Appendix 1 – documentation

Technical regulation 3.2.3 for thermal plants above 11 kW

|  |  |  |  |  |  |  |  |  |  |
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# Revision view

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| --- | --- | --- | --- |
| **Section no.** | **Text** | **Revision** | **Date** |
| All | Appendix 1 Documentation moved to separate document | 1 | 10.01.2017 |
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1. Documentation

Appendix 1 specifies the documentation requirements for the four *plant categories*, see section 1.2.5.

The documentation, as specified in section 8, must be sent electronically to the *electricity supply undertaking*.

The technical documentation must contain the configuration parameters and configuration data applicable to the *plant* at the time of commissioning.

All subsections in the appendix must be filled in for the *plant* in question.

If information changes after the time of commissioning, updated documentation must be submitted as required in section 2.2.

Templates for the various *plant categories* are available on the website [www.energinet.dk](http://www.energinet.dk/).

* 1. Appendix 1 for plant category A2

Please fill in the documentation form with data for the *plant*, valid at the time of commissioning, and submit it to the *electricity supply undertaking.*

* + 1. Identification

|  |  |
| --- | --- |
| *Plant* name: |  |
| *Plant owner's* name and address: |  |
| *Plant owner's* tel. no.: |  |
| *Plant owner's* email address: |  |
| Date of commissioning: |  |
| GSRN number (all numbers must  be provided for the *plant*): |  |
| Name of *electricity supply undertaking*: |  |
| Name of nearest 30-60 kV substation: |  |
| Name of nearest 132-150 kV substation: |  |
| Name and location of the *Point of Connection* (*POC*): |  |
| Voltage at the *POC* (rated): | \_\_\_\_\_ kV |
| Name and location of *Point of Common Coupling* (*PCC*): |  |
| Voltage at the *PCC* (rated): | \_\_\_\_\_ kV |
| Are there other connection points to the *public electricity supply grid*?  Description of other connection points: | Yes  No |

* + 1. Description of the plant

|  |  |
| --- | --- |
| Type  \*Describe the type: | Steam turbine  Gas turbine  Combined-cycle unit  Gas engine  Diesel engine  Other\* |
| Specification of fuel: |  |
| *Rated output (Pn)* | \_\_\_\_\_ kW |
| *Minimum power* (*Pmin*) | \_\_\_\_\_ kW |
| Overload capacity (Poverload) | \_\_\_\_\_ kW |
| Rated mechanical shaft power for drive system (*Pmech*) | \_\_\_\_\_ kW |
| Is a flowchart for the *plant* available?  Reference to document: | Yes  No |
| Is a line diagram available showing settlement metering, online metering, ownership boundaries and operation manager boundaries?  Reference to document: | Yes  No |

* + 1. Determination of voltage level

|  |  |
| --- | --- |
| What is the *normal operating voltage* (*Uc*) at the *POC*? | \_\_\_\_\_ kV |

* + 1. Normal operating conditions

|  |  |
| --- | --- |
| Within the *normal production* area*,* see Figure 4, can the *plant* be started and generate continuously? | Yes  No |
| Will the *plant* remain connected in the event of frequency and voltage deviations at the *POC,* in line with Figure 4?  Reference to type test/study or protection philosophy that verifies the above: | Yes  No |

* + 1. Abnormal operating conditions

|  |  |
| --- | --- |
| Will the *plant* remain connected in the event of phase jumps of 20° at the *POC*?  Reference to type test/study that verifies the above: | Yes  No |
| Will the *plant* remain connected in the event of transient frequency gradients of 2.5 Hz/s at the *POC*?  Reference to type test/study or protection philosophy that verifies the above: | Yes  No |

* + 1. Power quality

|  |  |
| --- | --- |
| When the *plant* is connected, do *rapid voltage changes* greater than the permissible levels (see Table 3) occur?  Reference to calculation/study that verifies the above: | Yes  No |

* + 1. Control functions

|  |  |
| --- | --- |
| Which of the following control functions are active in the *plant*? | *Frequency response* – LFSM-O  *Q control*  *PF control* |

* + 1. Frequency response (LFSM-U and LFSM-O)

|  |  |
| --- | --- |
| Is the *plant* designed with a *frequency response* system that can control active power as a function of frequency deviations from the reference frequency?  Reference to type test/data sheet that verifies the above: | Yes  No |
| In the event of a frequency deviation, is the *frequency response* activated within 2 seconds? | Yes  No |
| Is it possible to adjust the *frequency response droop* to a value in the 2-8% range of Pn? | Yes  No |
| Is the *droop* set to 6%? | Yes  No |
| Is it possible to set the *frequency response* limit frequency (fmin andfmax) to a value in the 47-52 Hz range? | Yes  No |
| Is it possible to set the *frequency response* activation frequency (fRmax) to a value in the 50.1-52 Hz range? | Yes  No |
| Is fRmax set to 50.2 Hz?  If 'no', what is the setting? | Yes  No |
| Is frequency measurement accuracy higher than 10 mHz and  the control function sensitivity higher than +/-10 mHz? | Yes  No |

* + 1. Frequency control

|  |  |
| --- | --- |
| Does the *plant* have to provide ancillary services?  If 'yes', which? | Yes  No  FCR – power frequency control  FCR – FNR  FCR – FDR  FRR-a  FRR-m |
| Is the *plant's* turbine governor set with the specific parameter settings for the ancillary service(s) to be delivered, in line with the specifications for ancillary services? | Yes  No |

* + 1. Reactive power control functions

|  |  |
| --- | --- |
| Where is the reference point for the reactive power control functions located?  \*Describe where: | *PGC*  *POC*  *PCC*  Elsewhere\* |

* + 1. Requirements for reactive power control area

|  |  |
| --- | --- |
| Can the generator *plant* supply reactive power at Pn and varying operating voltages, as specified in Figure 14?  Reference to study/type test that verifies the above: | Yes  No |
| Is the generator's PQ diagram available?  Reference to data sheet: | Yes  No |

* + 1. Generator

|  |  |
| --- | --- |
| Manufacturer: |  |
| Type: |  |
| Is there a data sheet for the generator?  Reference to data sheet: | Yes  No |
| Does the generator comply with relevant parts of the following European Standards:   * DS/EN60034-1, 'Rotating electrical machines – Part 1: Rating and performance', 2004 * DS/EN60034-3, 'Rotating electrical machines – Part 3: Specific requirements for turbine-type synchronous machines', 1995 | Yes  No |
| Does the generator have a *short-circuit ratio* of 0.45 or higher? | Yes  No |
| Does the generator have a transient reactance (X'd) of less than 0.35 pu? | Yes  No |

* + 1. Generator data

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **Symbol** | **Unit** | **Value** |
| *Rated apparent power*  (1 p.u.): | Sn | MVA |  |
| *Rated voltage* (1 p.u.): | Un | kV |  |
| Rated frequency: | fn | Hz |  |
| Rated *Power Factor* (cosφ): | cosφn | - |  |
| Rated minimum reactive power generation from PQ diagram: | Qmin,n | Mvar |  |
| Rated maximum reactive power generation from PQ diagram: | Qmax,n | Mvar |  |
| Synchronous speed: | nn | Rpm |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Total moment of inertia for rotating mass (generator, drive system, etc.): | Jtot | kg⋅m2 |  |
| Total moment of inertia for generator: | JG | kg⋅m2 |  |
| Total moment of inertia for drive system: | JD | kg⋅m2 |  |
| Rotor type: | - | - | Salient poles  Distinct poles |
| Stator resistance per phase: | Ra | p.u. |  |
| Temperature for resistance: | TR | ºC |  |
| Stator dispersion reactance per phase: | Xad | p.u. |  |
| Positive-sequence reactance, d axis: | Xd | p.u. |  |
| Transient reactance, d axis: | X’d | p.u. |  |
| Subtransient reactance, d axis: | X’’d | p.u. |  |
| Saturated positive-sequence reactance, d axis: | Xd,sat | p.u. |  |
| Saturated subtransient positive-sequence reactance, d axis: | X”d,sat | p.u. |  |
| Positive-sequence reactance, q axis: | Xq | p.u. |  |
| Transient reactance, q axis: | X’q | p.u. |  |
| Subtransient reactance, q axis: | X’’q | p.u. |  |
| Transient open circuit time constant, d axis: | T’d0 | s |  |
| Subtransient open circuit time constant, d axis: | T’d0 | s |  |
| Transient open circuit time constant, q axis: | T’q0 | s |  |
| Subtransient open circuit time constant, q axis: | T’’q0 | s |  |
| Potier reactance: | Xp | p.u. |  |
| Saturation point at 1.0 p.u. voltage: | SG1.0 | p.u. |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Saturation point at 1.2 p.u. voltage: | SG1.2 | p.u. |  |
| Reactance, inverse-component: | X2 | p.u. |  |
| Resistance, inverse-component: | R2 | p.u. |  |
| Reactance, zero-component: | X0 | p.u. |  |
| Resistance, zero-component: | R0 | p.u. |  |
| Is the generator star point earthed? | - | - | Yes  No |
| If yes, ground reactance: | Xe | Ohm |  |
| If yes, ground resistance: | Re | Ohm |  |
| Generator's *short-circuit ratio*  (Rated): | Kc | p.u. |  |

* + 1. Excitation system

|  |  |
| --- | --- |
| What type of *excitation system* is used?  \*Describe the type: | Rotating  Static  Other\* |
| Is there a data sheet for the AVR?  Reference to data sheet: | Yes  No |

* + 1. Protection

|  |  |
| --- | --- |
| Is a positive-sequence under-voltage relay used as protection against out-of-phase reclosing?  If 'yes', reference to study justifying use of the relay: | Yes  No |

* + 1. Protective functions and settings

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Protective function** | **Symbol** | **Setting** | | **Trip time** | | **Standard setting** |
| Positive-sequence undervoltage\* |  | 0.7 ∙ Un | V | ≤ 50 | ms | 50 ms |
| Overvoltage (step 2) | U>> | 1.10 ⋅ Un | V | < 50 ms | ms | < 50 ms |
| Overvoltage (step 1) | U> | 1.06 ⋅ Un | V | 30-60 | s | 60 s |
| Undervoltage (step 1) | U< | 0.90 ⋅ Un | V | 2…10 | s | 10 s |
| Overfrequency | f> | 52 | Hz | 300 | ms | 300 ms |
| Underfrequency | f< | 47 | Hz | 300 | ms | 300 ms |
| Change of frequency | *df/dt* | ±2.5 | Hz/s | 80-100 | ms | 80 ms |
| Overcurrent\* | I> |  | A | 50 | ms | 50 ms |
| Overcurrent – positive-sequence undervoltage relay is not used | I> | \*\* | A |  | ms |  |

* + 1. Measurement requirements

|  |  |
| --- | --- |
| Has settlement metering been implemented in line with market regulation D1 and D2? | Yes  No |
| Have online measurements and signals been implemented in line with ancillary services to be supplied in Denmark – specifications? (only relevant if the *plant* will provide ancillary services)  Reference to signal list that verifies the above: | Yes  No |

* + 1. Scope of signals

|  |  |
| --- | --- |
| **Signal #** | **Signal description** |
| **Set point** | Stop signal |
| **Set point** | 'Released for start' |

* + 1. Signature

|  |  |
| --- | --- |
| Date of commissioning |  |
| Company |  |
| Person responsible for commissioning |  |
| Signature |  |

* 1. Appendix 1 for plant category B

Please fill in the documentation form with data for the *plant*, valid at the time of commissioning, and submit it to the *electricity supply undertaking.*

* + 1. Identification

|  |  |
| --- | --- |
| *Plant* name: |  |
| *Plant owner's* name and address: |  |
| *Plant owner's* tel. no.: |  |
| *Plant owner's* email address: |  |
| Date of commissioning: |  |
| GSRN number (all numbers must be provided for *plant*): |  |
| Name of *electricity supply undertaking*: |  |
| Name of nearest 30-60 kV substation: |  |
| Name of nearest 132-150 kV substation: |  |
| Name and location of the *Point of Connection* (*POC*): |  |
| Voltage at the *POC* (rated): | \_\_\_\_\_ kV |
| Name and location of *Point of Common Coupling* (*PCC*): |  |
| Voltage at the *PCC* (rated): | \_\_\_\_\_ kV |
| Are there other connection points to the *public electricity supply grid*?  Description of other connection points: | Yes  No |

* + 1. Description of the plant

|  |  |
| --- | --- |
| Type  \*Describe the type: | Steam turbine  Gas turbine  Combined-cycle unit  Gas engine  Diesel engine  Other\* |
| Specification of fuel: |  |
| *Rated output (Pn)* | \_\_\_\_\_ kW |
| *Minimum power* (*Pmin*) | \_\_\_\_\_ kW |
| *Overload capacity* (*Poverload*) | \_\_\_\_\_ kW |
| Rated mechanical shaft power for drive system (*Pmech*) | \_\_\_\_\_ kW |
| Is a flowchart for the *plant* available?  Reference to document: | Yes  No |
| Is a line diagram available showing settlement metering, online metering, ownership boundaries and operation manager boundaries?  Reference to document: | Yes  No |

* + 1. Determination of voltage level

|  |  |
| --- | --- |
| What is the *normal operating voltage* (*Uc*) at the *POC*? | \_\_\_\_\_ kV |

* + 1. Normal operating conditions

|  |  |
| --- | --- |
| Within the *normal production* area*,* see Figure 4, can the *plant* be started and generate continuously? | Yes  No |
| Will the *plant* remain connected in the event of frequency and voltage deviations at the *POC,* in line with Figure 4?  Reference to type test/study or protection philosophy that verifies the above: | Yes  No |

* + 1. Abnormal operating conditions

|  |  |
| --- | --- |
| Will the *plant* remain connected in the event of phase jumps of 20° at the *POC*?  Reference to type test/study that verifies the above: | Yes  No |
| Will the *plant* remain connected in the event of transient frequency gradients of 2.5 Hz/s at the *POC*?  Reference to type test/study or protection philosophy that verifies the above: | Yes  No |

* + 1. Voltage dip tolerances

(Apply only to category B plants above 200 kW)

|  |  |
| --- | --- |
| Will the *plant* remain connected in the event of voltage dips at the *POC*, see Figure 5 and Figure 6?  Reference to type test/study or manufacturer declaration that verifies the above: | Yes  No |

* + 1. Power quality

|  |  |
| --- | --- |
| When the plant is connected, do *rapid voltage changes* greater than the permissible levels (see Table 3) occur?  Reference to calculation/study that verifies the above: | Yes  No |

* + 1. Control functions

|  |  |
| --- | --- |
| Which of the following control functions are active in the *plant*? | *Frequency response* – LFSM-O  *Q control*  *PF control* |

* + 1. Frequency response (LFSM-U and LFSM-O)

|  |  |
| --- | --- |
| Is the *plant* designed with a *frequency response* system that can control active power as a function of frequency deviations from the reference frequency?  Reference to type test/data sheet that verifies the above: | Yes  No |
| In the event of a frequency deviation, is the *frequency response* activated within 2 seconds? | Yes  No |
| Is it possible to adjust the *frequency response droop* to a value in the 2-8% range of Pn? | Yes  No |
| Is the *droop* set to 6%? | Yes  No |
| Is it possible to set the *frequency response* limit frequency (fmin andfmax) to a value in the 47-52 Hz range? | Yes  No |
| Is it possible to set the *frequency response* activation frequency (fRmax) to a value in the 50.1-52 Hz range? | Yes  No |
| Is fRmax set to 50.2 Hz?  If 'no', what is the setting? | Yes  No |
| Is frequency measurement accuracy higher than 10 mHz and  the control function sensitivity higher than +/-10 mHz? | Yes  No |

* + 1. Frequency control

|  |  |
| --- | --- |
| Does the *plant* have to provide ancillary services?  If 'yes', which? | Yes  No  FCR – power frequency control  FCR – FNR  FCR – FDR  FRR-a  FRR-m |
| Is the *plant's* turbine governor set with the specific parameter settings for the ancillary service(s) to be delivered, in line with the specifications for ancillary services? | Yes  No |
| Is it possible to change the parameter settings within 10 seconds? | Yes  No |

* + 1. Reactive power control functions

|  |  |
| --- | --- |
| Where is the reference point for the reactive power control functions located?  \*Describe where: | *PGC*  *POC*  *PCC*  Elsewhere\* |

* + 1. Requirements for reactive power control area

|  |  |
| --- | --- |
| Can the generator *plant* supply reactive power at Pn and varying operating voltages, as specified in Figure 14?  Reference to study/type test that verifies the above: | Yes  No |
| Is the generator's PQ diagram available?  Reference to data sheet: | Yes  No |

* + 1. Generator

|  |  |
| --- | --- |
| Manufacturer: |  |
| Type: |  |
| Is there a data sheet for the generator?  Reference to data sheet: | Yes  No |
| Does the generator comply with relevant parts of the following European Standards:   * DS/EN60034-1, 'Rotating electrical machines – Part 1: Rating and performance', 2004 * DS/EN60034-3, 'Rotating electrical machines – Part 3: Specific requirements for turbine-type synchronous machines', 1995 | Yes  No |
| Does the generator have a *short-circuit ratio* of 0.45 or higher? | Yes  No |
| Does the generator have a transient reactance (X'd) of less than 0.35 pu? | Yes  No |

* + 1. Generator data

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **Symbol** | **Unit** | **Value** |
| *Rated apparent power*  (1 p.u.): | Sn | MVA |  |
| *Rated voltage* (1 p.u.): | Un | kV |  |
| Rated frequency: | fn | Hz |  |
| Rated *Power Factor* (cosφ): | cosφn | - |  |
| Rated minimum reactive power generation from PQ diagram: | Qmin,n | Mvar |  |
| Rated maximum reactive power generation from PQ diagram: | Qmax,n | Mvar |  |
| Synchronous speed: | nn | Rpm |  |
| Total moment of inertia for rotating mass (generator, drive system, etc.): | Jtot | kg⋅m2 |  |
| Total moment of inertia for generator: | JG | kg⋅m2 |  |
| Total moment of inertia for drive system: | JD | kg⋅m2 |  |
| Rotor type: | - | - | Salient poles  Distinct poles |
| Stator resistance per phase: | Ra | p.u. |  |
| Temperature for resistance: | TR | ºC |  |
| Stator dispersion reactance per phase: | Xad | p.u. |  |
| Positive-sequence reactance, d axis: | Xd | p.u. |  |
| Transient reactance, d axis: | X’d | p.u. |  |
| Subtransient reactance, d axis: | X’’d | p.u. |  |
| Saturated positive-sequence reactance, d axis: | Xd,sat | p.u. |  |
| Saturated subtransient positive-sequence reactance, d axis: | X”d,sat | p.u. |  |
| Positive-sequence reactance, q axis: | Xq | p.u. |  |
| Transient reactance, q axis: | X’q | p.u. |  |
| Subtransient reactance, q axis: | X’’q | p.u. |  |
| Transient open circuit time constant, d axis: | T’d0 | s |  |
| Subtransient open circuit time constant, d axis: | T’d0 | s |  |
| Transient open circuit time constant, q axis: | T’q0 | s |  |
| Subtransient open circuit time constant, q axis: | T’’q0 | s |  |
| Potier reactance: | Xp | p.u. |  |
| Saturation point at 1.0 p.u. voltage: | SG1.0 | p.u. |  |
| Saturation point at 1.2 p.u. voltage: | SG1.2 | p.u. |  |
| Reactance, inverse-component: | X2 | p.u. |  |
| Resistance, inverse-component: | R2 | p.u. |  |
| Reactance, zero-component: | X0 | p.u. |  |
| Resistance, zero-component: | R0 | p.u. |  |
| Is the generator star point earthed? | - | - | Yes  No |
| If yes, ground reactance: | Xe | Ohm |  |
| If yes, ground resistance: | Re | Ohm |  |
| Generator's *short-circuit ratio*  (Rated): | Kc | p.u. |  |

* + 1. Excitation system

|  |  |
| --- | --- |
| What type of *excitation system* is used?  \*Describe the type: | Rotating  Static  Other\* |
| Is there a data sheet for the AVR?  Reference to data sheet: | Yes  No |

* + 1. Protection

|  |  |
| --- | --- |
| Is a positive-sequence undervoltage relay used as protection against out-of-phase reclosing?  If 'yes', reference to study justifying use of the relay: | Yes  No |

* + 1. Protective functions and settings

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Protective function** | **Symbol** | **Setting** | | **Trip time** | | **Standard setting** |
| Positive-sequence undervoltage\* |  | 0.7 ∙ Un | V | ≤ 50 | ms | 50 ms |
| Overvoltage (step 2) | U>> | 1.10 ⋅ Un | V | < 50 ms | ms | < 50 ms |
| Overvoltage (step 1) | U> | 1.06 ⋅ Un | V | 30-60 | s | 60 s |
| Undervoltage (step 1) | U< | 0.90 ⋅ Un | V | 2…10 | s | 10 s |
| Overfrequency | f> | 52 | Hz | 300 | ms | 300 ms |
| Underfrequency | f< | 47 | Hz | 300 | ms | 300 ms |
| Change of frequency | *df/dt* | ±2.5 | Hz/s | 80-100 | ms | 80 ms |
| Overcurrent\* | I> |  | A | 50 | ms | 50 ms |
| Overcurrent – positive-sequence undervoltage relay is not used | I> | \*\* | A |  | ms |  |

* + 1. Measurement requirements

|  |  |
| --- | --- |
| Has settlement metering been implemented in line with market regulation D1 and D2? | Yes  No |
| Have online measurements and signals been implemented in line with ancillary services to be supplied in Denmark – specifications? (only relevant if the *plant* will provide ancillary services)  Reference to signal list that verifies the above: | Yes  No |

* + 1. Scope of signals

|  |  |
| --- | --- |
| **Signal #** | **Signal description** |
| **Set point** | Stop signal |
| **Set point** | Released for start |

* + 1. Signature

|  |  |
| --- | --- |
| Date of commissioning |  |
| Company |  |
| Person responsible for commissioning |  |
| Signature |  |

* 1. Appendix 1 for plant category C

The documentation must be filled in with preliminary data for the *plant* and sent to the *electricity supply undertaking* no later than:

* twelve months **before** the date ofcommissioning for rated output ≥ 10 MW
* three months **before** the date ofcommissioning for rated output < 10 MW

No later than three months **after** the date of commissioning, documentation must be provided in the form of specific data for the entire *plant,* which must be sent to the *electricity supply undertaking*.

Required documentation comprises the following:

* + 1. Identification

|  |  |
| --- | --- |
| *Plant* name: |  |
| *Plant owner's* name and address: |  |
| *Plant owner's* tel. no.: |  |
| *Plant owner's* email address: |  |
| Date of commissioning: |  |
| GSRN number (all numbers must be provided for *plant*): |  |
| Name of *electricity supply undertaking*: |  |
| Name of nearest 30-60 kV substation: |  |
| Name of nearest 132-150 kV substation: |  |
| Name and location of the *Point of Connection* (*POC*): |  |
| Voltage at the *POC* (rated): | \_\_\_\_\_ kV |
| Name and location of *Point of Common Coupling* (*PCC*): |  |
| Voltage at the *PCC* (rated): | \_\_\_\_\_ kV |
| Are there other connection points to the *public electricity supply grid*?  Description of other connection points: | Yes  No |

* + 1. Description of the plant

|  |  |
| --- | --- |
| Type  \*Describe the type: | Steam turbine  Gas turbine  Combined-cycle unit  Gas engine  Diesel engine  Other\* |
| Specification of fuel: |  |
| *Rated output (Pn)* | \_\_\_\_\_ MW |
| *Minimum power* (*Pmin*) | \_\_\_\_\_ MW |
| *Overload capacity* (*Poverload*) | \_\_\_\_\_ MW |
| Rated mechanical shaft power for drive system (*Pmech*) | \_\_\_\_\_ MW |
| Is a flowchart for the *plant* available?  Reference to document: | Yes  No |
| Is a line diagram available showing settlement metering, online metering, ownership boundaries and operation manager boundaries?  Reference to document: | Yes  No |

* + 1. Determination of voltage level

|  |  |
| --- | --- |
| What is the *normal operating voltage* (*Uc*) at the *POC*? | \_\_\_\_\_ kV |

* + 1. Normal operating conditions

|  |  |
| --- | --- |
| Within the *normal production* area*,* see Figure 4, can the *plant* be started and generate continuously? | Yes  No |
| Will the *plant* remain connected in the event of frequency and voltage deviations at the *POC,* in line with Figure 4?  Reference to type test/study/protection philosophy that verifies the above: | Yes  No |

* + 1. Abnormal operating conditions

|  |  |
| --- | --- |
| Will the *plant* remain connected in the event of phase jumps of 20° at the *POC*?  Reference to type test/study that verifies the above: | Yes  No |
| Will the *plant* remain connected in the event of transient frequency gradients of 2.5 Hz/s at the *POC*?  Reference to type test/study or protection philosophy that verifies the above: | Yes  No |

* + 1. Voltage dip tolerances

|  |  |
| --- | --- |
| Will the *generator plant* remain connected in the event of voltage dips at the *POC,* seeFigure 5 and Figure 6?  Reference to type test/study or manufacturer declaration that verifies the above: | Yes  No |
| Do auxiliary supply and auxiliary facilities remain connected in the event of voltage dips at the *POC,* see Figure 5 and Figure 6?  Reference to type test/study/design philosophy or manufacturer declaration that verifies the above: | Yes  No |

* + 1. Voltage support during voltage dips

|  |  |
| --- | --- |
| Does the *plant* provide voltage support during voltage dips?  Reference to type test/study/data sheet or manufacturer declaration that verifies the above: | Yes  No |

* + 1. Recurring voltage dips in the public electricity supply grid

|  |  |
| --- | --- |
| Does the *generator plant* remain connected in the event of repeated voltage dips at the *POC*, see Table 2?  Reference to type test/study or manufacturer declaration that verifies the above: | Yes  No |

* + 1. Power quality

|  |  |
| --- | --- |
| When the plant is connected, do *rapid voltage changes* greater than the permissible levels (see Table 3) occur?  Reference to calculation/study that verifies the above: | Yes  No |

* + 1. Control functions

|  |  |
| --- | --- |
| Which of the following control functions are active in the *plant*? | *Frequency response* – LFSM-O  *Frequency response* – LFSM-U  *Q control*  *PF control*  Voltage control |
| Are all set point changes recorded with a 5-minute time stamp (*UTC*)? | Yes  No |

* + 1. Active power control functions

|  |  |
| --- | --- |
| Can a set point be set with a resolution of 1% of Pn or higher? | Yes  No |
| Can parameters in control functions be set with a resolution of 10 mHz or higher? | Yes  No |
| Can control function *droops* be set with a resolution of 1% or higher? | Yes  No |
| Do set points and effected control values deviate by more than 2% of Pn over a period of 1 minute? | Yes  No |

* + 1. Frequency response (LFSM-U and LFSM-O)

|  |  |
| --- | --- |
| Is the *plant* designed with a *frequency response* system that can control active power as a function of frequency deviations from the reference frequency?  Reference to type test/data sheet that verifies the above: | Yes  No |
| In the event of a frequency deviation, is the *frequency response* activated within 2 seconds? | Yes  No |
| Is it possible to adjust the *frequency response droop* to a value in the 2-8% range of Pn? | Yes  No |
| Is the *droop* set to 6%? | Yes  No |
| Is it possible to set the *frequency response* limit frequency (fmin andfmax) to a value in the 47-52 Hz range? | Yes  No |
| Is it possible to set the *frequency response* activation frequency (fRmax and fRmin) to a value in the 50.1-52 Hz range for fRmax and 47-49.9 Hz range for fRmin? | Yes  No |
| Is fRmax set to 50.2 Hz and fRmin to 49.8 Hz?  If 'no', what are the settings? | Yes  No |
| Is frequency measurement accuracy higher than 10 mHz and  the control function sensitivity higher than +/-10 mHz? | Yes  No |

* + 1. Frequency control

|  |  |
| --- | --- |
| Does the *plant* have to provide ancillary services?  If 'yes', which? | Yes  No  FCR – power frequency control  FCR – FNR  FCR – FDR  FRR-a  FRR-m |
| Is the *plant's* turbine governor set with the specific parameter settings for the ancillary service(s) to be delivered, in line with the specifications for ancillary services? | Yes  No |
| Is it possible to change the parameter settings within 10 seconds? | Yes  No |

* + 1. Reactive power control functions

|  |  |
| --- | --- |
| Where is the reference point for the reactive power control functions located?  \*Describe where: | *PGC*  *POC*  *PCC*  Elsewhere\* |

* + 1. Q control

|  |  |
| --- | --- |
| Does the *plant* begin adjustment to a new set point after 2 seconds and complete the adjustment within 30 seconds after receiving a new set point? | Yes  No |
| Do set points and effected control values deviate by more than 1% of QN over a period of 1 minute? | Yes  No |
| Is it possible to set a set point with a resolution of 100 kVAr or higher? | Yes  No |

* + 1. Power Factor control

|  |  |
| --- | --- |
| Does the *plant* begin adjustment to a new set point after 2 seconds and complete the adjustment within 30 seconds after receiving a new set point? | Yes  No |
| Do set points and effected control values deviate by more than 1% of the set point for *Power Factor* over a period of 1 minute? | Yes  No |
| Is it possible to set a set point with a resolution of 0.01 or higher? | Yes  No |

* + 1. Voltage control

|  |  |
| --- | --- |
| Does the *plant* begin adjustment to a new set point after 2 seconds and complete the adjustment within 10 seconds after receiving a new set point? | Yes  No |
| Can the *droop* for the voltage controller be set in the 2-8% range? | Yes  No |
| Is the *droop* for the voltage controller set to 4%? | Yes  No |

* + 1. Reactive power control requirements

|  |  |
| --- | --- |
| Can the *plant* supply reactive power at Pn and varying operating voltages, as specified in Figure 15?  Reference to study/type test that verifies the above: | Yes  No |
| Is the generator's PQ diagram available?  Reference to data sheet: | Yes  No |

* + 1. System protection

|  |  |
| --- | --- |
| Can the generator *plant* adjust active power down to five predefined power levels (70%, 50%, 40%, 25% and 0%)?  Reference to live test that verifies the above: | Yes  No |
| When system protection is activated, does adjustment begin after 1 second and is it completed after 10 seconds? | Yes  No |

* + 1. Generator

|  |  |
| --- | --- |
| Manufacturer: |  |
| Type: |  |
| Is there a data sheet for the generator?  Reference to data sheet: | Yes  No |
| Does the generator comply with relevant parts of the following European Standards:   * DS/EN60034-1, 'Rotating electrical machines – Part 1: Rating and performance', 2004 * DS/EN60034-3, 'Rotating electrical machines – Part 3: Specific requirements for turbine-type synchronous machines', 1995 | Yes  No |
| Does the generator have a *short-circuit ratio* of 0.45 or higher? | Yes  No |
| Does the generator have a transient reactance (X'd) of less than 0.35 pu? | Yes  No |

* + 1. Generator data

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **Symbol** | **Unit** | **Value** |
| *Rated apparent power*  (1 p.u.): | Sn | MVA |  |
| *Rated voltage* (1 p.u.): | Un | kV |  |
| Rated frequency: | fn | Hz |  |
| Rated *Power Factor* (cosφ): | cosφn | - |  |
| Rated minimum reactive power generation from PQ diagram: | Qmin,n | Mvar |  |
| Rated maximum reactive power generation from PQ diagram: | Qmax,n | Mvar |  |
| Synchronous speed: | nn | Rpm |  |
| Total moment of inertia for rotating mass (generator, drive system, etc.): | Jtot | kg⋅m2 |  |
| Total moment of inertia for generator: | JG | kg⋅m2 |  |
| Total moment of inertia for drive system: | JD | kg⋅m2 |  |
| Rotor type: | - | - | Salient poles  Distinct poles |
| Stator resistance per phase: | Ra | p.u. |  |
| Temperature for resistance: | TR | ºC |  |
| Stator dispersion reactance per phase: | Xad | p.u. |  |
| Positive-sequence reactance, d axis: | Xd | p.u. |  |
| Transient reactance, d axis: | X’d | p.u. |  |
| Subtransient reactance, d axis: | X’’d | p.u. |  |
| Saturated positive-sequence reactance, d axis: | Xd,sat | p.u. |  |
| Saturated subtransient positive-sequence reactance, d axis: | X”d,sat | p.u. |  |
| Positive-sequence reactance, q axis: | Xq | p.u. |  |
| Transient reactance, q axis: | X’q | p.u. |  |
| Subtransient reactance, q axis: | X’’q | p.u. |  |
| Transient open circuit time constant, d axis: | T’d0 | s |  |
| Subtransient open circuit time constant, d axis: | T’d0 | s |  |
| Transient open circuit time constant, q axis: | T’q0 | s |  |
| Subtransient open circuit time constant, q axis: | T’’q0 | s |  |
| Potier reactance: | Xp | p.u. |  |
| Saturation point at 1.0 p.u. voltage: | SG1.0 | p.u. |  |
| Saturation point at 1.2 p.u. voltage: | SG1.2 | p.u. |  |
| Reactance, inverse-component: | X2 | p.u. |  |
| Resistance, inverse-component: | R2 | p.u. |  |
| Reactance, zero-component: | X0 | p.u. |  |
| Resistance, zero-component: | R0 | p.u. |  |
| Is the generator star point earthed? | - | - | Yes  No |
| If yes, ground reactance: | Xe | Ohm |  |
| If yes, ground resistance: | Re | Ohm |  |
| Generator's *short-circuit ratio*  (Rated): | Kc | p.u. |  |

* + 1. Generator transformer

|  |  |
| --- | --- |
| Manufacturer: |  |
| Type: |  |
| Is there a data sheet for the transformer?  Reference to data sheet: | Yes  No |
| Is the generator transformer designed with short-circuit impedance less than the calculated value, see section 5.5.2.1?  Reference to calculation that verifies the above: | Yes  No |

* + 1. Transformer data

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **Symbol** | **Unit** | **Value** |
| Rated apparent power (1 p.u.): | Sn | MVA |  |
| Rated primary voltage (1 p.u.): | Up | kV |  |
| Rated secondary voltage: | Us | kV |  |
| Coupling designation, e.g. Dyn11: | - | - |  |
| Step switch location: | - | - | Primary side  Secondary side |
| Step switch, additional voltage per step: | dutp | %/step |  |
| Step switch, phase angle of additional voltage per step: | phitp | degree/step |  |
| Step switch, lowest position: | ntpmin | - |  |
| Step switch, highest position: | ntpmax | - |  |
| Step switch, neutral position: | ntp0 | - |  |
| Short-circuit voltage, synchronous: | uk | % |  |
| Copper loss: | Pcu | kW |  |
| Short-circuit voltage, zero system: | uk0 | % |  |
| Resistive short-circuit voltage, zero-sequence system: | ukr0 | % |  |
| No-load current: | I0 | % |  |
| No-load loss: | P0 | % |  |
| Short-circuit impedance: | ez | p.u. |  |

* + 1. Excitation system

|  |  |
| --- | --- |
| What type of *excitation system* is used?  \*Describe the type: | Rotating  Static  Other\* |
| Is there a data sheet for the AVR?  Reference to data sheet: | Yes  No |
| Is the *excitation system* in conformity with the following European Standards:   * EN60034-16-1 'Rotating electrical machines – Part 16: Excitation systems for synchronous machines – Chapter 1: Definitions' * IEC technical report IEC 60034-16-3 'Rotating electrical machines – Part 16: Excitation systems for synchronous machines – Section 3: Dynamic performance' | Yes  No |
| Is the *excitation system’s* open-loop *frequency response* amplification less than 20 dB in the 0.2-1.5 Hz frequency range? | Yes  No |
| Can the generator be overexcited to 1.6 times the excitation at rated output and tgφ = 0.4 and rated operating voltage for at least 10 seconds?  Reference to type test/study or data sheet that verifies the above: | Yes  No |
| Are limit functions in the *excitation system* selective with protective functions?  Reference to study/data sheet or live test that verifies the above: | Yes  No |
| Is the *excitation system* response time for a positive 10% voltage change no greater than 0.3 seconds for a static excitation system, and 0.5 seconds for a rotating excitation system?  Reference to type test/study or live test that verifies the above: | Yes  No |
| Is the *excitation system* response time for a negative 10% voltage change no greater than 0.8 seconds for a rotating *excitation system*?  Reference to type test/study/live test that verifies the above: | Yes  No |
| Is the *excitation system* response to a momentary ±10% voltage change non-oscillatory?  Reference to type test/study or live test that verifies the above: | Yes  No |
| Does overshooting of no more than 15% occur in connection with ±10% voltage changes?  Reference to type test/study or live test that verifies the above: | Yes  No |

* + 1. Protection

|  |  |
| --- | --- |
| Is a positive-sequence under-voltage relay used as protection against out-of-phase reclosing?  If 'yes', reference to study justifying use of the relay: | Yes  No |

* + 1. Protective functions and settings

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Protective function** | **Symbol** | **Setting** | | **Trip time** | | **Standard setting** |
| Positive-sequence undervoltage\* |  | 0.7 ∙ Un | V | ≤ 50 | ms | 50 ms |
| Overvoltage (step 2) | U>> | 1.10 ⋅ Un | V | < 50 ms | ms | < 50 ms |
| Overvoltage (step 1) | U> | 1.06 ⋅ Un | V | 30-60 | s | 60 s |
| Undervoltage (step 1) | U< | 0.90 ⋅ Un | V | 2…10 | s | 10 s |
| Overfrequency | f> | 52 | Hz | 300 | ms | 300 ms |
| Underfrequency | f< | 47 | Hz | 300 | ms | 300 ms |
| Change of frequency | df/dt | ±2.5 | Hz/s | 80-100 | ms | 80 ms |
| Overcurrent\* | I> |  | A | 50 | ms | 50 ms |
| Overcurrent – positive-sequence undervoltage relay is not used | I> | \*\*\* | A |  | ms |  |

* + 1. Measurement requirements

|  |  |
| --- | --- |
| Has settlement metering been implemented in line with market regulation D1 and D2? | Yes  No |
| Have online measurements been established in line with TR 5.8.1?  Reference to signal list that verifies the above: | Yes  No |
| Have online measurements and signals been implemented in line with ancillary services to be supplied in Denmark – specifications? (only relevant if the *plant* will provide ancillary services)  Reference to signal list that verifies the above: | Yes  No |

* + 1. Scope of signals

|  |  |
| --- | --- |
| **Signal type** | **Signal description** |
| **M** | Switch gear status in the *POC* Switch gear status in the collection radials |
| **M** | Active power supplied at the *POC.* |
| **M** | Reactive power – import/export at *POC* |
| **M** | *Power Factor –* calculated at *POC* |
| **M** | Voltage in the *voltage reference point* |
|  |  |
| **Set point** | Active power control – *frequency response –* LFSM-O – activate/deactivate |
| **Status** | Active power control – *frequency response –* LFSM-O – activated/not activated |
| **Set point** | Active power control – *frequency response* – LFSM-O – setting value – *fR*max |
| **Status** | Active power control – *frequency response* – LFSM-O – value – *fR*max |
| **Set point** | Active power control – *frequency response* – LFSM-O – setting value – *Droop 1* |
| **Status** | Active power control – *frequency response* – LFSM-O – value – *Droop 1* |
|  |  |
| **Set point** | Active power control – *frequency response –* LFSM-U – activate/deactivate |
| **Status** | Active power control – *frequency response –* LFSM-U – activated/not activated |
| **Set point** | Active power control – *frequency response* – LFSM-U – setting value – *fR*min |
| **Status** | Active power control – *frequency response* – LFSM-U – value – *fR*min |
| **Set point** | Active power control – *frequency response* – LFSM-U – setting value – *Droop* 2 |
| **Status** | Active power control – *frequency response* – LFSM-U – value – *Droop* 2 |
|  |  |
| **Set point** | Active power control – *frequency control* – activate/deactivate |
| **Status** | Active power control – *frequency control* – activated/not activated |
| **Set point** | Active power control – *frequency control* – setting value – f1 |
| **Status** | Active power control – *frequency control* – value – f1 |
| **Set point** | Active power control – *frequency control* – setting value – *Droop* 3 |
| **Status** | Active power control – *frequency control* – value – *Droop* 3 |
| **Set point** | Active power control – *frequency control* – setting value – f2 |
| **Status** | Active power control – *frequency control* – value – f2 |
| **Set point** | Active power control – *frequency control* – setting value – *Droop* 4 |
| **Status** | Active power control – *frequency control* – value – *Droop* 4 |
| **Set point** | Active power control – *frequency control* – setting value – f3 |
| **Status** | Active power control – *frequency control* – value – f3 |
| **Set point** | Active power control – *frequency control* – setting value – *Droop* 5 |
| **Status** | Active power control – *frequency control* – value – *Droop* 5 |
| **Set point** | Active power control – *frequency control* – setting value – f4 |
| **Status** | Active power control – *frequency control* – value – f4 |
|  |  |
| **Set point** | Active power control – *load regulator (absolute power limit)* – activate/deactivate |
| **Status** | Active power control – *load regulator (absolute power limit)* – activated/not activated |
| **Set point** | Active power control – *load regulator (absolute power limit)* – desired active power at POC |
| **Status** | Active power control – *load regulator (absolute power limit)* – desired active power at POC |
|  |  |
| **Set point** | Active power control – *ramp rate limit* – activate/deactivate |
| **Status** | Active power control – *ramp rate limit* – activated/not activated |
| **Set point** | Active power control – *ramp rate limit* – ramp rate for upward/downward adjustment |
| **Status** | Active power control – *ramp rate limit* – ramp rate for upward/downward adjustment |
|  |  |
| **Set point** | Active power control – system protection – activate/deactivate |
| **Status** | Active power control – system protection – activated/not activated |
| **Set point** | Active power control – system protection – Set point |
|  |  |
| **Set point** | Reactive power control – *Q control* – activate/deactivate |
| **Status** | Reactive power control – *Q control* – activated/not activated |
| **Set point** | Reactive power control – *Q control* – setting value – desired reactive power at *POC* |
| **Status** | Reactive power control – *Q control* – value – desired reactive power at *POC* |
|  |  |
| **Set point** | Reactive power control – *Power Factor control* – activate/deactivate |
| **Status** | Reactive power control – *Power Factor control* – activated/not activated |
| **Set point** | Reactive power control – *Power Factor control* – setting value – desired *Power Factor* at *POC* |
| **Status** | Reactive power control – *Power Factor control* – value – desired *Power Factor* at *POC* |
|  |  |
| **Set point** | Reactive power control – *voltage control* – activate/deactivate |
| **Status** | Reactive power control – *voltage control* – activated/not activated |
| **Status** | Reactive power control – *voltage control* – value – desired *droop* for *voltage control* |
| **Status** | Reactive power control – *voltage control* – value – desired voltage in *voltage reference point* |
|  |  |
| **Set point** | Stop signal |
| **Set point** | Released for start |

* + 1. Fault incident recording

(Apply only to category C plants above 10 MW)

|  |  |
| --- | --- |
| Is logging equipment installed at the *POC* to monitor the following parameters, as a minimum, in connection with incidents (faults, etc.) in the *public electricity supply grid*:   * Voltage for each phase for the *plant* * Current for each phase for the *plant* * Active power for the *plant* (can be computed values) * Reactive power for the *plant* (can be computed values) * Frequency for the *plant* | Yes  No |
| Is logging performed as correlated time series of measuring values from 10 seconds before the incident until 60 seconds after the incident? | Yes  No |
| Is logging equipment designed with a minimum 1 KHz sample rate for all fault logging? | Yes  No |
| Has it been agreed with the transmission system operator which incidents should be logged?  If 'yes', which? | Yes  No |
| Are incidents kept in the log for a minimum of three months after a fault situation? | Yes  No |

* + 1. Simulation model requirements

(Apply only to category C plants above 10 MW)

|  |  |
| --- | --- |
| Are simulation models available with associated parameters in line with IEEE 421.5 for the complete *excitation system,* including:   * Excitation system * Limit functions * Voltage regulator * Q controller * *PF* controller   Reference to document/study or model package that verifies the above: | Yes  No |
| Are simulation models available with associated parameters in line with IEEE PES-TR1 for the power/speed controller:  Reference to document/study or model package that verifies the above: | Yes  No |
| Are simulation models available with associated parameters in line with IEEE PES-TR1 for the complete drive system:  Reference to document/study or model package that verifies the above: | Yes  No |
| Does the model include all protective functions that can be activated in the event of incidents or faults in the public electricity supply grid?  Reference to document/study or model package that verifies the above: | Yes  No |
| Are the above models supported by model descriptions?  Reference to document/study that verifies the above: | Yes  No |

* + 1. Verification of simulation model

(Apply only to category C plants above 10 MW)

|  |  |
| --- | --- |
| Have all simulation models been verified or will these be verified in connection with the commissioning test?  Reference to study that verifies the above: | Yes  No |

* + 1. Signature

|  |  |
| --- | --- |
| Date of commissioning: |  |
| Company: |  |
| Person responsible for commissioning: |  |
| Signature: |  |

* 1. Appendix 1 for plant category D

The documentation form must be filled in with preliminary data for the *plant* and sent to the *electricity supply undertaking* no later than twelve months **before** the date of commissioning.

No later than three months **after** the date of commissioning, documentation must be provided in the form of specific data for the entire *plant,* which must be sent to the *electricity supply undertaking*.

Required documentation comprises the following:

* + 1. Identification

|  |  |
| --- | --- |
| *Plant* name: |  |
| *Plant owner's* name and address: |  |
| *Plant owner's* tel. no.: |  |
| *Plant owner's* email address: |  |
| Date of commissioning: |  |
| GSRN number (all numbers must be provided for *plant*): |  |
| Name of *electricity supply undertaking*: |  |
| Name of nearest 30-60 kV substation: |  |
| Name of nearest 132-150 kV substation: |  |
| Name and location of the *Point of Connection* (*POC*): |  |
| Voltage at the *POC* (rated): | \_\_\_\_\_ kV |
| Name and location of *Point of Common Coupling* (*PCC*): |  |
| Voltage at the *PCC* (rated): | \_\_\_\_\_ kV |
| Are there other connection points to the *public electricity supply grid*?  Description of other connection points: | Yes  No |

* + 1. Description of the plant

|  |  |
| --- | --- |
| Type  \*Describe the type: | Steam turbine  Gas turbine  Combined-cycle unit  Gas engine  Diesel engine  Other\* |
| Specification of fuel: |  |
| *Rated output (Pn)* | \_\_\_\_\_ MW |
| *Minimum power* (*Pmin*) | \_\_\_\_\_ MW |
| *Overload capacity* (*Poverload*) | \_\_\_\_\_ MW |
| Rated mechanical shaft power for drive system (*Pmech*) | \_\_\_\_\_ MW |
| Is a flowchart for the *plant* available?  Reference to document: | Yes  No |
| Is a line diagram available showing settlement metering, online metering, ownership boundaries and operation manager boundaries?  Reference to document: | Yes  No |

* + 1. Determination of voltage level

|  |  |
| --- | --- |
| What is the *normal operating voltage* (*Uc*) at the *POC*? | \_\_\_\_\_ kV |

* + 1. Normal operating conditions

|  |  |
| --- | --- |
| Within the *normal production* area*,* see Figure 4, can the *plant* be started and generate continuously? | Yes  No |
| Will the *plant* remain connected in the event of frequency and voltage deviations at the *POC,* in line with Figure 4?  Reference to type test/study or protection philosophy that verifies the above: | Yes  No |

* + 1. Abnormal operating conditions

|  |  |
| --- | --- |
| Will the *plant* remain connected in the event of phase jumps of 20° at the *POC*?  Reference to type test/study that verifies the above: | Yes  No |
| Will the *plant* remain connected in the event of transient frequency gradients of 2.5 Hz/s at the *POC*?  Reference to type test/study or protection philosophy that verifies the above: | Yes  No |

* + 1. Voltage dip tolerances

|  |  |
| --- | --- |
| Will the *generator plant* remain connected in the event of voltage dips at the *POC*, see Figure 7?  Reference to type test/study that verifies the above: | Yes  No |
| Will auxiliary supply and auxiliary facilities remain connected in the event of voltage dips at the *POC,* see Figure 7?  Reference to type test/study or design philosophy that verifies the above: | Yes  No |

* + 1. Voltage support during voltage dips

|  |  |
| --- | --- |
| Does the *plant* provide voltage support during voltage dips?  Reference to type test/study that verifies the above: | Yes  No |

* + 1. Recurring voltage dips in the public electricity supply grid

|  |  |
| --- | --- |
| Does the *generator plant* remain connected in the event of repeated voltage dips at the *POC*, see Table 2?  Reference to type test/study that verifies the above: | Yes  No |

* + 1. Island operation

|  |  |
| --- | --- |
| Can the *plant* be switched over to *house-load operation*? | Yes  No |
| Is the time during which the *plant* can run in *house-load operation* limited?  If 'yes', for how long? | Yes  No |
| Can the *plant* be switched over to *house-load operation*, as specified in 3.3.5.2? | Yes  No |
| Is start-up from a dead grid (black start) possible? | Yes  No |

* + 1. Power quality

|  |  |
| --- | --- |
| When the plant is connected, do *rapid voltage changes* greater than the permissible levels (see Table 3) occur?  Reference to calculation/study that verifies the above: | Yes  No |

* + 1. Control functions

|  |  |
| --- | --- |
| Which of the following control functions are active in the *plant*? | *Frequency response* – LFSM-O  *Frequency response* – LFSM-U  *Q control*  *PF control*  *Voltage control* |
| Are all set point changes recorded with a 5-minute time stamp (*UTC*)? | Yes  No |

* + 1. Active power and frequency control functions

|  |  |
| --- | --- |
| Can a set point be set with a resolution of 1% of Pn or higher? | Yes  No |
| Can parameters in control functions be set with a resolution of 10 mHz or higher? | Yes  No |
| Can control function *droops* be set with a resolution of 1% or higher? | Yes  No |
| Do set points and effected control values deviate by more than 2% of Pn over a period of 1 minute? | Yes  No |

* + 1. Frequency response (LFSM-U and LFSM-O)

|  |  |
| --- | --- |
| Is the *plant* designed with a *frequency response* system that can control active power as a function of frequency deviations from the reference frequency?  Reference to type test/data sheet that verifies the above: | Yes  No |
| In the event of a frequency deviation, is the *frequency response* activated within 2 seconds? | Yes  No |
| Is it possible to adjust the *frequency response droop* to a value in the 2-8% range of Pn? | Yes  No |
| Is the *droop* set to 6%? | Yes  No |
| Is it possible to set the *frequency response* limit frequency (fmin andfmax) to a value in the 47-52 Hz range? | Yes  No |
| Is it possible to set the *frequency response* activation frequency (fRmax and fRmin) to a value in the 50.1-52 Hz range for fRmax and 47-49.9 Hz range for fRmin? | Yes  No |
| Is fRmax set to 50.2 Hz and fRmin to 49.8 Hz?  If 'no', what are the settings? | Yes  No |
| Is frequency measurement accuracy higher than 10 mHz and  the control function sensitivity higher than +/-10 mHz? | Yes  No |

* + 1. Frequency control

|  |  |
| --- | --- |
| Does the *plant* have to provide ancillary services?  If 'yes', which? | Yes  No  FCR – power frequency control  FCR – FNR  FCR – FDR  FRR-a  FRR-m |
| Is the *plant's* turbine governor set with the specific parameter settings for the ancillary service(s) to be delivered, in line with the specifications for ancillary services? | Yes  No |
| Is it possible to change the parameter settings within 10 seconds? | Yes  No |

* + 1. Reactive power control functions

|  |  |
| --- | --- |
| Where is the reference point for the reactive power control functions located?  \*Describe where: | *PGC*  *POC*  *PCC*  Elsewhere\* |

* + 1. Q control

|  |  |
| --- | --- |
| Does the *plant* begin adjustment to a new set point after 2 seconds and complete the adjustment within 30 seconds after receiving a new set point? | Yes  No |
| Do set points and effected control values deviate by more than 1% of QN over a period of 1 minute? | Yes  No |
| Is it possible to set a set point with a resolution of 100 kVAr or higher? | Yes  No |

* + 1. Power Factor control

|  |  |
| --- | --- |
| Does the *plant* begin adjustment to a new set point after 2 seconds and complete the adjustment within 30 seconds after receiving a new set point? | Yes  No |
| Do set points and effected control values deviate by more than 1% of the set point for *Power Factor* over a period of 1 minute? | Yes  No |
| Is it possible to set a set point with a resolution of 0.01 or higher? | Yes  No |

* + 1. Voltage control

|  |  |
| --- | --- |
| Does the *plant* begin adjustment to a new set point after 2 seconds and complete the adjustment within 10 seconds after receiving a new set point? | Yes  No |
| Can the *droop* for the voltage controller be set in the 2-8% range? | Yes  No |
| Is the *droop* for the voltage controller set to 4%? | Yes  No |

* + 1. Reactive power control requirements

|  |  |
| --- | --- |
| Can the *plant* supply reactive power at Pn and varying operating voltages, as specified in Figure 16?  Reference to study/type test that verifies the above: | Yes  No |
| Is the generator's PQ diagram available?  Reference to data sheet: | Yes  No |

* + 1. System protection

|  |  |
| --- | --- |
| Can the generator *plant* adjust active power down to five predefined power levels (70%, 50%, 40%, 25% and 0%)?  Reference to live test that verifies the above: | Yes  No |
| When system protection is activated, does adjustment begin after 1 second and is it completed after 10 seconds? | Yes  No |

* + 1. Generator

|  |  |
| --- | --- |
| Manufacturer: |  |
| Type: |  |
| Is there a data sheet for the generator?  Reference to data sheet: | Yes  No |
| Does the generator comply with relevant parts of the following European Standards:   * DS/EN60034-1, 'Rotating electrical machines – Part 1: Rating and performance', 2004 * DS/EN60034-3, 'Rotating electrical machines – Part 3: Specific requirements for turbine-type synchronous machines', 1995 | Yes  No |
| Does the generator have a *short-circuit ratio* greater than the value specified by the transmission system operator? | Yes  No |
| Does the generator have a transient reactance (X'd) greater than the value specified by the transmission system operator? | Yes  No |

* + 1. Generator data

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **Symbol** | **Unit** | **Value** |
| *Rated apparent power*  (1 p.u.): | Sn | MVA |  |
| *Rated voltage* (1 p.u.): | Un | kV |  |
| Rated frequency: | fn | Hz |  |
| Rated *Power Factor* (cosφ): | cosφn | - |  |
| Rated minimum reactive power generation from PQ diagram: | Qmin,n | Mvar |  |
| Rated maximum reactive power generation from PQ diagram: | Qmax,n | Mvar |  |
| Synchronous speed: | nn | Rpm |  |
| Total moment of inertia for rotating mass (generator, drive system, etc.): | Jtot | kg⋅m2 |  |
| Total moment of inertia for generator: | JG | kg⋅m2 |  |
| Total moment of inertia for drive system: | JD | kg⋅m2 |  |
| Rotor type: | - | - | Salient poles  Distinct poles |
| Stator resistance per phase: | Ra | p.u. |  |
| Temperature for resistance: | TR | ºC |  |
| Stator dispersion reactance per phase: | Xad | p.u. |  |
| Positive-sequence reactance, d axis: | Xd | p.u. |  |
| Transient reactance, d axis: | X’d | p.u. |  |
| Subtransient reactance, d axis: | X’’d | p.u. |  |
| Saturated positive-sequence reactance, d axis: | Xd,sat | p.u. |  |
| Saturated subtransient positive-sequence reactance, d axis: | X”d,sat | p.u. |  |
| Positive-sequence reactance, q axis: | Xq | p.u. |  |
| Transient reactance, q axis: | X’q | p.u. |  |
| Subtransient reactance, q axis: | X’’q | p.u. |  |
| Transient open circuit time constant, d axis: | T’d0 | s |  |
| Subtransient open circuit time constant, d axis: | T’d0 | s |  |
| Transient open circuit time constant, q axis: | T’q0 | s |  |
| Subtransient open circuit time constant, q axis: | T’’q0 | s |  |
| Potier reactance: | Xp | p.u. |  |
| Saturation point at 1.0 p.u. voltage: | SG1.0 | p.u. |  |
| Saturation point at 1.2 p.u. voltage: | SG1.2 | p.u. |  |
| Reactance, inverse-component: | X2 | p.u. |  |
| Resistance, inverse-component: | R2 | p.u. |  |
| Reactance, zero-component: | X0 | p.u. |  |
| Resistance, zero-component: | R0 | p.u. |  |
| Is the generator star point earthed? | - | - | Yes  No |
| If yes, ground reactance: | Xe | Ohm |  |
| If yes, ground resistance: | Re | Ohm |  |
| Generator's *short-circuit ratio*  (Rated): | Kc | p.u. |  |

* + 1. Generator transformer

|  |  |
| --- | --- |
| Manufacturer: |  |
| Type: |  |
| Is there a data sheet for the transformer?  Reference to data sheet: | Yes  No |
| Has the generator transformer been designed with a short-circuit impedance less than that specified by the transmission system operator?  Reference to calculation that verifies the above: | Yes  No |

* + 1. Transformer data

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **Symbol** | **Unit** | **Value** |
| *Rated apparent power* (1 p.u.): | Sn | MVA |  |
| Rated primary voltage (1 p.u.): | Up | kV |  |
| Rated secondary voltage: | Us | kV |  |
| Coupling designation, e.g. Dyn11: | - | - |  |
| Step switch location: | - | - | Primary side  Secondary side |
| Step switch, additional voltage per step: | dutp | %/step |  |
| Step switch, phase angle of additional voltage per step: | phitp | degree/step |  |
| Step switch, lowest position: | ntpmin | - |  |
| Step switch, highest position: | ntpmax | - |  |
| Step switch, neutral position: | ntp0 | - |  |
| Short-circuit voltage, synchronous: | uk | % |  |
| Copper loss: | Pcu | kW |  |
| Short-circuit voltage, zero system: | uk0 | % |  |
| Resistive short-circuit voltage, zero-sequence system: | ukr0 | % |  |
| No-load current: | I0 | % |  |
| No-load loss: | P0 | % |  |
| Short-circuit impedance: | ez | p.u. |  |

* + 1. Excitation system

|  |  |
| --- | --- |
| What type of *excitation system* is used?  \*Describe the type: | Rotating  Static  Other\* |
| Is there a data sheet for the AVR?  Reference to data sheet: | Yes  No |
| Is the *excitation system* in conformity with the following European Standards:   * DS/EN60034-16-1, 'Rotating electrical machines – Part 16: Excitation systems for synchronous machines – Chapter 1: Definitions' * IEC technical report DS/CLC/TR 60034-16-3 'Rotating electrical machines – Part 16: Excitation systems for synchronous machines – Section 3: Dynamic performance' | Yes  No |
| Is the *excitation system’s* open-loop *frequency response* amplification less than 20 dB in the 0.2-1.5 Hz frequency range? | Yes  No |
| Can the generator be overexcited to 1.6 times the excitation at rated output and tgφ = 0.4 and rated operating voltage for at least 10 seconds?  Reference to type test/study or data sheet that verifies the above: | Yes  No |
| Are limit functions in the *excitation system* selective with protective functions?  Reference to study/data sheet or live test that verifies the above: | Yes  No |
| Is the *excitation system* response time for a positive 10% voltage change no greater than 0.3 seconds for a static *excitation system*, and 0.5 seconds for a rotating *excitation system*?  Reference to type test/study or live test that verifies the above: | Yes  No |
| Is the *excitation system* response time for a negative 10% voltage change no greater than 0.8 seconds for a rotating *excitation system*?  Reference to type test/study or live test that verifies the above: | Yes  No |
| Is the *excitation system* response to a momentary ±10% voltage change non-oscillatory?  Reference to type test/study or live test that verifies the above: | Yes  No |
| Does overshooting of no more than 15% occur in connection with ±10% voltage changes?  Reference to type test/study or live test that verifies the above: | Yes  No |

* + 1. PSS function

|  |  |
| --- | --- |
| Is the *PSS function* of type IEEE PSS2B, see IEEE 421.5?  Reference to model that verifies the above: | Yes  No |
| Is the *PSS function* set so that it contributes to a significant attenuation in the 0.2-0.7 Hz frequency range?  Reference to study that verifies the above: | Yes  No |

|  |  |
| --- | --- |
| Is the phase of the added damping signal in phase with speed changes in the 2-2 Hz frequency range?  Reference to study that verifies the above: | Yes  No |
| Is damping of the plant's power oscillations faster than 1 second in all load situations and disruptions?  Reference to study that verifies the above: | Yes  No |
| Has the *PSS function* been set so that no voltage change on the high-voltage side of the generator transformer greater than 1 % occurs during any power change?  Reference to study that verifies the above: | Yes  No |
| Is the output signal limit for the *PSS function* set to ±5% of the generator's rated voltage (Un)?  Reference to study or simulation model that verifies the above: | Yes  No |
| Is the *PSS function* automatically deactivated when power production from the *plant* is less than 20% of Pn? | Yes  No |
| Is it possible to activate and deactivate the *PSS function*? | Yes  No |

* + 1. Protection

|  |  |
| --- | --- |
| Is a positive-sequence undervoltage relay used as protection against out-of-phase reclosing?  If 'yes', reference to study justifying use of the relay: | Yes  No |

* + 1. Protective functions and settings

|  |  |
| --- | --- |
| Are studies on the scope and settings of protective functions available?  Reference to study: | Yes  No |

* + 1. Measurement requirements

|  |  |
| --- | --- |
| Has settlement metering been implemented in line with market regulation D1 and D2? | Yes  No |
| Have online measurements been established in line with TR 5.8.1?  Reference to signal list that verifies the above: | Yes  No |
| Have signals been implemented in line with TR 5.3.4.2?  Reference to signal list that verifies the above: | Yes  No |
| Have online measurements and signals been implemented in line with ancillary services to be supplied in Denmark – specifications? (only relevant if the *plant* will provide ancillary services)  Reference to signal list that verifies the above: | Yes  No |

* + 1. Data communication

|  |  |
| --- | --- |
| Have data communication protocols and data security factors been implemented as specified in section 7? | Yes  No |
| Are the signals specified in section 7 available in the *PCOM* interface? | Yes  No |

* + 1. Scope of signals

|  |  |
| --- | --- |
| **Signal type** | **Signal description** |
| **M** | Switch gear status in the *POC* Switch gear status in the collection radials |
| **M** | Active power supplied at the *POC.* |
| **M** | Reactive power – import/export at *POC* |
| **M** | *Power Factor –* calculated at *POC* |
| **M** | Voltage in the *voltage reference point* |
|  |  |
| **Set point** | Active power control – *frequency response –* LFSM-O – activate/deactivate |
| **Status** | Active power control – *frequency response –* LFSM-O – activated/not activated |
| **Set point** | Active power control – *frequency response* – LFSM-O – setting value – *fR*max |
| **Status** | Active power control – *frequency response* – LFSM-O – value – *fR*max |
| **Set point** | Active power control – *frequency response* – LFSM-O – setting value – *Droop 1* |
| **Status** | Active power control – *frequency response* – LFSM-O – value – *Droop 1* |
|  |  |
| **Set point** | Active power control – *frequency response –* LFSM-U – activate/deactivate |
| **Status** | Active power control – *frequency response –* LFSM-U – activated/not activated |
| **Set point** | Active power control – *frequency response* – LFSM-U – setting value – *fR*min |
| **Status** | Active power control – *frequency response* – LFSM-U – value – *fR*min |
| **Set point** | Active power control – *frequency response* – LFSM-U – setting value – *Droop* 2 |
| **Status** | Active power control – *frequency response* – LFSM-U – value – *Droop* 2 |
|  |  |
| **Set point** | Active power control – *frequency control* – activate/deactivate |
| **Status** | Active power control – *frequency control* – activated/not activated |
| **Set point** | Active power control – *frequency control* – setting value – f1 |
| **Status** | Active power control – *frequency control* – value – f1 |
| **Set point** | Active power control – *frequency control* – setting value – *Droop* 3 |
| **Status** | Active power control – *frequency control* – value – *Droop* 3 |
| **Set point** | Active power control – *frequency control* – setting value – f2 |
| **Status** | Active power control – *frequency control* – value – f2 |
| **Set point** | Active power control – *frequency control* – setting value – *Droop* 4 |
| **Status** | Active power control – *frequency control* – value – *Droop* 4 |
| **Set point** | Active power control – *frequency control* – setting value – f3 |
| **Status** | Active power control – *frequency control* – value – f3 |
| **Set point** | Active power control – *frequency control* – setting value – *Droop* 5 |
| **Status** | Active power control – *frequency control* – value – *Droop* 5 |
| **Set point** | Active power control – *frequency control* – setting value – f4 |
| **Status** | Active power control – *frequency control* – value – f4 |
|  |  |
| **Set point** | Active power control – *load regulator (absolute power limit)* – activate/deactivate |
| **Status** | Active power control – *load regulator (absolute power limit)* – activated/not activated |
| **Set point** | Active power control – *load regulator (absolute power limit)* – desired active power at POC |
| **Status** | Active power control – *load regulator (absolute power limit)* – desired active power at POC |
|  |  |
| **Set point** | Active power control – *ramp rate limit* – activate/deactivate |
| **Status** | Active power control – *ramp rate limit* – activated/not activated |
| **Set point** | Active power control – *ramp rate limit* – ramp rate for upward/downward adjustment |
| **Status** | Active power control – *ramp rate limit* – ramp rate for upward/downward adjustment |
|  |  |
| **Set point** | Active power control – system protection – activate/deactivate |
| **Status** | Active power control – system protection – activated/not activated |
| **Set point** | Active power control – system protection – set point |
|  |  |
| **Set point** | Reactive power control – *Q control* – activate/deactivate |
| **Status** | Reactive power control – *Q control* – activated/not activated |
| **Set point** | Reactive power control – *Q control* – setting value – desired reactive power at *POC* |
| **Status** | Reactive power control – *Q control* – value – desired reactive power at *POC* |
|  |  |
| **Set point** | Reactive power control – *Power Factor control* – activate/deactivate |
| **Status** | Reactive power control – *Power Factor control* – activated/not activated |
| **Set point** | Reactive power control – *Power Factor control* – setting value – desired *Power Factor* at *POC* |
| **Status** | Reactive power control – *Power Factor control* – value – desired *Power Factor* at *POC* |
|  |  |
| **Set point** | Reactive power control – *voltage control* – activate/deactivate |
| **Status** | Reactive power control – *voltage control* – activated/not activated |
| **Status** | Reactive power control – *voltage control* – value – desired *droop* for *voltage control* |
| **Status** | Reactive power control – *voltage control* – value – desired voltage in *voltage reference point* |
|  |  |
| **Set point** | Stop signal |
| **Set point** | Released for start |

* + 1. Fault incident recording

|  |  |
| --- | --- |
| Is logging equipment installed at the *POC* to monitor the following parameters, as a minimum, in connection with incidents (faults, etc.) in the *public electricity supply grid*:   * Voltage for each phase for the *plant* * Current for each phase for the *plant* * Active power for the *plant* (can be computed values) * Reactive power for the *plant* (can be computed values) * Frequency for the *plant* | Yes  No |
| Is logging performed as correlated time series of measuring values from 10 seconds before the incident until 60 seconds after the incident? | Yes  No |
| Is logging equipment designed with a minimum 1 KHz sample rate for all fault logging? | Yes  No |
| Has it been agreed with the transmission system operator which incidents should be logged?  If 'yes', which? | Yes  No |
| Are incidents kept in the log for a minimum of three months after a fault situation? | Yes  No |

* + 1. Simulation model requirements

|  |  |
| --- | --- |
| Are simulation models available with associated parameters in line with IEEE 421.5 for the complete *excitation system,* including:   * Excitation system * Limit functions * Voltage regulator * Q controller * *PF* controller   Reference to document/study or model package that verifies the above: | Yes  No |
| Are simulation models available with associated parameters in line with IEEE PES-TR1 for the power/speed controller:  Reference to document/study or model package that verifies the above: | Yes  No |
| Are simulation models available with associated parameters in line with IEEE PES-TR1 for the complete drive system:  Reference to document/study or model package that verifies the above: | Yes  No |
| Does the model include all protective functions that can be activated in the event of incidents or faults in the public electricity supply grid?  Reference to document/study or model package that verifies the above: | Yes  No |
| Are the above models supported by model descriptions?  Reference to document or study that verifies the above: | Yes  No |

* + 1. Verification of simulation model

|  |  |
| --- | --- |
| Have all simulation models been verified or will these be verified in connection with the commissioning test?  Reference to study that verifies the above: | Yes  No |

* + 1. Signature

|  |  |
| --- | --- |
| Date of commissioning: |  |
| Company: |  |
| Person responsible for commissioning: |  |
| Signature: |  |