European Solar Thermal Industry Federation (ESTIF)

# The Spanish Technical Building Code (Royal Decree 314/2006 of 17 March 2006)

## English translation of the solar thermal sections of the code

In March 2006, the Spanish government adopted a new Technical Building Code (TBC, or in Spanish CTE), which includes an obligation to cover 30-70% of the Domestic Hot Water (DHW) demand with solar thermal energy.

The TBC has great importance not only for the market actors active in the Spanish heating market but also for the current debate on effective support policies for solar thermal and other renewable energy technologies in the heating and cooling sector. ESTIF believes that the Spanish Technical Building Code will serve as a model for policy makers all over Europe and beyond.

New buildings planned today will be still in use when oil and gas have become more and more scarce and expensive. Solar thermal, which is already today one of the most cost-effective energy generating technologies, will replace large amounts of fossil fuel and should be integrated into buildings at the time of construction so as to avoid the additional retrofitting costs.

Spain is the first European country to make the implementation of solar thermal energy obligatory in new and refurbished buildings. We are confident that other countries will follow the Spanish example.

Because of the importance of the new Spanish Technical Building Code, the European Solar Thermal Industry Federation (ESTIF) has commissioned and published the following translation of the sections of the TBC which are the most relevant for solar thermal.

We hope this document will provide valuable input to the current debate on support policies for renewable heating and cooling in Europe. We welcome comments and suggestion on the TBC. At a later point, ESTIF will publish its comments on the details of this regulation.

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## Contents of this document



## Source of the original text

The Spanish Technical Building Code (Royal Decree 314/2006 of 17 March 2006) and its Annexes have been published in the Spanish Official Journal on 28 March 2006:
http://www.boe.es/boe/dias/2006/03/28/pdfs/A11816-11831.pdf
http://www.boe.es/boe/dias/2006/03/28/pdfs/SUP06_074C.pdf



This translation has been realised **with the kind support of** Intelligent Energy Europe

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***Abstracts*** ***of***

***ROYAL DECREE 314 of 17 March 2006, approving the Technical Building Code***
And of
***ROYAL DECREE 315 of 17 March 2006, creating the Council for Building Sustainability, Innovation and Quality.***

Published on BOE num 74, of 28 march 2006, pages 11816 ff.

[...]

The Technical Building Code is divided into two parts, both of regulatory nature. Part I contains general provisions (scope, structure, classification of uses, etc.) and the requirements that buildings must meet in order to comply with safety and habitability regulations.

Part II consists of Basic Documents, the appropriate use of which guarantees compliance with the basic requirements. These documents contain procedures, technical rules and examples of solutions for determining whether a building complies with the stipulated performance levels. Said Documents are not exclusive. Recognised Documents, external from and independent of the Code, are created to complement the Basic Documents for the application of the Code. They are used to facilitate compliance with specific requirements and help to promote the quality of construction.

To make these Recognised Documents optimally operable, a General Register of the Technical Building Code shall be created, in which said documents will be entered and made public, together with quality standards and other technical evaluations of a voluntary nature that contribute to compliance with the Code. Other technical evaluations of products, equipment of systems pertaining to their proper implementation or final performance, environmental certificates of product lifecycle analyses and other environmental assessments that promote superior quality in construction could also be entered in this Register.

[...]

**Final provision III.** ***Delegation of authority for regulatory development***

The Minister for Housing shall be vested with powers to approve, by Ministerial Order, such periodic amendments and revisions of the Basic Documents of the Technical Building Code as should prove necessary, as well as the organisation and operation of the General Register of the Technical Building Code, and such provisions as should prove necessary for the development and fulfilment of the provisions of this Royal Decree.

**(Part II of the Technical Building Code is published in a separate supplement)**

**5516** ***ROYAL DECREE 315 of 17 March 2006, creating the Council for Building Sustainability, Innovation and Quality.***

The building sustainability, innovation and quality are enshrined in the government's strategic policy planks for housing…
[...]

However, said sustainability requires the creation of a body, which whilst prompting the development and ongoing updating of the Technical Building Code with due attention to technical progress and the needs of society, can draw up proposals and make recommendations on pertinent policy strategies and measures on building sustainability, innovation and quality.

To that end, a Council for Building Sustainability, Innovation and Quality (hereinafter referred to by the Spanish initials CSICE) shall be formed, and shall see to compliance with what is known as the fourth dimension of sustainability: participation. The Public Authorities and economic and social agents involved in building processes shall be present in said Council so as to guarantee wide participation in actions to develop the Technical Building Code.

[...]

## TECHNICAL BUILDING CODE (TBC) - Contents

The parts translated into English in the present document are **marked in bold and larger font**. Some of them were fully translated, others only in abstracts. The places where text has been omitted sign are identified by the following sign **[…]**

# CHAPTER 1

## General provisions

### Article 1. *Object*

1. The Technical Building Code, hereinafter referred to as TBC, is the regulatory framework governing the basic quality requirements that must be met by buildings, including their installations, in order to comply with the basic safety and habitability regulations, in line with the second additional provision of Building Ordinance Act 38 of 5 November 1999, hereinafter referred to as BOA (known by the Spanish acronym LOE).

2. The TBC stipulates said basic requirements for each of the basic regulations for “structural safety,” “fire safety,” “safe use,” “health, hygiene and environmental protection,” “protection against noise,” and “energy saving and thermal insulation,” laid down in Article 3 of the BOA, and provides procedures for accrediting compliance with sufficient technical guarantees.

3. The basic requirements relative to “functionality” and the functional aspects of constructional elements shall be governed by their specific legislation.

4. The basic requirements must be met in the plan, construction, maintenance and preservation of the buildings and their installations.

### Article 2. *Scope*

1. The TBC shall apply, under the terms set out in the BOA, and with the limitations defined therein, to public and private buildings, the plans for which state precisely that the corresponding permit required by law has been obtained.

2. The TBC shall apply to new construction works, except for technically simple structures of negligible constructional consequence not designated for residential or public use, whether provisional or permanent, that are erected on one level only, and do not affect human safety.

3. The TBC shall likewise apply to extension, modification, alteration or renovation works that are carried out on existing buildings, as and when such works are compatible with the nature of intervention and, where applicable, the degree of protection that the buildings in question may enjoy. Any incompatibility must be justified in the plan and, where applicable, offset by alternative measures that are technically and economically viable.

4. To this end, renovation works shall refer to works intended to produce any of the following results:

a) Structural adequacy, considering as such works that provide the building with structural safety conditions that can guarantee its stability and mechanical resistance.

b) Functional adequacy, considering as such works that create better conditions for the building in regard to the basic requirements referred to in this TBC. In any event, actions intended to remove barriers and promote accessibility in accordance with the legislation in force shall be considered works for functional adequacy; or

c) The remodelling of a building with dwellings so as to modify the floor space intended for housing or to change the number of said dwellings, or the remodelling of a building without dwellings so as to create dwellings.

[...]

6. In any event, compliance with the basic requirements of the TBC shall be verified when the designated use of existing buildings is to be altered, even if this does not necessarily entail works.

[...]

## Article 3. *Content of the TBC*

1. To make it easier to understand, develop, use and update the TBC, the latter is divided into two parts:

a) Part I contains the applicable general terms and conditions of the TBC and the basic requirements that buildings must meet;

b) Part II consists of what are known as Basic Documents, hereinafter referred to as BD, for complying with the basic requirements of the TBC. Based on the consolidated knowledge of the different construction techniques, these documents shall be updated in accordance with technical advancements and social requirements and shall be approved regularly.

2. The BD contain:

a) The definition of the basic requirements and their quantification, inasmuch as scientific and technical development in construction allows, by establishing the limit levels or values for the performances of the buildings or their parts, whereby said performances are seen as all the objectively identifiable qualitative or quantitative characteristics of the building that determine its capability to meet the corresponding basic requirements; and

b) Certain procedures, the application of which accredits the fulfilment of those basic requirements that have been given concrete form through verification methods or solutions sanctioned by practice. They may also contain indications or references to instructions, regulations, or other technical standards for the specification and inspection of materials, test methods and calculation data or processes that will have to be taken into account in drawing up the plan of the building and its construction.

## Article 4. *Recognised Documents and General Register of the TBC*

1. By way of supplement to the Basic Documents, which are regulatory in nature and are included in the TBC for the purpose of making its application more efficient, Recognised Documents of the TBC shall be created, defined as non-regulatory technical documents recognised by the Ministry of Housing, which shall keep a register thereof.

2. Recognised Documents may contain the following:

a) Technical specifications and guides or codes of good practice that include procedures for the design, calculation, maintenance and upkeep of products, elements, and construction systems.

b) Evaluation methods and construction solutions, computer programmes, statistical data on the accident rate in construction and other basic data.

c) Comments on the application of the TBC; or

d) Any other document that facilitates the application of the TBC, excluding those that refer to the use of a particular or patented construction product or system.

3. A General Register of the TBC shall be created in the Ministry of Housing and shall be assigned to the Department of Architecture and Housing Policy. This register shall be accessible to the public for information purposes.

4. Recognised Documents of the TBC shall be entered in said General Register, as may also:

a) Marks, seals, certificates of conformity or other voluntary quality labels of the technical characteristics of products, equipment or systems that are integrated in the buildings and help fulfil the basic requirements.

b) Systems for the certification of conformity of the final performances of the buildings, certificates of conformity produced by agents who take part in the execution of the works, environmental certificates pertaining to product lifecycle analyses, other environmental assessments of the buildings, and other certificates that facilitate compliance with the TBL and promote a superior quality of construction.

c) Organisations authorised by the competent Public Authorities to conduct technical evaluations of the suitability of innovative products or systems or other authorisations or accreditations of organisations and entities which endorse the provision of services that facilitate the application of the TBC.

# CHAPTER 2

**Technical and administrative conditions**

**Article 5. *General conditions for compliance with the TBC***

**5.1 General**

1. Agents who take part in the building process shall be responsible for the application of the TBC in accordance with the provisions of Chapter III of the BOA.

2. To ensure that a building complies with the basic regulations of the BOA mentioned in Article 1 of this TBC, and that it meets the corresponding basic requirements, agents who take part in the building process shall, insofar as their intervention is concerned, comply with the conditions stipulated by the TBC for drawing up the plan, the execution of the works and the maintenance and upkeep of the building.

3. To justify that a building meets the basic requirements defined in the TBC, the parties concerned may opt to:

a) Adopt technical solutions based on the BD, the application of which in the plan, the execution of the works and the maintenance and upkeep of the building is sufficient to accredit compliance with the basic requirements relative to said BD; or

b) Alternative solutions, i.e. solutions that depart fully or partially from the BD. The planner or the supervisor of the works may, under his own responsibility and subject to the prior consent of the developer, adopt alternative solutions, provided that it be duly documented that the planned building meets the basic requirements of the TBC, so that its performances are at least equivalent to those that would have been obtained if the BD were applied.

**5.2 Conformity of products, equipment and materials with the TBC**

1. Construction products that are incorporated permanently in buildings according to their intended use, shall bear the CE mark, in accordance with Directive 89/106/EEC relating to Construction Products, transposed by Royal Decree 1392 of 28 July 1995, and development provisions, or other such European Directives as are applicable.

2. In certain cases, and to secure that the BD suffice, the latter shall define the technical characteristics of products, equipment and systems that are incorporated in buildings, without prejudice to the CE mark applicable to them in accordance with the corresponding European Directives.

3. Marks, seals, certificates of conformity and other voluntary quality labels that facilitate compliance with the basic requirements of the TBC shall be recognised by the competent Administrative Authorities.

4. Certificates of conformity for the final performances of the buildings, certificates of conformity produced by agents who take part in the execution of works, environmental certificates of product lifecycle analysis and other environmental assessments that facilitate compliance with the TBC.

5. TBC compliant shall be considered innovative products, equipment and systems that

are shown to fulfil the basic requirements of the TBC pertaining to construction pursuant to a favourable technical assessment of their intended use, issued, as of the entry into force of the TBC, by the entities duly authorised for that purpose by the competent Public Authorities, on the basis of the following criteria:

a) They shall act with impartiality, objectivity and transparency, deploying appropriate organisation and competent technical staff.

b) They shall have tried and tested experience in the conduct of tests, trials and assessments, guaranteed by an adequate installation of quality management systems for the trial, inspection and monitoring procedures of the assigned assessments.

c) They shall have a set of regulations, expressly approved by the competent Department that authorises the entity, to govern the assignment procedure and guarantee the participation of a balanced representation of the various building agents in the assessment process.

d) They shall provide permanent information to the public on the validity of the technical aptitude assessments and on their scope; and

e) Shall ensure that the characteristics of the products, equipment or systems that are the subject of a favourable technical assessment are maintained.

6. The recognition by the competent Public Authorities stipulated in Sections 5.2.3, 5.2.4 and 5.2.5 shall refer to marks, seals, certificates of conformity or other voluntary quality labels, as well as to certificates of conformity of the final performances of the buildings, environmental certificates, and authorisations from entities that issue technical assessments, legally issued in the EU Member States and the signatory states of the Agreement on the European Economic Area.

[...]

**Article 15. *Basic energy saving (ES) requirements***

1. The aim of the basic “energy saving” requirements is to obtain a rational use of the energy required for *buildings,* reducing their consumption to sustainable limits, and thereby ensuring that part of this consumption comes from renewable sources of energy, thanks to their *design, construction, use* and *maintenance* characteristics.

2. To attain this objective, *buildings* shall be planned, constructed, used and maintained in accordance with the basic requirements stipulated in the following sections.

3. The Basic Document “BD-ESEnergy Saving” shall specify objective parameters and procedures, compliance with which shall ensure that the basic requirements are met and that the minimum quality levels specific to the basic energy saving regulation are exceeded.

15.1 Basic requirement ES 1: Energy demand limitation: *buildings* shall feature a set of characteristics capable of adequately limiting the *energy demand* necessary to ensure *human thermal comfort* in accordance with the local climate, the use of the building, and the summer and winter regime as well as their characteristics of insulation and inertia, air permeability and exposure to solar radiation, reducing the risk of superficial and interstitial humidity that may affect their characteristics, with appropriate treatment of the *thermal points* to limit heat losses or gains and to avoid any hygrothermal problems therein.

15.2 Basic requirement ES 2: Efficiency of thermal installations: *buildings* shall feature appropriate thermal installations to ensure *human thermal comfort* by regulating the efficiency of said installations and their equipment. This requirement is currently being developed in the prevailing Regulation of Thermal Installations and Buildings (RTIB, known by the Spanish acronym 'RITE') and its application shall be defined in the *plan of the building.*

15.3 Basic requirement ES 3: Energy efficiency of lighting installations: *buildings* shall feature adequate lighting installations for the needs of *their users;,*said installations shall also be energy efficient, with a control system to adjust the light to the actual occupancy of the area, as well as a regulation system to optimise the supply of natural light in areas that meet certain conditions.

15.4 Basic requirement ES 4: Minimum solar contribution to domestic hot water: in *buildings* with foreseen demand for hot water or the conditioning of a covered swimming pool, in which, as established in this TBC, part of the thermal energy needs derived from said demand shall be covered by incorporating systems for the collection, storage and use of low temperature solar energy suitable for the global solar radiation of their location and the hot water demand of the building. The values derived from this basic requirement shall be considered minimum values, without prejudice to stricter values that may be established by the competent authorities which contribute to sustainability, in compliance with the specific characteristics of their location and territorial limits.

15.5 Basic requirement ES 5: Minimum photovoltaic contribution to electric power: in *buildings* thus defined in this TBC shall be incorporated systems for the collection and transformation of solar energy into electric power by photovoltaic processes for proprietary use or supply to the network. The values derived from this basic requirement shall be considered minimum values without prejudice to stricter values that may be established by the competent authorities which contribute to sustainability, in compliance with the specific characteristics of their location and territorial limits.

[...]

**March 2006**

# Basic Document ES

## Energy saving

ES 1 Energy demand limitation
ES 2 Efficiency of thermal installations
ES 3 Energy efficiency of lighting installations
ES 4 Minimum solar contribution to domestic hot water
ES 5 Minimum photovoltaic contribution to electric power

# Introduction

## I Purpose

The purpose of this Basic Document is to establish rules and procedures for meeting the basic energy saving requirements. The sections of this BD correspond to the basic requirements ES 1 to ES 5. The correct application of each section entails the fulfilment of the corresponding basic requirement. The correct application of the entire BD entails that the basic "energy saving" regulation is complied with.
The purpose of the basic "energy saving" regulation and the basic requirements, set out in Article 15 of Part I of this TBC, are as follows:

#### Article 15. Basic energy saving (ES) requirements

1. The purpose of the basic "energy saving requirements" is to obtain a rational use of the energy required for *buildings,* reducing their consumption to sustainable limits, and thereby ensuring that part of this consumption is from renewable sources of energy, thanks to *their design, construction, use and maintenance characteristics.*
2. To attain this objective, *buildings* shall be planned, constructed, used and maintained so as to meet the basic requirements stipulated in the following sections.
3. The Basic Document "BD ES Energy Saving" shall specify objective parameters and procedures, compliance with which shall ensure that the basic requirements are met and that minimum quality levels specific to the basic energy regulation are exceeded.

#### 15.1 Basic requirement ES 1: Energy demand limitation

Buildings shall feature a set of characteristics capable of adequately limiting the energy demand necessary to ensure human thermal comfort in accordance with the local climate, the use of the building, and the summer and winter regime as well as their characteristics of insulation and inertia, air permeability and exposure to solar radiation, reducing the risk of superficial and interstitial humidity that may affect their characteristics, with appropriate treatment of the thermal points to limit heat losses or gains and to avoid any hygrothermal problems therein.

#### 15.2 Basic requirement ES 2: Efficiency of thermal installations

*Buildings* shall feature appropriate thermal installations to ensure *human thermal comfort* by regulating the efficiency of said installations and their equipment. This requirement is currently being developed in the prevailing Regulation of Thermal Installations and Buildings (RTIB, known by the Spanish acronym 'RITE') and its application shall be defined in the *plan of the building.*

#### 15.3 Basic requirement ES 3: Energy efficiency of lighting installations

*Buildings* shall feature adequate lighting installations for the needs of *their users;* said installations shall also be energy efficient, with a control system to adjust the light to the actual occupancy of the area, as well as a regulation system to optimise the supply of natural light in areas that meet certain conditions.

**15.4 Basic requirement ES 4: Minimum solar contribution to domestic hot water**

In buildings with foreseen demand for hot water or the conditioning of a covered swimming pool, in which, as established in this TBC, part of the thermal energy needs derived from said demand shall be covered by incorporating systems for the collection, storage and use of low temperature solar energy suitable for the global solar radiation of their location and the hot water demand of the building. The values derived from this basic requirement shall be considered minimum values, without prejudice to stricter values that may be established by the competent authorities which contribute to sustainability, in compliance with the specific characteristics of their location and territorial limits.

**15.5. Basic requirement ES 5: Minimum photovoltaic contribution to electric power**:

In buildings thus defined in this TBC shall be incorporated systems for the collection and transformation of solar energy into electric power by photovoltaic processes for proprietary use or supply to the network. The values derived from this basic requirement shall be considered minimum values, without prejudice to stricter values that may be established by the competent authorities which contribute to sustainability, in compliance with the specific characteristics of their location and territorial limits.

## II Scope

The scope of this BD is specified, for its constituent sections, in the respective such section.
The content of this BD refers only to the basic “energy saving” requirements.
The basic requirements of other basic regulations must also be met, by applying the corresponding DB to each of them.

## III General criteria

Solutions other than those contained in this BD may be used, in which case the procedure set out in Part I, Article 5 of this TBC must be followed, and compliance with the basic requirements must be justified in the plan.
Citations of standards equivalent to EN standards, the reference of which has been published in the Official Journal of the European Union, pursuant to Directive 89/106/EEC on construction products and other directives, shall mention the version of said reference.

## IV Particular conditions for compliance with the BD-ES

The procedures of this BD shall be carried out in accordance with the particular conditions set out therein and with the general conditions for compliance with the TBC, the conditions of the plan, the conditions for the execution of the works and the conditions of the building set out in Articles 5, 6, 7 and 8 of Part I of the TBC.

## V Terms and definitions

For the purposes of this BD, the terms in italics must be used in accordance with the meaning and the conditions defined for each of them in Appendix A of each of the sections of this BD, or in Annex III of Part I of this TBC, when they are commonly used terms throughout the entire Code.

# Section ES 4

# Minimum solar contribution to domestic hot water

## 1 General

### 1.1 Scope

1 This section applies to newly constructed or renovated buildings, irrespective of their use, in which there is a demand for domestic hot water and/or the conditioning of a covered swimming pool.

2 The minimum solar contribution determined by virtue of the basic requirement developed in this Section, could be justifiably diminished in the following cases:

a) When this energy contribution to domestic hot water is covered by the use of renewable sources of energy, co-generation processes, or residual sources of energy from the installation of heat recovery units which are external to the buildings' own heat generation

b) When the attainment of this production level entails exceeding the calculation criteria stipulated by the applicable basic legislation;

c) When the location of the building does not afford sufficient exposure to the sun, owing to external barriers;

d) In the rehabilitation of buildings, when there are irremediable limitations derived from the prior configuration of the existing building or the applicable town planning legislation;

e) In newly constructed buildings, when there are irremediable limitations derived from the applicable town planning legislation, which clearly make it impossible to obtain the necessary collection surface;

f) When so stipulated by the competent body that has to give an opinion on historical and artistic protection.

3 In buildings where the foregoing cases b), c) d), and e) are encountered in the plan, the inclusion of alternative measures or elements that save thermal energy or reduce carbon dioxide emissions equivalent to the energy saving and emission reduction levels that would be obtained by the corresponding thermal solar system, shall be justified with respect to the basic regulations of the legislation in force, by obtaining improvements in the thermal insulation and energy efficiency of the equipment.

### 1.2 Verification procedure

1 For the purposes of this section, the following procedure must be followed:

a) The minimum solar contribution must be obtained according to Section 2.1;

b) The design and sizing conditions of Section 3 must be met;

c) The maintenance conditions of Section 4 must be met.

## 2 Definition and quantification of the requirements

1 The continuously collected solar contributions are minimum levels that can be increased at the developer's discretion or pursuant to provisions enacted by the competent authorities.

### 2.1 Minimum solar contribution

1 The annual minimum solar contribution is the fraction between the annual values of the contributed solar energy required and the annual energy demand obtained from the monthly values. Tables 2.1. and 2.2 show the minimum annual solar contribution for each climatic zone and different levels of domestic hot water demand (DHWD), at a reference temperature of 60 ºC, in the following cases:

a) General: supposing that the support energy source is gas oil, propane, natural gas, and others;

b) Joule effect: supposing that the support energy source is electricity through the Joule effect.

**Table 2.1. Minimum solar contribution in %: General**

| Total Domestic Hot Water Demand of the building (l/d) | Climatic zone | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| 50-5.000 | 30 | 30 | 50 | 60 | 70 |
| 5.000-6.000 | 30 | 30 | 55 | 65 | 70 |
| 6.000-7.000 | 30 | 35 | 61 | 70 | 70 |
| 7.000-8.000 | 30 | 45 | 63 | 70 | 70 |
| 8.000-9.000 | 30 | 52 | 65 | 70 | 70 |
| 9.000-10.000 | 30 | 55 | 70 | 70 | 70 |
| 10.000-12.500 | 30 | 65 | 70 | 70 | 70 |
| 12.500-15.000 | 30 | 70 | 70 | 70 | 70 |
| 15.000-17.500 | 35 | 70 | 70 | 70 | 70 |
| 17.500-20.000 | 45 | 70 | 70 | 70 | 70 |
| > 20.000 | 52 | 70 | 70 | 70 | 70 |

**Table 2.2. Minimum solar contribution in %: Joule effect**

| Total Domestic Hot Water Demand of the building (l/d) | Climatic zone | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| 50-1.000 | 50 | 60 | 70 | 70 | 70 |
| 1.000-2.000 | 50 | 63 | 70 | 70 | 70 |
| 2.000-3.000 | 50 | 66 | 70 | 70 | 70 |
| 3.000-4.000 | 51 | 69 | 70 | 70 | 70 |
| 4.000-5.000 | 58 | 70 | 70 | 70 | 70 |
| 5.000-6.000 | 62 | 70 | 70 | 70 | 70 |
| > 6.000 | 70 | 70 | 70 | 70 | 70 |

2 Table 2.3 shows, for each climatic zone, the annual minimum solar contribution for the application with covered swimming pool conditioning.

**Table 2.3. Minimum solar contribution in %. Swimming pool conditioning**

| | Climatic zone | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| Covered swimming pools | **30** | **30** | **50** | **60** | **70** |

3 In the case of partial occupancy of the systems used for tourist residential purposes as per Section 3, the reasons, design changes, calculations and results must be set out in detail; the sizing criterion being that the system must come as close as possible to the minimum solar contribution level. The sizing of the system will be subject to the condition that the energy produced by the system may not exceed, in any month of the year, 110% of the energy demand, nor 100% in more than three months; to this end, those periods in which the energy demand is 50% below the average corresponding to the rest of the year will not be taken into consideration, and protection measures will be adopted.

4 Irrespective of the intended use of the system, if the actual solar contribution should exceed 110% of the energy demand in a given month of the year, or 100% of said demand for more than three consecutive months, one of the following measures will have to be taken:

a) Fit the system with the capacity of dissipating such excess energy (with specific equipment or by means of night-time circulation of the primary circuit).

b) Partially cover the field of collectors. In this case, the collector is insulated from the heat generated by solar radiation, and in turn discharges any residual excess heat through the primary circuit fluid (which will continue to pass through the collector);

c) Partially empty the field of collectors. This solution prevents overheating, but as the loss from the primary circuit fluid has to be replaced by a fluid with similar characteristics, this operation must, in this case, be included in the tasks covered by the maintenance contract;

d) Divert excess energy to other existing applications.

5 If solutions b) and c) are chosen, operations must be programmed, as part of the maintenance, in line with the partial draining or partial covering of the field of collectors, and the initial conditions must be reinstated. One of these operations is to be carried out before and the other after each energy overproduction period. These solutions are nonetheless recommended only if the building has a continuous maintenance service.

6 When the system is used in a residential dwelling and solution d) is not possible, solution a) is recommended.

7 The system will moreover be monitored throughout the entire year to prevent any damage caused by possible overheating.

8 The orientation and tilt of the generator system and any shade shed on that system will be such as to keep the losses below the limits given in Table 2.4.

**Table 2.4 Maximum losses**

| Case | Orientation and tilt | Shade | Total |
|---|---|---|---|
| General | 10 % | 10 % | 15 % |
| Superposition | 20 % | 15 % | 30 % |
| Architectural integration | 40 % | 20 % | 50 % |

9 Table 2.4 considers three cases: general, superposition of the collectors and architectural integration. In architectural integration, the modules fulfil a dual -- energy and architectural – function, and also replace conventional structural elements, or are constituent elements of the architectural composition. In architectural superposition, the collectors are placed in parallel with the enclosure of the building. This design does not allow for a horizontal layout so as to facilitate the self-cleaning of the modules. A basic rule for the integration or superposition of solar systems is to maintain the alignment with the main axes of the building insofar as possible.

10 Three conditions must be met in all cases: losses by orientation and tilt, losses by shading and total losses must be lower than the limits stipulated in respect of the values obtained with optimal orientation and tilt and without any shade.

11 The optimal orientation will be considered to be due south, while, depending on the period of use, the optimal tilt will have one of the following values:

a) annual constant demand: the geographic latitude;

b) preferred demand in winter: the geographical latitude + 10 º;

c) preferred demand in summer: the geographical latitude – 10 º.

12 The losses due to orientation and tilt, and shade over the collection surface must, without exception, be assessed in accordance with the provisions of Sections 3.5 and 3.6. When, owing to exceptional architectural reasons, the entire annual minimum solar contribution indicated in Tables 2.1, 2.2 and 2.3 cannot be provided as required by the regulations in Table 2.4, justification must be furnished, analysing the distinct configuration alternatives of the building and the location of the system, whereby the solution that ensures the minimum solar contribution will have to be adopted.

# 3 Calculation and sizing

## 3.1 Previous data

### 3.1.1 Calculation of the demand

1 The unit values given in the table below will be taken to assess the demand (Reference demand at 60 ºC).

**Table 3.1. Reference demand at 60ºC** (1)

| Demand criterion | Litres of DHWD/day at 60º C | |
|---|---|---|
| Single-family dwellings | 30 | per person |
| Multi-family dwellings | 22 | per person |
| Hospitals and clinics | 55 | per bed |
| Hotel **** | 70 | per bed |
| Hotel *** | 55 | per bed |
| Hotel/Hostel ** | 40 | per bed |
| Camping | 40 | per site |
| Hostel/Boarding house * | 35 | per bed |
| Homes for the elderly, student dormitories, etc. | 55 | per bed |
| Dressing rooms/collective showers | 15 | per service |
| Schools | 3 | per pupil |
| Barracks | 20 | per person |
| Factories and shops | 15 | per person |
| Administrative premises | 3 | per person |
| Gyms | 20 to 25 | per user |
| Laundromats | 3 to 5 | per kilo of clothing |
| Restaurants | 5 to 10 | per meal |
| Cafeterias | 1 | per meal |

(1) The litres of DHWD/day at 60ºC in the table have been calculated from Table 1 (average daily unit consumption) of UNE 94002:2005 “Thermal solar systems for domestic hot water production: Calculation method for heat demand.”
Equation (3.2) was used for the calculation, with $T_i$ = 12ºC (constant) and T = 45ºC.

2 If a temperature other than 60ºC is selected in the final accumulator, the minimum solar contribution that corresponds to the demand obtained with the reference demands at 60ºC will have to be obtained. Nevertheless, the demand to be considered for the calculation, according to the temperature selected, will be that obtained using the following equation:

$$D(T) = \sum_{1}^{12} D_i(T) \qquad (3.1)$$

$$D_i(T) = D_i(60°C) \times \left[ \frac{60 - T_i}{T - T_i} \right] \qquad (3.2)$$

where

| | |
|---|---|
| D(T) | Annual domestic hot water demand at the selected temperature T |
| $D_i(T)$ | Domestic hot water demand for the month $_i$ at the selected temperature T |
| $D_i$(60 ºC) | Domestic hot water demand for the month $_i$ at 60 ºC |
| T | Temperature of the final accumulator |
| $T_i$ | Average temperature of cold water for the month $_i$ |

3 Values checked by experience or obtained from reliable sources will be taken for other uses.

4 The calculation of the number of people per residential dwelling shall be carried out using the figures below as minimum values:

| Number of bedrooms | 1 | 2 | 3 | 4 | 5 | 6 | 7 | More than 7 |
|---|---|---|---|---|---|---|---|---|
| Number of Persons | 1.5 | 3 | 4 | 6 | 7 | 8 | 9 | Number of bedrooms |

5 Heat losses in water distribution/recirculation at points of consumption will also be taken into account.

6 For the subsequent calculation of the annual solar contribution, the monthly demands will be estimated by taking into consideration the number of units (persons, beds, services, etc.) corresponding to full occupancy, except systems for tourist residential use, for which a specific demand profile based on partial occupancy is justified.

7 The sum of the domestic hot water demands of various buildings in the same area, including all the services, will be taken as pertaining to a single building. Similarly, in buildings with various dwellings or users of DHWD, the sum of the demands of all of them will be taken into consideration for the purposes of this requirement.

8 Where a DHWD level with differences of more than 50% between the days of the week is justified, the corresponding daily average for the week will be taken into consideration, and the accumulation capacity will be equal to that of the day of the week with the highest demand.

9 For covered swimming pools, the environmental temperature and humidity values shall be fixed in the plan; the dry air temperature in the premises will be between 2 ºC and 3 ºC higher than that of the water, with a minimum of 26 ºC and a maximum of 28 ºC, and the relative humidity will be maintained between 55% and 70%, the recommended value being 60%.

### 3.1.2 Climatic zones

1 Figure 3.1 and Table 3.2 indicate the limits of homogeneous zones for the purposes of the requirement. The zones have been defined by taking into account the annual daily average global solar radiation over a horizontal surface area (H), at intervals for each of the zones as indicated below:

**Table 3.2 Global solar radiation**

| Climatic zone | MJ/m2 | KWh/m2 |
|---|---|---|
| I | H < 13.7 | H < 3.8 |
| II | 13.7 ≤ H < 15.1 | 3.8 ≤ H <4.2 |
| III | 15.1 ≤ H < 16.6 | 4.2 ≤ H < 4.6 |
| IV | 16.6 ≤ H < 18.0 | 4.6 ≤ H < 5.0 |
| V | H ≥ 18.0 | H ≥ 5.0 |

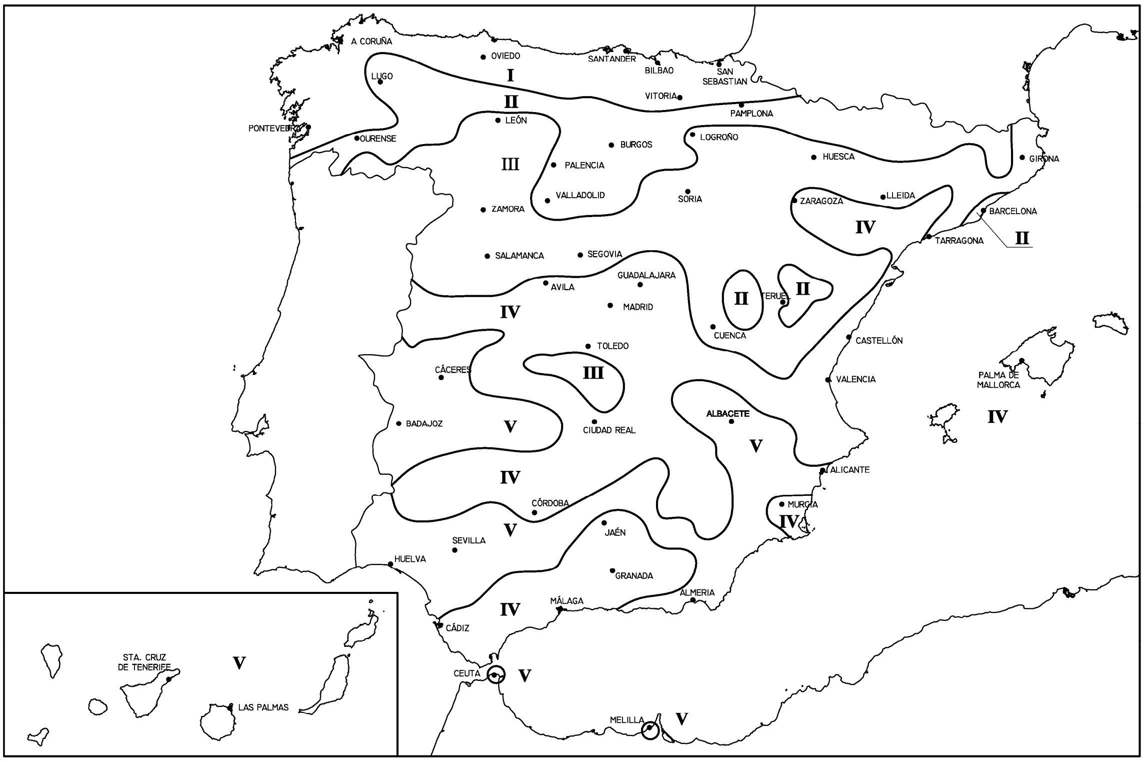


**Fig. 3.1. Zonas climáticas**

**Tabla 3.3 Zonas climáticas**

| | | |
|---|---|---|
| A CORUÑA | Arteixo | I |
| | Carballo | I |
| | A Coruña | I |
| | Ferrol | I |
| | Naron | I |
| | Oleiros | I |
| | Riveira | I |
| | Santiago de compostela | I |
| ALAVA | Vitoria-Gasteiz | I |
| ALBACETE | Albacete | V |
| | Almansa | V |
| | Hellin | V |
| | Villarrobledo | IV |
| ALICANTE | Alcoy | IV |
| | Alicante | V |
| | Benidorm | IV |
| | Crevillent | V |
| | Denia | IV |
| | Elche | V |
| | Elda | IV |
| | Ibi | IV |
| | Javea | IV |
| | Novelda | IV |
| | Orihuela | IV |
| | Petrer | IV |
| | San Vicente del Raspeig | V |
| | Torrevieja | V |
| | Villajoyosa | IV |
| | Villena | IV |
| ALMERIA | Adra | V |
| | Almería | V |
| | El Ejido | V |
| | Roquetas de mar | V |
| ASTURIAS | Aviles | I |
| | Castrillon | I |
| | Gijón | I |
| | Langreo | I |
| | Mieres | I |
| | Oviedo | I |
| | San Martín del rey Aurelio | I |
| | Siero | I |
| AVILA | Ávila | IV |
| BADAJOZ | Almendralejo | V |
| | Badajoz | V |
| | Don Benito | V |
| | Mérida | V |
| | Villanueva de la Serena | V |
| BARCELONA | Badalona | II |
| | Barbera del valles | II |
| | Barcelona | II |
| | Castelldefels | II |
| | Cerdanyola del Valles | II |
| | Cornella de Llobregat | II |
| | Gava | II |
| | Granollers | III |
| | L'Hospitalet de Llobregat | II |
| | Igualada | III |
| | Manresa | III |
| | El Masnou | II |
| | Mataro | II |
| | Mollet del Valles | II |
| | Montcada i | II |
| | El Prat de Llobregat | II |
| | Premia de mar | II |
| | Ripollet | II |
| | Rubi | II |
| | Sabadell | III |
| | Sant Adria de Besos | II |

| | | |
|---|---|---|
| | Sant Boi de Llobregat | II |
| | Sant Cugat del Valles | II |
| | Sant Feliu de Llobregat | II |
| | Sant Joan Despi | II |
| | Sant Pere de Ribes | II |
| | Sant Vicenç dels Horts | II |
| | Santa Coloma de Gramenet | II |
| | Terrassa | III |
| | Vic | III |
| | Viladecans | II |
| | Vilafranca del Penedes | II |
| | Vilanova i la Geltru | II |
| BURGOS | Aranda de Duero | II |
| | Burgos | II |
| | Miranda de Ebro | II |
| CACERES | Cáceres | V |
| | Plasencia | V |
| CADIZ | Algeciras | IV |
| | Arcos de la Frontera | V |
| | Barbate | IV |
| | Cadiz | IV |
| | Chiclana de la frontera | IV |
| | Jerez de la Frontera | V |
| CADIZ | La Línea de la Concepción | IV |
| | El Puerto de Santa Maria | IV |
| | Puerto Real | IV |
| | Rota | V |
| | San Fernando | IV |
| | San Roque | IV |
| | Sanlucar de Barrameda | V |
| CANTABRIA | Camargo | I |
| | Santander | I |
| | Torrelavega | I |
| CASTELLON | Burriana | IV |
| | Castellon de la Plana | IV |
| | La Vall d'uixo | IV |
| | Vila-Real | IV |
| | Vinaroz | IV |
| CEUTA | Ceuta | V |
| CIUDAD REAL | Alcazar de San Juan | IV |
| | Ciudad Real | IV |
| | Puertollano | IV |
| | Tomelloso | IV |
| | Valdepeñas | IV |
| CORDOBA | Baena | V |
| | Cabra | V |
| | Córdoba | IV |
| | Lucena | V |
| | Montilla | V |
| | Priego de Córdoba | V |
| | Puente Genil | V |
| CUENCA | Cuenca | III |
| GIRONA | Blanes | III |
| | Figueres | III |
| | Girona | III |
| | Olot | III |
| | Salt | III |
| GRANADA | Almuñecar | IV |
| | Baza | V |
| | Granada | IV |
| | Guadix | IV |
| | Loja | IV |
| | Motril | V |
| GUADALAJARA | Guadalajara | IV |
| GUIPUZCOA | Arrasate o Mondragon | I |
| | Donostia-San Sebastian | I |
| | Eibar | I |
| | Errenteria | I |
| | Irun | I |
| HUELVA | Huelva | V |
| HUESCA | Huesca | III |
| ILLES BALEARS | Calvia | IV |
| | Ciutadella de Menorca | IV |
| | Eivissa | IV |
| | Inca | IV |
| | Llucmajor | IV |
| | Mahon | IV |
| | Manacor | IV |
| | Palma de | IV |
| | Santa Eulalia del Río | IV |
| JAEN | Alcalá la Real | IV |
| | Andujar | V |
| | Jaén | IV |
| | Linares | V |
| | Martos | IV |
| | Úbeda | V |
| LA RIOJA | Logroño | II |
| LAS PALMAS | Arrecife | V |
| | Arucas | V |
| | Galdar | V |
| | Ingenio | V |
| | Las Palmas de Gran Canaria | V |
| | San Bartolome de Tirajana | V |
| | Santa Lucia | V |
| | Telde | V |
| LEON | León | III |
| | Ponferrada | II |
| | San Andres del Rabanedo | III |
| LUGO | Lugo | II |
| LLEIDA | Lleida | III |
| MADRID | Alcalá de Henares | IV |
| | Alcobendas | IV |
| | Alcorcón | IV |
| | Aranjuez | IV |
| | Arganda del Rey | IV |
| | Colmenar Viejo | IV |
| | Collado Villalba | IV |
| | Coslada | IV |
| | Fuenlabrada | IV |
| | Getafe | IV |
| | Leganes | IV |
| | Madrid | IV |
| | Majadahonda | IV |
| | Mostoles | IV |
| | Parla | IV |
| | Pinto | IV |
| | Pozuelo de Alarcon | IV |
| | Rivas-Vaciamadrid | IV |
| | Las Rozas de Madrid | IV |
| MADRID | San Fernando de Henares | IV |
| | San Sebastian de los Reyes | IV |
| | Torrejon de Ardoz | IV |
| | Tres Cantos | IV |
| | Valdemoro | IV |
| MALAGA | Antequera | IV |
| | Benalmadena | IV |
| | Estepona | IV |
| | Fuengirola | IV |
| | Malaga | IV |
| | Marbella | IV |
| | Mijas | IV |
| | Rincón de la Victoria | IV |
| | Ronda | IV |
| | Torremolinos | IV |
| | Velez-Málaga | IV |
| MELILLA | Melilla | V |
| MURCIA | Águilas | V |
| | Alcantarilla | IV |
| | Caravaca de la Cruz | V |
| | Cartagena | IV |
| | Cieza | V |
| | Jumilla | V |
| | Lorca | V |
| | Molina de Segura | V |
| | Murcia | IV |
| | Torre-Pacheco | IV |

| | | |
|---|---|---|
| | Totana | V |
| | Yecla | V |
| NAVARRA | Barañain | II |
| | Pamplona | II |
| | Tudela | III |
| OURENSE | Ourense | II |
| PALENCIA | Palencia | II |
| PONTEVEDRA | Cangas | I |
| | A Estrada | I |
| | Lalin | I |
| | Marin | I |
| | Pontevedra | I |
| | Redondela | I |
| | Vigo | I |
| | Vilagarcia de Arousa | I |
| SALAMANCA | Salamanca | III |
| SANTA CRUZ DE TENERIFE | Arona | V |
| | Icod de los Vinos | V |
| | La Orotava | V |
| | Puerto de la Cruz | V |
| | Los Realejos | V |
| SANTA CRUZ DE TENERIFE | San Cristobal de | V |
| | Santa Cruz de Tenerife | V |
| | Tacoronte | V |
| SEGOVIA | Segovia | III |
| SEVILLA | Alcala de Guadaira | V |
| | Camas | V |
| | Carmona | V |
| | Coria del Río | V |
| | Dos Hermanas | V |
| | Ecija | V |
| | Lebrija | V |
| | Mairena del Aljarafe | V |
| | Morón de la Frontera | V |
| | Los Palacios y Villafranca | V |
| | La Rinconada | V |
| | San Juan de Aznalfarache | V |
| | Sevilla | V |
| | Utrera | V |
| SORIA | Soria | III |
| TARRAGONA | Reus | IV |
| | Tarragona | III |
| | Tortosa | IV |
| | Valls | IV |
| | El Vendrell | III |
| TERUEL | Teruel | III |
| TOLEDO | Talavera de la Reina | IV |
| | Toledo | IV |
| VALENCIA | Alaquas | IV |
| | Aldaia | IV |
| | Algemesi | IV |
| | Alzira | IV |
| | Burjassot | IV |
| | Carcaixent | IV |
| | Catarroja | IV |
| | Cullera | IV |
| | Gandia | IV |
| | Manises | IV |
| | Mislata | IV |
| | Oliva | IV |
| | Ontinyent | IV |
| | Paterna | IV |
| | Quart de poblet | IV |
| | Sagunto | IV |
| | Sueca | IV |
| | Torrent | IV |
| | Valencia | IV |
| | Xativa | IV |
| | Xirivella | IV |
| VALLADOLID | Medina del Campo | III |
| | Valladolid | II |
| VIZCAYA | Barakaldo | I |
| | Basauri | I |
| | Bilbao | I |
| | Durango | I |
| | Erandio | I |
| | Galdakao | I |
| | Getxo | I |
| | leioa | I |
| | Portugalete | I |
| | Santurtzi | I |
| | Sestao | I |
| ZAMORA | Zamora | III |
| ZARAGOZA | Zaragoza | IV |

## 3.2 General conditions of the system

### 3.2.1 Definition

1 A thermal solar system consists of a set of components designed to collect solar radiation, transform it directly into thermal energy by transferring it to a working fluid, and finally using said thermal energy efficiently, either in the same working fluid of the collectors, or transferring it to another, so as to use it afterwards in the points of consumption. This system is supplemented with thermal energy production by a conventional back-up system which may, but need not be, integrated in the same installation.

2 The constituent systems of the solar thermal installation for hot water are as follows:

a) A collection system composed of solar collectors designed to transform the incident solar radiation into thermal energy so as to heat the working fluid that circulates through them;

b) An accumulation system composed of one or more tanks in which the hot water is stored until its use is specified;

c) A hydraulic system composed of pipes, circulators, valves, etc., which establishes the movement of the hot fluid to the accumulation system;

d) An exchange system that transfers the thermal energy collected from the circuit of the collectors, or primary circuit, to the hot water that is consumed;

e) A regulation and control system that ensures that the equipment functions correctly to supply the maximum thermal solar energy possible, while providing protection against many factors such as the overheating of the system, freezing risks, etc.

f) Furthermore, a conventional back-up energy unit is used to supplement the solar contribution by providing the energy necessary to cover the anticipated demand, thereby guaranteeing the continuity of hot water supply in cases of scarce solar radiation or higher demand than anticipated.

3 Factory-made systems are those produced under conditions presumed to be uniform, and are offered for sale as complete equipment ready to be installed, under a single trademark. Such systems may be compact or remote, but can also constitute an integrated system or a whole and uniform configuration of components.

### 3.2.2 General conditions

1 The basic aim of a thermal solar system is to provide the user with a solar installation that:

a) optimises the global energy supply of the installation in combination with the rest of the building's thermal equipment;

b) guarantees sufficient durability and quality;

c) guarantees a safe use of the installation.

2 Installations shall comprise a primary circuit and a secondary system independent of each other, with an anti-freeze chemical, avoiding any type of mixture of the different fluids that may operate in the installation.

3 In installations with more than 10 m² of collection surface corresponding to a single primary circuit, said circuit will be with forced circulation.

4 If the installation allows the water to attain a temperature of 60 ºC, galvanised steel components will be excluded.

5 With regard to protection against electric discharges, the installation must comply with the relevant regulation in force and the specific applicable standards. .

6 Electrolytic couplings will be installed between elements of different materials to avoid a galvanic couple.

#### 3.2.2.1 Working fluid

1 The carrier fluid will be selected according to the specifications of the manufacturer of the collectors. Tap water, demineralised water, or water with additives can be used as fluid in the

primary circuit, depending on the prevailing climatological characteristics where the system is located and the quality of the water used. If other thermal fluids are used, their composition and thermal capacity must be indicated in the plan.

2 The working fluid must have a pH between 5 and 9 at 20 ℃, and a salt content that will be adjusted as indicated below:

a) The salinity of the primary circuit water must not exceed 500 mg/l of total soluble salt concentration. If it does not have this value, the conductivity value will be taken as a limiting variable, not to exceed 650 µS/cm;

b) The calcium salt content must not exceed 200 mg/l, expressed as calcium carbonate content;

c) The maximum free carbon contained in water must not exceed 50 mg/l.

3 Outside these values, the water will have to be treated.

#### 3.2.2.2 Frost protection

1 The manufacturer, final supplier, installer and designer of the system shall fix the minimum permissible temperature in the system. All the parts of the system exposed to the exterior must be capable of supporting the specified temperature without permanent damage to the system.

2 Any component that is to be installed in an area where the temperature can fall below 0 ℃, must be protected against frost.

3 The system must be protected with a non-toxic chemical of a thermal capacity not less than 3 kJ/kg K, at 5 ºC below the recorded historical minimum so that the primary circuit of the collectors cannot be damaged by frost. Furthermore, said chemical will maintain all its physical and chemical properties within the minimum and maximum intervals of the admissible temperature for all the components and materials of the system.

4 Another frost protection system can be used provided it obtains the same levels of protection and is approved by the Competent Authority.

#### 3.2.2.3 Overheating

##### 3.2.2.3.1 Overheating protection

1 The solar installations must be fitted with manual or automatic control mechanisms that protect the system from overheating, as this can damage the materials or equipment and affect the quality of the power supply. Automatic mechanisms will prevent, in particular, losses of anti-freeze fluid, refilling with a direct connection to the distribution network, and overheating control through excessive waste of tap water. Particular care will be required for seasonally used systems whereby measures will be taken to avoid overheating that may be caused during the period that installations are not used.

2 When the system can be drained to protect it from overheating, the construction must be such that the hot water and/or vapour from the drainage do not pose any danger for the inhabitants and do not cause damage to the system or any other material in the building or dwelling.

3 When the waters are hard, i.e. with a calcium salt concentration between 100 and 200 mg/l, the requisite forecasts will have to be made so that the operating temperature does not exceed 60°C at any point in the consumption circuit, without prejudice to the application of the necessary measures against legionnaire's disease. In any event, the necessary means must be taken to help keep the circuits clean.

##### 3.2.2.3.2 Protection against burns

1 In Domestic Hot Water systems where the hot water temperature at the points of consumption can exceed 60 ℃, an automatic mixing or other system m ust be installed to limit the supply temperature to 60 ℃, although a higher temperature can be attained in the solar part to compensate for losses. This system must be able to support the maximum possible extraction temperature of the thermal solar system.

#### 3.2.2.3.3 Protection of materials against high temperatures

1 The system will have to be calculated in such a way that the maximum admissible temperature for all materials and components is never exceeded.

#### 3.2.2.4 Resistance to pressure

1 The circuits must be subjected to a pressure test 1.5 times the value of the maximum service pressure. The system must be tested with this pressure for at least one hour without any permanent damage or leaks produced in the installations and its interconnections. After this period, the hydraulic pressure must not drop by more than 10% of the average value measured at the start of the test.

2 The consumption circuit must be able to support the maximum pressure required by the national and European regulations on potable water for open and closed consumption water installations.

3 In case of open consumption systems with connection to the distribution network, the maximum pressure thereof will be taken into account to make sure that all the components of the consumption circuit can support this pressure.

#### 3.2.2.5 Backflow prevention

1 The installation of the system must ensure that no relevant energy losses are produced by unintentional backflows in any hydraulic circuit of the system.

2 The natural circulation that produces the backflow may be abetted when the accumulator is situated below the collector, so appropriate precautions must be taken in such a case to prevent this from happening.

3 Non-return valves are recommended for preventing backflows, except in the case of natural circulation equipment.

## 3.3 General calculation criteria

### 3.3.1 Basic sizing

1 The plan report shall indicate the calculation method, specifying, at least on a monthly basis, the average daily values of the energy demand and of the solar contribution. The calculation method shall also include the annual global performances defined for:

a) the thermal energy demand;
b) the thermal solar energy contributed;
c) the monthly and annual solar fractions;
d) the average annual efficiency.

2 It is necessary to verify whether, in any month of the year, the energy theoretically generated by the solar installation exceeds the demand corresponding to the actual occupancy or any other period in which overheating conditions may occur. In such cases appropriate measures must be taken to protect the installation. During this period, the monitoring works described in the maintenance section shall be intensified. Irrespective of the application and technology used, the efficiency of the collector in a solar energy installation must always be greater than or equal to 40%.

Furthermore, the average efficiency in a year in which the installation is used, must be greater than 20%.

### 3.3.2 Collection system

#### 3.3.2.1 General

1 The selected collector shall be certified by the competent body in accordance with the regulations set out in Royal Decree 891 of 14 April 1980, on the approval of solar collectors, and the Order of 28 July 1980, approving additional standards and instructions for the approval of solar collectors, or in accordance with the certification and conditions considered by the regulations that replace them.

2 It is recommended that collectors integrated in the installation are of the same model, in terms of both energy and construction criteria.

3 In installations intended exclusively for the production of domestic hot water by solar energy, it is recommended that the collectors have a global loss coefficient below 10 $Wm^2/°C$ with reference to the efficiency curve depending on the ambient temperature and the inlet temperature, in accordance with the coefficients defined in the legislation in force.

#### 3.3.2.2 Connections

1 Special attention must be paid to the tightness and durability of the collector's connections.

2 The collectors shall be arranged in rows preferably consisting of the same number of elements. The rows of collectors may be connected in parallel, in series, or in series and in parallel, whereby non-return valves must be installed in the inlet and outlet of the different batteries of the collectors and between the circulators, to insulate these components during maintenance, replacement, and other such works. Furthermore, one safety valve shall be installed per row to protect the installation.

3 Within each row, the collectors shall be connected in series or in parallel. The number of collectors that can be connected in parallel shall depend on the manufacturer's restrictions. In the case of an exclusively DHWD application, up to 10 $m^2$ can be connected in series in climatic zones I and 2, up to 8 $m^2$ in climatic zone III, and up to 6 $m^2$ in climatic zones IV and V.

4 The connection between collectors and between rows shall be carried out in such a way that the circuit is hydraulically balanced, with inverted return being recommended before the installation of the balance valves.

#### 3.3.2.3 Supporting structure

1 The safety requirements of the Technical Building Code shall apply to the supporting structure.

2 The calculation and construction of the structure and the collector fixing system shall allow for the necessary thermal dilations, without transferring loads that could affect the integrity of the collectors or the hydraulic circuit.

3 The fastening points of the collector shall be sufficient in number to hold the support area and relative position adequately so that no bending exceeding that permissible by the manufacturers occurs.

4 The fastening ends of the collector and the structure proper must not shade the collectors.

5 In the case of installations integrated in the roof that function as the roof of the building, the structure and tightness between collectors shall be adjusted to the requirements indicated in the corresponding section of the Technical Building Code and other applicable legislation.

### 3.3.3 Solar accumulation system

#### 3.3.3.1 General

1 The thermal solar system must be designed in accordance with the energy it is to contribute throughout the day and not according to the capacity of the generator (solar collector); accumulation must therefore be secured for demand not concurrent with generation.

2 For the DHWD application, the total area of the collectors shall have a value that meets the following condition:

$$50 < \frac{V}{A} < 180 \quad (3.3)$$

Where:

A is the sum of the areas of the collectors [m²];

V is the volume of the solar accumulation tank [litre].

3 The solar accumulation system shall, by preference, be composed of a single tank, of vertical configuration, and be located in interior areas. The accumulation volume may be broken down into two or more tanks, preferably connected in reverse series in the consumption circuit, or in parallel with the balanced primary and secondary circuits.

4 For factory-made systems as defined in section 3.2.1, the necessary thermal levels for preventing legionnaire's disease shall be obtained in accordance with the relevant legislation by not using the installation. For the other installations, and solely for the purpose and at the intervals stipulated by the legislation on the prevention of legionnaire's disease in force, punctual connections may be provided between the auxiliary system and the solar accumulator so the latter can be heated by the back-up system. In both cases, a thermometer that is easy for the user to read must be installed. Other methods to counter legionnaire's disease authorised by the legislation in force may also be used.

5 The accumulators of custom-built large systems with a volume greater than 2 m³ should have shut-off valves and other adequate systems to shut off unintended flows outside the tank in case the system is damaged.

6 For swimming pool conditioning installations only, no accumulation volume can be used, although a small inertia storage may be used in the primary circuit.

#### 3.3.3.2 Situation of the connections

1 The inlet and outlet connections shall be situated so as to avoid preferred fluid circulation paths; moreover

- a) The hot water inlet connection from the exchanger or from the collectors to the exchanger shall preferably be made at a point between 50% and 75% of the overall height;
- b) The cold water outlet connection from the accumulator to the exchanger or the collectors will be made in the lower part of the accumulator;
- c) The connection from the consumption return to the accumulator and cold tap water shall be made in the lower part;
- d) Hot water shall be extracted from the accumulator from the upper part.

2 In duly justified cases where it is necessary to install horizontal tanks, the hot and cold water taps will be situated in diagonally opposite ends.

3 The connection of the accumulators will be such as to allow disconnecting said accumulators individually without interrupting the operation of the installation.

4 A back-up generating system may not be connected to the solar accumulator, as this may reduce the solar installation's capabilities to obtain the energy performances that can be obtained by this type of installation. For equipment of solar installations prepared in factories to host aback-up electrical system, this option must be permanently neutralised with an irreversible seal or other means.

### 3.3.4 Exchange system

1 For an independent exchanger, the minimum capacity of exchanger P shall be determined by the operating conditions during the central hours of the day, with a solar radiation of 1000 W/m² and a 50% efficiency of solar energy to heat conversion , complying with the condition:

$P \geq 500 . A$ (3.4)

Where

P minimum capacity of the exchanger [W];

A area of the collectors [m²].

2 In the case of an exchanger built in the accumulator, the ratio between the useful surface of the exchanger and the total collection surface must not be less than 0.15.

3 A shut-off valve will be installed near the corresponding coupling in each of the exchanger's water inlet and outlet pipes.

4 The consumption circuit can be used as a second exchanger (tertiary circuit).

### 3.3.5 Hydraulic circuit

#### 3.3.5.1 General

1 A hydraulic circuit must be initially designed balanced in and of itself. If this is not possible, the flow must be controlled by balance valves.

2 The volume of the carrier fluid shall be determined in accordance with the manufacturer's specifications pursuant to the design of the product. In the absence of such specifications, said value shall be between 1.2 l/s and 2l/s per 100 m² of collector network. In installations where the collectors are connected in series, the volume of the installation will be obtained by applying the foregoing criterion and dividing the result by the number of serially connected collectors.

#### 3.3.5.2 Pipe system

1 The system of pipes and their materials must be such so as to exclude the possible formation of filling or lime deposits under operating conditions.

2 To avoid heat losses, the length of the pipes of the system must be as short as possible, and elbows and losses of load in general must be avoided as much as possible. Horizontal sections must always have a minimum gradient of 1% in the direction of the circulation.

3 The insulation of weather pipes must comprise external protection that ensures durability against climatological actions and can accept coating with asphalt paint, polyester reinforced with glass fibre, or acrylic paint. The insulation must not leave areas of pipes and accessories visible, leaving outside only those elements that are necessary for the proper functioning and operation of the components.

#### 3.3.5.3 Circulators

1 If the collector circuit is equipped with a circulator, the pressure drop must be maintained acceptably low in the entire circuit.

2 Whenever possible, in-line circulators must be mounted in the colder zones of the circuit, ensuring that no cavitation is produced, with the rotation axis always in horizontal position.

3 In installations larger than 50 m², two identical circulators shall be installed in parallel – with one serving as back-up -- both in the primary and in the secondary circuit. In such a case, these shall be alternatively operable manually or automatically.

4 In swimming pool conditioning installations, the elements shall be arranged as follows: the filter must always be placed between the circulator and the collectors, the direction of current being circulator-filter-collectors; to avoid that the resistance causes overheating that can be harmful for the collectors, particular attention must be paid to its maintenance. The hot water uptake must be from the lower part of the swimming pool, leaving the filtered water uptake on the surface.

#### 3.3.5.4 Expansion vessels

1 The expansion vessels must preferably be connected to the suction of the circulator. The open expansion vessels must be located at such a height as to ensure that the fluid does not overflow, and that no air gets into the primary circuit.

#### 3.3.5.5 Air bleeding

1 Air bleeding systems consisting of de-aeration containers and a manual or automatic bleed valve shall be placed in the high points of the outlet of batteries of the collectors and in all points of the installation where air can accumulate. The useful volume of such a container shall exceed 100 $cm^3$. This volume may be reduced if a de-aeration unit with automatic bleed valve is installed at the outlet of the solar circuit and before the exchanger.

2 If automatic bleed valves are used, the mechanisms necessary for manual bleeding must also be installed.

#### 3.3.5.6 Drainage

1 The drain pipes of the batteries of collectors shall be designed insofar as possible so that they cannot freeze.

### 3.3.6 Conventional back-up energy system

1 To ensure the continuity and supply of the thermal demand, the solar energy installations must have a conventional back-up energy system.

2 The use of conventional back-up energy systems in the primary circuit of collectors is prohibited.

3 The conventional back-up system shall be designed to cover the service as if there were no thermal solar system. It shall go into operation only when strictly necessary and in order to supply the maximum possible energy extracted from the collection field.

4 The conventional back-up energy supply system with accumulation or in line, shall always have a control thermostat to gauge the preparation temperature which, under normal operating conditions, must comply with the legislation in force on the prevention and control of legionnaire's disease.

5 If the conventional back-up energy system has no accumulation, i.e. it is an instantaneous source, the equipment will be modular, i.e. capable of regulating its capacity so that the required temperature can be obtained at all times irrespective of the water temperature at the inlet of said equipment.

6 In the case of swimming pool conditioning, there must be a temperature probe in the water return to the heat exchanger, and a safety thermostat equipped with manual resetting in the uptake that blocks the heat generating system. The tare temperature of the safety thermostat shall be at most 10℃ higher than the maximum uptake temperature.

### 3.3.7 Control system

1 The control system shall ensure the proper functioning of the installations, by managing to obtain a proper utilisation of the collected solar energy, whilst securing an adequate use of the back-up energy. The regulation and control system shall comprise the operational control of the protection and safety circuits and systems against overheating, frost, etc.

2 In forced circulation, the normal operational control of the collector circuit must always be differential, and, if there is a solar accumulation tank, it must operate according to the difference between the temperature of the carrier fluid in the outlet of the battery of the collectors, and that of the accumulation tank. The control system shall operate and be adjusted so that the circulators are not in operation when the difference of temperatures is less than 2 ºC and so that they are not

stopped when the difference is greater than 7 ºC. The difference in temperature between the starting and stopping points of the differential thermostat shall not be less than 2 ºC.

3 The temperature probes for the differential control shall be placed in the upper part of the collectors so as to represent the maximum temperature of the collection circuit. The accumulation temperature sensor will be placed, by preference, in the upper part, in the area not influenced by the circulation of the secondary circuit or by the heating of the exchanger, if the latter has been built in.

4 The control system will ensure that temperatures will under no circumstances exceed the maximum levels supported by the materials, components and treatments of the circuits.

5 The control system shall ensure that the temperature of the working fluid will at no time fall below a temperature three degrees higher than the fluid freezing temperature.

6 Control systems operated by solar radiation could be used alternately with the differential control.

7 Installations with various applications must be fitted with an individual system for selecting the activation of each of them, supplemented with another system that regulates the energy supply thereto. This can be carried out by temperature or volume control, activating by means of a delivery valve, three-way all or nothing, circulators, or by a combination of various mechanisms.

### 3.3.8 Measuring system

1 In addition to the temperature and pressure measuring instruments that ensure proper operation, at least one local analogue measuring system and data recorder shall be installed in each installation larger than 20 m², to indicate the following variables at least;

a) tap cold water inlet temperature;
b) solar accumulator outlet temperature;
c) tap cold water volume.

2 The data processing shall provide at least the thermal solar energy accumulated in time.

## 3.4 Components

### 3.4.1 Solar collectors

1 Collectors with an iron absorber may not be used in any design.

2 When collectors with an aluminium absorber are used, working fluids that have been treated to inhibit copper and iron ions must be used without fail.

3 The collector will preferably have a ventilation opening at least 4 mm in diameter in the lower part to drain water that has accumulated in the collector.
The opening will be made so that all the water can be drained without affecting the insulation.

4 The collector shall be chosen from the different types available on the market for being best suited to the characteristics and operating conditions of the installations, following the manufacturer's specifications and recommendations at all times.

5 The optical characteristics of the surface treatment of the absorber must not undergo substantial changes during the life as indicated by the manufacturer, including under the maximum temperature conditions for the collector.

6 The housing of the collector must ensure that inadmissible stress on the cover is avoided, including under the maximum temperature conditions for the collector.

7 The collector must have a plate in a visible place, indicating at the very least the following data:

a) name and address of the manufacturer, including the latter’s anagram, where available;
b) model, type and year of production;
c) manufacturing serial number;
d) total area of the collector;
e) weight of the empty collector, liquid capacity;
f) maximum service pressure.

8 This plate shall be drawn up at least in Spanish, and may be printed or engraved, provided that the characters remain indelible.

### 3.4.2 Accumulators

1 When the exchanger is built in the accumulator, the identification plate shall moreover indicate the following data:
   a) heat exchange surface in $m^2$;
   b) maximum operating pressure of the primary circuit.

2 Each accumulator shall be equipped, ex factory, by the necessary couplings, welded before the protective treatment, for the following functions:
   a) threaded couplings for the cold water inlet and the hot water outlet;
   b) flanged hole for inspecting the interior of the accumulator, and where necessary, coupling of the coil;
   c) threaded couplings for the inlet and outlet of the primary fluid;
   d) threaded couplings for accessories such as a thermometer and thermostat;
   e) coupling for the drain.

3 In any event, the characteristic plate of the accumulator shall indicate the loss of load thereof.

4 Tanks larger than 750 l shall have a manhole at least 400 mm in diameter that is easily accessible, situated on one of the sides of the accumulator and close to the ground, so that a person can get inside the tank easily, without having to dismantle pipes or accessories;

5 The accumulator shall be covered entirely by insulating material, and it is recommended to have a mechanical protection in oven-painted sheet, GRP, or plastic sheet.

6 Accumulators with the following characteristics and treatments may be used:
   a) Vitrified steel accumulators with cathodic protection;
   b) Steel accumulators treated for resistance to temperature and corrosion with a cathodic protection system;
   c) Stainless steel accumulators suitable for the type of water and operating temperature;
   d) Copper accumulators;
   e) Non-metallic accumulators that can support the maximum temperature of the circuit, the use of which is authorised for drinking water supply companies;
   f) Black steel accumulators (only in closed circuits, when the consumption water belongs to a tertiary circuit);
   g) Accumulators shall be situated in appropriate places where they can be replaced for ageing or damage.

### 3.4.3 Heat exchanger

1 Any heat exchanger between the collector circuit and the supply system to the consumer must not reduce the efficiency of the collector because of a rise in the operating temperature of the collectors.

2 If only one exchanger is used between the collector circuit and the accumulator, in a custom-built installation, the heat transfer from the heat exchanger per collector area unit must not be less than 40 $W/m_2 \cdot K$.

### 3.4.4 Circulation pumps

1 The materials of the circulation pumps of the primary circuit shall be compatible with the anti-freeze mixtures and in general, with the working fluid used.

2 When the connections of the collectors are in parallel, the nominal volume shall be equal to the design volume multiplied by the total number of collectors in parallel.

3 The parasitic electric power for the circulator must not exceed the values given in Table 3.4:

**Table 3.4 Maximum electrical power of the pump**

| System | Electrical output of the circulator |
|---|---|
| Small system | 50 W or 2% of the greater calorific value that the set of collectors can supply |
| Large systems | 1 % of the greater calorific value that the set of collectors can supply |

4 The maximum power of the pump specified previously excludes the power of the pumps of drainage systems with recovery, required only to refill the system after draining.

5 The pumps shall make it possible to carry out the de-aeration or bleeding operation with ease.

### 3.4.5 Pipes

1 Copper and stainless steel can be used as materials in the pipes of the primary system, with threaded, welded, or flanged couplings and exterior protection with anti-corrosive paint.

2 In the secondary or domestic hot water service circuit, copper and stainless steel may be used. Plastics that support the maximum temperature of the circuit and are applicable and authorised by the drinking water supply companies may be used.

### 3.4.6 Valves

1 The valves shall be selected in accordance with the function they perform and the extreme operating conditions (temperature and pressure), following by preference the criteria indicated below:

a) for insulation: globe valves;
b) for balance of the circuits; bedding valves;
c) for emptying: globe valve or male valves;
d) for filling: globe valves;
e) for air bleeding: globe or male valves;
f) for safety: spring valve;
g) for retention: double disc gate valves or swing check valves

2 Owing to their important function, safety valves must be able to derive the maximum from the collector or set of collectors, including in the form of vapour, so that the maximum operating pressure of the collector or the system is not exceeded under any circumstances.

### 3.4.7 Expansion vessels

#### 3.4.7.1 Open expansion vessels

1 When used as filling or refilling systems, the open expansion vessels shall have a feeder, using floating or similar systems.

#### 3.4.7.2 Closed expansion vessels

1 The closed expansion device of the circuit of collectors shall be sized in such a way that, even after an interruption in the power supply to the circulator of the collector circuit, just when solar radiation is maximum, the operation can be automatically re-established when the power is available again.

2 The expansion volume must be sized specially when the heat transfer medium can be evaporated under stagnation conditions. In addition to sizing said volume as usual in closed heating systems (the expansion of the complete heat transfer medium), the expansion tank must be capable of

compensating for the volume of the heat transfer system in the full set of collectors, including all the connecting pipes between collectors, plus 10%.

3 The insulation will not leave any visible areas of pipes and accessories, but will leave outside only those elements necessary for the proper functioning and operation of the components. The insulation used shall be resistant to inclement weather, birds and rodents.

### 3.4.8 Drain valves

1 Automatic drain valves must be avoided when vapour is expected to form in the circuit. Automatic drain valves must support at least the stagnation temperature of the collector and in any event, up to 130 ºC in climatic zones I, II and III, and 150 ºC in climatic zones IV and V.

### 3.4.9 Filling system

1 Circuits with closed expansion vessel must include a manual or automatic filling system for filling and maintaining the system under pressure. In general, it is highly recommended to opt for an automatic filling system that includes a recharging circuit or other device, so that a fluid with characteristics that do not comply with this Section of the Technical Building Code or with a lower concentration of antifreeze is never used directly for the primary circuit. It shall be compulsory when there is , a risk of frost at any time of the year in the area where the installation is located, or when the usual source of water supply does not meet the pH and purity conditions required in this Section of the Technical Building Code.

2 In any event, the primary circuit must at no time be filled with tap water if its properties are such that they can lead to the formation of scale, deposits or damage in the circuit, or if said circuit requires antifreeze to counter the risk of frost, or any other additive in order to function properly.

3 Installations that require antifreeze must include a system for the manual filling thereof.

4 To reduce the risks of failure, uncontrolled supplies of water to replenish closed circuits must be avoided, as must the entry of air that can increase the risks of corrosion from oxygen in the air. It is advisable not to use automatic filling valves.

### 3.4.10 Electric and control system

1 The location and installation of the temperature sensors must ensure a proper thermal contact with the part in which the temperature has to be measured; in the case of immersion probes, they shall be installed against the current with the fluid. The temperature sensors must be insulated against the influence of the ambient environmental conditions.

2 The probes must be installed so that they can measure with precision the temperatures they are designed to control, with the sensors being installed inside sheaths, avoiding separate pipes for the outlet of the collectors and the stagnation areas in the tanks.

3 Preference shall be given to immersion probes. Particular care must be taken to ensure an adequate connection between the contact probes and the metal surface.

## 3.5 Calculation of orientation and tilt losses

### 3.5.1 Introduction

1 The purpose of this section is to determine the orientation and tilt limits of the modules, in accordance with the maximum admissible losses.

2 Such losses shall be calculated according to:

a) the tilt angle, β defined as the angle formed by the surface of the modules with the horizontal plane; with a value of 0 for horizontal modules and 90º for vertical modules;

b) the azimuth angle, α defined as the angle between the projection over the horizontal plane of the normal to the surface of the module and the local meridian. Typical values are 0° for modules due south, -90º for modules due east and +90º for modules due west.

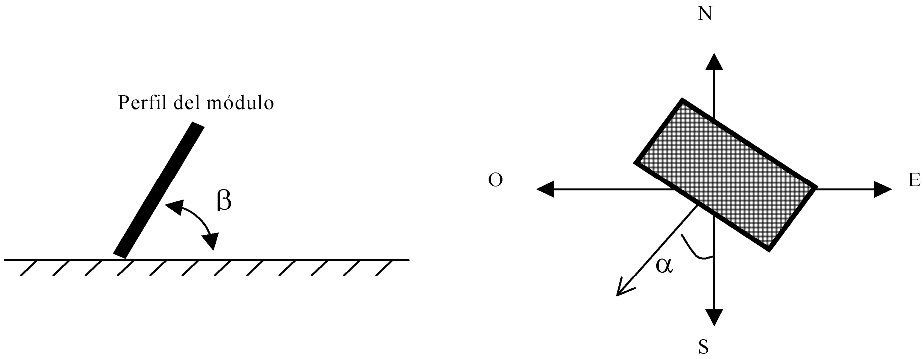


**Figure 3.2** Orientation and tilt of the modules

### 3.5.2 Procedure

1 Once the azimuth angle of the collector has been determined, the acceptable tilt limits will be calculated in accordance with the maximum losses in respect of the optimal tilt, established with Figure 3.3, valid for a latitude (φ) of 41º, as follows:

a) with the azimuth known, we determined in Figure 3.3 the limits for the tilt in case (φ) = 41º. For the general case, the maximum loss is 10%, for superposition 20% and for architectural integration 40 %. The intersection points of the limit of the losses with the straight azimuth give us the maximum and minimum tilt values;

b) If there is no intersection between the two, the losses are greater than those permitted and the installation will fall outside the limits. If the two curves intersect, the values for latitude (φ) = 41º are obtained and corrected as indicated below;

2 The acceptable tilt limits shall be corrected according to the difference between the latitude of the place in question and that of 41º, using the following formulas:

a) maximum tilt = tilt (φ = 41º) – (41º - latitude);

b) minimum tilt = tilt (φ = 41º) – (41º- latitude); its minimum value being 5º.

3 In cases close to the limit, and as a verification instrument, the following formula shall be used;

$$\text{Losses (\%)} = 100 * [\, 1.2*10^{-4} *(\beta - \beta_{opt})^2 + 3.5 *10^{-5}\, \alpha^2] \quad \text{for } 15° < \beta < 90° \qquad (3.5)$$

$$\text{Losses (\%)} = 100 * [\, 1.2*10^{-4} *(\beta - \beta_{opt})^2\, ] \quad \text{for } \beta[15° \qquad (3.6)$$

Note: α and β are expressed in sexagesimal degrees.

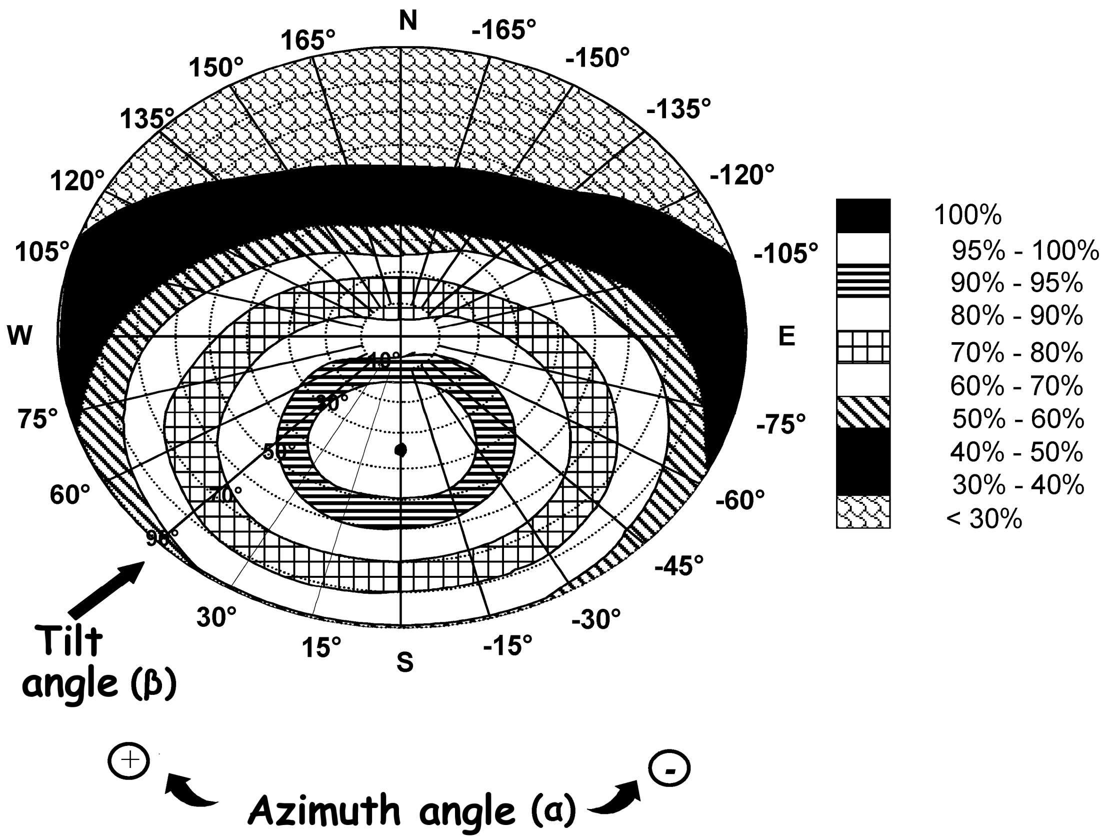


Figure 3.3.
Energy percentage with respect to the maximum as a result of losses due to orientation and tilt.

## 3.6 Calculation of solar radiation losses from shade

### 3.6.1 Introduction

1 This section describes a method for calculating the losses of solar radiation experienced by a surface owing to surrounding shade. Such losses are expressed as a percentage of the global solar radiation that would fall on the aforementioned surface, if there were no shade at all.

### 3.6.2 Procedure

1 The procedure consists of comparing the profile of the obstacles that affect the surface under study with the diagram of sun's trajectories. The steps to follow are:

2 Location of the main obstacles that affect the surface, in terms of their azimuth position coordinates (angle of deviation with the surface facing due south) and elevation (angle of tilt with respect to the horizontal plane). A theodolite can be used for this purpose.

3 Representation of the profile of obstacles in the diagram of Figure 3.4 in which the band of the sun's trajectories over the entire year is shown, valid for locations in the Iberian Peninsula and the Balearic Islands (for the Canary Islands the diagram must be moved 12° vertically upwards). Said band is divided into portions, delimited by solar hours (negative before noon and positive afterwards) and identified by a letter and a number (A1, A2, ..., D14).

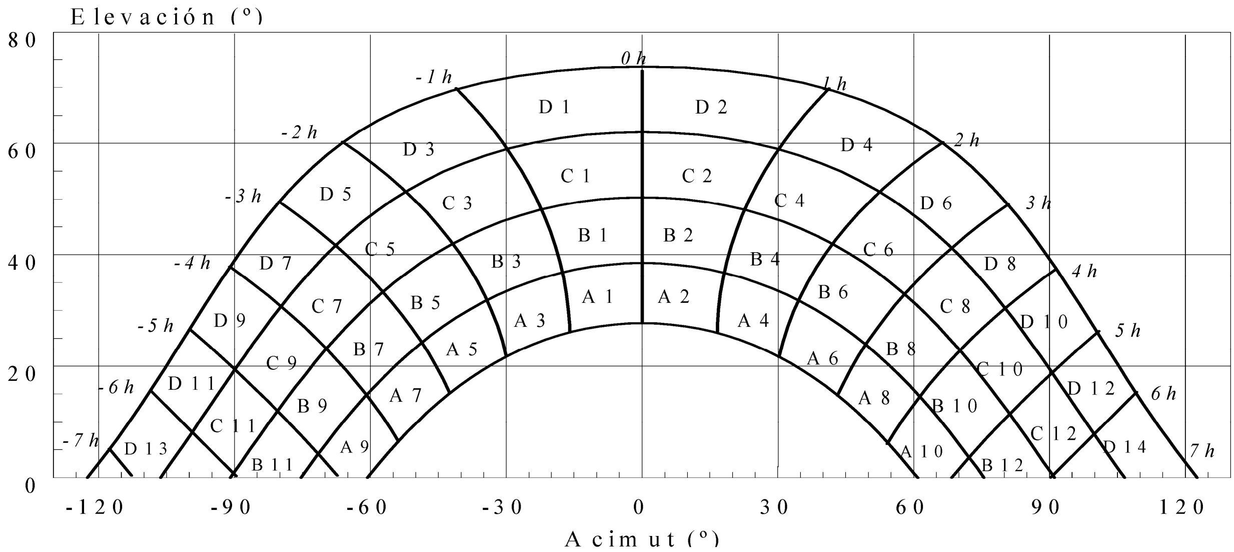


**Figure 3.4** Diagram of the trajectory of the sun

4 Each of the portions of Figure 3.4 represents the course of the sun (one hour throughout various days) and therefore makes a specific contribution to the annual global solar irradiation that falls on the surface under study. Thus, the fact that an obstacle covers one of the portions implies a certain loss of irradiation, in particular that intercepted by the obstacle. The most appropriate reference table of those in Annex B must be selected for the calculation.

5 The comparison of the profile of obstacles with the diagram of the sun's trajectories makes it possible to calculate the losses – to shade -- of the global solar irradiation that falls on the surface throughout the entire year. To this end, the contributions of those portions that are totally or partially concealed by the represented profile of the obstacles must be summed up. In the case of the partial concealment, the filling factor (fraction concealed from the total portion) closest to the values: 0.25, 0.50, 0.75 or 1 will be used.

### 3.6.3 Reference tables

1 The tables in this Section refer to the different surfaces characterised by their tilt and orientation angles (β and α, respectively). The one that seems most similar to the surface under study must be chosen. The numbers in each column correspond to a percentage of annual global solar irradiation that would be lost if the corresponding portion were intercepted by an obstacle.

# 4 Maintenance

1 Without prejudice to the maintenance operations from other legislation and standards, two additional steps are defined so as to include all the operations necessary during the life of the installation in order to ensure operability, increase reliability, and prolong the duration thereof:

a) a surveillance plan;

b) a preventive maintenance plan.

## 4.1 Surveillance plan

1 The surveillance plans refers basically to operations intended to ensure that the operational values of the installation are correct. It is a simple observation plan of the main functional parameters, so as to check that the installation is functioning properly.
It will have the scope described in Table 4.1:

**Table 4.1**

| System element | Operation | Frequency (months) | Description |
|---|---|---|---|
| COLLECTORS | Cleanliness of panes | To be determined | With water and appropriate products |
| | Panes | 3 | VI condensation in the central hours of the day. |
| | Joints | 3 | VI Cracks and deformations. |
| | Absorber | 3 | VI Corrosion, deformation, leaks, etc. |
| | Connections | 3 | VI leaks. |
| | Structure | 3 | VI deterioration, indications of corrosion. |
| PRIMARY CIRCUIT | Piping, insulation and filling system | 6 | VI Absence of humidity and leaks. |
| | Manual drain valve | 3 | Bleed the air from the bottle. |
| SECONDARY CIRCUIT | Thermometer | Daily | VI temperature |
| | Piping and insulation | 6 | VI absence of humidity and leaks. |
| | Solar accumulator | 3 | Accumulated mud in the bottom of the tank drained. |

(1) VI: visual inspection

## 4.2 Maintenance plan

1 This plan comprises operations entailing visual inspection, verification of actions and other operations, which applied to the installation should make it possible to maintain the conditions for the operation, performance, protection and durability of the installation within acceptable limits.

2 The maintenance entails, as a minimum, an annual verification of the installation for installations with a collection surface under 20 m², and a verification every six months for installations with a collection surface of over 20 m².

3 The maintenance plan must be carried out by competent technical staff familiar with thermal solar technology and mechanical installations in general. The installation will have a maintenance record in which will be entered all the operations carried out as well as the preventive maintenance.

4 The maintenance must include all the maintenance operations and replacement of consumable or worn elements, necessary to ensure that the system functions properly during its useful life.

5 The maintenance operations that must be carried out on the thermal solar energy installations for the production of hot water, the minimum frequency (in months), and comments on preventive actions are described in detail below.

**Table 4.2 Collection system**

| Equipment | Frequency (months) | Description |
|---|---|---|
| Collectors | 6 | VI differences from the original |
| | | VI differences between collectors |
| Panes | 6 | VI condensation and dirt |
| Joints | 6 | VI cracks, deformations |
| Absorber | 6 | VI corrosion, deformations |
| Housing | 6 | VI deformations, oscillations, ventilation windows |
| Connections | 6 | VI appearance of leaks |
| Structure | 6 | VI deterioration, indications of corrosion, and bolt torque |
| Collectors* | 12 | Partial covering of the field of collectors |
| Collectors* | 12 | Partial uncovering of the field of collectors |
| Collectors* | 12 | Partial draining of the field of collectors |
| Collectors* | 12 | Partial filling of the field of collectors |

** Operations to be carried out in case of opting for measures b) or c) of Section 2.1.*
(1) VI: visual inspection

**Table 4.3 Accumulation system**

| Equipment | Frequency (months) | Description |
|---|---|---|
| Tank | 12 | Presence of mud at the bottom |
| Sacrifice anodes | 12 | Check for wear |
| Impressed current anodes | 12 | Check for proper operation |
| Insulation | 12 | Check that there is no humidity |

**Table 4.4 Exchange system**

| Equipment | Frequency (months) | Description |
|---|---|---|
| Plate exchanger | 12 | OC efficiency and performances |
| | 12 | Cleanliness |
| Coil exchanger | 12 | OC efficiency and performances |
| | 12 | Cleanliness |

(1) OC: operational control

**Table 4.5 Hydraulic circuit**

| Equipment | Frequency | Description |
|---|---|---|

| | **(months)** | |
|---|---|---|
| Refrigerating fluid | 12 | Check its density and pH |
| Tightness | 24 | Carry out pressure test |
| Exterior insulation | 6 | VI deterioration of the protection of the connections and absence of humidity |
| Interior insulation | 12 | VI connections and absence of humidity |
| Automatic drain valve | 12 | OC and cleanliness |
| Manual drain valve | 6 | Bleed the air from the bottle |
| Circulator | 12 | Tightness |
| Closed expansion vessel | 6 | Check the pressure |
| Open expansion vessel | 6 | Check the level |
| Filling system | 6 | OC action |
| Shut-off valve | 12 | OC actions (open and close) to avoid seizing |
| Safety valve | 12 | OC action |

(1) VI: visual inspection
(2) OC: operational control

**Table 4.6 Electric and control system**

| **Equipment** | **Frequency (months)** | **Description** |
|---|---|---|
| Electrical switchboard | 12 | Make sure that this is always properly closed so that no dust can get in |
| Differential control | 12 | OC action |
| Thermostat | 12 | OC action |
| Verification of the measuring system | 12 | OC action |

**(1)** OC: operational control

**Table 4.7 Back-up energy system**

| **Equipment** | **Frequency (months)** | **Description** |
|---|---|---|
| Back-up system | 12 | OC action |
| Temperature probe | 12 | OC action |

(1) OC: operational control

Note: For systems smaller than 20 m², the maintenance plan tasks, with a frequency of 6 and 12 months, are performed jointly with the annual inspection.
The specific maintenance works of the back-up system are not included.

## Appendix A Terminology

**Absorber:** Component of a solar collector that absorbs radiant energy and transfers it in the form of heat or a fluid.

**Thermal solar collector:** Device designed to absorb solar radiation and to transmit the thermal energy thus produced to a working fluid circulating in its interior.

**Housing:** component of the collector that forms its exterior surface, fixes the cover, contains and protects the other components of the collector, and supports the detents thereof.

**Siding:** Function performed by the collectors when they constitute the roof or the façade of the architectural construction, intended to guarantee the requisite tightness and thermal insulation.

**Primary circuit**: Circuit that comprises the collectors and the pipes that connect them, in which the fluid collects solar energy and transmits it.

**Secondary circuit**: Circuit in which is collected the energy transferred from the primary circuit to be distributed to the points of consumption.

**Consumption circuit:** Circuit through which the consumption water circulates.

**Natural circulation:** When the fluid moves between the collectors and the exchanger of the accumulation tank by convection without being forced.

**Inverted-series connected solar tanks:** Tanks connected so that the consumption water circulates in the opposite direction to that of the solar water heating.

**Solar tanks connected in parallel with the balanced secondary circuit:** tanks connected in parallel so that the consumption water circulates in the opposite direction to that of the solar water heating.

**Shading elements:** When the collectors protect the architectural construction from the thermal overload caused by sunrays, by providing shade on the roof or the façade thereof.

**Architectural integration of the collectors:** When the collectors fulfil a double – energy and architectural – function (revetment, siding or shading), and also constitute conventional structural elements or are constituent elements of the architectonic composition.

**Solar irradiance:** Radiant energy incident on a given surface per unit area expressed in $kW/m^2$.

**Solar irradiation:** Energy incident on a given surface per unit area, obtained by integrating the irradiance during a given time interval, normally an hour or a day. It is measured in $kWh/m^2$.

**Orientation losses:** Quantity of solar irradiation not utilised by the collector system because of not being optimally oriented.

**Tilt losses:** Quantity of solar irradiation not utilised by the collector system because of not being optimally tilted.

**Shade losses:** Quantity of solar irradiation not utilised by the collector system because of shades over that system at a certain point of the day.

**Solar radiation:** Energy from the sun in the form of electromagnetic waves.

**Annual daily average global solar radiation:** Energy from the sun that reaches a specific (global) area, taking the annual value as sum of the daily average values.

**Revetment:** When the collectors constitute part of the envelope of an architectural construction.

**Superposition of the collectors:** When the collectors are placed in parallel to the envelope of the building, without the double function defined in architectural integration. Horizontal modules are not considered, however.

**Stagnation temperature of the collector:** This is the maximum temperature of the fluid obtained when, with the collector being subjected to high levels of radiation and ambient temperature, and the wind speed being negligible, there is no circulation in the collector and quasi-stationary conditions are obtained.

## Appendix C Reference standards

**Royal Decree 1751** of 31 July 1998, approving the Regulation of Thermal Systems in Buildings (known by the Spanish acronym 'RITE') and its Additional Technical Instructions (known by the Spanish acronym (ITE) and creating the Advisory Committee for the Thermal Systems of Buildings.

**Royal Decree 1244** of 4 April 1979, approving the Regulation of Pressure Devices (known by the Spanish acronym 'RAP').

Amended by Royal Decree 507 of 15 January 1982, amending the Regulation of Pressure Devices approved by Royal Decree 1244 of 4 April 1979 and by Royal Decree 1504/1990, amending certain articles of the RAP.

**Royal Decree 842** of 2 August 2002, approving the Electrotechnical Regulation for Low Voltage.

**Royal Decree 865** of 4 July 2003, establishing health and hygiene criteria for the prevention and control of legionnaire's disease.

**Environmental Protection Act no. 38** of 22 December 1972.

Amended by Integrated Prevention and Control of Contamination Act 16 of 1 July 2002.

**UNE-EN 12975-1:2001** "Thermal solar systems and components—Solar Collectors — Part 1: General Requirements"

**UNE-EN 12975-2:2002** "Thermal solar systems and components—Solar collectors — Part 2: Test Methods"

**UNE-EN 12976-1:2001** "Thermal solar systems and components—Factory-made systems— Part 1: General Requirements"

**UNE-EN 12976-2:2001** "Thermal solar systems and components— Factory-made systems — Part 2: Test Methods"

**UNE-EN 12977-1:2002** "Thermal solar systems and components— Custom-built systems— Part 1: General Regulations"

**UNE-EN 12977-2:2002** "Thermal solar systems and components— Custom-built systems — Part 2: Test Methods"

**UNE EN 806-1:2001** "Specifications for the conveyance of water for human consumption in buildings. Part 1: General"

**UNE EN 1717:2001** "Protection against pollution of potable water in water installations and general requirements of devices to prevent pollution by backflow"

**UNE EN 60335-1:1997** "Household and similar electrical appliances – Safety. Part 1: General Requirements"

**UNE EN 60335-2-21:2001** "Household and similar electrical appliances – Safety. Part 2: Particular requirements for electrical thermoses"

**UNE EN-ISO 9488:2001** "Solar energy. Vocabulary."

**UNE-EN 94 002: 2004** "Thermal solar systems for domestic hot water production: Calculation method for heat demand."