

Hydraulic turbines, storage pumps and pump-turbines — Cavitation pitting evaluation —

Part 1: Evaluation in reaction turbines, storage pumps and pump-turbines

The European Standard EN 60609-1:2005 has the status of a
British Standard

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National foreword

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**Hydraulic turbines, storage pumps and pump-turbines –
Cavitation pitting evaluation
Part 1: Evaluation in reaction turbines,
storage pumps and pump-turbines
(IEC 60609-1:2004)**

Turbines hydrauliques, pompes
d'accumulation et pompes-turbines –
Evaluation de l'érosion de cavitation
Partie 1: Evaluation dans les turbines
à réaction, les pompes d'accumulation
et les pompes-turbines hydrauliques
(CEI 60609-1:2004)

Wasserturbinen, Speicherpumpen,
Pumpenturbinen –
Bewertung des Kavitationsangriffs
Teil 1: Bewertung in Reaktionsturbinen,
Speicherpumpen und Pumpenturbinen
(IEC 60609-1:2004)

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 4/196/FDIS, future edition 1 of IEC 60609-1, prepared by IEC TC 4, Hydraulic turbines, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60609-1 on 2004-12-01.

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- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2005-09-01 |
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Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60609-1:2004 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

This part of IEC 60609 covers the subject of cavitation-pitting evaluation for reaction type hydraulic turbines, storage pumps and pump-turbines, while IEC 60609-2 covers the subject of cavitation-pitting evaluation for impulse (Pelton) type turbines.

Guarantees applied to cavitation pitting in hydraulic reaction turbines, storage pumps and pump-turbines are quite different from other performance guarantees stated in the contract documents representing inherent characteristics of the machine, such as efficiency. The extent of cavitation pitting depends essentially on five factors:

- a) type and design of the machine;
- b) material and surface condition of the parts subjected to cavitation;
- c) setting of the machine, i.e. the cavitation factor sigma (σ) value at the plant;
- d) duration of operation and type of operating conditions; and
- e) water quality.

Items a) and b) describe the machine while items c), d) and e) depend on plant operating conditions. Therefore, the guarantee for cavitation pitting can be established only by mutual agreement between the employer and the contractor during the planning of the plant or during the contract negotiations. Under certain severe conditions such as plant upgrades with runner/impeller replacements or wide operating ranges, it may be to the advantage of the employer to request that tenderers submit a guarantee to cover cavitation pitting in their proposals.

A cavitation-pitting guarantee may be negotiated in two ways:

- either the setting of the machine (and therefore the σ value of the plant) is given in the contract documents, and the amount of the cavitation pitting is agreed upon with due regard to the turbine or pump size, rotational speed, materials, surface conditions, operation, etc. (see Figure 1a);
- or the maximum amount of the cavitation pitting is given and the setting of the machine is agreed upon (see Figure 1b).

In most cases, a machine can be operated normally without cavitation pitting or may be required to operate without cavitation pitting. In some cases, it may be more economical to accept a slight amount of cavitation pitting, which means using a higher setting than would be required for operation of the machine without cavitation pitting. Of course, in the case of underground power stations, the cost of additional submergence is usually relatively low.

It is not feasible to make general recommendations for an acceptable amount of cavitation pitting primarily because items a) through e) make each plant unique. Economic evaluations, therefore, are recommended for each case as conditions warrant. For example, a deeper setting of the machine (higher σ value for the plant requiring higher cost for civil work) and/or a more expensive runner/impeller (shape and/or material) can reduce the amount of cavitation pitting. The benefits of these higher purchase costs are a reduction in the operating cost and/or frequency of repair, as well as a reduction in lost energy production during the shut-down of the unit.

Examples of amounts of cavitation pitting expressed as depth and volume (see 2.2.26 and 2.2.27) as a function of runner/impeller diameter D are given in Annex A.

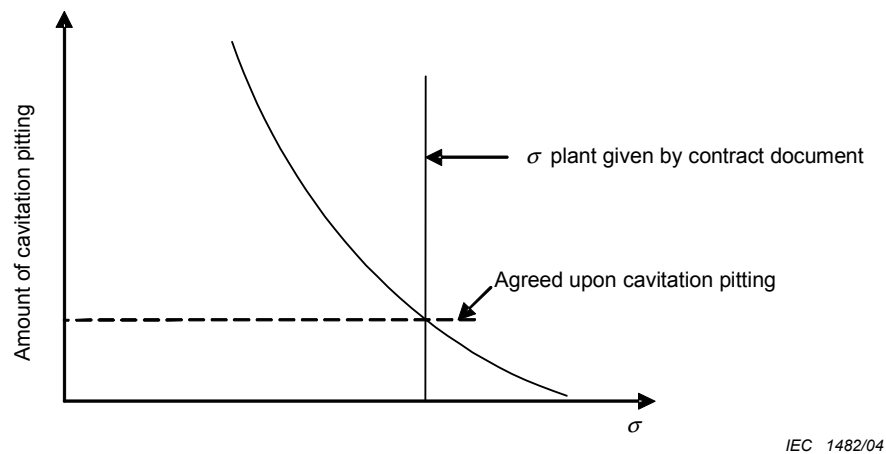


Figure 1a

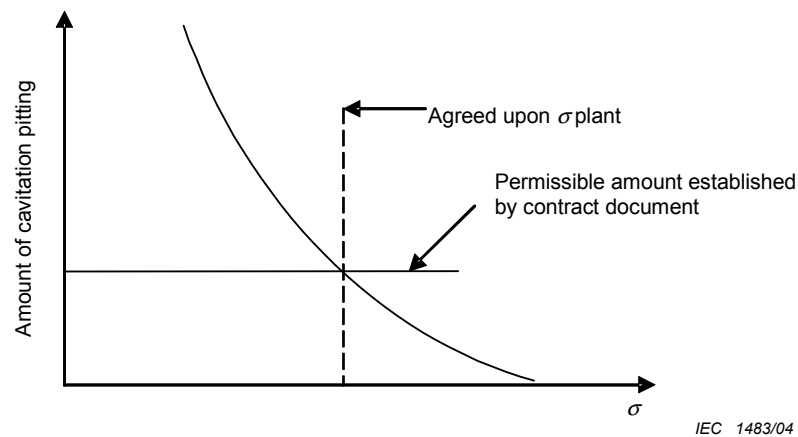


Figure 1b

Figure 1 – Amount of cavitation pitting as a function of σ for a given machine at constant discharge

HYDRAULIC TURBINES, STORAGE PUMPS AND PUMP-TURBINES – CAVITATION PITTING EVALUATION –

Part 1: Evaluation in reaction turbines, storage pumps and pump-turbines

1 Scope and object

This part of IEC 60609 serves as a basis for the formulation of guarantees applied to cavitation pitting for reaction hydraulic turbines, storage pumps and pump-turbines. It addresses the measurement and evaluation of the amount of cavitation pitting on certain specified machine components for given conditions, which are defined in the contract by output, specific hydraulic energy (E), speed, material, operation, etc.

The cavitation-pitting evaluation is based on the loss of material during a given time and under accurately defined operating conditions. All wetted surfaces are considered.

The contract documents shall state whether cavitation pitting on the hydraulic machine should or should not be anticipated in all or in some operating ranges.

Guarantees that restrict the extent of cavitation pitting are necessary in the contract whether cavitation pitting is anticipated or not.

1.1 Excluded topics and limitations

This standard does not cover other effects which cavitation may possibly have on the machine such as:

- output, efficiency, vibration, mechanical integrity, and noise; and
- material defects revealed during operation.

Material defects revealed by wear on the machine surfaces during operation are not included in a guarantee against cavitation pitting.

1.2 Considerations concerning chemical composition of water

It is assumed in this standard that the water is not chemically aggressive. In cases where the water is considered to be chemically aggressive, the cavitation-pitting guarantee shall be given on the basis of an agreed water analysis. Since chemical aggressiveness is dependent upon so many possible chemical compositions, and the materials of the machine, it is beyond the scope of this standard to set particular limits.

If it becomes apparent in the course of later analysis that the water is in fact more aggressive than the agreed analysis indicated, this must be taken into consideration when evaluating whether the cavitation-pitting guarantees have been met. If cavitation pitting occurs in zones where damage can be separately attributable to chemical or electrochemical corrosion, such damage shall be excluded from the evaluation of cavitation pitting. If cavitation pitting occurs in zones where damage can be proven to have been increased by chemical or electrochemical effects additional to those normal to cavitation in water of the agreed analysis, then such zones shall be excluded from the evaluation of cavitation pitting.