

Code of practice for

Solar heating systems for swimming pools

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- British Precast Concrete Federation Ltd.
- Chartered Institution of Building Services Engineers
- Consumer Standards Advisory Committee of BSI
- Consumers Association
- Copper Development Association
- Cranfield Institute of Technology
- Department of the Environment
- Department of the Environment (Building Research Establishment)
- Design Council
- Engineering Equipment and Materials Users' Association
- Flat Glass Manufacturers' Association
- Institute of Plumbing
- Institution of Gas Engineers
- International Solar Energy Society
- National Centre for Alternative Technology
- Royal Institute of British Architects
- Solar Trade Association
- Swimming Pool and Allied Trades Association Ltd.
- University College Cardiff

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- British Plastics Federation
- University of Exeter

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Foreword

This British Standard code of practice, prepared under the direction of the Refrigeration, Heating and Air Conditioning Standards Committee, gives recommendations for the use of solar energy for heating swimming pools. Because swimming pools do not need to be heated to a high temperature, but nevertheless need a great deal of energy, they are a particularly suitable application for solar heating. The relatively low temperature requirements allow collectors (often simple unglazed types) to operate at high collection efficiencies. In addition the swimming pool itself provides a heat store reservoir while the pool filtration system offers a means of circulating the pool water through the solar collector circuit for a minimum extra cost.

This code is intended to assist the swimming pool industry and building services engineers to provide well constructed and durable equipment for swimming pool heating. Reference is also made to the use of pool covers. Emphasis is on general principles but guidance is given on the method of operation and expected performance of solar heating systems; this should be furnished to customers, by way of preliminary information, in the interests of consumer protection and to help ensure satisfactory system service. The code provides a basis for estimating performance to be expected of a swimming pool solar heating system used in typical situations in the United Kingdom.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 22, an inside back cover and a back cover.

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

1 Scope

This British Standard code gives recommendations and guidance for the design, performance, installation and commissioning of solar heating systems for indoor and outdoor swimming pools.

Brief consideration is given to the thermal properties of pool covers.

The code does not deal with the filtration systems for swimming pools to which solar heating systems are often connected.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this code the following definitions apply.

2.1

collector (solar collector, solar panel)

the general term for a device in which solar radiation is absorbed and converted to heat which is removed by the heat transfer fluid

2.2

flat plate collector

a collector that employs no concentration of the incident solar radiation and in which the absorber plate is essentially planar

2.3

embedded collector

a collector in which the fluid passages are embedded either in the ground or within a covering such as paving slabs, asphalt or concrete

2.4

trickle collector

a flat plate collector in which the heat transfer fluid is not contained within passageways in the absorber plate but flows down the plate surface

2.5

absorber plate (absorber)

the element of a collector that receives and absorbs the solar radiation and converts it into heat

2.6

absorber plate surface coating

a coating whose principal function is to absorb solar radiation

2.7

selective surface

an absorber plate surface coating that will decrease the radiative emission from the absorber plate whilst maintaining a high absorptance for solar radiation

2.8

unglazed collector

a collector with the front surface of the absorber plate exposed to the surrounding air. The rear surface may or may not be insulated

2.9

glazed collector

a collector with an absorber plate covered by a translucent glazing material. The rear of the absorber plate will normally be insulated within a weatherproof envelope

2.10

direct system

a system in which the pool water passes through the solar collectors

2.11

indirect system

a system in which a fluid other than the swimming pool water passes through the solar collectors

2.12

integrated circuit

a system in which the solar collectors form part of the same pipework circuit as the pool filtration plant

2.13

separate circuit

a system in which the solar heating circuit is completely separated from the pool filtration circuit

2.14

drainback system

a system in which as part of the normal working cycle the collector is automatically drained and refilled

2.15

draindown system

a system within which heat transfer fluid is retained until manual draining takes place

2.16

differential temperature controller

a device that is able to detect a small temperature difference and control pumps and other electrical devices in accordance with this temperature difference

2.17

pool inlet

the point at which water from the filtration circuit is returned to the pool, generally by means of an inlet nozzle

2.18**pool outlets**

the points at which water is drawn from the pool to be filtered, generally from a sump outlet at the lowest point in the pool and from a skimmer outlet at the pool surface

3 Relevant statutory requirements**3.1 General**

There are statutory requirements that have to be observed before the installation of any swimming pool. This clause refers to the statutory requirements applying particularly to a solar heating system for a swimming pool.

As these requirements may vary slightly between different parts of the UK, the relevant local authority should always be consulted regarding planning and building regulations and, likewise, the local water undertaking regarding water supply requirements.

3.2 Planning

As a general rule, permission has to be obtained from the local planning authority before carrying out any development. Consequently, it should be ascertained from the local planning authority as to whether or not the proposed installation constitutes development.

3.3 Building regulations

General regulations have been enacted concerning the design and construction of buildings in the UK. Solar heating systems incorporated into buildings have to comply with these regulations in so far as they affect matters of construction, roof loading, weathertightness, fire resistance, insulation, etc.

Advice on some of these matters is given elsewhere in this code. However, responsibility for the application of the regulations in a particular area rests with the local authority, which may require plans to be deposited, showing how it is proposed to comply with the regulations.

3.4 Water supply

Water supply byelaws for preventing waste, undue consumption, misuse or contamination of water supplies have been made by the Water Authorities and Companies in England and Wales, and by the Regional and Island Councils in Scotland. These byelaws require that written notice (7 days in England and Wales, 10 days in Scotland) is given to the local water undertaking before installing or altering (except for repair or replacement) any water fitting used or to be used in connection with an existing supply of water from the undertaking. (Similar requirements exist under the Water Regulations (NI) which have been issued by the Department of the Environment, Northern Ireland.)

It should be noted that whilst the various sets of byelaws are identical except for a few minor respects, the interpretation and enforcement of byelaws rests with the particular water undertaking concerned. Bearing this in mind, it is considered that to attempt to give meaningful detailed guidance on the application of water byelaws in this code could be misleading. However, it can be assumed that where a solar heating system is to be used to heat water for domestic use, as well as to heat swimming pool water, then the recommendations contained in BS 5918 should be taken into account.

The application of the water byelaws will depend on for example, whether the solar heating system (for pool water only) is direct or indirect, whether the heat transfer fluid is pool water, potable water or a non-aqueous fluid and how the make up water to the pool and/or solar heating system is supplied. It is therefore recommended that early contact is made with the local water undertaking to discuss the proposed installation and to seek advice.

3.5 Other actions

In addition to complying with the legal requirements detailed in this clause, it is recommended that the occupier/owner informs the lessors, mortgagors, insurers, etc. of the property as applicable.

4 Components**4.1 General**

This clause describes the principal components used in solar heating systems for swimming pools.

Although there are no other British Standards dealing specifically with components for swimming pools, certain sections of other British Standards may be relevant and these should be taken into account. Some British Standards which may be relevant are listed in Table 1.

4.2 Collectors

4.2.1 Types of collector. Solar collectors intended for swimming pool applications are commonly of the flat plate variety but they may or may not be glazed and insulated.

Embedded and trickle collectors may be used.

Collectors are designed so that a heat transfer fluid, often the swimming pool water itself, can pass through the collector in close thermal contact with a matt black or similar heat absorbing surface. When the material used between the fluid passages is a good conductor of heat, e.g. copper, the fluid passages can be spaced apart. When a poorer heat conductor is used, it is important to bring the fluid passages closer together.

Table 1 — Relevant British Standards

Specifications Feed and expansion cisterns and expansion vessels: B 417, BS 2777, BS 4213, BS 4814		
Pumps:	BS 1394-1 and BS 1394-2	
Valves:	BS 5154	
Pipework and fittings:		
Form and material	British Standard	Type and application
<i>Tubes</i>		
Copper	BS 2871-1	Hot and cold water services
<i>Plastics</i>		
ABS	BS 5391-1	Cold water services
PP	BS 4991	Cold water services
UPVC	BS 3505	Cold water services
HDPE	BS 3284	Cold water services
Stainless steel	BS 4127-2	Hot and cold water services
<i>Fittings</i>		
Copper and copper alloy	BS 864-2	(capillary and compression) Hot and cold water services
	Part 3	Cold water services
UPVC	BS 4346-1 and BS 4346-2	Cold water services
ABS	BS 5392-1	Cold water services
Methods of test BS 6757		
Codes of practice BS 5918; BS 5955; CP 312		

4.2.2 Selection of collector type. Solar collectors used for pool heating can be installed without glazing or a similar translucent cover in front of the absorber if they operate close to the ambient temperature.

Glazing reduces the radiation incident on the absorber and this effect may outweigh the reduction in heat loss from the front of the collector. Similarly rear insulation may marginally improve the performance but the benefit may be too small to warrant the additional cost.

Unglazed and uninsulated collectors preferably should be mounted in a position that is sheltered from strong prevailing winds. If such a site is not available consideration should be given to the use of glazed and insulated collectors. In the case of pools maintained at temperatures appreciably above the ambient temperature the incorporation of front glazing gives better thermal performance for the same collector area, but the improvement may not justify the extra cost involved. The use of double glazing on the absorber is not likely to be worthwhile.

In indirect systems the use of glazed and insulated collectors may be appropriate because of the temperature differential across the heat exchanger. For the same reason the use of a selective surface may be advantageous.

Trickle collectors may have the advantage of being cheap but if glazed may have a reduced performance due to the build up of algae. Evaporative heat loss from unglazed trickle collectors may substantially reduce their performance.

NOTE Other forms of collector, e.g. concentrating, evacuated and tracking collectors, are not dealt with in this standard because these types are primarily used for higher temperature applications and insufficient experience is currently available about their use for pool heating.

4.2.3 Selection of materials. In direct systems it is important to select materials for the fluid passages that are suitable for contact with swimming pool water. The materials used should neither contaminate the pool water nor should they become corroded under normal service conditions.

Plastics materials, such as polypropylene, polyethylene or EPDM, are generally suitable for contact with pool water and solar collectors manufactured from these materials are available. Black pigmented material is normally utilized and it should be ensured that the material is stabilized against degradation by ultraviolet light.

Copper can also be used for the fluid passages in direct circulation solar collectors but it is important to maintain the pH of the pool water at between 7.2 and 7.6 or above in order to prevent corrosion. This, together with the correct total alkalinity and free residual chlorine level, will prevent undue corrosion/erosion of copper pipework at flow velocities up to 1.5 m/s.

Iron and carbon steel are unsuitable for the fluid passages because there may be rapid corrosion resulting in the failure of the collectors and rust staining of the pool walls and fittings. It is important to recognize that not all grades of stainless steel will resist corrosion in these applications and grade 316 type is recommended. Some aluminium alloys are not suitable for direct contact with pool water because of the probability of corrosion.

Adequate steps should always be taken to guard against bimetallic corrosion (see PD 6484) and pitting corrosion. For example, in indirect drainback systems (see Figure 3) it is important not to use galvanized steel cisterns combined with copper pipework since pitting corrosion of the steel may occur. The risk is particularly high in systems where the heat transfer fluid is highly aerated.

Reference should be made to BS 5918 regarding corrosion protection and the use of heat transfer fluids other than pool water in indirect swimming pool solar heating systems.

4.3 Controls

4.3.1 A control system is an important part of the swimming pool solar heating installation. The purpose of the control is to ensure that fluid is pumped through the collectors only when heat can be gained.

4.3.2 In direct systems it is usual to incorporate the solar collector circuit into the existing filtration circuit. This minimizes the total pumping power used for pool filtration and for solar collection. It is often cheaper and more convenient than using a separate circuit for the solar collectors (see 5.2.1).

The filtration pump is normally required to run during times when there may be no solar heat gain. It is therefore preferable to be able to run the filtration plant either continuously or on a time switch and to install the means of diverting the pool water through the solar collector circuit whenever a heat gain is available. This can be achieved by using a valve to divert the flow through the solar collector after filtration. Thus the water has to pass through the solar collectors and then back to the pool.

Alternatively, an additional pump may be used in the solar collector circuit which, when activated, draws filtered water and returns it to a point further downstream from where it can return in the normal way to the pool.

4.3.3 Whether a diverting valve or a pump is used, a control system is required to ensure that the pool water is only circulated through the collectors when there is a net heat gain available. An electronic differential temperature controller incorporating a pair of temperature sensors is usually used to activate the solar pump or diverting valve. One of these sensors detects the pool temperature while the other detects the temperature of a section of the absorber plate which is exposed to solar radiation but is thermally insulated and remote from a fluid passage. A collector sensor mounted in the fluid outlet pipe from a swimming pool solar collector may not be satisfactory because it may not adequately detect the relatively small temperature rises which can be considered as useful in a high flow rate system. The pool temperature sensor is normally mounted in close thermal contact with the water in the filtration circuit prior to the branch to the solar collectors (see 6.7).

NOTE In this context the net heat gain is achieved when the value of energy collected exceeds the cost of energy expended by a separate circulating pump. The temperature differential at which the controller turns the system off should therefore take account of any pump energy consumption. Since the relevant temperature differential is likely to be small it is important to select a controller with limited temperature drift characteristics.

4.4 Pool covers

4.4.1 Heat losses from swimming pools occur mainly from the water surface and various types of cover are available to reduce these losses in both indoor and outdoor pools. Covers can be regarded as a useful energy conservation measure with any type of pool and will enable many pools to function more efficiently as natural collectors of solar radiation.

4.4.2 Various types of floating pool cover can be used including the following types:

- a) single skin plastics film;
- b) double skin plastics film with encapsulated air bubbles;
- c) closed cell plastics foam.

All of these types are available in either translucent or opaque grades but the plastics foams are frequently supplied laminated onto an opaque woven material. Other covers are available which are stretched across the surface of the pool above the water level.

Covers are moved on and off the pool many times each season. Any pool cover should be sufficiently tough to allow necessary handling. Materials used for covers for open air pools should be adequately resistant to both ultraviolet radiation and to chemicals normally present in swimming pools.

The main function of a cover is to reduce or eliminate evaporation from the surface of the pool. All of the cover types mentioned are effective in this respect since they form a vapour barrier across the top surface of the pool. Any water lying on the top of the cover will reduce its effectiveness. With covers that are suspended above the water it is important to ensure that the edges are reasonably airtight since otherwise water vapour will escape.

The second function of the cover is to prevent heat loss by convection. The single film covers are the least effective in this respect.

The third function is to reduce the radiation heat loss from the swimming pool. This is the least significant heat loss from the surface of the pool.

For a pool that receives sunshine and where the cover may be in place for even only a few daylight hours it is advantageous to select a translucent cover. With such covers there can still be a very significant radiation heat gain to the pool. Sunlight that passes through the cover is largely absorbed by the pool water itself. The water can thus be heated naturally in the same way as with an uncovered pool but with the great advantage that the heat losses from the top surface are substantially reduced.

4.4.3 Safety is an important consideration as most covers cannot support the weight of a child or pet animal. Due to the risk of drowning, no one should swim beneath a cover. This is particularly important with floating covers.

5 System design

5.1 General

Principal design features of swimming pool solar heating systems are often determined by:

- a) the type of pool (indoor or outdoor);
- b) the intended period of use (typically summer only or all year);
- c) possible locations for the collectors, in particular their height relative to the pool surface.

In addition, the choice between a direct or indirect system is fundamental.

Whereas satisfactory system design details may in principle be determined by calculation, it is considered helpful to summarize the features that have been found to be crucial to successful operation and to give a brief description of the most popular system types.

5.2 Design considerations

5.2.1 Interaction with existing equipment. Any connection between swimming pool solar heating systems and existing filtration equipment has to be such as to ensure continuing satisfactory performance under all operating conditions.

A reduced flow rate through the filtration system may result in inadequate filtration as well as poor mixing of the water in the pool. This could contribute towards increased thermal stratification in the pool with a resultant increase in heat loss from the pool. Moreover care should be taken to ensure that there is no short circuiting of water between the inlets and outlets in the pool which could be caused by a reduced flow rate at the pool inlet nozzles.

5.2.2 Collector drainback and draindown. Many swimming pool solar heating systems need to be designed to ensure that the collectors (and often other exposed components also) may be fully drained under some conditions. Failure of components to be drained satisfactorily may, depending upon their design, result in extensive damage. It is therefore important both that the initial system design is correct and in accordance with manufacturer's recommendations and that users are aware of what constitutes satisfactory behaviour.

Two common situations are as follows.

- a) Systems in which collectors are located above pool level and drain whenever heat transfer fluid (usually pool water) is not delivered to them under pressure. This is the "drainback" mode of operation and is used typically to provide automatic frost protection or, in the case of some glazed collectors, protection against boiling.
- b) Systems in which heat transfer fluid may be retained within collectors for long periods but in which manual draining to preclude frost damage is necessary usually at the end of each swimming season (see 9.7).

In order to achieve satisfactory drainback careful system design is required and the following points should be considered.

- 1) A suitable air admittance device has to be fitted (see 5.2.3).