br>MWS approval |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.7.5 |
|---|---|---|---|---|---|---|
| Damage to components of the wind mill, the vessel, or the quayside | high risk | Feasibility studies at an early stage<br>Clear procedures<br>Interface management between yard, MWS, and contractor<br>Use of certified vessels: Experienced construction manager and installation engineers to be recruited early to set-up adequate procedures and establish engineering standards for weight control and design | very good | 3 | low risk | |
| Damage to components of the wind mill, the vessel, or the quayside | high risk | Feasibility studies at an early stage<br>Clear procedures<br>Interface management between yard, MWS, and contractor<br>Use of certified vessels: Experienced construction manager and installation engineers to be recruited early to set-up adequate procedures and establish engineering standards for weight control and design | very good | 3 | low risk | |
| Damage to components of the wind mill, the vessel, or the quayside | high risk | Feasibility studies at an early stage<br>Clear procedures<br>Interface management between yard, MWS, and contractor<br>Use of certified vessels: Experienced construction manager and installation engineers to be recruited early to set-up adequate procedures and establish engineering standards for weight control and design | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.5 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Offshore transports | Loading for sea transport | Loading of systems and equipment for turbine | Load-out | Grillage and/or sea-fastening incorrect<br>Soil risk on locations where jacks are used<br>Accessibility of the structures for loading<br>Accessibility of the quayside<br>Availability of required onshore equipment such as cranes<br>Weather conditions (wind)<br>Weight control<br>MWS approval |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.7.5 |
|---|---|---|---|---|---|---|
| Damage to components of the wind mill, the vessel, or the quayside | high risk | Feasibility studies at an early stage<br>Clear procedures<br>Interface management between yard, MWS, and contractor<br>Use of certified vessels: Experienced construction manager and installation engineers to be recruited early to set-up adequate procedures and establish engineering standards for weight control and design | very good | 3 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.7 Erection of tower, nacelle, and rotor

### 9.7.6 Sea transport to the wind farm

9.7.6

| Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|
| Execution planning of offshore transports | Sea transport to offshore wind farm | Route planning incl. alternative ports | | Planning | Route / port blocked<br>Interface between vessel inshore or offshore |
| Execution planning of offshore transports | Sea transport to offshore wind farm | Clear up allowed sea state and weather conditions with MWS / certifier | | | Only an issue if work is performed on a day-rate basis<br>Lump sum contracts should include weather downtime |
| Execution planning of offshore transports | Sea transport to offshore wind farm | Clear up whether MWS will be available during transport | | | Not applicable during transportation other than previous box |
| e) | Sea transport to offshore wind farm | Drawing up emergency plans / designation of responsible persons | | | Safety culture on board of the vessels, availability of safety equipments and means (helicopter platform for emergencies) |
| Offshore transports | Sea transport to offshore wind farm | Sea transport of tower | | Sailing | Grillage and/or sea-fastening incorrect<br>Exceeding movement tolerances of the structures<br>(sea state / conditions) |
| Offshore transports | Sea transport to offshore wind farm | Sea transport of nacelle | | Sailing | Grillage and/or sea-fastening incorrect<br>Exceeding movement tolerances of the structures<br>(sea state / conditions) |
| Offshore transports | Sea transport to offshore wind farm | Sea transport of rotor | | Sailing | Grillage and/or sea-fastening incorrect<br>Exceeding movement tolerances of the structures<br>(sea state / conditions) |
| Offshore transports | Sea transport to offshore wind farm | Sea transport of systems and equipment for turbine | | Sailing | Grillage and/or sea-fastening incorrect<br>Exceeding movement tolerances of the structures<br>(sea state / conditions) |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.7.6 |
|---|---|---|---|---|---|---|
| Requirement for alter-native route<br>Delay<br>Consequential standby charges of vessels | medium risk | See actions during planning stage<br>If this is done properly, item 1 should not appear<br>Ad item 2: Set-up interface communication between the different onshore and offshore contractors and avoid just in time planning | very good | 2 | low risk | |
| Delay<br>Damage to the compo-nents<br>Payment of additional day-rates | high risk | Contracts to include weather risk clarification, preferably as part of lump sum of the contractor<br>Contracts need to define required weather and sea state<br>Ensure a sufficient budget estimate on weather delays<br>Require fabricators to comply with reasonable limitations considering the anticipated sea state at the required location | adequate | 6 | medium risk | |
| Delays and consequen-tial costs | medium risk | Early involvement of MWS on transportation metho-dology | very good | 2 | low risk | |
| Missing the appropri-ate safety culture and required equipment and facilities hugely incre-ases the risk of damage or injuries | medium risk | Make sure the contractor has a good and proven safety system, procedures, and culture | very good | 2 | low risk | |
| Damage to / loss of property<br>Reconsideration of requirements by MWS, CA, or BSH | medium risk | Use certified vessels<br>Use actions identified at the planning stage<br>Endeavour to enforce an increase of acceptable movement tolerances of the components | very good | 2 | low risk | |
| Damage to / loss of property<br>Reconsideration of requirements by MWS, CA, or BSH | medium risk | Use certified vessels<br>Use actions identified at the planning stage<br>Endeavour to enforce an increase of acceptable movement tolerances of the components | very good | | | |
| Damage to / loss of property<br>Reconsideration of requirements by MWS, CA, or BSH | medium risk | Use certified vessels<br>Use actions identified at the planning stage<br>Endeavour to enforce an increase of acceptable movement tolerances of the components | very good | | low risk | |
| Damage to / loss of property<br>Reconsideration of requirements by MWS, CA, or BSH | medium risk | Use certified vessels<br>Use actions identified at the planning stage<br>Endeavour to enforce an increase of acceptable movement tolerances of the components | very good | | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.6 | Process steps | Short description of operation | Requirements for the operation | Requirements in detail | Risks | Events |
|---|---|---|---|---|---|---|
| | Offshore transports | Sea transport to offshore wind farm | Sea transport of rotor | Wave damage to blade tips | Sailing | Rotor star mounted to low on deck of transport barge |
| | Offshore transports | Sea transport to offshore wind farm | Sea transport of tower | Damage to towers | Sailing | Sea fastening design, frames inadequate or barge deck not strong enough to cope with uplift, shear, or overturning forces causing frame moving and flexing introducing stress into tower flange |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.7.6 |
|---|---|---|---|---|---|---|
| Damage to blade tips due to wave impact | medium risk | Full engineering checks and suitability surveys<br>Naval architect studies for vessel pitch and roll characteristics | very good | 2 | low risk | |
| Tower flange damaged preventing installati-on and erection from proceeding | medium risk | Full engineering checks and suitability surveys | very good | 2 | low risk | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.7 Erection of tower, nacelle, and rotor

### 9.7.7 Erection of tower, nacelle, and rotor

| 9.7.7 | Process steps | Short description of operation | Requirements for the operation | Risks | Events |
|---|---|---|---|---|---|
| | Offshore erection | Erection of tower, nacelle, and rotor | Assembly of tower | Weather / environment | Weather criteria, water depth (for jacking)<br>Accessibility, soil conditions (for jacking)<br>Clearances on the vessel<br>Alignment of tower sections |
| | Offshore erection | Erection of tower, nacelle, and rotor | Assembly of nacelle | Weather / environment | Weather criteria, water depth (for jacking)<br>Accessibility, soil conditions (for jacking)<br>Clearances on the vessel<br>Alignment of tower sections |
| | Offshore erection | Erection of tower, nacelle, and rotor | Assembly of rotor | Weather / environment | Weather criteria, water depth (for jacking)<br>Accessibility, soil conditions (for jacking)<br>Clearances on the vessel<br>Alignment of tower sections |
| | Offshore erection | Erection of tower, nacelle, and rotor | 1 piece installation | Weather / environment | Weather criteria, accessibility<br>Clearances on the vessel, alignment with the TP<br>Pitch and roll forces exceed bearing design capacity<br>Dynamic positioning |
| | Offshore erection | Erection of tower, nacelle, and rotor | Winter installation | Ice build-up | Ice build-up on jacking system or WTG components |
| | Offshore erection | Erection of tower, nacelle, and rotor | Installation work | Jack-up vessel | Jacking operations<br>Soil conditions |
| | Offshore erection | Erection of tower, nacelle, and rotor | General installation | Floating vessel | Shock load |
| | Offshore erection | Erection of tower, nacelle, and rotor | General installation | Dropped objects | Dropped objects injure worker on foundation |
| | Offshore erection | Erection of tower, nacelle, and rotor | General installation | Transfer of crew | Poor boarding<br>Landing facilities |
| | - | Erection of tower, nacelle, and rotor | Pulling of cables into the wind turbine | CHECK INTERFACE WITH CABLE SUBGROUP | CHECK INTERFACE WITH CABLE SUBGROUP |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Consequences | Risk assess-ment | Protection measure | Assessment of protection measures | Relevance | Status | 9.7.7 |
|---|---|---|---|---|---|---|
| Working towards the limitations of the vessels<br>Vessel cannot perform the work - delay<br>Damage to the compo-nents | medium risk | Ensure spare capacity on all required features of the vessel<br>Sound engineering checks at early stage<br>Better / more intensive soil surveys | poor | 6 | medium risk | |
| Working towards the limitations of the vessels<br>Vessel cannot perform the work - delay<br>Damage to the compo-nents | medium risk | Ensure spare capacity on all required features of the vessel<br>Sound engineering checks at early stage<br>Better / more intensive soil surveys | | | medium risk | |
| Working towards the limitations of the vessels<br>Vessel cannot perform the work - delay<br>Damage to the compo-nents | medium risk | Ensure spare capacity on all required features of the vessel<br>Sound engineering checks at early stage<br>Better / more intensive soil surveys | | | medium risk | |
| - damage to compon-ents / bearings due to exceeding of movement criteria | medium risk | Sound engineering checks at early stage<br>Change design of WTG to allow higher movement criteria | poor | 6 | medium risk | |
| Delay to the operation | low risk | Use a TJU with a non rack and pinion jacking system<br>Have steam lances and piping in place to quickly clear off ice build up | very good | 1 | low risk | |
| Jack-up leg punched through<br>Soil disturbance due to jacking | very high risk | Better / more intensive soil surveys | adequate | 8 | high risk | |
| Shock load during jacking<br>Shock load during installation (floating vessel) | high risk | Use of heave compensation (floating vessel)<br>Sound engineering checks | adequate | 6 | medium risk | |
| Injury | medium risk | Ensure good safety culture/system is in place | very good | 2 | low risk | |
| Injury | medium risk | Improve gangways and use of up-to-date marine vessels | very good | 2 | low risk | |
| CHECK INTER-FACE WITH CABLE SUBGROUP | | CHECK INTERFACE WITH CABLE SUBGROUP | | | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

## 9.7 Erection of tower, nacelle, and rotor

### 9.7.8 Commissioning

| 9.7.8 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assessment |
|---|---|---|---|---|
| | n) | Any offshore assembly, installation, test, inspection, etc. during commissioning | During mounting, installation, etc. heat intensive tasks (welding, abrasive cutting, etc.) or e.g. the test run of electric devices in connection with fire load can cause fire and explosions<br>Increased fire loads, such as stored fuel quantities to run emergency generators, cannot be excluded and present an increased danger compared to standard operation | very high |
| | n) | Any offshore assembly, installation, test, inspection, etc. during commissioning | During mounting, installation, etc. heat intensive tasks (welding, abrasive cutting, etc.) or e.g. the test run of electric devices in connection with fire load can cause fire and explosions<br>Increased fire loads, such as stored fuel quantities to run emergency generators, cannot be excluded and present an increased danger compared to standard operation | medium |
| | n) | Tests and inspection of fire protection equipment | Test not successful<br>Fire protection equipment to be repaired | medium |
| | n) | Tests and inspection of fire protection equipment | During the overall commissioning of the wind turbine and the mounting, installation, etc. heat intensive tasks (welding, abrasive cutting, etc.) or e.g. the test run of electric devices in connection with fire load can cause fire and explosions | very high |
| | n) | Commissioning work, in general | Faulty commissioning, programming, tests, etc. | high |
| | n) | Commissioning work, in general | Missing tools, material, etc. | high |
| | n) | Overall commissioning of the wind turbine together with the wind farm | Control room not yet finished / ready for test<br>Control technology faulty | medium |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.8 |
|---|---|---|---|---|---|
| Priority commissioning of fire detection and fire alarm systems, fire extinguishing system, etc. for the turbine | very good | 4 | medium risk | This aims at adequate fire protection especially for the commissioning to protect persons and property<br>Among other things especially for the case that no-one is on-site during commissioning and an increased fire load could be present and e.g. the effects of any assembly work (smouldering fires due to heat intensive tasks) is not detected early | |
| Use thermographic cameras during commissioning of electrical components to detect faults in planning or assembly | very good | 2 | low risk | The use of thermographic cameras during the commissioning of electrical components to detect weak points has been well tried | |
| Enough onshore tests<br>Adequate securing of cargo<br>Experienced and trained installation personnel and suitable installation equipment<br>Supervising and testing QA during manufacture<br>Assembly and commissioning | very good | 2 | low risk | | |
| Commissioning of the fire protection systems for the wind turbine prior to the overall commissioning of it | very good | 4 | medium risk | | |
| Priority commissioning of the machine guards and the emergency functions of the turbine | adequate | 6 | medium risk | In order to exclude any damage by switching errors, incorrect programming or operating, the machine guards should be set to work immediately upon erection<br>The same applies to the emergency functions of the turbine, e.g. alignment in the wind of the nacelle during a storm | |
| Prepare exactly<br>Simulate the sequences<br>Perform tests and trainings on prototypes / material reserves<br>Plan the tools in advance | adequate | 6 | medium risk | | |
| Time schedule to be synchronised with the overall project schedule<br>Early co-ordinate the work to be done | adequate | 4 | medium risk | Information to group 1<br>▪ Sub-station | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.7.8

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| n) | Overall commissi-oning of the wind turbine together with the wind farm | External mains connection not yet in working order | high |
| n) | Overall commissi-oning of the wind turbine together with the wind farm | External mains connection not yet in working order | high |
| n) | Overall commissi-oning of the wind turbine together with the wind farm | Documentation not yet on hand (e.g. certificate BGV A3, circuit diagrams, maintenance instructions, etc.) | medium |
| n) | Overall commissi-oning of the wind turbine together with the wind farm | Start-up personnel not sufficiently qualified | high |
| n) | Overall commissi-oning of the wind turbine together with the wind farm | Weather and sea conditions not optimum | medium |
| n) | Supervision of start-up by the certifiers | Missing resources at the certifier | high |
| n) | Supervision of start-up by the certifiers | Qualification of certifier and/or the persons involved | medium |
| n) | Supervision of start-up by the certifiers | Delay of commissioning due to insufficient co-ordination by certifiers and customer | medium |
| n) | Tests of single components | Parts of components, incl. the corrosion protection, are faulty etc. | medium |
| n) | Tests of single components | Inappropriate test carried out | small |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.8 |
|---|---|---|---|---|---|
| Time schedule to be synchronised with the overall project schedule | poor | 9 | high risk | Information to group 1<br>▪ Sub-station | |
| Early plan emergency power (e.g. emergency generators etc.) | adequate | 6 | medium risk | The project schedule should allow for the power supply required to maintain circuit integrity, particularly for the emergency functions of the wind turbine | |
| Early schedule documentation and corresponding documents<br>Make the start-up personnel and the operating personnel as well as the QA check the documentation to find errors<br>If required, subject submittal of documents to penalties | adequate | 4 | medium risk | | |
| Early hire personnel<br>Train and instruct the personnel<br>Proof of the employee's qualification when working for external service providers to be condition for deployment | adequate | 6 | medium risk | | |
| Plan the weather slot for start-up according to the meteorological data and taking experiences into account<br>Allow for sufficient buffer for bad weather / select alternative weather slot | adequate | 4 | medium risk | Normally, the overall project schedules are geared in the long run to the appropriate weather slots in the corresponding year | |
| Early synchronise resources and co-ordinate commissioning with the certifier to get hold of resources | adequate | 6 | medium risk | As only a limited number of certifiers is available in the market, book them early | |
| Early verify qualification (personal records etc.) of the test engineers involved<br>Where required, turn down the project manager | adequate | 4 | medium risk | | |
| Early co-ordinate the work to be done and the documents to be examined | adequate | 4 | medium risk | | |
| Enough onshore tests<br>Adequate securing of cargo<br>Experienced installation personnel and suitable installation equipment<br>Production supervision<br>Permanent quality assessment | very good | 2 | low risk | | |
| Clear specifications of test and testing criteria, to be laid down by the manufacturers<br>Make QA and the certifier carry out the tests | adequate | 2 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.7.8

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| n) | Tests and inspection of machine safety devices | Damage to machine safety device due to test | small |
| n) | Tests and inspection of machine safety devices | Faulty machine safety device | small |
| n) | Tests and inspec-tion of connections and joints to the sub-station | Faulty connections (design) | small |
| n) | Tests and inspec-tion of connections and joints to the sub-station | Injury to testing personnel, e.g. by overvoltage | high |
| n) | Tests and inspection of the overall wind turbine<br>(assumption: single wind turbine) | Defective components | small |
| n) | Tests and inspection of the overall wind turbine<br>(assumption: single wind turbine) | Injury to testing personnel | high |
| n) | Tests and inspection of the overall wind turbine<br>(assumption: single wind turbine) | Inappropriate test to sufficiently test the overall wind turbine | small |
| n) | Function tests, emergency functions<br>(assumption: emergency power system on OSS AdÜ: operations support system?) | Defective components | small |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.8 |
|---|---|---|---|---|---|
| Test procedures well-tried and exactly defined<br>Make experienced personnel carry out the tests<br>Use appropriate testing equipment<br>Correct execution of the tests (check lists) | adequate | 2 | low risk | The machine safety devices and the devices to maintain emergency functions are essential for functioning and to avert damage to a wind turbine | |
| Enough onshore tests, adequate securing of cargo<br>Experienced installation personnel and suitable installation equipment<br>Production supervision<br>In-process quality assessment | very good | 1 | low risk | | |
| Enough onshore tests, adequate securing of cargo<br>Experienced installation personnel and suitable installation equipment<br>Production supervision, permanent quality assessment | very good | 1 | low risk | | |
| Sufficient protection measures within the scope of work safety<br>Sufficiently experienced and qualified personnel | very good | 3 | low risk | | |
| Enough onshore tests<br>Adequate securing of cargo<br>Experienced installation personnel and suitable installation equipment<br>Permanent quality assessment | very good | 1 | low risk | | |
| Sufficient protection measures within the scope of work safety<br>Sufficiently experienced and qualified personnel | very good | 3 | low risk | | |
| Clear specifications of test and testing criteria, to be laid down by the manufacturers<br>Make QA and the certifier carry out the tests | adequate | 2 | low risk | See footing structure | |
| Enough onshore tests<br>Adequate securing of cargo<br>Experienced installation personnel and suitable installation equipment<br>Permanent quality assessment | very good | 1 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.7.8

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| n) | Function tests, emergency functions<br>(assumption: emergency power system on OSS AdÜ: operations support system?) | Injury to testing personnel | high |
| n) | Function tests, emergency functions<br>(assumption: emergency power system on OSS AdÜ: operations support system?) | Inappropriate test to sufficiently test the overall wind turbine | small |
| n) | Machine protection not yet operational during commissio-ning of wind turbine | Machines damaged | medium |
| n) | Function test of the entire system during operation | Defective components | small |
| n) | Function test of the entire system during operation | Injury to testing personnel | high |
| n) | Function test of the entire system during operation | Inappropriate test to sufficiently test the overall wind turbine | small |
| n) | Function test of the entire system during operation | Delay caused by ambient conditions (bad weather, poor winds, etc.) | high |
| n) | Function test of the entire system during operation | Damage to electrical components (transformer, generator, switch-gears, etc.) due to overvoltage during test operation (e.g. by invalid switching on USP AdÜ?) | high |
| n) | Acceptance of wind turbine by operating party and certifier | Missing resources at the certifier / contractor (operating party) | high |
| n) | Mains connection of sub-station | Damage to switchgear when connecting the first time | medium |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.8 |
|---|---|---|---|---|---|
| Sufficient protection measures within the scope of work safety<br>Sufficiently experienced and qualified personnel | very good | 3 | low risk | | |
| Clear specifications of test and testing criteria, to be laid down by the manufacturers<br>Make QA and the certifier carry out the tests | adequate | 2 | low risk | | |
| Early commissioning, in any case prior to the commissioning of the wind turbine as mentioned in the beginning of project stage 2 | adequate | 4 | medium risk | | |
| Enough onshore tests<br>Adequate securing of cargo, experienced installation personnel, and suitable installation equipment<br>Production supervision, permanent quality assessment | very good | 1 | low risk | | |
| Sufficient protection measures within the scope of work safety<br>Sufficiently experienced and qualified personnel | very good | 3 | low risk | | |
| Clear specifications of test and testing criteria, to be laid down by the manufacturers<br>Make QA and the certifier carry out the tests | adequate | 2 | low risk | | |
| Wait for appropriate weather slot and flexibly plan the resources (ships and persons) to ensure that the overall test passes off smoothly | adequate | 6 | medium risk | | |
| Properly design, dimension, and establish the entire integrated electrical system<br>Calculate and simulate potential switching procedures<br>Co-ordinate planning with grid operator and comply with connection conditions | adequate | | low risk | | |
| Early synchronise resources and co-ordinate commissioning with the certifier to get hold of resources | adequate | 6 | medium risk | | |
| Sufficiently experienced and qualified installation personnel<br>Enough onshore tests | adequate | 4 | medium risk | Interface to sub-station | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.7.8

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| n) | Overall commissio-ning of the wind farm as one component<br>(also see sub-station) | Delay caused by ambient conditions (bad weather, poor winds, etc.) | high |
| n) | Any offshore assem-bly, installation, test, inspection, etc. during commissio-ning | During mounting, installation, etc. heat intensive tasks (welding, abrasive cutting, etc.) or e.g. the test run of electric devices in connec-tion with fire load can cause fire and explosions<br>Increased fire loads, such as stored fuel quantities to run emergen-cy generators, cannot be excluded and present an increased danger compared to standard operation | very high |
| n) | Any offshore assem-bly, installation, test, inspection, etc. during commissio-ning | During mounting, installation, etc. heat intensive tasks (welding, abrasive cutting, etc.) or e.g. the test run of electric devices in connec-tion with fire load can cause fire and explosions<br>Increased fire loads, such as stored fuel quantities to run emergen-cy generators, cannot be excluded and present an increased danger compared to standard operation | very high |
| n) | Any offshore assem-bly, installation, test, inspection, etc. during commissio-ning | During mounting, installation, etc. heat intensive tasks (welding, abrasive cutting, etc.) or e.g. the test run of electric devices in connec-tion with fire load can cause fire and explosions<br>Increased fire loads, such as stored fuel quantities to run emergen-cy generators, cannot be excluded and present an increased danger compared to standard operation | medium |
| n) | Tests and inspection of fire protection equipment | Test not successful<br>Fire protection equipment to be repaired | medium |
| n) | Tests and inspection of fire protection equipment | During the overall commissioning of the wind turbine and the mounting, installation, etc. heat intensive tasks (welding, abrasive cutting, etc.) or e.g. the test run of electric devices in connection with fire load can cause fire and explosions | very high |
| n) | Commissioning in general | Faulty commissioning, programming, tests, etc. | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.8 |
|---|---|---|---|---|---|
| Wait for appropriate weather slot and flexibly plan the resources (ships and persons) to ensure that the overall test passes off smoothly | adequate | 6 | medium risk | Interfaces with wind turbine, cable, and sub-station to be cleared up, commissioning from control room, offshore or onshore | |
| Prepare risk analyses for all commissioning sequences Take steps against risks (such as permit procedure for heat intensive tasks, fire guards after heat intensive tasks, provision of corresponding fire detectors, provision of fire extinguishing agent, personnel training and practice, emergency plans, etc.) | adequate | 8 | high risk | Fire protection is to be integrated in all sequences and the safety officers are to be involved in all sequences, e.g. using risk analyses and by participation in project meetings, offshore inspections, etc. | |
| Priority commissioning of fire detection and fire alarm systems, fire extinguishing system, etc. for the turbine | very good | 4 | medium risk | This aims at adequate fire protection just for the commissioning to protect persons and property<br>Among other things especially for the case that no-one is on-site during commissioning and an increased fire load could be present and e.g. the effects of any assembly work (smouldering fires due to heat intensive tasks) is not detected early | |
| Use thermographic cameras during commissioning of electrical components to detect faults in planning or assembly | very good | 2 | low risk | The use of thermographic cameras during the commissioning of electrical components to detect weak points has been well tried | |
| Enough onshore tests<br>Adequate securing of cargo<br>Experienced and trained installation personnel and suitable installation equipment<br>Supervising and testing QA during manufacture, assembly, and commissioning | very good | 2 | low risk | | |
| Commissioning of the fire protection systems for the wind turbine prior to the overall commissioning of it | very good | 4 | medium risk | | |
| Priority commissioning of the machine guards and the emergency functions of the turbine | adequate | 6 | medium risk | In order to exclude any damage by switching errors, incorrect programming or operating, the machine guards should be set to work immediately upon erection<br>The same applies to the emergency functions of the turbine, e.g. alignment in the wind of the nacelle during a storm | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.7.8

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| n) | Commissioning in general | Missing tools, material, etc. | high |
| n) | Overall commissi-oning of the wind turbine together with the wind farm | Control room not yet finished / ready for test<br>Control technology faulty | medium |
| n) | Overall commissi-oning of the wind turbine together with the wind farm | External mains connection not yet in working order | high |
| n) | Overall commissi-oning of the wind turbine together with the wind farm | External mains connection not yet in working order | high |
| n) | Overall commissi-oning of the wind turbine together with the wind farm | Documentation not yet on hand (e.g. certificate BGV A3, circuit diagrams, maintenance instructions, etc.) | medium |
| n) | Overall commissi-oning of the wind turbine together with the wind farm | Start-up personnel not sufficiently qualified | high |
| n) | Overall commissi-oning of the wind turbine together with the wind farm | Weather and sea conditions not optimum | medium |
| n) | Supervision of start-up by the certifiers | Missing resources at the certifier | high |
| n) | Supervision of start-up by the certifiers | Qualification of certifier and/or the persons involved | medium |
| n) | Supervision of start-up by the certifiers | Delay of commissioning due to insufficient co-ordination by certifiers and customer | medium |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.8 |
|---|---|---|---|---|---|
| Prepare exactly<br>Simulate the sequences<br>Plan the tests and trainings on prototypes, material reserves, and tools in advance | adequate | 6 | medium risk | | |
| Time schedule to be synchronised with the overall project schedule<br>Early co-ordinate the work to be done | adequate | 4 | medium risk | Information to group 1<br>▪ sub-station | |
| Time schedule to be synchronised with the overall project schedule | poor | 9 | high risk | Information to group 1<br>▪ Sub-station | |
| Early plan emergency power (e.g. emergency generators etc.) | adequate | 6 | medium risk | The project schedule should allow for the power supply required to maintain circuit integrity, particularly for the emergency functions of the wind turbine | |
| Early schedule documentation and corresponding documents<br>Make the start-up personnel and the operating personnel as well as the QA check the documentation to find errors<br>If required, subject submittal of documents to penalties | adequate | 4 | medium risk | | |
| Early hire personnel<br>Train and instruct the personnel<br>Proof of the employee's qualification when working for external service providers to be condition for deployment | adequate | 6 | medium risk | | |
| Plan the weather slot for start-up according to the meteorological data and taking experiences into account<br>Allow for sufficient buffer for bad weather / select alternative weather slot | adequate | 4 | medium risk | Normally, the overall project schedules are geared in the long run to the appropriate weather slots in the corresponding year | |
| Early synchronise resources and co-ordinate commissioning with the certifier to get hold of resources | adequate | 6 | medium risk | As only a limited number of certifiers is available in the market, book them early | |
| Early verify qualification (personal records etc.) of the test engineer involved<br>Where required, turn down the project manager | adequate | 4 | medium risk | | |
| Early co-ordinate the work to be done and the documents to be examined | adequate | 4 | medium risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.7.8

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| n) | Tests of single components | Parts of components, incl. the corrosion protection, are faulty etc. | medium |
| n) | Tests of single components | Inappropriate test carried out | small |
| n) | Tests and inspection of machine safety devices | Damage to machine safety device due to test | small |
| n) | Tests of single components | Faulty machine safety device | small |
| n) | Tests and inspec-tion of connections and joints to the sub-station | Faulty connections<br>(design) | small |
| n) | Tests and inspec-tion of connections and joints to the sub-station | Injury to testing personnel, e.g. by overvoltage | high |
| n) | Tests and inspection of the overall wind turbine<br>(assumption: single wind turbine) | Defective components | small |
| n) | Tests and inspection of the overall wind turbine<br>(assumption: single wind turbine) | Injury to testing personnel | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.8 |
|---|---|---|---|---|---|
| Enough onshore tests<br>Adequate securing of cargo<br>Experienced installation personnel and suitable installation equipment<br>Production supervision, permanent quality assessment | very good | 2 | low risk | | |
| Clear specifications of test and testing criteria, to be laid down by the manufacturers<br>Make QA and the certifier carry out the tests | adequate | 2 | low risk | | |
| Test procedures well-tried and exactly defined<br>Make experienced personnel carry out the tests<br>Use appropriate testing equipment<br>Correct execution of the tests (check lists) | adequate | 2 | low risk | The machine safety devices and the devices to maintain emergency functions are essential for functioning and to avert damage to a wind turbine | |
| Enough onshore tests<br>Adequate securing of cargo<br>Experienced installation personnel and suitable installation equipment<br>Production supervision<br>In-process quality assessment | very good | 1 | low risk | | |
| Enough onshore tests<br>Adequate securing of cargo<br>Experienced installation personnel and suitable installation equipment<br>Production supervision, permanent quality assessment | very good | 1 | low risk | | |
| Sufficient protection measures within the scope of work safety<br>Sufficiently experienced and qualified personnel | very good | 3 | low risk | | |
| Enough onshore tests<br>Adequate securing of cargo<br>Experienced installation personnel and suitable installation equipment<br>Permanent quality assessment | very good | 1 | low risk | | |
| Sufficient protection measures within the scope of work safety<br>Sufficiently experienced and qualified personnel | very good | 3 | low risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| 9.7.8 | Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|---|
| | n) | Tests and inspection of the overall wind turbine<br>(assumption: single wind turbine) | Inappropriate test to sufficiently test the overall wind turbine | small |
| | n) | Function tests, emergency functions<br>(assumption: emergency power system on OSS AdÜ: operations support system?) | Defective components | small |
| | n) | Function tests, emergency functions<br>(assumption: emergency power system on OSS AdÜ: operations support system?) | Injury to testing personnel | high |
| | n) | Function tests, emergency functions<br>(assumption: emergency power system on OSS AdÜ: operations support system?) | Inappropriate test to sufficiently test the overall wind turbine | small |
| | n) | Machine protection not yet operational during commissio-ning of wind turbine | Machines damaged | medium |
| | n) | Function test of the entire system during operation | Defective components | small |
| | n) | Function test of the entire system during operation | Injury to testing personnel | high |
| | n) | Function test of the entire system during operation | Inappropriate test to sufficiently test the overall wind turbine | small |
| | n) | Function test of the entire system during operation | Delay caused by ambient conditions (bad weather, poor winds, etc.) | high |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.8 |
|---|---|---|---|---|---|
| Clear specifications of test and testing criteria, to be laid down by the manufacturers<br>Make QA and the certifier carry out the tests | adequate | 2 | low risk | See footing structure | |
| Enough onshore tests<br>Adequate securing of cargo<br>Experienced installation personnel and suitable installation equipment<br>Permanent quality assessment | very good | 1 | low risk | | |
| Sufficient protection measures within the scope of work safety<br>Sufficiently experienced and qualified personnel | very good | 3 | low risk | | |
| Clear specifications of test and testing criteria, to be laid down by the manufacturers<br>Make QA and the certifier carry out the tests | adequate | 2 | low risk | | |
| Early commissioning, in any case prior to the commissioning of the wind turbine as mentioned in the beginning of project stage 2 | adequate | 4 | medium risk | | |
| Enough onshore tests<br>Adequate securing of cargo<br>Experienced installation personnel and suitable installation equipment<br>Production supervision, permanent quality assessment | very good | 1 | low risk | | |
| Sufficient protection measures within the scope of work safety<br>Sufficiently experienced and qualified personnel | very good | 3 | low risk | | |
| Clear specifications of test and testing criteria, to be laid down by the manufacturers<br>Make QA and the certifier carry out the tests | adequate | 2 | low risk | | |
| Wait for appropriate weather slot and flexibly plan the resources (ships and persons) to ensure that the overall test passes off smoothly | adequate | 6 | medium risk | | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

9.7.8

| Process steps (see legend) | Short description of operations | Explanation of risks | Risk assess-ment |
|---|---|---|---|
| n) | Function test of the entire system during operation | Damage to electrical components (transformer, generator, switch-gears, etc.) due to overvoltage during test operation (e.g. by invalid switching on USP AdÜ?) | high |
| n) | Acceptance of wind turbine by operating party and certifier | Missing resources at the certifier / contractor (operating party) | high |
| n) | Mains connection of sub-station | Damage to switchgear when connecting the first time | medium |
| n) | Overall commissio-ning of the wind farm as one component, also see sub-station | Delay caused by ambient conditions (bad weather, poor winds, etc.) | high |

**Legend**
a) Execution planning of soil investigation for locations of offshore wind turbines
b) Soil investigation for locations of offshore wind turbines
c) Execution planning of the inland transport (overland and rivers) from the factory to the offshore port
d) Execution planning of the storage in the offshore port and the onshore assembly there
e) Execution planning of offshore transports
f) Execution planning of offshore erection
g) Execution planning of residual assembly work offshore
e) Execution planning of the commissioning and the test run until getting the PAC
i) Inland transport (overland and rivers) from the factory to the offshore port
j) Storage in the offshore port and the onshore assembly there
k) Offshore transports
l) Offshore erection
m) Residual assembly work offshore
n) Commissioning and test run until getting the PAC

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

| Protection measures | Assessment of protection measures | Relevance | Status | Comments | 9.7.8 |
|---|---|---|---|---|---|
| Properly design, dimension, and establish the entire integrated electrical system<br>Calculate and simulate potential switching procedures<br>Co-ordinate planning with grid operator and comply with connection conditions | adequate | | low risk | | |
| Early synchronise resources and co-ordinate commissioning with the certifier to get hold of resources | adequate | 6 | medium risk | | |
| Sufficiently experienced and qualified installation personnel<br>Enough onshore tests | adequate | 4 | medium risk | Interface to sub-station | |
| Wait for appropriate weather slot and flexibly plan the resources (ships and persons) to ensure that the overall test passes off smoothly | adequate | 6 | medium risk | Interfaces with wind turbine, cable, and sub-station to be cleared up, commissioning from control room, offshore or onshore | |

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

© VdS Schadenverhütung GmbH
Vervielfältigungen/Veröffentlichungen – auch für innerbetriebliche Verwendung – nicht gestattet
Heruntergeladen von IP 216.73.216.140 am 13.11.2026 - 05:01

Editor: Gesamtverband der Deutschen Versicherungswirtschaft e. V. (GDV) [German Insurance Association]

Publishing house: VdS Schadenverhütung GmbH · Amsterdamer Str. 174 · D-50735 Cologne
Phone: +49 221 77 66 0 · Mail: verlag@vds.de
Copyright by VdS Schadenverhütung GmbH. All rights reserved.