

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Guidance for installation procedures and tolerances of hydroelectric machines –
Part 5: Bulb turbines and generators**

**Lignes directrices des procédures et tolérances d'installation des machines
hydroélectriques –**

Partie 5: Turbines et alternateurs de type bulbe

[IEC 63132-5:2023](#)

63132-5-2023





THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2023 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Guidance for installation procedures and tolerances of hydroelectric machines –
Part 5: Bulb turbines and generators**

**Lignes directrices des procédures et tolérances d'installation des machines
hydroélectriques –**

Partie 5: Turbines et alternateurs de type bulbe

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 27.140

ISBN 978-2-8322-6742-4

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 Installation flowchart.....	6
4.1 Turbine and generator embedded parts.....	6
4.2 Turbine and generator mechanical parts	7
5 Steps.....	9
5.1 Turbine and generator embedded parts.....	9
5.1.1 Step 1: Benchmarks set-up.....	9
5.1.2 Step 2: Powerhouse primary stage concrete with anchor plates and embedded pipes	9
5.1.3 Step 3: Anchor plates, embedded pipes and workspace verification.....	9
5.1.4 Step 4: Handing over to installation	10
5.1.5 Step 5: Draft tube installation.....	10
5.1.6 Step 6: Secondary embedded pipes installation around the draft tube	12
5.1.7 Step 7: Handing over to concreting phase.....	12
5.1.8 Step 8: Draft tube embedment	13
5.1.9 Step 9: Concrete voids testing	13
5.1.10 Step 10: Draft tube grout injection	14
5.1.11 Step 11: Handing over to installation	14
5.1.12 Step 12: Draft tube dimensional inspection after embedment.....	14
5.1.13 Step 13: Installation of turbine housing.....	15
5.1.14 Step 14: Installation of pier nose liner.....	17
5.1.15 Step 15: Installation of generator foundation base	17
5.1.16 Step 16: Installation of generator hatch cover frame	18
5.1.17 Step 17: Secondary embedded pipes installation around the turbine housing.....	18
5.1.18 Step 18: Handing over to concreting phase.....	18
5.1.19 Step 19: Embedment of turbine housing, pier nose, generator foundation base plate and hatch cover frame.....	18
5.1.20 Step 20: Handing over to installation	19
5.1.21 Step 21: Corrosion protection for embedded parts	19
5.1.22 Step 22: Turbine and generator embedded parts complete	19
5.1.23 Step 23: Turbine and generator mechanical parts installation	19
5.2 Turbine and generator mechanical parts	20
5.2.1 Step 1: Turbine and generator embedded parts complete	20
5.2.2 Step 2: Handing over to installation	20
5.2.3 Step 3: Dimensional inspection of turbine housing after embedment.....	20
5.2.4 Step 4-1: Distributor assembly.....	20
5.2.5 Step 4: Distributor installation.....	21
5.2.6 Step 5: Lowering and storing of lower half of discharge ring	21
5.2.7 Step 6-1: Pre-assembly of shaft and bearings.....	21
5.2.8 Step 6: Shaft installation.....	21
5.2.9 Step 7: Shaft free	22
5.2.10 Step 8: Combined bearing installation.....	23
5.2.11 Step 9: Guide vane servomotor and counterweight installation	23

5.2.12	Step 10-1: Turbine runner assembly	24
5.2.13	Step 10: Runner installation.....	24
5.2.14	Step 11: Guide vane apparatus final adjustment	25
5.2.15	Step 12: Lowering and storing of bulb nose	26
5.2.16	Step 13-1: Rotor assembly	26
5.2.17	Step 13: Rotor installation	27
5.2.18	Step 14: Discharge ring installation	27
5.2.19	Step 15: Shaft alignment	28
5.2.20	Step 16-1: Stator assembly.....	29
5.2.21	Step 16: Stator installation.....	29
5.2.22	Step 17: Shaft seal installation	30
5.2.23	Step 18: Runner blade operating pipes installation	30
5.2.24	Step 19: Runner oil supply head and extension shaft installation	30
5.2.25	Step 20: Runner cone installation	31
5.2.26	Step 21: Bulb nose installation.....	31
5.2.27	Step 22: Generator supports installation	31
5.2.28	Step 23: Access shaft installation and hatch cover closing.....	31
5.2.29	Step 24: Remaining turbine parts installation completion	32
5.2.30	Step 25: Final installation and cabling generator.....	32
5.2.31	Step 26: Generator auxiliary systems installation.....	32
5.2.32	Step 27: Turbine auxiliary systems installation.....	33
5.2.33	Step 28: Cleaning, painting and inspection before initial tests.....	33
5.2.34	Step 29: Turbine and generator mechanical parts complete	33
5.2.35	Step 30: Commissioning	33
Bibliography.....		34
https://standards.ieh.ai/catalog/standards/sist/6d78d939-59d6-4d1e-9a46-9df6ce60432c/iec-63132-5-2023		
Figure 1 – Generic installation flowchart – Bulb turbine and generator embedded parts		7
Figure 2 – Generic installation flowchart – Bulb turbine and generator mechanical parts.....		8
Figure 3 – Draft tube liner installation		12
Figure 4 – Draft tube liner embedment plan		13
Figure 5 – Radial tilting of turbine housing flange.....		16
Figure 6 – Turbine housing installation		17
Figure 7 – Shaft free		23
Figure 8 – Guide vane apparatus final adjustment		26
Figure 9 – Discharge ring installation		28
Table 1 – Draft tube installation tolerances		11
Table 2 – Turbine housing installation tolerances.....		15
Table 3 – Shaft free verifications.....		22
Table 4 – Guide vane apparatus adjustment tolerances		25
Table 5 – Discharge ring measurement.....		28
Table 6 – Stator installation measurement		29

INTERNATIONAL ELECTROTECHNICAL COMMISSION

GUIDANCE FOR INSTALLATION PROCEDURES AND TOLERANCES OF HYDROELECTRIC MACHINES –

Part 5: Bulb turbines and generators

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 63132-5 has been prepared by IEC technical committee 4: Hydraulic turbines. It is an International Standard.

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

Draft	Report on voting
4/456/FDIS	4/462/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

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

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

(standards.iteh.ai)

[IEC 63132-5:2023](https://standards.iteh.ai/catalog/standards/sist/6d78d939-59d6-4d1e-9a46-9dfce60432c/iec-63132-5-2023)

<https://standards.iteh.ai/catalog/standards/sist/6d78d939-59d6-4d1e-9a46-9dfce60432c/iec-63132-5-2023>

GUIDANCE FOR INSTALLATION PROCEDURES AND TOLERANCES OF HYDROELECTRIC MACHINES –

Part 5: Bulb turbines and generators

1 Scope

The purpose of this document is to establish, in a general way, suitable procedures and tolerances for the installation of bulb turbine and generator. This document presents a typical assembly and whenever the words “turbine” and “generator” are used in this part, it refers to bulb turbine and generator. There are many possible ways to assemble a unit. The size of the machine, the design of the machine, the layout of the powerhouse, the sequence of concreting or the delivery schedule of the components are some of the elements that could result in additional steps, or 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.

The document excludes matters of purely commercial interest, except those inextricably bound up with the conduct of installation. It also excludes specifications of the civil works but this aspect of the work should be taken into consideration during the assembly of the units.

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

2 Normative references

There are no normative references in this document.

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:

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

4 Installation flowchart

4.1 Turbine and generator embedded parts

Figure 1 shows a generic installation flowchart for bulb turbine and generator embedded parts.

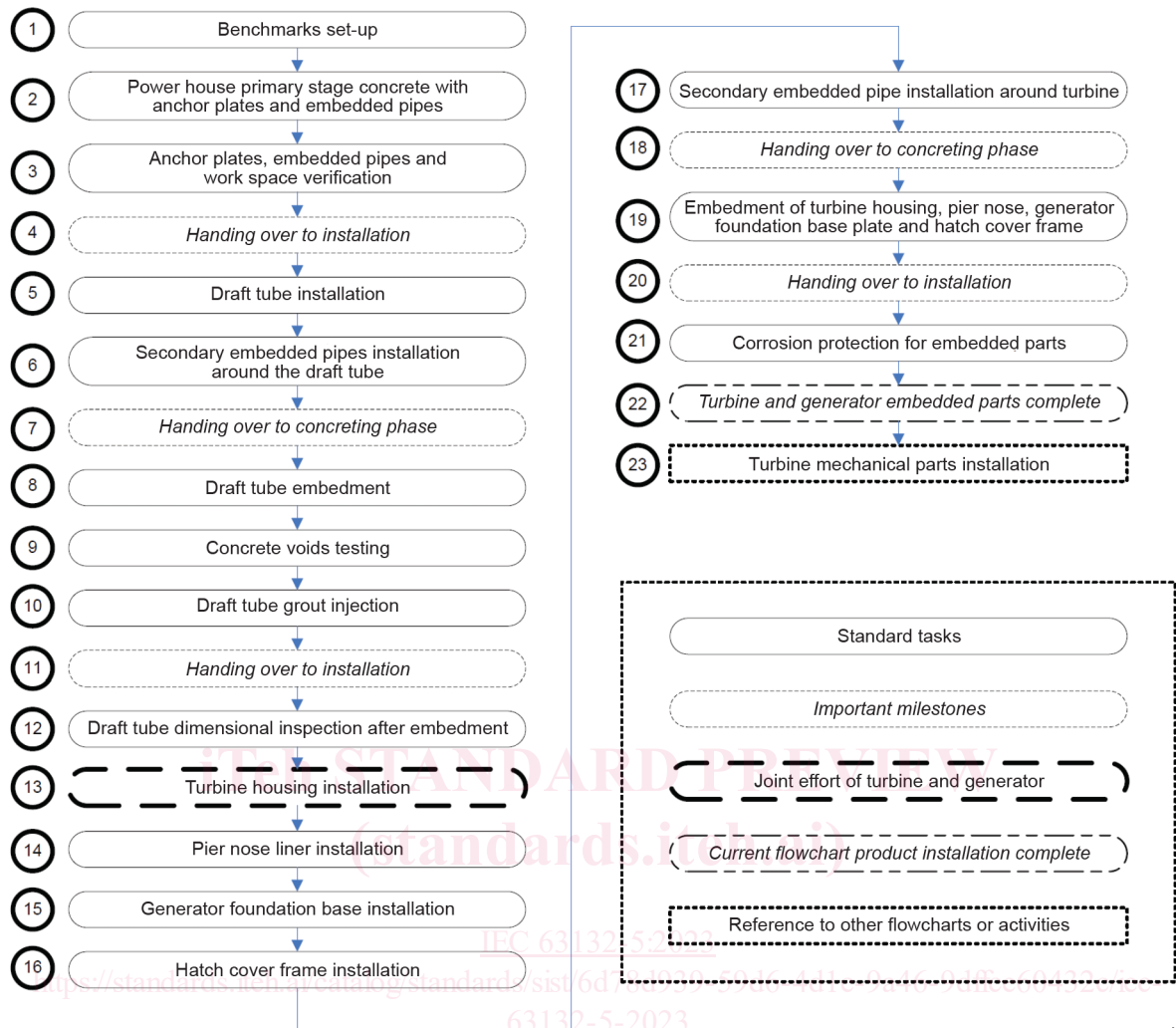


Figure 1 – Generic installation flowchart – Bulb turbine and generator embedded parts

4.2 Turbine and generator mechanical parts

Figure 2 shows generic installation flowchart for bulb turbine and generator mechanical parts.

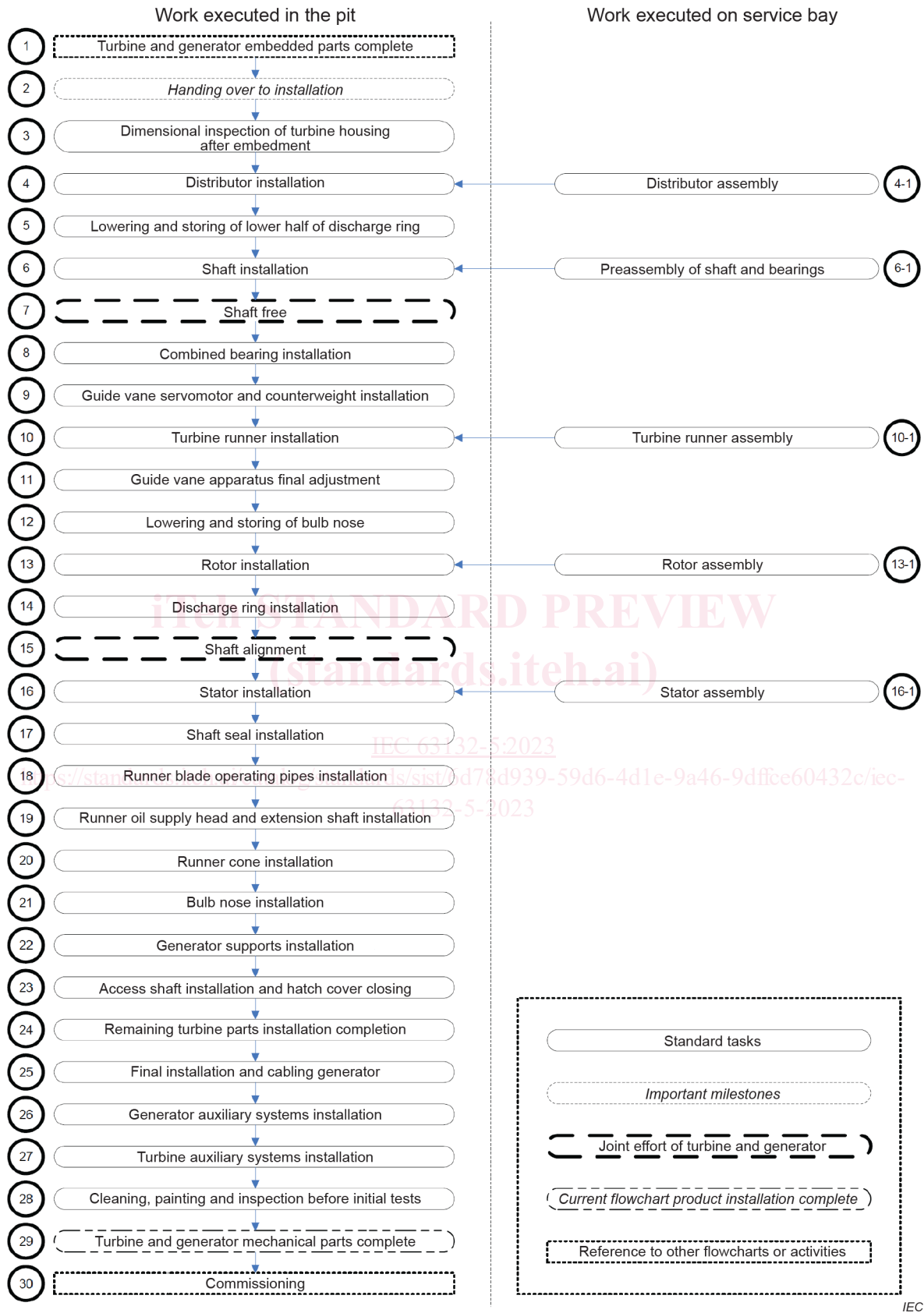


Figure 2 – Generic installation flowchart – Bulb turbine and generator mechanical parts

5 Steps

5.1 Turbine and generator embedded parts

5.1.1 Step 1: Benchmarks set-up

- a) Objective of work in the step
 - Set-up benchmarks to be used for starting proper installation of the turbine and generator.
- b) Explanation of work
 - Sufficient benchmarks should be provided to establish the unit centreline, axis and elevation.
- c) Recommendations

N/A
- d) Additional information

Depending on the project delivery system (EPC, design build, etc.), the benchmarks or their reference points could be provided by the owner, civil contractor, etc. Whoever provides the benchmarks or reference points is responsible to make sure they are correct.

The benchmark type (x, y, z coordinates, definition of the axis and elevations, etc.) should be agreed to before the beginning of the work.

The turbine supplier should take care to transfer the necessary benchmarks throughout the erection and/or concreting processes so that the benchmarks remain accessible as the unit is assembled.

5.1.2 Step 2: Powerhouse primary stage concrete with anchor plates and embedded pipes

- a) Objective of work in the step
 - Install primary embedded pipes, anchor plates and steel foundations in the correct locations.
- b) Explanation of work
 - Install the primary embedded pipes and supporting systems.
 - Install the foundation components of the draft tube liner, servomotor, stay columns and pier nose.
- c) Recommendations

Different designs require different tolerances; therefore, it is recommended that the turbine supplier should provide the tolerances. It is considered as a best practice to perform:

 - Non-destructive tests as applicable (i.e. visual inspections, pressure tests of the piping, test of welding seams).
 - Measures to prevent the concrete from entering the pipes or contaminating the machined surfaces of foundations during concreting.
- d) Additional information

The contract should define which party is responsible to install the primary embedded pipes and/or the foundation components of draft tube liner, servomotor, stay columns and pier nose.

5.1.3 Step 3: Anchor plates, embedded pipes and workspace verification

- a) Objective of work in the step
 - Confirm that the foundation components of draft tube liner, servomotor, stay columns and pier nose have been installed in the correct place. Verify that the shape of concreted area is per the design and there is sufficient access to the workplace.

b) Explanation of work

- Ensure that the dimensions of the shape of concreted area match the design.
- Ensure that there will be no interference between the concrete structures, the reinforcing steels, the scaffolding, etc. and the foundation components of draft tube liner, servomotor, stay columns and pier nose.
- Once the workplace is acceptable, the turbine and generator installation work can start.

c) Recommendations

It is recommended to check that the foundation components of the draft tube liner, servomotor, stay columns and pier nose and the primary embedded pipes were installed within the tolerances provided by the turbine and generator supplier.

d) Additional information

N/A

5.1.4 Step 4: Handing over to installation

a) Objective of work in the step

- The work space is transferred to the turbine and generator supplier.

b) Explanation of work

- There is normally an official transfer of the working area from the civil contractor to the turbine and generator supplier. The transfer is typically documented with some type of signed form.

c) Recommendations

N/A

d) Additional information

N/A

5.1.5 Step 5: Draft tube installation

a) Objective of work in the step

- Install the draft tube (see Figure 3).

b) Explanation of work

- Transportation of the draft tube flange and the draft tube liner segments to the foundation and placing them on the foundation plates.
- Tack-welding of the draft tube flange and the draft tube liner segments.
- Inspection of the alignment and principal dimensions of the draft tube flange and the draft tube liner before welding.
- Welding of the draft tube flange and the draft tube liner.
- Inspection of alignment and measurement of principal dimensions of the draft tube flange and the draft tube liner after welding.

c) Recommendations

The items showed in Table 1 should be checked.

Table 1 – Draft tube installation tolerances

Item	Tolerance	Minimum number of measurements	Measurement location
Junction	To be determined by turbine supplier	8	Difference between the outlet end of the draft tube liner and the inlet of the concrete portion of the draft tube.
Elevation	To be determined by turbine supplier	2 for each side (Left and right)	Elevation of inlet and outlet
Flatness	To be determined by turbine supplier	8 when RD < 4m 16 when RD ≥ 4m	Flatness of inlet flange
Vertical Inclination	To be determined by turbine supplier	2 (Top and bottom)	Vertical inclination of inlet flange
Horizontal Inclination	To be determined by turbine supplier	2 (Left and right)	Horizontal inclination of inlet flange
Orientation	To be determined by turbine supplier	1	Orientation of inlet flange
Concentricity	To be determined by turbine supplier	4 at both inlet flange and outlet end	Concentricity of both inlet flange and outlet end to centre line
Circularity	To be determined by turbine supplier	8 at both inlet flange and outlet end	Circularity of both inlet flange and outlet end
Axial position	To be determined by turbine supplier	1	Axial position of inlet flange to turbine centre line

- Non-destructive tests of the welding seams.
- Proper fixation of the draft tube.

d) Additional information

The sequence for the installation of the draft tube flange and the draft tube liner should be provided by the turbine supplier.

If the downstream concrete portion of the draft tube cannot be completed prior to the installation of the draft tube liner, the outlet position of the draft tube liner cannot be determined by the junction method. Therefore, another method will be required to position the outlet of the draft tube liner. The downstream concrete portion would then be adapted to the draft tube liner outlet.

Adequate supports or bracing are required to prevent the draft tube flange and the draft tube liner from moving or changing shape during placing of the secondary concrete.

The draft tube flange and segments should be checked for any erosion or deformation to be fixed prior to welding/assembly tasks.

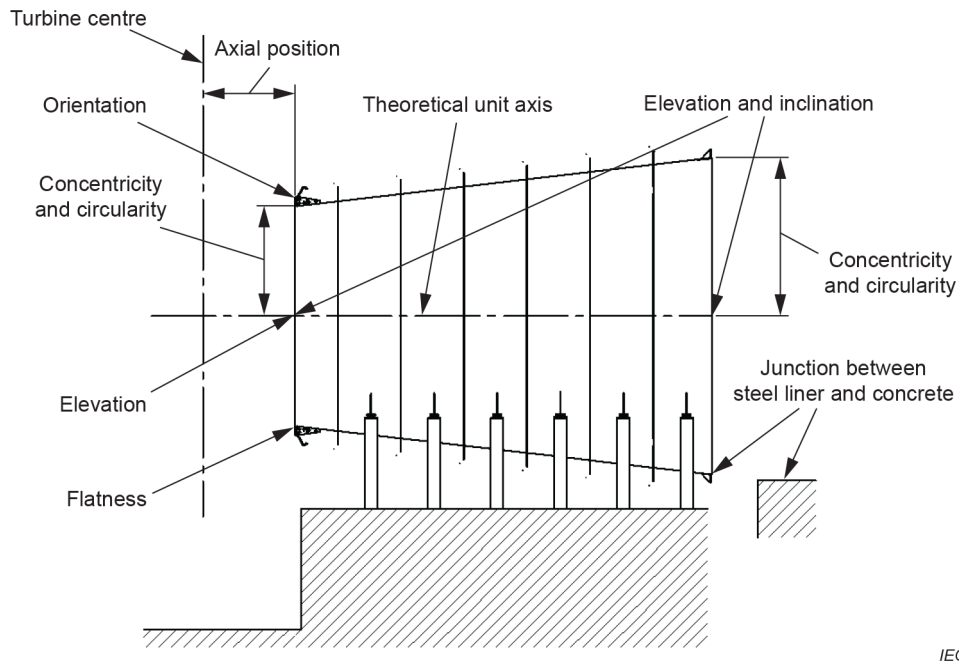


Figure 3 – Draft tube liner installation

5.1.6 Step 6: Secondary embedded pipes installation around the draft tube

- a) Objective of work in the step
 - Install the secondary embedded pipes.
- b) Explanation of work
 - Install the embedded pipes in the draft tube pit prior to concreting.
- c) Recommendations

The following items should be checked:

 - Non-destructive tests performed according to inspection and test plans.
 - Dimensional checks of the locations of the pipes.

The following preventive measures should be considered:

 - Support the pipes so they cannot move or be damaged during concreting
 - Cover/block the pipe openings to prevent concrete from entering the pipes during concreting.
- d) Additional information

Secondary embedded pipes should include draft tube dewatering piping, pressure tapping connections for testing or monitoring purposes, etc.

The condition of the piping, especially the small sizes, should be inspected for any deterioration.

5.1.7 Step 7: Handing over to concreting phase

- a) Objective of work in the step
 - The work space is transferred to the civil contractor.
- b) Explanation of work
 - The turbine supplier should confirm that the draft tube liner has been installed and aligned properly and is ready for concreting.
 - There is normally an official transfer of the working area of the draft tube from the turbine supplier to the civil contractor. The transfer typically is documented with some types of signed form.

c) Recommendations

Refer to Table 1 at step 5 of turbine and generator embedded parts.

d) Additional information

– N/A

5.1.8 Step 8: Draft tube embedment

a) Objective of work in the step

– Embed the draft tube (see Figure 4).

b) Explanation of work

- Install the reinforcements.
- Position of the formwork.
- Pour concrete.

c) Recommendations

The concrete pour rate, pour/step heights and allowable differential levels should be agreed among the concerned parties during the early stages of project development, due to the critical impacts to deformation and misalignment.

d) Additional information

Care should be taken when placing concrete not to damage any of the embedded components or piping.

Figure 4 shows an example of a concreting plan.

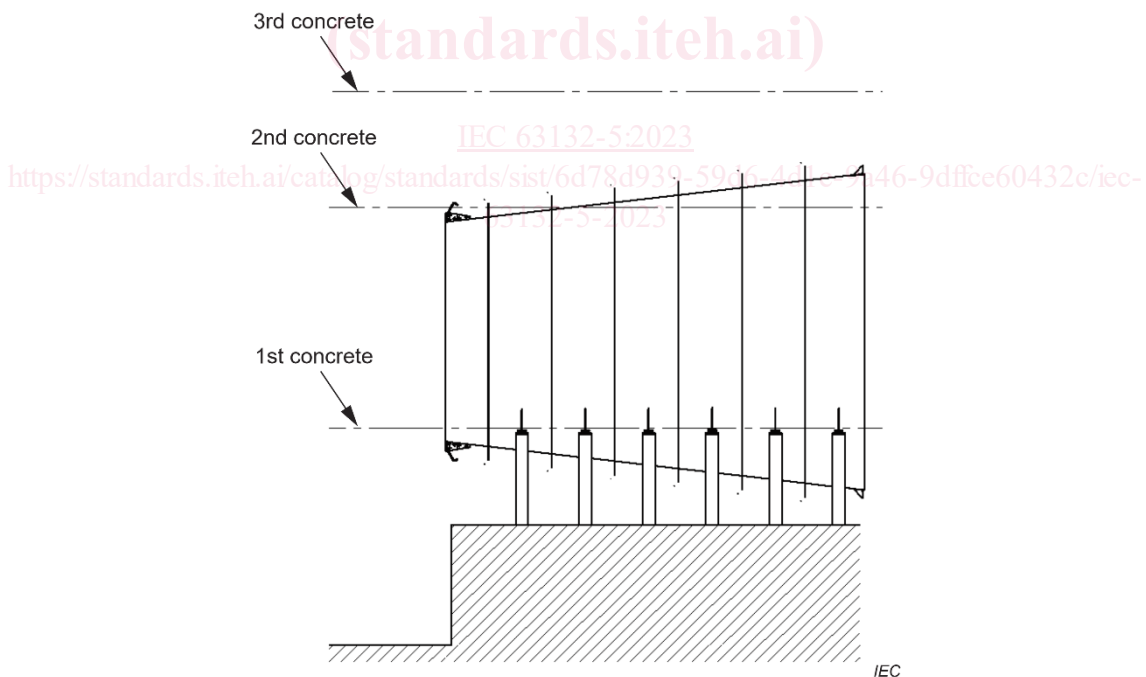


Figure 4 – Draft tube liner embedment plan

5.1.9 Step 9: Concrete voids testing

a) Objective of work in the step

– Determine if there are voids (hollow spaces) between the draft tube liner and the concrete.

b) Explanation of work

– A common method to detect voids is by tapping the inside surface of the draft tube liner with a hammer.