DNV·GL

SERVICE SPECIFICATION

DNVGL-SE-0078 Edition May 2015

Project certification of photovoltaic power plants

DNV GL AS

FOREWORD

DNV GL service specifications contain procedural requirements for obtaining and retaining certificates and other conformity statements to the objects, personnel, organisations and/or operations in question.

Any comments may be sent by e-mail to *rules@dnvgl.com*

CHANGES – CURRENT

General

This is a new document.

Contents

SECTION 1 GENERAL

1.1 Introduction

This service specification (SE) specifies DNV GL's services for project certification of photovoltaic (PV) power plants.

Furthermore, it provides a common communication platform for describing the scope and extent of activities performed for project certification of PV power plants.

The service specification is divided into four main sections.

Sec.1: Provides general information such as applicability of this service specification and general requirements regarding project certification of PV power plants.

Sec.2: Provides a service overview for the defined project phases and the deliverables of project certification.

Sec.3: Describes the services for the certification procedure of PV power plants starting from planning phase in detail.

Sec.4: Describes the services for the post-construction certification procedure of PV power plants in detail.

The latest revision of all DNV GL documents can be found in MyDNVGL / Rules and Standards on the DNV GL website www.dnvgl.com.

1.2 Scope

The services specified in this service specification are in compliance with the DNV GL project certification scheme (see Figure 2-1 and Figure 2-2), based on IEC, other international and DNV GL standards.

The project certification concept for PV power plants constitutes a robust means to provide, through independent verification, evidence to stakeholders (owner, financiers, partners, utility companies, insurance companies, the public, governmental and non-governmental organizations) that a set of requirements laid down in standards and that in addition a satisfactory performance has been shown during design and installation, and maintained during operation of a PV power plant.

The service specification describes as well how to maintain this certificate by periodic maintenance during the service life of the PV power plant.

1.3 Application

This service specification applies to project certification and related verification tasks during design, manufacturing, transport, installation, commissioning and operation of PV power plants.

The following PV power plants are covered by the services described herein:

— PV power plant projects (starting from planning phase)
— PV power plant projects after construction (post-construction).

This service specification is generally applicable for grid connected PV power plant installations. In case of stand-alone systems it is recommended to agree the scope of work for certification with DNV GL at an early stage.

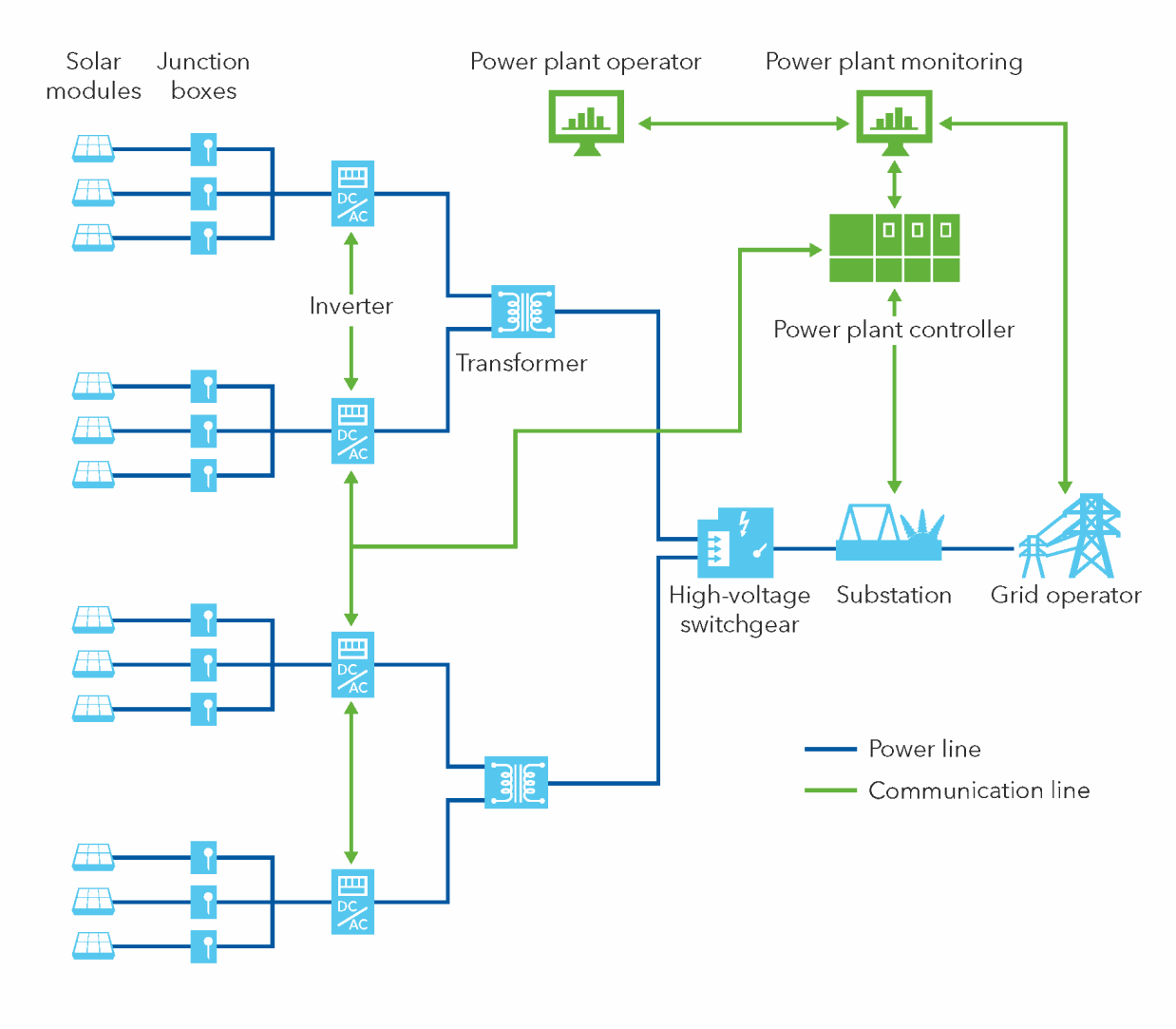

Figure 1-1 Definition of photovoltaic power plant components

1.4 Definitions

1.4.1 Terminology and definitions

Table 1-1 Definitions of verbal forms

Verbal forms	*Definition*
shall	verbal form used to indicate requirements strictly to be followed in order to conform to the document.
should	verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required
may	verbal form used to indicate a course of action permissible within the limits of the document

Table 1-2 Definitions of terms

Term	*Definition*
applicant	PV power plant developer, owner or operator, who is DNV GL's contractual partner (customer)
certification	third-party issue of a statement, based on a decision following review, that fulfilment of specified requirements has been demonstrated related to products, processes or systems (ISO/IEC 17000)
component	a main part of a PV power plant In this service specification, the term refers mainly to devices as part of the electrical system like solar module, inverter or power transformer. Parts of the support structure are also referred to as components.
customer	DNV GL's contractual partner (applicant)
distributed generation type	distributed energy, also district or decentralized energy is generated or stored by a variety of small, grid-connected devices
Eurocode	a series of 10 European standards, EN 1990 to EN 1999, providing a common approach for the design of buildings and other civil engineering works and construction products
European Efficiency	an averaged operating efficiency over a yearly power distribution corresponding to middle-Europe climate
foundation	the part below the support structure for solar modules that transfers the loads acting on the structure into the soil
generating plant	the aggregation of several generating units, connected to a common connection point, including other electrical equipment (e.g. power cables, power transformers, reactive power compensation installations, protection and control systems) Examples are wind farms and PV power plants. For single generating units at given sites (one unit per site) the terms *generating plant* and *generating unit* mean the same. A generating plant is a facility to convert primary energy to electrical energy which consists of one or more power generating modules connected to a network at one or more connection points.
generating unit	single current generating installations like single wind turbines, single inverters with connected PV solar modules etc., converting renewable energy sources like wind speed, solar radiation or bio mass into electrical power These are also called power generating facilities which are either: — a synchronous power generating module, or — a power park module.
inverter	an electronic device that changes direct current (DC) to alternating current (AC)
junction box	a container for electrical connections
low voltage ride through	in electricity supply and generation, low voltage ride through (LVRT) is a capability of electrical devices to be able to operate through periods of lower grid voltage
maximum power point	point in the current-voltage-graph of a solar module, where the largest power can be obtained, i.e. point, where the product of voltage and current has its maximum
optional services	services which are not part of the scope which is required in order to obtain statement of compliance and project certificates
outstanding issue	term used to denote a deviation from standards and technical requirements specified in the certification agreement, and which needs to be completed for full compliance

Table 1-2 Definitions of terms (Continued)

Term	*Definition*
performance ratio	a measure of the quality of a PV power plant that is independent of location and it therefore described as a quality factor The performance ratio is stated as percent and describes the relationship between the actual and theoretical energy outputs of the PV power plant. The calculation method can be found in IEC 61724.
photovoltaic	a method of converting solar energy into direct current electricity using semiconducting materials that exhibit the photovoltaic effect
project certificate	a document signed by DNV GL and affirming that, at the time of assessment, the PV power plant referred to in the certificate met the stated requirements
PV array	a series or parallel connected set of PV strings
PV generator	a power system consisting of an arrangement of several solar modules
PV power plant	a large-scale photovoltaic system (PV) designed for the supply of merchant power into the electricity grid The power conversion source is via solar modules that convert light directly to electricity. PV power plants are typically rated in terms of the DC peak capacity of the PV arrays, in megawatt-peak (MWp), or of the nominal maximum AC output in MW or MVA.
PV string	a series-connected set of solar modules
recommendation	non-mandatory advice
relevant network operator	electrical system operator in charge for the connection point or according to the connection agreement or power purchase agreement This is the operator of the network to which a power generating module is or will be connected.
Software as a Service	a software licensing and delivery model in which software is licensed on a subscription basis and is centrally hosted SaaS is typically accessed by users using a thin client via a web browser.
solar module	a packaged, connected assembly of solar cells Solar modules can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Each solar module is rated by its DC output power under standard test conditions (STC).
solar radiation	a portion of the electromagnetic radiation given off by the sun, in particular infrared, visible, and ultraviolet light.
standard test conditions	nominal power of solar modules is determined by measuring the electrical current and voltage in a circuit, while varying the resistance under precisely defined conditions These standard test conditions are specified in standards such as IEC 61215 and, IEC 61646; specifically the light intensity is 1000 W/m^2, with a spectrum similar to sunlight hitting the earth's surface at latitude 35°N in the summer (air mass 1.5), the temperature of the cells being 25°C.
stand-alone system	an off-the-grid electricity system for locations that are not fitted with an electricity distribution system. Also known as remote area power supply.
support structure	support structure of a PV generator is defined as the structure below the solar modules and includes the substructure, but not the foundation
verification	the confirmation, through the provision of objective evidence, that specified requirements have been fulfilled (ISO 9000)

1.4.2 Abbreviations and symbols

Abbreviations and symbols used in this service specification:

Table 1-3 Abbreviations

Abbreviation	*In full*
AC	alternating current
BG ETEM	Berufsgenossenschaft Energie Textil Elektro Medienerzeugnisse (German industrial injury insurance organisation for energy textile electrics and media products)
DAkkS	Deutsche Akkreditierungsstelle (German Accreditation Authority)
DC	direct current
EIS	electrical insulation system
FEM	finite element method

Table 1-3 Abbreviations (Continued)

Abbreviation	*In full*
HVSG	high-voltage switchgear
LVRT	low voltage ride through
MC	Multi-Contact
MPP	maximum power point
IAC	internal arc class
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
IP	international protection
PMPP	maximum module power output
PR	Performance Ratio
PV	photovoltaic
RNO	relevant network operator
SaaS	Software as a Service
SE	DNV GL service specification
SF6	sulfur hexafluoride
S_r	rated apparent power
STC	standard test conditions
UV	ultraviolet

1.5 References

This document makes reference to relevant international documents and DNV GL documents. Unless otherwise specified in the certification agreement or in this service specification, the latest valid revision of each referenced document applies.

Table 1-4 DNV GL documents

Reference	*Title*
GL TN GCC	GL Renewables Certification Technical Note - Certification of Grid Code Compliance

Table 1-5 IEC documents

Reference	*Title*
IEC 60076-1	Power Transformers – Part 1: General
IEC 60076-11	Power transformers – Part 11: Dry-type transformers
IEC 60076-16	Power transformers – Part 16: Transformers for wind turbines applications
IEC 60227	Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V
IEC 60228	Conductors of insulated cables
IEC 60364	Low-voltage electrical installations
IEC 60364-5-52	Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment - Wiring systems
IEC 60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1.2 kV) up to 30 kV (Um = 36 kV)
IEC 60721-1	Classification of environmental conditions – Part 1: Environmental parameters and their severities
IEC 60840	Power cables with extruded insulation and their accessories for rated voltages above 30 kV (Um = 36 kV) up to 150 kV (Um = 170 kV) – Test methods and requirements
IEC 60904	Photovoltaic devices
IEC 61000-6-1	Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments
IEC 61000-6-2	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments
IEC 61000-6-3	Electromagnetic compatibility (EMC) – Part 6-3: Generic standards –Emission standard for residential, commercial and light industrial environments
IEC 61000-6-4	Electromagnetic compatibility (EMC) – Part 6-4: Generic standards –Emission standard for industrial environments
IEC 61215	Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval
IEC 61646	Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval

Table 1-5 IEC documents (Continued)

Reference	*Title*
IEC 61683	Photovoltaic systems - Power conditioners – Procedure for measuring efficiency
IEC 61724	Photovoltaic System Performance Monitoring – Guidelines for measurement data exchange and analysis
IEC 61730-1	Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction
IEC 61730-2	Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing
IEC 61829	Crystalline silicon photovoltaic (PV) array – On-site measurement of I-V characteristics
IEC 61853-1	Photovoltaic (PV) module performance testing and energy rating – Part 1: Irradiance and temperature performance measurements and power rating
IEC 61936-1	Power installations exceeding 1 kV a.c. – Part 1: Common rules
IEC-62093	Balance-of-system components for photovoltaic systems – Design qualification natural environments
IEC-62108	Concentrator photovoltaic (CPV) modules and assemblies – Design qualification and type approval
IEC 62109-1	Safety of power converters for use in photovoltaic power systems – Part 1: General requirements
IEC 62109-2	Safety of power converters for use in photovoltaic power systems – Part 2: Particular requirements for inverters
IEC 62116	Utility-interconnected photovoltaic inverters – Test procedure of islanding prevention measures
IEC 62271	High-voltage switchgear and controlgear
IEC 62305-3	Protection against lightning – Part 3: Physical damage to structures and life hazard
IEC 62446	Grid connected PV systems – Minimum requirements for system documentation, commissioning tests and inspection
IEC-62548	Photovoltaic (PV) arrays – Design requirements
IEC 62727	Photovoltaic systems – Specification for solar trackers
IEC 62759-1	Transportation testing of photovoltaic (PV) modules – Part 1: Transportation and shipping of PV module stacks
IEC 62817	Photovoltaic systems – Design qualification of solar trackers

Table 1-6 ISO documents

Reference	*Title*
ISO 9000	Quality management systems – Fundamentals and vocabulary
ISO 9001	Quality management systems – requirements
ISO 12100	Safety of machinery - General principles for design – Risk assessment and risk reduction
ISO 12944	Paints and varnishes – Corrosion protection of steel structures by protective paint systems
ISO 14121-1	Safety of machinery – Risk assessment – Part 1: Principles
ISO/IEC 31010	Risk management – Risk assessment techniques
ISO 17000	Conformity assessment – Vocabulary and general principles
ISO/IEC 17025	General requirements for the competence of calibration and testing laboratories

Table 1-7 Other documents

Reference	*Title*
EN 1997-2	Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing
EN 50380	Datasheet and nameplate information for photovoltaic modules
EN 50524	Data sheet and name plate for photovoltaic inverters
EN 50530	Overall efficiency of grid connected photovoltaic inverters
EN 50178	Electronic equipment for use in power installations
DIN EN 62305-3	Protection against lightning – Part 3: Physical damage to structures and life hazard; Supplement 5: Lightning and overvoltage protection for photovoltaic power supply systems (in German)

1.6 Procedural requirements

1.6.1 Customer - DNV GL interaction

The project certification provides the customer with a third party verification and conformity of his PV power plant project considering specific needs.

This document has a dual objective. It serves as a publicly available description of DNV GL's project

certification services for PV power plants and it will be referred to as a contractual document in the project certification agreement between the customer and DNV GL. The document specifies the obligations of the customer when his PV power plant is to become certified, as well as DNV GL's service obligations to the customer.

The deliverables by DNV GL shall be agreed in detail between the customer and DNV GL as part of the contract. In general the DNV GL project certificate is issued when all the required statements of compliance according to the project certification scheme (see Figure 2-1 or Figure 2-2) have been issued and the final certification has been performed successfully. The deliverables are listed in [2.1.4].

Each certification phase can be verified independently according to the DNV GL project certification scheme and will be completed with the issue of a statement of compliance for the phase under verification. Final timeframes of the verification and certification activities shall be discussed and agreed between the customer, DNV GL and supplier(s) before commencement of the work.

The typical project certification applicant is the PV power plant developer, owner or operator. The splitting of the project certificate per phase allows for the involvement of phase related contractors in the project set-up. This allows for the involvement of additional resources from an applicant perspective.

1.6.2 Certification requirements, quality management

In general subsequent phases shall not be initiated before previous or dependent phases are completed and approved. For example, prior to verification of the manufacturing phase, the design phase must be completed and approved. Therefore the manufacturing of the components for the project shall not been started before the design is approved and surveillance is agreed. Alternative ways and the related risks shall be discussed and agreed with DNV GL in advance.

The customer shall provide evidence of a consistent quality management system covering all aspects of the development and operation of the PV power plant. In particular the customer shall show quality relevant procedures to DNV GL for his processes and his suppliers, covering design basis, design, grid code compliance, manufacturing, transport and installation, commissioning, inspection, operation and documentation processes. When a valid certificate for ISO 9001 of an accredited certification body is in place, DNV GL may reduce this evaluation to a plausibility check.

In general test reports delivered shall be prepared by accredited testing laboratories and meet the requirements of IEC/ISO 17025 and relevant standards. For non-accredited testing laboratories, DNV GL shall verify that the testing is carried out according to IEC/ISO 17025, as applicable.

1.6.3 Documentation requirements

The documentation submitted for the certification process shall be complete and self-explanatory. The content shall meet the requirements of the applied standards. All relevant documentation shall be subject oriented and in a logical sequence to facilitate cross checking between documents (e.g. design basis, design, grid code compliance, manufacturing, transport, installation, commissioning etc.). Each document shall be named explicitly by e.g. title, report no., page no., date and a revision description table. Furthermore the documents should be signed officially at least by the author and/or the approver to identify responsibilities. Alternatively the documentation submitted shall bear unambiguous evidence of having been subject to designer's and/or owner's own quality approval system.

The documentation, including standards and codes as well as other requirements and specifications, shall be prepared in English language, unless otherwise agreed in writing between DNV GL and the customer.

All documentation for verification shall be forwarded to DNV GL in electronic form, preferable as pdf-files. Other forms of documentation such as print-outs can be an alternative, if agreed.

Guidance note:
The documents submitted should be on a logical work package basis per phase (see Figure 2-1 and Figure 2-2) and cover the requirements as stipulated in Sec.3 or Sec.4 to facilitate the process.

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1.6.4 Standards, codes and additional requirements

The standards, codes and requirements which form the basis for the PV power plant project shall be listed

and agreed in a so-called design basis document in a very early stage. For the site in question, relevant statutory requirements shall also be listed. Such requirements could be decommissioning and safety related issues.

Other requirements relevant for the project certification such as requirements for the grid connection and other specific requirements from the owner and the grid operator shall be listed as well.

The standards, codes and additional requirements which are applicable for the project and the site in question will be verified for compliance with the design prerequisites of the project and for completeness and adequate suitability and applicability. The verification of the choice of standards, codes and requirements will be conducted early in the project phase in order to avoid fundamental discussions on this basic aspect of the design basis.

For dated standards and codes, only the edition cited applies. For undated references, the latest edition of the referenced document including any amendments applies. In case of deviations from this rule, it shall be agreed on an individual basis and in advance with DNV GL.

1.6.5 Combination of standards

DNV GL certification according to internationally recognized standards shall follow the principles described in this service specification. Wherever combinations of such standards and external criteria are used, the exact terms of reference and documents to be issued shall be agreed at the beginning of the project and shall be specified in detail in the design basis.

The application of standards other than those referenced here does not allow for a reduction of the targeted safety as described in the safety philosophy sections of the standards referenced in this document. DNV GL reserves the right to ask for additional requirements to cover issues essential to the certification process and not covered by the standards in question.

It is not allowed to combine safety measures from different standard systems due to the possible differences in the underlying safety philosophies of the different standard systems.

In case standards are combined, caution must be exercised and the choice of standards is subject to acceptance by DNV GL.

1.6.6 Surveillance requirements

The customer, or other entity having legal responsibility on the premises where DNV GL personnel will work, shall inform DNV GL of any safety and health hazards related to the work and/or any safety measures required for the work, prior to starting the work, or if such information is not available at that time, during the performance of the work.

Whenever DNV GL undertakes to work on site, the customer shall provide all adequate safety measures to ensure a working environment that is safe and in accordance with all relevant legislation.

If at any time during the execution of work on site a DNV GL employee judges that the work situation is unsafe then work shall be suspended until such situation has been made safe.

SECTION 2 SERVICE OVERVIEW – PROCEDURE AND CONTENT OF PROJECT CERTIFICATION

2.1 Overview

Project certification of PV power plants in accordance with this service specification is carried out according to the project certification scheme as described and defined in the following items.

Project certificates can be issued for following PV power plants:

— PV power plant certification, starting from planning phase, or
— PV power plant certification, starting after the construction (post-construction).

Certification of the PV power plant project starting from planning phase implies the overall verification beginning from the planning phase to the final commissioning. For the detailed description of the phases see [2.1.1].

Certification of the PV power plant project after the construction implies that the verification of the PV power plant starts after the commissioning (post-construction). The design of the PV power plant will be assessed as-built. For the detailed description of the phases see [2.1.2].

The DNV GL project certification scheme consists of different phases, see Figure 2-1 for the project certification starting from planning phase and Figure 2-2 for post-construction project certification.

The phases for project certification starting from planning phase refer to design basis, design, grid code compliance, manufacturing, transport and installation, commissioning and the maintenance of the certificate during in-service.

The phases for post-construction project certification refer to design, grid code compliance, commissioning and the maintenance of the certificate during in-service.

Statements of compliance will be issued after successful completion of each phase.

The project certificate for the PV power plant will be issued after successful completion of all phases of the PV power plant in question, either for project certification starting from planning phase or post-construction project certification.

In case of outstanding issues provisional statements of compliance and a provisional project certificate can be issued on request. An outstanding issue shall neither be non-safety-relevant nor performance-relevant and implies that the outstanding issues regarding compliance with specified or agreed standards have not been rectified (see [2.1.4]). Provisional certificates and statements are valid for maximum of one year.

The project certificate may be maintained throughout the in-service phase. For maintenance of the certificate throughout the in-service phase, reference is made to [2.1.5].

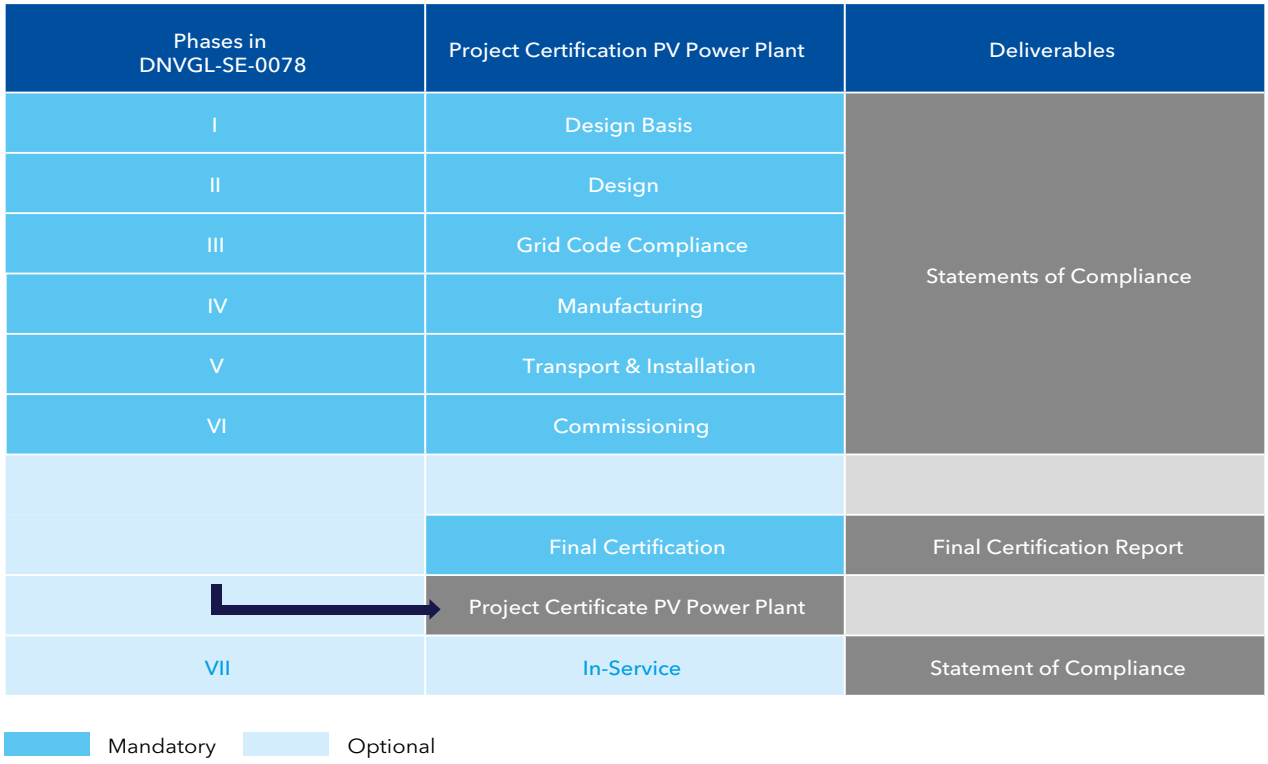

Figure 2-1 DNV GL project certification scheme PV power plant

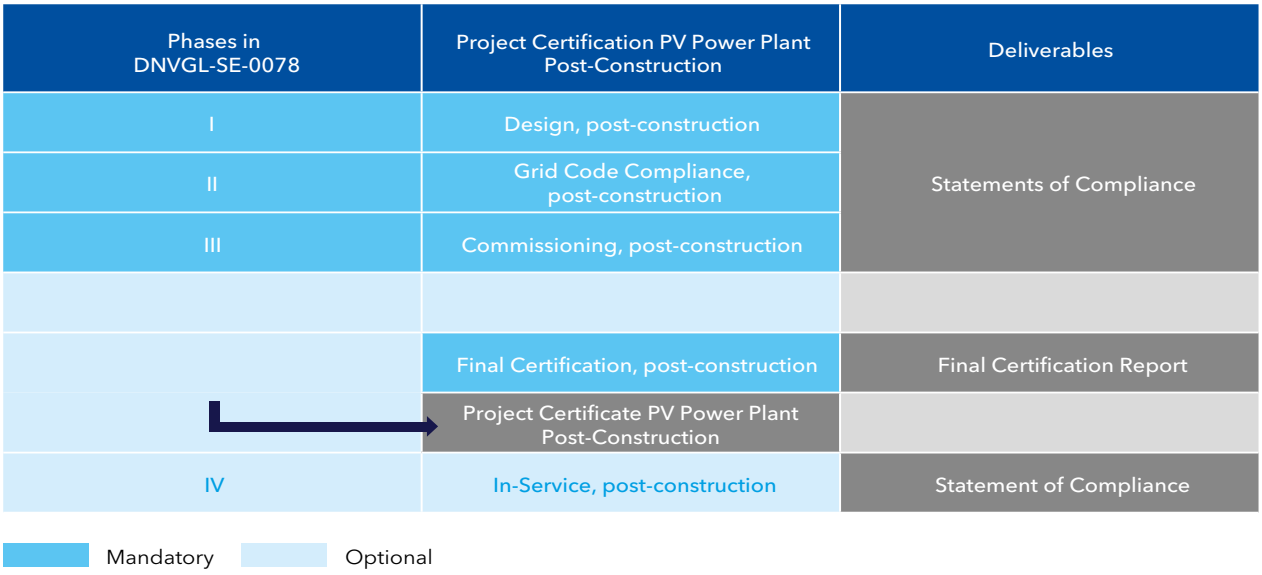

Figure 2-2 DNV GL project certification scheme PV power plant – post-construction

On request, optional services to DNV GL project certification may be performed and will be documented separately.

2.1.1 Project certification phases for projects starting in planning phase

The following project certification phases are shown in Figure 2-1.

Phase I Design basis covers the site conditions, performance assumptions and the basis for design (as e.g. standards, guidelines and procedures).

Phase II: Design covers the steps necessary to achieve final performance and design verification.

Phase III: Grid code compliance covers the steps necessary to achieve verification of the required network compatibility.

Phase IV: Manufacturing covers the surveillance during manufacturing of the project related components.

Phase V: Transport and installation covers the surveillance during transport and installation of the project.

Phase VI: Commissioning involves all follow-up verification and on-site inspections during the implementation of the project before operation.

Phase VII: In-service involves follow-up verification and periodical on-site inspections after start of operation and during the subsequent in-service period.

Each phase will be completed with the issue of a statement of compliance.

After completion of Phases I through VI and prior to the issue of the PV power plant project certificate, a final certification will be performed. During the final certification DNV GL will check all parts of the certification (certification reports and statements of compliance) for consistency and completeness with regard to the phases described in this service specification. A DNV GL project certificate for PV power plant will be issued after successful completion of the final certification. The certificate documents compliance with specified or agreed standards at the date of issue.

The verification activities associated with the various certification phases and the different PV power plant components are presented in more detail in Sec.3.

Table 2-1 provides an overview of the phases and the relevant sections of this document:

Table 2-1 Project certification of PV power plants – document section references

Phases	*Project certification for PV power plant*	
I	design basis	[3.2]
II	design	[3.3]
III	grid code compliance	[3.4]
IV	manufacturing	[3.5]
V	transport and installation	[3.6]
VI	commissioning	[3.7]
	Project certificate for PV power plant	
VII	in-service	[3.9]

2.1.2 Project certification phases for post-construction projects

The following project certification phases are shown in Figure 2-1.

— Phase I: Design covers the steps necessary to achieve final performance and design verification.
— Phase II: Grid code compliance covers the steps necessary to achieve verification of the required network compatibility.
— Phase III: Commissioning involves all follow-up verification and on-site inspections of the project before operation.
— Phase IV: In-service involves follow-up verification and periodical on-site inspections after the final certification and during the subsequent in-service period.

Each phase will be completed with the issue of a statement of compliance.

After completion of Phases I through III and prior to the issue of the PV power plant project certificate, a final certification will be performed. During the final certification DNV GL will check all parts of the certification (certification reports and statements of compliance) for consistency and completeness with

regard to the phases described in this service specification. A DNV GL project certificate for PV Power plant post-construction will be issued after successful completion of the final certification. The certificate documents compliance with specified or agreed standards at the date of issue.

The verification activities associated with the various certification phases and the different PV power plant components are presented in more detail in Sec.4.

Table 2-2 provides an overview of the phases and the relevant sections of this document.

Table 2-2 Project certification of PV power plants post construction – document section references

Phases	*Project certification PV power plant post-construction*	
I	design post-construction	[4.2]
II	grid code compliance post-construction	[4.3]
III	commissioning post-construction	[4.4]
	Project certificate PV power plant post-construction	
IV	in-service post-construction	[4.6]

2.1.3 Technical requirements

This service specification provides the key references to the technical requirements to be fulfilled for the PV power plant in question and subject to project certification.

2.1.4 Deliverables

A DNV GL project certificate can be issued for PV power plants as defined in this service specification.

Each certificate for a project starting from planning phase is supported by at least the following:

— statement of compliance design basis
— statement of compliance design
— statement of compliance grid code compliance
— statement of compliance manufacturing
— statement of compliance transport and installation
— statement of compliance commissioning
— final certification report
— statement of compliance in-service (for maintenance of the project certificate).

Each certificate for the post-construction project is supported by at least the following:

— statement of compliance design, post-construction
— statement of compliance grid code compliance, post-construction
— statement of compliance commissioning, post-construction
— final certification report, post-construction
— statement of compliance in-service, post-construction (for maintenance of project certificate).

Each statement of compliance is supported by subject related certification reports.

For surveillances during manufacturing, transportation and installation, commissioning and in-service, DNV GL will report critical findings to the customer immediately after the surveillance. DNV GL will issue surveillance reports to the customer and the frequency of these shall be agreed with the customer (for example daily, weekly or monthly). The report will describe the extent of the surveillance including findings, non-conformities and possible recommendations. The report will be issued in electronic form and sent by e-mail to the customer.

In the event that full compliance is not obtained during the project certification, the deliverables will depend on the character of the lack of compliance. Three deliverable options are available in this regard and

described in the following:

— *No outstanding issue*. A statement of compliance with the accompanying DNV GL certification reports will be issued. DNV GL project certificate will be issued based on the statements of compliance and the final certification report for the verified PV power plant.
— *Non-safety and/or non-performance critical outstanding issues*. A provisional statement of compliance will be issued with the outstanding issues listed in the statement of compliance. A provisional project certificate can be issued on request, which points out to the outstanding issues. The outstanding issues listed on the statement(s) of compliance will be repeated in the project certificate. Specific description of the outstanding issues will be given in the accompanying DNV GL certification reports. As outstanding issues become closed, an updated statement of compliance and project certificate with no outstanding issues can be issued.
— *Safety critical and/or performance critical outstanding issues*. A statement of compliance and project certificate will not be issued. DNV GL will deliver the DNV GL certification reports that would normally accompany the statement of compliance for the relevant phase. The DNV GL certification reports will list the outstanding issues whose rectification is required before a statement of compliance can be issued.

2.1.5 Certificate validity and maintenance

The DNV GL project certificate refers to statements of compliance issued for the completed phases of the project certification in question.

The validity of the project certificate is limited to the design life-time of the installation stated in the project certificate.

Maintenance of the project certificate is conditional on periodic in-service verification by DNV GL and requires the following information:

— annual reporting by the customer covering the certified PV power plant project and including information about:
  — installed components and additional installations as installed on the site
  — abnormal or deviant operating experience or operating failures as well as minor modifications
  — performance analysis of the PV power plant.
— reporting by the customer of planned major modifications without delay and in sufficient time to allow for evaluation by DNV GL before implementation and to enable updating of the design phase and others, if relevant
— the PV power plant is maintained at a standard complying with the requirements of applicable codes and relevant manuals
— periodic inspections by DNV GL or other acknowledged in-service inspectors during the validity period of the certificate to check that the PV power plant correspond to the certified design.

The project certificate should be reconfirmed one year after the date of first issuance by a statement of compliance in-service respectively statement of compliance in-service, post-construction. When a periodic in-service agreement for the PV power plant is in place between DNV GL and the customer, the interval of reconfirmation of the project certificate is set to the duration of the service agreement plus one year; however, five years is the maximum period of reconfirmation.

Following a successful completion of an in-service verification, a statement of compliance in-service respectively statement of compliance in-service, post-construction that validates the project certificate will be issued.

Re-certification may be necessary, if additional requirements for maintenance of the project certificate are set by national authorities or by the applicable design code or standard during the validity period of the certificate.

Safety and performance relevant incidents shall be reported to DNV GL without delay. DNV GL shall evaluate the incidents. In case of a serious defect, DNV GL will suspend the certificate until elimination of the cause.

The certificate will be reaffirmed after successful verification of the rectifying measure.

Provisional statements or provisional certificates have a maximum validity of one year. During this period the customer shall document the closing of the outstanding issues and they shall be evaluated by DNV GL.

Modifications to the PV power plant for which a project certificate has been issued are permitted only if they do not change or affect the principal characteristics at all, or if they change or affect the principal characteristics within the extent specified in the applicable design code or standard.

Any of the following changes will require a new project certificate:

— a change in type of solar modules and inverters
— a different design of the safety system
— a different way of limiting the power output
— increase of the power output by more than 5%
— major changes to the PV power plant design.

Major changes may lead to re-certification if required by the applicable standard or if deemed necessary by DNV GL.

Guidance note:
Examples of major design changes:

— change in number of solar modules and inverters
— change in monitoring system
— change in type and quality of material
— change in sub supplier e.g. transformer, high-voltage switchgear
— Example of minor design changes:
— change of standard parts (bolts, springs etc.)
— new corrosion protection according to specification
— exchange of weather station
— exchange of catalogue parts (circuit breakers, resistors, fittings, hoses, etc.)

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SECTION 3 SERVICE DESCRIPTION – POWER PLANT PROJECTS

3.1 General - objective

The objective of the DNV GL system described in this service specification is to detail and clarify the verification activities for each of the certification phases within the DNV GL project certification scheme for PV power plant projects starting from planning phase.

Once the verifications of the design basis, design, grid code compliance, manufacturing, transport and installation, and commissioning have been successfully completed and the final certification has been performed, DNV GL will issue a project certificate for PV power plant.

3.2 Phase I: design basis

3.2.1 General

The purpose of the verification of the design basis is to evaluate if the site conditions, performance assumptions and the basis for design including general specifications, criteria, parameters, design approach, manufacturing, basic quality requirements, supplier qualification and other assumptions relevant for the design are properly established and documented and that this design basis is sufficient for a safe design and implementation of the PV power plant in the specific project.

Hence, the design basis shall include codes and standards, design parameters, methodologies and principles of the PV power plant and will be checked for plausibility.

The standards, codes and additional requirements shall be agreed within the design basis (see [1.6.4]).

A design basis shall be provided to DNV GL. The design basis shall include documentation of the following:

a) site conditions (soil, environmental conditions, topography…)
b) analysis of the solar radiation data
c) energy production assessment
(estimation of power generation and Performance Ratio (PR)
d) preliminary design criteria (technology review, layout configuration)
e) grid code compliance requirements
f) manufacturing, transport, installation and commissioning requirements
g) operation and maintenance requirements
h) component and personnel safety
i) standards, codes and additional requirements.

The design basis shall refer to IEC and ISO standards when available for the detail, component or system in question. Otherwise, for support structure and foundation Eurocodes are recommended. Any other acknowledged load and structural design standard package, often prescribed by local authorities, is possible.

The design basis forms an essential tool with a view to ensuring, documenting and verifying the performance and safety of the total system and consistency between the different project parts. It is strongly recommended that the design basis is developed as an integrated document to be applied for all parts. If the development of the design basis is divided between suppliers of parts of the project, the design basis for each part shall contain all information of relevance for the design of that part.

DNV GL will verify that the design basis is properly documented and sufficient for performance and safe design of the PV power plant according to the DNV GL project certification scheme. DNV GL will verify that the selected codes, standards and guidelines together with assumptions, parameters, methods and other requirements are appropriate and in line with the requirements of the DNV GL project certification scheme.

Once the verification of the design basis has been successfully completed, DNV GL will issue a statement of compliance for Phase I: design basis.

3.3 Phase II: design

3.3.1 General

DNV GL will verify the final design for compliance with design criteria, standards and other requirements specified in the design basis. Following a successful completion of the verification of the final design, DNV GL will issue a statement of compliance for Phase II: design.

The design evaluation will address the following topics:

— site conditions and plant layout configuration
— electrical components and systems
— loads, structural and foundation design
— operation and maintenance
— component and personnel safety.

The customer shall supply all necessary documentation of the design.

As a minimum the documentation of the PV power plant shall comply with IEC 62446.

Details of the evaluation of each topic are given in the following subsections.

3.3.2 Site conditions and plant layout configuration

DNV GL shall evaluate the PV power plant layout for compliance based on applicable standards, industry best practices and specifications agreed in the design basis.

In general, the PV power plant shall comply with IEC 62548.

The plant layout documentation normally consists of descriptions, specifications, diagrams, schematics, drawings and part lists together with design calculations and performance simulations. DNV GL requires that the documentation clearly identifies the basis for the design, i.e. codes and standards, as well as relevant external conditions.

For performance simulations of the PV power plant specific PV software shall be used. Uncertainties and deviations have to be stated for simulations.

The review of the plant layout will include:

— site conditions
— analysis of the solar radiation data
— inclination, orientation and clearance of the solar modules
— PV design robustness against near and far shading effects
— electrical design of the PV strings and arrays incl. voltage drop calculations
— installation of the PV power plant
— inverter selection (DC/AC power ratio and temperature behaviour)
— coordination of software parameters of the components
— current carrying capability of AC and DC power cables
— energy production assessment
— performance ratio
— review of total losses /efficiency (site specific, on different operation points if applicable).

Optional services to be discussed with the customer.

The ratio between the theoretically simulated and measured Performance Ratio after the commissioning of the PV power plant shall be at least 95%.

3.3.3 Electrical components and systems

3.3.3.1 General

DNV GL will evaluate the design of electrical components and systems for compliance with the requirements

of IEC standards and the agreed additional codes, standards and manufacturer requirements specified in the design basis.

The design documentation related to electrical components and systems normally consists of descriptions, specifications, diagrams, schematics, drawings and part lists together with design calculations and if applicable also test reports. DNV GL requires that the documentation clearly identifies the basis for the design, i.e. codes and standards, as well as relevant external conditions.

For the DNV GL evaluation of the electrical components and system design the following shall be documented by the manufacturer/designer/customer:

- major electrical components including PV generator (solar modules), junction boxes, inverters, monitoring system, high-voltage switchgear, transformer and power cables
- safety relevant electrical systems and components such as low-voltage gear, control-gear, safety system (short-circuit, over voltage, over power etc.)
- protection against electrical hazards (direct and indirect contact; arcing)
- lightning protection, earthing and equipotential bonding (limitation of step and touch voltages; over voltage protection).

Specific requirements and issues that are relevant for design and testing of the major electrical components are given in [3.3.3.2] to [3.3.3.9].

3.3.3.2 General requirements for electrical installations and components

All electrical components shall be designed to comply with the operating and environmental conditions expected at the installation site.

The electrical system design shall comply with IEC 62548.

- Proof of qualification of specific electrical components for the PV power plant shall be carried out in accordance with IEC 62093. This shall be verified through corresponding tests reports.
- Upon completion of the verification of the electrical installation, an initial report according to IEC 60364-6 shall be provided.

3.3.3.3 Solar modules

The solar modules shall be designed, manufactured, tested and installed in accordance with following international standards and codes:

- IEC 60904
- IEC 61215
- IEC 61730-1
- IEC 61730-2
- IEC 61853-1
- IEC 61646
- IEC-62108
- EN 50380.

The solar modules shall not contain irregularities, visual spots or defects affecting the solar module performance or system reliability.

Minimum technical characteristics for each solar module are:

- upon delivery of the modules to the site, the customer shall submit the respective performance data for each solar module at STC (flash reports) in electronic format
- the rear junction box (connection box) of the solar modules shall be rated IP65 and shall include 3 by-pass diodes to protect the solar modules against partial shading and solar module overheating
- "multi-contact" (MC) connectors or equivalent with a clear indication of polarity for the connections
- factory fitted solar module cables shall be long enough to allow the solar modules to be interconnected electrically in series to form PV strings

- each solar module shall permanently and prominently display a technical characteristics plate as required by IEC 61215 and IEC 61730 carrying the following information as a minimum:
  - type of solar module (model part code) and name of the manufacturing company
  - maximum module power output (PMPP) at STC
  - serial number.
- all solar modules shall be electroluminescence tested
- solar modules shall be installed in accordance with the solar module installation manuals
- the solar module output can decrease over time. This performance degradation is the result of several factors. The solar modules shall be provided by the manufacturer with a performance warranty covering a period of 25 years. As a minimum 90% of rated power of the solar module after 10 years and 80% after 25 years shall be guaranteed.

Guidance note:
It is highly recommended that a linear performance warranty of the solar modules is provided by the solar module manufacturer.

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3.3.3.4 Inverters

The inverters shall be designed, manufactured, tested and installed in accordance with following international standards and codes:

- IEC 61000-6-1/2
- IEC 61000-6-3/4
- IEC 61683
- IEC 62109-1
- IEC 62109-2
- IEC 62116
- EN 50524
- EN 50530
- EN 50178.

The inverter unit design shall allow fully rated operation with the expected environmental conditions at the site.

It is highly recommended that the inverters use a control algorithm to maximize energy output via tracking of the maximum power point of the PV array.

The inverters nominal efficiency shall be not less than 97% (European Efficiency).

Enclosures for inverters shall be provided with ventilation equipment controls designed to limit the temperature difference between outside and inside to the value specified in the inverter installation and operation manual. Enclosures shall also have the following general characteristics:

- include adequate spacing to allow for maintenance activities, including replacement of entire inverters and/or transformers
- include internal and external lighting to perform maintenance activities
- feature fire detection and fire suppression systems.

Inverter protective characteristics shall include the following:

- overload
- short circuit
- high DC bus voltage
- high/low AC voltage
- loss/restoration of AC voltage
- phase asymmetry/phase loss

— high/low grid frequency
— insulation resistance monitoring
— internal faults
— high internal temperature
— automatic thermal protective control system.

3.3.3.5 Junction boxes

Junction boxes shall comply with following international standards:

— IEC 61000-6-1/2
— IEC 61000-6-3/4.

The junction boxes shall have the following characteristics:

— a degree of protection of at least IP 54
— suitable for outdoor installation
— designed for UV resistance
— self-extinguishing and halogen-free
— isolation protected
— equipped with surge arrestors of class II
— fully labelled and colour coded wiring
— operational ambient conditions:
  — temperature -25 to +50°C
  — relative humidity of up to 95%.

Guidance note:
The requirements for ambient conditions and over-voltage protection of the junction boxes can be adapted to the installation site during the verification of the site conditions and local requirements.

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3.3.3.6 Monitoring system

The following general requirements are to be fulfilled for the monitoring system:

— the monitoring system installed should be a Software as a Service (SaaS): the software and associated data are centrally hosted on a server which can be accessed by users using a client via a web browser
— all local monitoring system data shall be stored and made accessible via the client interface in a control centre. The collected data shall be recorded and made available throughout the operational lifetime of the PV power plant, including all historical data (up to 2 years storage)
— all databases shall be fully accessible for data integration with other third parties systems
— the monitoring system shall be connected to a server on site which shall be on a local area network. In the event of breaks in communication, data shall be stored and accessed locally until communication is restored
— during a communication failure, the monitoring system shall store all the unsent data locally and resend it when the communication line is restored. The database shall be so designed that gaps in the dataset will be detected and filled when communication is restored
— all software shall run on the most recent versions of market standard operating systems including Windows or Linux.

Data from the monitoring systems shall be capable of being communicated via DSL (Digital Subscriber Line) - or any other suitable and equivalent - telecom line provided by the local telecom provider on behalf of the owner. Where a phone line is not in existence, an alternative method of data transmission shall be employed, such as GSM/UMTS or satellite transmission.

The following data shall be recorded by the monitoring system:

— real time power for the following components:

  - PV power plant
  - inverter or power stage
  - power factor
  - active, apparent and reactive power.
- real time voltage and current for the following components:
  - inverter, DC and AC values
  - junction box
  - PV string.
- values for the following sensors:
  - irradiation, both inclined plane and horizontal plane
  - cell temperature
  - ambient temperature
  - wind speed
  - wind direction.
- energy production values of the following components:
  - PV power plant
  - inverter
  - PV string.

3.3.3.7 Power Transformers (S_r > 100 kVA)

Power transformers shall comply with the IEC 60076 series. This shall be verified through type test and routine test.

Power transformers shall be so designed and constructed that the permissible over-temperatures for the thermal class are not exceeded, irrespective of the operating time.

Transportation and storage conditions shall be considered and included in maintenance and operation manual.

The following requirements shall be fulfilled for installation:

- power transformers shall be installed in separate rooms which can be locked (interlocking with de-energization required) and which are accessible to authorized personnel only. The installation locations for power transformers shall be sufficiently cooled. The access to the transformer room shall only be possible with the power transformer disconnected and earthed on the grid side
- an exception to the above can be made for power transformers of encapsulated or insulated design (with cable connection terminals being integrated in this design)
- the fastening torque for cable connection terminals of power transformers has to be specified and shall be included in the design, erection and maintenance documentation
- transformer accessories, e.g. external protection devices and monitoring equipment mounted on the transformer, shall be made of environment-resistant materials, when exposed to e.g. sun radiation or salty air. Capabilities shall be proven by application of the IEC 60721 series.

The following requirements are to be fulfilled for protection:

- power transformers shall be protected against short-circuit and overload
- it shall be possible to switch off power transformers on all sides. Installation shall facilitate disconnection of this equipment on all sides if voltages can be applied on more than one side
- power transformers shall be fitted with temperature monitoring
- power transformers shall be protected against transient overvoltage and electrical stress on the insulation as needed.

In addition the following requirements shall be fulfilled for dry-type power transformers:

- IEC 60076-11 shall be applied for the design
- the transformer shall be able to withstand the conditions at the place of installation without accelerated ageing or weakening of the electrical insulation system (EIS) including the insulation of all transformer terminals, to prevent fire from being caused by the transformer. Such conditions are:
  - salty (and / or wet) air from outside which might come in contact with the EIS
  - pollution on the EIS from moisture, dust, coal powder and brake lining in the concentrations occurring inside the transformer enclosure.

  Withstand ability can best be achieved by using a protection degree of IP 55 for the transformer including transformer terminals and connection terminals. Transformer cooling shall be implemented accordingly, taking into account possible condensation
- the power transformer shall be self-extinguishing. The fire class shall be F1 according to IEC 60076-11, where applicable
- the enclosure of the transformer, including any internal cooling system, shall be designed with protection degree IP 55 or higher, if not:
  - regular cleaning (from salt and dirt) of the EIS surfaces is required in a way and frequency achieving sufficient surface resistance on the EIS to maintain the electrical integrity during lifetime
  - increased surface insulation level of the EIS to withstand the higher voltage of a permanently earthed insulation surface with a permanent and very low surface resistance
  - the transformer has passed the test E3 according to IEC 60076-16 with a humidity of above 95% and water conductivity in the range between 3.6 S/m to 4 S/m.
- resin-encapsulated or solid-cast design shall be used only.

In addition the following requirements shall be fulfilled for liquid-immersed power transformers:

- liquid-immersed power transformers shall be provided with a collecting pan / oil sump which permits the proper disposal of the liquid and prevents environmental pollution due to leakage
- liquid-immersed power transformers should be fitted with protection against overpressure (pressure relief device) and shall not pander outgassing
- the liquid temperature shall be monitored. An alarm shall be actuated before the maximum permissible temperature is attained. When the temperature limit is reached, the transformer shall be disconnected
- the liquid filling level shall be monitored
- Buchholz relay or adequate electronic relay is required for every non-hermetically sealed power transformer with conservator
- hermetically sealed power transformers shall be equipped with high quality tank designs and monitoring of the sealing shall prevent early aging of the transformer.
- if conservator is used a bagged conservator design is a must for transformer breathing.

3.3.3.8 High-voltage switchgear

High-voltage switchgears with rated voltages above 1 kV shall meet the requirements as set out in this section.

High-voltage switchgears shall comply with the IEC 62271 series. This shall be verified through type test records containing at least the following tests:

- dielectric tests
- short-time withstand current and peak withstand current tests
- internal fault.

The test reports will be assessed with regard to test conditions and the results of these tests will be assessed for compliance with the requirements of IEC 62271. Additionally, the IAC code as result of the internal fault test shall be stated in the test reports.

Information on the name plate shall be in accordance with the IEC 62271 series. A corresponding name plate shall be placed on each switchgear.

The following requirements shall be fulfilled for protective measures and tests:

— the risk of personal injury through electrical shock and internal arcs shall be minimized, independently of the necessary protection against foreign matter and water
— installation of the switchgear shall be in accordance with the IAC accessibility type of the switchgear used
— an exception can be made for switchgears installed in separate incombustible rooms which can be locked. Access to the room shall be granted only when the PV power plant is switched off.

National and local regulations shall be observed when undertaking the local operation, inspection or maintenance on the high-voltage switchgears. Special attention shall be paid to the work in the pressure-release area. It shall be ensured that all primary (all incoming- and outgoing feeders) and control circuits of the switchgear have been de-energized and grounded and that proper steps have been taken to ensure that they will remain de-energized until all work is completed.

The following requirements shall be fulfilled for pressure relief:

— if the gas pressure resulting from internal arcs within the switchboard is to be vented via pressure-release flaps, the installation space shall be as specified by the switchgear manufacturer and shall have an adequate volume. Suitable measures shall be taken to ensure that the overpressure occurring within the space is limited to physiologically acceptable limits. This overpressure shall be taken into account for the structural design of the installation space
— if the switchgear is so designed that the gas pressure caused by internal arcs is also, or only, released downwards, the floor shall be constructed so that it can withstand this pressure. Care shall be taken to ensure that sufficient volume of space is available below the floor for the expansion of the internal-arc gases
— combustible materials and low-voltage cables are not admissible in the endangered area
— suitable drawings of the installation place shall be included in the manuals (installation / operation / commissioning).

In addition the following requirements shall be fulfilled for SF6 switchgears:

— SF6 switchgear shall only be installed in spaces which are adequately ventilated.
— It shall be taken into account that SF6 is heavier than air and the gases escaping in the event of internal arcing have toxic and corrosive effects. For detailed information please refer to national requirements, e.g. for Germany the federal health and safety law (Arbeitsschutzrecht) and BGI 753 by BG ETEM (Berufsgenossenschaft Energie Textil Elektro Medienerzeugnisse).

High-voltage switchgear and maintenance and operating areas shall be designed according to IEC 61936-1:2010+AMD1:2014 subclause 7.5.4.

3.3.3.9 Power cables and accessories

Power cables and accessories shall be selected in accordance with the environmental conditions expected at the installation site.

In the case of power cables and accessories installed and laid outdoors UV resistance shall be ensured.

The standardized voltage of power cables and accessories shall not be below the rated operating voltage of the circuit involved. For circuits with variable voltage, the maximum voltage occurring during operation is decisive.

The manufacturers' technical documentation shall state the power cables and lines used, together with their standard designation and current-carrying capacities.

The connectors for PV systems shall comply with EN 50251. This shall be verified through corresponding tests reports.

Low-voltage installations shall comply with:

— IEC 60227 series
— IEC 60228.

High-voltage installations shall comply with:

— IEC 60502 series
— IEC 60840.

The following requirements shall be fulfilled for laying and installation of power cables and lines:

— multi-core cables or lines shall preferably be used for AC systems. If single-core cabling is provided instead, the following points shall be observed:
    — the cables shall not be armored with or sheathed in magnetic material
    — non-magnetic clamps shall be provided
    — the cables of a given circuit shall be laid contiguously and shall be arranged in the same tube or cable duct
    — single-core parallel cables shall be of the same type, length and cross-section.
— cables and lines shall be secured in such a manner that no unacceptable tensile, flexural, compressive or crushing stresses arise. Corrosion-proof or permanently corrosion-protected clips or mounts shall be used for weather-unprotected and outdoor installations
— extraordinary mechanical demands, such as increased tensile or torsional stress, operationally required mobility and increased risk of mechanical damage, shall also be taken into account
— for cables suspended freely without additional strain relief, the suitability of the type of cable used shall be verified. The possibility of ice loading shall be taken into account in this context
— if cables or lines are laid in metal tubes or ducts, these shall be earthed effectively. Warming of such cables shall be considered during design stage and selection
— the tubes shall be smooth on the inside and so protected at the ends that there is no risk of damage to the cable sheathing
— where there is a risk of mechanical damage, cables and lines shall be effectively protected by coverings or heat shrinks, protection tubes or equivalent
— strain relief devices of exposed cables shall be permanently protected against corrosion
— suspended cables shall be properly protected against damage and unacceptable constriction of the cable sheath
— the minimum specified bending radius of cables shall be observed for installation
— proof of the current-carrying capacity of power cables shall be given with consideration of the laying method and installation. IEC 60364-5-52 shall be applied while considering worst-case operating conditions, such as the minimum tolerable operating voltage and worst case power factor
— cables and lines shall be protected against short-circuit and overcurrent. If overcurrent protection is already provided in the circuit for the equipment, short-circuit protection shall be added. This shall be designed in accordance with the short-circuit loads at the point of installation
— for the rating of cables and lines, consideration shall be given to the loads expected during operation corresponding to the consumer demand, taking into account the duty of the electrical units connected
— if the connected consumers in a part of the system are not in operation simultaneously, a diversity factor may be used for determining the cross section of the group supply cable. A diversity factor is the ratio of the highest operating load expected under normal operating conditions to the sum of rated loads of all connected consumers.

In addition the following requirements shall be fulfilled for DC power cables:

— national codes and regulations applicable to the country shall be taken into account for the selection and sizing of DC cables for PV power plants. Care shall be taken to size the cable for the worse case of reverse current in an PV array
— the voltage limits of the cable to which the PV string or array cable is connected shall be taken into account

— the cable voltage drop and associated power losses shall be as low possible. Normally the voltage drop shall be less than 1.5%
— when sizing the string cables, the number of modules and the number of strings per array need to be considered. The number of modules defines the voltage at which the cable shall be rated. The number of strings is used to calculate the maximum reverse current that can flow through a string, in case of a fault when there are no string fuses.

3.3.3.10 Lightning protection

The lightning protection system shall comply with IEC 62305-3 and the German DIN EN 62305-3 Supplement 5.

3.3.4 Loads, structural and foundation design

3.3.4.1 General

The design documentation relating to structural components normally consists of descriptions, specifications, drawings and part lists together with design calculations and if applicable also test reports. DNV GL requires that the documentation clearly identifies the basis for the design, i.e. codes and standards, as well as loads and relevant external conditions.

The DNV GL evaluation consists of documentation reviews and independent analyses.

For non-standardized structural components whose design documentation includes advanced analyses, such as FEM analyses of highly utilized members, DNV GL may carry out independent analyses for verification of the design.

For structural components subject to component tests, the results of the component tests may be used as full or partial documentation of the structural capacity. In this case, the test plan is subject to approval by DNV GL.

3.3.4.2 Definition of structural design verification

The structural design verification comprises the following parts of the PV power plant:

— load carrying support structure for the solar modules
— structural verification of members and its connections
— the interface between foundation and the support structure has to be clearly defined
— the design of the foundation including the geotechnical site investigation is an optional element
— solar modules themselves are not part of the structural design evaluation.

3.3.4.3 Basic principles

The support structure shall be dimensioned in such a way that it withstands the loadings occurring during erection and the design lifetime. In general a consideration of all load cases and basic principles given in EN 1990 (Eurocode 0) and EN 1991 (Eurocode 1) is sufficient for dimensioning. However, a consideration of additional loads due to local load conditions as well as influences from local design standards and principles shall be taken into account, provided the general safety requirements will not be messed up by this. A consideration of additional actions according to local standards may also be necessary.

The design of the structure shall be in accordance with the Eurocode series with the applicable national annex and selected recognized local series of standards which may require additional design considerations. In particular the verification methods have to comply with the standards of the applied series to ensure a consistent design and the required minimum reliability level. It is not allowed to mix requirements of standards from different series unless it can be demonstrated that the mixture will not affect the reliability level in a negative way.

The design of the foundation shall be based on site specific soil properties. For obtaining the properties, a soil investigation according to an acknowledged standard (i.e. Eurocode 7) may be executed. The extend of the soil investigation heavily depends on the local site conditions, of the load level in the interface between foundation and soil and of the structural characteristics of the support structure above.

3.3.4.4 Durability and robustness

The foundation and the support structure shall be dimensioned in a way that time depending changes of

characteristics do not negatively affect their behaviour over the design lifetime. This includes also a sufficient dimensioning against cyclic (i.e. aerodynamically included) and accidental loads (e.g. earthquakes), if applicable.

Depending on the design assumptions and environmental conditions, an appropriate corrosion protection shall be considered for the support structure. If the corrosion protection is done by a coating, it shall be chosen and applied according to ISO 12944 or equivalent standards.

Furthermore, the service and maintenance intervals shall be observed to ensure a safe and reliable behavior of the support structure.

3.3.4.5 Principles of limit state design

Conditions that concern human safety or the integrity of the substructure can be considered as ultimate, serviceability or fatigue limit states. As a simplification the conditions before component failures may be treated as limit states, see ISO 2394.

In general, verifications for the following limit states have to be carried out for the foundation and support structure used in the design of PV power plants:

— failures due to excessive deformations or due to the transfer of the entire structure or of its components to a kinematic state or rupture or an unstable condition (ultimate limit state)
— limit states that impairs the function of the structure, one of its components under normal service conditions or the appearance of the structure (e.g. deflection) (serviceability limit state).

The ultimate limit state shall be verified for the governing design situations according to the applicable Eurocode series.

3.3.4.6 Structural analysis

The analysis shall be carried out with appropriate models of the structural system with respect to the relevant limit states.

It shall be verified that the ultimate and serviceability limit states are not exceeded and the appropriate design values are used for:

— the loads
— the material and geotechnical properties
— the component properties
— the geometric dimensions in the calculation models.

The verifications shall be carried out for all critical design situations and load cases. Where necessary, imperfections and load induced deformations of the structure shall be included.

The analysis shall also include the local requirements concerning the support structure below the PV power plant. (e.g. concrete foundation, roof structures, etc.).

The interaction between the soil and the foundation has to be taken into account, if applicable.

Any restrictions concerning the reliability of the support structures shall be considered during the design phase of a PV power plant.

3.3.4.7 Evaluation by tests

The design and analysis of the structure may also be carried out in combination with tests. With respect to the values of resistance the derivation of both characteristic or design values from tests is generally possible. The tests shall be carried out in a way that the required reliability level for the design situation according to the Eurocode series is met.

If the series of standards used for the verification of the structure provides rules for evaluation by tests these shall be considered.

For testing requirements see [1.6.2].

3.3.4.8 Materials

In this section requirements for structural and bolt material are specified. Other materials than that may be used if their material properties (e.g. ductility) comply with the assumptions made in the analysis.

All material used for solar module support structures shall be treated in accordance with relevant standards with regard to quality requirements and test conditions.

The following requirements shall be fulfilled for structural steels:

Only structural steel that meets the requirements regarding the ductility, fracture toughness and weldability according to the applicable codes and standards as well as the following conditions shall be used:

— only suitable materials with guaranteed properties (e.g. strength, cold deformability, suitability for welding etc.) may be used
— material tests respectively test certificates according to the relevant codes and standards shall be available as proof of guaranteed properties
— the chemical composition of the steel shall be suitable for welding according to the execution standards the design is based on.

The following requirements shall be fulfilled for structural aluminum:

— only structural aluminum that meets the requirements regarding the ductility, fracture toughness and weldability according to the applicable codes and standards shall be used
— the chemical composition of the aluminum shall be suitable for welding according to the execution standards the design is based on.

The following requirements shall be fulfilled for welding materials:

— The welding materials shall comply with the requirements stated in EN 1993 and in EN 1999. Welding materials which are not covered by the given standards may be used if material tests deliver sufficient results as regards chemical composition, strength, ductility, etc.

3.3.4.9 Solar tracking systems

Solar tracking systems shall comply with the following standards and codes:

— IEC 61000-6-1/2
— IEC 61000-6-3/4
— IEC 62817
— IEC 62727
— ISO 12100
— ISO 14121-1.

3.3.5 Operation and maintenance

DNV GL shall evaluate the inspection and maintenance plan of the PV power plant. Verification of the operation and maintenance program will be based on the design basis, applicable standards and industry best practice.

The following documentation shall be submitted for verification:

— description of risk based inspection and maintenance program, covering inspection, scheduled maintenance and unscheduled maintenance
— service and maintenance manual for key components
— performance reports of the PV power plant (preliminary examples).

The documentation will be verified regarding scope and intervals of the following:

— operational and condition monitoring
— design life-time of components, systems and structures
— service and maintenance manuals
— safety related inspection and maintenance
— scheduled maintenance
— unscheduled maintenance provisions

— record keeping and quality control.

Periodic inspections of the PV power plant shall comply with IEC 62446.

The performance monitoring shall comply with IEC 61724.

Measurements shall comply with IEC 60904 series.

3.3.6 Component and personnel safety

DNV GL shall evaluate personnel safety aspects on the basis of a risk assessment which has to be provided according to ISO/IEC 31010.

All technical measures arising from the risk assessment shall be contained in the design documentation designed to be fail-safe.

Concerning the component safety DNV GL will evaluate the documentation for the following aspects:

— system errors or failures detected by the monitoring system shall be reported unambiguously
— in case that possible temperature limits of components can be exceeded those temperatures shall be monitored and controlled according to the risk assessment. The corresponding limits (temperatures and delay times) for shut down and restart shall be stated
— the electrical cabinet(s) respectively the inverter(s) shall be mounted on non-combustible material and the instructions of the manufacturer shall be observed (cooling, ventilation, distance to other components, etc.)
— depending on risk assessment and governmental regulations measures concerning fire protection shall be applied
— the solar modules shall be protected against reverse current
— a serial fault arc shall be detected and extinguished by an appropriate protection device. The affected current circuit shall be shut down.

Concerning the personnel safety DNV GL will evaluate the documentation of the following aspects:

— depending on the risk assessment at least one emergency-off switch shall be located at a central point and quickly accessible for persons who could be endangered by the DC current of the PV power plant
— the safety instructions shall correspond with the results of the risk assessment
— climbing facilities shall be designed according to the requirements of the local regulations and protected against unauthorized use, if applicable
— access ways, passages and lighting shall fulfil the requirements of the local regulations, if applicable
— standing places and platforms shall be free of hazards (e.g. falling objects or electrical voltage)
— hazards by falling objects (e.g. solar modules) shall be avoided by measures according to the results of the risk assessment.

3.4 Phase III: grid code compliance

DNV GL shall verify the grid code compliance (GCC) by applying the technical note GL TN GCC by DNV GL and other standards and codes identified in the design basis.

GL TN GCC specifies how to prove compliance with requirements set by other documents (e. g. set by grid codes). The service specification also helps to find an approach to cover differing requirements.

Equipment used for the generation of electrical current using renewable energy sources like wind, solar radiation, bio fuels etc. have to be compliant with grid code requirements set by system operators, governments or others.
The above mentioned service specification helps proving such compliance. Such equipment can be structured in generating units and generating plants, as most of the equipment is of a distributed generation type.

Modern renewable energy generating plants are designed to support the electrical grid during normal operation as well as during electrical faults in the system. This is achieved by specific features of the generating units in order to help system operators keeping distribution and transmission systems in a safe

operational mode.

In some countries, system operators require to establish evidence that renewable energy generating units are compatible with the requirements of their grid codes in order to be connected to the grid. In most countries only generating plants can be compliant with grid codes, not generating units. This is due to the focus of system operators on power plants with aggregated power. Another reason is that the power plant structure is usually not within the responsibility of system operators but the power plant operator's responsibility. Nevertheless GL TN GCC shows a way, how types of renewable energy generating units can show grid code compliance by defining requirements which have to be implemented on renewable energy generating plant level.

During faults in the electrical system voltage drops or rises can occur at the output terminals of a renewable energy generating unit. According to the grid codes of various system operators a renewable energy generating plant shall stay operational during specific voltage drops (low voltage ride through, LVRT).

GL TN GCC describes a procedure to prove compliance with grid codes of equipment, generating units and generating plants as well as a corresponding field test of the behaviour of a renewable energy generating unit during defined voltage drops in the grid. The test shall in general be performed on a unit in operation and not at a test bench. Exceptions are acceptable if the results are technical equally representative for the fault assumption under investigation. The test plan shall be approved by DNV GL in advance. The evaluation of the resultsshall be described and the report shall be provided to DNV GL for evaluation for the project certification. A deviating procedure needs to be agreed with DNV GL before commencement of the evaluation.

Guidance note:
A project certificate (GCC) can be issued according to technical note GL TN GCC.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

Once the verification of the grid code compliance has been satisfactorily completed, DNV GL will issue a statement of compliance for Phase III: grid code compliance.

3.5 Phase IV: manufacturing

DNV GL shall conduct manufacturing surveillances in order to verify compliance between the approved design and the product. The surveillances will be conducted at the manufacturer's premises for production of main components and will involve:

— evaluation of manufacturing
— evaluation of the quality management system, if ISO 9001 certificates are not available
— product related quality audits
— surveillance of contractor's quality management activities.

The manufacturing surveillance consists of one initial audit of each main component and inspections of project related components. The surveillance activities comprise both on-site inspections and document review.

Manufacturing surveillance shall be carried out at the following main components:

— solar module(s)
— inverter
— support structure
— power transformer
— high-voltage switchgear
— inverter / transformer station
— high-voltage switchgear station.

The purpose of the initial audit is to check the qualification (ability to perform the production of relevant components according to the assumed quality and document this ability) of the manufacturing company prior to the commencement of production and to check the documentation forming the basis for production.

The customer shall assure that DNV GL gets access to the relevant manufacturing and assembly sites. Permissions required by suppliers shall be provided to DNV GL by the developer or contractor (customer).

The extent of the inspections and the number of surveillances to be carried out for project certification will be determined by DNV GL for each specific project and will depend on DNV GL's experience with the manufacturer.

For component manufacturers with higher production number (performing kind of serial production) and good track records the number of inspections may be reduced to a minimum. In other cases more detailed inspections will be performed.

The surveillances will be based on relevant standards and the design documentation previously submitted to DNV GL as input for the design verification, e.g. documentation of:

— critical items and procedures
— test programs
— inspection and test plan
— approved design drawings and specifications
— qualification of personnel.

Each surveillance shall be completed at the manufacturing premises. The following documentation shall be made available to DNV GL for the surveillance:

— workshop qualification
— general arrangement drawings and specifications
— manufacturing drawings, specifications and instructions
— inspection check sheets, test reports, and measurements reports
— certificates of personnel qualifications.

Each surveillance will be documented in a detailed surveillance report including photo documentation whenever deemed necessary. Permissions required by suppliers shall be provided to DNV GL.

Once the surveillances have been satisfactorily completed, DNV GL will issue a statement of compliance for Phase IV: manufacturing.

3.6 Phase V: transport and installation

3.6.1 General

DNV GL shall perform transportation and installation surveillance as part of the project certification process.

The transportation and installation surveillance will be followed up by a detailed surveillance report. This surveillance report will include photo documentation whenever deemed necessary. Permissions required by suppliers shall be provided to DNV GL.

Prior to the transportation of the components to the PV power plant, method statements for transportation and installation manuals including packaging, loading and unloading shall be issued for DNV GL review.

For the PV power plant and its components, DNV GL will require preparation of a transportation and installation manual, which as a minimum shall consist of the transportation and installation procedures specified by the component manufacturer(s) and/or the customer. The manual should also include contingency procedures.

DNV GL will review the transportation and installation manual for the PV power plant and its components and verify its compliance with the approved design basis. The review and verification will cover the following:

— transport procedures
— installation procedures
— procedures for safe shutdown; safe emergency shutdown
— environmental conditions concerning the limit values

— interface points, e.g. connection to foundation
— quality control, measurements and inspections
— personnel safety.

Once the transportation and installation surveillance has been satisfactorily completed, DNV GL will issue a statement of compliance for Phase V: transport and installation.

3.6.2 Transportation surveillance

Transportation testing shall be performed for the solar modules according to IEC 62759.
Corresponding test reports shall be submitted for DNV GL evaluation.

The surveillance starts from loading at the manufacturer's shop and ends at the PV power plant site.

Transportation surveillances of following components shall be performed:

— solar modules
— support structure
— inverters / inverter station.

The inspector will perform the tasks deemed necessary to verify compliance with the verification basis, verified design, drawings, specifications and procedures as far as safety is concerned. The inspector will ascertain that non-conformities and deviations from the verified design, drawings and procedures are identified, recorded and acted upon.

The extent of the inspections and the number of surveillances to be carried out for project certification will be determined by DNV GL for each specific project and will depend on the project details and complexity of the PV power plant.

3.6.3 Installation surveillance

A DNV GL inspector shall be present during the installation of the first main components.

Installation surveillances of following components shall be performed:

— power cables
— support structure
— solar modules
— monitoring system
— inverters / inverter station
— transformer / transformer station
— high voltage switchgear / HVSG station.

The inspector will perform the tasks deemed necessary to verify compliance with the verification basis, verified design, drawings, specifications and procedures as far as safety is concerned. The inspector will ascertain that non-conformities and deviations from the verified design, drawings and procedures are identified, recorded and acted upon.

The final as-built documentation shall be issued for DNV GL review in order to verify that the design is in compliance with the verified design.

The DNV GL inspector will be present during the first installation of the main components listed above. The surveillance amount depends on the project details and complexity of the PV power plant.

3.7 Phase VI: commissioning

DNV GL shall perform a commissioning surveillance as part of the project certification with the purpose to verify that the PV power plant installed on site has been commissioned according to the requirements of the manufacturer and is in compliance with relevant documentation provided in the design phase.

The following documentation shall be made available to the DNV GL inspector prior to the commencement of the surveillances:

— commissioning procedures
— commissioning checklists
— GCC certificates, if applicable.

If grid connection requirements, protection setting requirements or other conditions given by the RNO are in place this have to be checked accordingly on site. The inspector shall also check complete implementation of conditions listed in the certificate according to GL TN GCC or comparable.

The PV power plant commissioning shall be carried out in accordance with the submitted procedures reviewed and approved by DNV GL in advance of the commissioning.

During commissioning, systems and equipment shall be checked for compliance with approved documentation and commissioning procedures.

The relevant systems shall be functionally tested, as practicable as possible in accordance with approved procedures, to confirm proper, safe and functional operation of all devices, controls and equipment safe start-up.

The following procedures shall be witnessed by DNV GL or tested in presence of an attending inspector:

— starting and stopping routines
— checking of the control system settings
— function test of the protection system
— function test of the monitoring system
— coordination of software parameters of the components
— safe shutdown
— safe emergency shutdown
— running test of power production.

In general the commissioning of the PV power plant shall comply with following standards:

— for commissioning IEC 62446
— for performance monitoring IEC 61724
— for measurements IEC 60904 series
— for measurements of crystalline silicon solar panels IEC 61829
— for measurement of the lightning protection system IEC 62305-3.

The final acceptance reports from the operator after the commissioning shall be submitted to DNV GL stating correct operation and performance of the PV power plant.

The commissioning surveillance will be followed up by a detailed surveillance report. The surveillance report will include photo documentation whenever deemed necessary. Permissions required by suppliers shall be provided to DNV GL.

Once the commissioning surveillance has been satisfactorily completed, DNV GL will issue a statement of compliance for Phase VI: commissioning.

3.8 Final certification and issue of the project certificate

The final certification module summarizes the mandatory modules and will address whether the documentation is complete and in compliance with phases I to VI of the DNV GL project certification process.

The final certification report is issued when a satisfactory result of the assessment has been achieved.

The final certification report will contain a reference list of all supporting project documentation. It will contain an assessment of whether the detailed documentation is complete and will confirm that it is consistent with the certification reports and statements of compliance of each phase of the certification process.

The project certificate for the PV power plant subject to certification will be issued based on a satisfactory final certification. The project certificate will be issued in accordance with the DNV GL project certification

scheme for PV power plants, see Sec.2. The project certificate is valid for the life-time of the PV power plant and needs to be maintained. The interval of confirmation of the project certificate is set to the duration of the service agreement plus one year; however, five years is the maximum period of confirmation.

The project certificate refers to statements of compliance for the completed modules:

— design basis
— design
— grid code compliance
— manufacturing
— transport and installation
— commissioning.

3.9 Phase VII: in-service

3.9.1 General

The in-service phase implies an activity, by which the PV power plant is monitored regularly during its operational life. DNV GL shall conduct periodical in-service surveillances in order to confirm the validity of the project certificate and to verify that the required measures are observed and maintained.

Prior to DNV GL's initiation of surveillances, a maintenance, repair and inspection program shall be developed and submitted to DNV GL for approval. The program shall serve as a reference for parties involved in maintenance and repair carried out on the PV power plant. The maintenance, repair and inspection program shall be updated as required, based on findings and deviations. Any update of the program shall be subject to DNV GL approval.

In general the inspection and maintenance plan evaluated during the design phase (see [3.3.5]) shall be taken as a basis for the work to be carried out.

Once the verification of the in-service surveillance has been successfully completed, DNV GL will issue a statement of compliance for Phase VII: in-service that confirms validity of the project certificate.

3.9.2 In-service surveillance

The scope of work will include a detailed project-specific plan that identifies the DNV GL surveillance activities required, the surveillance intervals, the kind of testing and measurements and the reporting requirements. The first surveillance after commissioning of the PV power plant will usually take place after one year. Thereafter the scope will include evaluation of the status regarding any outstanding issues from the previous surveillance.

After the first surveillance the interval will be extended to the duration of the service agreement; however, five years is the maximum period of confirmation.

The DNV GL report will highlight any findings or deviations reported during the periodical in-service surveillance. Major findings and deviations will be reported to the customer in terms of recommendations.

A DNV GL surveillance shall be carried out to provide evidence as to whether the monitored installation or parts thereof continue to comply with the approved design. Prior to the surveillance the status of outstanding issues as well as information about all revisions made to the maintenance system since the last in-service surveillance shall be submitted to DNV GL.

As a part of the surveillance, records of performance checks, maintenance and repairs carried out since the previous surveillance will be reviewed and verified against the program. The company responsible for the performance monitoring, maintenance and repairs will be subject to audits in order to verify the documentation for the work carried out. The review will include:

— follow-up of outstanding issues from the previous surveillance and status regarding recommendations
— review of revised procedures
— review of maintenance documentation
— review of maintenance history in the file or any digital registration

— review of the performance of the PV power plant.

The surveillances conducted on-site may in general include:

— status on outstanding points from previous surveillances
— evaluation of the performance of the PV power plant
— verification that repair and maintenance according to the approved program and to the manufacturer's recommendations have been conducted
— general surveillance and test of selected systems and components.
— settings and parameters used by the control system
— test of the control and protection system (witness tests carried out by the operator)
— changes of connection requirements, protection setting requirements or other conditions given by the RNO according to the GCC certificate, if applicable
— additional surveillances identified based on findings and deviations, e.g. witnessing of tests and inspections in order to distinguish between random and systematic failures.

3.10 Acceptance of certificates not issued by DNV GL

The acceptance of certificates (e.g. component certificates, GCC certificates) originating from certification bodies other than DNV GL shall be agreed in advance for every project individually.

The quantity of certificates and statements to be integrated shall be limited to a feasible number to ensure the quality of the project certificate to be delivered. DNV GL shall evaluate the possibilities on project individual basis.

SECTION 4 SERVICE DESCRIPTION – POST-CONSTRUCTION POWER PLANT PROJECTS

4.1 General - objective

The objective of this section is to detail and clarify the verification activities for each of the certification phases within the DNV GL project certification scheme for PV power plant projects after construction (post-construction).

Once the verifications of the post-construction design, grid code compliance and commissioning have been successfully completed and the final certification has been performed, DNV GL will issue a project certificate for PV power plant post-construction.

4.2 Phase I: design, post-construction

4.2.1 General

DNV GL shall verify the final as-built design of the PV power plant for compliance with design criteria, standards and other requirements as described in this section. Following a successful completion of the verification of the final design, DNV GL will issue a statement of compliance for Phase I: design, post-construction.

The design evaluation will address the following topics:

— site conditions and plant layout configuration
— electrical components and systems
— loads, structural and foundation design
— operation and maintenance
— component and personnel safety.

The customer shall supply all necessary documentation of the design.

As a minimum the documentation of the PV power plant shall comply with international standard IEC 62446.

Details of the evaluation of each topic are given in the following subsections.

4.2.2 Site conditions and plant layout configuration

DNV GL shall evaluate the PV power plant layout for compliance based on applicable standards, industry best practices and specifications.

A detailed description of the review of the site conditions and plant layout configuration is given in [3.3.2].

4.2.3 Electrical components and systems

DNV GL will evaluate the design of electrical components and systems for compliance with the requirements of IEC standards and the agreed additional codes, standards and manufacturer requirements.

The design documentation related to electrical components and systems normally consists of descriptions, specifications, diagrams, schematics, drawings and part lists together with design calculations and if applicable also test reports. DNV GL requires that the documentation clearly identifies the basis for the design, i.e. codes and standards, as well as relevant external conditions.

For DNV GL evaluation of the electrical components and system design the following shall be documented by the manufacturer/designer/customer:

— major electrical components including PV generator (solar modules), junction boxes, inverters, monitoring system, high-voltage switchgear, transformer and cables
— safety relevant electrical systems and components such as low-voltage gear, control-gear, safety system (short-circuit, over voltage, over power etc.)
— protection against electrical hazards (direct and indirect contact; arcing)

— lightning protection, earthing and equipotential bonding (limitation of step and touch voltages; over voltage protection).

Specific requirements and issues that are relevant for design and testing of the major electrical components of the PV power plant are given in [3.3.3.2] to [3.3.3.10].

4.2.4 Loads, structural and foundation design

The design documentation relating to structural components normally consists of descriptions, specifications, drawings and part lists together with design calculations and if applicable also test reports. DNV GL requires that the documentation clearly identifies the basis for the design, i.e. codes and standards, as well as loads and relevant external conditions.

The DNV GL evaluation consists of documentation reviews and independent analyses.

For non-standardized structural components whose design documentation includes advanced analyses, such as FEM analyses of highly utilized members, DNV GL may carry out independent analyses for verification of the design.

For structural components subject to component tests, the results of the component tests may be used as full or partial documentation of the structural capacity. In this case, the test plan is subject to approval by DNV GL.

Specific requirements and issues that are relevant for the loads, structural and foundation design of the PV power plant are given in [3.3.4.1] to [3.3.4.8].

4.2.5 Operation and maintenance

DNV GL shall evaluate the inspection and maintenance plan of the PV power plant. Verification

of the operation and maintenance program will be based on applicable standards and industry best practice**.**

Specific requirements and issues that are relevant for the verification of operation and maintenance of the PV power plant are given in [3.3.5].

4.2.6 Component and personnel safety

Specific requirements and issues that are relevant for component and personnel safety of the PV power plant are given in [3.3.6].

4.3 Phase II: grid code compliance, post-construction

DNV GL shall verify the grid code compliance (GCC) by applying the technical note GL TN GCC by DNV GL and other standards and codes.

Detailed information for Phase II: grid code compliance, post-construction is given in [3.4].

Once the verification of the grid code compliance has been satisfactorily completed, DNV GL will issue a statement of compliance for Phase II: grid code compliance, post-construction.

4.4 Phase III: commissioning, post-construction

DNV GL shall perform a commissioning surveillance as part of the project certification with the purpose to verify that the PV power plant installed on site has been commissioned according to the requirements of the manufacturer and is in compliance with relevant documentation provided in the design phase.

The following documentation shall be made available to the DNV GL inspector prior to the commencement of the surveillances:

— commissioning procedures
— commissioning checklists
— GCC certificates, if applicable.

If grid connection requirements, protection setting requirements or other conditions given by the RNO are in place this have to be checked accordingly on site. The inspector shall also check complete implementation

of conditions listed in the certificate according to GL TN GCC or comparable. If these requirements have changed since the first issuing of the GCC certificate this have to be taken into account. Also changes made in the settings compared to the last inspection shall be checked.

The PV power plant commissioning shall be carried out in accordance with the submitted procedures reviewed and approved by DNV GL in advance of the commissioning.

During commissioning, systems and equipment shall be checked for compliance with approved documentation and commissioning procedures.

The relevant systems shall be functionally tested, as practicable as possible in accordance with approved procedures, to confirm proper, safe and functional operation of all devices, controls and equipment safe start-up.

The following procedures shall be witnessed by DNV GL or tested in presence of an attending inspector:

— starting and stopping routines
— checking of the control system settings
— function test of the protection system
— function test of the monitoring system
— coordination of software parameters of the components
— safe shutdown
— safe emergency shutdown
— running test of power production.

In general the commissioning of the PV power plant shall comply with following standards:

— for commissioning IEC 62446
— for performance monitoring IEC 61724
— for measurements IEC 60904 series
— for measurements of crystalline silicon solar panels IEC 61829
— for measurement of the lightning protection system IEC 62305-3.

The final acceptance reports from the operator after the commissioning shall be submitted to DNV GL stating correct operation and performance of the PV power plant.

The commissioning surveillance will be followed up by a detailed surveillance report. The surveillance report will include photo documentation whenever deemed necessary. Permissions required by suppliers shall be provided to DNV GL.

Once the commissioning surveillance has been satisfactorily completed, DNV GL will issue a statement of compliance for Phase III: commissioning, post-construction.

4.5 Final certification and issue of project certificate

The final certification module summarizes the mandatory modules and will address whether the documentation is complete and in compliance with phases I to III of the DNV GL project certification process.

The final certification report is issued when a satisfactory result of the assessment has been achieved.

The final certification report will contain a reference list of all supporting project documentation. It will contain an assessment of whether the detailed documentation is complete and will confirm that it is consistent with the certification reports and statements of compliance of each phase of the certification process.

The project certificate for the PV power plant subject to certification will be issued based on a satisfactory final certification. The project certificate will be issued in accordance with the DNV GL project certification scheme for PV power plants, see Sec.2. The project certificate is valid for the life-time of the PV power plant and needs to be maintained. The interval of confirmation of the project certificate is set to the duration of the service agreement plus one year; however, five years is the maximum period of confirmation.

The project certificate refers to statements of compliance for the completed modules:

— design
— grid code compliance
— commissioning.

4.6 Phase IV: in-service, post-construction

4.6.1 General

The in-service phase implies an activity, by which the PV power plant is monitored regularly during its operational life. DNV GL shall conduct periodical in-service surveillances in order to confirm the validity of the project certificate and to verify that the required measures are observed and maintained.

Prior to DNV GL's initiation of surveillances, a maintenance, repair and inspection program shall be developed and submitted to DNV GL for approval. The program shall serve as a reference for parties involved in maintenance and repair carried out on the PV power plant. The maintenance, repair and inspection program shall be updated as required, based on findings and deviations. Any update of the program shall be subject to DNV GL approval.

In general the inspection and maintenance plan evaluated during the design phase (see [4.2.5]) shall be taken as a basis for the work to be carried out.

Once the verification of the in-service surveillance has been successfully completed, DNV GL will issue a statement of compliance for Phase IV: in-service, post-construction that confirms validity of the project certificate.

4.6.2 In-service surveillance

Detailed information for the scope of work for the in-service surveillance is given in [3.9.2].

4.7 Acceptance of certificates not issued by DNV GL

The acceptance of certificates (e.g. component certificates, GCC certificates) originating from certification bodies other than DNV GL shall be agreed in advance for every project individually.

The quantity of certificates and statements to be integrated shall be limited to a feasible number to ensure the quality of the project certificate to be delivered. DNV GL shall evaluate the possibilities on project individual basis.

DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16 000 professionals are dedicated to helping our customers make the world safer, smarter and greener.