BRITISH STANDARD

BS EN 60609-2:1999

Incorporating Corrigendum No. 1 and Amendment No. 1 to BS IEC 60609-2:1997 (renumbers the BS as BS EN 60609-2:1999)

Cavitation pitting evaluation in hydraulic turbines, storage pumps and pump turbines —

Part 2: Evaluation in Pelton turbines

ICS 27.140

National foreword

This British Standard reproduces verbatim IEC 60609-2:1997 and implements it as the UK national standard.

The UK participation in its preparation was entrusted to Technical Committee MCE/15, Hydraulic turbines, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/ European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, the EN foreword page, pages i and ii, the IEC title page, pages ii to iv, pages 1 to 10, Annex ZA and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Amendments issued since publication

Amd. No.	Date	Comments
9968 Corrigendum No.1	March 1998	Title on front cover
15739 Amendment No. 1	28 April 2006	EN title page, EN foreword and Annex ZA

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60609-2

June 1999

ICS 27.140

English version

Cavitation pitting evaluation in hydraulic turbines, storage pumps and pump-turbines
Part 2: Evaluation in Pelton turbines
(IEC 60609-2:1997)

Evaluation de l'érosion de cavitation dans les turbines, les pompes d'accumulation et les pompes-turbines hydrauliques
Partie 2: Evaluation dans les turbines Pelton
(CEI 60609-2:1997)

Bewertung des Kavitationsangriffs in Wasserturbinen, Speicherpumpen und Pumpenturbinen
Teil 2: Bewertung in Peltonturbinen
(IEC 60609-2:1997)

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CENELEC

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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of the International Standard IEC 60609-2:1997, prepared by IEC TC 4, Hydraulic turbines, was submitted to the formal vote and was approved by CENELEC as EN 60609-2 on 1999-05-01 without any modification.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2000-08-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2002-08-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annexes A and ZA are normative and annex B is informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60609-2:1997 was approved by CENELEC as a European Standard without any modification.

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Partie 2: Evaluation dans les turbines Pelton

Cavitation pitting evaluation in hydraulic turbines, storage pumps and pump-turbines –

Part 2: Evaluation in Pelton turbines

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Contents

Foreword

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

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3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.

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International Standard IEC 60609-2 has been prepared by IEC technical committee 4: Hydraulic turbines.

The text of this standard is based on the following documents:

FDIS	Report on voting
4/127/FDIS	4/139/RVD

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

Annex A forms an integral part of this standard.

Annex B is for information only.

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Introduction

IEC 60609 (1978) treats cavitation pitting in reaction machines but does not refer to Pelton (impulse) turbines. Appendix A of IEC 60609 states that Pelton turbines "usually are not subjected to cavitation pitting".

However, experience shows that with increase of specific speed (especially of multijet turbines) and of specific hydraulic energy (head) the probability of cavitation pitting and drop erosion on Pelton turbines increases. Consequently weight loss guarantees on Pelton turbines may be required.

Various types of damage are observed, each the result of different flow phenomena, such as pitting due to:

— profile errors;

— unfavourable inflow conditions;

— erosion due to travelling droplets (drop erosion, also called jet impingement);

and in some instances

— setting conditions (e.g. setting of the runner referred to the tailwater level, or tailwater depression).

The causes of damage are often complex and have to be carefully investigated, taking into account also conditions which are excluded in the cavitation guarantee (see **1.2**). However it is not the objective of this part of IEC 60609 to describe the requirements and measures needed for avoiding cavitation pitting due to

— hydraulic shape and surface roughness of turbine parts (buckets, nozzles, etc.), or

— installation requirements (setting, inflow conditions).

Those requirements are part of the know-how of the turbine contractor.

The damage (i.e. pitting respective weight loss) due to these various causes (cavitation pitting and drop erosion) is combined in the following clauses as the term "cavitation pitting".

1 General

1.1 Scope and object

This part of IEC 60609 serves as a basis for the formulation of guarantees on cavitation pitting on Pelton turbine runners and also for the measurement and evaluation of the amount of cavitation pitting on Pelton turbine runners of a given turbine, which is defined in the contract by power, specific hydraulic energy of machine (head), rotational speed, material, operation, etc.

The sequence of clauses in this part of IEC 60609 is the same as in IEC 60609 (1978). The clauses on measurements and evaluation of the amount of cavitation pitting are practically identical to those of IEC 60609. Evaluation has to be based on the loss of material during a given time and under accurately defined operating conditions.

Guarantees which restrict the extent of cavitation pitting and drop erosion on Pelton turbines at the end of an operating period specified in the contract are necessary when cavitation pitting is expected in all or in some operating ranges. Such guarantees should include limits for operation which are consistent with specified operating conditions.

1.2 Excluded topics

It is assumed in this part of IEC 60609 that the water is not chemically aggressive to a significant degree and that it is essentially free from abrasive solids.

The cavitation guarantee shall, however, be given on the basis of an agreed water analysis. If it becomes apparent in the course of later analysis that the water is in fact more aggressive than the agreed analysis indicated, this shall be taken into consideration when judging whether the given guarantees have been met.

In case of a distorted inflow condition at the inlet of the turbine due to irregularities upstream of the turbine, hydraulic effects may be raised, which beyond the influence on hydraulic performance also may cause cavitation pitting. Therefore it is claimed for the basis of cavitation pitting guarantees that a satisfactorily uniform and vortex-free flow condition shall be provided. In case of damage, the influence of improper inflow condition shall be taken into account.

Abrasion due to water contaminated with solids (e.g. sand) cannot be considered as cavitation pitting. The solids content of the water and also — if relevant — the type of minerals and size and form of solid (sand) particles shall be stated in the water analysis and, if it reaches significant proportion, shall be the subject of a special agreement. Aspects of abrasive wear by sand erosion are dealt with in IEC 61366 (Annex H).

Abrasion may cause a change of the geometry of the needle and/or the bucket and subsequently cavitation pitting as secondary damage. Such damage shall be excluded from the evaluation of cavitation.

If cavitation pitting occurs in zones where damage can be separately attributable to abnormal chemical or electrochemical corrosion, abrasion or mechanical impact, such damage shall be excluded from the evaluation of cavitation.

If cavitation pitting occurs in zones where damage can be shown 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.

In this context, attention should be paid to the material selection in reference to abrasion by sand erosion and/or chemical or electrochemical corrosion.

Material defects revealed by wear on the machine surfaces during operation are not taken into account to verify a guarantee against cavitation pitting.

Special operating conditions such as discharging by means of deflector or cut-in deflector shall be excluded from cavitation pitting guarantees.

1.3 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of IEC 60609. At the time of publication, the edition indicated was valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60609 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60609:1978, *Cavitation pitting evaluation in hydraulic turbines, storage pumps and pump-turbines.*

2 Terms, symbols and definitions

2.1 Units

The International System of units (SI) has been used in this part of IEC 60609. Dimensions for pitting are given in centimetres.

2.2 List of terms

The terms, symbols and definitions adopted in this part of IEC 60609 are listed below[1]:

2.2.1	cavitation	Vapour bubbles which form when the level of local pressure drops to approximately that of vapour pressure and which collapse when the level of local pressure rises above that of vapour pressure.
2.2.2	cavitation pitting	Loss of material caused by cavitation.
2.2.3	drop erosion	Loss of material caused by impact of travelling droplets (liquid impact erosion, jet impingement).
2.2.4	abrasion	Loss of material caused by suspended solids (e.g. sand) eroding the material surface (abrasive wear, sand erosion).
2.2.5	cavitation guarantee	Number of months or years of service of a machine during which the period cavitation pitting guarantee is valid.
2.2.6	cavitation guarantee duration of operation	Number of machine operating hours during which the cavitation pitting guarantee is valid.

[1] They are also based, where relevent, on IEC 61364.

2.2.7	reference duration of operation t_R (h)	Number of machine operating hours used as a reference value for establishing cavitation pitting guarantees.
2.2.8	actual duration of operation t_A (h)	The actual number of machine operating hours at the time of cavitation pitting examination.
2.2.9	E (Jkg^{-1})	Specific hydraulic energy of machine (turbine), $E = gH$, see **2.2.11** and[b].
2.2.10	g (ms^{-2})	Acceleration due to gravity[a].
2.2.11	H (m)	Head of turbine $H = E/g$.
2.2.12	P (W)	Power, mechanical power of the turbine.
2.2.13	P_{CU}	Upper power limit for normal continuous operation specified for each specific hydraulic energy(see Figure 1).
2.2.14	P_{TU}	Upper power limit for temporary abnormal operation specified for each specific hydraulic energy (see Figure 1).
2.2.15	P_{CL}	Lower power limit for normal continuous operation specified for each specific hydraulic energy[c] (see Figure 1).
2.2.16	Continuous normal operating range	Limited by P_{CU} and P_{CL} (see Figure 1).
2.2.17	High turbine load temporary abnormal operating range	Limited by P_{CU} and P_{TU} (see Figure 1).
2.2.18	S (cm)	The absolute maximum depth of any pitted area measured from the original surface; for further explanation see also **2.3**; (guaranteed maximum depth = S_{max})
2.2.19	S_1, S_2, S_3, etc.	The maximum depth of a particular pitted area measured from the original surface.
2.2.20	A (cm^2)	Total area of the whole runner damaged by cavitation pitting: — inside of bucket (location 3, 4, 5 and 6 of Figure 2), — outside of bucket in the range of back of splitter and cut-out (location 1, 1a and 2 of Figure 2), defined, either: a) as all areas damaged by cavitation pitting which require repair (including those which only require grinding), or b) only such areas where a stipulated mutually agreed depth has been exceeded, or c) only such areas which require repair by welding (guaranteed maximum total area = A_{max}).
2.2.21	A_1, A_2, A_3, etc. (cm^2)	Individual areas damaged by cavitation pitting as defined in **2.2.20**.
2.2.22	A_i(cm^2)	Total damaged area of an individual bucket "I"
2.2.23	a	Coefficient defining the maximum allowed deviation from guaranteed maximum bucket area (= A_{max}/z_2); it will be $a > 1$ (see **3.2**).
2.2.24	V (cm^3)	Volume of material of the whole runner removed by cavitation pitting (guaranteed maximum total volume = V_{max}.
2.2.25	k, k_1, k_2, k_3 etc.	Coefficients used in approximate calculation of volume as indicated in **4.2.3** b).

[a] For full information, see IEC 60041.

[b] PCL may be defined by the restricted needle stroke: 15 % of the maximum needle stroke, if not otherwise agreed.

[c] Examples of maximum permissible values of cavitation pitting to be guaranteed for the reference duration (8 000 h): see Figure A.1 with values as a function of inner bucket width B; see also **3.2**.

2.2.26	C_R (cm, cm^2, cm^3)	Guaranteed limit of the amount of cavitation pitting for the reference duration of operation; ($C_R = S_{max}, A_{max}, V_{max}$)[d]
2.2.27	C_A (cm, cm^2, cm^3)	Guaranteed limit of the amount of cavitation pitting at the time of cavitation pitting examination.
2.2.28	B (m)	Inner bucket width (see Figure 2).
2.2.29	z_2	Number of buckets.

[d] Examples of maximum permissible values of cavitation pitting to be guaranteed for the reference duration (8 000 h): see Figure A.1 with values as a function of inner bucket width B; see also **3.2**.

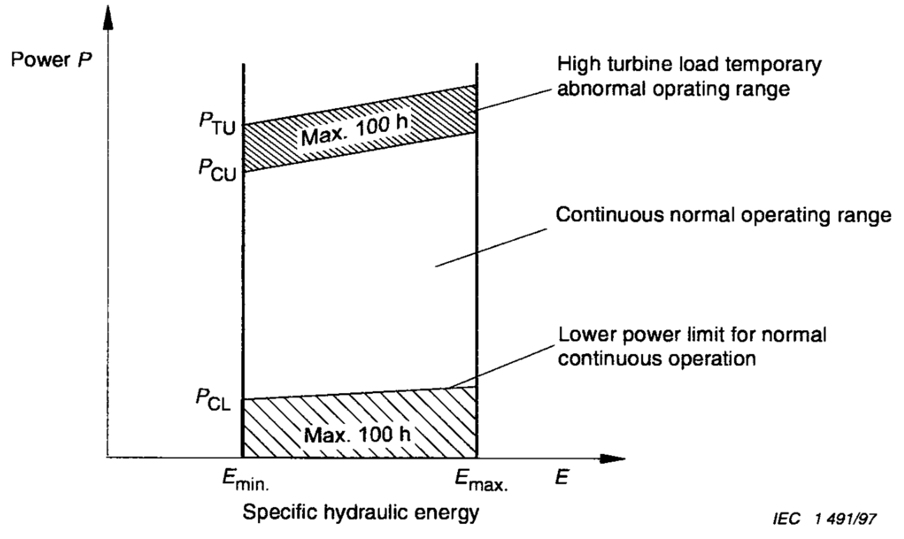


Figure 1 — Operating ranges

2.3 Location and type of damage to Pelton buckets

Various locations of damage due to cavitation pitting (i.e. cavitation pitting and/or drop erosion, see Introduction) to Pelton buckets may be observed, most of them at the inside of the bucket surface. They can be classified by the location which can be defined referring to Figure 2.

The evaluation of the amount of cavitation pitting expressed in depth S, area A or volume V (see **3.2** to **4.2**) is to be made independent of the question of the source of cavitation damage if caused by cavitation impact or by jet liquid impact.

Referring to the depth S, it is to be stated:

a) Of the three parameters defining the amount of cavitation pitting (depth S, area A and volume V) the absolute value of maximum depth S is important, as far as the structural strength is concerned depending on the location.

b) The depth S of pitting is defined in a cavitated area of at least 0,2 cm^2, excluding individual small holes which may be originated also by phenomena different from cavitation.

c) Pitting near or at sensitive locations as for instance cut-out of the bucket at locations 1, 2 and 3 of Figure 2 shall not have a greater depth than the lowest value shown in Figure A.1.

3 Nature and extent of cavitation pitting guarantees

3.1 Period of guarantee

Unless otherwise agreed, the cavitation guarantee period or the cavitation guarantee duration of operation shall be the same as that agreed in the contract for the Pelton turbine as a whole.

3.2 Definition of the amount of cavitation pitting

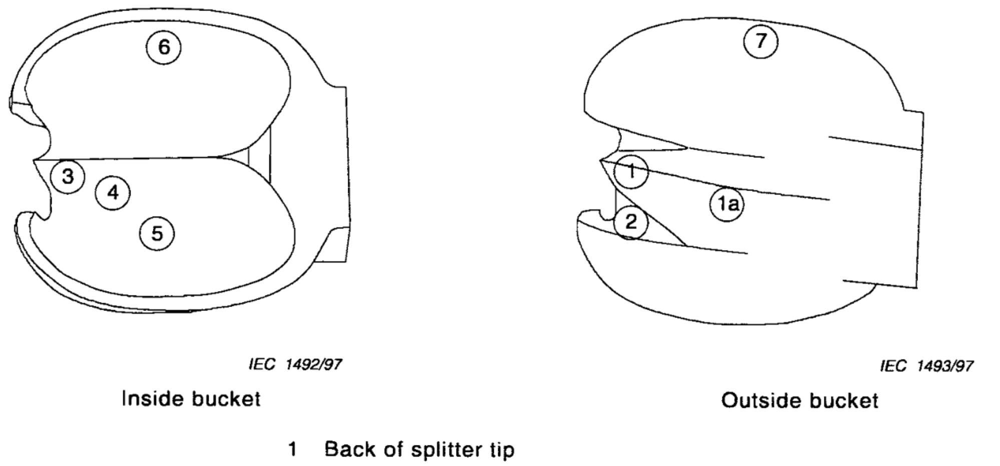
The supply contract should include stipulations governing

a) the amount of cavitation pitting which shall not be exceeded during an agreed reference duration of operation determined in accordance with **3.3.1**;

b) the methods of measurement and calculations to be used for checking fulfilment of the guarantee in accordance with **4.2**.

The guaranteed amount of cavitation pitting may refer to a limitation either of the maximum depth S (as defined in **2.2.18**) or to the area A (as defined in **2.2.20** with alternative a), b) or c) as specified) or the volume removed V (as defined in **2.2.24**) or to a limitation of any two or all three of these quantities.

Values for the guaranteed limit of permissible cavitation pitting S_{max}, A_{max} and V_{max}, and expressed by C_R for the reference duration of operation (see **2.2.26** and **5.1**) are given in Figure A.1.



1 Back of splitter tip
1a Back of splitter
2 Back of cut-out
3 Front of splitter tip
4 Upper zone of splitter
5 Bottom of bucket
6 Upper zone of inside bucket wall
7 Upper zone of outside bucket wall

Figure 2 — Location of damage due to cavitation pitting

A second condition for the damaged area can also be the amount of damaged area A_i of an individual bucket, taking into account the non-uniformity/disparity in cavitation pitting from one bucket to another one. In this respect, the following will apply:

— $A_i < a \times A_{max} / z_2$

definitions for A_i, a and z_2 are given in **2.2.22**, **2.2.23** and **2.2.29**.

— $1{,}5 < a \leq 2{,}0$

If not otherwise agreed, it is assumed $a = 2{,}0$.

3.3 Operating ranges and duration of operation

To establish the cavitation pitting guarantee and to determine whether the guarantee has been met, it is necessary to specify precisely the permissible machine operating range in terms of specific hydraulic energy and power (see Figure 1) together with the corresponding reference duration of operation.

The specific hydraulic energy, power and operating hours shall be recorded during the guarantee period. The turbine contractor shall be given the opportunity to verify whether the agreed conditions have been respected.

3.3.1 Reference duration of operation

In addition to the agreed cavitation guarantee period (see **3.1**) the reference duration — unless otherwise agreed — shall be 8 000 h (irrespective of the guarantee period) and serve as a basis for establishing (see Annex A) and checking the cavitation pitting guarantee (see **4.2**).

For any other agreed reference duration the linear correlation between duration and amount of cavitation pitting analogous to the formula in **5.1** can be applied.

The influence of load (power) which exists, especially at large ratios of jet diameter to bucket width, cannot be considered due to limited current experience.

3.3.2 Actual duration of operation

All operating time up to the time of cavitation pitting examination shall be taken from the station operating records and separated into periods of time for operation within continuous normal operating range and in the high turbine load temporary abnormal operating range and below the lower power limit P_{CL} (see Figure 1).

Unless otherwise agreed, the cavitation guarantee shall become invalid if the following duration of operation is exceeded within the actual duration of operation:

a) high turbine load temporary abnormal operating range, as defined in **2.2.17:** 100 h;

b) below the lower power limit P_{CL} for normal continuous operation as defined in **2.2.15:** 100 h.

3.3.3 Special conditions

The times required for the start-up and shut-down operations of the Pelton turbine shall be included in the actual duration of operation.

Operation of the turbine below P_{CL} should be limited to starting and stopping sequences. The times during which the Pelton turbine is operating with the runner rotating in air shall be excluded from the actual duration of operation.

4 Test procedure

4.1 Repair of cavitation pitting during the guarantee period

The turbine contractor shall have the opportunity to inspect the turbine, after a reasonable operating period (e.g. 200 h or 500 h) to be agreed upon with the user, and to carry out within an agreed period any work which he considers necessary.

If before the end of the guarantee period, the turbine contractor makes

— substantial repairs to cavitation pitting damage, and/or

— significant changes in the shape of components subject to the risk of cavitation (both measures being made by grinding and/or welding)

then the actual duration of the cavitation guarantee as defined in **2.2.6** shall commence from the time the turbine is put into operation again.

If such repairs or changes are of minor nature, i.e. if repair can be made by slight grinding and polishing, the cavitation guarantee period may, by mutual agreement, be considered as uninterrupted.

4.2 Measurement and calculation of the amount of cavitation pitting

Unless otherwise agreed and if the amount of cavitation pitting is being measured for the purpose of checking the fulfillment of the guarantee, the purchaser and supplier shall make such measurements jointly. Such a check should be made prior to the expiration of the cavitation guarantee period or guarantee duration of operation specified in the contract.

Prior to measurement of depth, the measuring points of S shall be ground down to sound material. Prior to measurement of area or volume, all areas damaged by cavitation shall be carefully cleaned or by prior agreement prepared by grinding for a repair by welding.

4.2.1 *The maximum depth S* of a pitted area shall be determined by means of a depth gauge, using a template or other suitable devices which, supported on undamaged areas of the bucket part under consideration, reproduce the original contours of the area with satisfactory accuracy in the zone where material has been lost (see also remarks in **2.3**).

4.2.2 *The individual damaged area A* should preferably be delineated, using a suitable paint — particularly if the contours are irregular and if the area curves in all three dimensions — and be transferred to stable paper by contact. The area shown on the paper may then be determined by planimetering or, if graph paper is used, by counting the squares.

The measuring uncertainty shall not exceed ± 10 %.

The area of pitting to be considered for guarantee purposes has to have a depth of pitting greater than 0,05 cm.

4.2.3 *The loss of material,* the volume V, shall be measured by a method consistent with the guarantee, as follows:

a) *by direct measurement* of the volume of a plastic filler (plastic compound) required to restore the original undamaged surface shape and used to get a negative print. In the event of damage due to cavitation occurring on areas curving in all three dimensions, the shape of the surface should be checked by means of templates or other suitable devices.

The measuring uncertainty shall not exceed ± 15 %.

b) *by approximate calculation*, which unless otherwise agreed may be done with either of the following formulae:

$$V = (k_1S_1A_1 + k_2S_2A_2 + ...)$$

or

$$V = k\ (S_1A_1 + S_2A_2 + ...)$$

where the values k_1, k_2 ... or k may be chosen by mutual agreement depending on the shape of the pitted areas, or with the simplified formula:

$$V = 0{,}5\ \Sigma\ S_iA_i$$

5 Computation of results

5.1 Fulfilment of the guarantee

The cavitation pitting guarantee has been met if, after an operation period within the ranges agreed upon according to **3.3**, the amount of cavitation pitting measured (with due consideration given to inaccuracies of measurement) on the relevant part of the turbine does not exceed the quantities specified in agreement with **3.3**, corrected using the formula

$$C_A = C_R \times (t_A/t_R)$$

Definitions are given in **2.2** (C_A in **2.2.27**, C_R in **2.2.26**, t_A in **2.2.8** and t_R in **2.2.7**).

The difference beween the actual duration of operation at the time of making the inspection (see **2.2.8**) and the reference duration of operation (see **2.2.7**) should be as small as possible. The permissible range of this difference should be mutually agreed upon in the contract. The amount of cavitation pitting is to be determined by using the measuring methods described in **4.2**. The chosen measuring methods shall be specified in the contract.

If operation without cavitation has been guaranteed for all the possible operating ranges specified in the contract, the guarantee has not been met if pitting occurs in operation and if such pitting is clearly attributable to cavitation.

Annex A (normative)
Examples of amounts of cavitation pitting

The diagrams of Figure A.1 show, as examples, the ranges within which the values of maximum depths S in centimetres, area A in cm^2 and volume V in cm^3 may be chosen for runners of Pelton turbines, of martensitic or martensitic/austenitic stainless steel or — may be — of aluminium bronze (in the case of lower specific hydraulic energy), and for the reference duration of operation (8 000 h), based on experience curves.

The values shown are based on the concept of a reasonable amount of repair required after an operating period of two years, irrespective of the above categories.

As stated in **3.1**, it has to be emphasized that the given values for area A and volume V are valid for the whole runner and not only for a bucket (see **2.2.20** and **2.2.24**). Damage on other components of the turbine such as the flow guide and the protection shield inside the casing are not included in the values indicated in Figure A.1.

Emphasis should be given to the fact that these values are examples, and there will be cases in which greater or lesser amounts are agreed upon, depending on the circumstances.

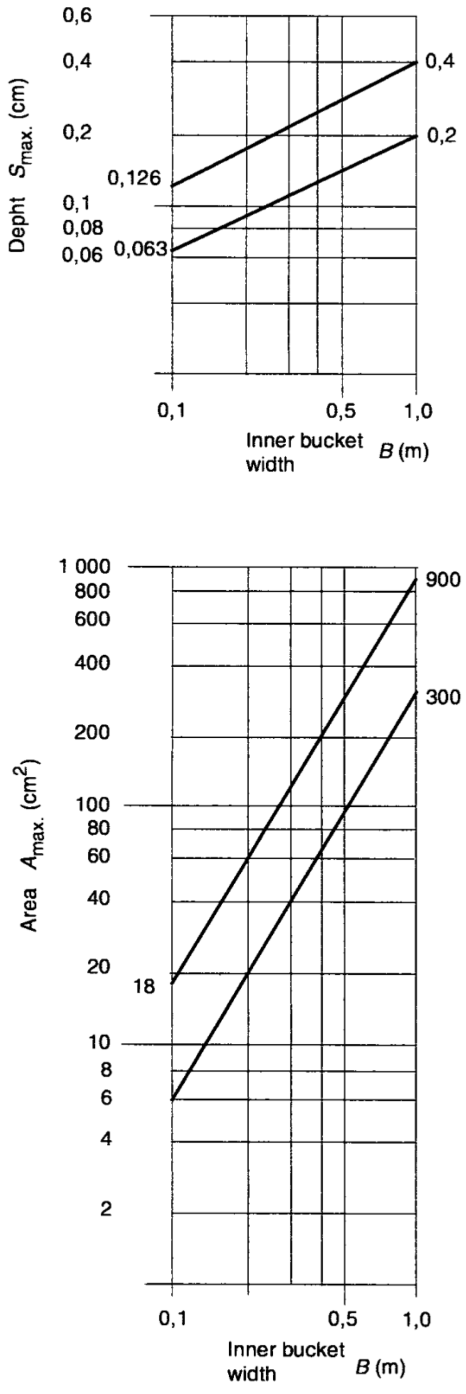
The values adopted should normally lie between the given boundaries. The upper boundary — indicating a greater tendency to cavitation pitting — should be considered if any of the following apply:

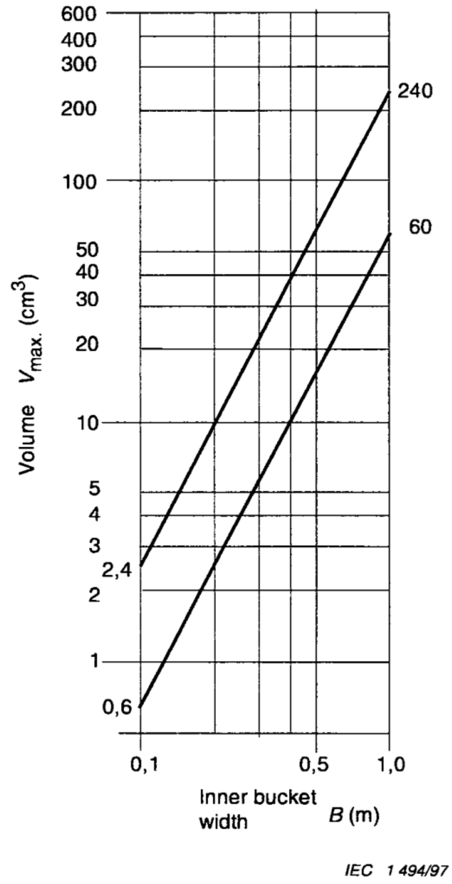
— large number of jets ($z_0 > 4$),

— high specific hydraulic energy of turbine ($E > 8\ 000\ \mathrm{Jkg^{-1}}$), as well

— wide operating range of specific hydraulic energy (in which the operation near E_{min}, see Figure 1, leads to increasing tendency for cavitation pitting).

The potential adverse effect of depth S on the structural strength at sensitive locations is discussed in **2.3**.





Equations for the upper and lower boundaries of the diagrams		
	Upper boundary	Lower boundary
S_{max} (cm)	$0,4 \cdot B^{0,5}$	$0,2 \cdot B^{0,5}$
A_{max} (cm^2)	$900 \cdot B^{1,7}$	$300 \cdot B^{1,7}$
V_{max} (cm^3)	$240 \cdot B^2$	$60 \cdot B^2$
where B is in metres		

Figure A.1 — Examples of maximum permissible values of cavitation pitting on a Pelton runner (for the reference duration of 8 000 h)

Annex B (informative) Bibliography

IEC 60041:1991, *Field acceptance test to determine the hydraulic performance of hydraulic turbines, storage pumps and pump-turbines.*

NOTE: Harmonized as EN 60041:1994 (modified).

IEC 60609:1978, *Cavitation pitting evaluation in hydraulic turbines, storage pumps and pump-turbines.*

IEC 61364, — *Nomenclature of hydraulic machinery*[2)].

IEC 61366, — *Guide for the preparation of tendering documents for hydraulic turbines, storage pumps and pump turbines*[2)].

[2)] To be published

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE: When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60609	1978	Cavitation pitting evaluation in hydraulic turbines, storage pumps and pump-turbines	-	-

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