FIBA GUIDE TO BASKETBALL FACILITIES
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**Special thanks to**: Shaheen Haunschild who contributed deeply in translating all the Italian content into English. Thank you very much Shaheen for your hard work!
Preface
This new revised GUIDE to Basketball Facilities appears just over ten years after the publication of the first edition.

At the invitation of FIBA, and in particular Mr. Aldo Vitale, I have undertaken to revise the texts, focusing on FIBA’s objective to ensure that this second edition remains a GUIDE which provides recommendations and specifications useful to all those involved in basketball and/or the organisation of international events, from managers and organisers, planners and developers, to clubs and players.

My approach was, first and foremost, to review the details presented in the first edition, in the light of the current needs of the sporting world and in particular basketball, a sport which has seen a significant change over the last ten years, in terms of popularity and calibre. Consequently, I found it necessary to focus on aspects which affect the planning of basketball facilities, given that facilities today must satisfy new needs for comfort, safety and multifunctionality.

A simple revision of the texts soon transformed the book into newly worded chapters, incorporating the latest recommendations and requirements. Particular attention was paid to issues such as the environment, safety, the elimination of architectural barriers, facility maintenance and energy containment, all of which have undergone significant development over the past decade, not only culturally but also technologically, with new technological advances also having an impact on the sports facilities themselves.

This entire guide follows a precise format, starting with a stricter analysis of the game equipment on and around the court, and ending with the management and maintenance of the equipment in relation to the entire facility. References are made not only to management and technological installations, but also to “new” topics such as the association between the facility itself and the events held in the facility, or the typical basic requirements of an open-air facility.

The guide also includes an introduction to the FIBA and NBA systems.

The major difficulty, however, lay in limiting the subject matter, for each chapter sparked an impulse to delve even deeper.

I would like to thank the partners of FIBA who contributed with valued input, information and experience, and in particular Mr. Gilles Page at Philips, who assisted with the editing of the texts on facilities.

Thanks also go to my colleagues, architects Roberto Fiorucci, Mariella Bonsangue, Than Truc Nguyen Hoang, and Mauro Barducci, engineer and specialist in acoustics, and Matteo Schiavone, bachelor of sports science and scholar in event management, who, apart from revising the texts, elaborating the graphics and conducting research for new chapters, all contributed actively and professionally with their critical observations on new phenomena in basketball... a discipline which is always receptive and responsive to the phenomena affecting modern sport.

Editor
Mauro Schiavone, Architect
GENERAL ASPECTS
The popularity of basketball, reflected by its worldwide appeal, rising number of competitions and growing interest shown by the public and mass media in basketball events, has prompted FIBA, the International Basketball Federation, to review the Guide to Basketball Facilities for High-Level Competitions published a few years ago.

There is a clear need not only to provide a modern concept of indoor sports facilities but also to establish standards and requirements which offer guidelines and support to organisers, whether they be hosting indoor and outdoor basketball events or merely setting up a temporary court. In order to keep pace with this development and be in line with new trends, FIBA has decided to extend the guide to include the non-conventional sectors, such as streetball or playground basketball, which have seen recent significant growth.

The main aim of this guide, therefore, is to provide firm guidelines for the planning, construction and homologation of basketball sports facilities and/or the restoration of existing basketball halls. The criteria adopted meet today’s needs in the organisation of sporting events, with the objective of targeting all the organisations and operators involved: government organisations, national sports federations, sports associations, clubs, sport managers, and professionals.

In other words, the guide studies the most important aspects, determines parameters, and provides a defined evaluation and implementation process for every element that can be standardised, yet without touching on the actual formal design of sports facilities, as this could inhibit the planners’ freedom of creative expression.

More precisely, sports facilities designed to host international competitions must meet the requirements included in this guide.

Compliance with the requirements must be shown by following a standardisation procedure based on special certification specifying the type and category of the sports facilities, with particular consideration given to the capacity of a facility and player and spectator safety.

International basketball activities are governed by the Official Basketball Rules adopted by the International Basketball Federation (FIBA).

The rules are updated on regular basis and guarantee total fairness in team competitions, having been tried and tested in many high-level competitions.

They include the basic guidelines for the construction of basketball facilities with regard to size and space, as well as details on equipment, as specified in the chapters that follow.

In other words, this guide is not intended merely as a theoretical tool but rather as a contribution towards standardising facility requirements and regulations in order to facilitate and accelerate the organisational and decision-making process for everyone involved in basketball events.

Technical and constructional requirements related to today’s planning criteria of sports facilities must take into account the delicate issues of global interest and respect the following principles:

- Attention to the environment;
- Structural safety;
- Personal safety;
- Elimination of architectural barriers;
- Attention to energy requirements;
- Rational use of water;
- Achievement of environmental welfare standards;
- Attention to technological innovation.

It is important to note that each part, each component, every planning aspect and every piece of equipment must be considered and evaluated according to international technical standards. These standards, issued by universally recognised international bodies, are currently incorporated and implemented into most national regulations, and affect the construction of buildings that will house sports facilities with or without a public presence.

Moreover, all new projects for sports facilities, including restoration projects for existing facilities, must always conform
Demand for Basketball Facilities

“Demand” is a fundamental element when planning the construction of basketball facilities. It is a good idea to promote a concerted agreement between all the prospective parties to be involved in the development of the construction plan and operational management from the onset, from service suppliers to end users.

- Demand for sports facilities generally depends on the following;
- The desire to promote the opportunity for sports activities;
- General public interest in sport;
- The promotion of local sports events;
- The need to add prestige to existing sports facilities.

Over the past few years, there has been a significant increase in the demand for sports in many countries, thanks to the influence of the mass media and the modern concept of sport as a means to promoting health and well-being, with the result that sports events have now become great social happenings.

In fact, in terms of quality, demand has been influenced by people’s desire to keep in shape, feel fit and healthy, relax, forge social contacts and actively take part in events. This latest trend is backed by the growing interest of youngsters and teenagers during training sessions at international competitions.

The demand for sports activities is also influenced by factors such as people’s age, profession, and financial situation, as well as the possibility and ability to organise sporting events.

Thanks to its defining characteristics and growing interest amongst youngsters, basketball, in particular, has seen a significant increase in popularity which, in turn, has given rise to a flourishing number of initiatives.

Adults are usually inclined to play basketball because of their fascination for the game as a whole, whilst youngsters tend to express their enthusiasm for the sport through their choice of clothing, not only influencing basketball fashion, but also ways of playing the game.

Streetball is now a thriving sector, enjoying worldwide success and popularity thanks to the growing interest shown by young players and the influence that this has on the mass media.

Other ways of playing basketball are continually developing and as interest in these new ways of playing grows, so their exposure to the public also increases.

Use of Sports Facilities

The use of existing and future facilities depends very much on the original conception of the structure and whether or not the facilities are included in a management plan that takes into account all the factors concerning the use of the facility.

Diagram 1.1

The only way to assess the feasibility of sports facilities is to conduct a complete management analysis.

The economic life of a facility starts in the planning phase when consideration is given to the rooms, halls, equipment and all other materials necessary for management executives to implement activity planning and realise economic growth.

Nowadays, planning represents a true investment cost as the planning and forecast phase has a direct impact on the future life of the facility; for this reason, planning must be developed in close collaboration with the facilities’ managers.

Diagram 1.2 summarises the relationship between the owner commissioning the sports facility, the planner and the future manager of the facility. The column on the left shows the requirements that the structure must meet, and the right hand column shows the performances it must deliver from a management point of view. It is the planner’s task to create
a sports facility that meets the requirements of both these columns.

Unfortunately, the management question is often ignored or given little consideration. This often results in managers finding themselves confronted with negative consequences which can arise when formally beautiful facilities become ultimately unmanageable due to complicated maintenance, and the excessive administrative and personnel costs involved.

The type of use of sports facilities should be foreseen in the conception phase and be based on the specific requirements of the region, as defined by a sport trend, organisation or club. It is imperative that those involved in promoting the construction or restoration of a sports facility have a clear idea, right from the start, of its intended use, or rather its potential use: should it be used only for national or international sports competitions or for other types of events as well?

This decision will determine a series of important factors regarding location, maintenance, energy consumption, safety measures for spectators, mass media and various other services.

By studying the potential use of a facility in the preliminary phase, energy costs can be forecast early on, thus allowing energy-saving measures to be explored in advance. Energy consumption could be reduced merely by virtue of specific equipment (for example, sports equipment approved according to international rules) or by installing mobile partition walls which enable a space to be divided into a number of areas so that several activities can take place at the same time.

At present, the most important requirement of a sports complex is multifunctionality: facilities must be able to cater for events and purposes other than just sports competitions, for example: conferences, exhibitions, theatre shows, concerts, trade fairs, etc. In this way managers can programme a constant use of the sports facilities, thus guaranteeing continuity in technical and economic terms. (Diagram 1.3)

Furthermore, over the last ten years, the concept of facilities with a multifunctional purpose has expanded to cover aspects which were once considered marginal and of secondary importance, such as reception and exhibition areas, merchandising and hospitality areas, which today represent one of the main sources of income in the organisation of events.

Multifunctional requirements should be the driving force in the redevelopment or restoration of existing facilities. Recent
surveys have shown that in various countries both government bodies and sports organisations support political strategies for the redevelopment and restoration of existing sports facilities and halls suitable for hosting sports activities, based on a programme with the following main objectives:

- Full exploitation of existing facilities;
- Restoration of abandoned or inadequate facilities;
- Flexibility in the use of the structures;
- Application of integrated and open management strategies;
- Identification of specific profitable interventions that will bring economic benefits to the management of the facility.

Considering the new concept of sport that is emerging in modern society, multifunctional requirements of this kind must also be taken into account for all new facilities, regardless of their size. 

Diagram 1.4 illustrates the increase in the areas required when building sports facilities today.

In order to be considered multifunctional, sports facilities must satisfy three main requirements:

- Rapid transformation of space;
- Maintenance of safety levels;
- Simplified maintenance of functional units.

The advantages of this approach include the increase in direct revenue, not only from the facilities themselves but also from ancillary services (bars, cloakroom, car parks, etc) and advertising which can reach a wider target.

These aspects will be examined in more detail in the chapter on management.

With regard to basketball, FIBA has been trying for many years to establish common standards for the planning of sports facilities and to promote the standardisation of basic basketball equipment (balls, backboards, game clocks, etc), to allow managers, athletes, experts, consultants, referees, commissioners, etc to carry out their respective activities in the best possible way, irrespective of the geographical location of
Quite often, promoting plans for sports facilities will help to bring basketball to areas where it tends not to be played for the simple reason that facilities are not available or there is not an active interest in the game in that region. It is also worth noting that the creation of sports facilities is often closely related to the need to promote and instruct experts to improve basketball organisation in general.

**Location of Basketball Facilities**

To determine in which geographical area a basketball facility would be most beneficial, it would be necessary to estimate the annual growth trend of sport in general. An evaluation of this kind, carried out on a worldwide scale, is undoubtedly a delicate and difficult task as there are certain geographical areas that have urgent needs and basic requirements, and other areas where basketball is more common and well-organised, and demands more or less satisfied.

The starting point of any type of process lies in being aware of the present situation. An assessment of the present situation provides an estimate of the balance between supply and demand, which in turn gives an idea of the level of satisfaction regarding equipment, and the use and condition of existing facilities. Scheduling of “new” facilities or planning of existing ones can be started on the basis of these elements.

The planning process must follow on a large geographical area in order to achieve a balanced development of sports facilities -otherwise influenced by local vocations and basketball traditions -and to avoid duplication, for example two facilities with the same characteristics in close proximity.

Sports facilities that host international events or competitions have a great environmental impact for various reasons: they involve the travel of a great number of people, the production of waste, power consumption for lighting indoor areas, meeting areas and large outdoor areas, noise pollution, and general high energy consumption, not to mention the repercussions caused by the actual construction in the case of new facilities.

Therefore, setting aside the geographical position, the location of a sports facility, be it on a national or local scale, must be foreseen as part of an accurate sustainability plan that takes into account the territory in which it is to be built.

The construction and alteration of sports facilities must be in harmony with the local environment, by conforming to the existing character of the natural and built surroundings. Not only must the building be well integrated, in order not to affect the primary function of the area, there are a number of factors to take into consideration, in particular:

- Health and safety of workers, staff and residents in the area concerned;
- Waste management (excavation and site waste, as well as waste produced during events and competitions);
- Rational use of energy aimed at reducing energy consumption;
- Sustainable mobility;
- Water management aimed at reducing water consumption;
- Prevention of natural risks;
- Preservation of the landscape;
- Sustainable architecture;
- Mitigation measures to minimise environmental impact;
- Control of greenhouse gas emissions;
- Sustainable use of the facilities when not used for events.

The construction of sports facilities has a fundamental role in an international cooperation project for sustainable development, the objective of which is to combat social alienation, encourage new consumer habits, contribute to health protection, promote an increased social use of sports structures, and favour the integration of environmental themes and the development of sports policies.

One important aspect concerning the location of sport facilities, which influences the optimisation of its use, is the infrastructure of public and private transport, and of car parks. This aspect is not only important in the case of large events but also in improving long-term management of the facility, in order to
avoid major problems in the future. Over the last few years, the organisers of basketball events have paid particular attention to this aspect, seeking solutions particularly in terms of public transport networks and urban management of parking areas for sports facilities. Parameters used to study such solutions include the age of the facility users, travel time, the schedule of sports events in relation to the total events organised in the town, and the ordinary use of the sports structure. Sports facility users (players, staff and spectators) usually reach the complex in the following ways:

- On foot;
- By public transport (train, bus, underground);
- By private or collective transport i.e. coach (supporters, players, etc.);
- By private vehicle (bicycle, motorbike or car).

Therefore, in order to calculate the number of users, a special study must be carried out that not only takes into account the mode of transport used to reach the facility, but also the potential appeal that an event or sports activity may have in the area. For this reason, sports facilities must have car parks for both public and private transport. The size of the parking areas should vary according to the purpose and use of the facilities, and be planned according to the respective provisions in force in each country. The layout of the car parks shall depend on the location of the sports facility and on the availability of areas for use. In the absence of specific regulations, the following standards may be applied, on the basis of 1m² per spectator:

- 1 person per bicycle or motorbike;
- 3 people per car;
- 60 people per coach;
- Adequate parking spaces for differently abled persons. Service car parks in close proximity to the sports facility are also essential for:

- Ambulances;
- Emergency services;
## Olympic Tournaments

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<thead>
<tr>
<th></th>
<th>Preliminary Round</th>
<th>Final Round</th>
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<tbody>
<tr>
<td><strong>Olympic Tournaments</strong></td>
<td>7,500 seats</td>
<td>12,000 seats</td>
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## Olympic Qualifying Tournaments for Men and Women

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<th>Final Round</th>
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<tbody>
<tr>
<td><strong>Olympic Qualifying Tournaments for Men and Women</strong></td>
<td>6,000 seats</td>
<td>10,000 seats</td>
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## World Championship for Men

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<thead>
<tr>
<th></th>
<th>Preliminary Round</th>
<th>Final Round</th>
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</thead>
<tbody>
<tr>
<td><strong>World Championship for Men</strong></td>
<td>7,500 seats</td>
<td>15,000 seats</td>
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## World Championship for Women

<table>
<thead>
<tr>
<th></th>
<th>Preliminary Round</th>
<th>Final Round</th>
</tr>
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<tbody>
<tr>
<td><strong>World Championship for Women</strong></td>
<td>4,000 seats</td>
<td>8,000 seats</td>
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## U-21 World Championships for Men and Women

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<th>Preliminary Round</th>
<th>Final Round</th>
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</thead>
<tbody>
<tr>
<td><strong>U-21 World Championships for Men and Women</strong></td>
<td>4,000 seats</td>
<td>8,000 seats</td>
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## U-19 World Championship for Men

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<th>Preliminary Round</th>
<th>Final Round</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U-19 World Championship for Men</strong></td>
<td>4,000 seats</td>
<td>8,000 seats</td>
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## U-19 World Championship for Women

<table>
<thead>
<tr>
<th></th>
<th>Preliminary Round</th>
<th>Final Round</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U-19 World Championship for Women</strong></td>
<td>3,000 seats</td>
<td>5,000 seats</td>
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## Continental or Zone Championships including all Qualifying Games and Tournaments for These Championships

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<thead>
<tr>
<th></th>
<th>Preliminary Round</th>
<th>Final Round</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Continental or Zone Championships including all Qualifying Games and Tournaments for These Championships</strong></td>
<td>5,000 - 8,000 seats</td>
<td>10,000 - 15,000 seats</td>
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Classifications of Competitions and Types of Sports Facilities

Over the years, international events have seen a constant increase in quantity, so now particular attention is being paid to aspects of quality.

To establish common criteria, official FIBA regulations describe the types of competitions that must be governed by the said regulations, and the technical requirements that must be met by the sports facilities in order to be able to host national and international competitions.

The first distinction is made by classifying the official international competitions governed by FIBA regulations:

Main official competitions:
- Olympic Tournaments (IOC Regulations);
- Olympic Qualifying Tournaments for Men and Women;
- World Championships for Men and Women;
- U-19 World Championships for Men and Women;
- U-17 World Championships for Men and Women;
- Continental or Zone Championships (including all qualifying games and tournaments for these championships).

Official competitions:
- Official cups and tournaments of FIBA;
- International cups and tournaments sanctioned and officially recognised by FIBA;
- International competitions or tournaments.

The second type of classification, without taking into account the technical specifications of the sports activity area (which are the same for all facilities and are described in the next chapter), is made on the basis of the minimum seating space required for each type of event:

The seating capacity determines the number of spectators and minimum number of service providers intended for a specific...
type of event; however, as we will see later in the guide, other aspects are required to qualify a sports facility, such as its location, safety measures, absence of architectural barriers, technological systems, and general meeting facilities.

In fact, it is important to remember that during the second half of the 90s, basketball experienced a significant increase in public interest, in terms of both paying spectators and television audience, and consequently there has been a growing interest of commercial partners who link their own corporate image to FIBA.

These partners have increased the potential of basketball, forcing organisers, in the planning and construction phase, to create spaces and services within the facilities which are apt to meet these new needs, to adopt innovative technological equipment and any other elements necessary to cater to public preferences, the needs of mass media operators and the requirements of commercial partners.

In short, all events organised by FIBA should be held in facilities suitable for high-level competitions. A difference in seating capacity (for example 3,000 seats as opposed to 15,000) must not, however, affect performance and technical standards. Seating capacity should only determine what type of competition can be held in a certain facility.

FIBA selects facilities for international basketball events on the basis of their compliance with the standards required for the homologation of facilities; in accordance with the homologation request forms submitted by the associations that take part in international competitions; and finally on the basis of the characteristics accurately described in this Guide.

During the bid procedure for candidates wishing to host an event, absolute priority will be given to those who are best able to meet FIBA’s requirements.
Subdivision of Sports Facilities Into Areas
SPORTS ACTIVITIES AREA

The heart of any sports complex is the actual playing area itself; the arena or central playing court with its perimeter area and, ideally, an additional area for training purposes and pre-game warm-ups.

Facilities hosting high-level competitions, in particular, should include a second playing area with a minimum seating capacity of 200-300 seats, which can be used for training purposes when the central court is occupied during games, or as a warm-up area before competitions. Depending on the size and purpose of a sports complex, the playing area and/or related premises can be fully exploited to optimise the facility’s overall use by organising other activities such as aerobics, physiotherapy, squash, bowling, etc.

Playing court and playing area

The playing court must have a rectangular, flat, hard surface, free from obstructions (Diagram 2.1a).

The dimensions of court must be 28m in length and 15m in width, measured from the inside edge of the boundary line. The height of the ceiling or the lowest obstruction above the playing floor must be at least 7m from the ground. The court surface must be uniformly and adequately lit. The lights must be positioned so they do not hinder the players’ and officials’ vision.

Court lines

All lines must be drawn in the same colour (preferably white), 5cm in width and clearly visible.

Boundary lines

The playing court must be limited by boundary lines, consisting of the endlines (on the short sides) and the sidelines (on the long sides). These lines are not part of the playing court.

Any obstruction, including seated team bench personnel, must be at least 2m from the advertising boards or any other obstruction.

Centre line, centre circle and semicircles

The centre line shall be marked parallel to the endlines from the mid-points of the sidelines and shall extend 15 cm beyond each sideline.

The centre circle shall be marked in the centre of the playing court and have a radius of 1.80m measured to the outer edge of the circumference. If the inside of the centre circle is painted, it must be the same colour as the restricted areas.

The semicircles shall be marked on the playing court with a radius of 1.80m measured to the outer edge of the semi-circumference and with their centres at the mid-points of the free-throw lines (Diagram 2.2).

Free throw lines and restricted areas

A free-throw line shall be drawn parallel to each endline. It shall have its furthest edge 5.80m from the inner edge of the endline and shall be 3.60m long. Its mid-point shall lie on the imaginary line joining the mid-points of the two endlines.

The restricted areas shall be the floor areas marked on the playing court, limited by the endlines, the free-throw lines and the lines which originate at the endlines, their outer edges being 3m from the mid-points of the endlines and terminating at the outer edge of the free-throw lines. These lines, excluding the endlines, are part of the restricted three-second area. The inside of the restricted areas may be painted but must be the same colour as the centre circle.

Free-throw rebound places along the restricted areas, reserved for players during free throws, shall be marked as in Diagram 2.2:

Three-point field goal area

For all national and international competitions and for all categories, a team’s three-point field goal area shall be the entire floor area of the playing court, except for the area near the opponents’ basket, limited by and including (Diagram 2.3):

Two parallel lines extending from and perpendicular to the endline with the furthest edge at 6.25\(^2\) m from the point on the floor directly perpendicular to the exact centre of the opponents’ basket. The distance of this point from the inside edge of the...
mid-point of the endline is 1.575m;
1. A semicircle with a radius of 6.25m measured to the outer edge of the circumference from the centre (which is the same point defined above) which meets the parallel lines.

2. **Throw-in side lines**

3. **No-charge semicircles**

4. **Team bench areas**

The team bench areas shall be marked as follows:

**Diagram 2.4:**

1. The team bench areas shall be marked outside the playing court, on the same side as the scorer’s table and the team benches;

---

3 Changes valid as per Oct. 2010: The two (2) small lines shall be marked outside the court, on the opposite side of the scorer’s table and the team bench areas, with the outer edge at the distance of 6.25m from the inside edge of the end lines, in other words, level to the top of the three-point line. During the last two minutes of the game and of the extra period, following the time-out granted to the team that has been entitled to the possession of the ball from its backcourt, the subsequent throw-in will be taken on the opposite side of the scorer’s table from the “throw-in side line” and not as presently from the centre line extended.

4 Changes valid as per Oct. 2010: The no-charge semicircles shall be marked on the playing court, under the baskets. The distance of the inner edge of the semicircles shall be 1.25m from the centre of the basket (on the floor). A charging (offensive) foul should never be called if the contract by the offensive player is with the defensive player standing within the no-charge semicircle.

2. Each area shall be limited by a line extending from the endline, at least two (2) m in length, and by another line at least two (2) m in length, drawn five (5) m from the centre line and perpendicular to the sideline;

3. There must be fourteen (14) seats available in the team bench area for the coaches, assistant coaches, substitutes and team followers. Any other people shall be at least two (2) m behind the team bench.

**Safety areas**

The area immediately surrounding the playing area is known as the “safety area” and is particularly important. The safety area around the playing area is marked by four lines parallel to the perimeter of the court at a distance of two (2) m. The area is reserved for the two playing teams; only the referees and the two coaches can stay in bench areas of their respective teams. The colour of the safety area shall be the same colour as the centre circle and the restricted areas.
Diagram 2.2
Free-Throw Lines

Diagram 2.3
Three-point field goal area
New facilities shall include an additional safety area of three (3) m, however in no case less than 1.80 m in width, which will be off-limits to the public and reserved solely for:

a. Officials;

b. Commissioners and/or FIBA representatives;

c. Team members;

d. Photographers.

Advertising boards around the court must not be higher than 80 cm and must be placed at least two (2) m from the endlines and sidelines. They may be fixed or free-standing and shall be adequately padded around the top with rubber or similar, at least five (5) cm thick and with an indentation factor of 50% in order to prevent injury to players or referees.

**Officials**

Officials shall be seated in the areas reserved for them along one of the sidelines, where the benches shall be placed at least 2 m from the edge of the line.

The officials’ table shall be at least 6 m long and placed on a platform at least 20 cm above floor level.

Five chairs must be placed at the officials’ table plus two sets of two chairs at the sides for player substitutions (Diagram 2.5).

If possible, for high-level competitions, one table with five chairs for the commissioners and/or FIBA representatives should be placed along one of the endlines, in the corner opposite the players’ benches and officials’ table. The Jury of Appeal and technical officials shall stay in this area. In high-level competitions, team benches shall be placed 3 m from the safety area in a 3x9 m rectangle formed by the extension of the endline and another perpendicular line drawn 5 m from the centre line. During a game, the photographers must stay behind the advertising boards, in the 3 m wide safety area beyond the endlines, near the area intended for commissioners and/or FIBA representatives.
Training Area
For high-level competitions, a training area with body-building equipment must be provided. The area must measure at least 50m², but the size may vary depending on the type of equipment provided. The training area should be located in close proximity to the changing rooms to give athletes easy access.

Warm-up Area
Sports facilities that intend to host high-level competitions such as Olympic tournaments, or World and Intercontinental championships, must have a second court for athletes to warm up and exercise prior to a game. If possible, this practice court should meet the same conditions as the central court (lighting, colour, air conditioning, flooring, baskets, etc.).

Support Services Area
General Aspects
The support service areas are those areas in which activities intrinsically linked to the sports activities themselves are carried out, such as the entrance and exit areas of the complex, the changing rooms, toilets and showers, cloakrooms for both teams and spectators, first aid, equipment maintenance, administration and other services.

These areas shall be free from obstructions in order to be accessible to people with reduced physical or sensory abilities and must include the following rooms in particular:

- Changing rooms for players, referees and other officials;
- Areas for Commissioners and/or FIBA representatives;
- A doping control station;
- A first-aid room for the players and the public;
- A storage room;
- Administrative offices.

a) Changing Rooms
Sports facilities must include changing rooms for the following users:

1. Players;
2. Referees and staff;
3. Game officials.

The changing room area shall be accessible from the main entrance and the playing hall.

Players’ changing rooms (Diagrams 2.6 to 2.11)
The players’ changing room area shall include the following:

- The actual changing rooms where the athletes get changed;
- An access room adjoining the changing rooms and separating them from the toilets and showers;
- A shower area with a number of showers proportionate to the actual number of changing rooms, and possibly without internal partitions;
- Toilets and washbasins;
- Possibly a hydrotherapy area.

The following environmental specifications should be met:

- The temperature inside the changing rooms shall be between 20°C and 24°C (optimum temperature is 22°C);
- A natural or forced ventilation system must be provided to purify the air, ventilation ducts must be placed near sources of odours or humidity or other appropriate areas (changing rooms, entrances, showers, toilets); the air must be changed 5 times per hour;
Chapter 2 • Subdivision of Sports Facilities Into Areas

Storage
Warm up area
Average natural lighting should be provided (at least 200 lux if artificial) and at least 30 lux for emergency lighting;
The noise level from all possible external sources which may reach the changing rooms must not be higher than 50dB (A).
It is advisable to build different types of changing rooms according to the various uses.
The changing room area should allow users adequate space to change in front of a bench, and hang their clothes on hooks or in lockers, as well as provide access to the toilets and showers through the access room.
The changing room area must be located next to the playing hall so that athletes, referees and officials can have direct access to the sports area when they are wearing their sports clothes. The minimum space required for an athlete in a changing room, the so-called “changing room unit”, is equal to 0.80m x 2m.
The players’ changing rooms should be planned according to their proposed use and the type of the activities envisaged.

In order to assure good organisation, an adequate number of changing rooms should be provided (a minimum of 4) which comply with the following standards:

When determining the size of the area required, calculations should be based on a variable number of users, ranging between a minimum of 10 and a maximum of 20. A good compromise, both functional and economic, would be to estimate 15 athletes per changing room. For practical reasons, the rooms should be sufficiently spacious (i.e. 3-4m wide).

Screens should be positioned in front of the changing room entrances to safeguard the privacy of the players when the doors are open.

The following building specifications serve as a guideline:

- The flooring shall be placed on a structure (specific floor or foundation) to prevent rising damp, and shall be made of non-slip tiles; the flooring shall slope towards the runoff grids used to collect the wash water. Drainage outlets should not be
located in transit areas or underneath equipment so that the area can be hosed down easily with running water;
- The walls shall be smooth and possibly treated with resin or painted, but not plastered, particularly not with non-washable plaster. For practical and safety reasons, the walls shall be smooth, with no protrusions or sharp corners; ceramic tile coverings or other coverings must extend to a minimum height of 2m;
- For the ceilings, only smooth materials shall be used;
- If false ceilings are installed, they shall be made of washable materials to enable easy maintenance of equipment and installations. The components must be easy to assemble to facilitate mounting and dismounting, but must be tamper-resistant to prevent unauthorised removal;
- External openings shall be positioned at least 2m from the ground and fitted with window grilles for privacy and security. The openings shall be transom-type windows with a transom operator appropriately positioned at least 1.10-1.20m off the ground. Skylights shall have the same opening system (Diagram 2.12).
- The doors leading to the corridor shall be fitted with a ventilation system. Double doors must have a minimum clearance span of 1.20m (90+30cm) and single doors a clearance span of 90cm and a net clearance of 80cm. All doors must, without fail, be fitted with a panic bar mounted at a height of 80cm and a lock; this system is not necessary for doors leading to the access rooms (Diagram 2.13);
- The benches shall be made of wood if possible and equipped with coat hooks and shoe shelves if lockers are not available; alternatively, they can be made of very resistant materials that can be hosed down and do not require particular maintenance. Any metal parts must be corrosion-resistant. All parts must be fixed together onto a main frame to prevent gradual distortion, or even damage due to sudden strain. Whenever
possible, the use of nails, screws and bolts should be avoided. The components shall be assembled to the frame in such a manner that the frame can withstand a minimum force of 120 kgf, emanating from the most unfavourable direction. Unsafe protrusions must be avoided and all corners and edges must be rounded. Plastic plugs, gaskets and all parts which may jut out or are prone to gradual wear and tear must be avoided as they may give rise to sharp and dangerous edges;

- An adequate number of benches must be planned on the basis of 80cm of bench per changing room unit;
- Lockers (two tier) shall measure approx. 30x50x90cm, and be fixed to each other at the sides at least 25cm from the floor for cleaning purposes. They must be lockable with a key and be made of corrosion-resistant material that can be hosed down easily for cleaning purposes. The locker components should be assembled in the same manner as the bench components, as described above. Lockers may be replaced by coat racks above the benches, with at least 2 per changing room unit; and must be made of metal or the same material as the benches. The coat rack components should be assembled in the same manner as the bench components, as described above (Diagram 2.14);

- If possible, hairdryers shall also be provided in the changing rooms. The number of hairdryers shall be the same as the number of showers. They shall be mounted to the wall at least 1,70m above the floor and have a thermostat with control button; the mounting fixture must bear the weight of the hairdryer plus a minimum additional load of 80 kgf. They must be corrosion-resistant and comply with safety and prevention standards. They may be placed in the access room provided that all safety and functional requirements are respected.

### PLAYERS’ CHANGING ROOM

| Dimensions | Min: 30-35 m²  
| Ceiling height: 2.70/2.80 m  
| Door height: 2.30 m |
| No. of athletes | 12-20 |
| Coverings | Flooring: Synthetic or non-slip tiles  
| Walls: Washable surface |
| Equipment | Benches for 12 to 20 people, coat racks and/or lockers, a massage table, a blackboard with markers and possibly a video player, a refrigerator, an ice box with ice, rubbish bins, 12 to 20 towels, soap, bottled water for 12 to 20 people, paper cups, a mirror, toilet paper. |

The size of the access room separating the changing rooms, toilets and showers, shall depend on the functional requirements related to the use of the toilets and other equipment. The following building specifications serve as a guideline:

- Floors, ceilings, doors and windows shall have the same characteristics as the changing rooms. To ensure easy cleaning of the areas, the floor must slope towards a siphon drain or channel to collect the water;
- The walls shall be totally covered with non-porous, washable material. The materials used for coverings should have similar qualities to ceramic tiles, but under no circumstances be of inferior quality. The access room shall include the following elements:
  - Washbasins without central pedestal, minimum size 50cmx60cm; they shall be hung on the wall 80 cm from the floor;
- 1 wall-mounted drinking fountain without pedestal;
- Urinals.

The number of urinals and wash basins shall depend on the size of the changing rooms and number of toilets.

**ACCESS ROOM**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Min: 5-8 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling height</td>
<td>2.80/2.70 m</td>
</tr>
<tr>
<td>Door height</td>
<td>2.30 m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coverings</th>
<th>Flooring: Easy to clean waterproof non-slip material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls: Washable surface and/or tiles</td>
<td></td>
</tr>
</tbody>
</table>

| Equipment        | Mirrors, hairdryers, coat hooks. |

The shower area shall be safe and comfortable; therefore, the space for each user (“shower unit”) should be at least 90cm x 90cm.

In front of each shower there shall be a free space of at least 90cm x 90cm, a space which is preferably common to all showers. Changing rooms with more than 10 units shall have at least 2 showers, whilst changing rooms with 15 units shall have at least 4 showers and those with 20 units at least 5 showers.

In short, there should be at least 1 shower for every 4 units.

Every changing room must have shower facilities suitable for differently-abled persons and wheelchairs.

According to the type of structure the following standards shall apply:
- The shower floors shall be non-slip and slope towards a water-collecting channel or gutter fitted with a removable grate (the use of shower trays is recommended);

All other specifications regarding walls, ceilings, doors and windows, are the same as those applicable to the access room. Each shower shall include the following (Diagram 2.15):
- A showerhead installed 2.40 m from the floor which can be easily dismounted and opened to clean and remove limescale;
- A tap to regulate water flow (both water pressure and flow duration) installed at least 1.40 m from the floor;
- A grid made of plastic or other material, with the exception of wood, which can be easily removed for cleaning. The grid should be flush with the floor in order not to obstruct differently-abled persons/wheelchair users (except in the case of floor gradients necessary for the collection of the water).

A shower for differently-abled persons/wheelchair users shall be situated in one of the corners of the room and shall include:
- A folding shower seat measuring 0.50x1.00m;
- A fixed showerhead installed 1.50m from the floor, operated by a tap mounted 0.85-1.10m above the floor;
- A handset showerhead hung 0.90m above the floor, with a separate tap fixed to the shorter side of the seat;
- A handrail made of steel or other corrosion-resistant material, installed around the entire shower area, 0.80m from the floor and cm from the wall;
- A vertical grab-rail, made of steel or other corrosion-resistant material, placed at a distance of 0.70m from the wall parallel to the short side of the seat, extending to a height ranging between 0.50m and 1.30m from the floor. The handrails, single mixer tap and adjustable handset shower shall be installed on the side wall next to the seat within easy reach.
SHOWERS

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Min: 6-10 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Showers</td>
<td>Qty: 4/5</td>
</tr>
<tr>
<td>- Showerhead</td>
<td>Height 2.40 m</td>
</tr>
<tr>
<td>- Shower tap</td>
<td>Height 1.30 m</td>
</tr>
<tr>
<td>Coverings</td>
<td>Flooring: Waterproof non-slip material that allows the water to drain easily</td>
</tr>
<tr>
<td></td>
<td>Walls: Washable surface and tiles</td>
</tr>
<tr>
<td>Equipment</td>
<td>Coat hooks, soap, (towels).</td>
</tr>
</tbody>
</table>

Changing rooms of up to 10 units shall have a toilet area large enough to cater for wheelchair users/differently-abled persons. Changing rooms of up to 15 units shall have 2 toilets including one toilet for differently-abled persons and changing rooms of more than 15 units shall have at least 3 toilets including one for differently-abled persons. The size of the toilets must be tailored to meet user requirements and should not, under any circumstance, be smaller than 1.00x1.20m. The toilets may be alaturka (squat) toilets or alafranga (flush) toilets with a push-button or metal chain flushing system.

Toilets for differently-abled persons shall measure at least 1.50x1.50m, and have a door with a clearance of at least 0.85m, (preferably 0.90m). They shall be equipped with a ventilation system, handrail and a toilet suitable for use by wheelchair users and the differently-abled persons.

In order to be able to clean the area with running water, the floor shall slope towards a trapped outlet, siphon drain or grid to collect the water or directly towards the squat toilet if installed flush with the floor.

The doors must be raised 10 cm from the floor. Furthermore, the toilet area shall be fitted with toilet roll holders fixed to the walls, toilet brush holders also fixed to the wall and clothes hooks on the inside of each door. For safety reasons, the door shall open outwards and must have a lock which can be locked from the inside using a lever and from the outside using a special square or hexagonal tubular key. For other specifications concerning walls and ceilings see the access room section.

-New facilities may wish to provide a hydrotherapy area measuring at least 7-10m².

Changing rooms for referees and staff (Diagram 2.16)

Changing rooms for referees and staff shall be planned according to the size and use of the sports facility, that is to say: two units for the referees and one or two units for staff, with the same internal dimensions, finishes and equipment as the players' changing rooms.

Differences in size and layout shall be based on the various requirements. The changing rooms should contain 4-6 changing room units and also be suitable for use by players if necessary. Therefore, there should be one shower for every 3-4 users and one toilet for every 4-6 users. Disabled showers and toilets are normally not provided in this area, however if staff includes differently-abled persons, such facilities may be included. There must be at least one changing room for officials.

**CHANGING ROOMS FOR REFEREES AND STAFF**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Min: 9 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Ceiling height: 2.70/2.80 m</td>
<td></td>
</tr>
<tr>
<td>- Door height: 2.30 m</td>
<td></td>
</tr>
<tr>
<td>No. of referees</td>
<td>4</td>
</tr>
<tr>
<td>Coverings</td>
<td>Floor: Tiles or synthetic</td>
</tr>
<tr>
<td></td>
<td>Walls: Washable surface</td>
</tr>
<tr>
<td>Equipment</td>
<td>Benches, coat racks and/or lockers, table, four chairs and a blackboard with markers, refrigerator, rubbish bin, towels, bottled water, paper cups, mirror.</td>
</tr>
</tbody>
</table>

**ACCESS ROOM**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Min: 4 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Ceiling height: 2.70/2.80 m</td>
<td></td>
</tr>
<tr>
<td>- Door height: 2.30 m</td>
<td></td>
</tr>
<tr>
<td>Coverings</td>
<td>Flooring: Waterproof non-slip material that allows the water to drain easily during cleaning</td>
</tr>
<tr>
<td></td>
<td>Walls: Washable surface and tiles</td>
</tr>
<tr>
<td>Equipment</td>
<td>Mirrors, hairdryers, and coat hooks.</td>
</tr>
</tbody>
</table>
FIBA GUIDE TO BASKETBALL FACILITIES: CHAPTER 2 • Subdivision of Sports Facilities Into Areas

### TOILETS

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Min: 1.00 x 1.20m - 1.50 x 1.50 m (disabled)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Toilets</td>
<td>Qty: 2 - Height: 0.52 m</td>
</tr>
<tr>
<td>- Urinals</td>
<td>Qty: 2 - Height: 0.67 m</td>
</tr>
<tr>
<td>- Wash basins</td>
<td>Qty: 2 - Height: 0.80 m</td>
</tr>
<tr>
<td>Coverings</td>
<td>Flooring: Waterproof non-slip material that allows the water to drain easily</td>
</tr>
<tr>
<td></td>
<td>Walls: Washable surface and tiles</td>
</tr>
<tr>
<td>Equipment</td>
<td>Mirrors, toilet paper.</td>
</tr>
</tbody>
</table>

### SHOWERS

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Min: 4 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Showers</td>
<td>Qty: 2 - 0.90 x 0.90 m</td>
</tr>
<tr>
<td>- Showerheads</td>
<td>Height 2.40 m</td>
</tr>
<tr>
<td>- Tap</td>
<td>Height 1.30 m</td>
</tr>
<tr>
<td>Coverings</td>
<td>Flooring: Waterproof non-slip material that allows the water to drain easily during cleaning</td>
</tr>
<tr>
<td></td>
<td>Walls: Washable surface and tiles</td>
</tr>
<tr>
<td>Equipment</td>
<td>Coat hooks, soap, (towels).</td>
</tr>
</tbody>
</table>

### CHANGING ROOMS FOR OFFICIALS

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Min: 9 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverings</td>
<td>Floor: Tiles or synthetic material</td>
</tr>
<tr>
<td></td>
<td>Walls: Washable surface</td>
</tr>
<tr>
<td>Equipment</td>
<td>Benches, coat hooks and/or lockers, table, four chairs and blackboard with markers, refrigerator, rubbish bin, towels, bottled water, paper cups, mirror.</td>
</tr>
</tbody>
</table>

### ACCESS ROOM

<table>
<thead>
<tr>
<th>Size</th>
<th>Min: 4 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverings</td>
<td>Flooring: Waterproof non-slip material that allows the water to drain easily during cleaning</td>
</tr>
<tr>
<td></td>
<td>Walls: Washable surface and tiles</td>
</tr>
<tr>
<td>Equipment</td>
<td>Mirrors, hairdryers, and coat hooks.</td>
</tr>
</tbody>
</table>

Legend

- H = Height
- TOILETS
- Dimensions
- Qty
- Height
- Urinals
- Wash basins
- Coverings
- Equipment
- SHOWERS
- Dimensions
- Qty
- Height
- Tap
- Coverings
- Equipment
- CHANGING ROOMS FOR OFFICIALS
- Dimensions
- Ceiling height
- Door height
- N° officials
- Coverings
- Equipment
- ACCESS ROOM
- Size
- Ceiling height
- Door height
- Coverings
- Equipment
Facilities designed to host international events: the changing room area shall include a suitable room for commissioners and/or FIBA representatives (min. 5 people) and shall be equipped with:

- one table, four chairs, coat hooks, and a locker (an additional table close to a power socket is recommended for a computer).

The minimum surface area of the room shall be 12-15m²; the room shall be well aired and well lit with natural and/or artificial light.

c) Doping Control Station (Diagram 2.18 - 2.18a)

The Doping Control Station (DCS) must be located inside the competition venue, close to the playing hall, athletes’ changing rooms and the athletes’ medical care room. To ensure athlete privacy, the Doping Control Station must be inaccessible to the public, located away from the media and spectator areas and guarded by a security officer who may only grant access to authorised persons. Doping control signs must be hung on the door of the Doping Control Station as well as in the corridors to indicate the way to the doping control area. The signs should be in English and French (“Doping Control/Contrôle de dopage”).

Sanitary and sterile conditions must prevail at all times, therefore the Doping Control Station must have easily cleanable walls and floors made of hygienic materials, and the room must not be used for any other purpose (storage, office, medical room, toilets, etc.). It should be well-lit and air-conditioned.

A secure route must be ensured from the Doping Control Station to the parking spaces to ensure safe transport of the samples.

The doping control area must contain the following areas:

**WAITING AREA**

| Dimensions   | Min: 15-24 m²  
|--------------|----------------
| Ceiling height: | 2.70-2.80 m  
| Door height:   | 2.30 m       

**Coverings**

| Floor: Tiles or synthetic material  
| Walls: Washable surface  

**Equipment**

| At least 10 comfortable seats, tables, a fridge with drinks and refreshments, satellite TV and sufficient reading material.  

---

### TOILETS

| Size | Min: 1.00 x 1.20 m - 1.50 x 1.50 m (disabled)  
| Qty: | 2 - height: 0.52 m  
| Qty: | 2 - height 0.67 m  
| Qty: | 2 - height 0.80 m  

**Coverings**

| Flooring: Waterproof non-slip material that allows the water to drain easily during cleaning  
| Walls: Washable surface and tiles  

**Equipment**

| Mirrors, toilet paper.  

### SHOWERS

| Size | Min: 4 m³  
| Qty: | 2 - 0.90 x 0.90 m  
| Height: | 2.40 m  
| Height: | 1.30 m  

**Coverings**

| Flooring: Waterproof non-slip material that allows the water to drain easily during cleaning  
| Walls: Washable surface and tiles  

**Equipment**

| At least 10 comfortable seats, tables, a fridge with drinks and refreshments, satellite TV and sufficient reading material.  

---

### b) Rooms for Commissioners and/or FIBA representatives

(Diagram 2.17)
Diagram 2.18
Antidoping Control Station

Diagram 2.18a
Antidoping Control Station - 3D
### SAMPLE-TAKING AREA

| Dimensions       | Qty: Preferably two  
| Min: 19 m²      | Ceiling height: 2.70-2.80 m  
| Door height: 2.30 m |
| Coverings        | Floor: Tiles or synthetic material  
| Walls: Washable surface |
| Equipment        | One desk, 5 chairs, a table for the samples, one cupboard, a small refrigerator for the samples, a large rubbish bin and an armchair.  
|                 | A reclining armchair, if blood samples are to be taken. |

**TOILETS**

| Dimensions       | Qty. 2  
| Min: 1.00 x 1.50 m (preferably 1.50 x 1.50m) |
| Coverings        | Floor: Tiles or synthetic material  
| Walls: easy to clean tiles or washable surface |
| Equipment        | Front-facing mirror or mirror with a ¾ reflection positioned at toilet-seat level, wash basin, toilet paper and soap. |

**BATHROOM**

| Size             | Qty: 1, if possible accessible only from sample-taking area  
| Min: 4 m²        |
| Coverings        | Flooring: Waterproof non-slip material that allows the water to drain easily during cleaning  
| Walls: Washable surface and tiles |
| Equipment        | Shower, toilet, wash basin, soap, front-facing mirror or mirror with a ¾ reflection positioned at toilet |

**Mandatory list of equipment/ consumables useful for a doping control procedure**

- Portable refractometer;
- pH meter or pH sticks;
- Full doping control kit of urine sampling;
- Doping control set for partial urine samples;
- Urine collection vessels 175ml;
- (*) Doping-control blood-kit for blood collection (tourniquet, venipuncture tubes etc);
- Centrifuge, centrifuge tubes and phials for doping control blood samples;
- Armbands for Doping Control Officers;
- Cool packs;
- Lots and bags for the selection of the players to be tested;
- Secure transport bag for doping control samples;
- Security seals for the secure transport bag;
- Disposable cover roll, 50cm width, for the examining table;
- Sterile disinfectant wipes or swabs;
- Latex surgical gloves;
- (*) Pasteur pipettes (for blood sampling only);
- (*) Water for injection;
- Individually sealed caffeine-free and non-alcoholic beverages.

(*) These items only concern the collection of blood samples if FIBA decides so.

**d) First-aid area for athletes and spectators (Diagram 2.19)**

For functional and safety reasons, facilities must include two medical stations for first-aid purposes, one for athletes and one for the public.

These areas should be used to administer first-aid as well as offer normal preventive medical consultations; they must be within easy reach of all the other areas of the facility.

The first-aid area should meet the standard requirements regarding size, access and internal partitioning, and must be adequately equipped, with the necessary sanitary devices and a stretcher.

A first-aid area must have a waiting room or access room adjoining the medical examination room, with toilets and a wash basin outside (and possibly a shower).

Furniture and equipment must mainly include:

- A bed for medical examinations, approx.2.40m in length and 0.60m wide with a maximum weight bearing load of 150 Kg, with a swivel stool and flexible-arm lamp;
- A folding stretcher;
- A desk, minimum size 0.90x1.60m, with three chairs;
- A wardrobe with mirror, measuring at least 0.60x1.60m;
- A coat rack with at least three hooks;
- An oxygen cylinder with equipment for resuscitation bag;
- A defibrillator for first-aid treatment of cardiac arrest;
- A cabinet to store medicines and medical equipment;
- A fridge.

Note: The detailed needed medical furniture, equipment and medications are available on the FIBA website www.fiba.com under Experts/Medical Corner/Anti-Doping/Facilities.

The first-aid room for players must be suitable for administering first-aid in the event of accidents or sudden illness. It must be situated on the ground floor, as close to the playing court as possible, and with a direct and clear passage to the outside for easy access by the emergency service vehicles (ambulance).

The emergency access route and exit should be appropriately marked with special signs and must always be free of obstacles.

The public first-aid room must be suitable for administering first-aid to spectators. It must have the same functional elements as the first-aid room for athletes but should be located in a different part of the facility to provide direct and easy access from the tribunes. It should be close to an emergency exit to be accessible to ambulances outside the hall. The emergency access route and exit must be appropriately marked with special signs and always be free of obstacles.

**ENTRANCE AREA TO FIRST AID ROOM**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Min. 10-15 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling height</td>
<td>2.70-2.80 m</td>
</tr>
<tr>
<td>Door height</td>
<td>2.30 m</td>
</tr>
<tr>
<td>Coverings</td>
<td>Floor: Tiles or synthetic material</td>
</tr>
<tr>
<td></td>
<td>Walls: tiles or washable surface</td>
</tr>
<tr>
<td>Equipment</td>
<td>Chair, benches and coat racks.</td>
</tr>
</tbody>
</table>
MEDICAL EXAMINATION ROOM

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Min. 15 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling height</td>
<td>2.70-2.80 m</td>
</tr>
<tr>
<td>Door height</td>
<td>2.30 m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coverings</th>
<th>Floor: Tiles or synthetic material</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Walls: tiles or washable surface</td>
</tr>
</tbody>
</table>

| Equipment      | A desk, 2 chairs, an examination bed 2.20m long, a first-aid cabinet, fridge and locker. |

TOILETS

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Min: 1.50 x 1.50 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilet</td>
<td>Qty: 1</td>
</tr>
<tr>
<td>Wash basins</td>
<td>Qty: 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coverings</th>
<th>Flooring: Waterproof non-slip material that allows the water to drain easily during cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Walls: Washable surface and tiles</td>
</tr>
</tbody>
</table>

Storage rooms shall be large enough to hold all the equipment necessary for the various sports. This area shall enable easy access to all equipment from outside the hall and must not hinder the transfer of equipment within the building. Storage and transfer of equipment shall be planned according to the maintenance requirements, size and weight of the equipment itself. For example, if the floor of the basketball court is made of removable wooden panels then particular attention must be paid to the storage room for these panels. The entrance to the storage room must be wide enough (min 2.40m) and high enough (min 3.50m) to accommodate vehicles transporting the wooden floor panels and equipment. Obviously, the doors also have to be of an appropriate size, depending on the equipment and furniture to be stored in the rooms. The room must have the correct temperature and humidity levels to prevent warping of the wood and damage to other materials in general. The storage room can be divided into separate areas according to constructional and functional requirements, with each area meeting respective specifications.

The corridors leading to the storage rooms must be of an appropriate width and height.

f) Administrative Offices (Diagram 2.21)

There shall be office rooms for the staff overseeing the management and technical running of the facility.

The rooms shall vary in size according to management requirements, but must be at least 20/25m² and, if possible have adjacent men’s and women’s toilets which are also suitable for differently-abled persons. Large facilities should have more than one office, namely one for management staff and one or more for the secretariat, plus a meeting room and a hospitality room.

PUBLIC AREA

This is the area reserved for visitors and spectators to sports events or competitions. This area encompasses many interconnected functions such as entering the hall, buying a ticket, going to one’s seat in the tribune, and watching the event.

The number of paying spectators, which is the key factor in management terms, can be influenced by what the area has to offer and by the composition of the spaces available.

This area includes all the spaces and routes necessary to involve spectators in the sports activities or other support activities that may be foreseen. The area’s dimensions may vary according to the facility’s structure, if the complex already exists, or to the
Diagam 2.21
Administrative Official

Diagram 2.22
Box Office

Administration Office

Toilets

Box Office

Separators
activities foreseen in the planning phase or to the dimensions necessary for the optimal management of activities. As a rule, the public area shall include:

- An entrance hall;
- Ticket offices which may be located in the entrance hall or elsewhere;
- Tribunes;
- Toilets;
- Ancillary services.

**Entrance hall**

The entrance hall shall be clear and spacious to allow the public to enter and exit freely and safely; it shall have information desks, screens with details on the sports services and the game in progress, supervisory staff, public telephones and a ticket office. This area must be free from architectural barriers to also enable differently-abled persons easy access into the heart of the building.

Depending on the type of facility and flow of public, entrances may be located in different areas to channel the spectators into the relative sectors. The different sectors may be subdivided according to their function or purpose.

Standard safety requirements shall also apply to the entrance area, so that entrances can be used by the public as an emergency exit in the event of a fire or other hazardous incident. Doors shall therefore open outwards and automatically remain open until manually closed. The doors shall be resistant, preferably made entirely or partially of safety glass and marked with clearly visible signs.

The dimensions of the entrances and exits shall be decided in the planning phase, according to the size of the sports facility, and taking into account regulations pertaining to the elimination of architectural barriers.

![Diagram 2.23a](image1.png)  
**Diagram 2.23a**

![Diagram 2.23b](image2.png)  
**Diagram 2.23b**

Prefabricated and telescopic tribunes
Ticket office (Diagram 2.22)
The ticket office, which may be inside the complex or outside, must be positioned so as not to obstruct the normal flow of people. If the ticket office is built outside the complex, it must comply with the safety standards applicable to the construction of public buildings.

In compliance with current regulations, outdoor facilities must have a ticket office located in an area separate from the main building and at least 10 m from the entrance. The standard requirement is one ticket office for every 2,000 spectators; ticket offices shall be located in the service area within the facility’s perimeter. If there are no service areas or if such areas are restricted by temporary structures then the ticket offices shall be located inside the building. For safety and security reasons, the ticket office windows shall be fitted with barriers made of resistant material or grilles placed 4 cm from the counter. Queue control systems shall be installed in front of each ticket office. The queue control barrier separating the path to the ticket office and the exit path shall be placed 1.20m from the edge of the ticket-office area. The barriers shall be at least 4m long and 0.90m high and fixed to the floor.

Tribunes
The area for the tribunes must ensure easy access for the public, circulation of spectators in the different sectors, visibility of the entire court, access to toilets and an unhindered exit route from the central hall. The size of this area may vary according to the estimated number of spectators and on the basis of the following criteria:

- The maximum capacity of the tribunes shall be calculated on the basis of the total length of the rows in metres divided by 0.48m (minimum space occupied by a spectator);
- The steps leading to the various sectors shall be at least 1.20m wide and must serve no more than 20 seats on each side and row;
- The step of each seat row shall have tread of at least 0.60m and a riser of between 0.40m and 0.50m depending on the curve of visibility, the shape and layout of the facility.

Tribunes must be easily accessible and comply with the same standards for access routes, corridors and doors pertaining to the entrance to the halls. More specifically, the paths diverting spectators to the various sectors shall be straight; the steps leading down to the rows in each sector shall be rectangular, with a riser of no more than 0.25m and a tread of at least 0.23m; the tread/riser ratio must be at least 1.3. A change in gradient between two consecutive tribune sectors is permitted as long as there is a gangway between the two tiers; the gangway shall be the same width as the steps, at least 1.20m deep, and shall comply with the size restrictions for steps and the tread/riser ratio.

Prefabricated and telescopic tribunes (Diagram 2.23a-b-c)
To ensure optimum use of the tribunes, these should be situated close to the basketball court and be prefabricated or, even better, telescopic.
Both types of tribunes allow quick assembly and disassembly, however the telescopic type offers more advantages as it can be rolled manually (on wheels) or electronically (using a remote control).

The use of telescopic stands allows the playing area to also be used for sports requiring more space or for entertainment events which require a particular emphasis on safety. Moreover, with a larger playing area, mobile partitioning walls can be used to divide the area into two or more basketball courts for training purposes.

Public bathrooms (Diagram 2.24)
The public area shall have at least two bathrooms, each with one set of toilet stalls for men, one set of toilet stalls for women, and at least one toilet for the differently-abled persons. The bathrooms should be located no more than 50m from the exits of the spectators’ area, and each bathroom should provide toilets, as well as urinals in the men’s bathroom, and at least one wash basin in the entrance room.

The number of toilets/bathrooms and their location may vary according to the size of the facility and consequently the number of visitors expected.

The size of both the men’s and women’s bathrooms must comply with the following parameters:
- Two urinals and one toilet for every 500 men and two toilets every 500 women, upholding a 1-to-1 ratio of men to women ratio;
- A minimum of 2 toilets (1 for men and 1 for women) for differently-abled persons;
- One wash basin in the entrance room for every toilet and urinal;

The following must also be taken into account:
- The layout of the bathrooms must guarantee privacy even when the entrance doors are open;
- Access to the bathrooms must be generous enough to cater
for people entering and exiting at the same time;
- The bathrooms should have natural ventilation, however where this is not possible, they must be fitted with an artificial ventilation system.

**Mass Media Area**

It is essential to carry out a study on how radio and television commentators, photographers and all other media representatives move and work within the area in order to be able to offer them the best working conditions and materials. Before considering individual requirements, it is important to look at the collective areas:
- An area reserved for the above mentioned media representatives with a smaller adjacent area for those with accreditation;
- A refreshment area for those who must often continue to work after the competition has finished.

Numerous prime positions shall be allocated for permanent television cameras in order to ensure high quality images of the event. The number of cameras and the exact position shall be determined by the event’s host broadcaster depending on the type of building and the importance attached to the event, however cameras are usually placed high up in the hall, along the endlines behind the team benches and the officials’ table, possibly in a central position to the right of the baskets and pointing towards the centre of the court.

A minimum of four places shall be available for radio and television; they shall be placed in the upper part of the hall, along the endlines behind the team benches and the officials’ table, possibly in a central position. Commentators notably prefer to work from commentary booths or cabins located in an area which provides the best view, without any visual obstacles, separated from other accredited media and protected from the public.

To enable the media representatives to work quickly and efficiently, the basketball hall shall include the following spaces:
- A room to be used as a television studio in which to interview players and other people involved in the sporting event;
- A storage area for equipment and materials;
- Ducts and raceways for cables and metal wires for connecting mobile television stations.

An area outside the complex shall be reserved for at least three television trucks and five cars; this area shall be easily accessible and well connected to the building.

**Journalists**

An area shall be reserved in the hall for journalists, in the lower central part of the tribunes, along the endlines, behind the team benches and the scorer’s table.

This area shall be equipped with at least 50 working positions, each with a chair, small table, electrical multi socket and at least 1 telephone/ADSL line. If the area does not have the necessary computer and Internet connections, the workstations shall be equipped with traditional fax machines. This area shall be easily accessible and separated from the rest of the tribunes by security barriers.

The following areas shall be provided within the facility to allow journalists to work efficiently:
- A press room adjacent to the tribune with at least 40 workstations, including, desks, chairs, electrical multi sockets and at least one telephone/ADSL line or fax per working position;
- A press conference room for at least 50 people for interviews with those involved in the event; the room shall be equipped with a good sound diffusion system and adequate auxiliary lighting to ensure television images suitable for broadcasting.

Parking spaces for at least 50 cars shall be reserved in an easily accessible area well connected to the building.

**Photographers**

An area in the hall shall be reserved for up to 50 photographers; photographer positions shall be at court-level, along the endlines, in the area between the advertising boards (2m from the endlines) and the spectator barriers (5 m from the endlines).
A number of working positions shall be provided to enable the photographers to work efficiently and transmit images. These working positions shall be located in the press tribune or in a press room equipped appropriately according to the number of accredited photographers.

Parking spaces for at least 20 cars shall be reserved in an easily accessible area well connected to the building.

**Telematics Office**
The transmission of data, results and images to mass media operators is achieved through telematics using internet and intranet networks. This technological resource can only be implemented if telematic infrastructures are available in the region; furthermore, an internal architecture must be planned defining the function and purpose of the facility and necessary equipment.

Therefore, when planning a new sports facility or the restoration of existing facilities, a space or room must be envisaged for a telematic transmission office with the task of coordinating, controlling, managing and maintaining the internal telematics network including the control system units for the entire complex.

The planning project shall provide for cabling and equipment; in this way, cable raceways, transmission bridges, aerials, and other equipment may be planned in advance, with particular emphasis on safety, considering the intended use.

The equipment and size of such resources shall be related to the type of facility and importance of an event. Telematic resources represent an added value in which organisers of international events must strive to invest.

**VIP Area**
The facility must accommodate hospitality areas suitable for receiving and entertaining VIPs, eminent figures, representatives of government organisations, and national public authorities.

Special VIP areas shall be located in the hall, and directly connected to the reserved VIP-tribunes. The VIP-areas shall include:

- A reception area at the entrance for accreditation inspection and information;
- A minimum of two hospitality areas (to hold at least 150 people);
- A minimum of two small private rooms;
- A refreshment area with service also available in the lounge areas; (the refreshment area should not be located in close proximity to normal telephone connections;)
- Lounge areas shall be fitted with wall-mounted screens and monitors;
- An adequate number of toilets;
- A cloakroom.

These areas shall all be connected by a common private area located in front of the VIP tribunes. This shall be examined in detail in the chapter on event organisation.

Reserved parking areas shall be provided according to the importance of the event; these areas shall be easily accessible and well connected to the building.

**Ancillary Services**
In addition to the support services areas listed above, a sports facility may also accommodate other spaces to cater for activities which are not essential to the actual running of the facility but which increase the quality of the services offered.

Activities related to wellness, relaxation, exhibitions, cultural and commercial events all require bars, refreshment points, catering rooms, meeting rooms and offices, exhibition areas, etc.

The decision whether or not to include such areas in the planning of a new facility or restoration of an existing structure depends entirely on the management’s strategic objectives and its management objectives.

The provision of certain ancillary services depends very much on the type of sports facility and its location, as well as the type of sporting event and its importance.
NEW FIBA COURT MARKINGS 2010

All court lines (black lines on the attached diagram) shall be 0.05 m in width. All red and dotted lines are just auxiliary lines that indicate correct measures.
Floor Types and Game Equipment
FIBA
We Are Basketball
The constant evolution of basketball and growing interest shown by the public have generated an increased exposure of all aspects involved in this sport, which has consequently led athletes to train and practice with greater regularity, not least because of the growing number of demanding competitions.

The heavy physical stress to which players are subjected is often the cause of accidents and injuries. It is therefore important to pay particular attention to accident prevention, and a first step in this direction is to improve the quality of all the equipment used in basketball facilities, in particular the equipment with which athletes are in direct contact, such as floors and baskets.

FIBA, together with its Study Centre, has therefore decided to constantly monitor the evolution of the game in terms of materials and equipment manufactured by specialist companies with the aim of protecting player safety by contributing to the improvement of the materials.

In line with these principles, FIBA has studied and approved special regulations that establish the dimensions and characteristics of equipment and court surfaces suitable for official events, both men’s and women’s.

The provisions contained in the Official Basketball Rules must be followed in their entirety by all parties directly involved in the game, including basketball equipment manufacturers, local organisers and FIBA, in order to implement the equipment approval programme and establish national and international standards.

Below are some excerpts from the Official Basketball Rules listing all the equipment necessary to play basketball, together with FIBA’s requirements for the different levels of competition, as stipulated in the Regulations:

The competitions are divided into three levels:

- High level competitions (Level 1): Main FIBA official competitions, as defined in Art. 1.1.1 of the FIBA Internal Regulations governing the FIBA Competitions.
  The facilities and equipment required for the following main FIBA official competitions are subject to FIBA approval (Levels 1 and 2): Olympic Tournaments; World Championships for Men, Women, U-19 and U-17; Zone Championships for Men and Women.
  All equipment at these competitions must be FIBA approved and must display the FIBA Study Centre logo in the FIBA approved layout.
- Medium level competitions (Level 2):
  All other FIBA official competitions as defined in Art. 1.1.2 and 1.1.3 of the FIBA Internal Regulations governing the FIBA Competitions, and high level competitions of the national federations.
- Other competitions (Level 3):
  All other competitions not included in the above.

**Playing Floor**

The playing floor is one of the most important components of a sports facility, not only because it provides the stage for entertainment, but also because of the role it plays in the cause and/or prevention of injuries to players and the effect it has on their performance. Incorrect or defective flooring is often the main cause of injuries to players’ ankles, knees, etc.; For this reason, the International Sports Federations, and in particular FIBA, have shown a great interest in studies on bio-mechanics and the safety of athletes, contributing to the compilation of a set of regulations which is recognised by most countries.

The choice of flooring is based on three main aspects:

- Financial
- Technical
- Sporting functionality
1. Financial aspect
From a financial point of view, it is important to remember that a sports floor has a significant impact on the overall cost of a sports facility. In terms of costs, thought must be given to the following factors which may influence the ultimate choice in flooring:

a) **Complete cost of flooring and sub-floor:** it may vary depending on the prevailing conditions;

b) **Cost of playing surface:** this may vary a great deal depending on the quality of the material as the overall cost includes the cost of the surface layer and any sub-structure or additional work required, such as supports and anchorage for equipment, scoreboards etc.;

c) **Maintenance cost:** to be foreseen and evaluated for all types of floors. Additional maintenance costs must also be anticipated for extra floor protection if the facility is also used for public events. In this case, the management should consider the possibility of installing removable flooring or supplying special matting to cover the floor.

d) **Usage time:** extent of floor use, as intended by the management, bearing in mind that a multifunctional floor means that the structure can be used all the time. This factor is influenced by the average lifespan of the entire flooring system which itself depends on the type and wear of the selected material.

2. Technical aspect
Detailed technical specifications of the material and installation conditions can be determined in the planning phase, based on the primary use and multifunctional nature of the floor. To make sure that the project requirements are met, it is important in the execution phase to contact companies with experience in this sector.

3. Sporting functionality aspect
To safeguard the sporting functionality and guarantee that sports
programmes can be carried out, the flooring must be certified as suitable for use in the foreseen competitions.

**The characteristics of sports floors**

The characteristics of sports flooring vary very much according to the type of sport practised; the quality of the flooring generally depends on the purpose for which the hall is to be used.

The parameters applicable to all types of flooring in order to comply with the principles above are as follows:

- **Elasticity**
  
  Elasticity is a fundamental property by means of which floors can elastically deaden the impact force of the body during jumping and running, thereby providing a feeling of comfort to players. Optimum values of elasticity provide for rapid action and reduced muscular stress, whereas excessive elasticity values lead to a slowing down of action. Floors that are too hard floors cause muscles to tire quickly, thus increasing the risk of injury to ligaments. There are two types of elasticity: point elasticity and area elasticity.

  Point-elasticity is the elasticity of the materials comprising the overlay flooring. These materials are usually synthetic, soft and flexible surfaces which provide cushioning and shock absorption, and almost no impact energy return. The point-elasticity value must be the same over the entire floor, thus, where synthetic surfaces are concerned, the materials must have a consistent thickness and create a homogenous layer. (Diagram 3.1).

  Area-elasticity is the elasticity of the possible foundation (sub-floor), generally made up of a network of wooden joists, rendering a stiff yet flexible layer which provides energy return but little cushioning. Excessive deflection is to be avoided and elasticity must be constant over the entire surface (for example, elasticity must have the same value on the joists and in the area between the joists) (Diagram 3.2).

- **Uniformity**
  
  The surface of the playing area must be perfectly level, as unevenness may cause irregular bouncing of the ball and disturb...
the practising of fast sports. In fact, if the foot senses superficial waviness, it may move less securely, impeding performance.

- **Shock absorption properties**
  
  Shock absorption is the non-elastic absorbency of the impact forces of the body, due to the inner viscosity of materials. It measures the impact force absorbed by the floor as opposed to returning the energy force to the athlete. The more impact energy the floor absorbs, the less impact the athlete must absorb, thus providing greater comfort for the feet. This parameter therefore ensures the greatest comfort to the foot. Excessive shock absorption levels may render sporting action more difficult.

- **Deformation**
  
  The buckling capacity depends on the elasticity, viscosity and thickness of the elastic layer and defines the overall deformation of the floor under a dynamic load. An excessive value reduces safety when putting down the foot, increasing the risk of sprains.

- **Superficial friction**
  
  Superficial friction is extremely important and has optimum values which vary according to the different sports. In running, for example, maximum adherence between the foot and the floor is needed, whereas tennis requires a controlled slide. In any case, however, the foot must be able to rotate easily on the point of support without blocking or risk of spraining. To improve superficial friction, synthetic materials are embossed on the surface (Diagrams 3.3-3.4).

- **Ball bounce**
  
  The rebound of the ball is a very important factor in ball sports. The bounce must be uniform and regular over the entire surface. What is more, the flooring should not absorb the bounce to such an extent that it is impossible to play regular competitions on that surface. The International Basketball Federation’s regulations stipulate that the rebound height of a ball dropped onto the playing surface from a height of 1.80m must be at least 90% of the rebound height when dropped on a cement surface (1.20-1.40m) (Diagram 3.5).
• **Colour**
The colour of the playing area must be dull, but not dark (with a factor of light reflection ranging between 0.25 and 0.50) so that the marks on the playing court are clearly visible.

• **Thermal insulation**
Thermal insulation is important when the playing area is predominantly used for exercises on the floor, because it increases comfort and contributes to reducing energy consumption (the floor being a major cause of heat loss).

• **Acoustic insulation**
Acoustic insulation is a fundamental parameter for sports halls. Although acoustic characteristics depend on the whole environment of the hall, the floor itself should not be allowed to cause excessive vibration as a result of running, jumping or bouncing of the ball. Floors built on elastic foundations, in particular, will require an appropriate solution to ensure the necessary acoustic insulation (use of deadening material).

• **Safety**
In addition to the above requirements, floors must also comply with safety standards, and therefore be fire-resistant (EN 13501) and not release toxic substances. Wooden surfaces must be splinter-free.

An important factor is the overall resistance of the floor which defines the fixed and mobile loads that the floor can withstand without the danger of being permanently deformed; loads include sports equipment, other equipment, telescopic tribunes, cleaning machines and scaffolding.

**Floor Requirements for Basketball**
Upon publication of this Guide, all floor materials or systems intended for installation must comply, according to the level of competition, with the requirements stipulated in the latest *Official Basketball Rules-Basketball Equipment*, namely:

*The playing floor shall:*
• Be a minimum length of 32m (28m+4m perimeter) and a minimum width of 19m (15m+4m perimeter);
• Have an antiglare surface.

For level 1 and 2, **permanent wooden flooring and synthetic flooring**, the following parameters shall be taken into account:

• **Sport functional requirements:**
  - Force reduction (shock absorption)
  - Vertical deformation
  - Vertical ball behaviour
  - Area deflection
  - Sliding properties

The requirements for the above properties must be fulfilled at each system testing point.

• **Uniformity requirements:**
  - Force Reduction
  - Vertical deformation
  - Vertical ball behaviour

NB: Norms and results to be viewed in the latest edition of the Official Basketball Rules & Basketball Equipment. To this day, the FIBA Study Centre relies essentially on tests done according to DIN 18032-2 and EN 14904

For Level 1 and 2, **portable wooden flooring**, the following parameters shall be taken into account:

• **Sport Functional requirements:**
  - Force Reduction (shock absorption)
  - Vertical deformation
  - Vertical ball behaviour
  - Sliding properties

The requirements for the above properties must be fulfilled at each system testing point.

• **Uniformity requirements:**
  - Force Reduction
  - Vertical deformation
  - Vertical ball behaviour

NB: Norms and results to be viewed in the latest edition of the Official Basketball Rules & Basketball Equipment. To this day, the FIBA Study Centre relies essentially on tests done according to DIN 18032-2 and EN 14904

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**FIBA GUIDE TO BASKETBALL FACILITIES • Chapter 3 • Floor Types and Game Equipment**

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56
The manufacturer, together with the flooring installation company, shall be obliged to produce documentation for each customer comprising at least the following: results of the prototype test, a description of the installation procedure, maintenance advice, results of the inspection and approval of existing installation carried out by approved inspection officials.

The height of the ceiling or the lowest obstruction above the playing floor shall be at least seven (7) m.

The playing floor shall carry mobile or floor-fixed backboard support structures without degrading the characteristics of the backboard support structure.

Furthermore, floors shall be fire-resistant and subject to examination within the framework of the fire protection system applicable for the building and the local area; the floors shall not release toxic substances.

Since every sports floor coating has a different composition, structure or superficial layer, each floor should undergo individual testing.

Usually in composed flooring, the elements to be tested are:
- Composition
- Thickness
- Surface or volume mass
- Surface structure
- Fabric colour and type.

**Sub-Floors**

Before describing the types of floors required for basketball it is important to bear in mind that generally the playing surface is installed on a sub-floor and there are numerous ways in which this can be done.

The sub-floor is fundamental for correct flooring. It must support and distribute load force on the floor. These loads are not usually very heavy and include the athletes as well as the game equipment and other equipment. Nevertheless, load capacity must also take into account the weight of small service vehicles and the telescopic tribunes for the spectators.

The sub-floor must be even, rigid and not deformable. It must be perfectly flat before laying the floor. The foundation ground must not be liable to subsidence or ground settling.

Sub-floors for indoor flooring do not have the drainage problems which outdoor surfaces may have, however, being installed directly on the ground, they may be prone to rising damp. This problem can be avoided by installing waterproofing barriers and ensuring that the sub-floor has an adequate ventilation system.

The choice of sub-floor depends on the location, financial factors, structure of the building and construction regulations in force in the different countries. Some of the most common types of sub-floor systems are described below:

- a. sub-floor on loose stone foundation;
- b. sub-floor on brick piers and hollow flooring blocks;
- c. sub-floor on floor;
- d. Loose stone sub-floor (Diagram 3.6).

This type of sub-floor is installed directly on filled and flattened ground. A bottom-up vertical section will show the parts described below.

**Creation of a loose stone foundation:** this is made up of loose stones of various sizes and a squat shape with non hygroscopic properties. A well-constructed loose stone foundation should include a network of air passages with a 15/20 cm section, placed at a centre-to-centre distance of 1.5m, interconnecting, that run along the walls and have sufficient outlets. The loose stone foundation must be built using stones that decrease in size the closer they are to the surface, ending with a level surface of fine pebble 30-40cm thick. At no point must the surface be more than 2cm higher than the nominal height and, when verifying flatness using a 4m rule, the width of the fissure must not be more than 3cm.

The loose stone foundation must be covered with an 8-10cm thick concrete screed made of lean concrete. The surface must be flat and even and the deviation when tested with a 4m rule must not be more than 1cm.

To avoid the problem of rising damp, a waterproof layer must be created using two layers of heat setting bitumen mortar for
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Diagram 3.6
Sub-floor on loose stone

Diagram 3.7
Sub-floor on brick piers and hollow flooring bricks
a minimum thickness of 1.2mm or alternatively using suitable waterproof sheets with overlapping and sealed joints. The waterproof layer must continue 10-15cm up the walls and must be correctly overlapped and joined to the wall.

A drainage layer made of sand or plastic sheeting is usually placed on top.

The finishing layer is made up of a screed of cement and sand mortar using a 3:4 ratio of cement type 325 per 3m of thickness according to the type of flooring. This is laid on the waterproofing layer or self-levelling material to prepare the floor base.

The surface of the screed must be laid using a rule. After a few hours, cement and fine sand mortar must be spread on the surface using a plastering trowel. The final surface must be perfectly level and flat. During the setting process the screed must be well watered/kept wet and then allowed to dry until the level of humidity is less than 25%.

b) Sub-floor on brick piers and hollow flooring bricks (Diagram 3.7)

The structure is made up of piers built from full bricks and cement mortar, laid down in parallel lines at a centre-to-centre distance equal to the maximum size of a hollow brick (1 m). The height of the walls is of about 40cm. The passages must be interconnecting and have air exchange outlets. The structure of the sub-floor may be as follows:

The surface must be covered with 8-10cm thick concrete slabs with metal mesh to stiffen the sub-floor; a finishing layer is placed on top, made up of a screed of cement and sand mortar using a 3:4 ratio of cement type 325 per 3m of thickness.

A waterproof layer must be placed on top of the surface, comprising two layers of heat-setting bitumen mortar for a minimum thickness of 1.2mm or, alternatively, suitable waterproof covers with overlapping and sealed joints. The waterproof layer must continue 10-15cm up the walls and must be correctly overlapped and joined to the wall.

The finishing layer is made up of a screed of cement and sand mortar using a 3:4 ratio of cement type 325 per 3m of thickness of at least 3cm, laid with the rule or using specific levelling material. During the setting process the screed must be well watered/kept wet and then allowed to dry until the level of humidity is less than 25%.

c) Sub-floor on floor (Diagram 3.8)

Here, the support structure is a cast and/or prefabricated floor laid down to form a network of parallel interconnecting air passages at a centre-to-centre distance of maximum 1.50

and with a section of no more than 15x20cm maximum. The application of a layer of waterproof material is recommended to avoid rising damp which may damage the playing floor.

The sub-floor structure is very simple, and is completed with a layer of cement and sand mortar (as described above) on top of the finished supporting floor.

Note: The thicknesses of the layers mentioned correspond to the thicknesses usually used for these types of sub-floors. The thickness of the final layer of the sub-floors depends on the type of playing floor (fixed or portable), use of the sports facility and recommended maintenance; on the basis of these factors, the finishing layer shall be made of civil or industrial material according to project specifications or local resources for the supply of materials.
**VARIOUS TYPES OF FLOORS**

The use of permanent or portable floors allows the practice of sports other than basketball, such as fencing, gymnastics, volleyball and futsal.

The most common types of flooring are the following:

**Wooden flooring**

**Dismountable wooden flooring**

**PVC flooring**

**Rubber flooring**

**Polyurethane-coated flooring**

**Linoleum flooring**

**Cement flooring**

*Note: All high-level competitions of FIBA (Level 1 competitions) must be played on a wooden floor.*

**Wooden flooring**

Wooden floors continue to be the most common type of flooring, particularly those built on an elastic foundation. Although wooden floors require regular maintenance, they can be easily restored by sanding and levelling the surface layer.

The choice of wood type depends in particular on factors such as durability, temperature and sensitivity to humidity, but it must also assure adequate insulation.

The structural elements of wooden sports flooring do vary, yet their different systems of assembly each guarantee the fulfilment of FIBA’s technical requirements. With regard to fixed wooden floors, some of the most common structures are described below.

Wooden floors may be laid on either **joists** or **stringers**. Joists are buried directly in the sub-floor screed, whilst stringers are placed on top of the sub-floor screed, with elastic strips or pads inserted if necessary.

**Wooden joists** are prismatic joists with a trapezoidal section; they must be 40-50mm thick with a width from the shortest base of at least 30mm, an angle of inclination of at least 15° and...
The thickness of the screed between the bottom side of the joists and the waterproofing layer must be at least 30mm.

Particular attention must be paid to the humidity level of the screed before laying the final surface (boards, strips, planks).

**Stringers** must be at least 40mm thick with a width one and a half times the thickness; they must be installed parallel to one another at a centre-to-centre distance of 25-30cm, with a gap of at least 5mm between adjoining ends. The top surface of the stringers must be completely flat with no protrusions. Stringers must be dry set, with elastic strips inserted if necessary. We recommend filling the space between the squared timbers with acoustic insulation material *(Diagram 3.10).*

The following can be anchored to a surface prepared with joists:

- panel boarding covered with parquet made of nailed planks *(Diagram 3.11)*;
- spruce boarding at 45° to the underlayment and covered with parquet made of nailed planks *(Diagram 3.12)*;
- panel boarding covered with parquet made of nailed strips *(Diagram 3.13)*.

The following can be anchored to a surface prepared with stringers:

- panel boarding covered with parquet made of nailed strips *(Diagram 3.14)*;
- spruce boarding at 45° to the underlayment and covered with parquet made of nailed planks *(Diagram 3.15)*;
- panel boarding covered with parquet made of nailed strips *(Diagram 3.16)*.

**Boarding** is the anchorage surface for parquet: it must be at least 20mm thick and can be made of boarding panels or plywood. It must be installed at right angles or, even better, at 45° to the axis of the joists and fixed to the hoists with stainless steel nails or screws. The distance between the boards must not be greater than the thickness of the parquet. Panels, plywood or particleboard (chipboard) usually have the following minimum dimensions:
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Diagram 3.11
Wooden flooring - on wooden joists - nailed planks on panel boarding

Diagram 3.12
Wooden flooring - on wooden joists - nailed planks on spruce boarding at 45°

Diagram 3.13
Wooden flooring - on wooden joists - glued strips on panel boarding

Diagram 3.14
Wooden flooring - on stringers - nailed planks on panel boarding
Width: minimum 200mm, maximum 400mm; Length: minimum 1000mm, maximum 1500mm. Use metal fasters on the four sides to join the panels. The boarding must have a gap of at least 2mm from walls, pipes or other fixed elements.

Parquet is available in various types and forms. Planks and strips are usually used for sports floors and the dimensions are as follows:

- **The planks** are made of solid wood and shaped like a parallelepiped, with slightly slanted ends and sides so they can be fitted close together as the elements are installed individually. The planks have male and female tongue-and-groove profiles on the four vertical sides. The profiles must be flawless so that the planks can be perfectly interlocked. Planks must be nailed onto a suitable support or fixed with metal clips. Planks used for sports floors must be at least 17mm thick, 60mm wide and 400mm long.

- **Strips** also have a shape similar to a parallelepiped, with slightly slanted ends and sides so they can be fitted close together, as the elements are installed individually. Strips must be glued to a suitable support. Adhesives must be specific for this use and have a low water-content. Strips must be at least 10mm thick, 50mm wide and 30mm long.

The dimensions are only indicative and depend on the type of wood used. The wood type must always comply with FIBA playing floor requirements.

Parquet is usually installed in the shiplap manner where the single elements are laid lengthwise so that the ends of the joints are staggered irregularly. When laying the parquet, the humidity of the wood should be between 9% ± 2%. Installation must be carried out at an ambient temperature higher than 12°C with 60% ± 5% humidity. Once the parquet has been laid, it should be allowed to rest for 10-15 days before treating the surface.

It is important to remember that the types of wooden floors...
described above do not have any particular elasticity properties. If a wooden floor needs to be highly elastic, it has to be laid on a substructure made of a double-crossed structure of stringers. The construction features of substructures for wooden floors and other floors are described below.

**Elastic Substructures for all Types of Floors**

All basketball surfaces require a good level of elasticity to enable the ball to bounce. For this reason, it is advisable to install an elastic substructure made up of double stringers covered by boarding on which to install the floor (wood or resilient materials).

The elasticity obtained in this way is different to the one provided by material compliance as it is an “area elasticity” resulting from the flexibility of the structure; this type of structure provides comfort to the players and does not affect the rebound of the ball. However, elasticity must not be excessive as this would slow down the game and create problems for the players.

The installation of the elastic substructure usually represents a significant part of the cost of the flooring (about 30%); furthermore, because it is made mainly of wood, it is also rather delicate both from a mechanical point of view and in terms of resistance to ambient conditions (humidity, mould, woodworm, etc.).

An elastic substructure cannot withstand heavy loads, such as telescopic tribunes, for a long period of time, as the floor may give way or be permanently deformed; for this reason, surfaces with such a substructure cannot be used to host public events such as concerts, shows, etc.

What is more, any repairs to the substructures would be complicated and costly.

Simplified substructures are often proposed to reduce costs; however, they do not provide a uniform elastic response over the entire surface. (Diagram 3.17)

The elastic substructure is generally built using a double frame of stringers (spruce or similar). The substructure is then covered with boarding onto which the chosen floor (wood or resilient material) is laid.
In the case of a wooden floor, the boarding is not necessary as the parquet can be directly laid on the secondary stringer frame to avoid a non uniform elasticity (in particular where the two stringer frames intersect). (Diagram 3.18)

Three solutions to completing the most common and correct substructures are described here below, from the simplest to the most complex:

- **First solution**: the primary frame stringers are laid on a perfectly even screed at a centre-to-centre distance of 50-60cm; they are nailed onto supports placed at 50-60cm intervals. A secondary frame is placed orthogonally on top of the first one at a centre-to-centre distance of 25-30cm. The supports of the second frame must be staggered in relation to the first ones. Chipboard or laminboard panels are then laid on top using galvanised screws or nails. The panels can be interlocked, if possible leaving a 2mm slit along the joint. Stringers of the same structures are joined together end to end leaving a 5mm slit. This solution lends itself to glued floors (wood or synthetic). (Diagram 3.19)

- **The second solution** is the same as the first, as regards the primary and secondary frames, however the difference is that boards are laid on top instead of panels. The boards are about 8cm wide and placed at a centre-to-centre distance of 15cm. Planks can then be nailed onto the boarding. The same technical recommendations adopted in the first solution are applicable here. (Diagram 3.20)

- **Third solution**: here, a double primary frame is nailed onto the supports placed at a centre-to-centre distance of 50-60cm; the frame is made of nailed spacers placed at the same centre-to centre distance as the supports, but staggered. The frame elements are joined in the same ways as in the first solution; they must be in line with the supports but staggered. Boarding is placed on top, as in the second solution, and then parquet planks can be installed on the boarding. (Diagram 3.21)

The structural components must be all fixed together securely using galvanised nails so that any vibrations do not subvert the structure.
The centre-to centre-distances and the sections of the structural components must be attested according to the mechanical stress anticipated (telescopic tribunes etc.) and the elasticity required.

Full strips must be installed along door thresholds. Special reinforcements must be foreseen to secure equipment. Supports and anchorage elements must be foreseen for mobile equipment and must be inserted in the screed and not connected in any way to the substructure so they do not alter the elasticity.

Special flush covers, comprising the same material as the floor, shall create a concealed, even surface when the equipment is not in use.

These covers must be perfectly level with the floor and firmly secured so they do not move or come out accidentally. Their diameter should not be more than 20cm.

The flooring must be approximately 2cm from walls, piping, etc. Consequently, as the flooring tends to stir a little, the substructure of the flooring must be interrupted at a distance of about 3 cm. There must be a slit of a few millimetres between the skirting and the finished floor.

It is important to protect the elastic substructure and the floor against humidity. (Diagrams 3.22 a, b and c)

Rising damp must not reach the wooden substructure or condense under the floor surface.

For this reason, if the concrete screed has not been waterproofed, a duly welded or glued plastic sheet should be placed under the substructure supports.

More Moreover, in order to ensure air circulation, the hollow space is usually fitted with a forced ventilation system with a pipe installed along one of the walls of the hall or along an external wall, at right angles to the stringers; external air outlets should be created along the centre line between two stringers. Openings in the skirting on the wall opposite the pipe function as air inlets.

A suitably powered extractor fan (500m³/hour per 700-1000m² of flooring) shall be connected to the pipe to guarantee the
necessary air exchange and convey the air outside.
Elastic substructures tend to produce a certain amount of noise caused by the hollow structure or by the joints of the boards. Thin cushions of elastic material (polyethylene, rubber, etc) are used to solve this problem; they are placed where the stringers meet. Acoustic insulation panels are also used to fill the hollow parts of the structure. Obviously these panels limit the ventilation of the substructure so the latter must be well insulated by the sub-floor.

**Removable wooden flooring**

The requirements of multifunctionality, together with the constructional characteristics and functional features of permanent wooden flooring, have led planners to prefer the use of portable flooring. This type of floor guarantees the material performances required by FIBA and allows the sports facility to be used for different purposes, thus satisfying the multifunctionality objective.

Obviously, when portable flooring is used, there needs to be a suitable storeroom close to the playing area for the flooring when not in use, and personnel must be trained to assemble and disassemble the floor.

One particularly interesting type of removable wooden flooring is prefabricated multilayer engineered wood flooring.

Continuous research has led to the development of a specific product for these types of floors: coloured engineered wood, in a range of colours that can vary according to the type of lighting (artificial or natural). In the case of natural lighting, exposure to the sun is an important factor: for example, facilities close to the Equator, where sunlight is strong and intense, will require darker colours to absorb the light, while facilities located near the North or South Poles will require lighter colours.

**Types of flooring**

Removable wooden floors are usually made of prefabricated, varnished wooden panels comprising numerous assembled elements. The panels currently available on the market measure between 800-1200x2000-2400mm, varying in thickness,
and weigh between 40 and 70 kg per panel depending on the composition. To create the final flooring, the panels are interlocked and/or fixed with hooks.

The panels are supplied ready for use and include the playing surface finish and elastic substructure which can be made of:

- elastic matting, which is at least as thick as the panels
- a single or double wooden frame

**Playing surface or wear layer**

The superficial layer of the panel, and therefore of the structure, represents the actual flooring itself.

It usually consists of planks made from different types of wood veneers, varying in thickness between 2-4-8mm. The floor can be laid in the shiplap design or another layout.

The veneers that make up the surface must be free from toxic substances and must be manufactured in compliance with international laws. The colour of the flooring shall meet local requirements.

**Elastic substructure**

The flooring substructure represents the panel frame and must be prepared in accordance with the technical requirements of FIBA. It can be made of one or two wooden frames placed on top of each other; the first one is usually 40-50mm thick and the second one (laid at right angles to the first) is 20-40mm thick; both structures are 60-80mm wide.

When the substructure is made of two structures, one of the two, usually the second, is sometimes made of engineered panels to distribute the loads over the entire surface of the panel. *(Diagram 3.23)*

The single or double frames often need to be installed on rubber cushions of different shapes and sizes or on elastic matting in order to reach the required elasticity. *(Diagram 3.24)*

There are different methods of joining panels together and these systems tend to be patented by the respective manufacturing companies. Bracket fasteners, tongue and groove, and interlock snap are the most common systems used by leading manufacturers.
The advantages of this type of floor compared to a traditional floor with nailed boards or boards glued onto cement are significant and include:

- Ideal for physical resistance;
- Easy to assemble and disassemble;
- Can be used on any type of sub-floor;
- Excellent stability;
- Long lifecycle;
- Fast restoration of the surface;
- Quick to expand if the required surface size varies.

**PVC Flooring**

PVC, polyvinyl chloride, is a thermoplastic resin produced by the polymerisation of vinyl chloride. It is usually combined with different types of plasticisers to improve pliability. The quality and quantity of plasticisers determines the elasticity and hardness of PVC, as well as its resistance to chemical agents.

Stabilisers, lubricants, fillers and pigments are also added to PVC.

The fillers are inert substances added to the resin. They provide the material with particular characteristics such as increased resistance to abrasion. The most common fillers are calcium carbonate and quartz powder; sometimes asbestos fibres are also used.

PVC is produced in sheets, available in various colours, which are made by the calendar manufacturing process of pressing several layers of material together. The sheets are generally 2-5 mm thick.

To improve elasticity, the sheets may be installed on 6-12 mm thick elastic layers (cellular resins, rubber granules, or cork). The surface can be smooth, rough or embossed in various designs to improve surface grip and prevent possible optic reflections.

PVC flooring offers several advantages: resistance to wear, thermal insulation, resistance to chemical agents, low maintenance and multi-purpose. PVC can only be used for indoor facilities as it is sensitive to changes in temperature and cannot be exposed to direct sunlight.

The sheets must be installed on a perfectly smooth and even sub-floor with no irregularities or defects. The sub-floor must be totally dry and impervious to damp.

The sub-floor can be made of concrete or bitumen; an already existing rigid floor may also be used if it exhibits the correct floor flatness requirements.

It can be installed on loose stone or ventilated slabs. In both cases, the top screed must be protected against rising damp which may cause bubbles to form or the floor to lift.

A solution to this problem is to create a waterproof sheath with a thin asphalt plastic sheet laid on the reinforced screed of the sub-floor. A final screed is then laid on top of the waterproof layer; the screed must be made up of cement, sand or gravel, using 350 kg cement per 3m. The screed should be at least 3-5m thick, applied with a trowel and accurately levelled with a rule.

Cementing work should be direct and continuous, avoiding a number of different castings. Within 24 hours of casting the surface, it must be finished with a 1:1 mixture of cement and fine sand, to create a smooth surface. For the first 4-5 days the surface must be kept wet to prevent shrinkage, especially in the warm season. The surface must then be left to dry for at least 60 days.

Before laying the flooring, the screed must be perfectly dry and clean. If the screed is not smoothed immediately (within 24 hours), resins must be added to the mortar to guarantee adhesion to the layer below.

Prior to installation, the PVC sheets and adhesives must be stored in a closed room for 48 hours at 24°C.

The material must be installed at an ambient temperature of at least 16°C and the same temperature must be maintained for 5 days after the installation.

A thin layer of adhesive must be spread evenly using a special spatula, applying no more than strictly necessary. The PVC sheets must be unrolled slowly. The adhesive must not seep.
Diagram 3.23
Movable flooring

Diagram 3.24
Panel to Boarding

Diagram 3.24
Panel boarding
out of the joints. The sheets must be installed continuously from wall to wall. The floor must not be used for 24 hours after the installation.

Once the sheets have been installed, it is important to go over the joints with a roller to ensure secure adhesion. With certain types of floor, the edges of the sheets can be welded together chemically or thermally. This depends on the characteristics of the PVC, for example homogeneous PVC has a high percentage of mineral filler and is not suitable for hot welding.

The markings on the floor can be made using special paints or by applying different colour adhesive floor strips during painting and prior to sealing. Adhesive markings must be applied perfectly to prevent them from peeling up. Vinyl floors must have a uniform colour and thickness, they must not bear any marks from mobile loads (equipment stands, telescopic tribune supports, etc); they must exhibit suitable hardness and flexibility values as well as good surface friction.

The floor must adhere well to the sub-floor and must not bubble, buckle or peel up.

Overall, the floor must be a uniform colour, and perfectly even with uninterrupted overlapping and almost invisible joints. In the case of interchangeable floors, the sheets must be simply laid down and the joints welded for an uninterrupted surface.

Particular care must be taken when hot welding the joint to avoid stretching or deforming the material.

PVC floors are only suitable for indoor use. They must not be exposed to direct sunlight as the heat may cause the material’s characteristics to deteriorate.

PVC floors are very low-maintenance, requiring only standard cleaning with readily available products. PVC is very durable, however, durability does vary according to the types of fillers contained in the material.

**Rubber floors**

The term rubber includes a wide range of natural or synthetic polymers. Rubbers have excellent elasticity, resistance to wear and to chemical agents.

Rubber floors are usually made of homogeneous elastomers. They consist of natural or synthetic rubber. The composition of synthetic rubber may vary as it may sometimes be mixed with mineral fillers (calcium carbonate, barite, kaolin, very fine silicates) or these may be used as additives. The fillers affect the hardness of the material and its resistance to wear.

Elastomer granules or cork may also be added to the mixture as fillers to provide elasticity and grip. According to the type of floor, the material may be homogeneous and compact, homogeneous with a cellular structure or comprising different layers.

Elastomers provide optimum elasticity and resistance to wear and to chemical agents.

Rubber floors are made of 3-8mm thick uninterrupted sheets which are made by the calendar manufacturing process and subsequent vulcanisation process.

The surface covering can also be smooth, hard or both to improve surface grip. The surface underneath can be fixed to the base using adhesives or cement.

Sheets are available in various colours and the markings are painted on.

Regardless whether cement or adhesive is used to fix the floor, particular attention must be paid to fitting to avoid bubbles, lifting or rupture.

Adhesives should be avoided in humid environments and when the cement base is still fresh.

Unlike PVC sheets, rubber ones cannot be welded. Rubber floors do not require any special maintenance, only standard cleaning.

Rubber floors are generally low-maintenance, however friction marks are difficult to remove.

**Multi-layer polyurethane floors**

The base is made of prefabricated rubber matting composed of selected granules of recycled SBR rubber and MDI-based polyurethane binders.

Matting is available in various densities and thicknesses, thus ensuring that the physical property requirements of the floor are appropriate for its intended use, and that the flooring meets...
the requirements of national and international sports floors standards. The prefabricated rubber matting is then fixed to an approved sub-layer which is made of concrete, bitumen or wood. The matting is fixed using two-component polyurethane adhesives or any other adhesive substance recommended by the manufacturer. The different layers of the self-levelling polyurethane mix are applied on top of the matting to bond sealing fissures and permanently seal the joints. The floor surface must be 2mm thick and applied with a special two-component polyurethane adhesive with a particular composition. Before work can begin, the area must be clean and dry, and a level and homogenous wall-to-wall surface is imperative. A special two-component polyurethane finish shall be applied to the final floor surface with a roller, to leave a slight “orange skin” type texture; this finish is available in various colours. Polyurethane paint is used to make permanent markings on the playing area, in compliance with international standards. This type of floor is low maintenance, suitable for basketball, other sports, meetings and exhibitions. Polyurethane floors are smooth, resistant to humidity and to deposits from various acid agents, food, drinks and even cigarette ends. Any marks can be easily removed with standard cleaning products, thanks to the resilient materials used in the prefabricated matting base, and the extremely hard polyurethane covering which makes this type of flooring extremely durable and very low-maintenance. Unlike other systems, this type of floor will not need polishing or refinishing for several years. Depending on the use of the floor, after several years it may be necessary to add another layer of polyurethane covering to the existing surface. In this way the floor will remain as good as new, without affecting the physical properties of the prefabricated recycled rubber matting.

**Linoleum flooring**

Linoleum floors are made from a homogeneous mixture of different substances; the main ingredient is linseed oil which is combined with different resins (e.g. colophony) so that it oxidises and then polymerises. The final components, known as “fillers”, include cork powder and other organic compounds, pigments and dyes. This mixture can be pressed onto a continuous roll of jute backing to make the linoleum sheets. Linoleum floors, particularly cork linoleum (“cork wood”), are characterised by their elasticity, resistance to wear, acoustic insulation and friction. Linoleum is produced in sheets, 4-4.5mm thick, in different colours. The surface of the sheets can be even or slightly rough, but not abrasive. Floor markings are applied using floor marking paints. Linoleum joints cannot be heat-sealed; it is imperative that the foundation is kept free from humidity. Maintenance will require some attention as linoleum is sensitive to water, inorganic acids, concentrated alkalis and solutions of sodium hypochlorite (bleach). Cleaning should be carried out using a damp cloth and then dry sawdust.

**Industrial or cement flooring**

Renowned for their “hardness”, cement floors are not really suitable for sports facilities. However, because of their low cost, they can be used as a foundation or sub-floor for wooden floors or floors of another resilient material. In short, they are industrial floors, comprising a mix of different aggregates and compounds (such as quartz powder and other mineral powders, slag, magnesite, oxides and pigments, and sometimes sawdust) and cement in quantities determined by the suppliers.

**Game Equipment for Basketball**

Game equipment is essential for basketball, and the precision and standardisation of the materials used are fundamental in ensuring correct and impartial competitions. For this reason, all playing equipment used in competitions organised under the aegis of the International Basketball Federation must be provided by companies whose products have been approved by the FIBA Study Centre.

The following is an excerpt from the latest *Official Basketball Rules-Game Equipment*, approved by the FIBA Central Board.

1 The *Official Basketball Rules- Game Equipment* is revised on a regular basis.
It lists the provisions which stipulate the number, dimensions and characteristics of the equipment required for official FIBA competitions:

**Backstop unit**

There will be two (2) backstop units (Diagram 3.25), one placed at each end of the playing court and each consisting of the following parts:

- One (1) backboard.
- One (1) basket ring with a ring mounting plate.
- One (1) basket net.
- One (1) basket support structure.
- Padding.

**Backboard**

The backboards (Diagram 3.26) shall be made of a suitable transparent material (for Level 1 and 2, of a tempered safety glass), made in one piece, non-reflective, with a flat front-surface and shall:

- Have a protective framework of the backboard support structure around the outside edge;
- Be manufactured such that, if broken, the pieces of glass do not split off.

For Level 3, the backboards may be made of other material(s) painted white, but must meet the other specifications above.

The backboards shall measure 1,800mm (+ a maximum of 30mm) horizontally and 1,050mm (+ a maximum of 20mm) vertically. All lines on the backboards shall be:

- In white, if the backboards are transparent;
- In black, if white painted backboards are non-transparent;
- 50mm in width.

The borders of the backboards shall be marked with a boundary line and an additional rectangle behind the ring as follows:

- Outside dimensions: 590mm (+ a maximum of 20mm) horizontally and 450mm (+ a maximum of 8mm) vertically;
- The top edge of the base of the rectangle shall be level with the top of the ring and 150mm (-2mm) above the bottom edge of the backboard.

For Level 1, each backboard shall be equipped with lighting around its perimeter, mounted on the inside borders of the backboards and which lights up in red when the game clock signal sounds for the end of a period. This is also recommended for Level 2. The lighting shall be at least 10 mm in width and cover a minimum of 90% along the edge of the backboard glass area.

The backboards shall be firmly mounted on the backboard support structures at each end of the playing court at right angles to the floor, parallel to the endlines. The central vertical line on their front surfaces, extended down to the floor, shall touch the point on the floor which lies 1,200mm from the centre point of the inner edge of each endline, on an imaginary line drawn at right angles to this endline.

Test of the rigidity of backboard tempered safety glass:

- When a square-shaped weight of 50 kg (250mm wide and high, and 1,100mm long) is applied along the centre of the backboard glass (without its frame), which is placed horizontally on two parallel wooden bars at a distance of 1,200mm from each other (Diagram 3.27), the maximum vertical deformation shall be 3mm;
- When a basketball is dropped onto the backboard, it shall rebound from it with a minimum rebounding height of 50%.

**Basket ring**

The rings shall be made of solid steel and shall:

(Diagram 3.28)

- Have an inside diameter of a minimum of 450mm and a maximum of 459mm;
- Be painted orange within the following Natural Colour System (NCS) FIBA-approved spectrum (see References [2]): 0080-Y70R 0090-Y70R 1080-Y70R;
- Have its metal a minimum of 16 mm and a maximum of 20mm in diameter.

The net shall be attached to each ring in 12 places. The fittings for the attachment shall not:
Game clock & 24-second device

Padding
(at least 25)

1.20m

2.00m

Endline 5cm

2.15m

2.00m

at least

1.05m

min 40 - max 45cm

15cm

45cm

Diagram 3.25
Backstop units

Diagram 3.26
Backboard markings.
Diagram 3.27

Rigidity of the backboard glass

- Have any sharp edges or gaps;
- Have gaps smaller than 8 mm, to prevent fingers from entering;
- Be designed as hooks for Level 1 and 2.

The rings shall be fixed to the backboard support structures in such a way that any force applied to the ring cannot be transferred to the backboard itself. Therefore, there shall be no direct contact between the ring mounting plate and the backboard (Diagram 3.29a).

The top edge of each ring shall be positioned horizontally, 3,050 mm (± a maximum of 6 mm) above the floor, equidistant from the two vertical edges of the backboard.

The point on the inside circumference of the ring nearest the backboard shall be 151 mm (± a maximum of 2 mm) from the face of the backboard.

For existing basket support structures, it is recommended that the ring mounting plate be fixed to the framework according to the measurements given (Diagram 3.29b).

Pressure release rings with the following specifications shall be used for Levels 1 and 2, and are recommended for Level 3:
- It shall have rebound qualities close to those of the fixed ring. The pressure release mechanism shall ensure these characteristics, but not cause any damage to either the ring or the backboard. The design of the ring and its construction shall be such that the players’ safety is ensured;
- The pressure release rings shall have a ‘positive-lock’ mechanism which must not disengage until a static load of 82 kg minimum and 105 kg maximum has been applied vertically to the top of the ring at the most distant point from the backboard. The pressure-release ring mechanism shall be adjustable within the given static load range.
- When the pressure release mechanism is released, the front or the side of the ring shall rotate no more than 30 degrees and no less than 10 degrees below the original horizontal position.
After release, and with the load no longer applied, the ring shall return automatically and instantly to its original position. No fissures and no permanent deformation of the ring should be observed.

Both rings must have identical rebound characteristics. For Level 1, the rebound/elasticity of the ring and support system should be within 35% -50% of the energy absorption range of the total impact energy and with a 5% differential between both baskets on the same playing court.

**Basket net**
The nets shall be made of white cord and shall be:
- Suspended from the rings;
- Manufactured so that they check the ball momentarily as it passes through the basket;
- No less than 400mm and no more than 450mm in length;
- Manufactured with12 loops to attach it to the ring.
The upper section of the net shall be semi-rigid to prevent:
- The net from rebounding up through the ring, creating possible entanglement;
- The ball from becoming trapped in the net or rebounding back out of the net.

**Backboard support structure**
For Level 1, only mobile or floor-fixed backboard support structures shall be used. This is recommended for Level 2.
For Levels 2 and 3, ceiling or wall mounted backboard support structures may also be used. Ceiling mounted backboards shall not be used in sports halls with a suspension height exceeding 10,000mm.
The backboard support structure shall be:
- For Levels 1 and 2, at a distance of at least 2,000mm including padding, from the outer edge of the endline.
- Of a bright colour, contrasting with the background, so that it is clearly visible to the players.
- Secured to the floor so as to prevent any movement. Should
**Diagram 3.29a**

Ring mounting plate

**Diagram 3.29b**

Ring mounting plate for existing ring
floor anchoring be not possible, an additional weight on the basket support base must be used to prevent any movement.

- Adjusted such as that once the top edge of the ring is at a height of 3,050mm from the playing floor, this height shall not be changed.

The rigidity of the backboard support structure with ring shall fulfill the requirements of the EN 1270 norms.

The visible vibration of the backboard support unit shall end within a maximum of four (4) seconds after a dunk shot.

**Padding**
The backboard and backboard support structure must be padded. *(Diagram 3.30)*

The padding shall be of a single solid colour and shall be the same colour on both backboards.

Bright blue is generally the colour used during FIBA competitions.

The padding shall be 20 to 27mm thick from the front, back and side surface of the backboards. The padding shall be 48 to 55mm thick from the bottom edge of the backboards.

The padding shall cover the bottom surface of each backboard and the side surface to a distance of 350 to 450mm up from the bottom. The front and back surface must be covered to a minimum distance of 20 to 25mm from the bottom of each backboard.

**Additional equipment for evaluation and measurements**
Sports facilities shall also include the following additional equipment for use by commissioners and/or FIBA representatives for inspection purposes:

- A metre ruler with millimetre graduation, at least 4m in length;
- A metal measuring tape, gauged from 0 to 50m, and/or other similar measuring devices;
- A dynamometer;
- A manometer;
- A level gauge.

**Technical Equipment**

**Basketballs**
For Levels 1 and 2, the outer surface of the ball shall be made of leather or artificial/-composite/synthetic leather. For Level 3, the outer surface of the ball may be made of rubber.

The surface of the ball shall not contain toxic materials or any materials which may cause an allergic reaction. The ball must not contain heavy metals (EN 71) or AZO colours.

The ball shall:

Be spherical, with black seams not exceeding 6.35mm in width, and either of a single shade of orange or of the orange/light brown FIBA-approved colour combination.

Be inflated to an air pressure such that, when it is dropped onto the playing floor from a height of approximately 1,800mm measured from the bottom of the ball, it will rebound to a height of between 1,200mm and 1,400mm, measured to the top of the ball.

Be marked with its respective size number.

For all men’s competitions in all categories, the circumference of the ball shall be no less than 749mm and no more than 780mm (size 7) and the ball shall weigh no less than 567 g and no more than 650 g.

For all women’s competitions in all categories, the circumference of the ball shall be no less than 724mm and no more than 737mm (size 6) and the ball shall weigh no less than 510 g and no more than 567 g.

In addition to checking the specifications listed above, the following tests shall be carried out:

- Fatigue strength test
- Heat-storage test
- Valve leak test
- Practice test (grip)
- Rebound height and reflection of the basketball test
- Ball geometry test
- Weight of the basketball
Surface material requirement.

**Game clock**

For Levels 1 and 2, the main game clock shall:

- Be a digital countdown clock with an automatic signal sounding for the end of the period as soon as the display shows zero (00:00);
- Have the ability to indicate time remaining in minutes and seconds and tenths (1/10) of seconds at least during the last minute of the period;
- Be placed so that it is clearly visible to everyone involved in the game, including the spectators.

If the main game clock is placed above the centre of the playing court, there shall be a synchronised duplicate game clock at each end of the playing court, each of which must be high enough that it is clearly visible to everyone involved in the game, including the spectators. Each duplicate game clock shall display the score and the playing time remaining throughout the game.

For Levels 1 and 2, a whistle-controlled time system, interfaced with the connector equipped game clock may be used by the officials to stop the game clock, provided that this system is used in all the games of a given competition. The officials shall also start the game clock, however, this is, at the same time, also done by the timer. All FIBA approved scoreboards may provide the interface with the whistle controlled system.

**Scoreboard**

For Levels 1 and 2, two (2) large scoreboards shall be:

- Placed one at each end of the playing court and, if so desired, a further scoreboard (cube) placed above the centre of the playing court. This does not exclude the need for the other two scoreboards.
- Clearly visible to everyone involved in the game, including the spectators.
In case video displays are used, it must be assured that the complete required information shall be visible at any time during the game. The readability of the displayed information shall be the same as on a digital scoreboard.

A game clock control panel shall be provided for the timer and a separate scoreboard control panel shall be provided for the assistant scorer. The control panels cannot be computer keyboard panels. Each panel shall enable easy correction of any incorrect data and have memory back-ups to save all game data for a minimum of thirty (30) minutes.

The scoreboard shall include and/or indicate:
- The digital countdown game clock.
- The points scored by each team, and for Level 1 the cumulative points scored by each individual player.
- The number of each individual player, and for Level 1 and their corresponding surnames.
- The team’s names.
- The number of fouls committed by each player on the team from 1 to 5. The fifth foul shall be indicated in red or orange. The number may be shown with five (5) indicators or a number display with a minimum height of 135mm. In addition, the 5th foul may be indicated with a slow flashing display (~ 1 Hz) for five (5) seconds.
- The number of team fouls from 1 to 5, stopping at 5.
- The number of the period from 1 to 4, and E for an extra period.
- The number of charged time-outs per half from 0 to 3.
- The team for the throw-in at the next alternating possession jump ball situation.
- A clock for timing the time-out (optional). The game clock must not be used for this purpose.

For Level 1 (compulsory) and Level 2 (recommended):
- The display on the scoreboard shall be in bright contrasting colours.

Diagram 3.32

Scoreboard for level 1 (example of the layout).
Diagram 3.33
Twenty-four second device display unit, duplicate game clock, and red light for level one and two (example of the layout)

- The background of the display shall be antiglare.
- The display numbers on the game clock and game score shall be a minimum height of 300mm (Level 1) or 250mm (Level 2) and a minimum width of 150mm (Level 1) or 125mm (Level 2).
- The display numbers of team fouls and periods shall be a minimum height of 250mm and a minimum width of 125mm.
- The display numbers of the team names, players’ surnames and numbers, and points scored by the players shall be a minimum height of 150mm.
- The scoreboard game clock, game score and the twenty-four second device should have a minimum viewing angle of 130°.

The scoreboard shall:
- Not have any sharp edges or burrs.
- Be mounted securely.
- Be able to withstand severe impact from any ball.
- Have specific protection, if necessary, which should not impair the readability of the scoreboard.
- Have electromagnetic compatibility in accordance with the statutory requirements of the respective country.

**Twenty-four second device**

The twenty-four second device shall have: *(Diagram 3.33)*

- A separate control unit provided for the twenty-four second operator, with a very loud automatic signal to indicate the end of the twenty-four second period when the display shows zero (0).
- A display unit with a digital countdown, indicating the time in seconds.

The twenty-four second device shall have the ability to be:
- Started from twenty-four (24) seconds.
- Stopped with the display indicating the seconds remaining.
- Restarted from the time at which it was stopped.
- Showing no display, if necessary.

The twenty-four second device shall be connected to the game clock so that when:
- The game clock stops, the device shall also stop.
- The game clock starts, it is possible to start the device manually.
- The device stops and sounds, the game clock count continues and may be stopped, if necessary, manually.

The twenty-four second device display unit, together with a duplicate game clock and a red light shall:
- Be mounted on each backboard support structure a minimum of 300mm above and behind the backboard or hung from the ceiling.
- Have the different colours of the numbers of the twenty-four second device and the duplicate game clock.
- Have the numbers of the twenty-four second display a minimum height of 230 mm and be larger than the numbers of the duplicate game clock.
- For Level 1, have three (3) or four (4) display surfaces per unit (recommended for Level 2 and 3) to be clearly visible to everyone involved in the game, including the spectators.
• Have the maximum weight of the three-sided twenty-four second device, including the support structure, not exceeding 80 kg.
• Pass the test of protection against damage by balls according to DIN 18032-3.
• Have electromagnetic compatibility in accordance with the statutory requirements of the respective country.

The electric light on the twenty-four second device display unit shall be:
• Of a bright red colour.
• Synchronised with the game clock to light up when the signal sounds for the end of playing time for a period.
• Synchronised with the twenty-four second device to light up when the signal sounds for the end of a twenty-four second period.

**Signals**

There shall be at least two (2) separate sound signals, with distinctly different and very loud sounds:
• One (1) provided for the timer and the scorer which shall sound automatically to indicate the end of the playing time for a period. The timer and scorer shall be able to sound the signal manually when appropriate to attract the attention of the officials.
• One (1) provided for the twenty-four second operator which shall sound automatically to indicate the end of the twenty-four second period.

Both signals shall be sufficiently powerful to be easily heard above the most adverse or noisy conditions. The sound volume shall be adjustable, according to the size of the sport hall and the noise of the crowd, to a maximum sound pressure level of 120 dBA measured at a distance of one (1) m from the source of the sound. A connection to the public information system of the sports hall is strongly recommended.

**Player foul markers**
The five (5) player foul markers provided for scorer shall be:
• Of white colour.

With numbers a minimum of 200mm in length and 100mm in width.
• Numbered from 1 to 5 (1 to 4 in black and the number 5 in red).

**Team foul markers**
The two (2) team foul markers provided for scorer shall be:
• Of red colour.
• A minimum of 350mm in height and of 200mm in width.
• Clearly visible to everyone involved in the game, including the spectators, when positioned on either side of the scorer's table.
• Used to indicate the number of team fouls up to five (5) and to show that a team has reached the team foul situation.

Electrical or electronic devices may be used but they shall meet the above specifications.

**Alternating possession arrow**
The alternating possession arrow (Diagram 3.34) provided for the scorer shall:
• Have an arrow of a minimum length of 100 mm and height 100 mm.
• Display on the front side an arrow, illuminated in bright red colour when switched on, showing the direction of the alternating possession.
• Be positioned in the centre of the scorer’s table and shall be clearly visible to everyone involved in the game, including the spectators.

![Diagram 3.34](image-url)
Advertising boards

Advertising boards may be located around the playing court and: *(Diagram 3.35)*

- Shall be located at a minimum distance of 2,000 mm from the endlines and sidelines.
- Those along the endlines must have a minimum gap of 900 mm on each side of the mobile backstop units so that the floor wiper(s) and portable TV camera(s) can pass through, if necessary.

Advertising boards are permitted in front of the scorer’s table provided that they are placed directly in front of and flush with the table.

Advertising boards shall:

- Not exceed a height of 1,000 mm from the playing court.
- Be padded around the top with a minimum thickness of 20mm.
- Have no burrs and all edges shall be rounded off.
- Be in accordance with the national safety requirements for electrical equipment in the respective country.
- Have mechanical protection for all engine driven parts.
- Be non-flammable.

For Level 1, only motorised rotating advertising boards are permitted.
TECHNOLOGICAL INSTALLATIONS
Nowadays, when planning a new sports facility or a restoration project, “the building and its technological installations” are no longer seen as two separate components but rather as “one single entity”. The installations represent vital and functional elements which can make an event more attractive and add comfort for its users. The actual building itself can also be seen as a technological installation.

This chapter deals with the technological installations necessary to create the ideal environmental conditions in terms of air and water temperature, lighting and sound. The chapter also includes recommended specifications for storage areas for equipment and machinery.

General descriptions are provided of the most common systems and technological installations used today, however, it must be remembered that each of these will need to be planned, sized and selected in accordance with the statutory regulations in force in the country of installation as well as with local geographical requirements. Obviously, facilities in hot countries will require cooling systems rather than heating systems, whilst the reverse will be true of facilities in colder countries.

Installations such as lighting and sound systems must not only meet comfort and safety requirements, they must also satisfy FIBA’s television coverage requirements, particularly for high-level competitions. As such, systems of an equivalent standard are recommended for all sports facilities.

The energy requirements of a sports facility will vary according to the location and type of building. The aim of this chapter, therefore, is to provide the main planning guidelines for technological installations in new basketball facilities or ones undergoing restoration.

The final part of this chapter will briefly focus on energy saving systems; the information is merely intended to serve as a guideline and is by no means exhaustive, thanks to ongoing scientific and technological research which is continuously putting forth new methods and technologies aimed at improving the public environment, sports facilities included.

**Air Conditioning Systems**

The ideal situation would be for all areas, spaces and rooms to have an external wall so that the air could be exchanged by taking it directly from outside. However, due to the layout of basketball facilities and the need to maintain uniform indoor climatic conditions, as required by FIBA for international events, an air conditioning system must be installed. This is particularly necessary in locations where the temperature and thermal range strongly affect environmental comfort.

The aim of installing an air-conditioning system in basketball facilities is to maintain a constant temperature range and ensure a renewal of air inside the entire facility whatever the weather conditions outside.

The microclimatic parameter values in a facility will obviously vary from one room to another, to ensure that each room offers the most comfortable thermal conditions possible. The temperature in the workout and warm-up halls should be lower than the temperature in the changing rooms, and lower still in the main basketball hall where spectators sit. Furthermore, with suitable filters to purify incoming air, the expulsion of stale air and the intake of fresh air from the outside will guarantee effective ventilation and renewal of clean air. From a management point of view, basketball facilities must have high sanitary standards and be easy to keep clean and functional. This is especially important in areas where mould and harmful bacteria can proliferate in warm and humid conditions, such as changing rooms and showers.

**Climatic conditions**

Basketball facilities should provide the following thermal conditions, according to the purpose and use of each area:

<table>
<thead>
<tr>
<th>Area</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main basketball court and tribunes</td>
<td>T + 18°C</td>
</tr>
<tr>
<td>Warm-up halls, workout halls, administration offices, etc.</td>
<td>T + 20°C</td>
</tr>
<tr>
<td>Changing rooms, toilets, first aid room, etc.</td>
<td>T + 22°C</td>
</tr>
</tbody>
</table>

_N.B.: These temperatures refer to normal thermal comfort conditions._
Chapter 4
Technological Installations

b) Summer

<table>
<thead>
<tr>
<th>Area</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main basketball court and tribunes</td>
<td>T + 28°C</td>
</tr>
<tr>
<td>Warm-up halls, workout halls, admin.</td>
<td>T + 27°C</td>
</tr>
<tr>
<td>Changing rooms, toilets, first aid</td>
<td>T + 26°C</td>
</tr>
<tr>
<td>room, etc.</td>
<td></td>
</tr>
</tbody>
</table>

N.B.: These are the maximum temperatures acceptable when trying to reduce the energy costs of the air-conditioning system.

\[ \text{C) Air renewal from the outside throughout the year} \]

<table>
<thead>
<tr>
<th>Area</th>
<th>Air renewal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main basketball court and tribunes</td>
<td>25m³/h/person</td>
</tr>
<tr>
<td>Warm-up halls, workout halls, admin.</td>
<td>5 vol./area/h</td>
</tr>
<tr>
<td>Changing rooms, toilets, first aid</td>
<td>5 vol./area/h</td>
</tr>
<tr>
<td>room, etc.</td>
<td></td>
</tr>
<tr>
<td>Toilets and showers</td>
<td>10 vol./area/h</td>
</tr>
</tbody>
</table>

Description of the system

Bearing these specifications in mind, the air-conditioning system should be one which uses external air only, heating it in winter and cooling it in summer, without controlling the humidity. The internal temperature can be controlled by measuring the difference between the energy levels of the incoming air and the expelled air.

This kind of air-conditioning system is ideal for the area occupied by the public, but it should be able to regulate the amount of incoming air in proportion to the number of people inside the hall. This can be achieved by installing air quality sound level meters that will automatically regulate the flow of both incoming and outgoing air according to the noise level measured.

Electric fans should be provided with static frequency converters capable of continuously varying the rotation speed and, consequently, the flow of air.

The recommended system should therefore have the following components:

- Heating and cooling plants;
- An air conversion plant;
- Air intake and supply to the various areas;
- Collection and expulsion of stale air;
- Additional systems for air heating and cooling.

\[ \text{a) Heating and cooling plants} \]

Two different power plants are recommended:

- A heating plant for hot water production;
- A refrigeration plant for cool water production.

The heating plant should consist of two or more hot water generators supplied with liquid fuel (diesel, fuel oil, etc.) or gas (methane), according to the temperature requirements of each area, and be driven by special electronic pumps. For safety reasons, the heating plant should be installed in a building detached from the sports facility.

The hot water should be conducted from the heating plant to the main building via insulated steel pipes, running in tunnels or channels which are easily accessible for inspection purposes.

Once in the main building, the pipes must be placed on distribution headers to feed the various areas.

The refrigeration plant cools water by means of a cooling fluid. This will obviously not be necessary in colder countries where fresh external air supplies sufficient cooling energy to maintain the correct temperatures inside the facilities. In the same way, another source of cold energy could be used if available, depending on the morphological location of the basketball facility, for example fresh filtered water from cold-water rivers or lakes.

The type of power plant should be chosen according to the environmental and ecological conditions prevalent at the building site. The plant could be one which cools by refrigerant gas compression and water cooling (in a closed circuit with cooling towers or in an open circuit with fresh water from a river or lake), or air cooling (where water is scarce).

Refrigeration units which make use of available energy sources, such as steam, hot water or low-cost gas, can also be used. The most suitable type of refrigeration unit will obviously depend on the location of the facilities, the availability and usability of resources, and also on technical and economic analyses.

b) Air-treatment units

Air-conditioning units should be part of the power plant. They
will provide for the autonomous and independent treatment of air in the different areas, thus also allowing a flexibility that is compatible with the varying occupancy of those areas.

The next step is the decentralisation of the system into three different areas:
- Main hall and tribunes;
- Workout halls, warm-up halls, etc.;
- Changing rooms, toilets, showers and annexes.

Therefore, three air-conditioning units should be foreseen, each one of them filtering the incoming air (according to the degree of air pollution outside).

In order to save energy, air-to-air heat exchangers should be installed. They can save at least 50% of the energy contained in the expelled air by using it to precondition the incoming air, thus reducing the overall cooling or heating load. Each air-conditioning unit must be equipped with air/water exchangers for hot and cold water (produced by the respective power plants); these exchangers can treat the air under the necessary conditions to regulate the internal temperature.

c) Supply and intake of air in the various halls

The air treated by the power plant should be sent to the various areas and then distributed appropriately according to each type of area.

- In the main hall, the air will be distributed to all parts of the hall through zinc-coated sheet steel pipes, isolated on the outside; the air pipes will lead towards the tribunes, and run around the whole perimeter of the hall as well as around the playing court under the telescopic tribunes. The use of long-range nozzles, which automatically adjust the airstream to balance the difference in temperature between the incoming air and the air already in the hall, allows for the intake of air along the perimeter area and consequently ensures a good and steady distribution of air.

- In the central area, where the air enters the hall at a considerable height (usually at least 15m), air diffusers equipped with corrective air blowing systems should be used. These can prevent blowing air in a radial stream in the case of cold air (refrigeration phase), or blowing in hot air during a heating phase, for example, thus averting both annoying cold draughts and the formation of hot air strata.

- Inside the workout halls, warm-up halls, changing rooms and adjoining access rooms, the air should be distributed by means of waterproof materials which can blow air into the various areas through micro-perforations set in the pipes at regular intervals. This solution has the following advantages:
  - Lightweight components that allow lightweight fastening to the structure;
  - Elimination of the usual diffusers which are large and heavy, and restrict the spaces along the ceilings;
  - Enable cleaning of the pipes above, therefore maintaining high standards of hygiene within the various areas.

d) Collection and expulsion of stale air

The stale air sucked in from the various areas is conveyed to the air treatment unit where it transfers its energy to the incoming air through special exchangers before being expelled. The incoming air then passes through a purifier before being used in the facility.

The organisation of the air intake units is suggested as follows:

- Main hall: a series of air-capturing units shall be connected to a net of zinc-coated steel pipes, both on the ceiling (20% of the whole air intake) and on the floor (80% of the air intake); an intake pipe will circuit the ceiling with ramifications at the highest points of the structure in order to capture smoke and steam which inevitably accumulate there.

In the same way, an intake pipe will circuit the playing court at the base of the fixed tribunes with grates imbedded into the steps and connecting with the playing area. This system improves both the air purification and the flow of air from above.

- Workout and warm-up halls and similar areas: These
areas shall have air intake pipes circuiting the areas at floor level or along the walls at floor level, in order to guarantee a descending air flow. Pipes shall therefore be dropped into the floor or run along the circuiting walls on the outside with air intake grates inserted in the walls.

- **Changing rooms and annexes:** These areas shall have powerful air intake pipes installed only in the toilets and showers, so that the lower air pressure in the changing rooms will always guarantee a flow of air towards the service areas. It is recommended that the changing room lockers have vent grilles for air intake and that these are connected with the central air intake system.

e) **Additional heating and/or refrigeration system**
For particularly hot or cold areas, it is advisable to provide the various areas with additional heating or refrigeration systems, in order not to “overload” the main plant with an excessive flow of air; for example, warm water radiators should be used in the changing rooms and in the first aid room, and self-contained air-conditioning systems in the offices. It rests with the planners to decide which system is most appropriate for the facility and its location.

**Electrical Power Supply**

a. The planning and construction of electrical power supply systems is be subject to the strictest standards and specifications.

b. Not only must the system itself conform to the above standards, but also all integral materials and components.

c. Not only must the laws and standards appurtenant to this kind of equipment be complied with rigorously, but there will also be certain general restrictive specifications to be followed.

**Maximum values of the drop in voltage**
When all the components of the low voltage system are connected and working simultaneously, each at its respective nominal load, the voltage measured at any point should not have dropped by more than 4% of the voltage measured at that same moment at the starting point of the system. The maximum drop in voltage of the furthest lamp in the lighting system shall be 3%.

**Size of the wires and cables**
Irrespective of the above values for the maximum drop in voltage, the density of electric current in the wires should not exceed 90% of the respective density legally in force, taking into account the variation coefficients based on the system layout.

a) The size of the wires and cables must be proportional to a coefficient of simultaneity of the loads equal to:
- 100% for lighting circuits
- 50% for plug circuits (less for service plugs)
- 00% if they supply predetermined equipment

b) Minimum diameter of phase wires.
Copper wires for low tension systems should not have a cross-section of less than 2.5mm². This value can be reduced to 1.5mm² for soft covered copper wires, provided they are inserted into pipes, conduits or protective sheaths, and to 1 mm² for signal circuits and remote control devices (including acoustic circuits).

c) Minimum cross-sections of earth wires and protection wires.
In order to enforce accident prevention, all cross-sections must conform to the strictest rules and specifications of the standards currently in force.

**Shunts and joints**
a) Wire shunts and joints should be connected through terminal boxes which are appropriately protected according to their location and in such a way that they:
- allow easy entry of the wires into the terminal;
- enable the joint to be made without having to reduce the cross-section of the wires;
- maintain a constant contact pressure;
- remain intact even under damp conditions.
Routing wires and cables

- **a)** Types of cables: all cables must be non-flammable, and not emit toxic gases if they do burn.
- **b)** Laying of cables: cables must be adequately protected by tubes, channels or conduits which can be inspected.
- **c)** Identification of the phase wires and terminals: all the phase wires must be identified by special signs or tags placed at their extremities.
- **d)** Identification of protection, and earth wires: all of them must be clearly identifiable from one another as well as from the other wires in the system.
- **e)** Crossing of fire-resistant constructions: fireproof barriers must protect cables passing through fireproof constructions, and have fire-resistant characteristics at least equal to those required for the constructions themselves.

Protection

- **a)** This refers to the protection of the following parts which are under tension:
  - Protection against direct contacts.
  - Protection against indirect contacts.
  - Protection against short circuits.
  - Protection against thermal effects.

Protection devices must obviously be adequate and adapted to the characteristics of the area in which they are installed.

Outside electric installations

- **a)** Electrical equipment and accessories installed outside must have an adequate degree of protection, compatible with where and how they are installed.
- **b)** Where cables run the risk of being damaged mechanically, they should obviously be adequately protected.
- **c)** Part of an electricity supply system is defined as being “outside” when it is not placed inside a room which will protect it from atmospheric conditions: porches, open galleries, cavities, grates and similar half-open spaces are considered as being “outside”.

Instructions on how to install electric supply system

- **a)** Instructions on how to install electric supply systems are listed below, according to the different types of location and installation.

Other special instructions for the installation of such systems can of course be used when a particular situation demands it.

- **b)** Systems imbedded under plaster in the walls and under the floor in changing room areas, toilets, showers and stairs. The following can be used for this kind of system:
  - Wires adapted to the required tension, laid in rigid protective tubes made of self-extinguishable thermoplastic material.
- **c)** Parts of the electric supply system which crosses outside areas of the buildings. The following can be used for this kind of system:
  - Insulated cables with flexible wires; the cables must be flame-retardant, non-corrosive and should not emit toxic gases if they do burn.
  - The cables must be laid in rigid protective tubes made of thermoplastic materials. This is vital when input cables are installed outside the building - in this case, connection shafts are required and the intervals between them must be fixed according to the cross-section of the cables set into the tubes.
- **d)** Open installations in the main basketball court area for the lighting installations, in the service areas, in the areas housing technological installations and their annexed corridors. The following can be used for this kind of system:
  - Insulated cables laid in metal galvanised channels of the open or closed type, fixed to the walls.
  - Single-pole cables with flexible wires, adapted to working voltage, passed through rigid protective pipes made of thermoplastic self-extinguishing material and free from toxic emissions in the case of fire, or alternatively in metal galvanised tubes. The tubes must be fixed together easily and securely to be close-fitting and watertight. They must be fixed securely and neatly to the walls, at intervals, using
small hooks.

e) External open installations: leading to open-air technological plants or for external lighting installations. The following can be used for this kind of installation:
   - Insulated cables laid in galvanised tubes, fixed to the walls.
   - Flexible PVC-coated steel tubes fixed together with easy-to-fit waterproof connection pieces, threaded at their ends, must be used for connecting machines to the main plant.

**Specifications for installations set into channels**

f) Each part of the service equipment and each plant (energy, telephone, acoustic installations, interphones, data transmission, etc.) should use totally independent channel sections, in other words, the channels must have appropriate separators.

g) The cables should be laid inside the channels, side by side, with a maximum of 2 layers. If more cables are necessary, other channels should be set one above the other, with a minimum gap of 30cm.

h) The cables should be appropriately marked with plastic tags indicating the exact type of installation or service the cables belong to.

i) In vertical and inclined stretches, the cables should be adequately fixed to the channels. The channels should be at least 20% larger than the total cables inside them.

j) The cable channels should be made of galvanised metal and have a maximum width of 50cm. They must have flush joints so that the protective coating of the cables is not damaged while they are being pulled through.

k) The channels must be fixed to the walls using support brackets, positioned at intervals proportional to the weight the channels must bear.

**Specifications for installations set in tubes**

a) Each part of the service equipment and each plant (energy, telephone, acoustic installations, interphones, data transmission, etc.) should be put into totally independent tubes and each have its own derivation box. These tubes should be made of a plastic material that does not relay the electric current or emit toxic gases in the case of overheating.

b) All the wires belonging to one and the same circuit must pass through the same tube. No connections are allowed inside the tubes.

c) The internal diameter of the tubes should never be inferior to 16mm and, once filled with wires, should be less than half full (filling coefficient = 0.5 = ratio between the total cross-section of the cables and the internal diameter of the tubes), however, the diameter of the tubes should always be greater than or equal to 1.4 times the diameter of all the wires held together.

d) The tubes should always be laid parallel to one another and must not cross or run diagonally. Any bend must have a large radius. The wires should be easy to remove and to replace.

e) In open stretches, the tubes should be fixed by means of plastic or metal supports held by screw anchors with a maximum interval of 60cm.

f) Special devices such as flexible pipes or double-coupling pieces should be used at the expansion joints of the buildings.

g) It is obviously prohibited to pass tubes anywhere near hot water or gas pipes, or to fix them to tubing, channels or any other kind of mechanical equipment.

h) Even if tubes are to remain empty, they must always be provided with a pilot wire.

i) Pipes used in open installations must pass through the cassettes, boxes or adequate devices which are to be kept waterproof by means of straight pipe fittings made of resin or metal.

**Description of electrical power supply systems**

a) The earthing should consist of a naked copper wire leading all around the building at the deepest end of its foundation
and in direct contact with the earth, connected to a general bus bar (earth rod).

b) This bus bar must be installed in the transformation room. All the metal parts of the structure of the building, as well as the neutral part of the secondary transformer windings, must be connected to this earthing ring.

c) The base of the flooring of the lower and intermediary voltage cabins must be equipped with an adequate equipotential net.

d) All the connections of all the metal parts must be equipotential; false floors and ceilings, lighting installations, machine frames, outside lamp posts, air-ducts, etc., must also have unwanted equipotential connections to prevent any indirect contacts with live parts.

e) A naked copper wire, starting at the bus bar in the transformation room, should run just below ground, all around the perimeter of the buildings, connecting the various dispersion points. There must also be an equipotential connection net of cables, independent from that of the earthing system, used to earth all the communication equipment. A connection should be made from the bus bar to the various communication boxes via their earth. All these communication earths should be connected to one another and to the main earthing system, rendering it one single system.

Power supply at medium voltage (new receiver and transformation cabin)

a) The electricity supply of the entire sports facility must be brought to a power supply box at the boundary of the premises (medium voltage reception zone) and be distributed from there.

b) The supply (usually considered at ...KV (kilo voltage)), from the connection for medium voltage made by the distribution company, must be directly connected to the terminals upstream from the inbound medium voltage panel (sender side) and the following should be provided:

- One (1) medium voltage power supplier for the entire sports facility (in a receiver cabin as described above) containing a medium voltage panel.

  c) The supply equipment must be installed on the inside perimeter of the premises (medium voltage receiver cabin).

  d) This medium voltage receiver cabin should consist of:

- One (1) receiver cell with bus bar knife switch and earthing knife switch.
- One (1) cell with SF6 switch (sulphur hexafluoride) with indirect protection relays.

The medium voltage receiver cabin must be certified by a qualified laboratory.

e) A medium voltage line must start at the receiver cabin with 3 unipolar medium tension cables and one spare conductor cable, pass through an underground tube and arrive at the transformation cabin which shall be placed at the perimeter of the building.

f) The low voltage cables must start from this cabin and feed the appropriate panels.

g) The rooms in which the receiving and transformation cabins are placed must have adequate protection against water infiltration. Ventilation in these rooms must be exceptionally good, particularly in the transformation cabins.

h) The equipment within these cabins must be proportional to the characteristics of the power supply, of the distribution company, as follows:

- Nominal operating voltage of present and future supply: ...KV (kilo voltage) (to be defined by the distribution company);
- Short circuit power, no less than ...MVA (mega volt ampere) (to be defined by the company);
- Mono-phase breakdown current towards the earth and repair time: ...A (ampere) (to be defined by the company).

Transformation cabin

a) The transformation cabin must be installed in a room which should be fire-resistant for a minimum of 120 minutes. Access to the cabin must be in the open-air or via a well-aired antechamber.
b) The supply load must be distributed over two transformation units, each with the same characteristics, set in parallel but independent of each other.

c) On the medium voltage side, the cabin should be provided with prefabricated medium voltage panels, all equipped with the appropriate safety systems which exclude any possibility of contact with live parts or unwelcome tampering.

d) The transformers should have resin insulation and each be placed in a cell separated from the others by walls, closed on the front with lockable wire-net hinged doors which must automatically stop the power supply as soon as they are opened in order to prevent any access to cells under tension.

e) The medium voltage cabin should consist of the following:
   - One (1) cell for the input power supply line.
   - One (1) general isolator cell under load.
   - One (1) output cell.
   - One (1) cell for measuring voltage and amperage.
   - Two (2) cells with SF6 switch (sulphur hexafluoride) for the transformers.

*The medium voltage cabin must be certified by a qualified laboratory.*

f) Furthermore, the following commands, signals and interblocks must be provided, at the least:
   - Medium voltage quick-release switch.
   - Every cell must have its own voltmeter.
   - Markings for the positions of bus-bar knife switches and other medium voltage switches.
   - Every transformer must be equipped with an electric interblockage between the medium voltage automatic switch and the low voltage switch (so that, by opening the medium voltage switch, the lower voltage switch is also automatically opened). Furthermore, a mechanical medium voltage blockage with a system of ringed keys should also be provided.
   - An electric device which, if the door to the respective transformer is opened, should immediately interrupt the medium voltage power supply.
   - Mechanical interblockage between the bus-bar knife switches and the door-opening device.

g) An equipotential earthing net should be placed underneath the floor of the transformer cabin (as well as under the input cabin) and must consist of a galvanised steel rod, 10mm in diameter, and a square mesh, the sides of which are at least 1m long.

h) A main earth collector should be provided, as well as a perimetral collector all around the cabin. The earths of the cabin and those that do not belong to the cabin should be connected to the perimetral collector. The wires coming from the dispersers and the equipotential earthing net should be attached to the main earth collector.

i) The cabin must be equipped with safety lighting as well as with the most modern safety devices for the prevention of accidents, in particular:
   - Rubber insulation mat, approved and certified by a qualified inspection company, laid down along the length of the front of the medium voltage panels.
   - Insulated gloves.
   - Various control signs and warning signals.
   - A circuit diagram under glass.
   - The wires should be coloured and a legend must explain the colour codes.
   - A 10kg CO2 fire-extinguisher.
   - A switch hook.
   - A battery-powered portable torch.
   - An insulated podium.

j) The same applies to the input cabin.

k) The auxiliary circuits of the cabin should be fed by direct current provided by the appropriate power station and situated inside the low voltage panel, of the ‘Power Centre’ type. The power station consists of a series of stationary type accumulators designed to work autonomously for at least 60 minutes and be kept charged by a completely automatic power rectifier which
is capable of completely recharging the accumulators within a maximum of 8 hours. This power rectifier should consist of two distinct rectifier branches: one to feed the permanent power loads (auxiliary circuits of the cabin and the main panel) and one to fully recharge the series of accumulators and keep them charged. The power rectifier, with its series of accumulators, should automatically feed the circuits branching off it, if there is an alternate current power cut.

i) To protect the wires from unwanted contact between the secondary terminals of the transformers and the distribution panel, additional insulation will be provided from the secondary terminals of the transformers to the input terminals of the machine switches on the main lower voltage panel.

m) Two transformers in natural cooling resin should be provided, with the following characteristics:

- Each transformer must have a nominal power of approximately 1000 KVA (kilo volt ampere) (to be defined according to the site).
- Main voltage KV (to be defined according to the site).
- Secondary voltage V (to be defined according to the site).
- Frequency Hz (to be defined according to the site).
- Diagram (to be defined according to the site).
- Connections (to be defined according to the site).
- Percentage of short circuit voltage (to be defined according to the site).

**Accessories:**

- Three (3) united medium voltage insulators.
- Four (4) united low voltage insulators.
- One (1) terminal for main voltage transformation.
- Four (4) adjustable rollers.
- Four (4) eyebolt levers.
- One (1) earth terminal.
- One (1) type plate indicating the electric characteristics.
- Three (3) thermic-sounds, type PT100 for the protection of the windings.

n) A low voltage panel, of the ‘Power Centre’ type, should also be provided, with various output cables and automatic power factor corrector.

**Diesel electric power station for emergency power supply**

a) The diesel-electric power station should be installed in a room which must fire-resistant for a minimum of 120 minutes. Access must be in the open-air or via a well-aired antechamber.

b) This power station should consist of a diesel engine which starts a coaxial synchronous generator by means of a flywheel and an elastic joint. The engine and alternator unit should be assembled onto a single chassis of structural steel and separated from the floor slab by vibration dampers.

c) The unit should have a continuous working power of 250KW and shall consist of:

- A diesel engine with a maximum speed of 1500rpm, and an automatic starter as soon as the net voltage falls below 70% of the nominal value; an automatic standstill, with adjustable retarder, once normal operating operations are resumed; complete with starting battery, exhaust silencer, fuel tank and working accessories:
  - A closed circuit water cooling system with a radiator and a ventilator powered by the engine;
  - A minimum number of instruments: oil manometer and thermometer, cooling water thermometer, speedometer and hour counter;
  - Safety equipment for setting off the alarm system or stopping the machine, should it start to function abnormally: at least when the pressure of the lubricating oil is at a minimum, or the temperature of the exhaust gases at a maximum or the cooling water temperature at a maximum.

- Synchronous auto-ventilating, auto-energising, auto-regulating three-phase alternator, for variations of load of ±2.5%, secondary voltage V at primary current (p.c.); connection according to standards.

- Control and protection electrical panel of the box type,
with an adequate degree of protection according to the site, assembled separately from the group and at least equipped for the following:
- Measurement of the delta and star voltage.
- Measurement of the voltage on all three phases.
- Measurement of the power.
- Measurement of the frequency.
- Calibration of the voltage.
- A device for fully charging the starting batteries and preserving battery life - automatic tetrapolar multiple switch for the protection of the input line of the main panel (its functioning characteristics must ensure protection against circuits and unwanted contacts for the whole plant fed by the generator-set when it is on).
- Auxiliary counters to control the network/generator exchange unit.
- Alarm and protection units against abnormal functioning of the engine and of the alternator, in particular the following:
  - Minimum oil pressure.
  - Hyper-temperature of the water.
  - Minimum fuel level.
  - Hyper-temperature of the exhaust gas.
  - Generator overload.
  - Non-start.
and any kind of safety equipment which the construction firm recommends to maintain perfect functioning of the unit.

d) When connecting the unit to the main distribution panel, every type of device and measure (electric and mechanical units) must be used to prevent the generator from working in parallel with the electricity network of the distribution company.

e) To obtain the size of the generator unit, at least the following installations have to function with the privileged electricity network, called ‘reserve’, and their percentages have to be calculated:
  - Reverser for the security lights but not for the central playing courts or the tribunes.
  - Reverser for the various electric plugs for the press area and computer input.
  - Reverser for the main data processing unit in the press room.
  - Reverser for the safety control panel and the various special installations.

f) Soundproofing of the room must comply with the current standards regulating airborne sounds. The construction company must supply and install the following:
  - A soundproof door at the entrance to the room.
  - Devices for the elimination of unwanted sounds both upstream and downstream of the room.
  - Soundproofing of the room using appropriate boards or foam. This is to keep the noise level down to a maximum of 45dBA, measured 1m away from the room.

Device to neutralise the voltage of electric power supply unit in an emergency

a) For safety reasons, all the electric circuits of the building must be neutralised in one single action, including the emergency lighting and power supplies.

b) In other words, this single action must also neutralise the emergency generator unit and the safety power supply unit.

c) The device should be easily recognised and placed in a position where it cannot be easily damaged or tampered with.

d) For this reason, buttons should be strategically placed behind glass.

Main low voltage distribution panel (in the transformer cabin)

a) The panel should be of the ‘Power Centre’ type and be placed behind bars with segregated output cables (segregation of the functioning equipment, of the bus bars and of the output terminals one from the other). The panel should consist of modular cubicles, made of doors, supports, shelves and sides in sheet metal, completely separated from the bus bar zone as well as from the neighbouring cubicles.
The low voltage Power Centre panel must have been tested by a qualified laboratory and be certified.

b) The equipment and instruments must be positioned so that they are easy to operate and maintain; they must also be easy to reach inside the panel without, however, endangering either persons or things.

c) Particular attention should be paid to easy access without accidentally coming into contact with live components or parts which need frequent inspection, such as fuses and relays.

d) The main bus bars of the panel must be made of electrolytic copper, wide enough for the current passing through them, and must be attached by means of insulated rigid mechanical supports strong enough to take the electro-dynamic forces of short circuit currents.

e) The panel must contain measuring instruments and command levers, signalling and shunting line protection levers and the network/generator change-over switches, and, if necessary, also the compensating systems of the reactive energy.

f) The automatic switches and differentials installed in the panel must be omnipolar and divided into sections (or removable). Each one of them must be equipped with a light signal announcing an interrupted relay.

g) The characteristics of the automatic switches must be chosen according to the following criteria:
   - Short circuit input current in the panel.
   - Cross-section, type and conditions of installation of the shunting lines, taking into consideration the continuous load and the energy that would pass through them in the case of a short circuit.
   - Maximum length of the shunting lines in relation to their operating time.

h) Coordination between each of the maximum current relays of the switches must assure their operating time selection.

i) Plates on the front of the panel must indicate the various circuits of the instruments and equipment.

j) Appropriate warning signs and circuit diagrams must be fixed close to and on the panel.

The panel must consist of several sections:

Input
a) Each transformer shall be equipped with:
   - Voltage and current measuring instruments.
   - Push button low voltage switch.
   - Automatic powered disconnecting switch with cut-off coil.
   - Flag relays on the monitoring board of the transformer.
   - Alarm bell for these relays.
   - Earth relays with secured spring inserted into the neutral connected to earth.

b) A push button to open the medium voltage switch must be fixed onto the panel of the input cabin.

Commuting of the network/generator unit
a) The following shall be installed on the input line of the generator unit:
   - an automatic powered switch and two tetrapolar powered switches with mechanical and electrical interblocks must be connected to each other to prevent the two current sources from functioning in parallel. They must be powered by an appropriate relay at low voltage.

Normal energy
a) Automatic and differential powered disconnecting tetrapolar switches with cut-off coil, divided into sections (or removable) must protect the input lines:
   - Normal energy sectors of the various secondary panels.
   - Air-conditioning panels.
   - Panel for the heating and water plants.

b) Each of the above switches must have its own ampere-meter, commutators and reduction ampere-meters, according to the project diagram.

Privileged energy
(Can be fed by the generator unit even in the absence of network power supply)

1 Neutral circuit conductor that may carry current in normal operation. Ground and neutral are closely related. (Wikipedia)
a) Automatic and differential powered disconnecting tetrapolar switches with cut-off coil, divided into sections (or removable) must protect the input lines:
- Privileged energy sectors of the various secondary panels.
- Reverser for a panel for the data processing system.
- A UPS continuity unit (Uninterruptible Power Supply) for the various safety garter springs.

b) Each of the above switches must be equipped with its own ammeter, commutators and reduction amperemeters, according to the project diagram.

Automatic compensation of reactive energy
a) This section should include the automatic compensation system of the reactive energy composed of static capacitors. Their number must be regulated by an automatic unit equipped with a varmeter relay in order to maintain the power factor.

b) Each power transformer must be equipped with its own power correction capacitors at a fixed value, protected by knife switches with fuses, upstream from each machine switch.

Various secondary panels
a) The panel must be fixed to the floor or the wall, and equipped with shatter-proof glass doors, to prevent accidental switching on or off of the instruments within.

b) Each section of the panel must have its own independent input, be completely separated from the others by internal separators and equipped with a door. General knife switches should prevent the door from being opened when in the “closed” position, thus safeguarding against accidental contact with live components. There must also be overload protection diaphragms on the connecting terminals of the input knife switches.

c) In general, in order to subdivide the zones and installation units served by the respective secondary panels, the following sectors of use should be applied:
- Main court and tribunes.
- Warm-up and workout halls.
- Changing rooms and other service rooms.
- Air-conditioning and refrigeration units.
- Heating system.
- Other panels to be defined.

d) 20% of the total switches on the secondary panels should be reserved as spare switches for the connection of other equipment, if necessary.

THE ARTIFICIAL LIGHTING OF BASKETBALL COURTS
by Gilles Page, PHILIPS LIGHTING

Introduction
The great interest of the media in sports events has an important effect on the development of the sports themselves. This, together with increased leisure time, has resulted in a booming number of active sportsmen and women all over the world, either taking part in the sport as a leisure activity or in amateur and professional competitions.

Consequently, numerous sports complexes have been developed in which all kinds of sports are practised, from the general physical training sessions to professional activities. In the organisation of sports activities and events, the quality of the facilities available is of the utmost importance for pleasure in and the outcome of the competition. Space, a good playing surface, heating/cooling, safety provisions, etc. are all of major importance.

One essential contribution to a successful sports venue, which is still not always recognised as such, is the standard and quality of the lighting system. This, of course, is not only for TV transmissions, where lighting levels of sufficient quality are an absolute necessity to assure an optimal television transmission, but also for the general practising of the sports, guaranteeing, for example, a clear view of the components, of objects like the ball and, of course, the indispensable marking of the competition area itself.

On too many occasions, sports activities and events have been allocated to indoor venues with insufficient and/or inappropriate lighting systems, which often necessitate costly supplements or modifications, normally on a temporary basis. Inadequate
lighting spoils not only the pleasure and interest of the players, but also the comfort of the spectators in both the venue and at home watching their TV.

This chapter has been prepared with the simple purpose of providing the owners and directors of all commercial and public basketball venues, together with their managers of in-house corporate facilities, with basic recommendations on lighting systems. The information is also for the benefit of the architect, the consultant, the engineer as well as the ultimate installer, who is employed to design and install an artificial lighting system in a new venue or an existing stadium.

**User Requirements**

The users of basketball facilities can be distinguished according to their activities:

- the players
- the technical staff, referees, team officials
- the spectators arriving, watching the game and leaving the sports facilities
- the television and film crews, and the photographers recording the event.

The players, referees and officials must be able to see clearly all that is going on in the competition area so that they can produce their best possible performance, and make accurate decisions.

Spectators should be able to follow the performance of the players and the action in an agreeable environment. The latter requirement means that they must be able to see not only the competition area but also its immediate surroundings. The lighting should also enable spectators to safely enter and leave the sports facility. With large groups this safety aspect is very important.

For television, and film coverage, the lighting must be able to ensure that high quality colour images can be obtained, not only of the overall action, but also close-ups of the players and spectators alike. Close-up images are important to convey the emotions and atmosphere in a stadium to the viewers watching at home.

As the competence level of athletes increases so too does the speed of the action, the visual task becomes more difficult, requiring more light of a higher quality.

**Sports lighting classes**

In general, five levels of sporting activities are recognised: international and national, regional, local, training and leisure. These levels are related to the standards of play, and the viewing distances of the spectators. These five levels do not all require the same quality of lighting. Lower standards are clearly more acceptable for leisure sport than for national competitions. To cover all five activity levels, three lighting classes are defined:

- Class I: Top-level competition such as national and international matches, which generally involve large spectator capacities with potentially long viewing distances. Top-level training may also be included in this class.
- Class II: Mid-level competition such as regional or local club matches which generally involve medium-size spectator capacities with medium viewing distances. High-level training may also be included in this class.
- Class III: Low-level competition such as local or small club matches which do not usually involve spectators. General training and recreation also come into this class.

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<tr>
<th>Competition level</th>
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**Lighting Criteria**

**Horizontal Illuminance**

Knowing the general user requirements, it is possible to determine the lighting criteria for each of the different levels of activity. The purpose of this section, therefore, is to identify these lighting criteria and, wherever possible, to derive the lighting parameters of interest in each case.
The illuminated playing surface forms a major part of the field of view for the players, officials and spectators. It is the illuminance on this horizontal plane, at ground level, commonly referred to as the horizontal illuminance (Eh), that chiefly serves to establish the adapted state of the eye, by creating a stable visual background against which people and objects will be seen. Because of this and because the illuminated field is necessary for the players, spectators and cameras as a visual background, an adequate horizontal illuminance on the court is important.

To ensure safety of movement for the spectators when entering and leaving the stands or surroundings, adequate horizontal illuminance in these areas is also required.

**Vertical Illuminance**

Because we are generally interested in following the progress of the players and the ball, which can be approximated as vertical surfaces, it is the illuminance on the vertical surfaces (Ev) which describes best what we see. However, experience shows that where the human observer is concerned, there is a good relationship between vertical and horizontal illuminance. Therefore, for all activities, with the exception of television broadcasting, if the specified horizontal illuminance is provided and the design rules are followed, the vertical illuminance will be sufficient.

The scene illuminance, and more particularly the vertical illuminance, has a major influence on the quality of the final television or film picture. To guarantee an optimal view and identification of players from all directions, specified illuminances on vertical planes at a height of 1.5m are required.

For television or filming with fixed camera positions, it is sufficient to ensure that the illuminances on planes at right angles to the camera positions are adequate.

In the case of an unrestricted choice of camera positions, the vertical illuminance on planes facing all four sides of the competition area should be taken into account.

**Surface Illuminance**

The illuminance on a vertical plane also has to ensure that the ball in flight can be followed at any time and at the relevant position and height above the competition area by the players, officials and spectators. Also the illumination of the basketball goal should be guaranteed optimal.

**The need for a maintained illuminance**

The illuminance value specified for a particular level of activity is that which should be present at all times. Therefore, the installation should not fall below this value throughout its life. During the life of a lighting system, the light output will fall mainly due to light output depreciation of lamps, but also due to dirt in the environment collecting on the light-emitting surfaces of the floodlights.

The light loss due to the collection of dirt is difficult to estimate and will vary for different locations around the world. The light output depreciation from lamps is rather easy to determine as lamp manufacturers publish this type of data. The light losses due to the dirt and to the lamp flux depreciation should be combined as a maintenance factor.

**Uniformity**

Good illuminance uniformity is important in order to avoid adaptation problems for both players and spectators. If the uniformity is not adequate, there is a risk that an object or player details, like sponsor logos and emotions, will not be clearly seen at certain positions on the competition area.

Uniformity is expressed as the ratio of the lowest to the highest (U1=Emin/Emax) illuminance and as the ratio of the lowest to the average (U2=Emin/E-average) illuminance. Also the ratio of the uniformity of the illuminances at a single point over the four vertical planes facing the sides of the competition area should be considered.

Even when the uniformity ratios as defined above are acceptable, changes in illuminance can be disturbing if they occur over too short a distance. This problem is most likely to arise when panning a television camera. Therefore, the illuminance
uniformity for TV/film coverage at a certain grid point has to be expressed as a percentage change from the average adjacent grid points. This is called the uniformity gradient.

To obtain optimal visual conditions for cameras, the ratio between the average illuminances in the horizontal and vertical planes should be considered.

**Colour and colour properties of lamps**

Colour perception is important in most sports and, while some colour distortion, attributable to artificial lighting is acceptable, there should be no problem to distinguish between different colours.

There are two important aspects of the colour properties of lamps:

- The colour appearances of the light itself. This is the colour impression of the total environment created by the lamps.
- The colour rendering properties of the lamps used. This describes how faithfully a range of colours can be reproduced by a light source.

Both the colour appearance and the colour rendering properties of lamps are completely dependent upon the spectral energy distribution of the light emitted. An indication of the colour appearance of a lamp can be obtained from its correlated colour temperature in degrees Kelvin, indicated as Tk, which vary mainly between 2000 and 6500k. The lower the colour temperature, the warmer the colour impression of the light; the higher the colour temperature, the cooler or more bluish the impression of the light.

The colour rendering properties of a light source can be indicated by its colour rendering index Ra, expressed as numerical values from 0-100. A light source having a colour rendering index of 100 will represent all scene colours faithfully and can be compared with daylight.

**Glare restriction**

Glare can have a disturbing effect on the visual comfort and performance of both players and spectators. Glare is expressed as the Glare Rating (GR) in the range 0-100, in which 0 represents zero glare and 100 represents saturation.

Until recently it has not been possible to quantify or measure glare for outdoor sports lighting installations. Therefore, guidelines for the positioning of floodlights were necessary. The development of the Glare Rating GR assessment method has led to a reliable system that can be used to make a qualitative statement about the suitability of a lighting system before it is installed.

**Modelling and shadows**

Modelling is the ability of the lighting to reveal form and texture. This “modelling” ability is particularly important to provide a pleasant overall impression of the athletes, objects and spectators on and around the playing field.

An installation where light only comes from one direction will cause harsh shadows and poor modelling. The players will appear to be pushed into the background and will only be seen from the same direction as that from which the light comes. From all other directions they will be seen as a dark silhouette only.

The design of the lighting systems for basketball facilities should be based on light coming from at least two directions (side lighting) or ideally from as many directions as possible to create a good visibility and modelling for players and spectators in all directions.

**Lighting Recommendations for Non-Televised Events**

Where basketball facilities are to be used for all levels of activity including recreation, training, club competitions and international levels for non-televised events, it is mainly necessary to provide a horizontal illuminance suitable for the required level of activity. Tables 1 and 2 indicate the lighting requirements necessary for indoor and outdoor basketball events.
**Table 1: Lighting requirements for non-televised indoor events.**

<table>
<thead>
<tr>
<th>Class</th>
<th>Horizontal illuminance</th>
<th>GR</th>
<th>Colour rendering</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>&gt; 500 lux</td>
<td>&gt; 0.7</td>
<td>&lt; 50</td>
</tr>
<tr>
<td>II</td>
<td>&gt; 200 lux</td>
<td>&gt; 0.6</td>
<td>&lt; 50</td>
</tr>
<tr>
<td>III</td>
<td>&gt; 75 lux</td>
<td>&gt; 0.5</td>
<td>&lt; 55</td>
</tr>
</tbody>
</table>

**Obstructive Light**

To safeguard and enhance the night time environment, in the case of outdoor lighting installation, it is necessary to control obstrusive light, which can present physiological and ecological problems to the surroundings and to people. In some cases, local authorities or municipalities have their own guidelines on such matters and their advice should always be sought. If not, the recommendation from CIE2 Publication 1503 could be applied.

It should be noted that stray light falling outside the playing area cannot be effectively controlled by lowering the mounting heights of the floodlights. This only results in luminaires being aimed in a more vertical direction causing even more glare.

**Lighting Recommendations for Televised Events**

**Illuminance**

Where colour television broadcasting is a requirement, it is necessary to provide an adequate vertical illuminance across the scene viewed by the camera. If the vertical illuminance is not sufficient, good quality broadcast pictures will not be possible. Television cameras are not able to adapt to changes and fluctuations in lighting level as quickly as the human eye. Therefore this limitation must be taken into account when designing lighting systems for televised events.

A television camera will be viewing predominantly vertical objects at a height of 1.5m above the ground. For the purpose of specifications, the *vertical* illuminance should be specified as the illuminance on a vertical plane 1.5m above the ground, facing the direction of the television camera as shown in the table below.

For the coverage of basketball events there is a main camera position fixed in the middle of the sideline. This camera is used to maintain an overall view and continuity of the action over the entire area. For cameras used in this way, the calculations should be made specifically for these cameras as described above. It is now common for many cameras to be used, and
distributed around the arena to obtain close-up action shots from along side each event area. Up to ten cameras are used today during a basketball event. However, each camera is required to cover a small area of the total competition area. It is therefore not practical to make calculations for each camera over the whole competition area. Further details on camera location can be found in Annex 1, FIBA TV Manual (FIBA premium standard production plan). In situations where unrestricted camera positions are used, it is recommended to calculate the vertical illuminances towards all four sides of the competition area and look at the situation for each camera for the appropriate viewing area. When this type of calculation is applied, the uniformity between the four vertical calculations at a single grid point must be: $E_{\text{vmin}}/E_{\text{vmax}} \geq 0.5$.

This ensures that the modelling for the television camera will be high enough to ensure the television picture has a well-balanced brightness; the ratio between the average vertical and horizontal illuminance should be as closely matched as possible, but should not exceed the ratio of 0.5:2, i.e. the horizontal illuminance should not be less than half the vertical illuminance or greater than twice the vertical illuminance.

To ensure that the reactions of spectators can be captured, there must be adequate lighting on the spectator areas immediately adjacent to the competition area. The average illuminance towards the main camera for the first 12 rows of seats should be between 10 and 25% of the average illuminance of the court towards the main camera; above the first 12 rows, the light level must decrease uniformly.

**Illuminance uniformity**

When a camera pans across the competition area, it is important that the illuminance does not vary greatly as this would cause the camera to adjust its exposure, thus creating a change in picture brightness.

<table>
<thead>
<tr>
<th>Competitions</th>
<th>Description</th>
<th>Illuminance</th>
<th>Light source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Average (lux)</td>
<td>Gradient (%/2m)</td>
</tr>
<tr>
<td>Level 1</td>
<td>E Cam</td>
<td>&gt; 2000</td>
<td>&lt; 10</td>
</tr>
<tr>
<td></td>
<td>E h</td>
<td>0.75 to 1.5 * E cam</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Level 2</td>
<td>E Cam</td>
<td>&gt; 1400</td>
<td>&lt; 10</td>
</tr>
<tr>
<td></td>
<td>E h</td>
<td>0.75 to 1.5 * E cam</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Level 3</td>
<td>E Cam</td>
<td>&gt; 1000</td>
<td>&lt; 20</td>
</tr>
<tr>
<td></td>
<td>E h</td>
<td>0.5 to 2 * E cam</td>
<td>&lt; 20</td>
</tr>
</tbody>
</table>
An adequate level of uniformity of the horizontal illuminance as well as of the vertical illuminance is required to create balanced lighting conditions so that the television cameras do not continually have to adapt to a different light level. It is also important that the change in the lighting level over a given distance is not too great. The gradient calculation per grid point shall be considered to assess this.

**Emergency lighting for broadcasting continuity**

For the broadcasting of major international events, it is desirable that, in the event of a power failure, the continuity of television broadcasting can be guaranteed. It is recommended that an emergency TV lighting mode is incorporated and that the average illuminance provided should not fall below 1000 lux, neither for specified camera locations nor for unrestricted camera locations, for which appropriate calculations should be provided.

To guard against total power failures, it is recommended that there is an emergency power supply to support the emergency TV lighting mode. This can be a generating system, a totally separate incoming mains circuit or a battery backed-up no-break system. The power supply shall incorporate redundancy or external back up to ensure that the continuity of the television broadcast can be guaranteed.

**Colour properties of the lamp**

For the purposes of lighting for television broadcasting, the quality of the light sources used should have a colour rendering index not less than Ra 80 and the colour temperature should be between 4000k and 6000k.

In practice, it appears that light sources with a colour temperature greater than 5500k and a colour rendering index greater than Ra 90 are best suited for the coverage of major events. The high colour rendering index, greater than Ra 90, ensures that colours are vividly reproduced to enhance the general quality of broadcast images.

**Glare Restriction**

*Direct Glare*

Glare should be limited due to its detrimental effect on visual performance.

The procedures for measuring the limitation of glare are mainly developed with a horizontal viewing direction and a regular layout of ceiling-mounted luminaires. Generally, the viewing direction of an active athlete will constantly change, however in basketball, there are frequently occurring viewing directions, where discomfort glare must be limited as far as possible.

The arrangement of the luminaires must take account of these viewing directions. The luminaire aiming angle (from downward vertical) should be <= 65° and the intensity of the light source should be adapted in relation to the installation height.

*Indirect Glare*

Specular reflection occurs when light strikes a surface and is reflected from it at the same angle at which it struck, the same way in which a mirror reflects light.

A basketball court with significant specular components can cause glare to persons or television cameras looking across the playing court. This occurs because the specular reflection from the court causes a mirror image of the floodlight reflected toward an observer for some viewing directions. It is difficult to design a lighting system to cope with this as it cannot easily be predicted where problems will occur, due to the infinite number of viewing directions possible.

To overcome this problem, it is recommended limiting the specular reflective properties of the court surface. This then becomes a part of court specifications rather than of the lighting system.

It should be noted that this is a common problem, as court may have a top surface causing a “shiny” effect. It is assumed that if the specular reflections can be limited to less than 5%; this can be avoided.

In large sports halls, large video screens and/or scoreboard systems are now commonplace. Where this is the case, care
must be taken to ensure that luminaires are not positioned too close to these screens as this could cause glare for persons looking up at the screen.

**Summary of recommended lighting levels for televised events**

FIBA has defined three competition levels for televised events. The table below defines the lighting levels required during televised events organised by FIBA.

The average values above shall be achieved during the event; usually a maintenance factor is specified to compensate for ageing and soiling of the light sources, reflectors and front glasses. In the absence of relevant information, it is recommended using a maintenance factor of 0.8.

In the event of a power failure, the lighting system should provide Level 3 conditions for broadcasting continuity.

Also as already mentioned at the beginning of this chapter dedicated to lighting recommendations for televised events, the average illuminance towards the main camera for the first 12 rows of seats should be between 10 and 25 % of the average illuminance of the FOP towards the main camera; above the first 12 rows, the light level has to reduce uniformly.

**Glossary:**

- **E Cam:** Camera illuminance; quantity of light into the direction of a camera, at grid points 1.5m above the FOP
- **E h:** Horizontal illuminance; quantity of light at grid points on the FOP
- **Ug:** Uniformity gradient; the percentage difference of illuminance between adjacent grid points
- **U1:** Uniformity of illuminance; calculated as E min/E max
- **U2:** Overall uniformity of illuminance; calculated as E min/E ave
- **E min:** Minimum illuminance on a grid
- **E max:** Maximum illuminance on a grid
- **E ave:** Average illuminance on a grid
- **FOP:** Field of Play
- **Grid:** The basic layout of measuring and calculation points over the FOP

As well:

1. **All lighting installations shall:**
   - Be in accordance with the national safety requirements for electrical equipment in the respective countries.
2. **For level 1, the strobe light system shall have:**
   - A wiring harness for the installation of four lines, one in each corner of the playing court.
   - Each line with the ability to power a set of four strobe lights.
   - Each set with synchro-cabling and accessibility for the photographers via a switch exchange located in the vicinity of the basket support structure.
   - Each set located at a distance of at least 5m from the boundary line and at a height of 15m recommended)
   - Four sockets for the strobe lights located 2m from the flashes. Each socket shall be separate and protected against interference between the lamps (thermal recognition differential magnet)
   - The harness installed safely and out of the reach of the spectators.
   - The flashes installed safely to prevent them from falling.
3. **Individual flash photography is not permitted.**

**Lighting Design**

The lighting design will define the quantity, type and positioning of the luminaires necessary to achieve the lighting parameters for the chosen level of activity.

The illuminance value indicated for a particular level of activity is considered as the minimum value to which illuminance is allowed to fall during its lifecycle and is termed “maintained illuminance”.

Design proposals must take into account that the light output of a lighting installation will fall over a given period of time. This will give facility owners or operators the reassurance that the lighting will always comply with competition regulations, and provide a clear indication of the facility’s maintenance costs.

Any design proposal shall clearly indicate the average
illuminance and uniformity achieved and the point (in hours) after which the installation will no longer achieve the illuminance level stipulated for a particular activity level. Lamp data should be provided to verify such statements.

The area for which the calculations have been made should be in compliance with the indicated calculation grid. Any additional calculations provided shall be clearly explained.

The lighting design should meet all the required lighting parameters. This has to be proven by computer-aided lighting designs.

**Calculations**

For computer calculations to be meaningful it is necessary to first specify the area for which calculations should be made. The diagram below shows the area of interest for an international basketball facility. The diagrams show the overall dimensions of an approved basketball facility and the calculation grid to be used as the basis for all calculations, shown in the figures. The principal playing area (PPA) for basketball should be divided into 7x13 grid points and the calculated total playing area (TPA) into 9x15 grid points.

The use of computer-aided design systems is now commonplace and enables numerous calculations to be made relatively quickly. Consequently, it is recommended that, for design purpose, calculations be made with a maximum interval between calculation points. The use of a grid with this definition allows the designer to assess the uniformity and illuminance gradient, ensuring that undesirably very high or very low values will be present when the system is installed. If a larger calculation grid is used, it is possible that these high or low values could fall between the grid points and not be seen in the calculations.

**Lamp and luminaire selection**

The principal factors for lamp selection are: lumen output, lumen depreciation, lamp life, energy consumption, colour rendering and colour temperature (appearance). It is important to find the right balance between these factors in order to create a successful lighting installation.

The efficiency of a luminaire is evaluated by its light output ratio (LOR). This ratio must be considered in conjunction with the light distribution, which is the availability of the luminaire to direct the light where it is needed. It is important to remember that the mounting positions of the luminaires can influence the light distribution. There are other criteria to consider when selecting luminaires:

- Compliance with the luminaire standard EN 60598, which is the norm for luminaire electrical safety.
- IP rating, which is the resistance to dust and water (for outdoor use).
- Maximum ambient temperature. This is particularly relevant for indoor venues.
- Luminare wind-drag factor. This will determine the required strength of the supporting structure outdoors.
- Weight.
- Ease of maintenance. Consider how accessible the lamp is and how easily the reflector can be cleaned.
- Ease of installation.

**Arrangement of luminaires**

The lighting design for a basketball facility can be based on a number of basic floodlight arrangements. The luminaires can be mounted on poles for outdoor venues or on the stadium structure itself for indoor venues.

The possible column arrangements and permanent floodlight positions are too numerous to list. The drawings indicated in this guide are for illustration purposes only and may, in practice, need adapting to meet the specific circumstances of individual site locations.

In view of the constant advancement in lighting technology, it is always advisable to seek the advice of a lighting professional when planning a refurbishment or a new installation. A lighting professional will be able to advise on the best solution to a customer’s specific needs and circumstances, as well as carry out the necessary design work. This is particularly important where major stadia are concerned as there are now many factors which must be considered when planning and making
design proposals for these types of facilities, which cannot be fully explained in this kind of Guide.

**Selecting mounting height in major venues**
Where lighting systems are intended for colour television broadcasting, the mounting heights and positions selected must be based on the furthest aiming points used and not on the centre field line or point. Floodlights will generally need to be aimed at the far sides of the competition area and will therefore need to be mounted at a greater height.

The lighting designer should be given the freedom to position the floodlights to provide the best technical solution for a given situation. Mounting positions are often limited in large venues due to the architecture of the structure. Lighting equipment should not obstruct large video screens which may be in use. A glare rating assessment will ensure that a specific design proposal is suitable for a particular purpose.

**Mounting arrangements for indoor basketball**
Luminaires should not be positioned directly over the PPA to prevent dazzling when players look up towards the light source to follow the ball. It is better to install the luminaires outside the field boundaries. The mounting height of luminaires should be at a free height of at least 8m above the court surface. As players do need to look up from time to time, it is advised to guard against glare by reducing the contrast between the luminaires and the ceiling. Furthermore in basketball, luminaires should not be positioned within a 6m radius of the baskets.

**Drawing of the luminaire-free area around the basket**
Particularly where a court has polished floors, the luminaires should be positioned in such a way that light not reflected in the direction of the spectators or the cameras Main cameras are normally located in the stands at right angles to the long side of the court. Secondary cameras are positioned behind the basket support structures and endlines.

In the design phase of indoor basketball facilities, glare and loss of contrast can be avoided by excluding the installation of rows of transparent roof segments above the PPA. However, if they are installed, the material should be diffuse and preferably screened (e.g. baffles). Windows should, for the same reason, always be installed at a height of at least 4.5m above court level.

**Cost of ownership**
There is a wide variety of lighting systems available on the market and it might be tempting to opt for the cheapest solution, however, it is important to bear in mind that in most cases you get what you pay for and the cheapest luminaires may have reduced photometric efficiency, be made from low-quality materials or the manufacturer may have little expertise and provide poor levels of support. For this reason, it is important to follow the recommendations in this Guide when assessing the most appropriate lighting design.

A cost-of-ownership study should also be carried out, taking into account the following factors:

**Quantifiable aspects**
- Initial cost of luminaires and lamps
- Number of luminaires needed to achieve the required result
- Ease of installation
- Ease of maintenance
- Quality of luminaire materials/likely lifetime of product
- Power consumption
- Competent support from the manufacturer—is this available?
  If not, what will a consultant cost?
- Cost of gear replacement
- Efficiency of the gear system, taking into account ballast losses.

**Less quantifiable aspects**
Even during non-television events, the competitors, judges and spectators attach great importance to their sport and expect the lighting to work effectively.

In the case of televised events, the sponsorship for the event and the status of the venue depend very much on the performance of the lighting. It is not wise to rely on a poor system.

A good quality lighting system is a simple way to ensure
optimum conditions for an event to take place and the right ambiance to ensure the event is enjoyed by the participants and the spectators, both in the arena and at home.

**Installation and Operation**

**Installation**

Whether it is on poles for outdoor installations or on the structure of the venue for indoor installations, it is important to remember the following points when installing luminaires:

- The luminaires should be installed as indicated in the lighting design.
- Sufficient space should be given for the luminaires to be aimed as indicated in the lighting study.
- Easy access should be planned for commissioning and maintenance.
- To meet these requirements in indoor venues, it is recommended installing luminaires on a narrow pathway, without light being cut off by any structural elements.

**Commissioning**

Luminaires should be aimed as indicated in the lighting design. This operation is crucial to guarantee that the lighting results predetermined during the calculation can be achieved in reality and should be done in cooperation with a sports lighting specialist.

During the final stage, illuminance measurements should be carried out to check the lighting levels provided by the lighting installation. After switching on the lighting, sufficient time should be allowed to ensure that the lamps have warmed up. The warm-up time required depends on the type of lamps used; information on this will be given in the lamp manufacturer’s specifications.

In addition to illuminance measurements, it is necessary to measure the supply voltage at the input to a group of luminaires or at the base of the lighting column. This is because, if the supply voltage deviates greatly from the nominal supply voltage of the floodlight, the light output will vary as a percentage difference. If the supply voltage is lower than required, the light output will also be lower and adversely affect the performance of the lighting scheme.

Lighting measurements should take place on the same grid point used for the calculation and should be carried out using a calibrated luxmeter and all the appropriate measuring equipment.

A difference between the measured and calculated values is likely to occur as a result of:

- Tolerances in manufacturing luminaires, lamps, etc.;
- Tolerances in the photometric measurements;
- Tolerances in position and aiming of luminaires.

Taking these tolerances into account, the differences between the measured and calculated average values should be ≤10%. Additional differences can be caused by voltage variation, which also has to be taken into account.

It is recommended that illuminance measurements are taken each year, before the competition season starts, to ensure that the lighting installation still meets the required illuminance and uniformity for which it was designed. These measurements can also be used to determine how close the installation is to the required maintenance point.

**Maintenance**

Once an investment has been made in a lighting system, regular maintenance should be carried out to ensure the system continues to perform as intended.

The maintenance of lighting systems must not only include the replacement of lamps but also the inspection of electrical and mechanical components and the replacement of worn or failing items. This type of maintenance can be planned at regular intervals and will usually avoid unexpected system failures.

**Emergency Lighting**

Emergency lighting systems must be provided in locations accessible to the public, like the basketball hall.

The primary objective of emergency lighting is to provide adequate visual conditions to avoid panic and facilitate safe evacuation of people from a building during a power failure.
Battery-backed safety lighting devices are designed to come on automatically when the power goes out and continue to operate long enough to evacuate a building.

In most countries, states or towns, statutory regulations relating to emergency lighting already exist. For this reason, the appropriate authority should always be consulted before commencing the design of a specific emergency lighting system. Where such a regulation does not exist, reference should be made to the European Standard EN 1838 (Lighting Applications - Emergency Lighting).

**Acoustics in Sports Facilities**

*By Mauro Barducci*

*Sound engineer and sound environmental consultant*

**Introduction**

When planning a sports facility, it is important to consider creating a structure suitable for other types of events and spin-off activities such as music concerts, dance performances, and artistic sport shows. The multifunctionality of a complex is almost a must nowadays, not only because of the increasing number and types of sporting events that attract the public and but also the increase in building and management costs (resulting from greater demands in quality of service by users and in higher safety standards).

The acoustics in a sports facility represent an aspect which requires special attention, since each room and hall has its own particular purpose and therefore quite different requirements. What is more, the structural and functional nature of a building can also affect the acoustics inside a building.

It is often very difficult to integrate a sound system in already existing structures, due to the prevailing structural and architectural aspects.

Large sports facilities must be equipped with a sound system that meets the following requirements:

- Use as a safety device to convey warnings in the case of emergencies;
- Use as a PA system to convey announcements throughout

<table>
<thead>
<tr>
<th>AMPLITUDE</th>
<th>Practical examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>130</td>
<td>Jet airplane at take off</td>
</tr>
<tr>
<td>120</td>
<td>Threshold if pain, pneumatic drill</td>
</tr>
<tr>
<td>115</td>
<td>Brass band from the first rows</td>
</tr>
<tr>
<td>110</td>
<td>Dancing floor in a discotheque, symphony orchestra from the first rows</td>
</tr>
<tr>
<td>105</td>
<td>Klaxon from a distance of 1m</td>
</tr>
<tr>
<td>100</td>
<td>New born baby crying</td>
</tr>
<tr>
<td>90</td>
<td>Cry of “goal”, percussion instruments at a distance of 10 m</td>
</tr>
<tr>
<td>85</td>
<td>Background noise from a railway station bench</td>
</tr>
<tr>
<td>80</td>
<td>Noise in a crowded street, loud volume of a hi-fi set</td>
</tr>
<tr>
<td>70</td>
<td>Public speech</td>
</tr>
<tr>
<td>65</td>
<td>Washing machine</td>
</tr>
<tr>
<td>60</td>
<td>Background noise in a shop, limiti of normal conversation</td>
</tr>
<tr>
<td>50</td>
<td>Office, restaurant</td>
</tr>
<tr>
<td>40</td>
<td>Conference room, soft music, quiet bar</td>
</tr>
<tr>
<td>35</td>
<td>Rustling leaves, light wind</td>
</tr>
<tr>
<td>30</td>
<td>Silent club room</td>
</tr>
<tr>
<td>20</td>
<td>Very quiet room</td>
</tr>
<tr>
<td>0</td>
<td>Threshold of perception</td>
</tr>
</tbody>
</table>

Tab. n. 4.2 - Indicative values of acoustics pressure in normal every day life. The human ear cannot perceive acoustic pressures inferior to 0dB.
the sports facility;
- Reinforce a clear sound (of speech and music) to increase the appeal of a sporting event;
- Ensure that players can clearly understand the officials;
- Ensure that players can hear the instructions from the team bench.

This chapter describes the sound diffusion problems that can be encountered in any hall hosting sporting events. Irrespective of the technical system installed, the fact remains that a sound system can improve the sound in all areas and help to correct the negative aspects in facilities requiring restoration. The chapter will focus on the environment and how to best exploit the acoustics of a sports hall in order to gain the most out of the complex and the equipment.

The main objective in a space dedicated to sporting events is to guarantee speech intelligibility to all spectators whatever their position in the hall, both in terms of speaker comments and service announcements (whereby the latter must also reach the ancillary areas), and yet without disturbing the athlete areas.

**The main objective in a space dedicated to listening to music** (such as an auditorium or theatre) is to guarantee excellent acoustic comfort and high quality sound diffusion within the space, paying particular attention to the timbric content and dynamics in the reproduction, direct or amplified, of voice or instruments.

Modern facilities usually need some form of acoustic correction which invariably entails treatment or modification of internal structures depending on the different intended uses. This can be done by measuring and testing the acoustic characteristics ante operam or by using specific calculation software that takes into account the different conditions of use (number of spectators).

Basically there are two types of intervention:
- Treatment of the different internal surfaces with sound

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<table>
<thead>
<tr>
<th><strong>Site</strong></th>
<th><strong>Noise level dB</strong></th>
<th><strong>Required Sound Level dB</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Entertainment and recording studios</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Television or radio studio</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Recording studio</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Monitoring studio</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Theatre</td>
<td>40-45</td>
<td>65-80</td>
</tr>
<tr>
<td>Concert Hall</td>
<td>45-50</td>
<td>85-110</td>
</tr>
<tr>
<td>Cinema</td>
<td>50</td>
<td>70-80</td>
</tr>
<tr>
<td>Night club</td>
<td>75</td>
<td>95-110</td>
</tr>
<tr>
<td><strong>SHOPs AND SUPERMARKETS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boutique</td>
<td>55-65</td>
<td>70</td>
</tr>
<tr>
<td>Supermarket</td>
<td>65-70</td>
<td>75</td>
</tr>
<tr>
<td>Bar</td>
<td>60-65</td>
<td>65-70</td>
</tr>
<tr>
<td><strong>WAITING ROOMs, PUBLIC BENCHes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airport</td>
<td>65-70</td>
<td>75-80</td>
</tr>
<tr>
<td>Railway Station</td>
<td>80</td>
<td>85-90</td>
</tr>
<tr>
<td>Underground</td>
<td>90</td>
<td>95-100</td>
</tr>
<tr>
<td><strong>SPORT FACILITIES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gym</td>
<td>55-65</td>
<td>70-75</td>
</tr>
<tr>
<td>Swimming pools, ice skating rings</td>
<td>60-70</td>
<td>75-80</td>
</tr>
<tr>
<td>Multi-purpose facilities</td>
<td>75-80</td>
<td>90-95</td>
</tr>
<tr>
<td>Sport Facility at the moment a point is scored</td>
<td>90</td>
<td>90-95</td>
</tr>
<tr>
<td><strong>PLACE OF WORSHIP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Church</td>
<td>50-55</td>
<td>60-65</td>
</tr>
<tr>
<td>Mosque</td>
<td>50-55</td>
<td>65-75</td>
</tr>
</tbody>
</table>

*Tab. n.4.3 - Values of background noise in everyday life situation*
absorbing/diffusing materials.

- Selection of an amplification and sound diffusion system which covers all areas required and takes into account the dimensions and characteristics of the hall as well as the different intended use. This system should be easy to reconfigure and adjust to suit different situations.

**Fundamental Concepts of Acoustics**

Sound, both useful (spoken and musical sound) and disturbing (noise or other incidental background sounds), has two fundamental characteristics: amplitude and frequency.

In terms of physics, sound refers to pressure perturbations (oscillatory) that propagate through a transmission medium (air), stimulating the hearing system.

- **Amplitude**

  Amplitude refers to the intensity perceived by the hearing system generated by an acoustic signal. Sound intensity (acoustic pressure level) is measured in decibels (dB). *(Table n. 4.A)*

  It is important to bear in mind that a decibel is a logarithmic unit (an increase of 10 dB decibels in the power of a signal is equivalent to increasing its power by a factor of ten); decibels are used to measure the sensitivity of the human ear which can perceive sounds from very low-energy sounds (whisper, human breathing, 10-20 dB) to very high-energy sounds (jet taking off 120 dB).

- **Frequency**

  The speed of pressure oscillation (number of cycles per second) determines the frequency of a sound. For humans, the general range of hearing is between 20 Hz and 20,000 Hz (20 kHz). Frequency is the parameter that characterises the pitch of sound, thus enabling sound to be perceived as low (grave), medium and high (acute).

  Normally, no sound is ever made up of one single frequency (pure tone) but is a very complex combination of sounds with different frequencies and amplitudes which together create an acoustic signal with an overall amplitude and a combination of frequencies. In terms of frequencies, the quality of sound is referred to as timbre. The sound spectrum represents the combination of audible frequency bands ranging between 20Hz and 20,000Hz. These bands are divided into octaves. The centre frequency values on the octave band are 31.5, 63, 125, 250, 500, 1000, 2000, 4000, 8000, 16000Hz.

- **Sound propagation**

  The rule for sound propagation in free field conditions is as follows: in the case of a sound point source, for every doubling of distance there is a 6 dB drop in sound pressure level in that point. The partially reflecting ground (where the source and listener are) increases the level calculated in this way by 0 to 6 dB. The attenuation due to absorption by the atmosphere should also be calculated; however, this value is rather irrelevant for distances less than 100m. *(Table n. 4.B)*

**Characteristics of the Sound Field of Large Rooms**

Unlike sound propagation in open spaces, in a closed environment the acoustic field is made up of direct sound waves (source-listener) as well as sound waves reflected by the surfaces within the area.

The acoustic quality depends on a number of different
elements: direct sound and diffused sound, delay of the many
reflections (due to the geometric and physical characteristics of
the room and walls), frequency response of the sound diffusion
and absorption elements present; in other words, it depends
on the direct (source characteristics) and reverberated (room
characteristics) sound field.

The direct sound field
The sound pressure level of the direct wave that reaches the
listener depends on:
- Power of the source.
- Directivity of the source.
- Source-receiver distance.
- Sound absorption along the propagation line. This includes
  the absorption caused by spectators and seating which is
  higher for a sliding tangential sound wave (especially at low
  frequencies); therefore, absorption can be reduced by having
  an inclined seating surface.
- Background noise (disturbing).

Sound decay and reverberation time
Scientific research in the field of architectural acoustics began
with the work of American physicist, Wallace Clement Sabine
who, at the beginning of the 20th century, recognised the
fundamental importance of the size of the room and the amount
of absorption surfaces present (reverberation). Sabine defined
reverberation time (T60) to be the number of seconds required
for the intensity of sound to drop from a level of audibility 60 dB
above the threshold of hearing to the threshold of inaudibility.

After this, researchers focused on defining a way of predicting
reverberation time and identifying the optimal T60 values
according to the volume and use of a room. As research
progressed, it became obvious that an evaluation criteria
based only on reverberation time had its limits and was only
really useful in the case of perfect diffusion of reverberated
power within the room, in other words a situation which is not
realistic.

The information provided by reverberation time has to be
integrated with other criteria, still related to multiple reflections
but capable of highlighting the differences in quality in the
different points of a room caused by the imperfect diffusion
and relative importance of direct and reverberated sound.

The reverberant sound field
Limiting the initial time delay gap serves to increase the useful
sound; this improves speech intelligibility (sports events) and
music quality (performances).

If the initial time delay gap is greater than 50 milliseconds for
speech or 75 milliseconds for music, and the difference between
the level of the direct sound and reflected sound is significant
(more than 10 dB), this may cause excessive prolongation of
the reverberation tail; in this case an echo may occur in which
the reflected wave is perceived as a distinct and, therefore
disturbing, sound.

For a sound speed of 340 m/s, the gap limits of useful reflected
sound correspond to path-length differences between the
waves of 17 and 25 metres respectively.

With regard to the quality of sound perceived by listeners, it is
necessary to focus on the first part of the decay curve; the initial
slope is extrapolated to 60 dB decay to obtain the parameter
of the T60 (RT).

The following parameters are taken into account, calculated by
extrapolating the initial decay slope to 60 dB; the parameters
correspond to the first 10-15 dB respectively:
- T10 Early Decay Time (EDT)
- T15 Initial Reverberation Time

Diagram 4.1 shows an example of the difference between T10
and T60 on the basis of the graphic representation of the decay
in sound pressure level.

The comparison between the T10 value and the conventional
reverberation time T60 provides further information on the T60,
as it highlights the linearity or non-linearity of the decay curve;
the curve is exponential only in conditions of perfect diffusion.
The Initial Time Delay Gap (ITDG) is another important parameter
in the objective measurement of the acoustic quality of a room.
To define the acoustic quality of a room, it is also important to take into account the reverberations that follow the initial ones, which create the so called reverberation tail.

The optimal combination of the two sound fields (direct and reverberated) varies according to the use of the room: speech (sporting events) or music (different types of performances). In fact, in the case of music events, a prolonged reverberation tail of each single sound element is preferred, compared to events where speech intelligibility is required.

It is important to remember that irregularities present on a reflecting surface (due to shape or unevenness) transform it into a reflecting surface for low frequencies (long wave lengths) and propagating surface for high frequencies. These reflection or selective diffusion phenomena may result in frequency distortion: the sound signal that reaches the listener does not have the same spectrum composition (timbre) as the one emitted by the source.

The T<sub>60</sub> value depends on the volume of the room and total absorption of its internal surfaces; as the absorption of the materials varies with the frequency, also the T<sub>60</sub> varies with the frequency. In rooms of the same given shape, the T<sub>60</sub> will increase as the size increases.

The optimal reverberation time value is between 1 and 2 seconds for different types of music, yet it should be less than 1 second for speech.

When the use of reverberation time alone to predict the acoustic quality of a room was found to be insufficient, another element started to be taken into account: the energy ratio based on the arrival time of energy related to a sound signal in a specific listening point, also called “acoustic ratio” These can be summed up as follows:

a. useful signal/residual reverberation formula:

\[ R_{s,r} = \frac{E_s}{E_r} \]
The previous pages highlighted the importance of first reflections with a short delay gap in relation to direct sound (T_{10}, acoustic source) the contribution of which is added to direct sound to create the “useful sound”, for satisfactory listening of sound emissions.

For a correct perception of the space by the listener (spatial impression), the direction from which the first reflections arrive is also important, particularly the lateral ones.

It is also important to remember that the architectural acoustics must not only meet the requirements of the spectator but also the needs of athletes (sporting events) and artists (music events). Three or four carefully selected parameters can provide a useful assessment of the architectural acoustics of a hall.

As regards the study of parameters in the planning phase, there are three main factors influencing the acoustics of large halls: the sound that reaches the listeners directly from the sound source (direct sound), the early reflections, and the late reflections (reverberation).

**ACOUSTIC DESIGN OF LARGE HALLS**

The previous pages highlighted the importance of first reflections with a short delay gap in relation to direct sound (T_{10}, acoustic source) the contribution of which is added to direct sound to create the “useful sound”, for satisfactory listening of sound emissions.

For a correct perception of the space by the listener (spatial impression), the direction from which the first reflections arrive is also important, particularly the lateral ones.

It is also important to remember that the architectural acoustics must not only meet the requirements of the spectator but also the needs of athletes (sporting events) and artists (music events). Three or four carefully selected parameters can provide a useful assessment of the architectural acoustics of a hall.

As regards the study of parameters in the planning phase, there are three main factors influencing the acoustics of large halls: the sound that reaches the listeners directly from the sound source (direct sound), the early reflections, and the late reflections (reverberation).

**DIRECT SOUND**

The importance of reverberation, highlighted by Sabine’s work, may lead planners to underestimate the contribution of the direct sound field. Experience shows that the possibility of receiving sound waves directly from the source, without obstacles, and at an adequate level, is paramount in ensuring a satisfying listening experience.

Therefore, the condition to be respected is of a geometric nature and concerns the position of each listener vis-à-vis the sound source and other listeners in the hall. This is illustrated in the diagram below, which shows that the line of sight of each spectator must be adequately inclined to enable the sound source to be seen without being blocked by the head of the person sitting in front.

If H_s and H_e are respectively the height of the source and the height of a listener compared to the floor, then the maximum distance of the source at which the pit can be horizontal is given by the following formula:

\[ d = \frac{s}{h} (H_s - H_e) \]
where \( s \) is the distance between two adjoining rows of seats and \( h \) is the minimum incline of the line of sight.

The graph in Diagram n. 4.2 illustrates the maximum horizontal extension of the pit.

Beyond this distance, the pit must be inclined at an angle defined by the following formula (Diagram 4.3):

Acceptable values for the parameters \( H_e \), \( S \) and \( h \) are as follows:

\[
H_e = 1.00 \div 1.20\text{m} \\
S = 0.90 \div 1.00\text{m} \\
h = 0.10 \div 0.20\text{m}
\]

Values of \( \vartheta \) should not be greater than 15°–20°.

Instead of basing calculations on the spectators furthest away, on the horizontal and inclined plane respectively as in previous diagrams, it is also possible to define an outline of the surface that ensures the same visibility for all rows of spectators, as in the following diagram.

The same method can be used to calculate the incline of a balcony.

Another essential condition for a direct sound field is that it must have an adequate level even for the listeners who are furthest away. (Diagram 4.4)

**EARLY REFLECTED SOUND**

The following conditions are necessary for early reflected sound from walls and ceilings to contribute to form a useful signal:

- Limited delay compared to direct sound,
- Sufficient level of reflected wave.

As mentioned above, the limit for the delay time gap is of 50 milliseconds for speech and 75 milliseconds for music which corresponds to path-length differences between the waves (reflected and direct) of 17 or 25 metres respectively. For the reflected wave to assist the useful signal, its intensity (sound energy) must be at least 10% the intensity of the direct wave. This is valid for reflections from both the ceiling and side walls of a hall.

---

**Table 4.C**

<table>
<thead>
<tr>
<th></th>
<th>125 Hz</th>
<th>250 Hz</th>
<th>500 Hz</th>
<th>1 kHz</th>
<th>2 kHz</th>
<th>4 KHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area occupied by the public</td>
<td>0.52</td>
<td>0.68</td>
<td>0.85</td>
<td>0.97</td>
<td>0.93</td>
<td>0.85</td>
</tr>
<tr>
<td>Area with seats upholstered with cloth without public</td>
<td>0.44</td>
<td>0.60</td>
<td>0.77</td>
<td>0.89</td>
<td>0.82</td>
<td>0.70</td>
</tr>
<tr>
<td>Area with seats upholstered in leather without public</td>
<td>0.40</td>
<td>0.50</td>
<td>0.58</td>
<td>0.61</td>
<td>0.58</td>
<td>0.50</td>
</tr>
<tr>
<td>Area with hard wooden seats without public</td>
<td>0.04</td>
<td>0.05</td>
<td>0.06</td>
<td>0.08</td>
<td>0.12</td>
<td>0.10</td>
</tr>
<tr>
<td>Wall with plaster</td>
<td>0.01</td>
<td>0.01</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Polished marble</td>
<td>0.01</td>
<td>0.01</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Floor tiles or concrete</td>
<td>0.01</td>
<td>0.01</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Parquet wood floor on concrete</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Wooden floor joists</td>
<td>0.16</td>
<td>0.14</td>
<td>0.12</td>
<td>0.11</td>
<td>0.09</td>
<td>0.07</td>
</tr>
<tr>
<td>Linoleum flooring</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
<td>0.03</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Rubber flooring</td>
<td>0.04</td>
<td>0.04</td>
<td>0.06</td>
<td>0.06</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Glass walls</td>
<td>0.30</td>
<td>0.20</td>
<td>0.15</td>
<td>0.10</td>
<td>0.07</td>
<td>0.04</td>
</tr>
<tr>
<td>Average thickness of glass (window acoustic)</td>
<td>0.15</td>
<td>0.06</td>
<td>0.04</td>
<td>0.03</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Curtains cotton (300 g/mq) a wall without drapery</td>
<td>0.03</td>
<td>0.05</td>
<td>0.10</td>
<td>0.15</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>Velvet curtains</td>
<td>0.05</td>
<td>0.12</td>
<td>0.35</td>
<td>0.45</td>
<td>0.38</td>
<td>0.36</td>
</tr>
<tr>
<td>Velvet curtains with little thin wall drapery</td>
<td>0.08</td>
<td>0.30</td>
<td>0.50</td>
<td>0.50</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>Velvet curtains with very heavy drapery wall</td>
<td>0.50</td>
<td>0.50</td>
<td>0.70</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
</tr>
<tr>
<td>Carpet thin</td>
<td>0.05</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Carpet heavy</td>
<td>0.10</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Porous acoustic plaster (not painted) 15 mm</td>
<td>min 0.02</td>
<td>0.05</td>
<td>0.05</td>
<td>0.10</td>
<td>0.20</td>
<td>0.10</td>
</tr>
<tr>
<td>Panel porous mineral fiber, according to the thickness and mounting</td>
<td>min 0.10</td>
<td>0.30</td>
<td>0.50</td>
<td>0.60</td>
<td>0.70</td>
<td>0.80</td>
</tr>
<tr>
<td>Panel porous wood fiber pressed to the wall</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
<td>0.40</td>
</tr>
<tr>
<td>Wood panels, with space between the panel and wall, depending on the thickness of the panel and empty space</td>
<td>min 0.20</td>
<td>0.10</td>
<td>0.05</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Wooden elements</td>
<td>0.21</td>
<td>0.22</td>
<td>0.28</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Suspended ceiling plaster, thickness 25 mm.</td>
<td>0.10</td>
<td>0.08</td>
<td>0.05</td>
<td>0.05</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Sheet of aluminium foil shaped, drilled to 15% of the area, with the rear of rock wool</td>
<td>0.50</td>
<td>0.75</td>
<td>0.75</td>
<td>0.85</td>
<td>0.75</td>
<td>0.70</td>
</tr>
<tr>
<td>Gypsum panel holes at 12%, with the rear of rock wool</td>
<td>0.40</td>
<td>0.60</td>
<td>0.80</td>
<td>0.60</td>
<td>0.60</td>
<td>0.50</td>
</tr>
</tbody>
</table>
In the case of the side walls, it is important to note that different building specifications (constructional, architectural, seating-capacity related) often restrict the most suitable building shape, from an acoustics point of view. This problem can be overcome by creating rough and irregular side walls with vertical elements so they will reflect in a variety of different directions.

If the ceiling and side walls do not provide sufficient useful reflections towards the listeners, acoustic reflectors can be installed, with correctly shaped and adequately sized surfaces to ensure that the incident energy is reflected consistently.

**Delayed Reflections and Reverberation**

As each reflection is usually accompanied by a partial diffusion, reverberation is characterised by a progressively increasing degree of diffusion.

In large halls, the first delayed reflections may occur after the 50 (or 75) ms limit; these reflections can cause disturbances such as “echoes” if their intensity is greater than the regular reverberation.

To identify the areas affected by “harmful” reflections in the building/reconstruction plans, it suffices to remember that these areas are those in which the difference between the distance of the image source and the real source is greater than the limit distance (17 or 25 metres).

Disturbing reflections are not only caused by distance and delay time but also by the shape (curve) of reflecting surfaces as they may focus (or reduce) the reflected energy towards specific areas, thus creating unwanted irregularities in the sound field. Therefore, if “harmful” reflections cannot be avoided, the solution is to treat the reflecting surfaces to render them sound absorbing and sound diffusing surfaces.

There are three basic types of sound-absorbing materials available: porous sound-absorbing materials, vibrating panel and perforated resonant-absorbing panels. In the first type of materials, sound absorption properties depend on the porosity, while in the other two types, the properties are linked to resonance phenomena perhaps resulting from a panel or an acoustic resonator. In large halls, the audience contributes significantly to the overall required sound-absorption value. Obviously, in order to obtain acoustic behaviour that does not vary considerably according to the size of the audience, it is important, where possible, to use seats and structures that provide a similar sound absorption to that of the audience. Sound absorption by seated audience (and unoccupied seats) can be calculated by attributing an absorption coefficient to the audience area, occupied and unoccupied.

Examples of acoustic absorption coefficients are shown in **table 4.C**

**Design Criteria of a Hall**

In light of the above, basic criteria for the design of a hall can be defined with particular reference to its volume and surface treatment.

- **c.** Study the characteristics of the hall and sound amplification systems to guarantee a good level of direct signal to all spectators.

- **d.** Check the differences between the paths of the direct and reflected waves, respecting the “useful signal” limits and avoiding excessive delays. Surfaces which may cause reflected waves with an excessive delay must be treated with sound-absorbing material. To guarantee clarity, definition and lateral efficiency, the early first reflected sounds must be sufficiently intense and come from directions different from that of the direct sound. For this purpose, the hall ceiling may be used as reflectors in parts of the hall which can generate useful reflections, or, alternatively, the ceiling may be used to address harmful reflections outside the audience area. Side walls can also be used as reflectors but only if the width of the hall is limited. A rectangular plan usually offers good distribution of reflected sound. Excessively flat and wide halls tend to reduce the spatial impression, due to the lack of importance of the first lateral reflections. The surfaces which are furthest away (end walls) usually have to be treated to become sound-absorbing due to the excessive path-lengths.
of the reflected waves. The ceiling can also be used for the acoustic correction of a hall, using treatments or suspended elements to improve the useful reflections or increase the sound absorbing elements.

e. To guarantee a sufficiently uniform sound field, a compact shape must be achieved (one dimension should not be much greater than the others).

f. To avoid reciprocal multiple reflections and the flutter effect, shapes which are too regular must be avoided (similar dimensions in different directions) and opposing walls must not be parallel (if reflecting).

g. Harmful reflections are not only those which reach the listener with excessive delay and energy, but also those which, due to the shape for the reflecting surface, tend to focus the sound energy only in certain points or create zones which generate a non-uniform sound field. In these cases, the surfaces causing the problem must be treated with sound-absorbing materials or diffusing structures. In multifunctional halls which call for the projection of various kinds of music, live and recorded, as well as speech, there may be a need to install elements and structures which can alter the acoustic characteristics in a hall, these may include mobile reflectors or panels which can adjust their absorption characteristics.

**Sound System for a Hall**

To guarantee adequate speech intelligibility and good quality music sound in a large hall, as mentioned above, the characteristics of the hall must be studied alongside the amplification and sound diffusion systems, in order to:
- Guarantee a good direct signal level to all spectators;
- Avoid multiple reflections characterised by excessive delay time.

It is best to avoid sound diffusion systems with excessive power and reduced directionality as these are known to create considerable non-uniformity in the power and quality perceived by the audience, and could even interfere with an event, by disturbing the protagonists (artists, athletes) or, alternatively, having a detrimental effect on spectator comfort in some areas.

In fact, in a large hall it is usually very difficult to obtain a reverberation time within the values theoretically required: this represents a limit in terms of music listening quality and is even more problematic when it comes to speech intelligibility (sporting events).

A sufficient number of loudspeakers must be installed to overcome these problems, in order to:
- Reach each and all spectators present;
- Make sure that the sound levels generated are sufficiently consistent with the sound source distance constant;
- Achieve good loudspeaker directivity; loudspeakers must be positioned so that in each point the sound generated by one single loudspeaker, or maximum two equidistant ones, prevails. The lateral overlapping of radiation cones from sufficiently directive loudspeakers creates harmful delays between the two signals.
- Not to exceed the levels generated by each loudspeaker, thereby minimising the following “non useful” reflections (reverberation tail).

In this way, by avoiding sound systems with a reduced number of high-power loudspeakers with little directivity, part of the acoustic problems usually encountered in large public halls can be solved. The acoustic problems are usually due to:
- Not being able to treat the walls with sufficient sound-absorbing elements;
- Various types of problems in the acoustic treatment of the ceiling;
- The presence of a reflecting floor required for a sporting event;
- The architecture of the hall having been designed without taking into account multiple reflections or critical points, as is often the case in “sports centres”.
**Identification and Solution of Acoustic Problems of a Sports Hall**

Large sports halls usually have considerable acoustic problems, due to their large dimensions and expansive reflecting surfaces (cement or plaster walls and ceilings, windows, rigid and smooth flooring suitable for sporting events).

These problems become even more pertinent when the same space is increasingly used for commercial activities or other events, and will require recourse to experts in environmental acoustics and sound diffusion system specialists.

In other words, the following steps are necessary:

- Study of the geometry of the hall, also in terms of the acoustic characteristics of the surfaces.
- Identification of the distribution of the paths of the multiple reflections and of any critical points.
- Calculation of the reverberation time in the different areas of the hall at different frequency bands, also to identify any resonance problems.
- Calculation of sound-absorbing units required to reduce the reverberation time to values more in line with the limits recommended for the acoustic use, taking also into account the behaviour of the main acoustic parameters mentioned above;
- Choice of the surfaces to be treated and type of treatment, sound absorbing and/or diffusing, taking into account the architectural limits and use limits, and the frequency responses of the hall;
- Design of the amplification and sound diffusion systems according to the aforementioned principles; the size of this system must compensate for part of the remaining acoustic problems of the hall by carefully selecting the power, directionality and position of the loudspeakers.

The sound diffusion system may also be modular so it can be adapted to the different conditions of use (sporting event, music event, mixed activities).

**Technological Video Surveillance Systems**

**Introduction**

Large events usually attract a considerable number of visitors and so video surveillance systems are usually installed for security reasons. The systems are installed by the management on their own initiative or following the request of public authorities. These systems, combined with other devices, offer greater efficiency in security management and enable fast intervention in the case of accidents or unfortunate incidents.

Video surveillance systems should therefore be included in the overall cost of a new sports facility or in the restoration of an existing one, particularly if the facility is intended to host large events.

Video surveillance systems are also recommended for smaller sports centres or outdoor ones to monitor a number of different area and rooms, as well as to deter vandals or intruders.

This chapter deals with the video surveillance system for high-level competition sports facilities with a large number of spectators.

Before installing a video surveillance system to monitor the movement of spectators inside and outside the sports facility, a structural analysis of the facility itself must be conducted. This chapter provides some guidelines for the design and installation of a video surveillance system.

First of all, video surveillance must not only be limited to the inside of the building because, as recent facts have shown, security is very important in the surrounding and neighbouring area, in particular for preventing potential incidents.

Recording equipment and monitors should be positioned in all public areas, near entrances and exits, in order to supervise all movements near the outer perimeter of the sports facility. In this way, every person or group of people can be monitored from the outdoor area along the perimeter up to the entrance of the facility where controls are usually strengthened by security officers within the building.

The recording equipment used to monitor the external areas
should also capture visual information on the inflow and outflow of the following types of visitors:

- Suspicious groups.
- Blacklisted fans.
- Large groups of supporters.

Video surveillance systems must include at least the following equipment:

- Auxiliary power supply in case of electrical interruptions.
- Lighting system that guarantees full and effective visibility of the playing area, adequate lighting of spectator areas and all access areas, including external ones.
- Room to be used as a central control booth with good visibility of the entire sports facility.
- Optical or digital recording equipment.
- Digital photographic systems.
- Multi-screen monitor for simultaneous viewing of the different areas.
- Thermal printers.
- Equipment for image transmission and data communication.
- Operators.

**Control booth**

The minimum equipment required in a control booth should be:

- Three Super VHS video recorders, or three DVCAM players/recorders, one to record/play the images shot outside the sports facility, one for the images taken inside the building, plus a spare one;
- A sufficient number of monitors to view images from all operating cameras simultaneously, plus one monitor for each operator in the central control room;
- A system to control the movements of the cameras and recording/playing equipment;
- Work stations complete with personal computer;
- Two thermal printers;
- Equipment to transmit images;
- An adequate number of radio channels, telephone lines and personal computers with Internet connection to communicate with the public safety authorities.

The amount of recording equipment required depends on the type of facility. It is important to be able to monitor the entire venue as well as the immediate surrounding area. In this way, any attempts to climb over the perimeter can be captured on film.

It is essential that sufficient cameras are in place to record potential incidents or commotions, both inside and outside the facility, to enable the public safety authorities to identify people if necessary. The cameras must be positioned out of reach of the public and anchored securely so they do not vibrate.

The most common recording equipment requested has the following features:

- Horizontal and vertical movement and variation of the shooting angle controlled from the control booth.
- A maximum image resolution of 1024x576 pixels for photographic systems and 768x576 pixels for analog television recording systems and 720x756 pixels for digital recordings.
- A Charge Coupled Device (CCD) for at least front-illumination and a focal length of at least 75mm, with an optical magnification of at least 5x.
- Sufficient luminosity to recognise visitors from profiles, also at night and in individual video frames.

There must be one monitor for each video-camera, plus one for each operator in the control room.

Operators must be qualified to use the system. At least two operators are recommended: one to monitor the areas outside the building and the other for internal surveillance. The operators may sit in the control room and work together, however each one must monitor his designated area independently.

**Energy Saving Systems**

Over the last few years, the growing importance of the energy problem has led to the need for a rational use of energy and,

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4 Charge-coupled device, an electronic light sensor used in digital cameras
consequently, to a need to reduce and contain the cost of energy required for staging activities.

Prompted by Agenda 21, a global programme run by the United Nations, many countries have agreed to adopt policies aimed at sustainable development. Over recent years, the International Olympic Committee (IOC) has also turned its attention to environmental protection and sustainable development, culminating in the adoption of the Olympic Movement’s Agenda 21. The section on “Sport and Environment” states that energy saving in sports facilities is a priority issue.

Most of the industrialised nations have ratified the Kyoto Protocol, committing to reduce the emission of pollutants (carbon dioxide and five other greenhouse gases, i.e. methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) by at least 5.2% compared to the emissions registered in 1990 -considered as the reference year - over the 2008-2012 period. In recent years, a great deal of research has been carried out on methods, technologies and strategies to reduce energy consumption. This has led to the growth and diffusion of an environmentally beneficial energy saving culture, the ultimate aim of which is to limit the release of carbon dioxide into the atmosphere.

Building planning methods have also been influenced by this bid to protect the environment because the energy consumption behaviour of a building can be anticipated early on in the planning phase, thus enabling energy requirements to be defined in advance. The choice of energy sources can therefore be foreseen, studied and optimised from the start of a project on the basis of traditional innovated sources or renewable energy sources (sun, wind, geothermal energy, etc). Other methods or technological systems can also be considered as renewable energy sources as long as they derive from raw materials, such as biomasses from sugar or wood, obtained in a sustainable way, and provided they help to reduce energy consumption.

At present, research and experimentation is working on how to improve processes to exploit organic waste to produce thermal energy. A wide range of opportunities are available to reduce energy consumption. In this chapter we look into the most common aspects and the methods most regularly used for sports facilities.

The convenience of using one or more renewable energy sources varies from country to country according to the geographic position, sun exposure, available materials, national energy policies, type of management and lifespan of the sports facility.

In sports facilities, energy is used to create the artificial environmental conditions necessary for the different activities. Energy consumption can be divided as follows:

- Air conditioning.
- Hot water.
- Indoor lighting of sports areas, ancillary services and facilities, offices, etc.
- Outdoor lighting: car parks, pedestrian walkways, green areas and fencing.
- Power for different machines.

A number of different factors can significantly influence the consumption of energy:

- The relation between the building and surrounding environment, such as position, exposure to wind, local climate, presence of natural and artificial barriers and exposure to sun.
- Building specifications: volume, extension and characteristics of external surfaces, internal layout, in relation to the internal environmental characteristics and technological systems.
- Technological characteristics: construction method, specifications of materials, fixtures and fittings.
- Environmental characteristics: temperature, relative air humidity, hot water temperature, light level and sound level.
- Characteristics of machinery: quantity, power efficiency, type of power used and installation methods.
- Application procedures: thermo-technical controls, level of

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5 The Kyoto protocol is an international environmental agreement on global warming, signed in the Japanese town of Kyoto on 11 December 1997 by over 160 countries during the 3rd Conference of Parties of the United Nations Framework Convention on Climate Change (UNFCCC).
lighting and sound, maintenance type and method.

**Energy-saving strategies**

In basketball facilities for high-level competitions, most of the energy consumption (98-99%) is used to heat the halls, ancillary service areas and public facilities, offices, etc. as well as for the production of sanitary hot water. 72–78% of this thermal energy is absorbed by the air-conditioning and ventilation systems, and the rest for the production of hot water.

On the basis of these observations, and considering that a sports facility or outdoor sports complex represents a particular type of building or structure, complicated in terms of structure and activities carried out, the most common energy-saving methods used in the planning phase are inspired by bio-architecture. These methods include:

- Increasing the building’s thermal inertia (prevent thermal dispersion through the external shell and floors, and prevent the formation of thermal bridges).
- Allowing building materials to breathe.
- Using natural ventilation for cooling in the summer or for air exchange, exploiting the position of the rooms according to the orientation of the building and prevailing winds.
- Fitting all facades prone to overheating and solar glare with appropriate screening.
- Planting trees and green areas to protect the building from winds and to humidify the external temperature.
- Collecting and recycling rainwater to flush toilets, water the green areas and clean the common areas.
- Using glass surfaces for natural lighting.
- Using renewable energy sources and geothermal energy.

These principles suggest that

- Solar radiation can be exploited for heating and lighting if the position of the different parts of the building can be planned along with the window surfaces.
- Sports facilities which require a form of heating should be located in wind-protected areas and strategically positioned in relation to other buildings, embankments, barriers and trees.
- Sports facilities requiring air conditioning should be located in windy areas with little exposure to the sun.
- The best solutions for architectural construction and plans must be found in order to best reduce the volumes to be heated and cooled, thus eliminating thermal bridges.

In the case of already existing buildings, meeting these objectives may entail significant changes and investments. If a facility is in need of restoration, it is generally advisable to opt for the more economic measures, particularly with regard to correct use and maintenance of the systems. The economic return should be estimated on the basis of the costs.

The main strategies for reducing energy consumption in existing facilities can be summed up as follows:

- Check that the hall temperature is suitable for the proposed activities (16°C-19°C for basketball, 18°C-20°C for all other activities); the temperature in other areas should not exceed 20°C.
- Keep machinery in good working order; this means regular cleaning of boilers, drainage pipes, burners and filters.
- Adjust thermostats and other control and adjustment devices.
- Only heat the areas actually used.
- Eliminate air dispersion through doors and windows.
- Exploit natural lighting as much as possible by keeping internal surfaces and windows clean.
- Keep lamps and lighting devices in good working order by regularly cleaning, and replacing the lamp bulbs.
- Avoid increasing the power of the lamp bulbs when replacing them (reduced efficiency is mainly due to aging or lack of cleaning).
- Only light the areas in use and adjust the lighting level to the requirements of the activities carried out.
- Try to reduce hot air stratification by calibrating the distributors of in-flowing and out-flowing air and the heating units.
- Adjust the air supply according to the number of users present in the facility, foreseeing at least 2 exchanges in the case of
maximum crowding (users and public), and normal crowding (only users) equal to 30 m³ per person per hour.

- Close external air inlets when the systems are switched on, in order to reduce the time necessary to reach the optimal temperature.

Other similar suggestions concern the production of hot water using a traditional system:

- Limit the temperature of the water according to user requirements.
- Activate the circulation pump only when the showers are in use.
- Keep water production devices and water distribution equipment in good working order (water heaters, thermostats, taps etc).

These simple suggestions are part of the standard and continuous maintenance of facilities; following them can lead to a reduction in energy costs of 20%-30% or more.

Main interventions concerning some sub-systems of the technological installations include:

**For air conditioning:**

- Installation of control unit and distribution ducts.
- Use of economic fuels or low cost maintenance fuels (for example methane instead of diesel).
- Different generators must provide the required thermal supply.
- Installation of a device to recover the heat from the air expelled by the centralised systems.
- As regards non-centralised systems or parts of systems, more efficient devices must be adopted (convection fans instead of convection heaters to reduce the heating time).
- Increase thermal inertia with non-conductive materials, double glazing or double doors and windows.
- Use of devices to generate more efficient heat, for example condensing boilers or boilers that use low-temperature heat sources, such as heat exchange pumps.

**For heating water:**

- Combination boilers. Appliances capable of supplying both space heating and domestic hot water.
- Installation of heat pump water heater.
- Heat recovery unit.
- Use of solar collectors.

**For lighting:**

- Use of light colours for walls and ceilings.
- Use of high efficiency lamps such as fluorescent lamps, iodide and mercury-discharge lamps.
- Reduction of lighting points and use of closed circuits to use lights only when required.
- Use of devices for the cogeneration of electricity and heat if the facility uses electricity and thermal energy in parallel.

**Exploitation of solar energy**

The sun is the most widely used source of renewable energy. At present, solar thermal and solar photovoltaic systems are the most commonly used systems in the tertiary sector and, in particular, for sports structures. The solar thermal system is specifically used to heat water for sanitary installations.

**Solar thermal systems** include:

- Collectors.
- Accumulation tanks.
- A distribution circuit.
- Supplementary traditional devices.
- A control unit.

The size of the collectors and, consequently of the accumulation tanks, depends on a number of factors and, importantly, on the intended use. With regard to sports structures, it is important to consider the actual consumption, and the time of day in which energy is consumed. As for all solar thermal systems, a traditional source must also be provided to meet the requirements during reduced daylight exposure.

**Photovoltaic solar systems** are made up of a series of photoelectric cells of about 10cm²; the cells are made up of two
thin layers in contact with each other, one is made of boron-doped silicon and the other of phosphorous-doped silicon. The single cells are usually incorporated in a module measuring 0.6/1.00 m². The modules are assembled in parallel rows to make up the actual photovoltaic generator.

There are two principal photovoltaic systems:
- Isolated system.
- Mains-connected system.

The isolated system is used when mains electricity is not available: this type of photovoltaic system is electrically isolated and self-sufficient; the main components are:
- Photovoltaic modules.
- Charge regulator to control the energy collected, and manage it within the system, working at 12 or 24 V.
- Accumulation battery for periods of reduced or no daylight exposure.
- Inverter if alternating current utilities are present.

Systems connected to the mains are much more complex. These systems use a photovoltaic grid-interactive inverter to change the direct current (DC) produced from the solar panels to alternating current (AC), synchronise with a grid and feed the energy into the mains electricity grid for use. These systems do not need accumulation batteries to store the energy produced as the mains grid has an infinite capacity. Power from the solar cells can be fed directly to the consumers and to the mains grid, enabling other consumers to benefit from surplus power.

Recently, many sports facilities have begun to install photovoltaic solar panels on their own roofs. Their expansive surface lends itself to becoming involved in urban plans for the production of renewable energy, which guarantee energy for the sports facility itself as well as a reasonable number of homes in the area. This serves as a perfect example of how a sports facility can be both significant and useful!
Management of Sports Facilities
Over the last decade, the concept of a sports facility has evolved rapidly, particularly in terms of its significance and its regional presence.

Nowadays, sports facilities not only represent a place in which sports are played but, most of all, they also represent financially self-sufficient structures that provide employment. It is not surprising therefore, that sports facilities now adopt concepts of management, organisation, efficiency and effectiveness, sports facilities have become an “economic entity”.

All these processes and principles are part of the greater concept of planning and programming.

Sports facilities should not be planned and designed in relation to a single sporting event, but with the long-term focus of fully exploiting the potential of a sports complex and ensuring a long and productive lifespan.

Sound architectural planning can help to reduce the under-use of facilities or even the abandonment of structures no longer in use. Indeed, an incorrect assessment of demands can lead to an inadequate offer and supply, and consequently to low staff resources, inadequate service, high running costs, etc. These are all aspects which could render a facility unmanageable and unsustainable.

As already described in the preceding chapters, it is essential to study the future potential of a sports facility early on, in the planning and conceptual stage. Consequently, the management of a facility becomes closely linked to the planning and construction of the building and, thus, ultimately, with an understanding of the territory and its requirements.

**What is management?**

The word management has a complex meaning and includes leading or directing, planning and organising, scheduling and budgeting, problem solving, and accomplishing goals.

All these actions are related to one another but each one must be able to be developed individually through an effective and efficient organisational structure.

Efficiency and effectiveness are the key points, in economic terms. The services foreseen do not necessarily have to be related to a programme of high-level events, but they must take into account the facility’s intended location and purpose, the objective being to build a successful sports facility.

This way of thinking has introduced marketing concepts into the management of multifunctional facilities, both small and large.

Competitive management must include the basic business marketing concepts for a detailed analysis and forecast of the services and activities to be offered. These concepts include:
- Demand segmentation (and identification of reference target)
- Differentiation of services and offer
- Organisational and instrumental optimisation

Management is therefore influenced by different parameters that include all operating costs, including activities, personnel and equipment. All these factors must be considered when examining management, and particularly expenditure, as it is the cost factor that primarily affects the final result and, at the same time, ultimately influences the performance of other parameters.

**Management approach**

The logic behind sports facility management is to maximise the potential of a facility and see a high-level basketball facility simply as a multifunctional complex. This requires the support of an organisational structure which should include qualified and competitive staff who will work with the stakeholders interested in the sports facility (sports associations, local bodies, sponsors, media, etc.), all cooperating for the success of the facility. This type of approach is very business-like, but in today’s market this is a way of guaranteeing the quality of a sports structure and a long lifespan. Not to be underrated is the role of facility manager who must have similar attributes to those of a company manager, with good business organisation and PR skills, and leadership values recognised by the work team and the stakeholders. Another fundamental element of sports facility management is the
The activities have been divided into groups for an easier analysis of the problem:
- **Sporting activities**
- **Additional activities**
- **Personnel**

### a. Sporting activities

These include all the activities that can be conducted in multifunctional facilities.

Each sporting activity has its different distinguishing aspects:
- Training
- Competition
- Education
- Fitness/Wellness

The distinction is very important as the different elements can influence organisation and have an impact on the ancillary services and equipment requirements.

Organisation must also guarantee the necessary services related to a particular activity.

Sports and other activities must be:

**Programmed**: All activities must be scheduled and supervised; they must not be double-booked and must be included in an “activities’ calendar”. Activity periods should be divided into three types of cycles: micro, meso and macro. Facility use is programmed by coordinating the various sections, staff activities, and user and management requirements. This programme can be divided into a daily, weekly, monthly and annual schedule to best accommodate the varying requests. Optimum management results will obviously only be evident when the facility is in regular and continuous use, with the exception of the unoccupied periods when the building is closed at night or for maintenance works. For obvious reasons, the requirements of regular users shall have priority over those of occasional users, who would be allocated alternative spaces designed for temporary activities. Reserving the facilities for use by schools could represent a long-term investment with immediate and significant positive social implications.
**Coordinated:** The activities must be adequately supervised and managed by the staff; guidelines must be prepared for each activity, and the supervisors must be qualified sports instructors:

- Coaches, federation representatives, technical commissioners, medical staff, professional assistants for persons with a disability, physiotherapists, post-trauma rehabilitation experts;
- Organisation staff for the users and their activities, such as:
- Team managers, group leaders, facility managers, facility users, etc.

**Functional:** Every activity carried out in a facility, from the playing court to the ancillary services, must be aimed at achieving the maximum quality possible, guarantee long-term comfort and safety for its users. This can be achieved through the effective technical and administrative coordination of a series of functions and their costs.

**b. Additional activities**

Over recent decades we have seen a rapid growth in sports coverage worldwide, both in print and on broadcast media. This interest has not been limited to high-level sports alone, but has also devoted attention to all kinds of amateur and non-professional sports. The knock-on effect of this has led to a vast improvement of the sports culture in general, and ultimately to a generation of well-informed athletes and users with expectations and requirements of their own. These requirements are directed mainly at the services offered by a sports facility, in particular the collateral activities.

**c. Personnel**

The staff responsible for a facility represent the heart of a sports facility. Operators must be qualified, and be offered professional training to meet new demands. Good organisational structuring of the different services will be required to ensure the best management possible. This structure often includes:

1. Owner (person-public body-private body)
2. Chief Executive Officer (CEO)
3. Director
4. Managers
5. Supervisors
6. Operators

(One same person may often cover different roles, for example the owner may also be the CEO).

This is a simplified version of the complex and complicated mechanism of the human resources organisation of a sports facility. Obviously, it all depends on the size of the facility, type of activities anticipated, amount of investments, and media reach of the facility. The more complex the sports facility, the more complex the operational structure.

The owner and managers are responsible for the strategic management of a basketball and/or multifunctional facility, while the operational efficiency is managed directly by the personnel responsible.

Unfortunately there is no single common effective strategic and decision-making policy to guarantee the success of a facility; however, the list below describes some operational points to pursue as management objectives:

1. Constant quality standards
2. Ordinary maintenance of structures and equipment
3. Extraordinary maintenance of structures and equipment
4. Surveillance
5. Ancillary services (hospitality, information, refreshment areas, entertainment, etc.)
6. User services.

**Cost/Benefits Analysis**

**General aspects**

A cost/benefits analysis is an instrument that enables management staff to evaluate decisions taken in the past and assess future ones. It involves a number of variables and represents an immediate element of reference to evaluate the return of an investment.
According to the laws of economics, as well as common sense, the cost/benefit ratio should be almost equal to zero at the beginning and then in time develop into a positive result. Despite the variable financial expenses, the cost evaluation is rather simple both in the medium and long term. It is certainly more complicated to define how to evaluate the benefits. To make it easier, the benefit aspects can be divided into “quantitative and qualitative”.

The first factors are simply a “calculation” of the revenue produced by the activities. The second can be grouped under “customer satisfaction”. The perception of customer and user satisfaction is fundamental because it defines the quality of the service. **Diagram a1**

Public services can be influenced by a number of factors: some are strictly related to the use and organisation of the facility (intrinsic) and others depend on local choices and planning (extrinsic).

**Intrinsic factors**

These include:
- The ability to meet user requirements related to sports and support activities, such as providing flexible opening hours for users, appropriate working hours, appropriate facility and equipment specifications, adequate security and hygiene.
- The effective running, maintenance and organisation of the services provided. Only some of these factors can be easily quantified, for example the comfort values such as air temperature and relative humidity, lighting, acoustics; all other factors can only be evaluated on the basis of statistics, experience and good common sense.

**Extrinsic factors**

These include:
- The ability to meet the demand for basketball (in our case) according to the type and size of the facility, and how well integrated it is in the social and regional context;
- The provision of appropriate and affordable services which are compatible with the organisation of activities and local infrastructure.

**Costs**

As previously mentioned, the most significant costs in facility management emanate from energy consumption (lighting, air conditioning, water, telephone, etc) and human resources.

With regard to the selection of personnel, it is very important to employ motivated staff keen to pursue an improvement in the quality of the services offered. A detailed cost-analysis must differentiate fixed costs from variable costs; fixed costs are independent of or only minimally dependent on the use of the structure while variable costs are strictly related to the use of the sports facility.

Fixed costs generally include:
- Personnel, including salaries, insurance contributions, social security, etc. for employees and associates;
- Depreciation including accrued costs for the recovery of invested capital;
- General expenses including taxes, insurance policies on the facility, etc.;
- Ordinary maintenance, including all repairs (defective machinery, leakages, damp, plastering, etc.).

Variable costs generally include:
1. Expendable supplies, equipment and other services necessary to run a facility;
2. Extraordinary maintenance including servicing, inspections and possible repairs.

**Management Planning**

*Management and planning*

In order to achieve successful management of a basketball or sports facility in general it is necessary to study the level of involvement of the management aspect in the planning phase. As mentioned earlier in the introduction, running a sport facility is not an easy task.

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**ANNUAL BUDGET OUTLINE - MANAGEMENT OF BASKETBALL FACILITIES**

<table>
<thead>
<tr>
<th>EXPENDITURE</th>
<th>Quantity</th>
<th>Price</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>Consumption</td>
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<tr>
<td>Water Supply</td>
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<td>Fuels</td>
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<tr>
<td>Machinery and Equipment</td>
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<td>Technical Services</td>
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<td>Ordinary Maintenance</td>
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<td>Technical Administration</td>
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<td>Setup</td>
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<td>Surveillance</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>X</strong></td>
</tr>
</tbody>
</table>

| INCOME                           |          |       |       |
| Events                           |          |       |       |
| Basketball                       |          |       |       |
| Other Sports                     |          |       |       |
| Other Activities Than Sports     |          |       |       |
| Sporting Activities              |          |       |       |
| Training                         |          |       |       |
| Group Courses                    |          |       |       |
| Individual Courses               |          |       |       |
| Extra Hiring                     |          |       |       |
| Advertising                      |          |       |       |
| Main Sponsor of Facilities       |          |       |       |
| External Advertising             |          |       |       |
| Internal Advertising             |          |       |       |
| Possible Exhibition Stands       |          |       |       |
| Sound Advertising                |          |       |       |
| Television Rights                |          |       |       |
| Marketing Activities             |          |       |       |
| Bar/Restaurants - Selling Points |          |       |       |
| Video Games                      |          |       |       |
| Parking Areas                    |          |       |       |
| **TOTAL**                        |          |       | **Y** |

**FINAL RESULT TO BE ACHIEVED Y ≥ X**
The management aspect has an important economic impact on the financial investment to be made as it represents the most dynamic component. Annual management costs can amount to 10%-15% of the construction costs, or rise above 20%, if they are not adequately controlled. A business plan must therefore be drawn up, not only for construction costs, but also for management expenses. With reference to the current management of basketball facilities, the budget should include the following main items:

- **d. Income**: the proceeds from sports competitions, sporting activities, advertising and possibly marketing activities;
- **e. Expenditure**: consumption, technical services and administrative costs.

An example of a possible annual budget outline for a sports facility is shown in [diagram b2 (Annual budget)].

In short, as far as income is concerned, planning should concentrate on achieving optimal results in terms of:

1. Use of the facility
2. Allocation of space
3. Ancillary services.

**Use of facilities**

Apart from the specific-use requirements of special facilities, the construction of a facility should be planned to meet the requirements of as many users as possible; this means that **multifunctionality** is an increasingly fundamental requisite to meeting the demands of different sports. The main aspects influencing the functionally of a facility are the dimensions of the facility itself, of the playing areas as per official regulations, and of the flooring.

Other criteria must be implemented, to organise the spaces of a facility according to the planned activities, such as dividing the space using mobile partitions, correctly distributing the services, etc.

The complexity of the structure and the consequent increase in costs resulting from these operations are countered by a greater flexibility and a suitable exploitation of the spaces.

**Allocation of space**

The correct integration of the various sections and spaces of a facility influences the use and running of the facility itself, with implications in terms of activities, number of operations, and personnel. The areas and spaces must be:

- Arranged so as to enable sports activities to be practised appropriately (dimension of the courts, height, etc.);
- Suitably equipped for these activities (fixed and mobile equipment, accessories, services, offices, first aid, access to different areas, etc.).

Obviously the various sections of a facility, with their respective components, must meet the requirements of users and personnel, in terms of physical and psychological comfort, physical integrity and hygiene. Any inadequacy in this sense will have repercussions on the use of the facility, on staff employment and on maintenance interventions which will be more complicated and frequent; consequently, all this will have a negative impact on management costs.

**Ancillary services**

Basketball halls can be integrated in spaces which are also intended for other recreational and social activities suited to multifunctional facilities. Planners must therefore study the whole local context and arrange a compatible timetable to accommodate other activities. Even if a hall is not integrated in another recreational or social structure (such as a library building or community centre), a series of services such as bars, restaurants, sports shops and advertising should be provided, particularly in facilities used for professional competitions, as they can significantly reduce management costs. Management planning should be based on operational requirements, equipment maintenance and installation maintenance requirements. A maintenance and operational plan must be drawn up to implement this aspect of management planning. These points are dealt with in greater detail in the chapter on facility maintenance.
Use and Utilisation of Basketball Facilities

One of the management’s main activities is planning the utilisation of the sports facility. The revenue of the facility and the management strategies depend on the study of facility use and the implementation of the plan; maintenance costs are also relative to the intended use of the facility. A facility that is being utilised 365 days a year for 10 hours a day will obviously require a complex maintenance programme, while a sports facility that is only utilised for just a few events per year would only require temporary maintenance during the actual event period.

The planning of the use and consequent utilisation of a facility must start well before the conceptual phase. Furthermore, it is necessary to find out how many and which structures in the area are under-exploited in relation to the total number of facilities, in order to identify the areas in which the construction or restoration of a sports facility may be necessary.

The assessment should define the following:

- Under-exploited structures
- Total number of facilities

The study should include key points such as the organisation and management of existing activities in a specific territory, the demographic analysis of the population, production sites of particular interest, infrastructure such as roads, railway lines, airports, interchange points, etc., as well as consolidated sports facilities in the area concerned.

This study should help:

1. Local administrations to implement local plans and programmes in relation to sports facilities, in terms of new structures or the restoration of existing ones if the catchment area or territory does not need a new facility.
2. Private companies to direct their own management towards a particular use of a sports facility, and towards a qualitative evaluation of the services offered and an evaluation of management costs.

The following definitions provide a better understanding of the concepts of use and utilisation of a sports facility:

- **Use means**: operational days per year and opening hours per day;
- **Utilisation means**: users per hour (users may vary according to the spaces provided and the sports activities planned, etc.)

The data collected should be compared and contrasted to prepare graphs and tables to illustrate the level of use and utilisation of a facility.

In the case of an existing facility, the aim is to constantly improve the use of the facility and the exploitation of the activities and to highlight those activities which are not very popular, to bring them in line with other activities available in the surrounding area.

More precisely, the “use of a facility” is the time during which it is open to users.

This is expressed in terms of operational days (o.d.) and an average number of opening hours per day.

A calculation of the amount of acceptable operational days (o.d.) is reached by subtracting the number of maintenance days (m.d.) and non-operational days of seasonal activities (s.d.) from the number of days in a year.

The formula is as follows:

\[ o.d. = 365-(m.d. + s.d.) \]

Maintenance days are calculated according to the type of planned maintenance, with average maintenance requirements, for the main areas of the facility.

The seasonal nature of activities must also be taken into account, so the calculation must consider the length of the sports season, the quality of the demand and the type of activities.

The parameters mentioned above can be used to predict the potential exploitation of activities in a new sports facility and to classify it as fully exploited or under-exploited.

A similar approach should be adopted to evaluate the operational hours.
A further requirement to be checked is the utilisation of a facility.
This factor is variable as it takes into account the number of users per hour of activity; the value of this factor can be compared with an average acceptable value obtained by actually observing the activities. In this way it is possible to compare the number of under-exploited activities with the total number of activities.

**Access to Facilities**

It is important to differentiate between facilities located in areas with a high concentration of facilities which are not utilised or not easily accessible and thus accessibility has to be improved, and areas where facilities are easily accessible and fully exploited. The number of facilities which are not accessible or not utilised must be calculated and compared with the total number of facilities. The formula is as follows:

\[
\text{Non-accessible facilities} / \text{Total number of facilities}
\]

This parameter is also useful to evaluate the following factors:
- Location of the facilities in relation to their catchment areas.
- Presence of adequate access routes.
- Efficient public transport service.

These factors must be evaluated in a feasibility study that takes into account the environmental context, sporting activities and the social and economic indicators of the area concerned.

The elaboration of tables and diagrams, based on data collected from surveys on the different areas to identify the existing imbalances in terms of accessibility, can help in the planning phase to determine the primary and secondary interventions required.

**Catchment area and classification** - A basic point of reference when examining access to facilities is the definition of their catchment areas in terms of distance-time and users.

A simple classification method is described below:

1. **Small facilities** with a catchment area limited to the immediately adjacent residential area, where activities are accessible in a short time of 15-30 minutes. Activities in this kind of facility should focus on sports education and rehabilitation (small outdoor playing areas, multifunctional areas, tarmac courts, etc.).

2. **Medium facilities** with a catchment area covering a distance which enables activities to be accessed in an average time span of 30-60 minutes. Activities in a facility of this size should focus on the most common sports, but the facility may be designed for more specialised sporting activities.

3. **Large facilities** with a catchment area extending to a distance over 60 minutes away from the activities; this area can include an entire province in the case of large-scale events. These facilities are used for major sporting activities and entertainment events that require large spaces.

**Criteria to Evaluate the State of Preservation of a Facility**

With existing sports facilities, the state of preservation of the building is an important factor that influences management decisions and maintenance plans.

Three basic and intersecting parameters can be used to assess the state of preservation of a sports facility:

1. Property value estimate.
2. Facility-use estimate.
3. Location estimate.

These parameters may be linked to one another, for example, an economic investment in a facility with a low real-estate value may be prompted or justified by the fact it is located in an interesting catchment area; in this case, what may otherwise be considered a drawback now becomes an objective to re-launch an existing structure. This means that in the case of sports facilities, all factors must be considered for a true assessment of the state of preservation, and not merely the value of the property.

One method to understand the relation between existing sports facilities in a bad state of preservation and the total number of facilities is to compare the areas (and their respective activities)
where the state of preservation is worse, and which therefore require intervention, and the areas where preservation is better, and new facilities may possibly be built.

The relation can be defined as follows:

**Sports facility with poor state of preservation**

\[
\text{Total number of sports facilities}
\]

For a correct assessment, criteria for the evaluation and collection of data must be defined.

A gradual approach is recommended, starting with the analysis of general information and then moving onto a more detailed analysis and evaluation. The aim is to establish whether the state of preservation can be considered adequate or inadequate for sporting activities according to the requirements of national and international sports organisations. Moreover, it is important to assess whether the additional areas for recreational or commercial activities respect the standards in force in the country in which the sports facility is located.

The main point of reference of a sports facility is the actual performance of the various sports, therefore the state of preservation can be considered to be adequate when all the scheduled sports can be performed in the playing areas without any hindrance or interference.

The evaluation procedure should involve all parts of the sports facility (sporting activities, support services, public ancillary services), the premises and the basic constructional elements (flooring, equipment, technological installations). In other words, defining the state of preservation of the playing areas is a very complex process and must be carried out with accuracy and precision in order to prevent grouping together facilities with very different requirements, from slight renovation to total restoration.

The schematic approach (adequate/inadequate) must be supported, as mentioned above, by a study of the general geographic context; however, a detailed analysis of the individual parts of a facility is also necessary to prioritise the restoration work to be carried out.

The aim is to understand how many and which activities are functional in relation to the demand for sport, and in terms of structural solidity, and adaptability of the staff and organisation. This enables a distinction between areas with a high concentration of facilities which are not yet operational as the sports halls still require maintenance and repair, and areas which already have fully operational facilities.

The relation is as follows:

**Non-operational facilities**

\[
\text{Total number of facilities}
\]

Another parameter requiring a qualitative assessment is the distinction between functionality in terms of structural solidity, and functionality in terms of qualified personnel and an efficient organisation.

In terms of structural solidity, facilities can be considered functional, if the structure is complete in all its parts: sections, rooms and construction components. In this context, the indispensable elements must be distinguished from those elements which, although useful, are not indispensable (public section, support services, etc.).

From a strictly technical point of view, to assess the solidity and stability of a building it may be necessary to check the structure’s static situation by testing the materials or part of the components.

As regards the organisation and personnel, the staff required for the activities may vary significantly according to the management strategies, use, etc.

The starting point for a realistic evaluation is the comparison between the current conditions of a facility and the ideal standard of the construction and management; this comparison should be carried out using:

- diagrams;
- layout plans: areas divided into sub-areas;

This will highlight any existing imbalance and establish the priorities for the work to be carried out. This rather schematic approach is aimed at showing how many and which activities are
not functional, and to establish where and which interventions are necessary, on the basis of future plans for restaurants and bars, management strategies, new activities, etc.

Another, yet rather complex, method of evaluation, both in theory and in practice, is to distinguish global values from “conventional” ones. The global value refers to the overall number of facilities, while the conventional value is attributed to each facility which can be used for basketball on the basis of an assessment of the structural solidity and management efficiency.

**Maintenance**

As already mentioned in the management chapter, a sports facility must be built to last as long as possible or better, according to the “property value analysis theory”, to maintain the efficiency characteristics throughout its entire lifespan. (Diagram 6.1)

The lifespan of a building for sporting activities is strictly related to the requirement of multifunctionality. This implies that the structures should be transformable and adaptable as nowadays large structures are not only built with the intent of housing sports facilities. The structures must be constructed so as to be rapidly transformed internally to house a sporting event as well as a series of other different sporting events depending on the market opportunities.

As a consequence, the physical, functional and economic lifespan is long-term, but the technological installations must be rapidly updated to suit the functional requirements of the planned activities. (Diagram 6.2)

From this point of view, maintenance takes on an important role as it can help the management to identify the following factors in a timely manner:

- When a facility no longer meets the requirements for which it was built;
- Identify any intervention necessary to improve the facility;
- Predict when the facility will no longer be able to meet the requirements and will enter a negative management period.

Management must therefore concentrate on continuously monitoring the relationship between the requirements of the sports facility “system” and what it offers. Management must also focus on the relationship between the economic value expressed by the continuity of the operation of the facility, which also includes the deterioration time of the structures, and components in time (Diagram 6.3).

In general, the overall maintenance and restoration cost for the entire lifespan of a building equals 2-3 times the actual construction cost.

Maintenance operations are necessary for at least four main reasons:

1. To provide hygienic and safe living and working environments.
2. To monitor the obsolescence of technical systems and materials.
3. To monitor any possible deterioration and prevent it from becoming irreparable.
### Lifespan of a Building

<table>
<thead>
<tr>
<th>Physical Lifespan</th>
<th>The facility should meet the requirements for which it was built. The facility should not be affected by environmental damages. The facility should be tested to answer all needs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Duration</td>
<td>At all moments, one should be able to identify any intervention necessary to improve the facility; requirements should be reviewed on a regular basis.</td>
</tr>
<tr>
<td>Economic Lifespan</td>
<td>It is necessary at all times to predict when the facility will no longer be able to meet the requirements and will enter a negative management period which may generate financial issues.</td>
</tr>
</tbody>
</table>

#### Economic Planning of Financial Investment for the Construction and Management of Sports Facilities

| Phase | Year | 1 Year | 2 Year | 3 Year | 4 Year | 5 Year | 6 Year | 7 Year | 8 Year | 9 Year | 10 Year | 11 Year | 12 Year | 13 Year | 14 Year | 15 Year | 16 Year | 17 Year | 18 Year | 19 Year | 20 Year | 21 Year | 22 Year | 23 Year | 24 Year | 25 Year | 26 Year | 27 Year | 28 Year | 29 Year | 30 Year |
|-------|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
|       |      | Financial investment for the construction of building | Scheduled time for depreciation of financial investment for the construction | Scheduled time for the pension resulting from the financial and technical management | Unprofitable stage of technical management |
4. To duly safeguard the value of the property. Maintenance planning must start in the project phase when the materials and equipment are selected, layout decided, technologies for the supply of energy chosen and the functional parameters of the technological installations established. An extremely important aspect that influences the planning of maintenance both in operational and cost terms is the use and utilisation of the sports facility as mentioned earlier. The main elements influencing maintenance costs are the buildings constructional elements and the technological systems. (Diagram 6.4) A maintenance plan should be drawn up in the project phase, including ordinary preventive/predictive maintenance and long-term programmed maintenance (extraordinary). In other words, it is possible to anticipate the operational management of the services and the personnel required for the said services. The more the project phase takes into account the maintenance of the parts, materials and equipment, the easier it is to predict and plan future maintenance costs. (Diagram 6.5) Maintenance planning calls for a series of operations:
- Programme of maintenance interventions.
- The breaking up of the building-system into sub-systems according to their function and technology.
- The setting up of an information system to monitor technical stability, materials, equipment, components and their behaviour in time.
- The definition of intervention procedures for each operation in terms of the equipment to be used, work organisation, type of labour, and interference with users.
- The identification of sets of operations to be carried out simultaneously or in succession;
- The evaluation of the cost of single operations.
- The evaluation of the cost of more operations carried out at the same time in one single intervention.

The total cost to ensure the maintenance and rehabilitation of a building throughout its lifespan is equivalent to 2-3 times its construction cost.
These planning and analysis steps are useful and necessary both in the case of new buildings and in the case of the reuse of an existing building.

Diagram 6.6 shows how a sports facility can be divided into functional units. Each functional unit must include spaces that allow for the independent operation of each sub-unit.

Layout planning must take place in the project phase of the sports facility when analysing what exactly is necessary for the running of sports activities and other activities in the facility (sporting events, training, wellness, restaurants and bars, commercial activities, etc.) in relation to the spaces to be created or, in the case of the restoration of a facility, spaces already available.

In operational terms, the first simple step towards monitoring the entire “sports facility system” is to create an “information system” to regulate the interventions in the operational phase; this database should be used to keep track of all the interventions, the means, the equipment used and the assistance services employed.

Diagram 6.7 shows an example of a data sheet for the creation of a database.

Operational rules of maintenance
For maintenance to be effective, it must be continuous and follow certain rules such as:
- The constant check of the property status; this is very important for security reasons and to preserve the building-system in an efficient working order;
- Continuous cleaning: this is an essential daily activity undertaken to assure a safe working environment;
- Fast and expert intervention where necessary to avoid higher costs and worse results when it is too late.

Maintenance strategies
Every management organisation can choose one or more maintenance strategies. The choice depends on the type of building and on management policies.

The concept of ordinary and extraordinary maintenance, organised according to fixed and rigid intervention plans, has been replaced by more dynamic maintenance concepts related to a management objective. These new methods are based on durability, reliability and practicability of the parts and components of the entire sports facility. A combination of different methods can be used to prepare maintenance, intervention and cost plans.

These concepts are widely recognised and accepted, however the intervention methods are subject to the regulations and provisions in force in the different countries.

The list below briefly describes the most widely adopted maintenance methods.

4. Predictive maintenance is condition-based maintenance, i.e. maintenance is scheduled only when operational or mechanical conditions warrant. Equipment is periodically monitored and repaired or replaced when the condition reaches an unacceptable level. This approach also requires personnel with the skills and time to perform the maintenance, and also allows replacement parts to be ordered in advance and repairs to be scheduled at suitable times, only when needed.

5. Preventive maintenance is a time-based form of maintenance that entails scheduling maintenance activities at regular intervals or set time intervals to ensure that damages are repaired or replaced before obvious problems occur. This approach works well for equipment that does not run continuously, and with personnel who have the skills and the time to perform the preventive maintenance work.

6. Opportunity-based preventive maintenance defines preventive or failure maintenance carried out during an intervention service originally performed for another reason.

7. Emergency (or accidental) maintenance can be convenient depending on the criticality of the function and the level of interaction with other components of the building-system. This type of maintenance usually concerns unforeseeable problems; the unpredictability cannot be reduced but a statistical evaluation can be made of the size and number of
# Division of Sports Facility Info Functional Units

<table>
<thead>
<tr>
<th>Parts of the sports facility</th>
<th>Sub unit</th>
<th>Environmental unit</th>
<th>Denomination</th>
<th>Size</th>
<th>N. Spaces</th>
<th>Floor</th>
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</thead>
<tbody>
<tr>
<td>Signs</td>
<td>Sections/unit functional</td>
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<tr>
<td>SA</td>
<td>Section Sports Activities</td>
<td>SA1</td>
<td>Area game</td>
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<td></td>
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<td>Lateral surface</td>
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<tr>
<td></td>
<td></td>
<td>SA3</td>
<td>Athletes with changing rooms including toilets and showers</td>
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<tr>
<td></td>
<td></td>
<td>SA4</td>
<td>Athletes with changing rooms including toilets and showers</td>
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<td></td>
<td></td>
<td>SA5</td>
<td>Changing rooms coaches/ referees with including toilets and showers</td>
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<td></td>
<td></td>
<td>SA6</td>
<td>Changing rooms official/ referees with including toilets and showers</td>
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<td></td>
<td></td>
<td>SA7</td>
<td>Infirmary</td>
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<td></td>
<td></td>
<td>SA8</td>
<td>Deposit-shed</td>
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<td></td>
<td></td>
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<td>Section Sports Activities - Wellness - Miscellaneous</td>
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<td>SAWM7</td>
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<td>SAWM8</td>
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<td>SAWM9</td>
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<td></td>
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<td>PS10</td>
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</tbody>
</table>
# Division of Sports Facility Info Functional Units

## Parts of the Sports Facility

<table>
<thead>
<tr>
<th>Parts of the sports facility</th>
<th>Sub unit</th>
<th>Environmental unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Signs</strong></td>
<td><strong>Sections/unit functional</strong></td>
<td><strong>Denomination</strong></td>
</tr>
<tr>
<td>SMM</td>
<td>SMM1 Workstations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SMM2 Microphones Positions</td>
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<tr>
<td></td>
<td>SMM3 Cameras’ Positions</td>
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<tr>
<td></td>
<td>SMM4 Conference Room</td>
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<tr>
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<td>SMM5 Pressroom</td>
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<tr>
<td></td>
<td>SMM6 Bar-Cafeteria</td>
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<tr>
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<td>SMM7 Bathrooms</td>
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<tr>
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<td>SMM8 Infirmary</td>
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<td>SMM9 Deposit-Shed</td>
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<tr>
<td>SO</td>
<td>SO1 Director Office</td>
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<td>SO2 Assistant Director Office</td>
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<tr>
<td></td>
<td>SO4 Secretariat</td>
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<td>SO5 Secretariat</td>
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<td>SO6 Archive</td>
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<td></td>
<td>SO7 Deposit-Shed</td>
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<tr>
<td></td>
<td>SO9 Meeting Room</td>
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<td></td>
<td>SOA6 Control Point</td>
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<td>SOA7 External Installation</td>
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## Technological System

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<tr>
<th>Technological System</th>
<th>Relationship</th>
</tr>
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<tr>
<td>TS2</td>
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</tr>
<tr>
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*Diagram 6.6*
failures in a set period of time in order to programme and size the technical intervention;

8. **Run-to-failure maintenance** is reactive maintenance which is performed only when problems occur and equipment has run to failure. This approach requires facilities to shutdown equipment for repair immediately until the problems are resolved.

**Preventive/predictive maintenance (ordinary)**

Preventive/predictive maintenance foresees all the operations necessary to maintain the required level of efficiency and performance of the parts and components of all the maintenance groups (cleaning of premises, good working order of doors and windows, of locking systems, of sports equipment, etc.).

Ordinary maintenance includes the replacement of materials and equipment, worn or aged materials, and partial repairs. Maintenance operations must be easy to carry out, without involving high costs or complicated means, and should cause as little inconvenience as possible to the public. For example, the replacement of a panel, false ceiling unit or other component must be carried out without having to dismantle all the other components or, at the most, involving only the adjacent parts. Particularly with regard to the technological systems, predictive maintenance must be foreseen alongside regular inspection maintenance; predictive maintenance must be implemented according to the building characteristics and maintenance requirements supplied by the manufacturer or installer for each machine or piece of equipment. It must also provide an estimate of costs for faults or failures during special events such as sporting events or championships; in these cases greater attention must be afforded to the use of the facility and more specialised personnel must be available.

**Opportunity-based maintenance (extraordinary)**

Extraordinary maintenance is carried out on an opportunity-basis as scheduled by the manager; the aim is to restore the technical level or performance level of parts or components

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**SHEET DATA ENVIRONMENT**

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of building units or of systems and technological installations, which was lost during normal annual activities, or to improve performance and efficiency.

Opportunity-based maintenance operations in sports facilities relate to all the interventions required by the continuous sporting events held, during which the technological systems and components must demonstrate a high level of efficiency. Based on the events’ schedule, the management can predict which systems and components will require inspection and overhaul, and the cost of specialised personnel during events.

Suggestions

**Equipment assembly plan**

Sporting events and shows require a lot of equipment which is usually fixed or anchored to the ceiling, such as reflectors, sound diffusers, luminescent screens and boards. Such equipment often generates high maintenance costs unless potential problems due to the weight of the equipment in relation to the structure of the ceiling are tackled early on in the project phase and regular maintenance is scheduled.

A preventive maintenance plan for the equipment must include service walkways to enable the operators to work safely from above, as well as hooks, fasteners and winches with safety devices, and tracks on which to move the equipment. In this way the plan becomes a valid instrument that combines equipment maintenance with safety at work, as well as providing a budget and limiting the costs.

In the case of facility restoration, a plan must be drawn up specifying the necessary devices for regular maintenance and emergency repairs of equipment and components.

**Diagram 6.8** shows an equipment assembly plan usually adopted in sports facilities hosting high-level events.

**Use of skilled labour and assistance services**

Equipment, flooring, components and elements that make up a sports facility have a high economic and technological value; therefore, as far as maintenance is concerned, it is advisable to stipulate an agreement directly with the equipment
or flooring manufacturers and specialist companies installing the technological systems. In this way, a schedule, costs and type of interventions can be established in advance and the management can count on skilled labour.

**Maintenance management**
The correct operation of basketball facilities hinges on the proper use and operation of the various parts and components, and must be coordinated by specialised personnel employed by the facility to follow and supervise the different maintenance operations. Regular inspections can be scheduled using special maintenance logbooks to record the correct management and maintenance operations to be carried out, thanks to the fact that nowadays all equipment and components certified by the manufacturer come with instructions on correct use and maintenance. On the basis of the manufacturers’ specifications, facility managers can plan the operational management and a maintenance plan including an estimate of the costs.

**Simple-to-use materials and adequate spaces**
All materials must maintain their properties throughout the running time of the facility without requiring costly and frequent maintenance. In the service areas and rooms, flooring and walls must be of a non-slip material that can be cleaned with disinfectants and detergents. The rooms containing the technical installations must be spacious enough to allow for easy maintenance. The rooms must be large enough to accommodate the relevant equipment, and must have good lighting and ventilation to allow operators to move easily and safely. For simpler sanitary maintenance, sanitary installations must be fitted with shut-off taps (for each system, or at least for a group of systems, in order to differentiate them from the taps used on a daily basis).

**Introduction of automated systems**
Sports facilities can be fitted with a number of more or less technically automated control devices. Some of these devices (in particular those designed to monitor thermal-humidity conditions, acoustic levels, lighting, fire protection devices, internal CCTV, etc.) can be very useful for checking or stabilising parameters which are otherwise difficult to monitor. These devices are very sophisticated and maintenance must be carried out by specialised firms and personnel.
SAFETY AND SECURITY IN SPORTS FACILITIES
Safety is a problem of growing importance in modern society. Over the years, accidents of various natures, and a growing need to protect people and preserve the existing patrimony, have resulted in the demand for a higher level of preventive safety measures. Even in sports facilities, repeated episodes of violence and hooliganism have led to the need for preventive measures in order to ensure the safety of players and spectators alike.

What do we mean by safety? The protection of persons and goods from accidental events, caused by natural calamities or use of machines.

What do we mean by protection? The protection of persons or goods against attacks by third parties aimed at causing damages or stealing goods.

In terms of facility construction, the safety aspect prompts specific choices in terms of the dimensions and characteristics of the building, depending on the type of sport practised. As spectators are involved, the safety analysis must focus on collective behaviour which may reveal new aspects and changes in the social mentality and habits.

Current public behaviour patterns can be used to appropriately define the spectator areas. Yet even if structural interventions are carried out, or managerial interventions in the course of organising sporting events, the information provided by this behavioural model is not always sufficient, because certain behavioural models depend on factors related to education (family, school, etc.) and society (politics, social differences, etc.).

The study of preventive safety criteria certainly contributes to the success of a sporting event; if the event is well organised then it can become a safe and functional activity to be enjoyed by those who believe in sport.

**Considerations**

To tackle safety in basketball activities certain factors must be taken into account.

The main factor lies in the increasing number of users, both men and women, and today's longer life expectancy.

What is more, sport is no longer elitist; it has become a mass phenomenon with growing popularity, engaging people of all ages and all social strata.

This quantitative development and the diversification of sports have contributed to a redefinition of the demand for sports and related services.

The increased number of users has led to a growing demand for sports facilities, organisational skills and qualified operators, including the managers.

Another factor to take into account is the evolution of technologies, materials and equipment, as well as training techniques.

In other words, quantitative development, qualitative differentiation and technological advancement have all contributed to a new definition of safety in sports facilities.

The issue of facility safety should be aimed at protecting the following groups of people:

a. The users.

b. The public.

c. Those who practice sport.

d. Facility personnel.

Considering the problematic nature of sports in general, sports activities can be divided into different phases:

e. The actual sports activity itself.

f. The various ancillary activities.

g. Maintenance services.

h. The sporting event in terms of spectators.

Finally, there are other different safety aspects such as functional and static safety, fire and earthquake prevention, electrical safety, and hygiene safety standards.

The safety of a basketball facility can be compromised by inadequate solutions throughout the construction cycle:

- Programming
- Planning
In other words, safety is now seen as the overall result of integrated interventions concerning not only the people involved, but also the phases, aspects and moments of the entire sports cycle. After all, even well-constructed sports facilities can become unsafe due to incorrect maintenance, inadequate organisation or insufficient maintenance of their components.

The key groups prone to safety problems and thus requiring particular safety supervision are:

- Players whilst practising sport;
- Player/spectator relations during games;
- Spectators when they arrive, during the event and when they leave;
- Personnel during the organisation and running of the activities.

Even though a great deal of thought and careful planning goes into selecting the best geographical position or urban location to ensure that an outdoor complex fits in with the surrounding environment, safety planning is in fact far more complex for indoor facilities than it is for outdoor facilities.

The first measures of collective safety, which should be implemented in the conception and planning phases, are those related to the general environmental impact of the sports facility.

As far as the technological aspects of safety are concerned, it is worth remembering that the environmental comfort of players can significantly reduce the risk of accidents. A fundamental factor in this sense is adequate natural and artificial lighting both in quantitative and qualitative terms (uniformity, etc.). In multifunctional sports facilities, lighting systems should vary according to the different areas and operate independently.

The more complex a facility is, the more serious are the consequences of incoherent management, inadequate maintenance or inappropriate functional organisation. For example, the control and maintenance of the fire prevention system, sound diffusion, the emergency exits, etc. are all decisive elements in the sudden evacuation of a sports facility.

**Appliances and equipment**

The practice of sport generally calls for specific equipment and appliances. In all sport disciplines there is a specific dynamic relation between the equipment, facilities and players that determines the safety level of the sports facility.

Equipment may be removable or fixed. Fixed equipment is an integral part of the sports facility which defines the sports practised (baskets for basketball, nets for volleyball, etc.) whereas removable equipment tends to belong directly to the players (basketball shoes, tennis rackets, skis, bicycles, etc.).

Fixed equipment is most important in basketball. From a safety point of view, the following factors must be taken into account:

- The reaction of equipment to stress;
- The installation of appropriate anchoring and mounting fixtures;
- Adequate maintenance, particularly of parts exposed to dynamic stress.

With removable or mobile equipment, it is important to remember that a good athletic performance relies on equipment which is resistant to stress and meets current quality standards.

**Resistance of structural parts and components**

With regard to the construction aspect, an adequate level of safety is required when it comes to the resistance to static and dynamic stress of the facility as a whole, and of the individual components.

The load which a building must resist is generally related to the size of the building and usually includes permanent loads, wind, earthquakes, land subsidence, etc.

The entire fabric of a facility, the walls, doors and windows, the floors and ceilings, the machinery, equipment and supplies, all are prone to exposure to dynamic stress, sometimes even violent stress, be it through normal use or accidental. For
example, a collision between two people whilst running, or between light and heavy objects (balls and other equipment) thrown at great speed, can create considerable kinetic energy. Hence, spaces must be planned appropriately and strategies adopted to assure the safety of users and the integrity of the structures and components.

What is more, even under normal conditions, players, staff and the public can subject the various structural components to sudden strain and often more so than in other types of buildings, a classic example being through hooliganism, an act which can really only be prevented through education and the promotion of public and individual responsibility.

As far as sports equipment is concerned, such as the baskets, testing protocols have been drawn up and, in the case of FIBA, there are specific standards that must be met for a basket to be suitable for international events. The exact standards are laid down in the section on baskets of the Official Basketball Rules. Today it is possible to plan and monitor the safety of a sports facility thanks to software based on a finite-element calculation. The present tendency is to include in the structural plan different levels of safety according to the type of building and customer requirements. In many cases the costs for the maintenance of the safety of the structure also include sensors to signal any variations in the sensitive parts of the structure (roofing, frame structures, etc) in ordinary operating conditions or following exceptional atmospheric events (tornados, heavy snow falls, etc.).

These devices may seem excessive; however, some events in the past few years have demonstrated how solid and sturdy sports facilities can be transformed into community shelters, offering a safe haven to people hit by exceptional atmospheric events or natural catastrophes (windstorms, flooding, etc).

As regards vertical-closing and partitioning elements (walls, windows and frames), a series of tests can be carried out to check the resistance to light and heavy collisions, reproducing the conditions of use mentioned above. To simulate light collisions, cylindrical or spherical sacks can be filled with sand to weigh 30-50 kg, and then suspended from ropes. The element or component to be tested must be positioned vertically, exactly as it will be when installed, and then the sack must be allowed to swing so as to hit the element or component at a height suitable to test the dynamic strain foreseen.

Heavy collision tests can be carried out using steel spheres weighing between 500 g and 1 kg, dropped vertically onto a horizontal element, or suspended as in the system mentioned above for vertical elements. These tests are carried out with the elements already installed.

Other tests can be carried out to test the seismic resistance (usually with sand-filled balls) and the resistance against the passage of small bodies with a significant kinetic energy (10 cm ball filled with sand).

Equally important in sports facilities is the resistance to eccentric loads and tearing, with similar tests in place to determine the strength of anchoring elements and load-bearing walls.

**Fire Prevention**

A fire in a sports facility is one of the most dangerous occurrences that can happen because both people and objects are at risk at the same time.

By studying the effects of fires and examining “case” studies, nowadays we can say that fires always develop according to a specific model, within foreseeable limits, and that a fire usually takes a while before the maximum level of danger is reached. This observation has allowed planners to shift their attention to fire prevention by adopting an FSE approach (Fire Safety Engineering), particularly in the case of complex buildings or buildings with leading-edge technology.

In the project phase, fire protection engineers identify potential risks and design safeguards to aid fire prevention, by hypothesising and studying scenarios (or models) that may trigger a fire. These elements are then used to evaluate and plan the fire prevention systems.

Information technology offers an invaluable insight into fire development and combustion, thanks to specially designed fire
simulation software which allows a thermodynamic analysis of the behaviour of buildings from the onset of a fire to structural collapse. The simulation highlights the critical parts of the structure and the time it takes for the fire to reach those parts.

**Prevention measures**

Fire prevention is the most important element in safeguarding against the risk of fire and is based on two main concepts:

- Passive fire protection aims to prevent or contain fires, or to slow the spread through the use of fire-resistant systems and elements such as floors, walls and doors, which act as barriers;

- Active fire protection is often seen as a supplementary protection measure, adopted when a sufficient level of passive protection cannot be obtained or maintained. It involves the installation of fire protection systems which are activated manually or automatically to control or extinguish a fire.

Passive protection measures are adopted in both the planning and the operational phase with a view to reducing the probability of a fire in the following way:

- Correct position of the buildings;

- Reduction of fire load;

- Choosing the right furnishing materials (carpeting, wallpaper, etc);

- Adequate occupancy separation of the areas with fire-resistant rated floors and walls;

- Exit routes and safe areas appropriate for number of people, location and building characteristics.

When passive protection is not sufficient, despite having adopted the criteria above, an active protection system must be put into service to reduce the consequences of a fire. This includes:

- A suitable fire detection/alarm system to protect the substance and content of the building and compensate for any weak points which may arise, for example, due to the escape routes or the reaction to fire;

- A fire extinguishing system, manual or automatic;
A smoke extraction system, natural or forced.

**Reaction of materials to fire**

The materials used in the construction of sports facilities are the most widely studied elements in the reaction of materials to fire. For obvious safety reasons, all the parts of a basketball facility must be sufficiently fire-resistant. Fire resistance is rated in minutes, and corresponds to the length of time during which an element may be exposed to fire without impairing its function. This duration should comply with the national regulations in force or with the fire prevention code adopted.

The materials, apart from being fire-retardant, must not release toxic substances or harmful gases in a quantity that may jeopardise people's safety. (Table 7a)

Today, the most commonly used materials in the construction industry, as well as in the finishing and fitting sectors, undergo rigorous fire-resistance testing, and so their reaction to fire is known. The materials are supplied with a product certificate that specifies the behaviour in case of fire, thus allowing planners to select the most suitable materials. Nowadays, the regulations in force in many countries prescribe the types of materials to be used in relation to the type of building and the activities to be carried out.

The main characteristics of the most common materials are briefly described below.

Even if reinforced concrete structures are built with fire resistant materials, it is important to remember that the mechanical and physical characteristics of these materials may change as temperatures increase; thus, the reaction of a reinforced concrete structure to fire depends on the reaction of its component materials.

What is important where steel comes into play is the critical temperature at which the elasticity limit coincides with the tensile strength of steel; the temperature at which steel begins to change its shape is lower than the temperature which causes concrete to disintegrate.

Resistance to fire can therefore be improved by selecting components that are less sensitive to heat or by increasing the thickness of the materials covering the steel in order to increase the cross-section of the constructional component.

The reaction of pre-stressed concrete to fire is usually more critical than the reaction of ordinary reinforced concrete because high resistance steel is used which is cold-drawn.

To increase fire-resistance, many solutions suggest reinforcing concrete structures with appropriate insulation (gypsum, vermiculite, etc).

**Steel structures** have better mechanical properties, however, they are very sensitive to changes in temperature because their high thermal conductivity favours the transmission of heat.

The critical temperature for mild steel is 550°C while for hardened steel and hot-rolled bars it is 400°C. Even in this case, fire resistance can be improved in different ways, such as the use of protective paint, immersion of construction elements in materials with good fire resistance properties, in particular the use of heat-resistant steel, and the use of protective coatings to protect the construction elements from being in direct contact with the flames.

**Timber structures** have very interesting resistance characteristics despite being made of combustible materials. In fact, when timber is exposed to rising temperatures, the wood releases humidity (which can reach values between 10% and 20% of its weight) through its surface layer, thus maintaining its characteristics up to a temperature of 300°C. Higher temperatures cause the combustion and charring of the lower layers (500°C); at this stage, the combustion process slows down because of the quality of the oxygen and the speed of transmission of the heat from the outside to the inside, which, in turn, depends on the thermal conductivity of the material. In fact, char has a very low thermal conductivity value (approx. 0.03kcal/m2h°C)

Another characteristic of timber structures is that their resistance to fire is proportionate to the dimension of their cross-sections, whereas the cross-section of steel is irrelevant to fire protection. This allows the construction components to be sized according to their resistance to fire: In fact, assuming that the average
char rate is 0.64mm/min, the dimension of the necessary section can increase by 0.64 mm/min within the nominal fire resistance duration. The char rate may also reach the highest value, which, depending on the exposure to the flames and shape of the components could reach 0.84 mm/min in the case of pillars and columns, for example. Resistance to fire can also be improved by using fire protection treatments and solutions, such as protective paints, cavity walls or pressure treatments with chemical solutions. Measures of this kind are usually taken when the cross-section of the construction components are small and therefore have a low resistance to fire.

**Structures made of full bricks** that have already been subjected to rather high firing temperatures (800°C -1,000°C) have excellent levels of fire resistance.

As regards **plastered walls**, plaster made with normal lime mortar acts as a first barrier, delaying the diffusion of heat and thus allowing a gradual increase of temperature inside the walls rather than a sudden increase as in the case of bare walls. Improved levels of fire resistance can be achieved by using a sand and cement mortar for plastering and for the roof layers.

**Walls and partitions made of hollow bricks** are less resistant to fire because, once the plaster gives way, the outer surface is suddenly exposed to a high temperature, the size of the holes is reduced and the bricks crumble.

Structures made of tiles, perforated tiles, concrete blocks, hollow concrete blocks, or ventilated concrete blocks are highly resistant to fire. The best and most fire-resistant structure is one with mortar that binds the layers of bricks. Resistance to fire can be improved even further by increasing the quantity of ordinary sand and lime mortar, cement and sand plaster, gypsum and cement plaster, or cement and vermiculite plaster.

Robust horizontal concrete edge beams in the walls prevent high walls from swelling and collapsing outwards in the event of a fire. Structures made of hollow bricks and, above all, mixed floor types and reinforced tile floors are, without a doubt, less resistant to fire because they are sensitive to heat and therefore may react to sudden variations in heat and in particular to sudden cooling. In these types of structures, the resistance of the surface exposed to the fire depends on the type of plastering and the method of construction. In other words, it is the combination of two elements that determines the fire resistance of a structure: the plaster and the structure.

**Factors influencing fire resistance**

The fire resistance of a structure depends on the use of various elements and on the degree of danger. The resistance to fire may also vary according to the hierarchy of a structural component. For this reason, load-bearing structures must have a certain degree of mechanical resistance and endurance, as well as other properties such as thermal insulation, non-deformability and continuity between elements. A series of factors can influence the fire resistance of structures:

- Temperature at which the structure is exposed and its variation (a sudden variation may cause a fast change in the mechanical properties and compactness of materials).
- Exposure time;
- Thermal tensions;
- Internal thermal conductivity;
- Thermal expansion;
- Material degradation with reduced resistance to mechanical stress and high temperatures;
- Humidity contained in the structures during the fire prevention tests.

It is important to remember that a decrease in the resistance to fire and an increase in the deformation of materials do not only depend on the temperature, but also on the length of exposure to this temperature.

An increase in temperature inside a structure depends on:

- The thermal capacity of the structure's materials;
- The thermal conductivity;
- The nature and thickness of the covering material.

Resistance to fire is usually influenced by the following variables:
The temperature and its variation, exposure time and amount of heat developed per time unit;

- The mechanical and thermal characteristics of the materials that make up the structure, that is to say, the expansion coefficient and the thermal conductivity coefficient;
- The thermal capacity of the structure, the actual reaction of the material to high temperatures, the state of degradation and the level of humidity of the materials.

Each structure transfers the heat produced by a fire in different ways. An overheated skeleton of a structure may crumble or break, and major damage can be caused if water is used to extinguish the fire. This factor is taken into account in the following descriptions of the most suitable substances to extinguish a fire.

**Fire extinguishing systems**

Different types of fire extinguishing systems (active fire protection) are available:

- Water systems;
- Foam systems;
- Carbon dioxide systems;
- Powder systems;
- Semi-fixed systems;
- Automatic fire detection systems.

Some of these systems are “fixed”, others are “portable”. The portable type are the “extinguishers”, special cylindrical pressure vessels containing extinguishing agents. Extinguishers must be placed strategically throughout the building, be clearly visible, well signed and easy to handle. *(Diagram 7.1)*

**Water systems**

Water is the most well known and widely used substance to fight fires. It is easily available in most countries and cost-effective if the supply is easy. Systems that discharge water can be used directly against a fire, to cool the burnt material and smother combustion by transforming water into vapour, removing the oxygen and transforming the surface of certain products such as oil and alcohol (emulsion and dilution). These systems also keep the temperature of the materials and facilities at a safe level, to prevent explosions or the collapse of structures. In this way, a fire can be extinguished under safe conditions.

There are different types of water systems:

- **The fire sprinkler system** is the oldest system but not necessarily the best one. It consists of a series of sprinklers connected to a water distribution piping network fixed to the ceiling. In automatic systems, the nozzles are fitted with special sensors to detect when a certain temperature has been reached; the water pressurised in the pipes is opened and water is discharged. The pipes are continuously supplied by a system of special valves and pumps. Given the height at which the sprinklers are installed, temperature measurement is slow and before a large quantity of water is discharged, the fire has probably fully developed.

- **Dry sprinkler systems** are used as an alternative if the fluid-containing pipes have to be mounted outside the building, or
inside but at temperatures liable to reach freezing point. In this case, water is not actually present in the piping until the system is in operation. Instead the pipes contain pressurised air at a “maintenance” pressure lower than the water supply pressure. When the sprinklers are exposed to sufficient heat, they open the maintenance air vents, the air pressure in the piping drops allowing the special dry pipe valves to be opened manually or automatically, and releasing water into the piping system. This system is preferable when a large scale intervention is required because the hazardous nature of the materials must be protected.

The water barrier consists of a series of special sprinklers connected to one another and to a water supply pipeline. It has the function of isolating the adjacent area and creating a barrier to stop the fire from propagating or to contain the effects of radiation.

**Deluge water spray systems** use special water-spraying nozzles under relatively high pressure to obtain a spray which can cool and smother the fire. This system is suitable for fighting fires that may develop in tanks and deposits, to protect special equipment, transformers or generators, or substances such as oil.

**Foam systems**

Foam contains a multitude of gas bubbles contained in pockets formed by liquid surface tension. It can be used to progressively extinguish a fire without flashback.

Different types of foams are available with different functions according to their intended area of use: protein based, fluoride protein based, synthetic surface type, alcohol-resistant agents and AFFF (aqueous film forming foam). Protein based foams are made from organic animal products; they deteriorate quickly and their effectiveness is limited. Synthetic surface foams, used in special types of extinguishers, can be preserved for a long time. Alcohol-resistant foams are used for particular substances such as aqueous solution polar solvents, alcohols, ketones and ethers; these foams contain a polymer that forms a protective layer between the burning surface and the foam, preventing foam breakdown by alcohols present in the burning fuel, at the same time trapping and preserving the water they contain.

According to the quality and type of generators used, foams are divided into the following categories according to their expansion ratio (ER), i.e. the ratio between the concentrated mixture (water + foaming liquid) and the foam produced by the generator:

1. Low expansion foams: \( ER = 1:5 \) to \( 1:20 \).
2. Medium expansion foams: \( ER = 1:20 \) and \( 1:200 \).
3. High expansion foams: \( ER = \) greater than \( 1:200 \).

Low and medium expansion foams are low-viscosity and mobile; they are able to quickly cover large areas, superficially extinguish a fire and provide isolation by covering burnt material. High expansion foams offer volumetric protection and saturation and are particularly suitable for enclosed spaces where quick filling is needed.

Foams cannot be used for certain materials, such as peroxides which produce oxygen and self-fuel during combustion, cancelling the smothering effect.

The use of high expansion foams to obtain the volumetric saturation required does not pose a hazard to people as it still allows them to breathe; unlike water, it does not have a wet effect and does not contaminate materials, not even the most delicate. The high efficiency of these systems considerably reduces water consumption and consequently the need for a water supply.

The effectiveness of fire-fighting foam systems depends exclusively on their compatibility with the product to be protected, their specific use in relation to the surface and volume to be protected and the quality of their foaming agent.

Aqueous film forming foams (AFFF) are used for vapour suppression, to extinguish fires involving hydrocarbons. If these foams are used in devices suitable for the generation of low expansion mechanical foams, they produce a vapour-
resistant foam blanket, with exceptional characteristics compared to other foaming agents. When the bubbles break, the mixture flows gradually and floats on the surface of the fuel making it completely resistant to vapour, thus preventing a rekindling of the fire or continuing combustion on the surface. Low expansion systems are usually based on the principle of proportioning and mixing the foaming liquid with water. These systems are made up of a network of pipelines which distribute the mixture, and spraying nozzles which create the foamy emulsion. The nozzles must be positioned towards the area to be protected. They must be appropriately installed to enable a rapid and uniform distribution of the foam on the area to be protected. Medium and low expansion systems require a dosing system and pipelines to take the mixture to the generators. The generators are installed on the ceiling or upper part of the premises to be protected; there must be enough generators to saturate the premises in a relatively short time (3-6 min) depending on the type of material.

The use of high expansion foams (as for low and medium expansion foams) is limited to the protection of indoor areas because this type of foam is very light and can easily drift away with the wind or air currents if sprayed outdoors.

**Carbon dioxide systems**
Carbon dioxide is an inert gas, heavier than air, dielectric, non-corrosive and non-toxic, but with a smothering effect. Because of its weight, the discharged gas tends to settle in layers towards the ground. Carbon dioxide extinguishes a fire by displacing the atmospheric oxygen and reducing its concentration so that combustion stops. This system can be used to fight all types of fires, in particular to protect materials for which other systems are not recommended, due to the high costs and vulnerable nature of the materials and equipment to be protected. Carbon dioxide systems are usually operated with one single discharge; for this reason, it is important that qualified technicians take over the planning of such systems. There are two carbon dioxide discharge systems: high pressure and low pressure. High pressure systems utilise pressure cylinders (30 kg-45 kg) to house the CO2 gas which is kept in a liquid state at room temperature (20°C) and under a pressure of approximately 57 kg/cm². Low pressure systems (used when large amounts of gas are required) utilise a low pressure refrigerated tank to store CO2 at its typically low storage temperature of -20°C; these systems are connected to cooling systems which require considerable servicing.

Carbon dioxide systems can be operated manually or automatically. They are made up of a series of cylinders, gas manifolds, distribution pipelines and gas distributor. The cylinders are opened by means of special valves and servo controls, allowing the gas to flow into the pipelines and be discharged.

The efficiency of carbon dioxide systems depends on two basic elements: with total saturation systems, the gas must not be allowed to escape when being discharged, so it is essential that all doors and windows are closed and any air conditioning or ventilation systems which may remove the gas must be switched off. Carbon dioxide is lethal because once it has been discharged it rapidly absorbs the oxygen indispensable for human survival. Alarm and evacuation systems are therefore essential and the gas must only be released once the premises have been completely evacuated.

**Dry powder systems**
Like carbon dioxide systems, powder systems allow for one single, short discharge (unless reserves are present). Powder systems are undoubtedly very effective, yet they do not eliminate the risk of a fire rekindling. These systems may be made of pressurised tanks, discharge devices and powder distribution pipelines; if the tanks are not pressurised, cylinders containing propelling gas are used to pressurise the tank when needed. The valves which control the opening of the tank can be operated manually or automatically.
**Semi-fixed fire suppression systems**

Compared to the fixed systems, these systems offer various levels of safety and reliability. Human intervention is necessary to position, activate and handle the equipment. The result is that an intervention of this kind often takes longer than expected. A good level of success can be obtained through continued personnel training, a certain degree of familiarity with fires (through practical training) and valid technical equipment for all types of risk. These systems include water supply networks with hydrants and fire hose boxes with rolled hoses, because despite having a fixed water supply, mobile equipment is needed to reach the fire. *(Diagram 7.2)*

The components of the fire fighting supply system (pumps, piping) must be used exclusively for this purpose and be independent from the components that supply fixed systems (sprinklers, deluge, foam, etc.).

There are two types of hydrants: above-ground and underground. *(Diagram 7.3)*

Those above ground have the advantage of always being visible and accessible, they have numerous nozzles, which can be rapidly put into use and allow different interventions to be carried out at the same time. The hydrants should be positioned at intervals of 40m to 60m along the fire prevention network.

The fire hoses should be fitted with spray nozzles which enable the water pattern and water pressure to be controlled and fires to be extinguished with greater success. Special smaller devices may also be installed (pre-mixers) so that foam can be used with both special nozzles and traditional fire hoses.

Fire pumps must be practical and robust, capable of reaching full-flow capacity in a short time and without any problems. Electric pumps should have a double supply of energy or use an emergency generator. Motor pumps should have powerful diesel engines, preferably water-cooled.

The water supply should be able to supply water to the system for at least two hours, otherwise there must be systems in place which can be activated when water is most needed.

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*Diagram 7.2*

Hydrant
Automatic fire detection systems

These systems do not have an actual fire extinguishing function, but merely detect and signalise the presence of a fire. They can be connected to fixed fire extinguishing systems to create an automatic system or they can be installed independently to simply detect a fire and raise the alarm.

The right choice of detectors is fundamental to guarantee a fast and effective warning system to alert people to an impending fire.

Smoke detectors are the most effective in the case of small fires. With rapidly propagating fires, smoke detectors, thermal detectors or radiation detectors can be used, however, a combination of detectors is generally the best solution.

Automatic detection systems have alarm signal delay systems which allow safety officers to objectively evaluate the situation before taking any important decision. Unless the alarm system is faulty or has been tampered with, it starts automatically, once the delay period is over (during which the detection alarm is suspended). In this way the following objectives can be achieved:

- Cost-effective management (actual balance and fewer false alarms);
- Immediate intervention of the internal organisation, indispensable when lives are at risk;
- False alarms can be prevented thus avoiding needless calls to the fire brigade;
- Well trained internal organisation: this is fundamental for a successful fire fighting operation.

Public Safety

Introduction

The safety of players has already been studied in detail in the chapter on the playing area. This chapter is dedicated specifically to the safety of the public.

In general, all basketball facilities open to the public must be authorised by special commissions for the control of public buildings. A certificate confirming the fire prevention measures
adopted by the sports facility must be presented to the commission for authorisation.

Most national regulations require both the authorisation and the fire prevention certificate; these regulations pay particular attention to the level of crowding caused by the presence of a large number of people, and to the use of modern construction materials and sophisticated technological installations.

Particular attention must also be paid to the regulations concerning the escape routes from the sports facilities, the layout of space and dispersion of people. Concrete precautions must be identified and a study of the modifications to implemented in existing facilities must be carried out.

**Parking areas and external access routes**

The area intended for the construction of a basketball facility must be large enough to allow for rapid evacuation in an emergency; this area can be used for one or more parking areas near or adjacent to the facility, calculated according to the national regulations in force and the total capacity of the facility.

The minimum size of the car parks must comply with the town planning regulations in force in the country in which the facility is located.

The spaces required for service vehicles should not be calculated as part of the parking area. Service vehicles should be allowed to approach the facility, make the necessary manoeuvres and quickly reach the adjacent area. Access to the spaces reserved service vehicles to manoeuvre must meet the following specifications:

- Clear height of at least 4 m;
- Minimum width of 4 m;
- Gradient less than 10%;
- Load resistance for vehicles weighing over 20 t.

A service area must be provided next to the sports facilities; this area must include open-air spaces which are clearly marked and will not impede the flow of people coming out of

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**Diagram 7.4**

**Exit in one direction**

The site of the sports facilities shall allow the circulation and handling of emergency vehicles, as well as the possibility of elevation towards the adjacent areas.

- A= Entrance and handling areas for emergency vehicles.
- Leave width > 3.50 m
- Incline > 10%
- Resistance to load > 20t

**Exit in two directions**

The exit roads for the public have a width equal to half the width of the total exit doors when leaving the facility by both directions.
the hall and vehicles leaving. These spaces must be level and large enough to guarantee a crowd density of one person per square metre, with a minimum distance of 3.50 m from the exit, although 4 m are recommended.

The boundary of the service area must have openings which are the same width as the exit of the facility. (Diagram 7.4)

It is also advisable to have open-air spaces within 50m from the exits of the facility which should be large enough to accommodate the public, assuming a crowd density of one person per square metre. These spaces should be used for people to collect in a safe place until emergency services arrive.

High-level facilities must have an external barrier at least 2.20m high, made of inflammable material, capable of resisting a thrust of 80N/m² at the highest point. The barrier openings should be commensurate with the facility’s exit width.

Each opening must be fitted with gates which must be kept open during sports competitions.

The aforementioned specifications for external barriers are also valid for barriers inside the service area, if required.

**Public access and spectator areas**

The official seating capacity reserved for the public must be established for all facilities.

The number of seating spaces is usually determined by the total number of seating elements (seats) or by the length in linear meters of the steps or benches, divided by 0.45-0.48m. All seats must be clearly numbered.

The spaces reserved for the free flow of people during events must not be taken into account when calculating the total capacity. The capacity of the playing area, on the other hand, depends on the sporting activities and is based on the number of users and personnel.

In high-level facilities, the spectator area should be divided into sectors.

The capacity of each sector should not exceed 4,000 spectators.

Each sector should be separated from the adjacent one/s using adequate partitions.

Each sector must have at least two exits, service areas and independent exit routes; these must be easily identifiable and marked with signs that conform to the national regulations.

Metal access doors should be installed to allow entry to the different sectors.

A CCTV surveillance system is recommended in high-level facilities to monitor the spectator areas and spectator access to the facility.

**Internal access routes**

The steps leading to the various sectors should be at least 1.20m wide and serve no more than 20 seats per row on each side.

Above and below every 15 rows of the tribune, there must be a gangway parallel to the rows, which is at least 1.20m wide. Gangways are not necessary when the access routes to the various sectors lead directly to the exits. (Diagram 7.5)

The step of each seat row must have tread of at least 60 cm and a riser-tread ratio of at least 1:2.

The stairway leading spectators to the various sectors must be straight.

The steps of each flight must have a constant tread and riser value. The riser must not be more than 23cm and the tread must be at least 25cm. Here, too, the riser-tread ratio must be at least 1:2.

**Exits**

The spectator area and the sports area must have separate exits. Separation of the two areas must comply with existing regulations, however, access between the two areas should be made possible via metal access doors.

The total width of the exits in indoor facilities must be sized according to the crowd flow rate of more than 50 people per door module.

The width of each exit must be of at least as wide as two modules, whereby one door module is 60cm wide.
The stairs must be rectangular, with consistent treads and risers, with the riser no higher than 17 cm and the tread at least 30 cm deep.
The stairways must be straight with a minimum of three steps and a maximum of 15 per flight.
Intermediate landings must be as wide as the stairs, not wider or narrower.
The walls along the stairs must be smooth up to a height of 2 m from the stair floor, and there should be no niches or parts jutting out. All stairways must be fitted with a handrail that must not project beyond the tolerance limit allowed; the end of the handrail must be turned towards the walls.

Two staircases can be combined to form one single one as long as the width of the single staircase is the same as the sum of the widths of the two separate staircases.
For staircases wider than 3 m, a central handrail may be required.
The exit routes in the spectators’ area must not be longer than 40-50 m if appropriate smoke evacuation systems are installed and linked to fire detection systems.
There must be at least two exits per sector.

Information
Nowadays mass media play a fundamental role in the psychology of supporters as they are generally key to discussions on sporting events.
Given the growing importance of the mass media in the world of sports in general, and particularly inside sports facilities too, closer cooperation with the mass media, and rationalisation in this sense, could undoubtedly help in terms of safety prevention during events.
Detailed information on the venue, safety routes and services within the facility could be published in special guides, magazines or leaflets to familiarise visitors with the facility.
From a safety point of view, it is important to remember here the importance of the facility’s sound diffusion system. A satisfactory sound system can be used as a valuable mass notification tool to alert people throughout the entire facility to emergencies and coordinate safe evacuation.
In fact, if used correctly and wisely, a sound system is one of the most effective ways of providing information to prevent and reduce incidents.
In some cases, incidents can be managed by transmitting audio messages from safety operators to control panic and the crowd flow; these operators work from a special room and must be so familiar with the facility that they can guide the public safely to the exits.
Organisation

For safety reasons, the local authorities and event organisers must be in contact with one another and their work must be coordinated.

Particular attention must be paid to defining the roles of those responsible for public safety and to emergency intervention planning.

Helicopter surveillance of crowds, in conjunction with first aid services and the fire brigade, has often proved to be essential for spectators leaving the facility en masse.

Public safety is synonymous with comfort; therefore, the criteria to make the public’s entrance and exit as smooth as possible should be defined separately from the fire prevention measures.

Access routes, main public transport services, car parks, and parking areas for the visiting team’s supporters must be clearly marked, for this is the basis of effective public safety.

One difference must, however, be made between ordinary and extraordinary sporting events:

• Ordinary events do not require any additional measures compared to those planned at the beginning of the professional sports programme.

• Extraordinary events require a careful study of the event plan and programme.

Another important aspect is the collaboration between the organisers, safety bodies, owner and/or manager of the facility and, obviously, the local authorities.

Awareness and knowledge of the local area and the overall coordination of all the parties involved should also be considered.

Safety bodies and facility staff must be familiar with the area to be monitored and know how to act in case of emergency.

The most important aspect of public safety is the control of the public at the entrance and at the pre-selection barriers where security officers can check to ensure that no dangerous objects are taken into the sports facility.

To avoid unpleasant occurrences, some cities chose to provide all potential spectators with identity cards before the event. The spectators must then show their ID card at the information points before purchasing their tickets. This precaution has proved to be beneficial as it enables unwanted spectators to be refused entry to events.

On the whole, sporting events are there to attract the public, therefore, the onus is on the organisers to ensure that spectators can enjoy an event in the best possible conditions of comfort and safety.

Safety Signs

Introduction (Diagram 7.6)

The purpose of safety signs is to draw people’s attention quickly and easily to objects and situations which can be potentially hazardous. Safety signs are based on simple, straightforward symbols which are associated with concepts which are easy to understand. (Diagram 7.6 a, b, c, d)

Safety signs do not, however, replace the necessary safety measures.

Safety signs should be used exclusively to point out hazards or provide information quickly and precisely.
Diagram 7.6a-b
Signs

Diagram 7.6c-d
Signs

Diagram 7.6a

Diagram 7.6b

Diagram 7.6c

Diagram 7.6d
The colours of safety signs have the following meanings: (Table 7.7b)

- Red - prohibition;
- Yellow - caution, indicates a potential hazard;
- Green - indication;
- Blue - information or directions.

The table below contains further specifications: (Table 7.7c)

**Combination of colours and shapes**

The configuration established by existing regulations is as follows:

- **a.** Prohibition signs: white background with text or symbols in black;
- **b.** Information, indications, attention signs: background of the safety colour and symbol or text in a contrasting colour;
- **c.** Additional signs: white background with black text or safety colour background and text in a contrasting colour;
- **d.** Symbols: these must be as simple as possible with no detail.

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**Diagram 7.7b**

<table>
<thead>
<tr>
<th>COLOUR</th>
<th>SHAPE</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>RED</td>
<td>◉</td>
<td>△</td>
<td></td>
</tr>
<tr>
<td>YELLOW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GREEN</td>
<td></td>
<td></td>
<td>SAFE SITUATION FIRST AID EQUIPMENT</td>
</tr>
<tr>
<td>BLUE</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Diagram 7.7c

Combination of colours and shapes

<table>
<thead>
<tr>
<th>COLOUR</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED</td>
<td>STOP, EMERGENCY STOP DEVICES, PROHIBITION</td>
</tr>
<tr>
<td>YELLOW</td>
<td>DANGER (FIRE, EXPLOSION, RADATION, CHEMICAL SUBSTANCES, THRESHOLDS, DANGEROUS PASSAGES, OBSTACLES)</td>
</tr>
<tr>
<td>GREEN</td>
<td>PASSAGES AND EMERGENCY EXITS, FIRST AID SHOWERS, FIRST AID AND RESCUE AREAS</td>
</tr>
<tr>
<td>BLUE</td>
<td>OBLIGATION OF WEARING A PERSONAL SAFETY EQUIPMENT, LOCATION OF THE TELEPHONE</td>
</tr>
</tbody>
</table>
Elimination of Architectural Barriers
ndoor and outdoor spaces of all buildings, including sports facilities, should be planned and built to welcome all potential users, both able-bodied persons and persons with physical or sensory disabilities.

To meet these requirements, the people involved in commissioning, planning and managing buildings must have the necessary competences to identify the principles of good accessibility.

These requirements should be included in the initial specifications, and should be an integral part of the project starting from the planning process; they should be taken into account throughout the project phases, construction process and management phase once the project has been completed.

This approach will deliver the following positive results:

- Coordination of the specific needs into one single general project, consequently reducing the need for separate facilities for persons with a disability or the need to adapt buildings to accommodate specific needs which were not taken into account from the start;
- General benefits deriving from a careful and safe project; benefits enjoyable by all users, some of which may have similar needs to persons with a disability, such as children, parents with children, or elderly people;
- Strategic positioning and optimum use of special areas for specific needs, or in the case of building restoration ensuring that different levels can be connected to make every floor easily accessible.

The advice provided in this chapter is in line with what is typically established by good practice. The dimensions, standards and diagrams contained in this chapter are based on the standards followed in the UK, Italy and Europe in general, although in some cases, different local regulations may have precedence.

This guide specifies the general measures foreseen with regard to access to sports facilities, circulation inside the building and usability of the facilities. The specific needs of athletes with a disability will vary according to the type of disability; these needs can be met by equipping playing areas with special equipment and devices. Particular reference is made to this at the end of the chapter.

**Access**

Every sports facility must provide a series of disabled parking bays close to the entrance of the facility. The parking spaces must be clearly marked, both on the ground and with sign posts using the international disabled sign.

- An access road with parking bays reserved for persons with a disability is essential for those arriving by car or another form of transport;

In particular:

- The access point for cars must be clearly marked at the entrance of the car park;
- Car spaces must be clearly identified, indicating spaces for drivers or passengers with a disability;
- Disabled parking bays must be as close to the facility entrance as possible. If the pathway to the entrance is uncovered, the parking bays must be no more than 50 m from the building, or a maximum of 100 m if the pathway is covered;
- In the car parking areas for spectators, a minimum of 3% of the parking spaces should be reserved for people with a disability;
- The pathway between the parking bays and the route towards the entrance must be free of obstacles in order not to impede wheelchair users. The parking spaces must be close to pedestrian routes so they can be accessed directly from the car, avoiding potential hazards (passing cars) or obstacles along the way (steps or steep ramps);
- Traffic routes must be distinguishable from pedestrian routes through coloured and textured markings.

Parking spaces reserved for vehicles transporting persons with a disability must have the following minimum dimensions:

- Minimum width of 3.20m for herringbone pattern spaces (Diagram 8.1) or perpendicular to the pavement (Diagram 8.2), divided into two sections; one for the actual car and the
Diagram. 8.1

Diagram. 8.2

Diagram. 8.3

Diagram. 8.3a
other as a transfer bay to allow people with a disability to get in and out of the car with ease;

- At least 6m in length for spaces parallel to pavement, taking into account the space necessary for a wheelchair to pass between one vehicle and another (Diagram 8.3).

The space for the actual car and the space for the transfer bay must either be on the same level or on different levels with a maximum difference of 2.5cm.

These two areas must be clearly identified using different colours, i.e. the disabled transfer bay must be marked with yellow diagonal stripes.

Loading and unloading zones should be in areas with zero or low inclination. If low-floor accessible buses are to be used, provisions for suitable pavements or temporary ramps should be made.

There must therefore be an aisle of at least 2.40m wide and 7m long, adjacent and parallel to the vehicle pull-up space (Diagram 8.3a).

A ramp or dropped kerbs must connect the pedestrian area of the car park with nearby pedestrian routes when there is a height difference of more than 2.5cm.

Clear signage must be provided at the entry from the public highway indicating the main areas of the facility and their access routes. Maps and signs must be clearly visible and easily accessible.

**Tactile information**

All routes should provide aural and tactile information, supplemented by Braille tables, to provide orientation for the blind and visually impaired, and alert them to vehicle routes, pathways and crossings. Tactile surfaces can be used to identify crossings, ramps, steps and stairs, as well as other critical points such as entrances and doors. These surfaces must have a minimum width of 30cm (Diagram 8.4). Other elements, such as handrails, should also be installed to complete the textured route, making it safe and convenient.

**Routes and ramps**

At least one route must be foreseen on a level surface, leading from the external areas to the main entrance, to enable persons with low or impaired mobility to benefit from car park facilities and outdoor services. Where necessary, rest areas with a bench should be provided every 30 metres.

External routes must take into account the limited ability of many users to cover long distances on foot or in a wheelchair. Distances and physical elements that require an additional effort, such as ramps, should be reduced in order to be practical (Diagram 8.5).

In general, the routes should be 1.20m-2.00m wide to allow for wheelchairs. In some countries a minimum width of 90cm is allowed for wheelchairs, however, a minimum width of 1.50m will allow wheelchair users to pass one another freely. The total width must not be reduced by obstacles.

In particular, the routes must have the following characteristics:

- Maximum 5% gradient. If this is not possible, a gradient of up to 8% is allowed as long as the following elements are foreseen
- A level horizontal surface every 9 linear metres of the pedestrian route, measuring at least 1.50x1.50m Ramps must have level landings at the top and bottom, each measuring at least 2.10x2.10m. Landings must also be foreseen in the middle if there is a change in direction of the ramp
- A 10cm raised kerb on each side of the pedestrian route unless a flat parapet or balustrade is provided
- A handrail along one side of the route at a height between 80-92cm, and where necessary a second hand rail at the height of 75cm, each extending 30cm beyond the end of the ramp
- The handrail must be continuous to allow for an uninterrupted hold; it must be 3.5-5.0cm in diameter and must be nylon-coated or covered with PVC-u or similar so it is not cold to the touch
- All ramps must have a handrail on either side
Diagram 8.4
Access Tactile Information

Diagram 8.5
Ramps

Warning code
Code of rectilinear direction

Diagram 8.4
LONGITUDINAL SECTION

Continuous handrails Ø 45/60
Ramp max 9.00 min. 1.50
Landing max 8°
Ramp max 9.00 min. 1.50
Top 0.30
Antiskid floor
Cross section

Diagnoam 8.5
Ramps
The maximum transversal gradient allowed is 1%
- Pedestrian routes which are adjacent to unpaved areas must be defined with a kerb 10cm from the ground and made of a different material and colour from the route paving. The kerb must not have sharp corners and must incorporate a dropped kerb every 10m to allow access to the unpaved areas.
- Any joins and seams in the surface must be level. Any changes in level of the route must be connected by slight gradients or ramps (with or without steps) and highlighted with a different colour.
- The surface material must be resistant to atmospheric conditions and must be selected, maintained and protected to avoid difficult and hazardous joints and seams.
- The paving of the pedestrian route must be slip-resistant, made of materials with a friction coefficient, measured according to the British Ceramic Research Association Ltd method, of more than 0.40 for a leather element on a dry surface and 0.40 for standard hard rubber on a wet surface.
- These friction values must not be altered by polishing or protective layers, which, if applied, must be done so before the tests.
- The conditions of the floor (wet or dry), as well as low temperatures, must be taken into account when constructing the ramps.
- The layers supporting the paving must be strong and durable enough to support both paving and capacity overload, as well as ensure a lasting anchorage of the paving components.
- Joints between paving elements must not be greater than 5mm; they must be made from durable materials, and be applied evenly so that any difference in level is not more than 2mm.
- Grids and gratings set in the paving must have a mesh small enough to stop a sphere with a diameter of 2cm from falling through; grids with parallel elements must be placed with the elements perpendicular to the sense of direction.

Diagram 8.6

HANDRAIL: max 3.5/5.0cm in diameter. Must be nylon-coated or covered with PVC-U or similar.

Ensure continuity at return flights.

LANDING: at the top, intermediate, bottom level. 180x180cm to guarantee a clearance with of 120 cm. Illuminated and clear of any swinging door.

Distinct edge. Protective strip on the step must be non-slip and noticeable.

Open risers not recommended. Prosthesis devices or using crutches should be assisted.

Tactile warning surface to suggested profile.

0.26
0.16 max
0.60 Above edge line
0.30
0.92 edge line
0.30
0.40

0.30
0.30
0.40
**Steps**
Steps are potentially hazardous and must only be used in areas where ramps cannot be built (Diagram 8.6).
The riser must be solid and the protective metal strip on the step must be non-slip and noticeable when coming down the steps. The riser must not be more than 15cm and the tread must be at least 28cm.

**Landing**
The areas just before and just after the entrances must be correctly sized to allow for wheelchairs to be manoeuvred and to allow the doors to open correctly.
The spaces before the entrances must allow for external doors to be opened correctly. Usually they must all be of the same size, minimum 1.80x1.80m, to guarantee a clearance width of 1.20m. External routes and access routes must be consistently and adequately illuminated to ensure a smooth transition from external to internal lighting levels. Above all, lighting at the entrances and in the entrance lobby must be continuous.

**Entrances**
The entrance to a facility represents the boundary and intermediary point between the outdoor area and the indoor area. This area must therefore be protected against atmospheric agents; at the same time, the area connecting the indoor floor with the external route must be free of obstacles at all times. Entrances must be easily distinguishable from the façade as a whole. The entrance door is fundamental to good accessibility of a building and it is important that the following elements are taken into account in the project phase (Diagram 8.7):
In particular:
- Access doors must be easy to use, respect the minimum clearance width for easy passage (85cm but 95cm is recommended) (Diagram 8.8).
- The door space and the area before and after the door must be level; the best solution is to install single-leaf doors no wider than 1.20m, preferably with viewing panels. These should be placed at least 40cm from the floor, and must allow

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**Diagram 8.7**

**DOORS: DIFFERENT TYPOLOGIES**
A - Automatic door with ante flowing
B - Door to manual opening with delayed closing
C - Door to double manual opening to ante with delayed closing
wheelchair users to see into the building. It must be possible to open a mobile door leaf exerting a force of no more than 8 kg.

- The size, position and type of opening of a door must allow the leaves of the door to open on both sides of use; sliding doors or folding doors are recommended. Revolving doors, automatically controlled doors and doors with glass panels should be avoided if they are not appropriately equipped to comply with safety standards. Glass doors must be easily distinguishable from their surroundings, with special safety markings and signs.
- Lever-type handles, duly rounded and curved, are recommended; they must be positioned at a height of 85-110 cm.
- For safety and access reasons, thresholds must be level or duly rounded (Diagram 8.9).
- Gates or other openings which lead to other public areas, must comply with the accessibility provisions presented. Where turnstiles or other ticketing control devices are provided, which are not typically wheelchair-accessible, an appropriately accessible gate or opening must also be provided in immediate proximity.

Reception area
The entrance area must have an information point with staff available to provide verbal information. There must be a tactile route for the visually impaired from the entrance door to the information point, and a tactile map must be placed near the entrance and close to the amenities inside.

In particular:
The level of lighting in the lobby should be adjustable to provide a smooth transition from external to internal lighting levels and vice versa and must be automatically adapted to external conditions.
The entrance lobby should be finished with a 2 metre-long recessed cleaning surface to clean the wheels of the wheelchairs. The cleaning surface must be flush with the floor, firm, smooth and obstacle free, and offer minimum resistance to wheelchair wheels.

Counters and desks must be designed to suit wheelchair users on either side, i.e. both visitors and staff with a disability.

Waiting areas must offer an acoustically balanced, quiet environment, and also have adequate artificial or natural lighting offering good visibility.

Any type of automated equipment for public use must be accessible to wheelchair users, in terms of position and height.

Routes inside the buildings - including lifts and stairs - must be clearly identified and appropriately signed.

Safety barriers, machines or control push-buttons must be accurately identified for use by all visitors without the need for specific/special devices for persons with a disability. Digital buttons are usually difficult to use for the visually impaired.

Horizontal Connection Systems
Passage areas
Corridors and passages must be designed to provide a continuous flow, and changes in direction must be clearly marked.

Corridors must be on one level and if this is not possible ramps must be provided.

The width of corridors and passages must allow easy access to the areas they serve and should always be at least 1 m wide.
The corridor width should be increased at regular intervals, not too far apart, about every 10 metres, to allow wheelchair users to pass one another or change direction. Splayed walls and corners at corridor junctions and at the end of the corridors will also benefit wheelchair users and visually impaired visitors. (Diagram 8.10)

A corridor that intersects a vertical connection system (stairs, ramps, lifts, stair-lifts and platform lifts) must have adequate unobstructed floor space in front of the vertical system to allow for convenient access. These spaces must also lead horizontally to the various other areas in the building, with the exception of the technicians’ rooms.

Routes inside the building must be obstacle-free, comfortable
Diagram 8.8
Access door

Diagram 8.9
Access door

CLEARANCE OF THE DOOR

A - Sliding door
B - Leaf

HEIGHT < 2.00 cm
shape of threshold preferably rounded off
and safe, and must include information points and meeting points to help people in difficulty.

Wheelchairs used by basketball players are significantly wider than the standard wheelchairs habitually used by persons with a disability. This should be taken into account in all relevant parts of the building, in particular the areas of circulation, door openings, toilets, in front of washbasins and wherever space is limited and might restrict manoeuvring.

Furthermore, in particular:

- Potential obstructions must be hidden or protected so as not to reduce the circulation space.
- Corridors should have a minimum clear width of at least 1m (1.20m is optimal) for a straight passage with limited length. The minimum width near entrance doors should be 1.5m. Turning spaces should be 1.4m, and passing points for two wheelchair users 1.8m (2m is optimal). (Diagram 8.11)
- Corners must be splayed to limit damage to the building and to benefit visually impaired people or persons with a disability. Splayed corners allow for easier wheelchair movements and easier passage of first aid equipment.

**Internal doors**

Internal doors are potentially the most common barriers and obstacles; where possible they should be eliminated or kept to a minimum.

In particular:

- Ideally, internal doors should only be used in the case of a fire and so should be connected to the fire prevention system and only operated when necessary
- During normal use door closers should be set to the minimum force required to open/close the door and adjusted during use
- The use of low-energy door operators or remote controls should be considered instead of keys for heavy doors
- Changing room doors or doors in similar spaces must be fitted with push-buttons, latches or levers to allow wheelchair users or others to close the door behind them
Alternative solutions to hinged doors must be carefully studied. Power-operated sliding doors must ensure enough space for a wheelchair to pass through and must have an easily accessible push-pad fitted on each side to open/close the doors.

Doors must be protected against damage caused by wheelchairs; protection plates or panels must be installed at a height of 40cm to be effective.

**Vertical Connection Systems**

Vertical connection systems are used in sports facilities to overcome changes in levels; these systems can be categorised in two main groups:

- **Architectural elements such as stairs and ramps**
- **Mechanical devices such as lifts, platform lifts and stair-lifts**

For persons with reduced or impaired mobility, stairs represent a physical barrier; therefore alternatives must be found and evaluated for each individual project.

Ramps may be installed as long as the difference in height is no more than 3.20m. However, in order to overcome such a level change with a 5% gradient, a considerably long ramp will be required. It is also important to remember that where there is a succession of changes in levels, it would be very tiring for people with a disability to have to negotiate a number of different ramps.

Apart from regular passenger lifts, a structured and complex solution designed to overcome any difference in level, there are other solutions suitable for changes in level up to 4 m, such as short rise platform lifts and stair-lifts, which are easier to install and more cost-effective.

Stair-lifts are not acceptable for every type of disability and can sometimes discriminate users with a certain physical condition. Therefore, stair-lifts should only be considered as a final option, once it has been established that a platform lift cannot be installed.

To overcome level changes greater than 4 m, long-rise platform lifts or passenger lifts can be installed, depending on the number of floors to be served, and the space and budget available.

Unlike mechanical devices, architectural elements are never out of order and do not require a person with a key to activate them.

**Stairs**

Stairs must be level and uniform throughout their length. When this is not possible any variation must be mediated with adequately sized landings. The steps of a flight of stairs must have the same riser and tread. If possible, each flight of stairs must have the same number of steps, with a correct riser/tread ratio. (Diagram 8.12)

Where doors open towards the stairs, there must be sufficient access space in front of the door.

The tread of the steps must be slip-resistant, preferably rectangular and possibly with a continuous profile and rounded nosing.

Stairs must be fitted with a balustrade on the open side and a handrail made of durable material which is easy and comfortable to grip.

The width of the stairs and landings must be sufficient to allow two people to pass at the same time and allow for a stretcher to be transported horizontally with a maximum gradient of 15% lengthwise.

Short flights of stairs are preferable, however, if this is not possible, there must be intermediate landings or platforms to stop the fall of a person.

Handrails must be installed on both sides.

Where a lot of the users are children, a second handrail should be positioned at an appropriate height.

Natural side lighting is preferable; the stairs should have artificial lighting, also lateral; there must be a light control device on each landing which is visible in the dark.

Staircases must be easy to perceive, also for the visually impaired through tactile markings.

In particular, the stairs must be safe and obstacle-free. Moreover, they must meet the following requirements:

- A flight of steps must have a clear width of at least 1.20m
The gradient of a flight of steps must be limited, and constant throughout the length of the staircase.

- Steps must have an appropriate riser/tread ratio; the sum of double the riser and the tread must be 62-64cm.
- Maximum riser height 18cm.
- Minimum tread depth 28cm.
- The profile of the steps should be continuous with rounded edges, the risers must be closed and the angle of incline between tread and riser should be 75°-80°, but definitely no less than 60°.
- Floor markings (a band of contrasting material that can also be perceived by the visually impaired) must be placed at least 30cm from the first and last step to signal the beginning and end of a flight of steps.
- The balustrade on the open side must be at least 1m high, with vertical supports a maximum of 10cm apart.
- When the handrail is not continuous, it must extend 30cm beyond the first and last step.

- Handrails must be placed at a height of 80-92cm; if a second handrail is necessary it must be placed at a height of 75cm.
- The handrail on the balustrade or full wall must be positioned at a distance of 4.5-6cm.
- The width of the stairs should be adjusted according to their position and use within the building.

**Ramps**

The gradient of a ramp must be such that a wheelchair user can use the ramp without tiring; the length of the ramp must also be taken into consideration. In the case of particularly long ramps, level landings must be provided. The specifications and precautions described for the stairs, as well as the details mentioned in the definition of external routes, are also valid for indoor ramps.

**Lifts**

The means in place for accessing different levels in a building must be suitable for all users. Even where there are complementary systems of access to different levels, such as stairs and ramps, lifts must be provided throughout to serve all levels. **(Diagram 8.13)**

The lift car must be at least large enough to accommodate one wheelchair. The lift doors and floor doors must be automatic and large enough to allow a wheelchair to pass through. The door opening system must be fitted with a suitable mechanism (photoelectric cell, safety contacts) to stop and open the doors in case of obstruction. The lift must stop at the landings with closed doors. The control buttons inside and outside the lift must be positioned at an appropriate height for wheelchair users and must be easy to use for visually impaired people, preferably with tactile or Braille markings. In front of the lift door there must be a clear space large enough for manoeuvring to ensure convenient entry by wheelchair users.

All in all, the layout and detailed project must include the following specifications:
Minimum car size: depth 1.70m, width 1.50m in new buildings; depth 1.20m and width 0.85m in existing buildings to be restored.

The lift door, positioned on the short side, must have a minimum opening of 95cm in new buildings and 75cm in existing buildings to be restored.

At each floor level there must be a minimum clear space of 1.50x1.50m in front of the lift.

Car doors and floor-level doors must be of the “automatic sliding” type; in restored buildings, the floor-level door can be hinged as long as it is fitted with an automatic door-opening system; in all cases, the doors should remain open for at least 8 seconds with closing time of at least 4 seconds.

Levelling at landings is critical and a tolerance of only + 2cm is allowed; the lift car must stop at floor levels with closed doors.

The control buttons inside and outside the lift must be positioned no higher than 1.20m from the floor; the inside control buttons should be positioned on a side wall at least 35cm from the car door.

Inside the car there must be an alarm as well as an emergency telephone or intercom positioned at a height no less than 0.85m from the floor; the emergency lighting system in the lift must remain operative for 3 hours.

The control buttons must have raised tactile numbers and Braille translations of any words; next to the control buttons outside the lift there must be a Braille panel indicating the floor level.

Within the car and at each landing there must be audible announcements and a clear visual display of the floor level reached. There must also be a luminous sign to signal an alarm.

Consider providing fold-down seats in larger lifts.
Stair-lifts and platform lifts

Stair-lifts and platform lifts can be used as an alternative to ramps or lifts where space is limited. They can also be used in restored buildings or small facilities where passenger lifts cannot be accommodated.

These kinds of lifts must be fitted with a protection system to guard against falls, crushing or collision; devices must also be fitted to guarantee safe movement, as well as mechanical, electrical and operational safety.

When stair-lifts or platform lifts are not in use, the foot rest or platform should be folded towards the wall or fitted into a recess in the floor.

The space in front of the platform, when departing and landing, must be large enough to allow convenient access or exit by a person in a wheelchair.

Functional and dimension specifications:

Stair-lifts (Diagram 8.14)

- A stair-lift is intended to transport persons with reduced or impaired mobility; it is powered by an electric engine and runs on a track installed along one side of the stairs (in both directions) or other inclined surface
- Types of stair-lifts
  a. Perch lift: to transport a person standing up
  b. Chair lift: to transport a person sitting down
  c. Perch stair-lift with fold up seat: to transport a person sitting down or standing up
  d. Platform stair-lift with fold-up platform: to transport a person in a wheelchair
  e. Platform stair-lift with fold-up platform and fold-up seat: to transport a person in a wheelchair or sitting down

Stair-lifts are an alternative to lifts when the change in level is not more than 4m.

- In public places, and generally in communal parts of a building, stair-lifts must also allow wheelchair users to overcome a change in level. In this case, if the visibility between a person on the platform and a person positioned along the route of the stair-lift is less than 2 metres, then the entire space occupied by the moving platform must be protected and closed off by a balustrade. The stair-lift must have its own separate and enclosed route with automatic gates at each end of the run
- An alternative to an enclosed stair-lift is a stair-lift which enables another person to accompany the user; these have the same kind of controls as the regular stair-lift, as well as acoustic and visual signs to indicate that the stair-lift is moving

Platform lifts (Diagram 8.15)

- Platform lifts are designed for vertical travel of no more than 4 metres and at a maximum speed of 0.1m/s; if compatible, platform lifts should comply with the technical provisions described for stair-lifts
- The platforms and the shaft enclosure must be protected and both accesses fitted with gates or doors
- The minimum load capacity must be 130 kg
- The shaft enclosure must measure at least 90x120cm
- If the platforms are installed outside the facilities, they must be protected against atmospheric agents.

Surfaces

General information

The floor surfaces in a sports facility are of significant importance to visually and/or hearing impaired people, and wheelchair users.

- Hard surfaces cause noisy reverberations than can confuse people with visual impairment
- Shiny or glass surfaces may cause confusion especially if they reflect elements, such as handrails, and lead people to see double
- For easy use of wheelchairs, surfaces must not have ridges and bumps, and must be firmly fixed
- Junctions between different flooring materials must be smooth to prevent wheelchair obstruction or tripping hazards.
- The floor colour should be different to that of the walls and that of the ceiling; all additional features, such as emergency
Diagram 8.14
Stair-lift

Diagram 8.15
Platform lift
lights and rubbish bins, must also have a contrasting colour. The use of colour differentiation, tonal contrast and special textures makes a significant difference to visually impaired people navigating a building.

- Textured surfaces provide information to people with reduced or impaired vision who rely on contact to gain orientation. Tactile or textured flooring can be used to warn of an approaching hazard, such as a change in elevations, or to provide directions. Tactile or textured walls provide guidance to those who rely on direct contact to gain orientation.

- Wall coverings should be slip-resistant to provide additional support elderly people and those who using walking aids such as sticks or crutches.

If the facility has fixed routes, push gates, turnstiles etc., these must be sized and adjustable to ensure the passage of wheelchairs. Any automatic opening and closing systems must be timed to allow for the convenient passage of people in wheelchairs. Where required, a suitable waiting area with seats must be provided.

**Furniture - Fixtures and Fittings**

**Indoor furniture**

Social areas must allow unhindered access to people in wheelchairs and easy accessibility to all the furniture in the area. Furniture should not have rough edges or sharp corners.

In particular:

**Counters and table tops**

- Counters and table tops for general public use must be installed so that at least a section of these is lowered to be accessible to people in wheelchairs i.e. between 75cm and 80 cm from the ground (Diagram 8.16 a/b).

- A head-on approach in a wheelchair is preferred; this requires a clear under-the-counter-knee space of 40cm in height and a maximum depth of 50cm across the top of the counter. Where a sideways approach is unavoidable, the counter depth may be reduced to 30cm. There should be a clear space in front
of counters, with a minimum width of 80cm suitable for either wheelchair approach

**Seating and tables**

- Seats should be stable but movable, and tables should have corner legs or legs which are positioned to enable wheelchairs to fit underneath so that wheelchair users can sit together with companions
- Raised seating areas should be avoided or kept well below 50% of the total provision in order not to restrict choice unreasonably, or segregate groups of users from specific facilities

**Telephones**

- Telephones should incorporate features for universal use, including couplers
- Single telephones should be fitted at a convenient height, with the top row of operating buttons no higher than 140cm and card or coin slots no higher than 120cm above floor level. A group of telephones can offer a range of heights
- Perching seats and incorporated shelves are practical
- Telephones should be located sheltered from background noise.

**Spectators’ area**

**Spectator seating provisions (Diagram. 8.17)**

The route to the spectators’ area should be easily identifiable with tactile surfaces and an orientation system to help persons with a disability to reach their destination. Different coloured walls, floors and ceilings should be used to define different sectors, and an adequate lighting system should be installed in all main areas of the building. At present there is no regulation to stipulate the exact number of spaces to be reserved for people in wheelchairs, however, French guides suggest the following minimum specifications:
- 2 spaces for a seating capacity of 50 people
- 3 spaces for a seating capacity between 51 and 100 people
- 4 spaces for a seating capacity between 101 and 500 people
- 21 spaces or more for a seating capacity of 1001 or more people.

The Regulations issued by the Italian National Olympic Committee state that the ratio of spaces reserved for persons in wheelchairs should be 1:400 and that these spaces should all be concentrated in the same area. This ratio refers to large facilities with a high number of spectators; in small facilities, a minimum of 4 spaces should be reserved for wheelchair users.

Provisions for wheelchair-accessible seating should be made at an overall rate of no less than 1% of venue’s net capacity and in all different categories of ticket prices, to allow for a free and wide choice. In certain competition venues, particularly ones hosting paralympic sports, where a greater number wheelchair visitors is expected, this rates increases to 1.5% of the venue’s net capacity.

The spaces should be positioned so that spectators in wheelchairs can sit together with their seated companions. Sight lines must enable wheelchair spectators to have a clear
view of the action over the area of play, and should not be obstructed by people in front or by structural features such as screens or balustrades which should be as low as possible or made of transparent material. Wheelchair spaces should meet the following specifications:

- Length 120-150cm - width 90-110cm
- Clear space in front or behind for easy exit; this area must be at least 100cm long and as wide as the actual space for the wheelchair
- The spaces must be enclosed by a protection system 80cm from the floor, with a wheelchair stop 20cm from the floor
- The floor must be horizontal and level.

**Toilets**

All facilities, installations and fittings should be designed for use by all visitors, including people with impaired mobility, hearing or vision, without having to adopt special measures. Adequate space must therefore be provided and particular care must be given to the choice of fittings.

Adequate space must be provided in the toilet cubicles to allow wheelchair users to manoeuvre and reach the sanitary fittings. Particular attention must be paid to the following:

**Entrance door**

The door should have a minimum clearance of 85cm (though 90 cm is recommended); the door should be of the sliding type or one that opens outwards. Sliding doors allow a person in a wheelchair to manoeuvre without the encumbrance of the door, while an outward opening door enables easy access if help is needed.

**Washbasin**

The washbasin must be accessible from the front; the area below the washbasin must be obstacle-free. The hand basin should be large, possibly 60-70cm, with the top edge 80cm from the floor. There must be a space in front of the basin, at least 80cm from the front edge of the basin.
The taps should be single-lever mixer taps, with an extendable pull-out hand spray.

**Toilet (Diagram 8.18)**

If possible, the toilet should be wall-hung or suspended so that wheelchair users can approach it from the front; the axis of the toilet should be 40cm from the wall. The size of the toilet and its position in the cubicle must favour wheelchair-to-toilet transfer; accessories to aid transfer include a fixed grab-rail on the side of the toilet installed 70-80cm from floor level, and a wall-mounted fold-away grab-rail on the free side. There must be a lateral transfer space at least 1m wide (measured from the axis of the toilet) to allow a wheelchair user to manoeuvre the chair more or less parallel to the toilet so the user can slide from chair to toilet seat (and back).

**Athletes’ area**

**Area and playing surface**

These spaces should not be any different from the other areas of the sports facility and therefore be accessible to “everyone”.

Access to the playing area must be obstacle-free and level with the other areas of the facility; if this is not possible, suitable ramps or routes must be provided as previously described.

The competition area must be made of hard, compact and slip-proof materials that allow wheelchairs to run smoothly; this is particularly important in the case of wheelchair basketball where the floor must be made of wood, artificial flooring or hard rubber. Soft flooring or surfaces which are semi-stabilised or stabilised but non-uniform should be avoided.

**Changing rooms**

The aforementioned accessibility specifications and general accessibility standards (doors, routes, flooring, etc.) also apply to the changing rooms. More specifically:

- **Changing area**
  - Seats for athletes in wheelchairs must be installed at a height of 50cm from floor level, with adequate clear space to one side to manoeuvre and position the wheelchair
  - Lockers, hooks, stands and racks for clothes, and similar equipment, must be easily accessible, and therefore positioned at a height of 120cm from the floor level
  - Hairdryers should be wall-mounted no higher than 140cm from the floor and should have flexible outlets
  - Mirrors must be full-length and positioned 20cm to 180cm from the floor
  - Shelves for personal objects must be fixed 90cm from the floor

- **Toilet area**

  The toilet area must include a toilet and washbasin with the aforementioned specifications. Specifications for the showers are listed below:
  - The shower must be flush to the floor slightly sloping towards the drainage point.
  - A fold-up seat should be foreseen, installed at a height of 50cm from the floor; the seat should be 90x120cm and should have sufficient space next to it to manoeuvre a wheelchair. Accessories to aid wheelchair-to-seat transfer (and back)
should be installed.
- Shower controls must be lever-operated with a mixer installed 90 cm from the floor at the side of the seat.
- Two showerheads should be foreseen at different heights and on different walls: one fixed showerhead 190 cm from the floor and one with a flexible tube installed on the wall next to the seat 80 cm from the floor.

**Signs**
All sports facilities should have clearly visible signs to provide information and directions. There should also be signs to indicate the location of facilities accessible by people with reduced or impaired mobility. These signs should carry the International Symbol of Access (ISA), also known as the wheelchair symbol.

*(Diagram 8.19)*

All signs must be easily legible. Additional signs in Braille or audio systems should be provided for visually impaired people. Potentially hazardous situations must be immediately obvious and signalled by visual and/or acoustic means. More specifically:
- There must be a strong contrast between the background colour of the sign and the colour of the letters, numbers and pictograms, and between the sign and the surface behind it. Transparent material should not be used for signs as it creates confusion.
- Bold letters, raised pictograms and direction arrows help people with reduced vision.
- Signs should be suitably illuminated by natural or artificial lighting.

**Additional information**
Building diagrams or maps should be clear, possibly raised and positioned between 90 and 170 cm from the floor.
Graphic diagrams can be used in large buildings to help users identify specific points and the best routes, and to facilitate evacuation in the case of an emergency.

**Emergency Management**

*Emergency* - most procedures in place for the emergency evacuation of persons with a disability include the following rules:
- Incorporation of refuge areas - relatively safe areas on escape routes where people with reduced mobility can rest or wait for assistance before they exit the building
- Use of lifts - facilities with lifts must ensure their safe operation in the case of an emergency, in cooperation with the fire brigade.
- Emergency protocol - implementation of clear procedures for the assisted evacuation of persons in refuge spaces and evacuation lifts where these are present and working. Alarm systems must be able to avert all users, and therefore be both audible and visible (flashing beacons).
- Personnel trained for emergencies - Staff at the facility must be adequately trained to assist persons with a disability in emergencies.

The success of a facility depends on the maintenance of accessibility devices such as fixtures and fittings, surfaces, and control systems. Continuous and regular maintenance will safeguard or improve the specifications contained in this guide and ensure that they are not compromised or rendered ineffective and invalid.
Special Technological Installations and Security Systems
One extremely important factor in today’s management of a sports facility is the continuous monitoring and control of the entire structure, carried out on a daily basis and during special events.

Technological installations which control devices, parts of the facility or building components, represent a large part of the overall cost of the facility, as previously described, and are fundamental for its operation. Technological installations still tend to be considered separately from the overall structural and architectural planning of a sports facility; as such, they are often added after a building has been completed to correct unforeseen environmental conditions, for example air conditioning, sound diffusion, lighting, etc.

With the recent advances in the technology and innovation sector, we have seen a shift from manually operated and therefore cost-intensive installations to automated systems or intelligent systems, which we now increasingly rely on to manage and monitor technological operations.

Innovation technology is part of our everyday life, on the one hand improving communication processes, simplifying the management of technological systems and improving the quality of services, and on the other hand increasing the demand for comfort and safety and increasing the desire to live in an ecologically clean and safe environment. Technological convergence has grouped traditional automation and control operations together with innovative digital communications; in this way, new needs for information accessibility and availability can be met alongside the demand for energy optimisation, safety, and improvement in the quality of services.

The use of automated systems enables comprehensive control of the installation and system components which is undoubtedly a great advantage for a large basketball facility or large outdoor sports centre. Automated systems can be used to control:

**Environmental management (microclimate and energy requirements)**
- Air conditioning (temperature control, control of air speed and humidity);
- Heating of hot sanitary water;
- Lighting (indoor and outdoor), emergency lighting and emergency power supply;
- Sound diffusion;
- Distribution of electricity and load management;
- Irrigation of green areas;
- Operation of opening mechanisms and entrance systems;
- Management of pre-planned scenarios during events or special situations.

**Management of devices and equipment**
- Operation of telescopic tribunes, screens, partitioning, mobile walls, etc;
- Automation of refrigerating and computer equipment;
- Automation of water and sanitary equipment, saunas, and whirlpools.

**Management of communication and information**
- Management of the analogue telephone network and telephone traffic (fax and answering machines);
- Management of the video intercom and intercom system;
- Transmission of data for remote control;
- Management of internal communication (audio-video).

**Security management**
- Access management;
- Operation of security systems: burglary alarms, anti-intrusion systems, perimeter security systems, anti-theft systems;
- Operation of fire protection systems and safety systems in the case of smoke, gas leaks or flooding;
- Local and remote video control of internal and external areas or specific points;
- Automatic operation of visual and audible warning signals in case of emergency.

It must be remembered, however, that Building Automation Systems (BAS) are still very expensive and, in order to achieve...
building automation, there needs to be a change in today’s concept of a building, from an “ordinary” to an “intelligent” building.

An “intelligent building” is one which is controlled by a Building Automation System; it is designed and constructed to allow for the integrated and computerised management of technological installations, IT equipment and communication networks.

Buildings of this kind are equipped to optimise the lifecycles of their component systems and their equipment, reduce maintenance staff costs and increase organisational productivity through correct planning and management.

“Intelligent” equipment cannot, therefore, be considered as a separate system from the building, but must be conceived and planned alongside the installation, construction and structural specifications in terms of organisation of space. Planning must be a joint effort between specialist planners, operators in the building and the IT sector, all of whom must interact to combine their knowledge and expertise in order to achieve high performance levels, not only of individual operating systems but of the building as a whole.

A building automation project must therefore include the plan of the building structure (a traditional building structure planned to offer maximum performance), integrated with a computerised system which represents the “intelligence of the building”.

There are three areas to be taken into account when planning an intelligent building:

- System automation;
- Information processing;
- Communication.

These three areas refer to systems which require very detailed design, right up to defining singular and specific technical characteristics, yet without disregarding their integration with the building structure and the synergies that this integration can generate.

In fact, if we consider that the cost of integrating these systems in tertiary sector buildings represents one third of the total building cost, and if we add to this the high management cost of these structures, it is easy to understand the importance of careful planning if we want to avoid oversized or redundant systems and installations, and optimise management costs.

Basically there are two automation systems:

- A system based on a central elaboration unit that manages all the operations on the basis of the results collected through monitoring operations;
- A system distributed throughout the building where interaction is on a local basis and the results are sent to a central unit for a general coherence check.

The second system is the one that mostly meets the requirements of a sports facility; control devices are connected by a fieldbus and central interactive monitoring (Diagram 9.1), allowing a horizontal integration of the functions. Fieldbus technology is achieved by installing a cable throughout the building which connects all systems and equipment necessary for the required operation. A good example of this is automatic temperature
regulation in an office to optimise energy consumption.

A smart system can carry out a number of tasks such as:

- Automatic operations and/or adjustments of the technological installations (heating, water supply, thermal ventilation, etc.);
- Control automatic functions;
- Centralise all important information on the monitored installations (conditions, alarms, volumes);
- Centralise all the necessary information for an adequate financial and technological management of the installations (volumes, energy consumption);
- Remote-control monitoring and function control using energy saving schemes and optimisation plans;
- Tackle critical operational conditions with emergency programmes which regulate the installations to minimise inefficiency;
- Display, graphically illustrate and automatically save information or retrieve information on request (historical data);
- Create a databank to transfer the information in the overall memory;
- Allow the remote transfer of data and remote control of installations.

**System architecture**

The architecture of a smart system is generally structured as follows:

- Central monitoring unit;
- Peripheral controllers;
- Technological installations;
- Regulation of environmental factors;
- Safety;
- Fire detection;
- Comprehensive services:
  - Monitoring of central units;
  - Closed-circuit television (CCTV).1

The level of control is defined according to the performances and services required by the facility manager. The smart system is configured according to management needs and desired results; for example, the level of relative humidity and temperature during ordinary facility use or on the basis of the number of spectators during events, the adjustment of mechanical operations, control of surface or component overheating, etc.

The central monitoring unit must process and collect all the information transmitted by the peripheral controllers, and record statistical and historical data to optimise maintenance. The peripheral controllers receive information on the status of the services; they are activated on the basis of precise system requirements and transmit important commands to components of operational units. Peripheral controllers are part of a distributed information system and consequently also have specific functions such as controlling, adjusting and resetting the functions at local level independently from the central monitoring system.

This type of system architecture is called a “distributed information system” system which generally operates with a greater processor speed. Information is distributed across the installations to be controlled, providing a higher level of protection because the information does not depend on one single, albeit efficient, central computer.

This type of system architecture obviously requires compatible hardware and software to enable it to connect different systems physically (through the same type of network) and logically (through a uniform definition of a communication protocol to exchange data and messages across all sub-systems).

An effective functional integration between homogeneous sub-systems and other subsystems (those that use software applications of different manufacturers) is extremely difficult to achieve and is often limited to a simple integration. Facility managers wishing to adopt “building automation” tools are advised to contact specialised firms that can provide all the necessary tools, hardware and software updating, and system

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1 Closed-circuit television (CCTV) is the use of video cameras to transmit a signal to a specific place, on a limited set of monitors. It differs from broadcast television in that the signal is not openly transmitted, though it may employ point to point wireless links. CCTV is often used for surveillance in areas that may need monitoring such as banks, casinos, airports, military installations, and convenience stores. (Wikipedia)
If we look at basketball facilities from a technical point of view, in particular those designed for large events, they include a great number of installations and/or functions that need to be controlled and computerised. In fact, they include all the installations present in a basketball facility:

- Air conditioning systems;
- Electrical installations;
- Sound diffusion systems;
- Lighting;
- Mobility connection systems (lifts, elevators, etc.), etc;
- Systems for the production of energy derived from alternative sources.

Furthermore, they include the various security systems in place to safeguard the building, and the people and objects in the building:

- Fire detection systems;
- Anti-intrusion systems;
- CCTV;
- Access control systems, etc.

**Control Systems for Technological Installations**

The system architecture must therefore include control systems specifically for technological installations: one for the electrical installation, one for fire detection, etc.

The following provides a brief description of the main functions that can be controlled by a computerised control system:

**Air conditioning** - the main function of this sub-system is to monitor, adjust and automate the building’s air conditioning systems to significantly reduce the amount of energy consumed through heating, air conditioning and ventilation.

The functions to be controlled are usually the following:

- Heat production (boiler, heat pump, etc);
- Production of cold air (refrigeration equipment, etc);
- Heat conversion (hot-cold batteries, converters, etc.);
- Humidification/dehumidification;
- Transport of convector fluids (pumps, ventilators, etc).

**Lighting and electrical systems** - the main function of these systems is to check and control the supply of electricity. More precisely, a complete system includes:

- Low/high voltage transformer rooms;
- Low voltage distribution boundaries;
- Local panels;
- Electricity supply back-up systems such as generators, UPS;
- Lighting;
- Occupancy sensors to automatically controlled lighting in the different rooms (changing rooms, offices, storage areas, toilets).

Several software programmes designed specifically for electrical systems can be used for energy saving. Their main attributes are:

- Limiting electric power peaks
- Cyclical stop
- Light control
- Monitoring underlying conditions of lifts or elevators

**Sound diffusion systems** - the main functions include:

- Control of sound according to the type of event
- Correction of distortions
- Relay of emergency messages.

**Special Safety and Security Systems**

Components of certain types of systems used for the ordinary management of a sports facility or during a sporting event can be used as safety and security devices.

Apart from the technology of the smart control systems described above, here is a list of some systems which collect data though the use of sensors and can be managed by an automated system to contribute to the implementation of the overall safety and security system.

Before examining this matter in depth, it is important to stress the difference between security and safety systems.

A safety system provides protection of persons and goods from accidental events caused by natural calamities or use of
machines. The fire detection system is a typical example of a safety system.

**A security system** provides the protection of persons or goods against attacks by third parties, aimed at causing damage or stealing goods. The anti-intrusion system is a typical example of a security system.

Most safety systems installed in buildings use sensors to protect people and objects; safety sensor devices include:
- Gas/fire detection;
- Automatic extinguishers;
- Flood detection;
- Evacuation and emergency management;

Most security systems include:
- Anti-intrusion device;
- CCTV;
- Access control.

These systems are usually interfaced with others, forming part of one universal system to protect the entire building.

**Fire detection** - the main objective of a fire detection system is to give immediate warning of a fire.

An efficient fire detection system must function from the initial stages of a fire to stop it from spreading, and thus limit damage to people and objects.

The direction and rate of fire development obviously depends on a number of factors, including the materials contained inside the building and the building’s structural components.

A fire detection system is typically made up of:
- A field detection device that usually includes:
  - Temperature sensors;
  - Photoelectric sensors;
  - Ionisation sensors;
  - Flame sensors;
  - Combined sensors;
  - Infrared linear sensors;
  - Manual alarm devices, such as push buttons in corridors or other suitable areas;
- Warning devices, such as:
  - Sirens;
  - Alarms;
  - Visual warning signs;
  - Visual/acoustic signs;
  - Sound dispersion systems.

The input/output module is usually made up of a microprocessor with a serial output for connecting to the monitoring system. The exchange is analogue.

In this type of system each sensor transmits an analogue value to the exchange module, corresponding to its current state (temperature according to temperature sensors, degree of darkness in a room according to optical sensors, etc.).

The exchange module constantly analyses the value transmitted by each sensor and compares it with the values set. For example, an optical sensor can distinguish between a long-term increase in the clouding or darkening of a room (caused by natural factors or dust accumulation) and a short-term increase in clouding or darkening (caused by fire). Specific procedures can therefore be implemented at this point (request for maintenance or alarm), enabling the threshold for each sensor to be set individually as well as on a time-basis (e.g. pre-alarm, alarm, fault, etc.), and thus reducing the number of false alarms. For instance, a lower pre-alarm can be set when the building is not occupied and the chances of triggering a false alarm (for example, through cigarette smoke) are considerably lower.

The main advantages of these systems are the following:
- Increased reliability and significant reduction in false alarms;
- Improved flexibility with regard to re-distribution of the indoor areas of the building (more or less frequent);
- Reduced cabling costs which partially counters the system costs.

**Gas detection**

The object of this system is to detect and signal the presence of toxic and/or explosive gases such as methane, liquefied
petroleum gas (LPG), carbon monoxide, etc.

It is made up of detectors, alarms and an input/output module.
The module and alarms can be the same as those used for the
fire detection system, of which the gas detection system can be
considered an integral part. Thus, the above information also
applies to the gas detection system.

However, whereas a smoke detector is triggered at the start of a
fire, in the case of explosive gas, the alarm should be actuated
before the gas concentration reaches a critical level that may
cause an explosion.

Specific sensors must therefore be used according to the type
of gas in question.

The most common types of sensors include:
- Semiconductors;
- Electrochemical cells.

The installation of sensors is a fundamental operation and
should be based on essential yet simple considerations which,
unfortunately, cannot always be applied in practice.

Explosive gas detectors should be ceiling-mounted when the
gas to be detected is lighter than air and tends to stratify in the
lower parts of a room; if the gas in question is heavier than air,
the gas detectors must be installed at floor-level;

Toxic gas detectors should be wall-mounted at head height.

**Flood and water-leakage detection**
The aim of this system is to detect and signal the presence of
water in the protected area of the building.

This type of system usually includes water detection probes
which react upon contact with liquids, an in/out module and
alarms; again, the module and alarms can be the same as those
used for the fire detection system, of which the water-leakage
and flood detection system can be considered an integral part.
Thus, the above information also applies to the water-leakage
and flood detection systems.

This system is generally used to protect those areas of a building
which contain pipe networks carrying liquids such as:
- Hot and cold water;
- Drinking water;
- Hot sanitary water;
- Waste water.

It is particularly important to protect areas with raised floors in
computer centres, piping in the under-passages, or with loose-
stone foundations, etc.

**Anti-intrusion system**
The main objective of this system is to stop people from
accessing unauthorised areas, or areas which may only be
accessed at certain times.

An anti-intrusion system is used to:
- Prevent breaking and entering;
- Check for persons in unauthorised areas;
- Check the security patrol services.

The composition of the sub-system varies from building to
building according to the various parameters. In theory, the
system is made up of three main elements:

**Sensors**: these devices are based on different physical laws
to accurately and rapidly detect any movement within the
monitored area as well as those typical signs of breaking and
entering;

**Alarm processing units**: these logical units manage the
signals received from a group of sensors and compare them
with a set of parameters to establish a genuine alarm situation;

**Actuators**: these devices transform the processing unit’s
input signal into an operational signal or other types of signals.

**Sensors**

**Peripheral sensors** - these are installed along the outer edge
of the area to be protected against intruders breaking and
entering.

Specific types of sensors placed underground detect changes
in pressure in the ground or changes caused by traffic in certain
areas; sensors installed on top of the fencing record changes
caused by electrical and mechanical stress, and other sensors,
which are built into the fencing, can detect perforation.
**Immaterial barriers** - these devices are made up of two parts, transmitter and receiver. The transmitter emits beam of radiation, which drops into the receiver, creating a barrier across a specific path. If the path is crossed, the optical connection between transmitter and receiver breaks and triggers an alarm. These barriers can be of the infrared or microwave type, and the devices can be installed indoors or outdoors, whereby special planning is required for indoor use.

**Volumetric sensors** - these sensors can detect the presence of people moving in the area monitored. There are three types of sensors used in motion detectors: microwave, infrared or ultrasonic.

**Microphones** - installed inside the structures, they can be used to monitor security armoured rooms by detecting vibrations caused by perforation, through the use of explosives, drilling machines, or pullers and cutters, for example.

**Contact sensors** - a magnetic contact sensor system monitors doors, windows and their mechanical parts, and signals when the magnetic circuit broken and entry breached.

**Temperature sensors** - these sensors use temperature gradients to detect the casual distribution of temperature typically produced by drills or similar tools in the walls of safes and armoured rooms or cabinets.

**Push-buttons** - mechanical push-button switches or “panic alarms” must be manually activated to send out an alarm.

- Regardless of the type of alarm employed, all sensors must not be too complicated to use

**Central alarm processing unit** - the main functions of a modern alarm processing unit are:

- Independent management of the sensors depending on the sensor type, with different timers for different areas;
- Connection of alarm signals transmitted by each sensor, identification of signals and protection against programmed tampering;
- System diagnostics, of both structural and electrical components, diagnostic procedures of test sensors;
- Reconfiguration of the system with reduced functionality when a part of the system is malfunctioning;
- Distinction between genuine and false alarms;
- Registration of all occurring events;
- Activation of actuators according to the specific procedures adopted;
- Interface with remote control unit to exchange information on the systems with particular reference to alarms, intervention procedures and transmission protection using sufficient cryptographic methods;
- Adequate autonomous power supply for the entire system;
- Protection against tampering of the logic, connection elements and power supply;
- Independent access keys according to their function.

**Actuators**

Depending on the particular specifications of the system, actuators may be required to transmit impulses (open or close doors, switch lights on and off, start and stop various equipment, etc.) or send out a warning signal (sirens, lights, pre-recorded information, etc.) to the control panel.

The appropriate services will then be activated by the processing unit by means of relays.

A good security system must always be able to monitor, restrict and allow the movement of people through entry/exit points of a site.

Usually people are admitted into an area of the building when their presence is desired or required. Access can be monitored by installing an access control system without having to resort to surveillance staff.

The access control system in a basketball facility should have one or more card-readers installed at the entrances to monitor access using personal identification cards, with security chips or magnetic stripes. These cards must be inserted into the card reader which will release a device allowing authorised passage after having checked the validity of the card. Some systems
use contactless smart cards which contain chips that can be read by just holding the card close to the reader without actually inserting or swiping it (proximity readers). Some high-level security systems use fingerprint, voice or retina readers.

As a rule, access procedure includes:

a. Checking the correct coding of the card and verifying its authorisation
b. Checking whether the card is authorised for the respective entrance
c. Checking whether the validity period is correct
d. Checking whether the weekday is correct

If all these conditions are met, the reader releases the locking mechanism, authorising the cardholder to pass through.

The magnetic card reader will also produce the following in/out signals throughout the operation:
- Open/closed status of the monitored entrance (door, sliding gate, etc.) detected by mechanical and magnetic contact
- Control the electronic closing system to open and close the entrances using a 24/12Vcc contact
- Supply power to a push button to enable manual operation of a monitored door or entrance

Security can be enhanced by adding a keypad to the card reader, requiring the cardholder to enter a personal identification number (PIN). A typical example of this is a normal electronic bank card for use at automated teller machines (ATM).

Closed-Circuit Television (CCTV)

The simplest version of a CCTV system comprises a video camera to collect and transmit images. If several video cameras and monitors are used, an adequate video switcher will be required.

The following operational requirements must be taken into account when designing a CCTV system:
- Illumination levels: daylight, night light, natural and/or artificial light, shade, etc;
- Field of view: fixed or adjustable, distant or close, narrow or wide;
- Image quality: high or low resolution;
- Camera placement: is the location clean or dirty, damp or dry, subject to vibrations, etc.?
- Operation control: automatic or manual;
- Image viewing: fixed, sequential, split screens, movement-activated;
- Recording: real time, time lapse, activated alarm.

The television camera must have a clear lens and a change-coupled device (CCD)\(^2\) image sensor to capture the images. Compared with earlier telecamera lenses, the advantages of these lenses are:
- Reduced dimensions;
- Limited consumption (2-3W);
- No geometric image distortion;
- Insensitivity to external magnets;
- Durability;
- Reduced warm-up period (0.5s);
- Low maintenance.

Lens performance can be improved by automatic scanning and automatic lens control devices, such as a zoom lens or focusing lens. The use of these systems increases the area covered by each optical system without manual intervention. If the camera is installed outdoors it must be sheltered from bad weather and be fitted with a thermostatic heating system.

The optical system is a very important part of a video camera. The angle of view of a lens depends on the focal length which can vary from 5mm (wide angle lens) to 150mm (telephoto lens). There are two types of lenses:
1. Fixed-focal-length or prime lens;
2. Zoom lens.

Fixed-focal-length lenses are characterised by a variable focal lens (e.g. 50mm): only the focal lens and aperture can vary. These optical systems can therefore cover only one field of view, without the use of supplemental lenses.

\(^2\) Charge-coupled device, an electronic light sensor used in digital cameras (Wikipedia)
Zoom lenses have a focal length that varies within a range (e.g. 16-160 mm) and can cover all the fields of view included within that range. The focal length can be altered manually or automatically to alter the field of view. Optical zoom lenses are the most commonly used in security systems.

**Monitors**

Monitors are used to display the images generated by the video cameras. Nowadays they are almost all colour monitors. The screen is measured diagonally in inches and can vary between 3 and 26 inches; the most common sizes go from 9 to 12 inches. Screen resolution is measured in television lines (e.g. 700 TVL). The number of vertical lines defines the quality of the image. A greater number of lines generally equates to a higher image resolution. A high-resolution monitor usually has television lines (TVL)\(^3\) rating between 800 and 1,000.

**Central control unit**

The central control unit represents the highest number of monitors that can be controlled by one single person and it is generally estimated to be four.

A more accurate control can be carried out when there are only two monitors.

A central control unit is necessary to display the images from several cameras on a limited number of monitors.

Different types of control units are available: some are very simple and have a fixed number of inputs and outputs with a manual switch; others are sequential, displaying different camera scenes simultaneously, in sequence, on a given number of monitors.

Some systems have configurable automatic alert functions which are activated when a particular event occurs. The CCTV can be linked to other security systems, such as the anti-intrusion system, and be automatically activated when an event such as intrusion occurs, or, if equipped with a detection system, the CCTV can detect an event and trigger an alert.

**Additional equipment**

The CCTV system can be integrated with supplementary devices to improve performance, add information or simply make cabling easier.

The main devices are:

- Video amplifier - used to amplify the distance between the optical system and the monitor to over 600m;
- Distribution amplifier - to transmit the signal of one camera to multiple locations. A typical unit has one input and four outputs;
- Time and date generator, and camera identification - this generator is used to superimpose the date and time on the image displayed on the monitor, and it identifies the camera using a code system;
- Screen splitter - to simultaneously display images from different cameras (2, 4 or 16) on one monitor. This is particularly useful when combined with a second monitor programmed for the sequential display of the camera images;
- Video recorder - fixed recording time - This system is usually used with an alarm system: the system automatically switches from time-lapse to real-time mode when an alarm signal is received and records for the length of time set;
- Motion detector - this device is used to activate one or more cameras and initiate recording if a movement is detected in a given part of a camera-projected image;
- Dial-up system (video frame rate reduction) - a general term to describe a system that transmits images using the telephone line. This system is typically applied to monitor areas which are not controlled by a central security unit, using an intercom system or specially assigned telephone line.

\(^3\) Television lines - a video camera specification defining image resolution (in lines) (Wikipedia)
Outdoor Basketball Facilities
Outdoor basketball courts are becoming extremely popular in the urban areas of cities all around the world, where youngsters often have their very first taste of basketball.

This realistic “vision” emphasizes the importance of an outdoor basketball facility for the local area, both from a sporting and social point of view. Outdoor basketball facilities can be considered special places because they promote socialisation between youngsters, and offer a simple and unconventional first approach to sport.

This ideological concept can also be found in the Olympic Movement’s Agenda 21 whose overriding principles encourage the international community to contribute towards improving social and environmental policies:

“An environmental policy which aims at efficient and sustainable management of resources must take account of those who depend upon those resources and ensure that they can live with the dignity to which every individual is entitled. This is why the Agenda 21, adopted by the United Nations, proposes that action plans should take account of the fight against poverty and encourages the integration of disadvantaged social groups”. (Olympic Movement’s Agenda 21)

“The Olympic Movement has shown by its history that it has an essential part to play in combating poverty by enabling individuals and groups to fight against social exclusion through participation in sport”. (Olympic Movement’s Agenda 21)

Small-scale basketball facilities can be integrated into urban communities more easily.

Outdoor facilities do not necessarily have to be located on the outskirts of cities where infrastructure is lacking; they can be located down-town, on the inner-city fringe, in former industrial areas, now abandoned, where all that remains are old decaying buildings. Or they could be located on vacant land, once part of the town, and now relinquished, uncultivated and unused. These settings are ideal for introducing new concepts to urban and local planning.

Basketball facilities of this kind are not intended merely to attract players and spectators but lend character to the local social and urban environment. Thus, if a facility is set up close to other sports or recreational facilities, nestled within surrounding green areas, the return on investments made for the entire operation will be greater in terms of long-term benefits.

On the basis of these principles, the International Basketball Federation (FIBA) intends to encourage people from disadvantaged social environments to become involved in sporting activities by promoting the diffusion of outdoor basketball facilities; these should be located on the outskirts of large cities or in densely populated urban areas where there is a strong presence of youngsters.

The construction of adequate infrastructures can provide today’s youth with a source of fun and enjoyment through social activities.

The exact location of an outdoor basketball court is very important, and ideally lends itself to a site close to an existing structure already frequented by young people, such as schools, sports centres, green parks in scarcely populated areas, car parks of underused office blocks or facilities and areas used for exhibitions or markets.

Another interesting location for outdoor basketball courts is in tourist areas, near beaches, campsites and tourist villages; this is ideal for occasional or seasonal activities, offering tourists and locals a fun alternative in their free-time.

**Project of an Outdoor Basketball Court**

**General aspects**

The project of an outdoor sports facility includes two fundamental phases: **design and execution**.

A correct design phase takes into account the intended use of the facility at all stages, from planning to the technological
choices.

When conceiving a facility, it is important to consider the geomorphologic characteristics of the land; the ground should be geologically stable and level requiring only minimum intervention, and the site should ensure correct orientation of the court, bearing in mind minimum size and future expansion, and steer clear of any possible water drainage problems (groundwater sources, lowering of the water table, etc.) or potential flooding (flood beds, river beds, etc.).

The size of the facility will depend on the intended use. It is not always necessary to create large facilities; at times it may be wiser and more practical to create several smaller ones.

The choice of the materials depends on the characteristics of the facility, on management availability and the budget at hand.

The sports flooring market offers a wide range of outdoor sports surfaces at varying prices. It is advisable to contact companies with experience in this sector and, if possible, have the same company install the sub-floor and the top flooring layer.

**Main Features of an Outdoor Court**

FIBA standards are very precise and stipulate that:
- The courts should measure 28x15m with a perimeter band of 2m for a total surface area of 608m²;
- The court should be level and obstacle-free;
- The climate is a very important factor for outdoor basketball courts. Outdoor courts which are constantly exposed to the sun require very careful planning in order to ensure that the sun’s glare does not disturb or distract players during competitions (backs to the sun);
- Changing rooms and artificial lighting should be provided;
- The specifications for the changing rooms are the same as those for indoor facilities; they must be functional and integrate well with the surroundings and any other amenities.

**Evaluation of the Effects of Construction on the Environment, the General Environmental Impact, and Area Specifications**

**Area Specifications**

In addition to the above features, the area on which an outdoor basketball court is built should have the following characteristics:

1. The site should take into account the need for the correct and appropriate orientation of the court and any future extensions.
2. The geomorphologic characteristics of the ground should be considered; it should be geologically stable and level to limit ground movements and support foundations (walls, etc.) as much as possible.
3. The court should not slope towards once side only to eliminate rainwater or be fitted with other systems.
4. The site should be protected from particular climatic conditions such as winds.
5. The site should be linked to a road network and public transport infrastructure to enable easy access for spectators and emergency vehicles, as well as orderly and effective crowd dispersal.
6. The location should allow easy use of energy sources such as electricity and water, as well as access to primary services such as sewerage.
7. The court should be flexible in terms of use so it meets the multifunctionality requirement.
8. The area should be far from large electromagnetic sources, acoustic pollution and toxic gas emissions.
9. The area should not be close to any particular type of vegetation that may damage the playing area or create a hazard.
10. The site should undergo a geological survey to ascertain the type of terrain, and to check for harmful elements and underground springs. The presence of underground
watercourses can amplify electromagnetic pollution.

**Study of sunlight**

Natural lighting is fundamental for outdoor basketball; therefore the position of the court in relation to the solar path is important.

For this reason, the court should be situated so that the sun is in a lateral position to the main axis of the court. The latitude at which the court is built must also be taken into account.

In order to ensure the most appropriate position of the court, planners must know at what times of the day the court will be most used.

Ideally, the court should have a north/south orientation, with a tolerance of +/- 15° deviation depending on whether it is used in the morning (+) or afternoon (-), but not around midday. If the court is used around midday, then the ideal orientation is east-west with a tolerance of +/- 15° deviation as needed.

If the outdoor facility is intended to attract spectators, an area should be reserved for them on the side parallel to the longitudinal axis, so the sun is behind them.

Below are some indications on the study of sunlight, and on the *sun path Diagram* and its use.

Observing the sky or celestial sphere, it is apparent that:

The sun's path seems to change every day of the year. As one moves across the earth’s latitudes, the path changes.

The size or elevation of the path also changes in the northern hemisphere; it is at its lowest during the winter solstice and reaches its peak during the summer solstice when it is at its highest, after which the path gradually lowers again until the next winter solstice.

If you place a screen between your observation point and the sun, and if you mark the position of the sun at different times of the year, the graphic result would be the following (Diagram 11.1).

*Diagram 11.1*
Sun Path Diagram

The cylindrical sun path diagram is a convenient and user-friendly instrument used to predict the position of the sun in the sky as seen from an observation point placed on earth between 28° and 56° North latitude. The diagram is a vertical projection of the sun path seen from the earth.

We could say that the sun path diagram is a vision from the earth of the apparent movement of the sun across the skyline. The above diagram relates to the latitude of the city of Geneva in Switzerland.

The instruments mentioned above can be used to ascertain the position of the sun at different times of the year and thus gather information that can be used to ensure that an outdoor court is protected from excessive exposure to the sun or prevent irritating contrasts between very shady and intensely bright areas. Once the position of the sun has been identified, appropriate screening can be provided to add light or create shade in the areas concerned.

Studies on outdoor court lighting for evening and night use

Outdoor basketball courts which are used in the evening or at night will require suitable lighting. The ideal system should include four lamp poles emitting direct light towards the free throw line; this will avoid any problems of glaring light for free-throwing players.

When defining the position of the poles and the lamp fixtures, it is important to minimise the risk of dazzling as basketball players are often forced to look upwards during play.

With regard to the choice of lamps and lighting fixtures, this depends on the intended use of the facility, the range of products offered by local firms and the available budget.

The best type of lighting is without doubt one that distributes light evenly over the entire playing area; the lighting intensity should be adjustable according to requirements and the type of competitions organised.

For training and recreational activities, an average lighting of 100 Lux is required with an illuminance uniformity of 0.5 (min/average), while for local competitions average lighting must be 200 Lux with a uniformity of 0.6.

Study on the effect of wind velocities

In the building sector wind velocity is often underestimated, however it should not be disregarded because, ultimately, it can be a source of pollution. What is more, wind affects the static electricity of an area which may result in an increase in risks caused by energy fields.

The importance of natural windbreaks is examined later in this guide.

Planning and maintenance of green areas

Landscaping is a new element in building planning. Apart from being aesthetically pleasing, green areas are also very important as natural barriers for outdoor sports facilities.

Evergreen plants will protect north-facing courts from winter winds.

Deciduous plants will protect south-facing courts in the summer and allow the light to filter through in winter.

Green areas do not have to complement the types of competitions played, but it is important to have the right amount of bushes and shrubs to create a regular vegetation cycle.

Soil testing will be necessary to ensure the soil has enough nourishment for the plants, and the soil and climate properties must be studied, along with soil treatment and treatment methods.

When planning the landscape around an outdoor sports facility, it is important to incorporate the plants already present, or those typical of the area, so that the project is as natural as possible.

Technical and Safety Aspects

Compliance with local safety laws

In many countries, the planner must provide sports ground safety certification alongside all other graphic and technical documentation during the planning phase. The safety certificates often relate to the planning and construction phase. Safety
certification in the planning phase should include a study and detailed evaluation of the risks related to the construction areas and relevant equipment. The planner must also define procedures in place to eliminate the risks mentioned. An expert must cost out the safety requirements and this budget must not be reduced.

During the construction phase, the planner must affirm that all work carried out complies with the Safety Plan, by conducting on-site inspections and recommending safety improvement measures.

**Certification and raw materials**

In many countries, the materials used to construct a sports facility must be certified; the quality of the raw materials must also be certified, as well as their conformity with the specifications and standards for their specific use. Safety standards bodies overlooking the procedures must provide certification in accordance with the standards in force in the respective country in which the facility is to be located (CEN or ISO certificates in Europe).

Special equipment which is installed directly by the manufacturer must be supplied with the manufacturer’s certification. Once construction of a site has been correctly completed, the site manager must be in possession of all the certificates supplied by the various suppliers of equipment and materials. (See FIBA Study Centre Approval).

**Compliance with local technical and sanitary regulations**

Outdoor basketball facilities and ancillary services (changing rooms, storage areas, first aid rooms, offices, etc.) are subject to an inspection once construction is complete, to check that everything has been built in compliance with the local regulations in force. These regulations often include provisions on the distance between buildings of the same type or of different types, distance from roads, industrial areas etc.

With regard to the construction of ancillary sports services (changing rooms, indoor areas, toilets and bathrooms, etc.) specifications contained in local regulations must be heeded.

These regulations often concern specific hygienic-sanitary requirements such as lighting, ventilation, waste-water system and sanitary water supply.

It is important to remember that most countries have technical regulations concerning building materials for which, as indicated above, certification must be issued testifying that these products are not hazardous or toxic.

**Maintenance**

**Ordinary maintenance**

Ordinary maintenance includes the work necessary to ensure the continuous functionality of the entire system. Ordinary maintenance ensures continued use of the facility, thus preserving the facility’s economic value.

Maintenance of an outdoor facility requires particular attention to the surface of the playing area and the equipment:

- Maintenance of the floor surface involves repairing flooring elements which become detached or uneven, or treating and improving areas exposed to heavy impact and abrasions. This type of maintenance is necessary regardless of the kind of floor materials used. Asphalt courts may require special maintenance given the surface film;

- Maintenance of the equipment involves checking for rust, deformed metal parts, splintered or rotting wooden parts, broken baskets, benches and tables. Equipment foundations and anchorage devices must also be checked for wear and tear.

The ancillary areas must also be regularly maintained; the structures and partitioning walls of changing rooms must be inspected, and sanitary fittings and facilities kept in good working order. This type of maintenance may involve the repair or replacement of fixtures and fittings, lights and other accessories. Finally, fencing and walls must be inspected for damage.

**Extraordinary maintenance**

Extraordinary maintenance involves any special intervention required by the facility. This type of maintenance is necessary when, considering the age and prolonged use of a facility,
ordinary maintenance no longer guarantees the use and availability of the facility. Extraordinary maintenance is required in the case of sudden and/or unforeseen occurrences which may result in closure of the facility (extraordinary weather conditions, exceptional events, etc.).

**Constructing the Playing Area: Technology and Materials**

**GENERAL ASPECTS**

**Origins of raw materials**

In compliance with international environmental standards, the building sector must adhere to certain regulations and commit to:
- Ensure that the raw materials originate from an ethical source;
- Ensure that the raw materials are derived from renewable resources;
- Ensure that the environmental damage caused by their use is minimal.

The aim is to protect the environment throughout the entire transformation process.

The sustainable nature of a material depends on its environmental impact throughout its lifecycle. The entire lifecycle must be taken into account: extraction of the raw material, intermediate transformation process, packaging, transport and distribution, use and consumption, disposal, recycling and final removal.

The sustainable nature of a material is evaluated on the basis of its entire lifecycle through a careful study of its history. The complex nature of the transformation sector makes it particularly difficult to assess the environmental quality of building material and to plan a correct “ecological balance”.

**Guidelines for the selection of building materials using sustainability tests**

A preliminary list of useful guidelines in the selection of raw materials includes the following:

1. Study what has already been tested - ecological balance of the material;
2. Maintain a closed cycle - comparison with natural materials for an overall recycling plan;
3. Use renewable raw materials - guarantee development and continuity;
4. Save energy - during the excavation, production and distribution phases;
5. Save resources - evaluation of raw materials;
6. Opt for various different materials rather than one same type - select materials according to function and use;
7. Encourage “regionalism” - buy local raw materials;
8. Implement the threshold principle - evaluate needs and requirements, eliminate what is superfluous;
9. Use natural energy elements - conformity.

Some useful elements for the evaluation of the biological properties of building materials are listed below.
- Heat storage capacity;
- Thermal conductivity: ability of material to transfer heat;
- Temperature: temperature measurable on the surface of the material;
- Hygroscopic property: ability to absorb and release humidity from/into the surrounding atmosphere;
- Diffusion: non-convective transfer of liquids and gase;
- Absorption: ability to filter, accumulate and regenerate volatile elements;
- Ventilation: circulation of air according to the different temperatures, pressure and density of the materials.

**Properties of constructional materials**

The following list of materials commonly used in the construction sector and/or required in the construction of outdoor basketball facilities is based on the above criteria:

**Cement**

The use of pure cement is recommended; only the minimum required amount of additives is needed to ensure ample resistance and adequate treatment. Tests should be carried out by local institutes to verify the absence of radioactivity or other
harmful components. White cement is preferred to grey cement.

**Iron**
Steel, an iron alloy, is generally recommended because its high traction coefficient (high resistance to tensile stress) means the amount used can be limited. Even better, however, is stainless steel, a steel alloy. Due to its particular micro-structure, stainless steel has a low magnetic permeability and therefore a low or negligible response to electromagnetic fields. Stainless steel therefore acts as a magnetic shield, eliminating problems otherwise caused by the electromagnetic fields typical of metal elements, especially reticulated metals.

**Wood**
Wood can be used for ancillary structures, spectator areas or storage areas, however it is generally unsuitable for outdoor court flooring due to its high water permeability and absorption properties, causing it to shrink or break when dry and exposed to heat. Wood is also prone to damage by insects and parasites.

Wood used for indoor facilities, or outdoor facilities which are protected against direct exposure to atmospheric agents, should be dense, hard and strong, as it is more durable and more resistant to decay and insect damage.

**Stone**
Stone is not recommended if it has a high radioactive content, which is generally the case with many marble products or stones of volcanic origin such as tuff.

**Materials and Technologies for Outdoor Basketball Facilities**
Drawing on the experience from courts built in various locations using various materials (earth, asphalt, cement, etc.), this guide provides practical suggestions with technical and structural concepts and solutions that comply with recent safety standards and recent technology in flooring materials.

**Surface types**
Having determined the location, dimensions and orientation of the court, an analysis of the construction concepts should be provided so that the building work can proceed. To do this, we must consider how the surface will be built with the appropriate sub-grade (binder).

The structure of the surface should consist of the following:
- Base level;
- Base course;
- Sub-grade;
- Surface.

**Base level (excavation and filling material)**
This is the base on which the various layers of the surface must rest; therefore, it must have the necessary stability and uniformity requirements.

If the chosen site is level, general excavation will be carried out to eliminate the top layer by 30 to 40cm.

If the site is on a slope, excavation will include terracing the higher part, transporting the material to the lower part, and containing the material with support work. Adequate consolidation should be ensured to avoid subsequent differentiated settlement or subsidence.

**Drainage**
After the location of a court has been determined, drainage should be a primary consideration in assessing the elevation of the court. The ability of the soil to handle the surface runoff of an entire basketball court will vary widely from place to place. If the area surrounding the court is a very porous, granular material, then drainage sometimes takes care of itself. In most cases, special consideration will have to be paid to where the water goes when it rains. A full-sized basketball court (15x28m with a 2-metre safety border = 608m²) will collect a lot of water. Often local building codes will require the flow of water runoff to be controlled. This is especially important on hillsides where there are erosion concerns. One way to handle runoff is to create a drainfield capable of absorbing this water. Alternatively, rainwater can be collected in drain pipes and moved along these pipes to an appropriate outlet.
Reinforcement
Once the court has been located and the forms for the concrete are set, the steel reinforcement is put into place. This most commonly comprises steel bars (rebar) or wire mesh. The purpose of the reinforcement is to control shrinkage during the curing process, to give the concrete greater strength and to keep the “plane” of the concrete consistent. Movement of concrete occurs during the freeze/thaw cycles or as the concrete expands and contracts due to the changes in the temperature or humidity, or if the ground shifts.

Mesh should be placed approximately 5cm below the surface of the concrete. The rebar or mesh should never extend beyond the outside edge of the concrete or touch the dirt, as deterioration of the bar will be accelerated.

Base course (aggregate)
The base course consists of granular material, from a river or quarry, stabilised with natural binding material or crushed quarry stones in continuous grading, covered with gravel and chippings 8-10cm thick, well rolled and compacted. Compaction tests must be carried out on the aggregate, in line with the current regulations at the place of construction.

Two solutions are possible for the type of surface and its sub-grade:

Asphalt surface

Sub-grade (binder)
The sub-grade should consist of hot bitumen-coated chippings, spread with a vibratory finisher and rolled with a sufficiently heavy roller, after spraying the aggregate with bitumen emulsion. The function of this layer is to link the surface subject to wear with the base course; it will therefore not be as resistant to wear as the upper layer.

Surface (upper layer)
The upper layer should consist of hot bitumen-coated chippings and sand, spread with a vibratory finisher and rolled with a sufficiently heavy roller, after spraying the binder below with bitumen emulsion.

Concrete surface

Sub-grade (concrete base)
The base should consist of a 9-10cm layer of concrete with a cement mixture of 350 kg/m³, reinforced with electrically welded mesh, and placed on the underlying layer of fine sand 2 to 3cm thick, separated by a polythene sheet (0.2.mm thick). The function of the sand and polythene is to separate the base from the aggregate and therefore allow movements of the base due to shrinkage and variations in temperature.

Surface (base finishing layer)
The base must have a surface finish with cement screed and final finishing and smoothing; the court lines should then be painted on.

The choice of one solution over the other will depend on availability and therefore the cost of the materials, as well as the heat and climatic conditions prevailing in the respective location.

A resin surface may be applied to both an asphalt and a concrete surface.

Alternatives
Asphalt is often used for courts and can be an economical alternative to reinforced concrete. Typically, to have the same strength as reinforced concrete, the asphalt has to be applied significantly thicker (7.5cm thicker) and placed on top of a thicker engineered sub-base. When the thicker sub-base and thicker asphalt are taken into account, the price is often comparable to that of reinforced concrete. Asphalt will be a little softer than a concrete court, but will not stand up as well to freeze/thaw cycles over time.

In some climates, freeze/thaw is not an issue and it may be possible to create a compacted base without the use of asphalt or concrete. Instead, layers of large rock are put down with layers of smaller and finer rock on top. The final layer of material...
should be very fine and have good cohesion properties. Cement powder may be added to the final layer to aid cohesion. Rot resistant lumber is used for the forms and is left in place. Stakes are placed both inside and outside the forms and recessed slightly below the forms.

Compaction of each layer of rock is critical. Finally, a “landscape blanket” or other type of geotextile fabric is laid over the compacted rock. Geotextiles act as a filter, allowing water to pass down through the fabric but not come back up. The drawbacks of this type of court are that maintenance is higher, ball reaction may not be as good as on asphalt and concrete courts, and a prefabricated synthetic playing surface will be needed to cover the base. A compacted base court can easily be converted to a concrete or asphalt court as the compacted base becomes the sub-base for the concrete or asphalt.

**Performance surfaces**

While FIBA Level 1 championships will always be played indoors on high quality wood surfaces, wood-based courts will never be suitable for outdoor or exposed basketball facilities. Asphalt and concrete are excellent building materials, but they offer little in the way of shock absorption for the athlete. There are currently three types of synthetic sports surfaces for outdoor courts: coatings applied directly to the asphalt or concrete surface, rolls or mats glued directly onto the surface, or suspended synthetic products that lock together and lie on top of the concrete or asphalt.

Coatings are available in varying degrees of thickness. Some are painted on and contain granules of rubber and other materials. As many as 16 coatings can be applied in this process, resulting in a total thickness ranging from less than 1mm up to 8mm thick. These products are very popular in outdoor tennis courts.

Poured-in-place (in-situ) surfaces are mixed on site and adhered directly to the concrete or asphalt court. These can be thicker than the coatings, and the finish can be modified from smooth to more textured. Outdoors, these are most popular in running-track applications.

Mats are consistent in height, width and finish as they are produced in the factory and shipped to site, requiring nothing more than installation. They are available in varying textures and degrees of thickness, and are glued directly to the asphalt or concrete.

Suspended synthetic flooring uses loose interlocking tile modules which are laid on top of the asphalt or concrete with no need for glue. Often perforations in the surface allow water and dust to pass through and run off below the playing surface while still offering enough surface area for good shoe traction and consistent ball bounce.

**Basketball Equipment**

The following equipment will have to be provided:

**Baskets**

Two baskets fixed to the ground with one or two poles for each basket, placed at a height of 3.05m from the ground. The distance of the pole from the end court line must be at least 1m. The backboard and net must comply with the dimensions stipulated in the regulations while the choice of material must take into account the problems of wear and tear due to the meteorological and climatic conditions prevailing in the respective location.

**Backboards on sidelines**

Where an outdoor court doubles as a playground, additional backboards should be installed on the sidelines. Up to four backboards can be installed on each side, thus giving the court a total of 10 hoops (four on each side and one at each end), allowing 60 children to “shoot baskets” simultaneously, as opposed to the original number of 10 players in a regular game.

**Players’ benches**

These must be set out on the same side as the court officials’ table. They can be benches or seats, intended for use by coaches and players when temporarily not on the court. The bench area must be marked out in accordance with FIBA rules.
Court officials’ table
This must be set up alongside the halfway line and positioned at least 1m from the sideline. The length of the table can vary depending on the type of competition.

Additional options
In addition to the general requirements described above, some other items can be provided to make the facility more comfortable.

Synthetic performance surfaces
A synthetic performance surface is a perfect addition to a basketball facility, providing comfort and durability. This kind of surface has excellent shock absorption and energy return properties, improving performance qualities and friction control, and reducing injuries to players when falling. The high quality of the materials now used by manufacturers to produce this type of flooring has led FIBA regulations to allow these surfaces to be used even in some international competitions.

A safe outdoor basketball court should have consistent ball bounce and allow for water to drain off without accumulating on the surface. The surface should have consistent vertical shock absorption and a consistent level of friction that is neither too high nor too low. Debris should not be able to accumulate on or stick to the surface, nor should the surface require costly ongoing or annual maintenance, such as recoating or repainting.

The quality of these outdoor basketball surfaces should be consistent, and not be dependent on chemical adhesion to various sub-bases; nor should they be mixed and prepared on site as outdoor installations will vary in climate, in extreme temperatures and humidity levels. The materials used in manufacturing the product should be of a high quality and durable enough to withstand extreme climactic elements. The basketball surface should be produced by a company with an extended history in production of this product, which itself has proven its longevity in outdoor sporting applications.

The specific characteristics of a FIBA-approved outdoor basketball surface and internationally accepted tests used to measure these attributes are as follows:

<table>
<thead>
<tr>
<th>Performance characteristics:</th>
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<tbody>
<tr>
<td>Ball rebound</td>
<td>ASTM 1551</td>
</tr>
<tr>
<td>Section 31</td>
<td></td>
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<tr>
<td>Water drainage</td>
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<table>
<thead>
<tr>
<th>Safety:</th>
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<tbody>
<tr>
<td>Shock absorption</td>
<td>(HIC/GMAX) ASTM - 1292, F - 355</td>
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<tr>
<td>Coefficient of friction</td>
<td>ASTM E - 303 British Pendulum</td>
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<th>Durability:</th>
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<tbody>
<tr>
<td>Static load</td>
<td>ASTM - D1621</td>
</tr>
<tr>
<td>Cold/roomtemperature/high temperature impact tests</td>
<td>ASTM D5420</td>
</tr>
<tr>
<td>UV durability</td>
<td>ASTM - D4798, ASTM D4329, ISO 4892</td>
</tr>
<tr>
<td>Abrasion resistance (taber abrasion)</td>
<td>ASTM D - 4060</td>
</tr>
<tr>
<td>Expansion issues</td>
<td>STM D696, ASTM D 6341</td>
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<td>Warranty/life expectancy</td>
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<table>
<thead>
<tr>
<th>Maintenance:</th>
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<tbody>
<tr>
<td>Debris resistant</td>
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<tr>
<td>Maintenance</td>
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</table>

<table>
<thead>
<tr>
<th>Installations:</th>
<th></th>
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<tbody>
<tr>
<td>Adhesives - adhesive-free installations</td>
<td></td>
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<tr>
<td>Sub-base restriction</td>
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<tr>
<td>Product pre-manufactured: no on-site manufacturing</td>
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<table>
<thead>
<tr>
<th>Quality assurance:</th>
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</thead>
<tbody>
<tr>
<td>Manufacturer qualification - ample manufacturer experience</td>
<td></td>
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<tr>
<td>Installer qualification - manufacturer certified</td>
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<table>
<thead>
<tr>
<th>Physical properties:</th>
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<tbody>
<tr>
<td>High-end materials</td>
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<tr>
<td>Melt flow</td>
<td>ASTM D 1238</td>
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<tr>
<td>Tensile strength</td>
<td>ASTM D 638</td>
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<tr>
<td>Elongation at yield</td>
<td>ASTM D 638</td>
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<tr>
<td>Flexural modulus</td>
<td>ASTM D 790</td>
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<tr>
<td>Notched izod impact</td>
<td>ASTM D 256</td>
</tr>
<tr>
<td>Un-notched izod impact</td>
<td>ASTM D 4812</td>
</tr>
<tr>
<td>Gardner impact</td>
<td>ASTM D 5420</td>
</tr>
<tr>
<td>Rockwell hardness</td>
<td>ASTM D 785</td>
</tr>
<tr>
<td>Head deflection</td>
<td>ASTM D 648</td>
</tr>
</tbody>
</table>

Fencing
The court, measuring 32x19m including the outer bands, may
be surrounded by a fence, often made from wire mesh, extending to a height of at least 1m. This fencing must be large and strong enough to resist any lateral pressure from a load, in accordance with the local safety standards in force. The choice of the dimensions and technical features of the fencing will depend on the cost and availability of the product, but must comply with the current safety regulations. The fencing is supported by posts, possibly galvanised, and fixed along the edging which should be completely buried under the perimeter around the entire court. Access to the court should be through two gates situated at the corners of the fence, each possibly being no less than 1.20m wide.

**Changing rooms**
If there are no changing room facilities in the immediate vicinity, a structure should be built for this purpose. Ideally, this construction should be prefabricated in metal or PVC resin or another suitable material, allowing it to be erected and dismantled easily and quickly, as required. Alternatively, changing rooms could be provided as a fixed structure in concrete, steel, laminated wood etc, however this would inevitably involve higher costs, not least because a fixed structure must also include changing rooms for referees, a first aid room, and storage room.

**Court extensions**
in the planning phase, it is advisable to provide for free space adjacent to the court, where a second court could possibly be built in the near or distant future. This would not only reduce the building costs, but also facility management costs, as well as provide a better service for the user if an extension were necessary.

**Important Reminders for Basketball Court Construction**
The aim of this chapter was to discuss project techniques while integrating them with constructional needs and requirements, and also to analyse the correct or incorrect usage of some of the elements constituting outdoors courts. We believe this will help engineers to avoid the mistakes that are most common in the building practice, such as unexpected additional costs for future maintenance.

Indeed, when building outdoor basketball courts, costs are a crucial aspect to take into consideration. The same criteria should be applied for the construction of an outdoor court as for a multi-sport arena, and a multi-sport arena, regardless of the different facilities within, must always ensure the highest level of safety for visitors and allow easy monitoring of the sport activities carried out. If the best possible components are used to construct these facilities, maintenance costs may be significantly reduced, and damaged components easily repaired or replaced.

Nevertheless, given the complexity of the building practice and the diverse views associated with it in different countries, we are unable to analyse every possible element: every sample must be integrated and designed to match the needs of the respective communities.

Note: The FIBA Research and Study Centre department published “The FIBA Outdoor Project” in 2006, which could be an addition to this chapter.
Sports Facilities and the Organisation of International Basketball Events
The new concept of sport and sports facilities is based on contemporary requirements and characterised by many revised and improved factors.

Basketball, the sporting symbol of dynamicity and entertainment, represents the driving force in this transformation, especially as far as sports facilities are concerned. The simple concept of a facility being built to do nothing more than house activities has become outdated and given way to an increasingly functional and versatile multipurpose structure, which provides a home for a multitude of sports lovers, whether actively participating on a professional, amateur or recreational level, spectating, or working on and off the court. Special occasions, such as international events, highlight the demand for changes which balance and round off a sporting event or show with a series of spin-off activities; these side events heighten awareness and exposure, making the main event even more attractive, yet they require increasingly dynamic management and organisation of the sports facility.

Attention to detail, attainment of comfort, and an optimal layout of spaces within the facility can make all the difference to a large event where the stakeholders are not only represented by the public and the players, but, above all, also by the media and partners who revolve around the event.

Television and media exposure of international basketball events has seen a significant increase over the last ten years, thanks to an overabundance of basketball competitions attracting worldwide interest.

The management of a sports facility during an event is very closely linked to the dynamics of marketing and business management, in both their essence and their principles. The reason for this is that the stakeholders are no longer only on the court, but nowadays also include the public, media and event investors, each with his own particular requirements.

In order to study the organisation of a sports facility during an international event, a series of critical factors must be identified, on which to base a clear and exemplary model. This chapter follows a precise path, starting from the arrival at the sports facility and terminating with the end of the competition.

Each sports facility has its own configuration and organisational logic, however in the case of major international basketball events all facilities must have certain common characterising elements. For a better understanding, the facility must be examined separately, both inside and out.

During major sporting events, entertainment areas or sites for side events outside the facility are becoming increasingly popular; these optional spaces must be located close to the event areas themselves, such as car parks, ticket offices and accredited zones. The same applies to indoor areas which must include adequate space for the media and VIPs, as well as refreshment areas and attractions for the public, where possible. All these requirements, and others, follow a common logical thread which weaves its way along the explanatory tour on the pages that follow. (Table 12.1)

The explanatory tour presents the different characteristics of the facility but does not include the particular requirements of the playing areas and activities related to the teams and/or referees as these have been sufficiently described in earlier chapters.

A sports facility generally comprises:

A. External areas

B. Indoor areas

These “areas” must then be divided into areas of interest:

A. External areas

A - 1 Car parks
A - 2 Accreditation points/ticket offices
A - 3 Entertainment areas
A - 4 Outdoor events

B. B - Indoor areas

B - 1 Public
B - 2 Media
B - 3 Partners and/or sponsors
B - 4 VIPs & guests
B - 5 Hospitality
### Areas Needed in a Sports Facility for Conducting an International Event and Functions Assigned to Spaces

<table>
<thead>
<tr>
<th><strong>A</strong></th>
<th><strong>EXTERNAL AREAS</strong></th>
<th><strong>A1</strong></th>
<th>Parking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>A2</strong></td>
<td>Accreditation/ticket</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>A3</strong></td>
<td>Entertainment areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>A4</strong></td>
<td>Outdoor events</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td><strong>INDOOR AREAS</strong></td>
<td><strong>B1</strong></td>
<td>Spectators</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>B2</strong></td>
<td>Media</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>B3</strong></td>
<td>Partner / Sponsor</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>B4</strong></td>
<td>Vip &amp; Guests</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>B5</strong></td>
<td>Hospitality</td>
</tr>
</tbody>
</table>

### Further Breakdown of Spaces and Functions of the Internal

<table>
<thead>
<tr>
<th><strong>B1</strong></th>
<th>Spectators</th>
<th>Ancillary services for spectators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B1.a</strong></td>
<td></td>
<td>Commercial areas</td>
</tr>
<tr>
<td><strong>B1.b</strong></td>
<td></td>
<td>Areas of support/Information</td>
</tr>
<tr>
<td><strong>B2</strong></td>
<td>Media</td>
<td>Media Area</td>
</tr>
<tr>
<td><strong>B2a</strong></td>
<td>Media</td>
<td>Press Print</td>
</tr>
<tr>
<td><strong>B2a.1</strong></td>
<td>Media</td>
<td>Press seats</td>
</tr>
<tr>
<td><strong>B2a.2</strong></td>
<td>Media</td>
<td>Press room</td>
</tr>
<tr>
<td><strong>B2a.3</strong></td>
<td>Media</td>
<td>Refreshments area</td>
</tr>
<tr>
<td><strong>B2a.4</strong></td>
<td>Media</td>
<td>Press seats</td>
</tr>
<tr>
<td><strong>B2b</strong></td>
<td>Photo</td>
<td>Field edge</td>
</tr>
<tr>
<td><strong>B2b.1</strong></td>
<td>Photo</td>
<td>Press seats</td>
</tr>
<tr>
<td><strong>B2b.2</strong></td>
<td>Photo</td>
<td>Field edge</td>
</tr>
<tr>
<td><strong>B2c</strong></td>
<td>TV/radio</td>
<td>Fixed positions for cameras</td>
</tr>
<tr>
<td><strong>B2c.1</strong></td>
<td>TV/radio</td>
<td>Range mobile cameras</td>
</tr>
<tr>
<td><strong>B2c.2</strong></td>
<td>TV/radio</td>
<td>Positions for radio/tv remarks</td>
</tr>
<tr>
<td><strong>B2c.3</strong></td>
<td>TV/radio</td>
<td>Liaison with external area for television production</td>
</tr>
<tr>
<td><strong>B2c.4</strong></td>
<td>TV/radio</td>
<td>Lighting necessary</td>
</tr>
<tr>
<td><strong>B2c.5</strong></td>
<td>TV/radio</td>
<td></td>
</tr>
<tr>
<td><strong>B3</strong></td>
<td>Partner / Sponsor</td>
<td>Partner/Sponsor Areas</td>
</tr>
<tr>
<td><strong>B3.1</strong></td>
<td>Partner / Sponsor</td>
<td>Entertainment and promotion partner area</td>
</tr>
<tr>
<td><strong>B3.2</strong></td>
<td>Partner / Sponsor</td>
<td>Partner lounge</td>
</tr>
<tr>
<td><strong>B3.3</strong></td>
<td>Partner / Sponsor</td>
<td>Positioning advertising boards</td>
</tr>
<tr>
<td><strong>B4</strong></td>
<td>Vip &amp; Guests</td>
<td>Vip Area</td>
</tr>
<tr>
<td><strong>B4.1</strong></td>
<td>Vip &amp; Guests</td>
<td>VIP seats</td>
</tr>
<tr>
<td><strong>B4.2</strong></td>
<td>Vip &amp; Guests</td>
<td>VIP lounge</td>
</tr>
<tr>
<td><strong>B5</strong></td>
<td>Hospitality</td>
<td>Refreshment area, marketing space, relax area, private lounges, conference room, space for performance</td>
</tr>
</tbody>
</table>
A - EXTERNAL AREAS

AREA A1
Car parks
Car parks are an essential, decisive and fundamental element in the course of an event (which may last one day or more).
Initially, the size or capacity of the car-park area must be based on the regulations in force and local town planning rules of the host country; ultimately, the area must be proportionate to the capacity of the sports facility and adequately equipped.
A guideline for the car-parking capacity is based on the overall capacity of the facility as follows:

*Car Park/Spectator Ratio*

1 m² for each spectator expected.

<table>
<thead>
<tr>
<th>Spectators</th>
<th>Car Park Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 5,000</td>
<td>5,000 m²</td>
</tr>
<tr>
<td>5,000-10,000</td>
<td>5,000-10,000 m²</td>
</tr>
<tr>
<td>≥ 10,000</td>
<td>≥ 10,000 m²</td>
</tr>
</tbody>
</table>

This ratio applies to single one-day events, several events in one day, and several events over several days.
The parking area should be divided into smaller sections based on the distribution and location of the public (VIPs, media, teams, partners) inside the building. Each parking zone should have clearly defined spaces, which meet various requirements, and should be adequately monitored and controlled. Areas must be reserved for emergency vehicles, technical vehicles for TV broadcasting, and for VIP-related vehicles (catering, security, etc.).

AREA A2
Accreditation points/ticket offices
Following on from the car park area, we move on to the access area which must ensure the safe arrival, circulation, distribution and departure of the public. A properly equipped area must be foreseen to deal with any problems related to tickets and accreditations.
We suggest creating two easily accessible ticket office/accreditation areas in front of the facility; these areas may possibly incorporate welcome and hospitality areas.

Accreditations for the media and VIPs should be dealt with directly by the event organisers and press office respectively.

AREA A3
Entertainment areas
The importance of a large international event is reflected by the external set-up. In fact, in recent years, attention has been paid increasingly to the design and layout of a sports facility, in particular the external area, for an attractive and scenic setting will heighten the overall appeal of the facility. Public amenities are now available outside the sports hall and are run by the event organisers and/or other organisations or firms (e.g. partners).

AREA A4
Outdoor events
Spin-off and support events organised alongside main events have now become standard practice, particularly during basketball events.
Because it is often difficult to organise basketball exhibitions or other sports displays inside a sports facility due to the amount of space required, entertainment areas are often set up outside for this purpose. Obviously, any form of entertainment must be relative to the main event and coordinated with possible hospitality and entertainment areas.

B - INDOOR AREAS
There are many factors to be taken into account in the study of indoor spaces so, in order to make the task easier, it is recommended the sports facility be divided into four large sections:

Area B1 - Ancillary spaces for the public
Area B2 - Media spaces
Area B3 - Spaces for partners and/or sponsors
Area B4 - VIP spaces
Despite the subdivision, these sections are quite definitely interconnected, particularly in the heart of the facility.
Area B1
Ancillary spaces for the public
Since the main public area has already been examined in detail in earlier chapters, in particular in Chapter 2, here we shall concentrate on the ancillary structures which are available to the public during a large international event:
B1a - Commercial areas
B1b - Support/information areas

Commercial areas
During a large basketball event, these areas are the key points for attracting and involving the public, or for promoting new products. They must be easily accessible for everybody, ideally situated in communal assembly and meeting areas. Commercial and refreshment areas/stands are often positioned near the entrances/exits of the sports facility, “obliging” visitors to see them as they proceed along the guided route to the event. The number of these amenities, their distribution and, in some cases, their set-up must be follow in consultation with FIBA and local organisers.
In new sports facilities, to meet new “management requirements”, the commercial areas are an integral part of the structure from the start of the project as they contribute to its “survival” throughout the year, particularly during periods when no events are organised.

Support/information areas
Support/information areas are ones which help the spectator reach all areas of interest, both inside and outside the sports facility, easily and clearly.

Area B2
Media area
Sport needs the media just as the media need sport. This relationship is essential, especially on the eve of and during large sporting events. Over the last few decades, basketball has seen a rise in popularity and exposure, attracting interest from an international audience and becoming one of the most watched and followed sports in the world.
The media therefore play an important role and any sports facility wishing to host large-scale events must give due consideration to the media and ensure meticulous organisation.
There are generally many more press representatives present at major events than at weekly competitions. The capacity of the facilities must be assessed, adapted and organised in advance to accommodate the media requirements of a large number of media representatives. The media area can be divided into three main parts:
B2a - Press (print media)
B2b - Photographers
B2c - TV/Radio (broadcast media)
The section B2a must meet certain specifications in terms of space and the organisation of this space, based on the event concerned. This area can be divided into four sectors:
Press (2a):
1 – Media Accreditation Area (B2a)
2 – Press Tribune (B2a)
3 – Press Conference Room (B2a)
4 – Media Workroom (B2a)
5 – Communication Centre (B2a)
6 – FIBA Press Office (B2a)
7 – Refreshment Area (B2a)
Access to these sectors of the facility must be separate yet controlled; a parking area must also be reserved for media representatives. This car park area must be reserved for all three sections, press, photographers and TV representatives, and should be commensurate with the overall capacity of the facility, the type of event and the number of accreditations.
1 - Media Accreditation Area: here, the organisers monitor the arrival of the journalists and check their accreditation prior to an event. This area should be positioned next to the Press Tribune. The area does not necessarily have to be large, but it must be functional and allow the different media representatives to circulate.
2 - **Press Tribune:** this must be a prime location inside the playing hall to provide accredited journalists with the best possible view. The criteria to guarantee a clear view for the media are the same as those described in earlier chapters to offer spectators an unobstructed view.

Based on past experience, at major sporting events provision should be made in the Press Tribune for a minimum of 50 working positions and up to 150+

A guideline for the number of working positions in the Press Tribune is based on the overall seating capacity of the sports facility:

<table>
<thead>
<tr>
<th>Press Tribune Positions/Spectator Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5,000 spectators</td>
</tr>
<tr>
<td>5,000-10,000 spectators</td>
</tr>
<tr>
<td>&gt; 10,000 spectators</td>
</tr>
</tbody>
</table>

Each position must measure approximately 1 m² and include the following:

- A desk;
- A chair;
- A power socket;
- An ADSL line (if a wi-fi system is not available);
- A telephone socket;
- A monitor connected to the internal circuit.

The Press Tribune must be directly linked to the other media sectors B2a-B2b-B2c.

The Press Tribune should also have three workstations for the statisticians.

3 - **Press Conference Room:** an area reserved for press conferences and media presentations.

This area must be located close to the Press Tribune, allowing journalists easy access. The room should include the following:

- A table (for a minimum of 6 people)
- Chairs (for a minimum of 50 people)
- A sound system and microphones.

In addition, there must be small interview areas in the room or nearby, where event backdrops can be hung.

4 - **Media Workroom:** This area must be located close to the Press Conference Room and include working positions reserved for the journalists. The Media Workroom must be equipped with the following:

- Tables
- Chairs
- Internet connections for each working position.

The size of the Media Workroom should be proportionate to the size of the facility and the Press Tribune.

5 - **Communication Centre:** An area in which journalists can follow the event on screens which show images of the game in real time. The Communication Centre should be close to the Press Tribune with a direct link to the Refreshment Area. The centre should be equipped with the following:

- Chairs
- Lounge chairs and sofas
- Screens

6 - **FIBA Press Office:** this area, reserved exclusively for the FIBA Press Office. It should be the same size as the Media Workroom and similarly equipped. Furthermore, it should ensure direct access to the sections B2a, B2b and B2c.

7 - **Refreshment Area:** an area within the sections B2a-B2b-B2c reserved exclusively for the media. This area should include a media lounge where media representatives can rest.

Toilets must be included in each media section.

**Photographers (2b):**

The section B2b is reserved for photographers during an event.

Working positions should be provided in two areas:

B2b.1 **Press Tribune** (B2a.2)

B2b.2 **Court-side**

1 - A minimum number of positions in the **Press Tribune** (B2a.2) must be reserved for photographers; the amount of photographer
positions should be based on the number of requests received by the organisers in advance, and must be proportionate to the event organised.

Each working position must measure approximately 1m² and include the following:
- A desk
- A chair
- A power socket
- An ADSL line (if a wi-fi system is not available)
- A telephone socket

2 - Court-side photographers should be positioned along the endlines of the playing court, however away from the bench side. They must maintain a distance of at least 2.20m (the distance from the basket base to the endline) in order not to disturb the game and/or obstruct the action.

FIBA provides precise specifications for photographers’ positions in existing facilities which may have an unconventional layout.

For details on refreshment areas and related services, please refer to B2, Media Area, above.

**TV/Radio (B2c):**

The section 2c is reserved for the accredited television and radio broadcast media.

Broadcast media requirements include:
1 – Fixed-cameras positions (B2c.1):
2 – Mobile cameras and viewing angle range (B2c.2):
3 – Commentary positions (B2c.3):
4 – Television studios (B2c.4):
5 – Direct link to an outside broadcasting van (mobile production unit) (B2c.5):
6 – Adequate lighting (B2c.6):
7 – Radio (B2c.7):

- Fixed cameras (B2c.1): in agreement with the production room, fixed cameras must be centrally positioned at key vantage points high up in a tribune. The viewing angle range should be approximately 6m² per camera.
- Mobile cameras (B2c.2): there are usually two to three along the courtside, or more depending on the type of event. During the event, they must be positioned at the corners of the court and/or behind the baskets, maintaining the same distance from the courts as the photographers.
- Commentary positions (B2c.3) should be similar to mobile camera positions (B2a.2). The provision of commentary positions will vary according to the importance of the event, however, their number must be proportionate to the number of broadcasters present. For special events (such as World Championships and Olympic Games), the Press Tribune usually has to be adapted to meet special requirements.

Commentary positions are usually located high up in the tribunes and in line with the centre of the court and on the same side as the fixed cameras, to ensure a clear view of the court for the commentary team. The positions should be separated from the spectators, in a secure area which also guarantees acoustic separation. The commentary desks should be 75cm high and large enough to accommodate a computer, monitor, etc.

Each commentary position should seat two to three people and be at least 1.80m long.

A guideline for the number of commentary positions is based on the overall seating capacity of the sports facility:

**COMMENTARY POSITIONS/SPECTATOR RATIO**

<table>
<thead>
<tr>
<th>Number of Spectators</th>
<th>Number of Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5,000 spectators</td>
<td>5 positions</td>
</tr>
<tr>
<td>5,000 - 10,000 spectators</td>
<td>5-10 positions</td>
</tr>
<tr>
<td>&gt; 10,000 spectators</td>
<td>10-15 positions</td>
</tr>
</tbody>
</table>

4 - There must be a room inside the facility which, if required by the TV stations, is suitable for use as a television studio. The minimum size of the room should be 6.00x4.0x2.50m.

5 - An area must be reserved outside the facility, close to the tribune with the commentary positions, for one or more outside broadcast (OB) vans (B2c.4) necessary for production, transmission and other technical aspects.
Approximately 15m² should be reserved per vehicle (OB van).

6 - The lighting requirements for television broadcasting for international events are the same as those stipulated by FIBA. The average maintained illumination should be no less than 1,800 Lux distributed evenly over the entire court, with approximately 1,000 Lux throughout the rest of the arena. For further details, please refer to the chapter on technological installations. The television broadcasters are responsible for meeting their own special or additional requirements, such as an increased power supply.

7 - Radio broadcasting positions with the same specifications as those under point B2a.2 should be provided next to the television commentary positions.

**Mixed Zone:** this area is particularly important because it represents the first true communal zone between the media areas and the players’ changing rooms.

This is a restricted area where media representatives can meet players and team staff who are not otherwise involved in the press conference with journalists.

The Mixed Zone should be located close to the changing rooms, en route to the teams’ stadium exit door. Media representatives should have easy access to the Mixed Zone from the Press Tribune.

The Mixed Zone should be divided into three areas:
- For broadcasters with television rights to the event.
- For broadcasters without television rights.
- For all other journalists

For more detailed information regarding television broadcasting, please refer to the FIBA TV Manual which be downloaded free of charge from the FIBA Website (www.fiba.com).

**Area B3**

**Partner and sponsor area**

Sport has proved to be a good means of investment, and major international basketball events have confirmed its value in this sense. If investors and partners wish to become involved in an event by setting up stands or organising entertainment, provisions must be made in the facility to accommodate them as best as possible.

Partner and sponsor areas are restricted to Area 1 (public area) because these zones are intended to increase the exposure and accessibility of an event and its partners. Partner and sponsor requirements of this nature are usually limited to main international basketball competitions or major sports events.

Technical difficulties are often encountered when trying to organise areas for partners and sponsors in old sports structures, yet in new facilities these areas often provide a distinguishing feature as the partners and sponsors become involved in the construction and life of the facility, sometimes even giving their “name” to the building.

The sub-sections in this area include:

B3.1 - Partner promotion and entertainment areas
B3.2 - Partner lounge
B3.3 - Position and size of advertising boards around the playing court

Partner promotion and entertainment areas (B3.1) are the ancillary areas set up during an event by the event partners and/or sponsors. These areas are assigned by the facility managers and event organisers but the actual organisation is usually left to the sponsors who apply their own image or corporate identity to the event, and promote their products and services.

As well as a lounge for VIPs (B4.3), partners often need an area where stakeholders can meet and talk. If space is limited but there is sufficient interest, the two areas can be combined in one room.

The greatest impact that sponsors have on an event results from sponsor exposure during the game itself. This is achieved by installing advertising boards around the court or, more recently, LED screens (B3.3).

Obviously, in order not to interfere with the game, advertising boards must be positioned at least 2 m from the sidelines and end lines.
The colours used for animation and graphics are subject to the approval of the organisers, facility managers, team managers and referees, to ensure they do not detract from the game. For equipment specifications see Chapter 3.

**Area B4**

**VIP area**

Given the fact that a major basketball event attracts media attention, it goes without saying that it will also attract the attention of celebrities and VIPs from the world of show business, politics and sport itself, thus increasing the overall appeal of the event and generally raising interest.

For this reason, it is important to reserve appropriate VIP areas.

**General aspects** - An adequate number of functional areas should be provided to efficiently accommodate VIPs. The VIP areas should reflect the importance of the event, conform to particular formal protocols, respect the host town or city and be proportionate to the overall size of the sports facility.

**Equipped areas** - Provisions must be made in the hall for suitably equipped areas, directly connected to the reserved tribunes:

- At least two information and hospitality areas, to accommodate;
- 150 people (at international events);
- 500 people (at events organised and/or supervised by FIBA);
- 1,000 people (at World Championships);
- At least two small private rooms;
- A refreshment area with service to the various lounge areas (the refreshment lounge must be positioned at a suitable distance from telephone points). These lounge areas should be equipped with screens or monitors mounted on the walls and/or ceiling;
- A sufficient number of toilet facilities.

At the entrance to the VIP area, there should be a reception area to welcome visitors, check accreditation and provide information. A VIP parking area should be reserved for at least 30 cars. This area should ensure easy and direct access to the inside of the hall.

The VIP area is divided into three main sections:

- B4.1 - VVIP Tribune of Honour
- B4.2 - VIP Tribune of Honour
- B4.3 - VIP Lounge

The Tribune of Honour for VVIPs (high-ranking federation and LOC representatives and figures of local authority) should be positioned in the central part of the tribune on the bench side (parterre). The number of seats must be commensurate with the importance of the event. The Tribune of Honour for VIPs (important guests, partners, sponsors) should be on either side of the Tribune of Honour for VVIPs. Private access and car parking for these areas should be reserved following the same proportions.

These VIP tribunes should be positioned on the opposite side to the officials’ table. The tribunes should be connected to one or more private rooms to be used as VIP lounges (B4.3).

During international events recognised by FIBA, the seating arrangements in the VIP tribunes must comply with the provisions of protocol stipulated in the Internal Regulations adopted by the International Basketball Federation (FIBA).

**Area B5**

**Hospitality**

Hospitality activities are becoming an increasingly important element in corporate marketing strategies.

Sporting events offer a great potential to stimulate working relationships in an entertaining and informal atmosphere.

Hospitality refers to the relationship process between guests and hosts, and the provision of space within a facility or in conjunction with an event where business relationships can be established; these spaces may offer additional services such as catering or hostess services.

In marketing terms, hospitality offers a company the opportunity to welcome and entertain people whom may influence its business future.
Requirements for Hospitality Structures

Practicability: Temporary structures may only be installed once the necessary licenses and permits have been obtained.

Availability: The hospitality areas must be available for the Local Organising Committee or persons authorised by the committee.

Security: The hospitality lounge should be located within the restricted and secure area. Security staff are responsible for protecting people from public interference and safeguarding items in the hospitality area.

Access: Organisers and guests must have free access without any restrictions. Car parks must be sufficiently close to the playing hall.

Location: The hospitality area must not be more than 300 m from the playing hall.

In order to best meet all of these requirements, a number of variables must be taken into account. Most importantly, there must be a structured decision-making organisation at hand to solve problems in a fast and efficient manner. A responsibility chart is recommended, which clearly indicates the areas assigned to each staff member. The different sections of the facility should be identified using different colours to provide visitors with a simple layout to guide them efficiently structure and allow them to make the most of the amenities available. Facility layout diagrams should be posted at the entrances/exits, listing the main activities and areas of interest.

For events where a particularly large number of spectators is anticipated, first-aid points should be provided in easily accessible key locations both inside and outside the building, with qualified personnel trained to deal with emergencies. Smoking areas may be provided if the regulations in force in the host country so allow.

Facilities need Events like Events need Facilities
Two elements living and lasting together.
FIBA & NBA
Comparing Basketball Facilities
This chapter serves to briefly illustrate just some of the main differences which identify the two major basketball entities at international level: FIBA and the NBA.

**FIBA**

The *International Basketball Federation* was founded in 1932 by eight nations with the common aim of promoting and regulating the game of basketball. Today it unites 213 national federations representing all five continents. The abbreviation ‘FIBA’ derives from the French ‘Fédération Internationale de Basketball Amateur’. The word ‘Amateur’ was dropped in 1986 after the distinction between amateurs and professionals was eliminated. However, the ‘A’ in FIBA was left, not only for traditional reasons but also because of the ‘BA’ at the beginning of the name of our sport… BASKETBALL!

FIBA is recognised as the sole competent authority in basketball by the *International Olympic Committee (IOC)*. FIBA is a non-profit making organisation and does not pursue any economic objective for its own gains.

FIBA establishes the Official Basketball Rules, the specifications for equipment and sports facilities, as well as all internal executive regulations that must be applied to all international and Olympic competitions, for which FIBA also determines the system of competition.

FIBA controls and governs the appointment of international referees, regulates the transfer of players from one country to another, and controls and governs all international competitions.

FIBA does not have to generate a profit or business via basketball; its aim is to guarantee the development of the game and carry out its activities throughout the world.

**NBA**

The *National Basketball Association* is the premier professional basketball league in the United States and Canada. Founded in 1946, and following a sequence of changes, today’s league comprises 30 franchise clubs. Although each basketball club represents a certain city franchise, clubs may relocate, particularly if their markets are interesting and lucrative for the NBA.

The NBA is not dependent on any sports federation, nor does its system of competition entail any form of league relegation. In 1997, the women’s counterpart to the NBA, the WNBA (Women’s National Basketball Association), was founded to govern the female professional basketball league, and, in 2001, the NBA set up a minor league, the NBA Development League, with 15 teams linked directly to NBA teams.

Because of its autonomous status and its independence from any federation, the NBA has been able to nurture and develop new ideas over the years. This is particularly evident at regulatory level, where the NBA has its own set of rules aimed at improving the impact of the game and turning it into a spectacular show, rules which have proved to be the precursor for the official rules of FIBA.

The characteristics and origins of FIBA and the NBA elucidate the major difference between the two sporting entities, particularly in their respective “mission”.

There is also a legal-organisational difference between FIBA and the NBA. FIBA is an *institutional sports body*, whilst the NBA is a *private sports association*. Here we have two very different organisations which have been travelling parallel on the subject of sports facilities for many years but whose paths are now beginning to converge.

NBA basketball epitomises professionalism and spectacularism at club level both in terms of the game and organisation. For decades the main features of the NBA system appeared to be distant and far removed from the international world of basketball, especially for professional basketball players.

With time, the export of talented international players to the USA, the continual development and improvement of the sport of basketball, and the undeniable influence of basketball throughout the sporting world have led FIBA to steer ever closer
to NBA regulations, and obliged the NBA to keep a constant eye on FIBA events. A comparison of the two would be neither just nor possible, however, in order to create a better understanding of the two systems (particularly in terms of sports facilities), and with a view to future improvement, it is worth considering some of the most striking characteristics.

Although the two organisations obviously have different ways of reaching their goals, they do in fact have some elements in common, particularly when it comes to playing sites, or rather sports facilities.

**FIBA and Sports Facilities**

The importance and significance of international competitions (world championships, continental championships, youth championships, etc.) held under the aegis of FIBA have steered not only the sports performances themselves, but also the services revolving around them, towards a spectacularly high level and, in many cases, standards of excellence. Obviously, sports facilities themselves are repeatedly a subject for debate, and FIBA's attention is always directed towards establishing common standards for sports facilities wishing to host events of particular importance. Nevertheless, the extent of FIBA competitions at international level makes it impossible to classify and monitor all features of a sports facility and to define an “one-for-all” type of facility.

All the same, FIBA knows how best to make its competitions a showcase for its championships, at the same time conveying messages of great socio-cultural importance that have a further-reaching impact than the game itself.

Yet FIBA's interest in international competitions does not come back chiefly to the need to involve the public (apart from studying the flow of people) or study the market, but is fundamentally aimed at guaranteeing high-quality "itinerant" services inside and outside the arena. Of course, such services must correspond with the means available and the number of competitions to be played during the competition season.

*Why “itinerant”?* FIBA events are not always organised in the same location and, as such, the organisation for each new competition must be adapted to suit the host facility selected from candidatures submitted by various member countries.

As far as sports facilities are concerned, FIBA's aim is to achieve a form of certification which is on a par with a quality mark accrediting the standard of the facility and the building, and which follows established and functional criteria. A procedure of this nature obviously involves those facilities able or hopeful to host international events, but also those at national and local level looking to promote and develop basketball.

It goes without saying that a multifunctional facility with a capacity of 20,000 is quite different from a mono-functional facility for only 5,000, or indeed one which is not designed to accommodate any spectators at all. It is for this reason that a quality scale should be introduced to assess parameters relating to capacity, functionality and all other attributes which can influence the award of FIBA quality certification.

**NBA and Sports Facilities**

The situation is quite different in the USA where a comparison of the 30 NBA arenas and the kind of events they organise shows that it is possible to identify common characteristics (facility size, exposure, support services, etc.) which all tend to be the same in the various sports facilities designed to host basketball events.

The keystone to the NBA system could well be the multifunctionality and versatility of their sports facilities, in their entirety. An NBA arena has to stand out, and showcase the space it has, its promotion stands, kiosks, refreshment areas, and even its less conventionally commercial areas such as changing rooms, training rooms or other service provisions - anything and everything that could be in the media spotlight where strong visual communication is the answer.

Any arena in the NBA network becomes a focal point, a gathering place, not just for basketball but for other kinds of events, and not necessarily sporting events. These are modern arenas, built recently in the mid-nineties and constantly undergoing...
reconstruction and modernisation, particularly where public services are concerned.

The aim is to entertain the public without dwelling on the actual outcome of the game. The NBA exploits its fans’ emotions by increasing the level of amenities and involving them in secondary activities which add to the suspense before the event.

In basketball, more than in any other sport, the public is “close” to the players, but not only in a physical sense, for the NBA system guarantees its fans a “psychological” sense of closeness as well, by offering various initiatives inside and outside the arena.

This is achieved thanks to the strong synergy between the commercial activities and support services in the facility, and the message that they carefully and accurately convey to the users. Customer satisfaction in the form of discreet attention is what the public wants and needs; this can be attained by studying what has stimulated fans in the past and what they expect in the future. The ultimate aim is to promote a loyal fan base.

Managing an NBA arena is complex and intricate, both strategically and operatively. For this reason, in almost all of the 30 NBA arenas, there is a difference between owner and manager; in most cases the owner can be public or private, whereas the manager is always private. Help is often at hand from professional facility management companies or cooperative-like management companies set up by interested parties using the facility’s services. This latter aspect is a key factor in the success of an NBA facility, bearing in mind that on average in every arena there are at least three sports clubs playing different sports (NBA or WNBA basketball, NHL hockey, AFL American football, etc.) in home games in the course of the calendar year, not to mention other side events which attract a big following on the court. This means that the facility and all its installations must be in perfect working order, regularly maintained, and operated by experienced and skilled staff. The court arena can change its purpose and form as often as four times a week, at an impressive speed.

The factors mentioned above highlight the following:

Every NBA arena is planned and equipped with the best technological and operating systems available.
The arena changes its appearance but not its substance, with ancillary services remaining the same.
Intense and repeated activities ensure that a facility is long-lasting and efficient.
High-level activities give a facility exposure, not just at national and continental level, but also at international level.
Public or private ownership and private management, together with optimum exposure, allows the arena’s naming rights to be sold to private investors, or shared management of the indoor and outdoor areas of the arena with another tenant.

All these points support the earlier reference to the need for absolute professionalism inside an arena to ensure the smooth progress of activities.

The cost factor is the main problem in the planning and construction of this kind of facility. Thoughts are immediately turned to finding a way to reducing costs, containing costs and finally making a profit. It is interesting to note how high the initial construction costs are.

Looking at the 2007/2008 basketball season, the average capacity of NBA arenas was close to 20,000, whereby the actual figure obviously varied depending on the event scheduled. There are no arenas with a capacity less than 17,000, all of which are suitable for and equipped for potential international events. Over the past few years, facility capacity has been increased to reflect the growth in basketball interest. The 2006/2007 season was the fourth consecutive season in which a record number of tickets were sold with spectator figures reaching approximately 20,000 for each event.

Differences and similarities

There is no place for rivalry between FIBA and the NBA; these are two separate movements that can come together, allowing each to profit from the other.

Nevertheless, the two organisations do have more than one
factor in common when it comes to organising events, even though FIBA generally has to organise several games over several days in the same facility and many events in different locations throughout the year, assigning event organisation to local organising committees set up especially for the occasion, and each time relying on different facilities, whereas the NBA has a network of arenas under the continual direct management of their affiliate basketball clubs.

The greatest common factor is the provision of a well-equipped media area, given the influence the media can have during an event, competition, or hospitality activity. The press tribunes always seem to have the latest equipment, with leading-edge systems, and strategically positioned with good, if not optimum, visibility; press lounges which are welcoming and functional at the same time; interview areas inside and outside the playing hall, television camera positions, and increasingly sophisticated recording facilities.

Of course, the most obvious differences pertain to the size of the NBA playing area and the FIBA court, due mainly to the difference in metric and traditional measuring systems, the shape of court zones and certain game management rules:


**NBA** overall court size = 94x50 ft (equivalent to 28.65x15.24m)

**FIBA** overall court size = 28x15m

**NBA** three point line = 23’9” (7.24m with an irregular area)

**FIBA** three point line = 6.25m (6.75m as of 2010)

**NBA** free-throw area/three-second restricted area=rectangular

**FIBA** free-throw area/three-second restricted area=trapezoidal (rectangular as of 2010)

**NBA** personal fouls (for electronic boards) = 6

**FIBA** personal fouls (for electronic boards) = 5

**NBA** playing time: four 12-minute quarters

**FIBA** playing time: four 10-minute quarters
Diagram 13.1

FIBA & NBA COURT DIFFERENCES
Diagram 13.2
NEW FIBA COURT MARKINGS 2010

All court lines (black lines on the attached diagram) shall be 0.05 m in width. All red and dotted lines are just auxiliary lines that indicate correct measures.
Basketball and Variations of the Game
The game of basketball, known for its dynamic characteristics, has spread from its birthplace in America across the globe to become a worldwide sensation, enjoyed by people of all ages and all cultures. As it has taken root in various countries, the sport has evolved considerably, with the original playing rules having been amended, sometimes out of necessity, sometimes for fun, to adapt to their prevalent social, cultural, geographical or political context.

These changes gave rise to variations of the game, such as wheelchair basketball, beach basketball or bankshot basketball, each with its own following, and games organised independently in suitable and well-defined environments. These related disciplines also have their share of complications when it comes to sports facilities, but their needs and requirements are quite different from the general casuistic elements inherent in regular basketball.

With the many facets of basketball too numerous to list, here is an overview of the most popular disciplines, including their defining characteristics and distinctive rules.

All based on the fundamental elements of the ball and basket, the various disciplines fall into two categories: FIBA-recognised disciplines and non-recognised disciplines.

**FIBA-Recognised Disciplines**

**Wheelchair basketball**

The most common and popular variation is undoubtedly wheelchair basketball which over the past decade has assumed international significance.

It was first introduced back in 1946 by German-born neurologist Sir Ludwig Guttmann, who fled to England in 1939 where he set up wheelchair basketball as part of a rehabilitation programme for injured war veterans.

Wheelchair basketball is probably one of the most well-known sports for the disabled, and ranks as one of the most popular disciplines in the Paralympic Games organised by the International Paralympic Committee (IPC).

What is most remarkable about this discipline is the fact that it brings together athletes with different kinds of disabilities and, more significantly, different levels of physical prowess, who play on the same court at the same time. Obviously, because a certain balance needs to be guaranteed on the court, a disability rating system was introduced by the Player Classification commission which classifies athletes according to their physical ability. Players are given a points’ rating between 1.0 and 4.5 with the lowest value corresponding to the highest disability level.

The playing rules are almost identical to the official rules for able-bodied athletes, with the main difference being that, on the basis of the rating classification, the total number of points of all the players on the court at any one time should not exceed 14 points.

Today, wheelchair basketball is played in more than 90 countries by more than 100,000 men, women and children with a physical disability that prevents them from playing competitive basketball on their feet.

Although the essence of the wheelchair game differs very little from the “running” game, there are nevertheless some violations which are specific to wheelchair basketball, for example:
- Lifting: a player may not lift himself from his wheelchair seat.
- Travelling: a player is only allowed to take two pushes before he dribble shoots or passes the ball.
- Raising: a player may not raise both rear wheels of his chair from the ground whilst holding the ball.

The form and size of the wheelchair is very important and competition chairs must meet the specifications of the International Wheelchair Basketball Federation (IWBF).

The chair may have either three or four wheels, with two large wheels at the back with a maximum diameter of 69 cm, each equipped with a hand rim. The maximum seat height from the ground is either 58 cm or 63 cm depending on the player’s classification.

The impact that wheelchair basketball has on sports facilities is easy to recognise.
Regardless of their size or importance, facilities should not have any architectural barriers, but should allow for easy access to the changing rooms, support services and the playing court. These elements are covered in detail in the chapter on “Architectural Barriers”.

Wheelchair basketball and running basketball share the same playing area and equipment specifications, as stipulated in the current International Wheelchair Basketball Federation (IBWF) and FIBA.

**Beach basketball**

Beach Basketball is an exciting variation of the game, played on sand.

The game was developed more than 30 years ago on the physical education fields of Gulf Shores School in Alabama, USA. This modified version of basketball, invented by Philip Bryant, has grown from a selective skill-improvement game into a popular, widespread competitive sport. Obviously, the fundamentals of beach basketball are closely related to regular basketball, yet they bring great diversity to the game.

Beach Basketball spread gradually throughout the rest of the USA and the rest of the world, thanks to the World Beach Basketball Association which organises world championship tournaments. The federation has divided the continents into Regions, 36 in total, some of which comprise several American states, numerous Pacific islands, groups of countries and, in the case of the Rising Sun Region No. 19, one entire country, Japan.

Obviously, in beach basketball there is no dribbling because it is almost impossible on sand. Instead, the ball is moved down the court by passing, with a maximum of 2.5 steps.

The greatest difference in beach basketball lies in the actual playing court which is circular and on sand. There are no backboards attached to the baskets which are supported by a pole system. The European version of the game uses a rectangular playing area, measuring 20x10 m, and has two baskets with backboards.

The baskets are 2.80 m from the ground.

**Streetball**

Streetball is an urban form of basketball, played outdoors on tarmac or concrete courts and playgrounds all over towns and cities.

Streetball started off mainly as a non-competitive leisure game (as a way of passing time and having fun), although streetball players may compete amongst themselves in outdoor tournaments. Streetball is directly linked to urban culture and is very popular amongst today’s youth.

The playing rules are essentially the same as the Official Basketball Rules, but there are no precise rules about the playing time or playing area. These are decided by the players on the court at the time.

The playing area, frequently referred to as “playground”, is often defined and surrounded by metal fencing which keeps the ball in. The size of the playgrounds often varies, ranging from regular sized courts with two baskets to just a few square metres with only one basket.

The number of players in a game also varies, sometimes allowing only one-on-one games and other times games with two full teams of five each.

More detailed information on streetball playing areas and facilities are covered in the chapter on “Outdoor Basketball Facilities”.

**Deaf basketball**

Basketball for hearing-impaired men and women (completely or partially unable to hear in one or both ears) was introduced around 1920.

Today Deaf Basketball is played according to the same Official Basketball Rules of FIBA.

The Deaf International Basketball Federation (DIBF), founded in 2002, is the world governing body for international deaf basketball which has the support of FIBA and works in cooperation with the Deaflympics, and related national organisations.
can have anywhere between 3 and 24 different stations, depending on the size of the playing area. (Diagram 14.2) Because the number of stations and their layout are determined by the court size available, the playing area will differ from one facility to another, always maintaining a degree of originality.

Bankshot courts can be installed indoors or outdoors. The surface is usually a tarmac pad, but synthetic flooring is better for outdoor facilities.

**Variations not recognised by FIBA**

**Slamball**

Slamball is a recently invented team-based sport which took its inspiration from basketball, yet at the same time combines elements of trampolining, ice-hockey and American football. It is a fast-moving game with a very high-entertainment value. There are eight (8) players per team. Four (4) players from each team are allowed to be on the court at one time. The game consists of 2 periods of ten (10) minutes, with a 15-second shot clock controlling possession of the ball.

The perimeter of the court is based on an ice-hockey rink, enclosed by a 2.4m high plexi-glass wall. Players wear protective gear at all times, as in American football, and are spurred on by the flexible rules governing physical contact in this hard-hitting game. Slamball is to be played on a court 29.6mx17.4m (Diagram 14.3). The main characteristic distinguishing a slamball court from a regular basketball court is the use of trampolines, all rectangular in shape. At each end of the court, underneath the baskets, four trampolines are set into the floor. The area between the trampolines is known as the “island”.

The DIBF endeavours to encourage the growth and development of basketball for the hearing-impaired by offering a programme of education, instruction and support, with the ultimate aim of conducting international competitions in cooperation with the Deaflympics and its confederations.

The playing area and equipment is the same as that for regular basketball.

**Bankshot basketball**

Bankshot basketball, invented by American Rabbi Reeve Brenner in 1981, is a “non-exclusionary” form of basketball which allows able-bodied and disabled people to play together at the same time, with nobody being at a disadvantage.

This game does not involve running, dribbling, jumping, or even physical contact, but relies primarily on shooting skills.

The game is open to players of all ages and all abilities, for a competitive yet sporting shooting competition.

A Bankshot playcourt consists of series of stations with uniquely shaped backboards, called Bankboards, supported by steel poles and with traditional baskets. The unconventionally shaped and brightly coloured backboards are characteristic of Bankshot playing courts.

There are three different coloured circles at different distances on the floor in front of each basket which mark the shooting spots and each carry a different number of points. Before moving on to the next station, the players must bank a shot from each of the three circles at each station. (Diagram 14.1) Each basket is unique to the station it represents, and a Bankshot court
Players can only stay on the island for three (3) seconds. The playing area extends another 3m behind the basket, measured from the centre of the basket.

**Netball**

A well-known and popular sport in many Commonwealth countries, netball is now the pre-eminent women’s team sport as a spectator and participant sport in Australia and New Zealand. It is, however, not limited to women and mixed-team competitions do indeed take place.

There are seven (7) players on each team. In professional competitions the game lasts 60 minutes and is played over four (4) 15-minute periods. At the beginning of every quarter or after a goal is scored, play starts from the centre of the court with a “centre pass”. If the ball leaves the court boundaries, play is restarted by a player who must stand with both feet behind the side lines. The court is 30.5mx15.25m, divided into three zones comprising one centre third and two goal thirds. *(Diagram 14.4).* The goal posts are 3.05m high and have no backboards.

The goal rings have an internal diameter of 38cm.

**Waterbasket**

Water basketball is a fairly new sport which mixes the rules of basketball and water polo. It is played by two teams of five players, plus five substitutes. The game is divided into four (4) periods of 9 minutes each, with a two minute interval in between each quarter. Baskets must be fixed at the ends of the pool or attached to the pool wall at a height of 1.30m from the water surface. The backboards must be 1.10x0.72m, and the ring must be 45cm in diameter.

Pools measuring 20mx15m are ideal for a pool court, but the game can also be played in any expanse of water (sea or lake) if it is appropriately equipped and marked off for the game. *(Diagram 14.5).*
Diagram 14.4
Netball

Diagram 14.5
Waterbasket
A Multifunctional Hall Project
A Multifunctional Hall Project

By Erminio Ravasio

This chapter presents a model project for a basketball facility designed as a multifunctional hall which is suitable not only for sporting events but also for shows, conventions and exhibitions.

The planner has chosen a city in northern Italy to simulate his design, pin-pointing a location close to a new exhibition centre. The aim is to position the project in a territory and, in experimental terms, study its urban inclusion in a setting that would allow a new sports facility to take advantage of the infrastructures of an existing exhibition centre.

The design proposal is based on studies and research carried out by FIBA with the aim of presenting a visual idea of how a basketball hall can be conceived on the basis of all the aspects mentioned in the previous chapters. The project guarantees the standards necessary for the different activities planned, ensuring that basketball competitions can be played under the best functional and organisational conditions so that the events are as spectacular and engaging as possible. (Diagram 1A)

The illustrations which will be presented in this report depict the functional plans and the suggested layout of the hall for different sporting events, shows and conventions.

The building is conceived as a multifunctional structure with a high user-capacity. The multifunctional hall is therefore designed to host not only high-level sporting events but also everyday sporting activities, and to include commercial areas, entertainment areas for concerts and shows, cinemas, exhibition rooms, bars and restaurants, with the ultimate aim of implementing the concept of large-scale self-supporting facilities in the best way possible. (Diagram OB)

With a capacity of about 18,000 people, users access the multifunctional hall via a filter area which is large enough to accommodate the flow of people and acts as a meeting place on arrival, and can also be used as an all-important area for open-air events. (Diagram 13A)
Transport terminals, car parks and those services which do not require natural lighting and ventilation are positioned in the internal parts of the multifunctional hall.

Separate access ramps have been planned according to the various vehicle categories and user-types to ensure user-friendly access for all, whether service providers, athletes, spectators, journalists or emergency services.

Car parks have been appropriately located so that passengers arrive on the correct level, for example team coaches arrive and park on the same level as the court, thus enabling teams' direct access to the changing rooms from the car park. Separate access routes are provided for VIPs, partners and journalists, which lead them directly to their reserved areas, ensuring that the different categories remain segregated during a heavy influx of visitors.

The spaces are designed to enable service and emergency vehicles quick and easy access to the court when setting up equipment for events, carrying out maintenance services or any emergency or fire prevention operations, whilst long-term parking is offered in the adjacent parking areas.

The service areas and playing areas are distributed on different levels of the hall.

The car parks and court are below ground level.

The parterre is on the first underground level where there is also a large car park that enables suppliers and equipment trucks direct access to the building. In this project, the car park and a part of the multifunctional hall have been placed underground for two reasons: to reduce the visual impact of an obviously large structure and to contain underground those functions which are not deemed to be particularly attractive, such as the car park which, now under cover, serves as a public square above. (Diagrams 6A and 16A)

On the second underground level there are two courts for training and pre-competition warm-ups. As mentioned in previous chapters, it is imperative that during high-level events teams are designated an area where they can practise and...
warm up before a game. Stairs and lifts can, however, be used by authorised public to access the additional court area as this area is also suitable for small exhibitions, conventions or conferences which may be organised alongside large events and trade fairs. The second car-park level is also on this level. All levels are connected by common areas with stairs, lifts or escalators. Different accesses are foreseen for different user categories, including a special access route reserved for the players which takes them directly into a closed and protected area; this can be used by players arriving in the team coach as well as those travelling with their own vehicles for home games. The reserved access route leads directly to court level, which corresponds to the first underground level. En route to the court, players must pass through the changing rooms where they can get ready for the game.

The changing room area, large enough to accommodate several teams at the same time, also houses a first-aid room and an anti-doping room. For security reasons, this area is reserved exclusively for players and coaches, thus averting contact with other users or spectators and ensuring a smooth running of the event. As the players leave the court at the end of a game, they pass through a “mixed zone” in one of the four corners where the service sections are located, where journalists may descend directly from the press area to meet with the players and their coaches. (Diagram 1B)

It is important to highlight that the entire hall, with the exception of the playing court, is on different levels. Stairs, lifts and escalators lead up to the first level. On this floor, there is the main entrance to the multifunctional hall and general public facilities, such as the reception area, refreshment area and commercial area. (Diagram 2B)

The communal area on the second level can also be reached
using stairs and elevators, after access has been authorised by means of an electronic pass or showing identification at reception. (Diagram 3B)
The court is generally visible from the commercial area, but may be closed off from public view by covering the glass partitions to conceal the court or parterre whenever necessary, for example during training or a concert.

The stands are accessed from the next level, the third floor, which is reached using the escalators. On this floor there are no commercial spaces apart from the refreshment areas. Thus, the space on this level is intended solely to accommodate the flow of spectators entering and leaving the stands. Next to each corner section there are two independent staircases which are defined by reinforced concrete walls; near the stairs there are lifts. In general, spectators heading to the stands will use the escalators to reach the third level and will therefore see the commercial area as they pass through the second level.

Each floor offers restricted and reserved areas for special purposes. (Diagram 4B)

The dimensions of the service section are fixed and the space within uninterrupted and pillar-free, thus allowing the space to be divided and used in different ways. This is a positive aspect which improves the multifunctional hall’s versatility, and thus promotes its use throughout the year. Not only can the space be redesigned according to the event in question, but enhanced versatility also allows space requirements to change in line with technological evolution. What is more, with the public’s changing interests, the spaces can easily be adapted to satisfy new requirements. (Diagram 7A)

Spaces inside the service sections, in the basement, on the first floor and sometimes on the second floor, are dedicated exclusively to service operators, whatever the event.

The corresponding spaces on upper levels, however, can be dedicated to permanent ventures which will benefit from a view of the court.

In the corner sections there is also the wellness centre with a
captivating view of the court. *(Diagram 4A)*

The strategy of this project is to also involve users who would not usually follow basketball events.

Regarding the structure of the hall, the roofing consists of a structural part made up of iron beams with a double-T section or reticulated beams that cover the main lighting system using the reinforced concrete ducts (near the fire escape stairs mentioned earlier) as support.

The reinforced concrete ducts are used because they are both fire-resistant and load-resistant; in fact, they can support the emergency stairs, lifts, part of the stands and the roofing itself. The structure of the roofing includes the main beams which form a grid on which nine secondary squares rest; these are alternately connected with the upper and lower parts of the main beams.

With a building of this type, the following elements can be located indoors: lighting systems, wiring for the fixed lighting above the court, wiring for the arena’s audio system, ducts for the air treatment system as well as fire-prevention systems and other safety installations. Frames are placed below the roofing to fix the spot-light system for the court.

The roofing in the filter area comprises metal elements which intersect to leave openings between one panel and another. The part of the same roofing which covers the arena has sealed infills which insulate the roof and render it waterproof.

The filter area can be accessed from the sides, through different accesses. The aim of this space is to offer a first welcome point for all visitors as well as an intermediate space where exhibitions and “street” sports can be offered entertainment during major events. *(Diagram 5A)*

The thought behind this area is to increase exposure by showcasing events on large screens. This is particularly valuable during any popular world championship as it enables fans to follow the games on maxi-screens or LED-walls as they are broadcast live.

The facility offers a central multifunctional assembly room which
Diagram 5A
can accommodate up to 300 people. This room is necessary for press conferences or meetings. For easy access, and evacuation in case of an emergency, the room has four entrances; these also allow the room to be divided into four smaller areas where up to four conferences or meetings can then be held simultaneously. Men’s and women’s toilet areas are located nearby, each with 10 cubicles.

The section reserved for journalists includes areas equipped with computer workstations, press conference areas and refreshment areas, all of which are connected by stairs and lifts and not accessible to the public. Considering the versatility of the multifunctional hall, ample storage space is very important. The building must have a storeroom large enough to hold all the equipment necessary for the different sporting activities, for example, the mobile floor of the basketball court which, given the total surface area, is particularly large.

The multifunctional hall can be used for the following sporting activities:

- Basketball
- Boxing
- Volleyball
- Hockey
- Equestrian events
- Athletics
- Tennis
- Shows, conventions, conferences

Given the versatility of the hall and the different activities that can be organised in the arena, it is important that the position of the stands can be altered to cater to the needs of the different activities; for this reason, retractable stands are preferred. (Diagrams 1G, 2G, 3G, 4G, 5G, 6G, 7G and 8G)

There are eight LED-walls near the four corner sections inside the arena.

LED-walls provide close-up coverage of the game as well as replays of televised games. Furthermore, they offer visual support during conferences as internal filming allows images of the speakers to be brought closer to those seated further away. During trade fairs and exhibitions, or whenever the arena is divided, each area will be fitted with two or four LED-walls with independent controls for advertising, announcements, information and security.

The project foresees the use of renewable and recyclable materials produced without causing damage to the environment, and also the use of energy-saving technologies.

The use of energy saving materials and equipment for the rational production of energy is important in both environmental and economic terms, once again supporting the concept of a self-supporting structure.

The building shell is one of the main aspects taken into account in this project.

The shell has three main characteristics:
- high level of insulation
- good breathability and sufficient mass to reach a good level of thermal inertia
- high capacity to withhold the heat or cold for as long as possible.

The imposing size of the facility is considered a unique architectural feature: the building slopes downwards towards the public access area until it reaches the ground. The zig-zag roof rises on the opposite side but is still lower than the top of the arena, leaving space for a second entrance. (Diagrams 16AB and 16ABC)

The outside facades of the sports facility are rendered visible in the dark through the installation of LED-walls and luminous projectors that project event-related information and advertising. (Diagrams 14A and 15A)

In the model project proposed, the front of the facility extends as far as the exhibition centre in the hypothetical location; as such, it acts as a giant advertising board to those travelling along the arterial roads close to the facility, providing the ideal opportunity to publicise events being held there. (Diagram 11A)
diagram 5G - Equestrian events

diagram 6G - Boxing

diagram 7G - Concert

diagram 8G - Basketball
Diagram 11A