IEC 63132-2

Edition 1.0 2020-04

INTERNATIONAL STANDARD

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Guidance for installation procedures and tolerances of hydroelectric machines – Part 2: Vertical generators

Lignes directrices des procédures et tolérances d'installation des machines hydroélectriques – Partie 2: Alternateurs verticaux

IEC 63132-2:2020-04(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 27.140

ISBN 978-2-8322-8102-4

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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GUIDANCE FOR INSTALLATION PROCEDURES AND TOLERANCES OF HYDROELECTRIC MACHINES –

Part 2: Vertical generators

FOREWORD

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The text of this International Standard is based on the following documents:

FDIS	Report on voting
4/381/FDIS	4/391/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 63132 series, published under the general title *Guidance for installation procedures and tolerances of hydroelectric machines*, can be found on the IEC website

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,
- replaced by a revised edition, or
- amended.

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GUIDANCE FOR INSTALLATION PROCEDURES AND TOLERANCES OF HYDROELECTRIC MACHINES –

Part 2: Vertical generators

1 Scope

The purpose of this part of IEC 63132 is to establish, in a general way, suitable procedures and tolerances for installation of generator. This document presents a typical assembly. There are many possible ways to assemble a unit. The size of the machines, design of the machines, layout of the powerhouse or delivery schedule of the components are some of the elements that could result in additional steps, the elimination of some steps and/or assembly sequences.

It is understood that a publication of this type will be binding only if, and to the extent that, both contracting parties have agreed upon it.

This document excludes matters of purely commercial interest, except those inextricably bound up with the conduct of installation.

This document applies to vertical generators according to IEC 60034-71.

The tolerances in this document have been established upon best practices and experience, although it is recognized that other standards specify different tolerances.

Brushless excitation system is not included in this document.

Wherever this document specifies that documents, drawings or information is supplied by a manufacturer (or by manufacturers), each individual manufacturer will furnish the appropriate information for their own supply only.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60034-7:-, *Rotating electrical machines - Part 7: Classification of types of constructions, mounting arrangements and terminal box position (IM Code)* [2]

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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1 Third edition under preparation. Stage at the time of publication: IEC/ACDV 60034-7:2019.

2 Third edition under preparation. Stage at the time of publication: IEC/ACDV 60034-7:2019.

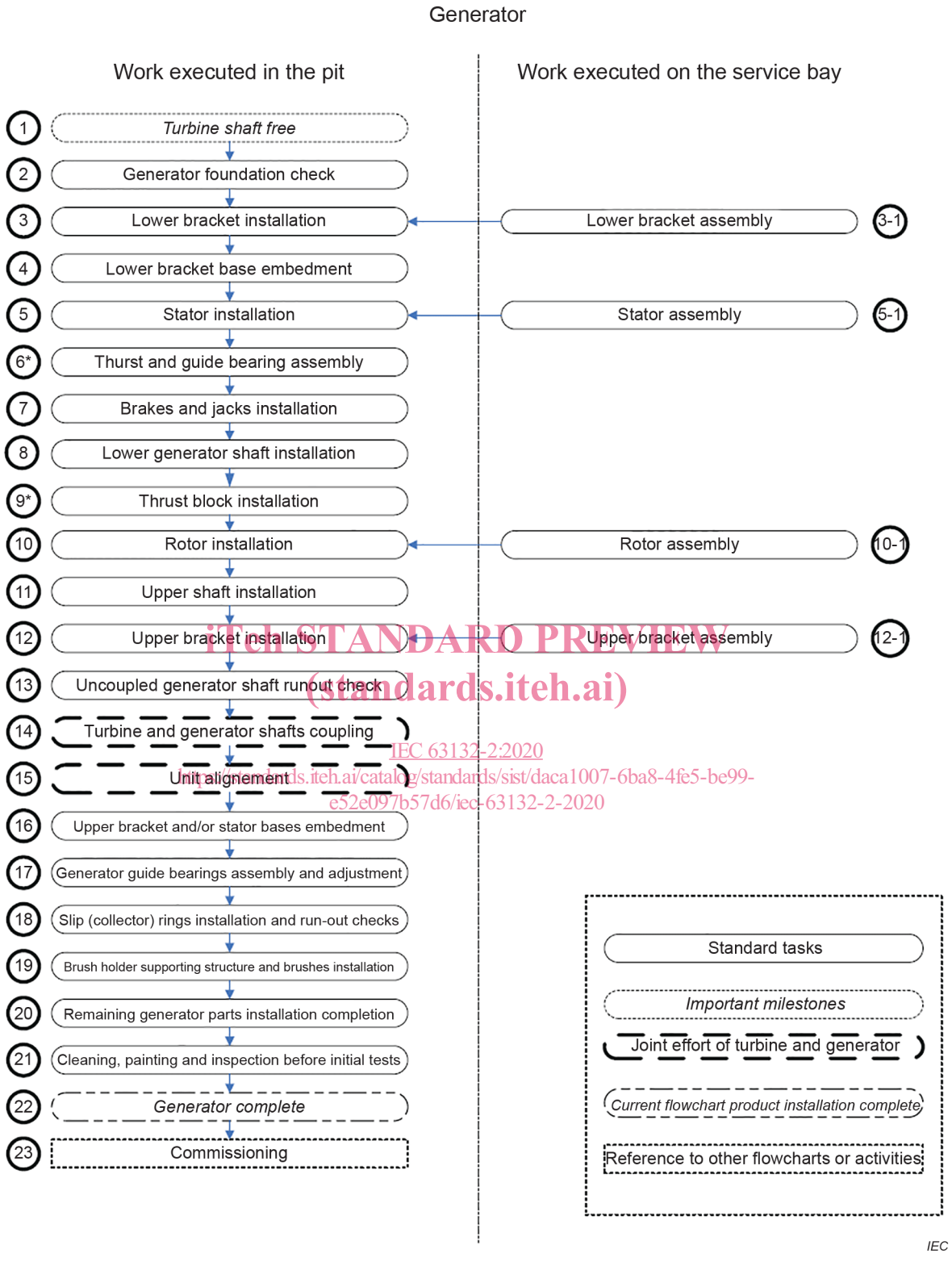
- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 Preparation

Embedded parts such as piping and foundation plates are covered in the turbine embedded parts.

5 Installation flowchart

The installation flowchart of this document showed in Figure 1 is mainly based on a vertical generator having its thrust bearing under the rotor. If the generator has the thrust bearing above the rotor or supported by the head cover, some corrections to the flowchart will be necessary.



NOTE 1 This flowchart represents a generator with thrust bearing below the rotor. For generators with thrust bearing above the rotors, the steps with an asterisk would be totally or partially done between steps 11 and 12 in the flowchart.

NOTE 2 The generator installation is linked to the turbine installation.

Figure 1 – Generic installation flowchart – Generator

6 Steps

6.1 Step 1: Turbine shaft free

See the relevant turbine part of this document.

6.2 Step 2: Generator foundation check

a) Objective of work in the step

- Check the foundations for the upper and/or lower brackets (if applicable) and the stator.
- Check the openings for cables/bars for phase terminals and neutral point.
- Check the embedded water and oil piping.

b) Explanation of work

- Check the foundations for the lower bracket, upper bracket and the stator.
- Check the dimension of the openings.
- Check the position of piping (if secondary stage concreting is used, also check).
- Install the foundation bolts.
- Install the sole plates.

c) Recommendations

The tolerances should be provided by the generator supplier.

- If a one-stage concreting method is used

  The location in plan, elevation and/or locations of the foundation plates should be checked.

- If a two-stage concreting method is used

  The location in plan, elevation and/or locations of the foundation bolts, embedded parts and block-outs should be checked.

d) Additional information

There are two different methods for embedding the sole plates; one-stage concreting or two-stage concreting method.

Care shall be taken when placing concrete to avoid moving the generator foundations.

If the two-stage concreting method is used, the entire surface of the block-out for the lower bracket and stator bases should be prepared to ensure proper bonding between secondary and primary concrete.

There are many different generator configurations. See IEC 60034-7 for a description of the possibilities. The various configurations may or may not have a lower or an upper bracket.

6.3 Step 3-1: Lower bracket assembly

a) Objective of work in the step

- Assemble the lower bracket.

b) Explanation of work

- Attach the arms to the hub, as per the design (i.e. welding, bolting).
- This task is generally carried out outside of the pit.

c) Recommendations

The tolerances should be provided by the generator supplier, if required.

If the lower bracket is assembled by welding, non-destructive tests (NDT) according to the inspection and test plan (ITP) may be required.

d) Additional information

The generator supplier should take precautions to limit the distortion by welding in order to be able to connect to the embedded parts.

The lower bracket, upper bracket, rotor and stator assemblies are typically the largest components in a unit and take considerable time (days to months) to assemble. Their assembly works are often carried out in parallel and can greatly affect the assembly space requirements and availability. This step is presented to ensure the reader is aware that there are often challenges to find space and have all parties work effectively together on this issue.

6.4 Step 3: Lower bracket installation

a) Objective of work in the step

– Install the lower bracket in the correct position.

b) Explanation of work

– Place the lower bracket on the sole plates.

– Control the concentricity, elevation and level of the lower bracket.

c) Recommendations

Concentricity, elevation and level should be checked. The tolerances should be provided by the generator supplier. When determining the correct elevation, the lower bracket deflection due to the total weight of the rotating parts and the hydraulic thrust acting on the runner when the unit is at the desired operating condition should be considered.

d) Additional information

Different designs require different tolerances; therefore, it is recommended that the generator supplier provides the tolerances.

The lower bracket is aligned to the centre of bottom ring. The turbine shaft is typically to be a relative reference. Other methods that employ benchmarks could also be used to align the lower bracket.

In some cases, the brakes and jacks are installed in this step instead of Step 7: Brakes and jacks installation.

6.5 Step 4: Lower bracket bases embedment

a) Objective of work in the step

– Embed the lower bracket bases.

b) Explanation of work

– Grout the through-bolts or the foundation bolts and sole plates.

c) Recommendations

Before embedment, check that any reinforcement will not interfere with the sole plates and foundation bolts.

d) Additional information

Ensure that the air can escape upwards during grouting. Some designs do not require second stage concrete.

Depending on the design, it may be possible to embed the lower bracket foundation plates before installation of the lower bracket.

Care shall be taken when placing concrete to avoid moving the lower bracket bases.

6.6 Step 5-1: Stator assembly

a) Objective of work in the step

– Assemble the stator.

b) Explanation of work

– Assemble the stator frame by bolting or welding.

– Stack the core.

– Install the winding.

– Execute the electrical tests and mechanical measurements.

c) Recommendations

Please see Step 15: Unit alignment. The tolerances depend on the design.

d) Additional information

The stator can be assembled in the shop, in the pit or beside the pit. The stator can be assembled from a number of pre-assembled blocks comprising cores, windings and frame, or the frame is assembled first at the site and then the core is stacked in one complete ring. Protect all winding parts especially during drilling and welding work occurring nearby.

See the additional information in Step 3-1: Lower bracket assembly.

6.7 Step 5: Stator installation

a) Objective of work in the step

– Install the stator in the pit.

b) Explanation of work

– Install the stator at the proper level, elevation and position.

c) Recommendations

Please see Step 15: Unit alignment. The tolerances depend on the design.

The stator magnetic centre elevation and stator core verticality should be checked. The tolerances should be provided by the generator supplier.

d) Additional information

The stator is aligned to the centre of the bottom ring using a relative reference. The turbine shaft flange is typically the relative reference. Other methods that employ benchmarks could also be used to align the stator.

The alignment of the stator will be checked during the unit alignment (see Step 15: Unit alignment). In some cases, the stator position may require adjustment.

6.8 Step 6: Thrust and guide bearing assembly

a) Objective of work in the step

– Assemble the combined thrust and guide bearing.

b) Explanation of work

– The thrust and guide bearing components and accessories are installed in the oil reservoir located on the thrust bearing bracket.

– Check and eliminate any oil leakage from the oil reservoir.

c) Recommendations

The thrust bearing and bracket assembly is located concentric, at the proper elevation and level. The tolerances should be provided by the generator supplier.

d) Additional information

The thrust bearing is aligned to the centre of the thrust bearing bracket. This may be required for the bearing to function properly.

The alignment of the thrust bearing, the thrust bearing bracket and the rotating components will be checked in Step 15: Unit alignment. In some cases, the position of these components may require adjustment.

In order to install the rotor, a minimum of four guide bearing segments, spaced 90° apart, shall be installed.

In some designs, the thrust bearing may be supported on the top of the head cover. In this case, the thrust bearing housing is aligned to the centre of the head cover. The thrust bearing is aligned to the centre of the thrust bearing housing.

In some designs, the generator guide bearing(s) may not be combined with the thrust bearing. Other designs may also have a smaller diameter on the generator guide bearing preventing the installation of the thrust block.

The electrical insulation of the bearing system should be checked.

NOTE The term "thrust bearing bracket" means either the lower or the upper bracket on which the thrust bearing is located. In the case of a thrust bearing located below the rotor, the thrust bearing bracket is the lower bracket.

6.9 Step 7: Brakes and jacks installation

a) Objective of work in the step

– Install the brakes and lifting jacks.

b) Explanation of work

– Assemble the jacks, as per the design (i.e. on the lower bracket arms or on support pedestals on the concrete).

– Assemble the pipes.

– Install the accessories (compressor, control panel, air tank, oil reservoir, etc.).

c) Recommendations

The level and height tolerances for the brake shoes should be provided by the generator supplier.

d) Additional information

N/A

6.10 Step 8: Lower generator shaft installation

a) Objective of work in the step

– Install the lower generator shaft (if applicable) for coupling with the turbine shaft.

b) Explanation of work

– Install the lower shaft in the pit.

c) Recommendations

The level, elevation, concentricity and inclination should be checked. The tolerances should be provided by the generator supplier.

d) Additional Information

N/A

6.11 Step 9: Thrust block installation

a) Objective of work in the step

– Place the thrust block on the thrust bearing and assemble to the shaft.

b) Explanation of work

– Connect the thrust runner to the thrust block.

– Connect the thrust block to the lower shaft (when the thrust bearing is below the rotor).

– Connect the thrust block to the upper shaft (when the thrust bearing is above the rotor).

c) Recommendations

Level, elevation, concentricity and inclination should be checked. The tolerances should be provided by the generator supplier.

d) Additional information

It is assumed that the thrust runner is connected to the thrust block.

There are different designs which require different checks during installation of the shaft and thrust block. In some designs, the thrust block may be integral to the shaft; in other designs, the thrust block may attach to the rotor. There are also designs where the thrust block is located on the turbine shaft, in which case the sequence of steps shall be revised.

In case of the thrust bearing being above the rotor, this step will follow Step 12: Upper bracket installation.

6.12 Step 10-1: Rotor assembly

a) Objective of work in the step