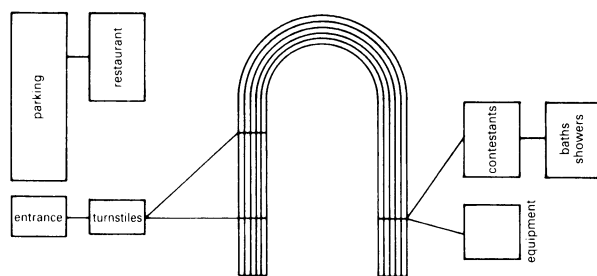
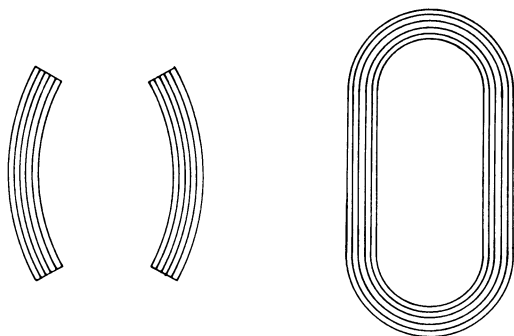


## SPORTS: STADIUMS

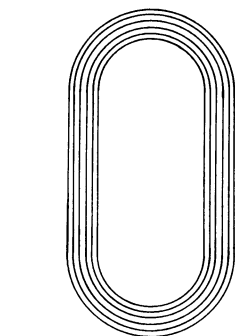
## General Layout



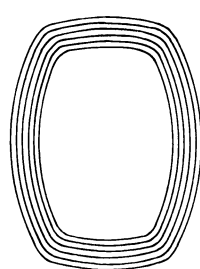
① U-shaped stadium layout



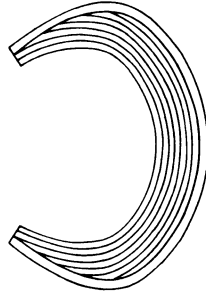
② USA: segmented layout



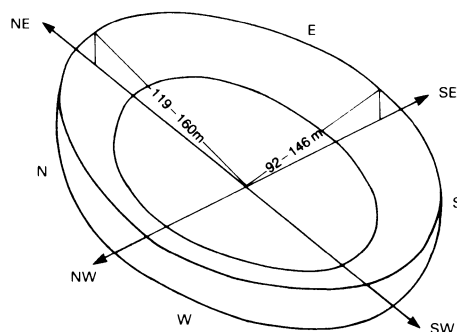
③ Amsterdam: semicircular ends



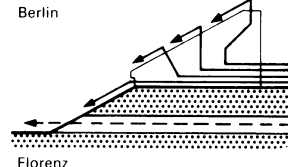
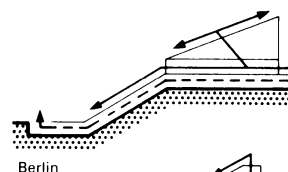
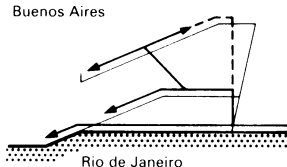
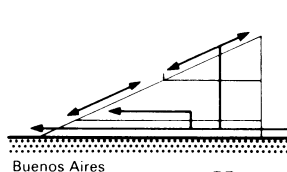
④ Rotterdam: curved sides and corners



⑤ Budapest: horseshoe around long axis



⑥ Viewing distance determines the stadium size



⑦ Access arrangements in individual stadiums

The stadiums of antiquity have never been matched for grandeur (the Circus Maximus in Rome, for instance, could hold 180 000 spectators) but they form the basis for modern sports stadiums. The size of the inner sports field can be based loosely on the size of a football pitch, with measurements of 70×109 m. For athletics stadiums there should be a running track surrounding the field (see page 500). The basic shape for the playing area is usually similar to the elliptical shape used in ancient stadiums. As a rule a stadium is partly below ground with the excavated earth heaped up around it. In relation to town planning, sports grounds must fit in well with the local topography and be designed with good transport links and supply facilities (train, bus and tram stations, large car parks etc.). They should not be sited close to industrial areas where smoke, odours and noise might create unpleasant conditions. Covered and open grounds for various sports can be combined and integrated into the town/district plan.

The orientations of ancient arenas were determined by the variable timing of the contests – axes ran west to east or south to north. In Europe today the main axis is usually north-east to south-west so that a maximum number of spectators have the sun at their backs → ⑥. Access gates are therefore situated to the east. The turnstiles are positioned so as to direct the stream of visitors to the various stadium entry points. Access into the stadium is often through the embankment formed from the excavated earth or via stairways leading halfway up the terraces to a point from which the rows above and below can be reached → ⑦.

To give spectators a clear view and ensure good acoustics, Vitruvius recommended a fixed gradient of 1:2 for both seating and standing areas. (If a public-address system is incorporated, then, of course, the view is the only determinant of the gradient.)

In staggered seating rows, spectators in every row should be able to see over the heads of those in the corresponding two rows in front. This results in a parabolic curve. The best viewing conditions are to be found on the 'long side' of the segment.

The arrival of spectators happens relatively slowly so the widths of entrances and stairways have to be calculated on the basis of the flow of spectators leaving the stadium. This is when the flow rate is at maximum. According to research in the Amsterdam stadium → ③, every 5000 spectators needs 7 minutes or 420 seconds to leave via the 9.5 m wide steps. (In equivalent stadiums the times are: Los Angeles, 12 minutes; Turin, 9 minutes.) Therefore, one spectator uses 1 m of staircase width in

$$\frac{9.5 \times 420}{5000} = 0.8 \text{ seconds}$$

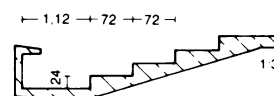
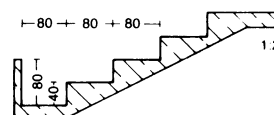
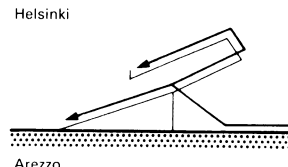
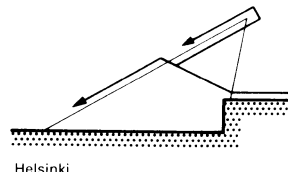
Or, in 1 second a 1 m wide staircase accommodates

$$\frac{5000}{9.5 \times 4.20} = 1.25 \text{ spectators}$$

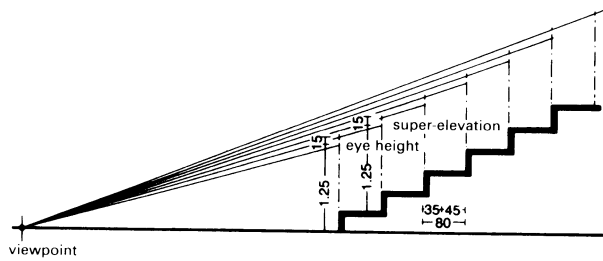
The formula giving the staircase width necessary to allow a certain number of spectators to leave the stadium in a given time is:

$$\text{staircase width (m)} = \frac{\text{number of spectators}}{\text{emptying time (s)} \times 1.25}$$

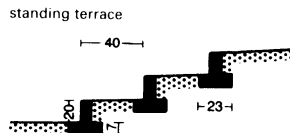
First aid rooms for the spectators should be provided close to the spectator area. First aid treatment for 20 000 or more spectators requires a suite of rooms: treatment and recovery rooms 15 m<sup>2</sup>, storeroom 2 m<sup>2</sup> and two toilets with ventilation. For sports grounds with 30 000 capacity or greater, provide an additional room of 15 m<sup>2</sup> for the emergency services (police, fire brigade). Commentary boxes in the main stand must have a good view onto the field of play and each box should be at least 1.5 m<sup>2</sup>. Behind every five press boxes a control room of 4 m<sup>2</sup> is necessary. One car parking space should be provided for every four spectators and spaces should be allocated for coaches and buses.



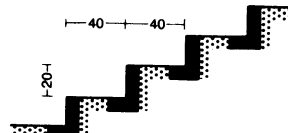
⑧ Stand profiles



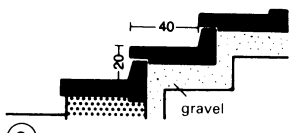
① Construction of sightlines



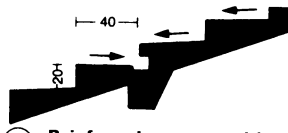
② Movable concrete units



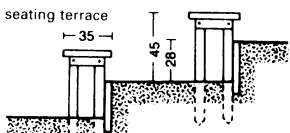
④ Angle steps



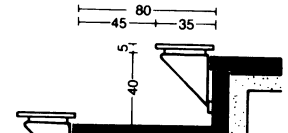
③ Angle steps



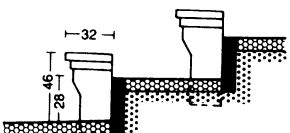
⑤ Reinforced concrete with drainage



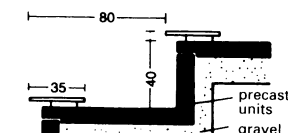
⑥ Wooden bench with step board



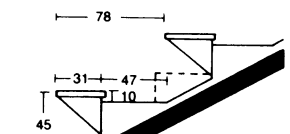
⑧ Cantilevered seating



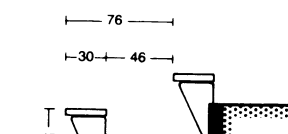
⑦ Raised seats on concrete uprights



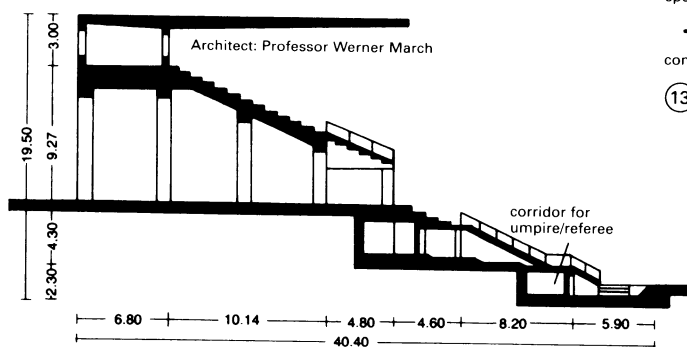
⑩ Seating on precast concrete units



⑨ Sloping concrete floor with steps



⑪ Seats on metal brackets set in concrete



⑫ Section through the Olympic Stadium, Berlin

### SPECTATOR FACILITIES

All planning must be done in accordance with national 'regulations for the construction and management of meeting places', in which the requirements for access ways, stairways, ramps and spectator accommodation are set out.

Depending upon the planned capacity, seating is provided either along the long side of the ground (to take advantage of the shortest viewing distance) or, for capacities above 10000, around the whole ground. As most events take place in the afternoon, the best position for spectators is on the west side so that the sun is at their backs.

To improve viewing conditions in the multi-row layout, there has to be sufficient super-elevation. In smaller grounds with up to 20 rows of terracing or 10 rows of seats, a linear gradient of 1:2 can be taken as a basis. In all other grounds the linear gradient should ideally be replaced with one which is parabolic. In this case the gradient for seating and standing places is to be set using a construction based on the spectators' line of sight. In terracing stands the super-elevation should be 12cm and in rows of seating it should be 15cm → ①.

### Seating Areas

The necessary space for seating areas is calculated as follows:

width of seat	0.5 m
overall depth	0.8 m
of which:	
seat depth	0.35 m
circulation	0.45 m

Rows of seats (benches) as well as single seats can be planned. Seats with back rests offer greater comfort. Depending on the arrangement of entrances and exits, each row can comprise:

on each side of a passage	
in shallow rising rows	48 places
in steeply rising rows	36 places

Seating and standing areas must be separated by fences. For every 750 seats an escape route (stairway, ramp, flat surface) with a minimum width of 1.00 m must be provided.

### Standing Areas

The necessary space for standing spaces is calculated as follows:

width of standing space	0.5 m
depth of standing space	0.4 m

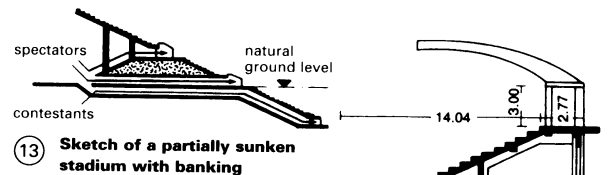
Again, for every 750 spaces an escape route (stairway, ramp, flat surface) with a minimum width of 1.00m must be provided. To allow standing areas to fill and empty evenly, and to prevent dangerous overcrowding, they should be divided into groups or blocks of around 2500 places. Each block should have its own entry/exit points and should be separated from the others by fences.

Inside the blocks of standing places, a staggered arrangement of crush barriers will be necessary to prevent diagonal crowd surges. It must also be ensured that there is a suitably strong barrier, with a height of around 1.10m, between every ten rows of standing spaces.

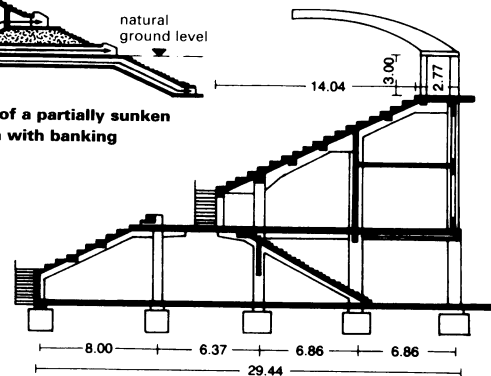
The building industry produces pre-cast concrete steps for the construction of spectator areas → ⑧ + ⑩.

*Guests of honour:* In larger stadiums an enclosed 'Royal box' with movable furniture may be needed.

*Roofing of stands:* Covering as many places as possible should be the aim. By designing overlapping stands the number of covered seats can be increased.



⑬ Sketch of a partially sunken stadium with banking



⑭ Section through the Vienna Stadium

## SPORTS HALLS

type of hall	dimensions (m)	useable sports area (m <sup>2</sup> )	indoor games <sup>1)</sup>	number of training courts/pitches	number of competition courts/pitches <sup>2)</sup>
multifunctional halls					
single hall	15 × 27 × 5.5	405	badminton basketball volleyball	4 1 1	
triple hall	27 × 45 × 7 <sup>3)</sup> <sup>4)</sup> div. into 3 sections (15 × 27) <sup>5)</sup>	1,215	badminton basketball football handball volleyball	12 3  3	5 <sup>6)</sup> 1 1 1 1
quadruple hall	27 × 60 × 7 <sup>3)</sup> div. into 4 sections (15 × 27) <sup>5)</sup>	1,620	badminton basketball football handball hockey volleyball	16 4  3	7 <sup>6)</sup> 2 1 1 1 1
alternative: double hall	22 × 44 × 7 <sup>3)</sup> <sup>4)</sup> div. into 2 sections (22 × 28 + 22 × 16 or 22 × 16 + 22 × 18 <sup>5)</sup> )	968	badminton basketball football handball hockey volleyball	6   3	5 <sup>6)</sup> 1 1 1 1 1
games hall					
single hall	22 × 44 × 7 <sup>3)</sup> <sup>4)</sup>	968	badminton basketball football handball hockey volleyball	6   3	5 1 1 1 1 1
triple hall	44 × 66 × 8 <sup>3)</sup> div. into 3 sections (22 × 44) <sup>5)</sup>	2,904	badminton basketball football 20 × 40 30 × 60 handball hockey volleyball	24   3 3 3 9	15 4 <sup>6)</sup> 3 1 3 3 3
quadruple hall	44 × 88 × 9 <sup>3)</sup> div. into 4 sections (22 × 44) <sup>5)</sup>	3,872	badminton basketball football 20 × 40 40 × 80 handball hockey volleyball	32 5 <sup>6)</sup>  12	25 <sup>6)</sup> 4 4 4 4 4 4

<sup>1)</sup> normal hall games without regard to national or regional practices

<sup>2)</sup> dimensions according to the regulations of the international sports organisations (can possibly be reduced for national events)

<sup>3)</sup> the hall height may be reduced around the edges if in accordance with the functional requirements of the sport

<sup>4)</sup> in the case of several halls on one site or in the same complex, it is feasible to reduce the height to 5.5m in some halls, depending on the planned uses

<sup>5)</sup> minus the relevant thickness of the divider

<sup>6)</sup> maximum number without accounting for the dividers

### 1 Hall dimensions

The planning basics for multipurpose games halls should take into account the competition regulations of the individual sports organisations to give the best possible integration of all individual types of activity → ①. Note that a divisible hall offers more versatility than several separate dedicated halls.

The necessary size of the site depends on the area required for the desired sporting activities and administration rooms. As a rule of thumb, it can be estimated as follows: required sports area × 2 + necessary distance to site boundary + necessary parking area for vehicles.

The following ancillary rooms and spaces are required for sports events: an entrance area with ticket office, spectator cloakroom and cleaning equipment room (→ ② 0.1m<sup>2</sup> per spectator); spaces for spectators (0.5 × 0.4–0.45m per seat, including adjacent circulation area), and, as appropriate, for guests of honour, press, radio and television (including circulation areas: 0.75 × 0.8–0.85m for each member of the press; 1.8 × 2.0m per commentary box; 2.0 × 2.0m per camera platform). A box office, cafeteria, emergency services room, administration office and meeting room will also be required.

room type	dimensions (m)	useable area (m <sup>2</sup> )
conditioning/weight training room	depending on the range of apparatus, minimum height 3.5 m	35 to 200
fitness room	depending on the range of apparatus, minimum height 2.5 m	20 to 50
gymnastics room	10 × 10 × 4 to 14 × 14 × 4	100 to 196

### 3 Dimensions of additional activity rooms

<sup>1)</sup> minimum room height generally 2.5 m

<sup>2)</sup> space requirement per person is 0.7 to 1.0m<sup>2</sup>, based on allowances of 0.4 m bench length per person, 0.3 m sitting depth and minimum 1.5 m between benches or between bench and wall (1.8 m recommended)

<sup>3)</sup> one shower per 6 persons (but a minimum of 8 showers and 4 wash-basins per facility), shower space including a minimum circulation area of 1.0m<sup>2</sup> and circulation space at least 1.2 m wide

<sup>4)</sup> training supervisors', umpire/referees' room, perhaps including first aid post (minimum 8m<sup>2</sup> for separate first aid room), with changing cubicle and shower; can also be used as an administration room if correctly positioned, designed and of sufficient size

<sup>5)</sup> because the range of apparatus provided varies according to location, it is likely that these minimum dimensions will have to be exceeded; no hall section in a multifunctional hall should have less than a 6m length apparatus room

<sup>6)</sup> divided into two sections, each with half of the apparatus;

<sup>7)</sup> room depth normally 4.5m, maximum 6.0m;

<sup>8)</sup> room depth normally 3m, maximum 5.5m;

<sup>9)</sup> according to need;

<sup>10)</sup> alternatively, two bigger rooms with proportionally more shower and washing facilities

type of hall	entrance area (m <sup>2</sup> )	changing room (at least 20 m <sup>2</sup> ) <sup>2)</sup>	shower room (at least 15 m <sup>2</sup> ) <sup>3)</sup>	toilets		instructors' room <sup>4)</sup> (12 m <sup>2</sup> min; with no first aid post, min 8 m <sup>2</sup> )	equipment room		cleaning equipment room (min 5 m <sup>2</sup> )	caretaker's room (min 10 m <sup>2</sup> )
				for each changing room	entrance area		multifunctional hall	games hall		
	m <sup>2</sup>	minimum number	number	minimum number	minimum number W M	minimum number	m <sup>2</sup> minimum <sup>5)</sup>	m <sup>2</sup> minimum <sup>5)</sup>	minimum number	number
single hall	15	2	1 <sup>6)</sup>	1	1 1	1	60 <sup>7)</sup>	20 <sup>8)</sup>	1	1 <sup>9)</sup>
double hall	30	2	2	1	1 1	1	90 <sup>7)</sup>	–	1	1 <sup>9)</sup>
triple hall	45	3 <sup>10)</sup>	3 <sup>10)</sup>	1	1 1	2	120 <sup>7)</sup>	60 <sup>8)</sup>	1	1
quadruple hall	60	4 <sup>10)</sup>	4 <sup>10)</sup>	1	1 1	3	150 <sup>7)</sup>	80 <sup>8)</sup>	1	1

### 2 Sports hall ancillary rooms

## SPORTS HALLS

type of sport	net useable area				additional obstruction-free zone		obstruction-free gross useable areas		clear height
	permissible dimensions		standard dimensions						
	length m	width m	length m	width m	long sides m	short sides m	length m	width m	
badminton	13.4	6.1	13.4	6.1	1.5	2.0	17.4	9.1	9 <sup>2)</sup>
basketball	24–28	13–15	28	15	1 <sup>3)</sup>	1 <sup>3)</sup>	30	17	7
boxing	4.9–6.1	4.9–6.1	6.1	6.1	0.5	0.5	7.1	7.1	4
cricket <sup>7)</sup>	29.12–33.12	3.66–4.0	33.12	4.0	1	1	35	6	4.0– 4.5 <sup>8)</sup>
football	30–50	15–25	40	20	0.5	2	44	21	(5.5)
weightlifting	4	4	4	4	3	3	10	10	4
handball	40	20	40	20	1 <sup>4)</sup>	2	44	22	7 <sup>5)</sup>
hockey	36–44	18–22	40	20	0.5	2	44	21	(5.5)
judo	9–10	9–10	10	10	2	2	14	14	(4)
netball	28	15	28	15	1	1	30	17	(5.5)
body-building	12	12	12	12	1	1	14	14	(5.5)
gymnastics	52	27	52	27	–	–	52	27	8
bicycle polo/stunt cycling	12–14	9–11	14	11	1	2	18	13	(4)
rhythmic gymnastics	13 <sup>6)</sup>	13 <sup>6)</sup>	13 <sup>6)</sup>	13 <sup>6)</sup>	1	1	15	15	8 <sup>2)</sup>
wrestling	9–12	9–12	12	12	2	2	14	14	(4)
roller-skate hockey	34–40	17–20	40	20	–	–	40	20	(4)
roller-skating/dancing	40	20	40	20	–	–	40	20	(4)
dancing	15–16	12–14	16	14	–	–	16	14	(4)
tennis	23.77	10.97	23.77	10.97	3.65	6.4	36.57	18.27	(7)
table tennis	2.74	1.525	2.74	1.525	5.63	2.74	14	7	4
trampoline	4.57	2.74	4.57	2.74	4	4	12.57	10.74	7
volleyball	18	9	18	9	5	8	34	19	12.5 <sup>2)</sup>

<sup>1)</sup> figures in brackets are recommended dimensions; <sup>2)</sup> 7 m is sufficient for national events; <sup>3)</sup> if possible, 2 m where there is a spectator area adjacent to the court; <sup>4)</sup> additional space for the timers' table and reserves bench (possibly in sports apparatus room); <sup>5)</sup> a uniform reduction to 5.5 m is permitted over a 3.3 m wide boundary zone around the net playing area; <sup>6)</sup> 12 m for national competitions; <sup>7)</sup> dimensions of a single practice net bay; <sup>8)</sup> height of horizontal top net

## 1 Sizes of sports halls for competition use

apparatus	obstruction-free total area <sup>1)</sup> length × width × height (m)	safety distance <sup>2)</sup> (m)			
		side	in front	behind	between each other
floor gymnastics	14 × 14 × 4.5	–	–	–	–
pommel horse	4 × 4 × 4.5	–	–	–	–
vaulting horse	36 <sup>3)</sup> × 2 × 5.5	–	–	–	–
suspended rings <sup>4)</sup>	8 × 6 × 5.5	–	–	–	–
parallel bars	6 × 9.5 × 4.5	4.5 <sup>5)</sup> <sup>6)</sup>	4 <sup>5)</sup>	3 <sup>5)</sup>	4.5
horizontal bar	12 × 6 × 7.5 <sup>7)</sup>	1.5	6	6	–
asymmetric bars	12 × 6 × 5.5	1.5	6	6	–
beam	12 × 6 × 4.5	–	–	–	–
swinging rings <sup>4)</sup>	18 × 4 × 5.5	1.5 <sup>5)</sup> (2) A	10.5 <sup>5)</sup> (7.5) A	7.5 <sup>5)</sup>	1.5 <sup>5)</sup>
climbing rope	–	1.5	4.5 (4) A	4.5 (4) A	1.5 (0.8) A
header hanging ball	–	4.5 <sup>5)</sup>	4.5 <sup>5)</sup>	4.5 <sup>5)</sup>	7
wall bars, freestanding	–	–	4.5 <sup>5)</sup> <sup>6)</sup>	4.5	4.5

<sup>1)</sup> for competition standard; <sup>2)</sup> for school and leisure standard (between fixed apparatus and wall or other fixed apparatus); <sup>3)</sup> run-up length 25 m, apparatus length 2 m, run-out length 9 m; <sup>4)</sup> distance between centres of ropes 0.5 m; <sup>5)</sup> measured either from centres of apparatus posts, end of spar or centre of rope; <sup>6)</sup> possible reduction to 4 m to walls or to 3.5 m to netting walls; <sup>7)</sup> for national competitions 7 m height is sufficient; A = Austria

## 2 Obstruction-free areas and safety distances for fixed sports apparatus

An area of 0.1 m<sup>2</sup> per visitor should be allowed for administration rooms adjacent to the entrance in multipurpose halls.

Cloakroom space of 0.05–0.1 m<sup>2</sup> should be allowed per visitor, with 1 m of counter for each 30 spaces.

The required number of toilets per visitor is 0.01, of which:

- 40% toilets for women
- 20% toilets for men
- 40% urinals

The storage space for tables and chairs per visitor works out at 0.05–0.06 m<sup>2</sup>.

For cleaning/maintenance equipment stores, allow 0.04 m<sup>2</sup> per 100 m<sup>2</sup> (8 m<sup>2</sup> minimum) for hand tools and 0.06 m<sup>2</sup> per 100 m<sup>2</sup> (12 m<sup>2</sup> minimum) for machinery. If central services or outside contractors (who transport their own equipment) are used, this space can be dispensed with.

Stores for sports and maintenance equipment for adjacent outdoor facilities have to be included in the room programme of the sports hall if separate buildings are not provided. Allow 0.3 m<sup>2</sup> per 100 m<sup>2</sup> of useable sports area (minimum area of 15 m<sup>2</sup>).

If the centre is equipped with a small demountable stage (e.g. 100 m<sup>2</sup>), 0.12 m<sup>2</sup> of storage per m<sup>2</sup> of stage will be required. Changing facilities for actors also need to be considered.

The following dimensions apply to catering provision:

1.0 × 0.6 m standing area per vending machine;

12–15 m<sup>2</sup>, with 6 m<sup>2</sup> storage, for a coffee shop;

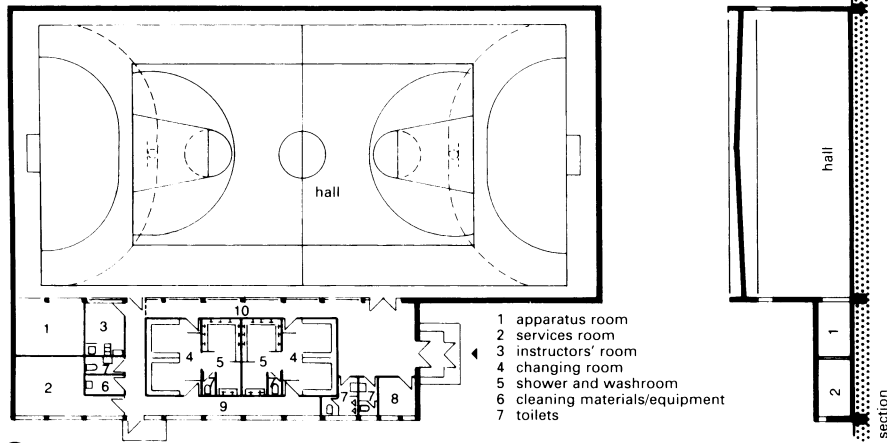
8–12 m<sup>2</sup>, with 10–12 m<sup>2</sup> storage, for a kiosk with bar;

1.5–2.7 m<sup>2</sup> per seat for a cafeteria/restaurant, of which 1.0–1.5 m<sup>2</sup> is for guests and 0.5–1.2 m<sup>2</sup> is for kitchen and storage;

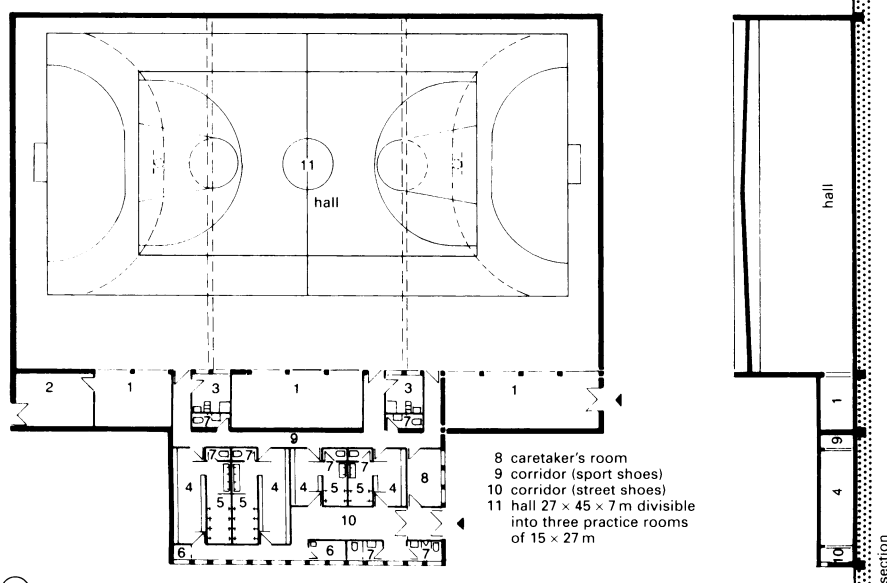
1 m of service counter per 50 visitors for self-service and waiter service.

Rooms for lectures and a games room for board games, billiards etc., even a bowling alley, can also be considered.

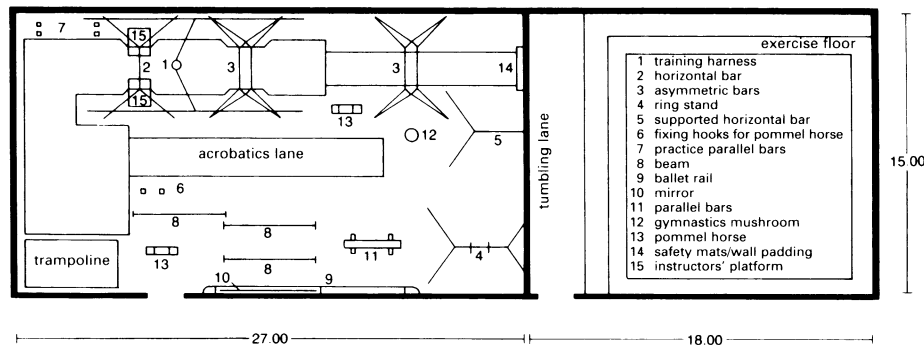




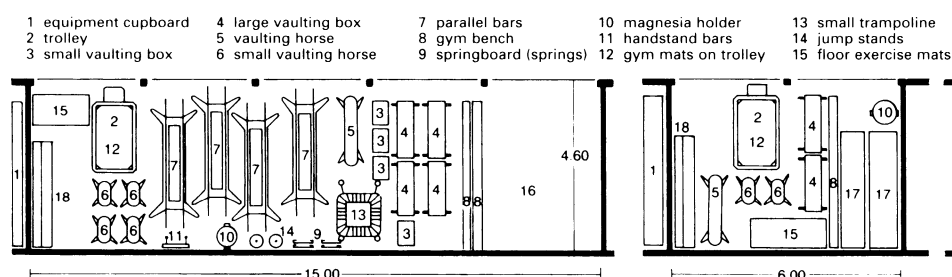
1 Plan layout of a games hall (22 x 44 x 7 m)



2 Plan layout of a triple sports hall



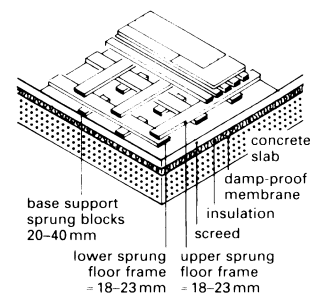
3 Gymnastic apparatus hall with adjacent floor exercise hall



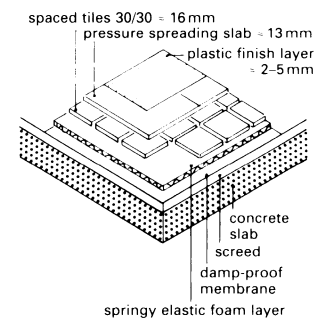
4 Arrangement plan for apparatus storeroom in a 15 x 27 m sports hall

5 Apparatus storeroom

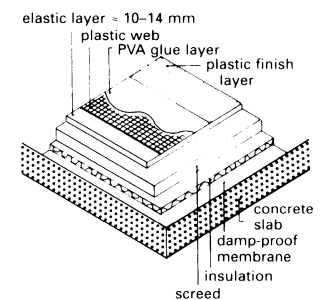
6 Apparatus storeroom



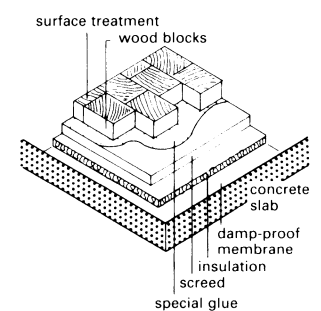
7 Sprung floor construction



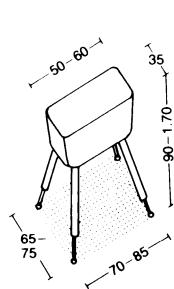
8 Flexible floor



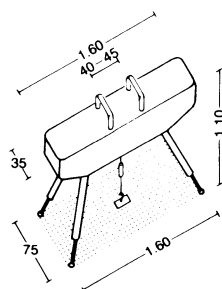
9 Impact absorbing floor



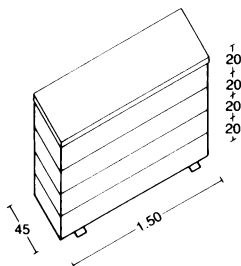
10 Construction of surface treated, glued wood-block floor



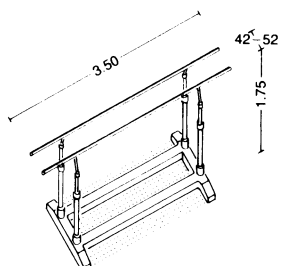
① Vaulting horse



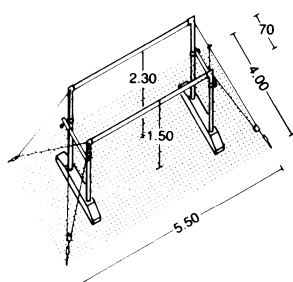
② Pommel horse



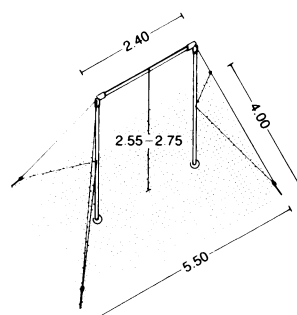
③ Vaulting box



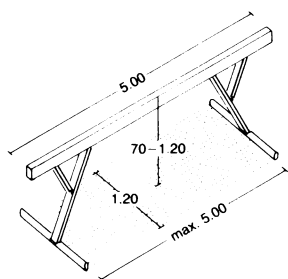
④ Parallel bars



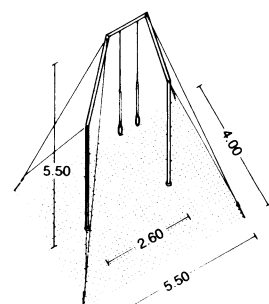
⑤ Asymmetric bars



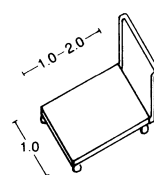
⑥ Horizontal bar



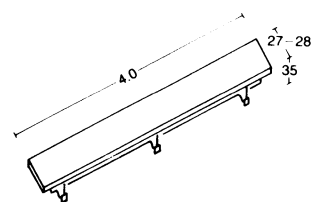
⑦ Beam



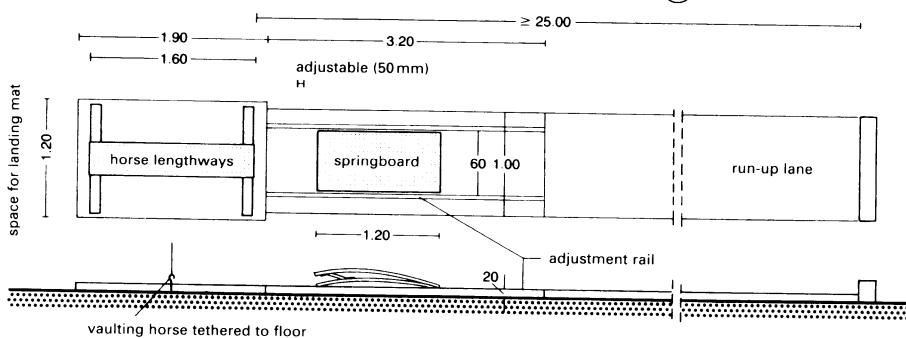
⑧ Rings



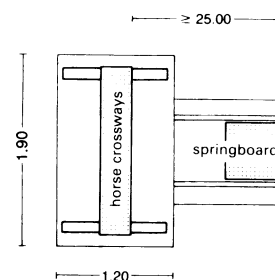
⑪ Mat trolley



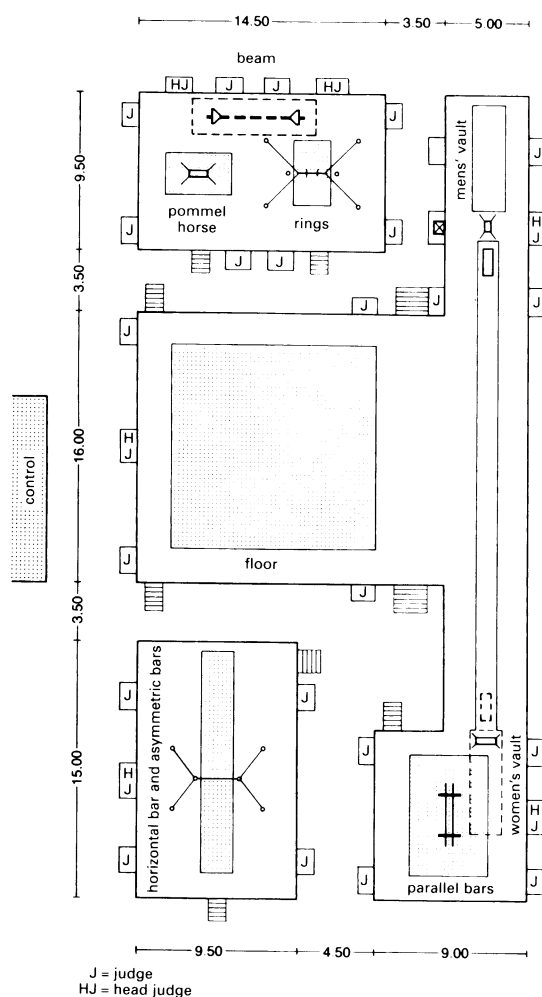
⑫ Gym bench



⑨ Vault layout for men

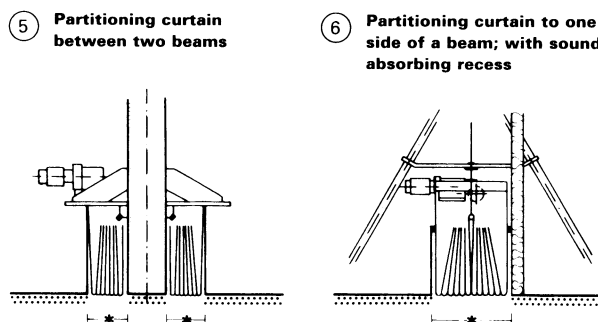
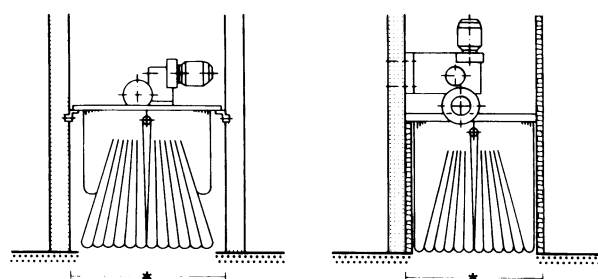
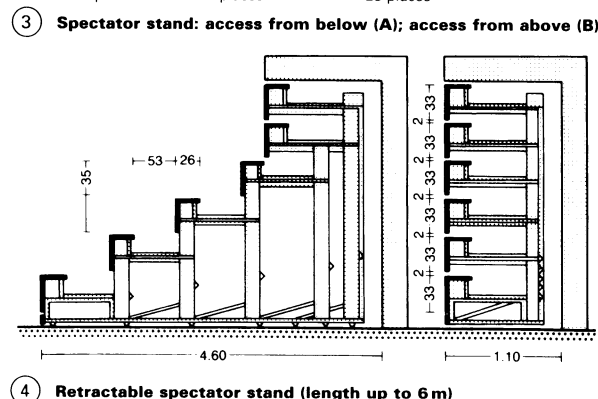
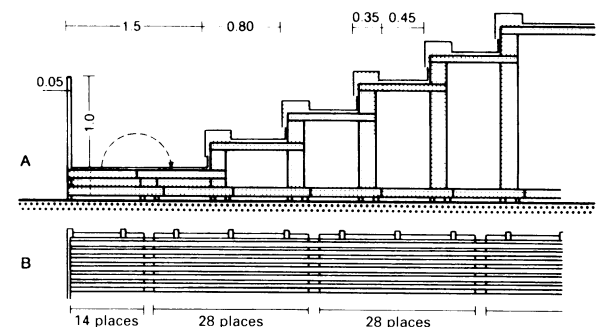
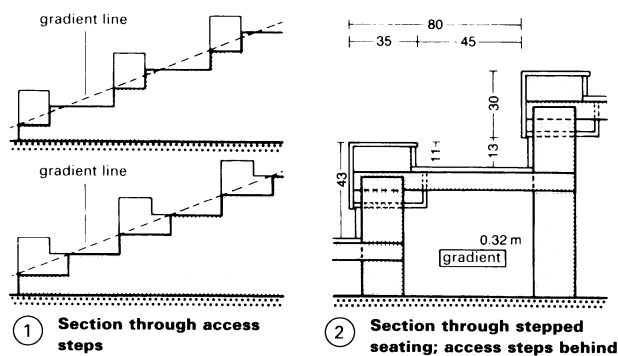


⑬ Vault layout for women



⑩ Competition area requirements: podium measurements and location of umpire places

## SPORTS HALLS



\* - width, depending on height of hall and thickness of material

- ⑤ Partitioning curtain between two beams
- ⑥ Partitioning curtain to one side of a beam; with sound absorbing recess
- ⑦ Partitioning curtains on both sides of a beam
- ⑧ Partitioning curtain with pulley system mounted in a sound absorbing recess within a truss

Stands for spectators can be fixed or movable → ① – ④. For small stands with up to 10 steps of seating, the gradient of the rows can be linear (height 0.28–0.32 m). A parabolic slope should be planned for larger stands (height of eye level: 1.25 m seated, 1.65 m standing; height of sight-line: 0.15 m seated, 0.12 m standing). The distance between rows of seating should be 0.80–0.85 m → ② + ③ and for standing spaces 0.4–0.45 m. The point of reference for the sight-line is 0.5 m above the playing area boundary marking. Spectator areas behind goals should be protected with mobile safety nets.

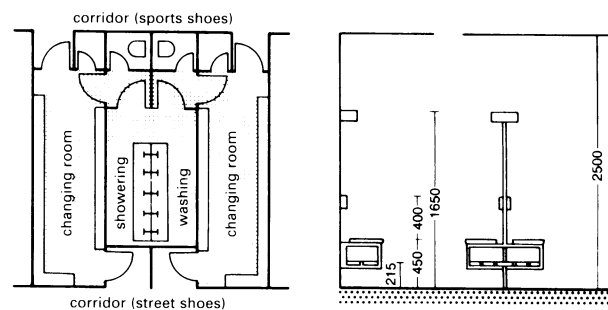
Spectator stands can be accessed from above or below. Access from below is more cost-effective (saving on staircases and separate entrances) but has a disadvantage in that people arriving during an event will disturb the players and the spectators already present. Open sides need to have protective barriers at least 1 m high, measured from the surface of the circulation area → ③.

The design of ceiling and wall areas adjacent to partitioning curtains should ensure that sound bridging is minimised when the curtain is in the lowered position → ⑤ – ⑧.

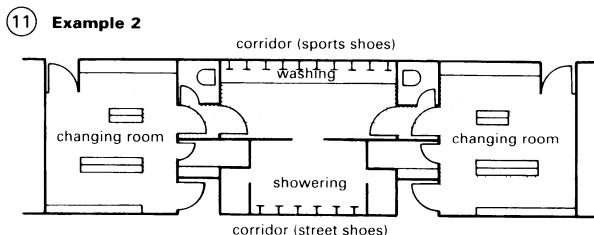
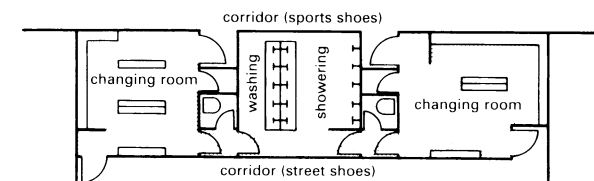
It is recommended that walkways either side of the changing and shower rooms are segregated into those for street shoes and those for sports shoes only.

Showers have to be immediately accessible from the changing rooms and there needs to be a drying area in between. The shower rooms should be designed as two separable sections, both connected to the two neighbouring changing rooms in such a way that from each changing room either one or both sections can be accessed.

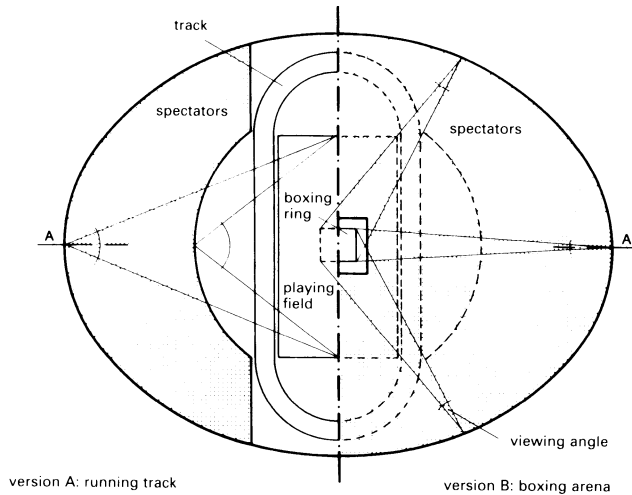
The first aid room should be on the same level as the playing area and could be integrated with the instructors'/referees' room, which should be near the changing rooms.



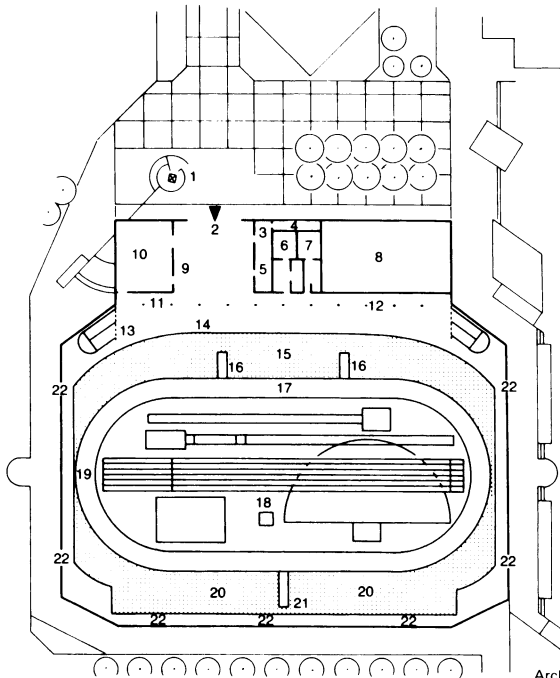
- ⑨ Example 1
- ⑩ Wall-mounted and freestanding benches



- ⑪ Example 2
- ⑫ Example 3  
Three suggested changing room layouts (shaded area: floor with PVC duckboard matting)



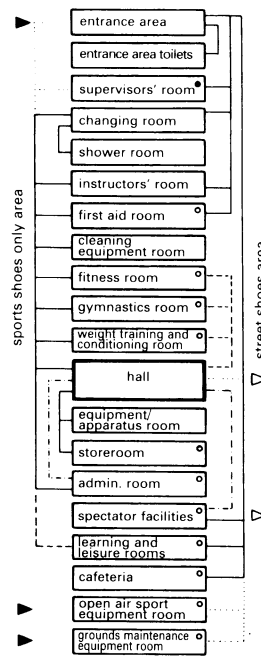
① Principles of spectator area design



② Plan of Europahalle, Karlsruhe

Architects: Schmitt, Kasimir, Blanke  
section → ③

② Space arrangement diagram

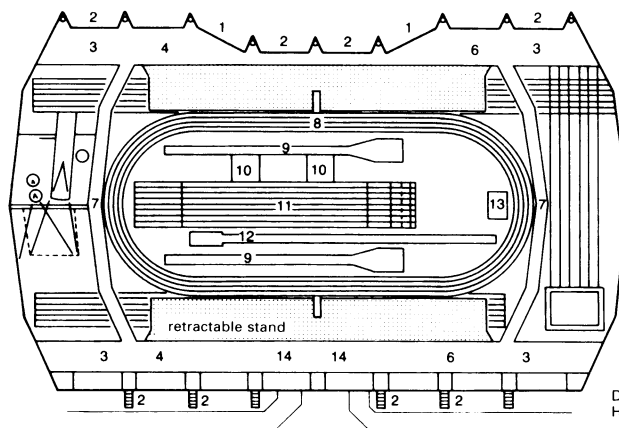


- ▶ direct entrance
  - ▽ alternative emergency exit
  - principal connection
  - - - visual connection
  - - - alternative connection
  - ... additional connection
  - additional rooms with multipurpose halls
  - additional rooms and facilities depending on local situation and need
- ②

key → ③

plan of entrance floor level  
1 entrance on the competition level;  
2 entrance and foyer for spectators;  
3 administration; 4 ticket office;  
5 cloakroom; 6 male toilets; 7 female toilets; 8 area above warm-up hall;  
9 information; 10 teaching and leisure room; 11 access to lower floor; 12 drinks dispensary; 13 access to gallery;  
14 control room with signboard and public address; 15 fixed spectator stand;  
16 connection between changing area and hall; 17 200m running track;  
18 sports hall; 19 large sign board;  
20 mobile spectator stand; 21 game signboard; 22 hall surround corridor with emergency exits

Flexible hall used for tennis, handball, athletics, boxing and school sports → ③. Partitioning curtains, with catching nets at the ends, allow the hall to be split into four parts, each the size of a school sports hall. With the warm-up hall and a training area below the retractable stand, a large sports hall such as this offers schools and clubs six practice areas. It is also large enough to stage top level sporting competitions.



④ Plan of Dortmund Athletics Hall

Design and planning:  
Hochbauamt Dortmund

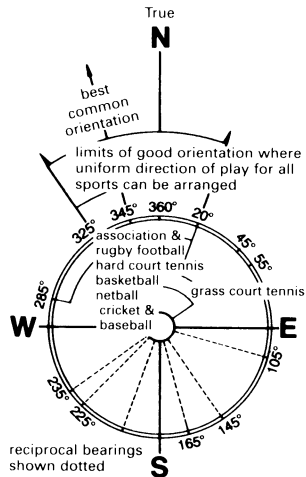
section → ④

key → ④

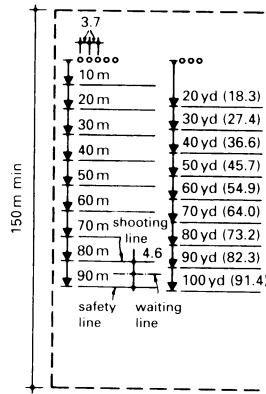
plan of entrance level  
1 entrance concourse with ticket offices;  
2 exits/emergency exits; 3 foyer; 4 drinks dispensary; 5 telephone; 6 steps to the spectator toilets; 7 access as bridge over the sports level; 8 200m running track;  
9 pole vault facilities; 10 high jump facilities; 11 sprint competition track;  
12 long jump facilities; 13 shot put facilities; 14 access to administration

The Dortmund athletics hall → ④ has a competition standard 200m running track, a 130m + 100m straight sprinting track and facilities for shot put, discus and high jump.

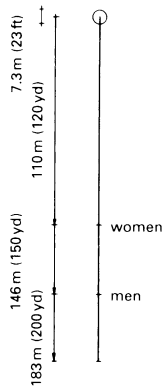
# OUTDOOR PITCHES



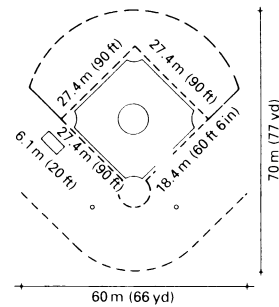
- ① **Orientation diagram, based on the following seasons (northern hemisphere):**  
**association football, August-May; hard court tennis, basketball, netball, all year round; cricket, baseball, grass court tennis, May-September.**  
**Pavilions should avoid SW-NW aspect (225°-315°)**



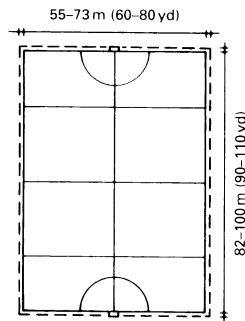
② **Archery, target**



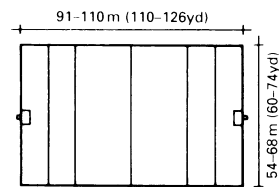
③ **Archery, clout**



④ **Baseball (little league two-thirds size)**

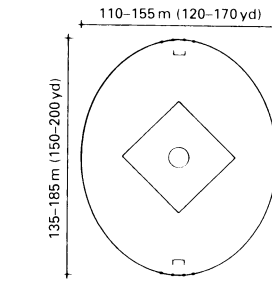
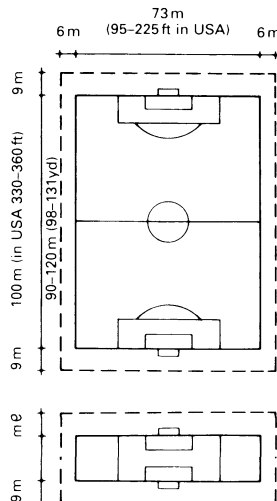


⑤ **Bicycle polo**

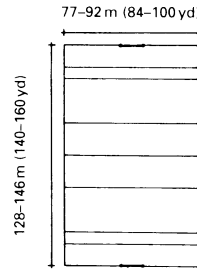


⑥ **Camogie**

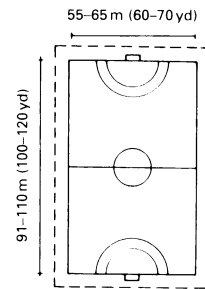
- ⑦ **Association football:**  
**senior pitches 96-100 × 60-64 m;**  
**junior pitches 90 × 46-55 m;**  
**international pitches 100 × 64-75 m;**  
**junior pitches 90 × 46-55 m;**  
**international pitches 100-110 × 64-75 m**



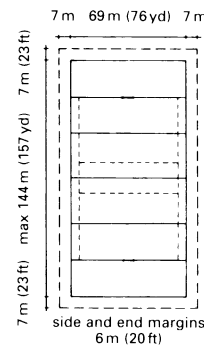
⑧ **Football, Australian rules**



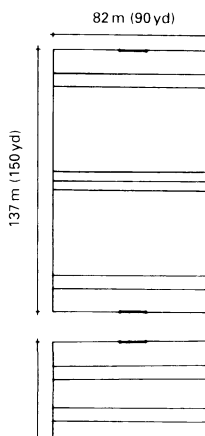
⑩ **Gaelic football**



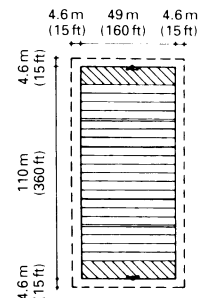
⑫ **Handball**



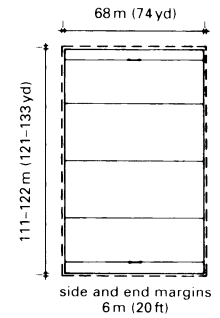
⑭ **Rugby union**



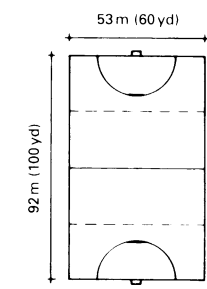
⑬ **Hurling**



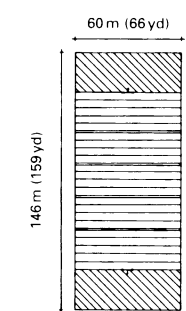
⑨ **American Football**



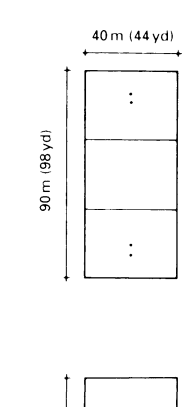
⑪ **Rugby league**



⑬ **Hockey: 90 × 55 m (95 × 60 m overall space) recommended for county and club matches**



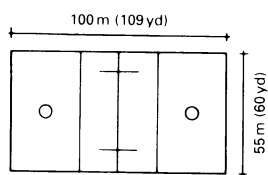
⑮ **Canadian football**



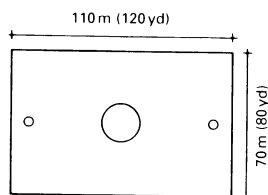
⑰ **Korfball**

⑱ **Korfball**

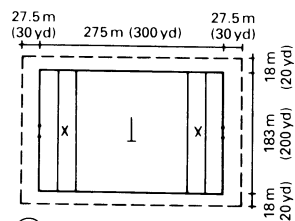
## OUTDOOR PITCHES



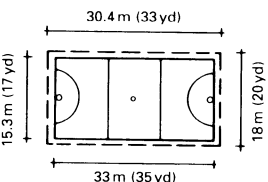
① Lacrosse, men



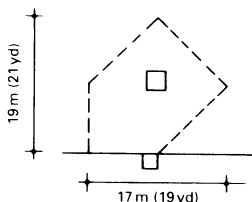
② Lacrosse, women (no measured or marked-out boundaries)



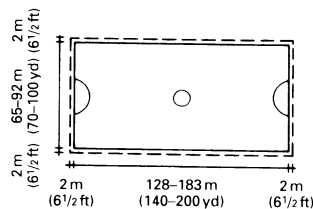
③ Polo



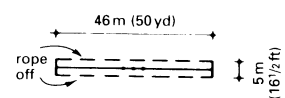
④ Netball



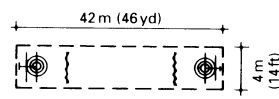
⑤ Rounders



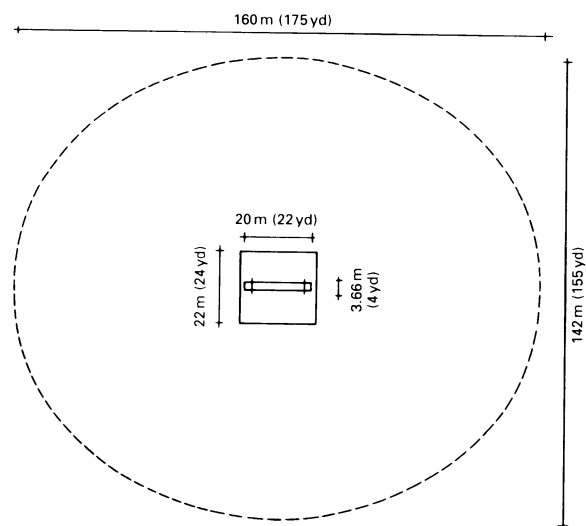
⑥ Shinty



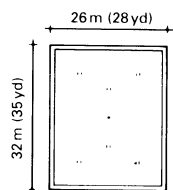
⑦ Tug-of-war



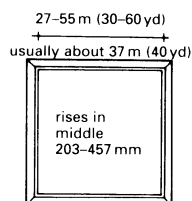
⑧ Curling



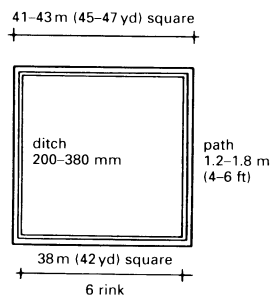
⑨ Cricket



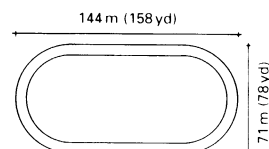
⑩ Croquet



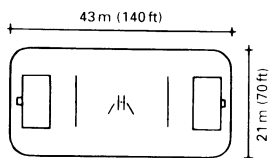
⑪ Bowls, crown



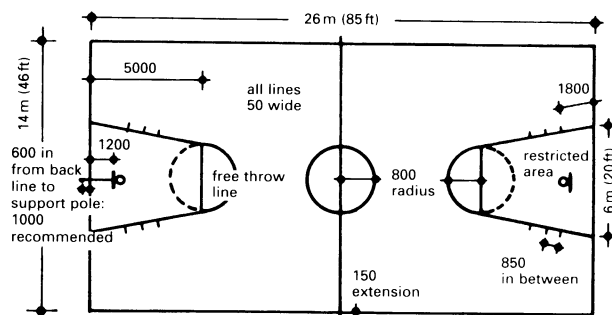
⑫ Bowls



⑬ Cycling track

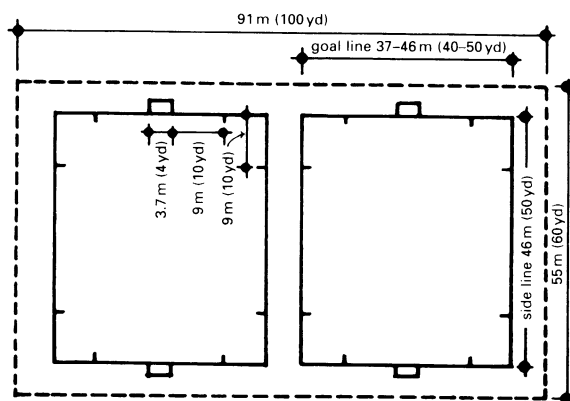


⑭ Roller hockey

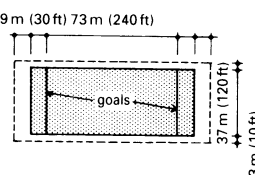


minimum margin at sides and ends 1000;  
where spectators present minimum 2000;  
dimensions are to inside of lines

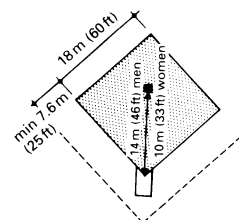
⑮ Basketball



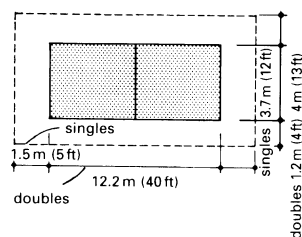
⑯ Mini-hockey



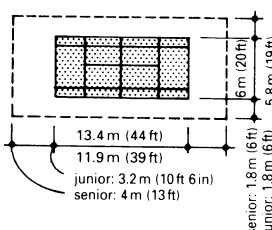
⑰ Six-man football



⑱ Softball

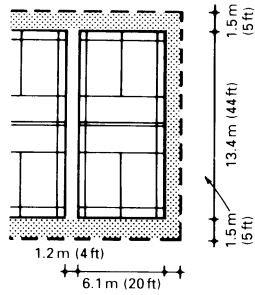


⑲ Deck tennis

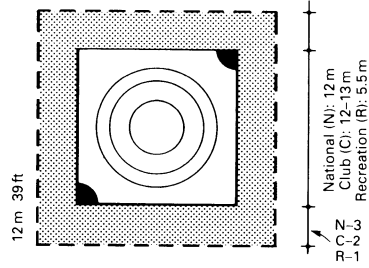


⑳ Paddle tennis

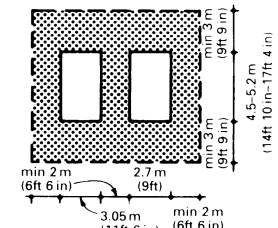
# INDOOR PITCHES



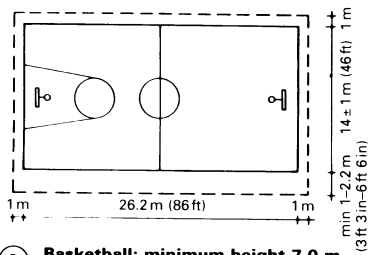
1 Badminton: minimum height 7.6 m



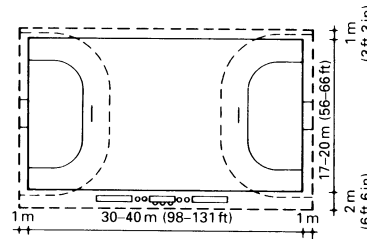
6 Wrestling



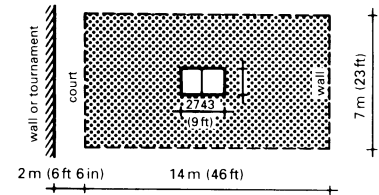
11 Trampoline



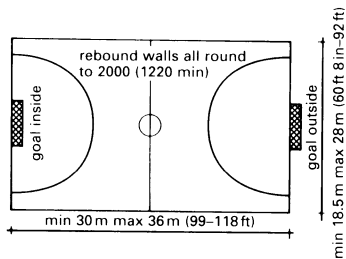
2 Basketball: minimum height 7.0 m (see also previous page)



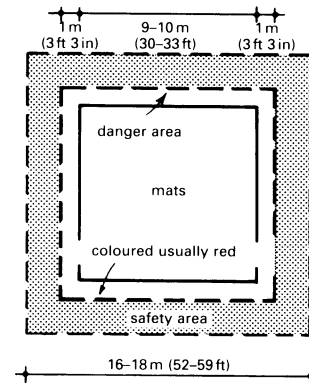
7 Handball (seven-a-side)



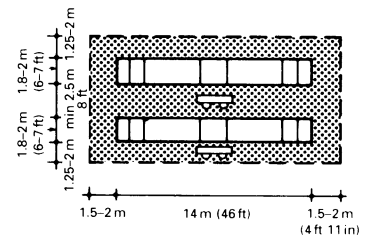
12 Table tennis: minimum height 4.2 m



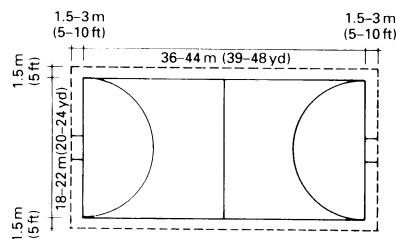
3 Five-a-side football



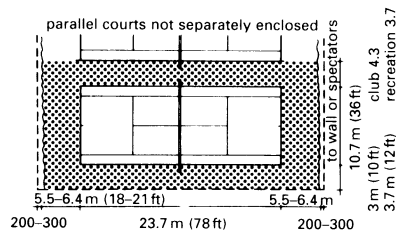
8 Judo



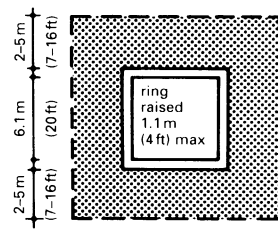
13 Fencing pistes



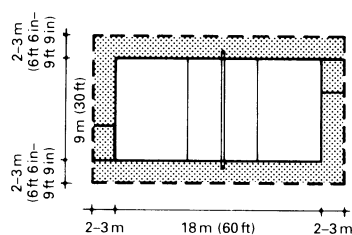
4 Hockey: team size according to pitch size



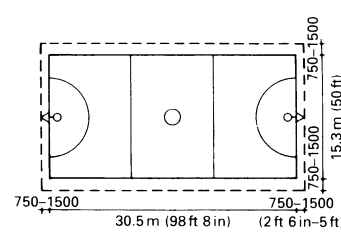
9 Tennis



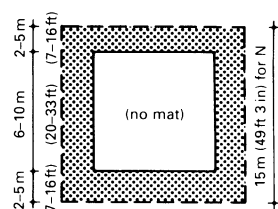
14 Boxing



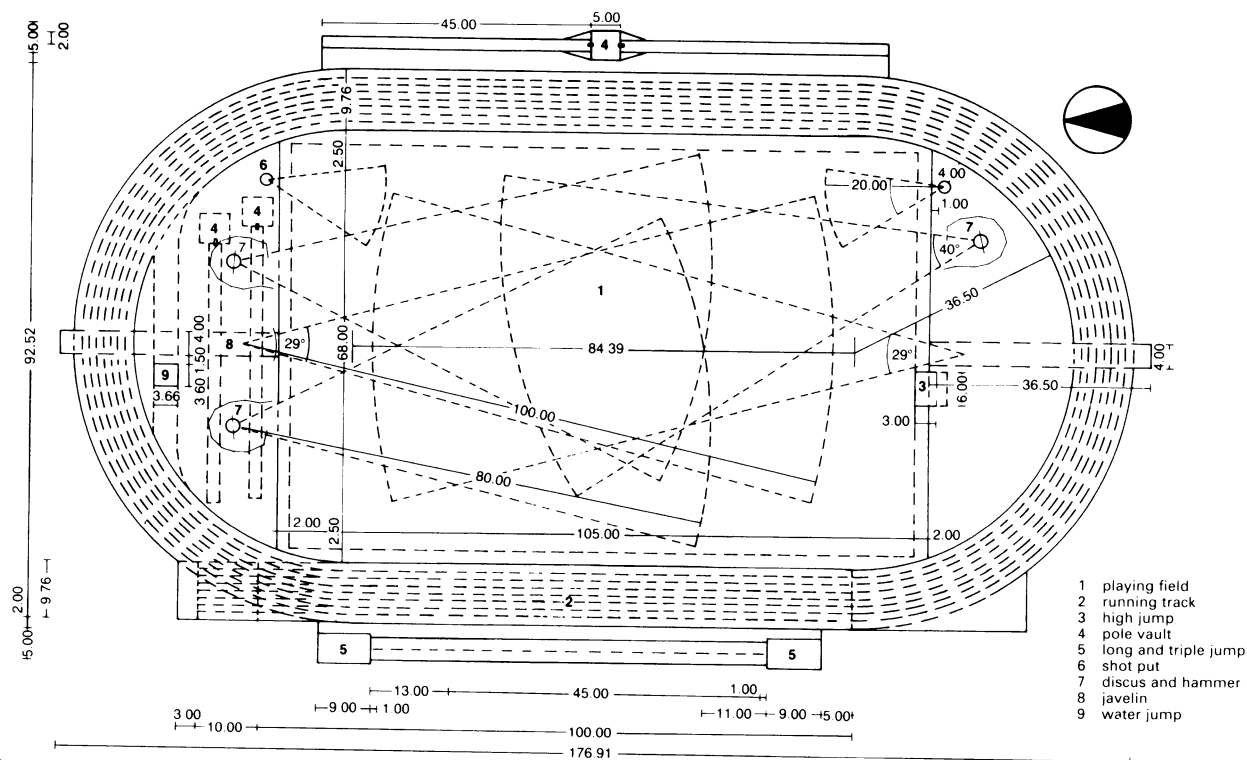
5 Volleyball



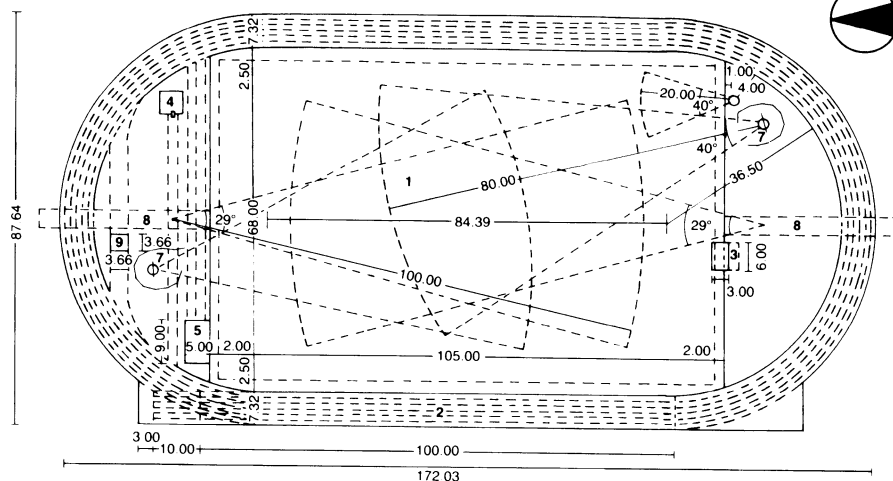
10 Netball



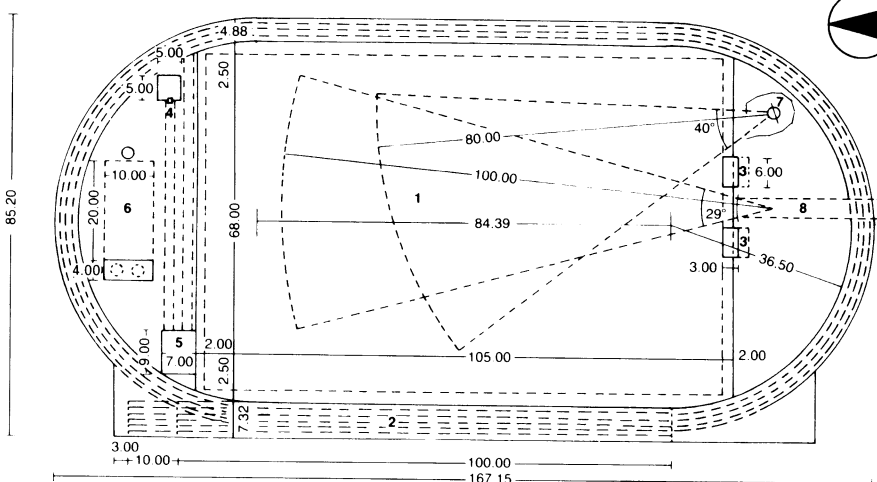
15 Karate



1 Arena type A



2 Arena type B



3 Arena type C

**Arena type A**

These consist of an eight-lane running track around a central sports field. The field has areas for shot-putting, discus, hammer and javelin throwing. In the northern sector there is a water jump for the steeplechase; the high jump takes place in the southern sector. The pole-vaulting area is outside the running track, as are the pits for long and triple jumping. The former runs parallel to the easterly straight of the track while the latter are beside the straight to the west.

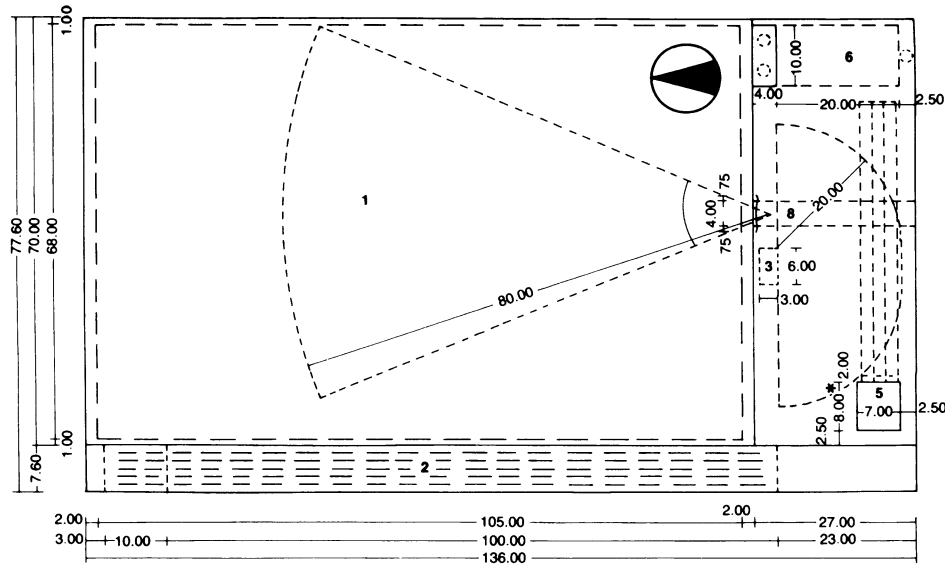
**Arena type B**

These consist of a six-lane running track around the interior field area. The layout is similar to type A arenas except that the pole vault, long jump and triple jump take place within the track, in the northern sector. However, these facilities can also be arranged outside of the running track.

**Arena type C**

These consist of a four-lane running track around a sports field. Areas for the discus, hammer and javelin are in the southern sector within the track, as is the high jump. The run-ups for pole-vaulting, long jump and triple jump are in the northerly segment, which also has an area for the shot put.





① Arena type D

- |                 |                             |
|-----------------|-----------------------------|
| 1 playing field | 5 long jump                 |
| 2 running track | 6 shot put                  |
| 3 high jump     | 7 discus and hammer         |
| 4 pole vault    | 8 javelin and ball throwing |

## Arena type D

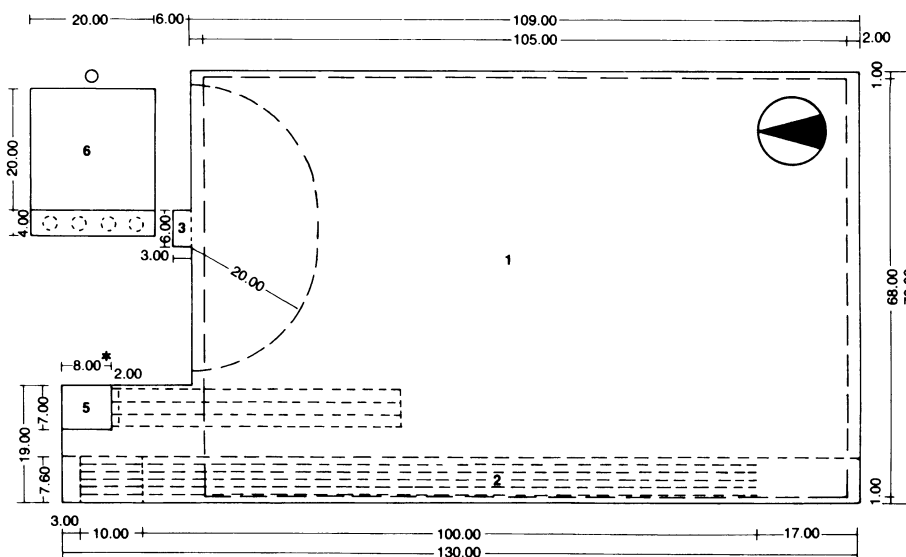
These consist of the following separate facilities → ①:

- four- to six-lane sprint/hurdles track;
- playing field 68 × 105 m (70 × 109 m with safety zones);
- shot put training area, throwing south;
- multipurpose area for long/triple jump, run-up west;
- high-jump area, run-up north;
- shot-putting ring, throwing north;
- javelin/ball throwing area, throwing north.

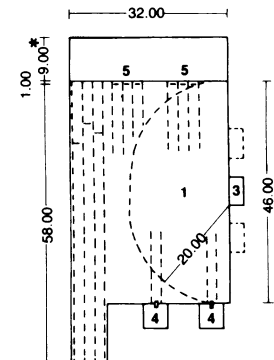
Generally the running track surface in type D arenas is earth and cinders, but for very high usage it is advisable to use a synthetic finish.

Large combined playing fields include a straight running track and facilities for high/long/triple jump and shot-putting both next to and on the main playing field.

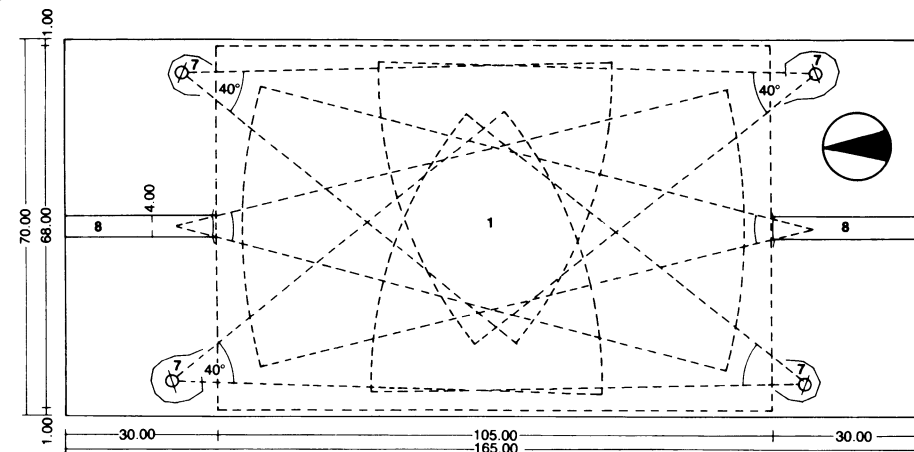
For training in field sports it is advisable for safety reasons to provide a 'throwing field'. This is simply a grassed target area of approximately the same size as an arena playing field → ③.



② Large combined sports field

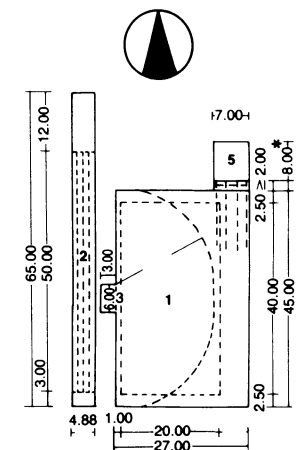


④ Central run-up area



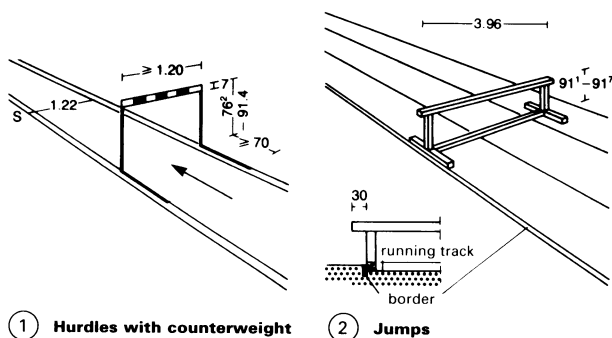
③ Throwing field

- 9.00 m for competitions (take-off board offset 1.00 m)
- 8.00 m for training (take-off board offset 2.00 m – see also the following page)



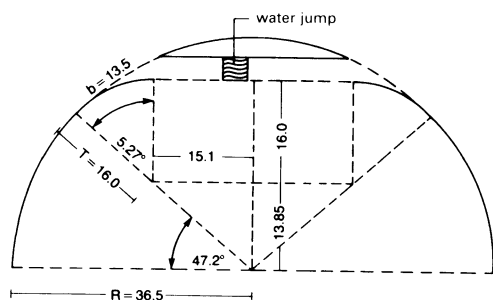
⑤ Small combined sports field

## ATHLETICS FACILITIES

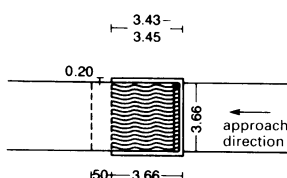


① Hurdles with counterweight

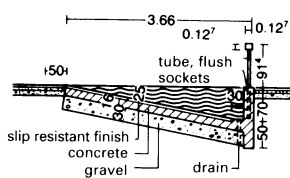
② Jumps



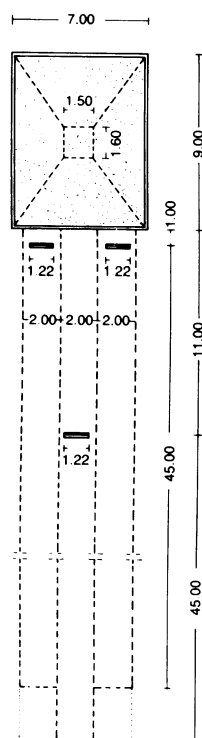
③ Steeplechase track with 16 m transition curve and water jump



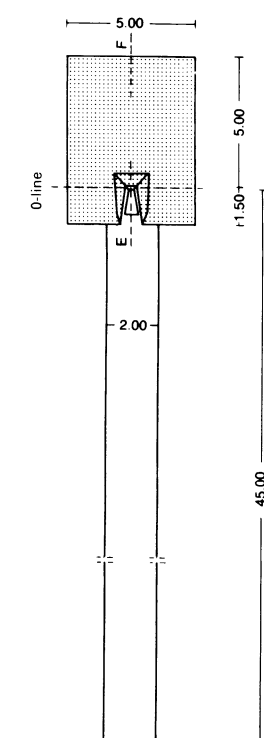
④ Steeplechase water jump: plan



⑤ Steeplechase water jump: section



⑥ Long and triple jump: plan



⑦ Pole vault: plan → ⑫-⑭

track type	length of start area (m)	track	run-out	lane widths <sup>1)</sup>
sprint track	3	110 <sup>2)</sup>	17	1.22
elliptical track	— <sup>3)</sup>	400	17	1.22

<sup>1)</sup> an obstruction-free safety zone, 28 cm wide, is required for the outer lane; it need not be constructed as running track  
<sup>2)</sup> 110 m length is needed for the hurdle track; 100 m for sprints  
<sup>3)</sup> no additional starting area is required

## ⑧ Running track dimensions → ①

race distance	class	number of hurdles	height of hurdles	run-in	distance between hurdles	run-out
400 m	men/male youths A + B	10	0.914 m	45.00 m	35.00 m	40.00 m
400 m	women/female youths A	10	0.762 m	45.00 m	35.00 m	40.00 m
110 m	men	10	1.067 m	13.72 m	9.14 m	14.02 m
110 m	men/m. youths A	10	0.996 m	13.72 m	8.90 m	16.18 m
110 m	men/m. youths B	10	0.914 m	13.50 m	8.60 m	19.10 m
100 m	women/f. youths A	10	0.840 m	13.00 m	8.50 m	10.50 m
100 m	f. youths B (from 1984)	10	0.762 m	13.00 m	8.50 m	10.50 m
100 m	f. youths A (from 1983)	10	0.840 m	12.00 m	8.00 m	16.00 m
80 m	schoolboys A	10	0.840 m	12.00 m	8.00 m	12.00 m
80 m	schoolgirls A	8	0.762 m	12.00 m	8.00 m	12.00 m
60 m	schoolboys B	8	0.762 m	11.50 m	7.50 m	11.00 m

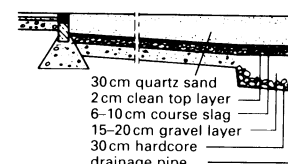
note: permissible tolerance of  $\pm 3$  mm of the standard heights

## ⑨ Hurdles track dimensions → ①

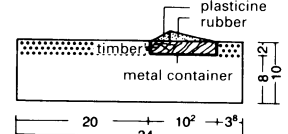
type	run-up length (m)	width (m)	pit (P) or mat (M)	length (m)	width (m)
long jump	$\geq 45$ <sup>1)</sup>	1.22 <sup>2)</sup>	P	$\geq 8$	2.75
triple jump	$\geq 45$ <sup>3)</sup>	1.22 <sup>2)</sup>	P	$\geq 8$	2.75
pole vault	$\geq 45$	1.22	MP	$\geq 5$	5.00
high jump	radius $\geq 20$ m		M	3	5 to 6

<sup>1)</sup> take-off board at least 1 m in front of the pit; distance between take-off line and end of the pit at least 10 m; length of pit is 9 m  
<sup>2)</sup> for multipurpose facilities, the single lane width is 2 m  
<sup>3)</sup> take-off board 11 m in front of the pit (youths 9 m; top-level 13 m)

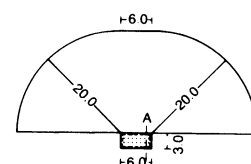
## ⑩ Jump facilities dimensions → ⑥-⑦-⑬



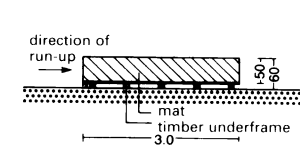
section through long jump pit



section through take-off board

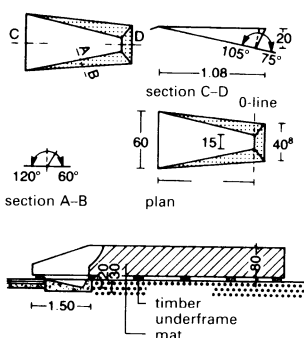


high jump: plan



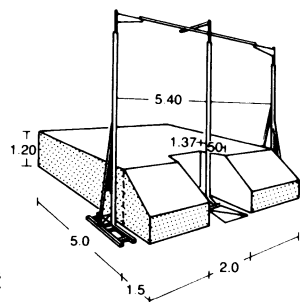
section A-B through mat and mat-frame

## ⑪ Long and triple jump

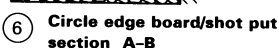
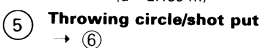


⑫ Pole vault → ⑦

## ⑬ High jump



⑭ Uprights and landing mat for pole vault → ⑦

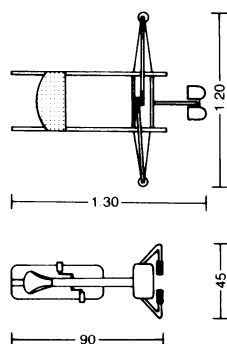


For the shot put, a throwing circle and throwing sector are required → ⑤ – ⑥. The overall length required is normally 20m; in top-level sport, 25m.

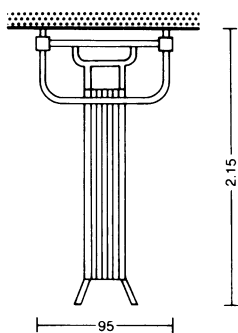
- 1) can also be used for hammer after insertion of a profile ring
- 2)  $\geq 30$  m

1 running track type B	14 000 m <sup>2</sup>
1 multipurpose combined playing field	8 400 m <sup>2</sup>
4 large playing fields (70 × 109 m)	30 520 m <sup>2</sup>
10 small playing fields (27 × 45 m)	12 150 m <sup>2</sup>
leisure area	6 000 m <sup>2</sup>
1 fitness course	3 300 m <sup>2</sup>
1 fitness area	1 400 m <sup>2</sup>
1 fitness play area	1 000 m <sup>2</sup>
2 playing and gymnastics lawns	2 000 m <sup>2</sup>
total useable area	ca. 80 000 m <sup>2</sup>

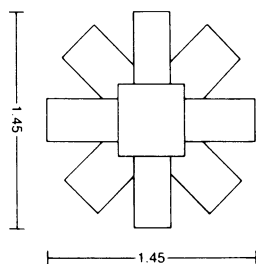
## 503



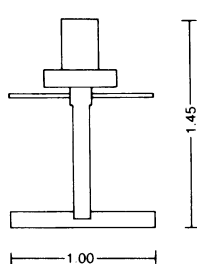
① Rowing machine and exercise bike



② Stomach exercising bench with pull-up bar and wall bars



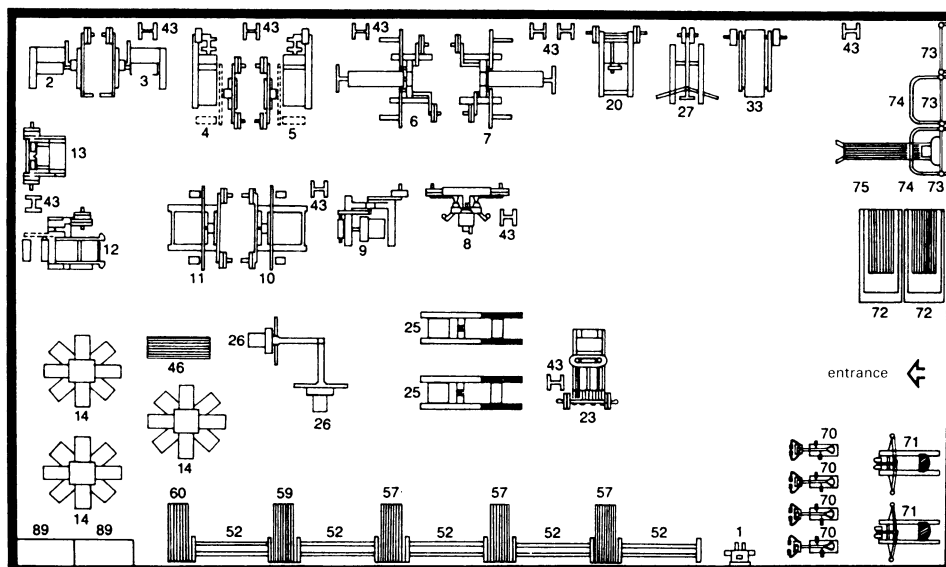
③ Multi-exercise centre



④ Workout bench

area	equipment	exercise	motor skills and/or strength	training aim
A	general training station	single-joint	strength/mobility	fitness/condition
B	special training station	multi-joint	strength/speed	fitness/condition
C	weightbench (with multipress or isometric extensions)	multi-joint	strength/speed/co-ordination	condition
D	usual small equipment	single- and multi-joint	strength/mobility	fitness
E	special training equipment plus space for warming up (gymnastics etc.)	single- and multi-joint	stamina/co-ordination mobility/co-ordination	fitness/condition fitness/condition

⑤ Arrangement of equipment into categories



⑥ Example fitness room (approximately 200 m²)

## CONDITIONING AND FITNESS ROOMS

area	training area			equipment list
	40 m²	80 m²	200 m²	
A		2/3* 4/5* 6/7* 8 9 10/11* 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13 14 (3×)	1 handroller 2 biceps station 3 triceps station 4 pull-over machine I 5 pull-over machine II 6 latissimus machine I 7 latissimus machine II 8 chest station 9 abdominal station 10 hip station I 11 hip station II 12 leg station 13 foot station 14 multi-exercise centre
B		25 26	20 23 25 (2×) 26 (2×) 27 33	20 press equipment I 23 leg-press equipment 25 stomach muscle station 26 pulley equipment 27 high pulley 33 latissimus barbell bench
C	46 (2×)	43 (4×) 46 (2×)	43 (10×) 46	43 small plate stand** 46 training bench
D	50 51 52	50 51 52  56 57 58  60 61 62	50 (3×) 51 (3×) 52 (5×) 53  57 (3×)  59 60	50 fist dumbbells 51 short dumbbells 52 short dumbbell stand** 53 practice barbells 56 bench press 57 sloping bench I 58 sloping bench II 59 multipurpose bench 60 general workout bench 61 compact dumbbells 62 dumbbell stand
E	70 (3×) 71 (2×) 72 73 74 75  79 (2×) 80 (2×) 81 (2×) 82 (2×) 83 (2×)  89	70 71 (3×)  73 (2×) 74 (2×) 75 78 79 (2×) 80 (2×) 81 (2×) 82 (2×) 83 (2×)  85 (2×) 89 (2×)	70 (4×) 71 (3×) 72 (2×) 73 (3×) 74 (2×) 75  79 (3×) 80 (2×) 81 (3×) 82 (3×) 83 (3×)  85 (3×) 89 (2×)	70 exercise bike 71 rowing machine 72 treadmill 73 wall bars 74 pull-up bar 75 stomach muscle bench 78 punch ball 79 chest expander 80 skipping rope 81 vibrating belt 82 finger dumbbells 83 ball equipment 84 ball dumbbells 85 water dumbbells 89 equipment cupboard

\* note that 2 and 3, 4 and 5, 6 and 7, and 10 and 11 are supplied by some manufacturers as dual-function machines

\*\* note that 2-8 in the example illustrations are shown with the necessary stands for barbell plates, and fist, short and compact dumbbells; there are many different types of stands available and they must therefore be matched with the type and number of dumbbells, bars and plates to be stored

⑦ Suggested equipment for fitness rooms

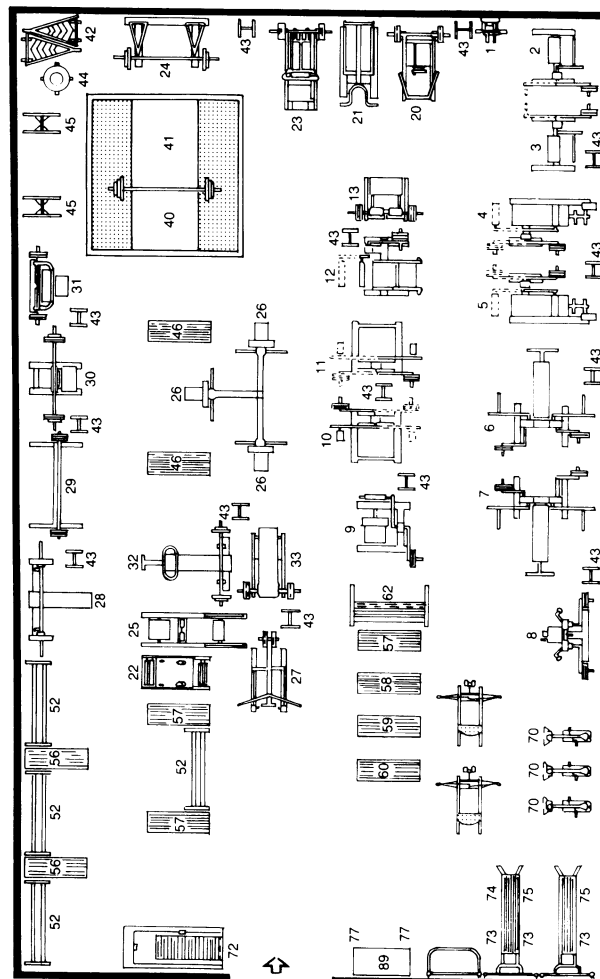
- 1 handroller
- 2 biceps station
- 3 triceps station
- 4 pull-over machine I
- 5 pull-over machine II
- 6 latissimus machine I
- 7 latissimus machine II
- 8 chest station
- 9 abdominal station
- 10 hip station I
- 11 hip station II
- 12 leg station
- 13 foot station
- 14 multi-exercise centre
- 20 press equipment I
- 23 leg-press equipment
- 25 stomach muscle station
- 26 pulley equipment
- 27 high pulley
- 33 latissimus barbell bench
- 43 small plate stand
- 46 training bench
- 52 short dumbbell stand
- 57 sloping bench I
- 59 multipurpose bench
- 60 general workout bench
- 70 exercise bike
- 71 rowing machine
- 72 treadmill
- 73 wall bars
- 74 pull-up bar
- 75 stomach muscle bench
- 89 equipment cupboard

area	no.	description	movement	required space (cm)
A	1	handroller	bending/stretching hands	60/ 30
	2	biceps station	bending arms	135/135
	3	triceps station	stretching arms	135/135
	4	pull-over machine I	raising arms in front of the body	190/110
	5	pull-over machine II	lowering arms in front of the body	190/110
	6	latissimus machine I	raising and lowering arms to the sides	200/120
	7	latissimus machine II	moving arms together and apart	200/120
	8	chest station	moving bent arms together	165/100
	9	abdominal station	stretching and bending abdomen	135/125
	10	hip station I	lowering and lifting legs	175/125
	11	hip station II	lifting/pulling up legs	175/125
	12	leg station	stretching/bending legs	125/155
	13	foot station	stretching/bending feet	140/ 80
	14	multi-exercise centre	various leg and multi-joint movements	various
B	20	press equipment I	stretching arms horizontally (while standing)	120/140
	21	press equipment II	stretching arms vertically, and/or calf training while standing	70/160
	22	leg-stretch equipment	stretching legs on a sloping surface	90/140
	23	leg-press equipment	stretching legs horizontally (while seated)	120/160
	24	knee bending apparatus (with weights attachment)	stretching legs vertically (while standing)	200/ 90
	25	stomach muscle station	various exercises for stomach and back muscles	65/200
	26	pulley equipment	various single and multi-joint basic movements	100/140
	27	high pulley	bending and stretching arms vertically (hanging or stemmed)	120/155
	28	bench press I	stretching arms vertically (lying on bench)	200/120
	29	barbell equipment (multipress machine)	bench press, knee bending, standing pressing and pulling exercises (all exercises with controlled weights)	200/100
	30	bench press II (sloping bench for pull-ups)	press on sloping bench (while seated)	185/100
	31	curl bench	bending arms	150/ 70
	32	bench press III	bench press (lying on back sloping towards head)	160/170
	33	latissimus barbell bench	bending arms, pull-ups in stomach position	120/130
C	40	weightlifting mat with rubber sections	all exercises with free barbells (knee bending, press and push exercises)	300/300
	41	practice barbells bar		200
	42	large plate stand		50/100
	43	small plate stand		30/ 30
	44	magnesia holder		0/ 38
	45	kneebend stands (in pairs)		each 35/ 70
	46	training bench		40/120
	47	rubber plates (10, 15, 20, 25 kg)		
	48	plates with vulcanised rubber edges (15, 20, 25 kg)		
	49	cast iron plates (1.25, 2.50, 10, 25, 50 kg)		
D	50	fist dumbbells (1, 2, 3, 4, 5, 6, 7, 8, 10 kg)	various single and multi-joint exercises with fist and compact dumbbells, and barbells	
	51	short dumbbells (2.5, 5, 0, 7.5 etc. -30 kg)		
	52	short dumbbell stand		140/130
	53	practice barbells		185
	54	knee bending bar (padded)		200
	55	curl bar		140
	56	bench press (adjustable)		40/120
	57	sloping bench I		40/120
	58	sloping bench II		40/120
	59	multi-purpose bench		40/120
	60	general workout bench (12 positions)		
	61	compact dumbbells (2-60 kg)		
	62	dumbbell stand		145/ 80

1 Equipment for workout and fitness rooms

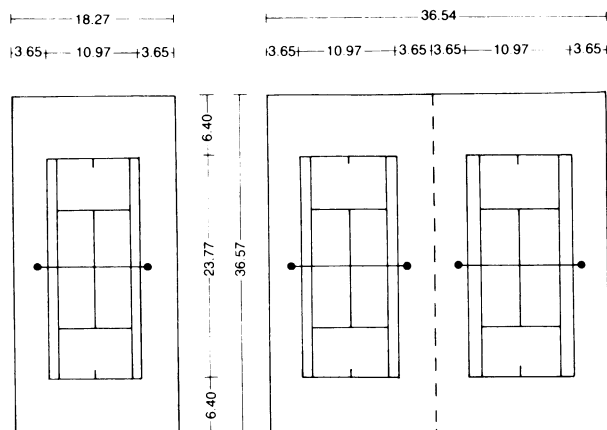
## CONDITIONING AND FITNESS ROOMS

For 40-45 users a room size of at least 200m<sup>2</sup> is needed → ②. Clear room height for all rooms should be 3.0m. For an optimum double-row arrangement of machines, the room should be at least 6m wide. To allow clear supervision of all training, the room length needs to be 15m or less. The minimum room size of 40m<sup>2</sup> is suitable for 12 users.

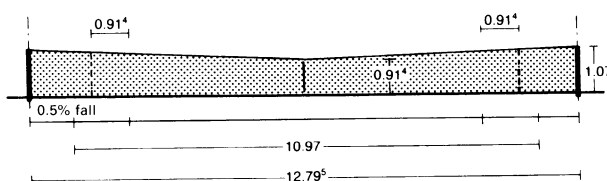
2 Example of a 200 m<sup>2</sup> workout room

E	70	exercise bike	70-76: stamina, co-ordination (bending arms)	40/ 90
	71	rowing machine		120/140
	72	treadmill		80/190
	73	wall bars		100/ 15
	74	pull-up bar for wall bars		120/120
	75	stomach muscle bench for clipping in		100/180
	76	spine support equipment		70/150
	77	power jump testing equipment	77-88: mobility, co-ordination	
	78	punch ball		
	79	chest expander		
	80	skipping rope		
	81	vibrating belt		
	82	finger dumbbells		
	83	ball equipment		
	84	ball dumbbells		
	85	water dumbbells		
	86	weighted vest		
	87	weight packs for arms/legs		
	88	mirror		
	89	equipment cupboard		50/110

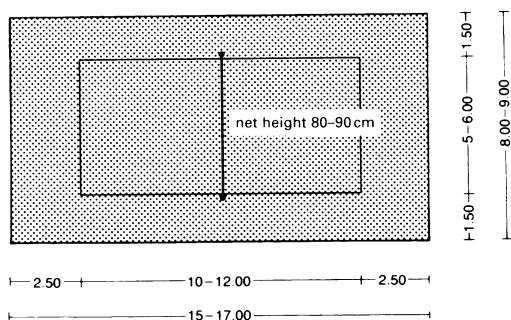
## TENNIS FACILITIES



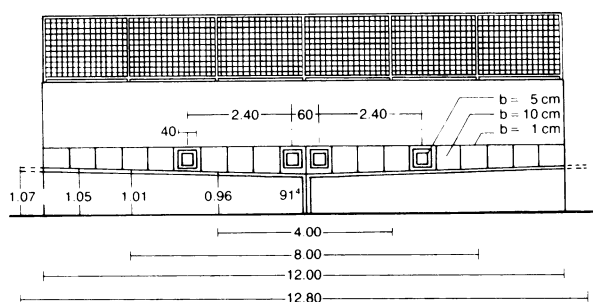
① Court dimensions



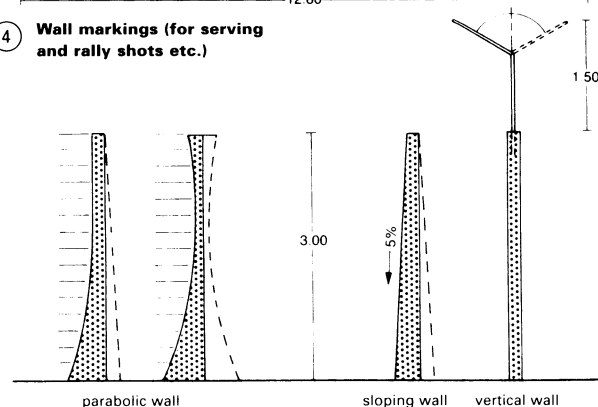
② Net



③ Children's tennis court



④ Wall markings (for serving and rally shots etc.)



⑤ Forms of tennis walls

doubles court → ① - ②	10.97 × 23.77 m
singles court	8.23 × 23.77 m
side margin	≥ 3.65 m
side margin for competitions	4.00 m
end margin	≥ 6.40 m
end margin for competitions	8.00 m
between two courts	7.30 m
net height in the middle	0.915 m
net height at the posts	1.07 m
height of surround netting	4.00 m

Use 2.5 mm thick wire net, with a 4 cm mesh width, for surround netting.

The number of active tennis players at present is between 1.6% and 3% of the total population. Use a 1:30 court:player ratio as a rule of thumb for the calculation of the number of courts needed in new developments.

$$\text{necessary courts (T)} = \frac{\text{population} \times 3}{100 \times 30}$$

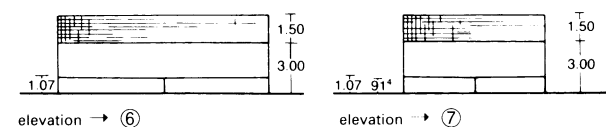
The area needed for tennis courts in children's facilities is between 120 and 153 m<sup>2</sup> → ③.

For recreational tennis courts (i.e. where there are no spectators) four car parking spaces should be provided per court.

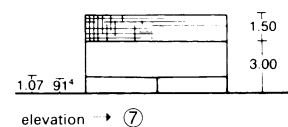
To calculate the size of plot required, add the net areas ('usable sports areas') needed for the planned number of tennis courts, training walls and children's facilities. To this add an additional 60-80% of the total net area to give the overall plot size.

Outdoor courts should, as near as possible, be orientated in the north-south direction. It is recommended that no more than two courts should be immediately next to one another and if they are behind each other a sight screen must be used to separate them. Artificial lighting should be at least 10 m high and along the sides of the court.

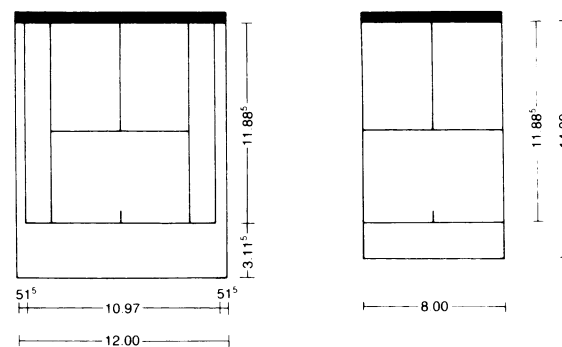
The layout should be designed so as to allow adaptation to meet future needs and planned so that any future building activity can take place without interrupting the playing activities. Potential future needs for accommodation (groundsman, trainer, tenant) and garages should be anticipated in the plans from the beginning. Tennis courts should not be 'foreign bodies' in the environment: they should fit in with their surroundings.



elevation → ⑥



elevation → ⑦

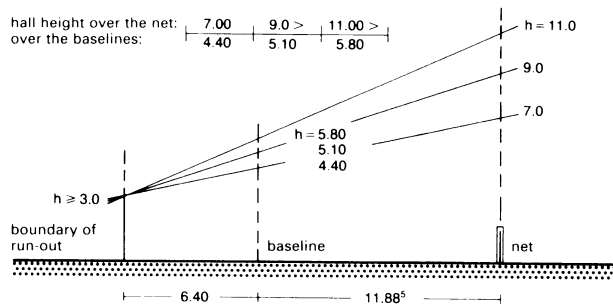


recommended dimensions for tennis walls and the playing areas in front

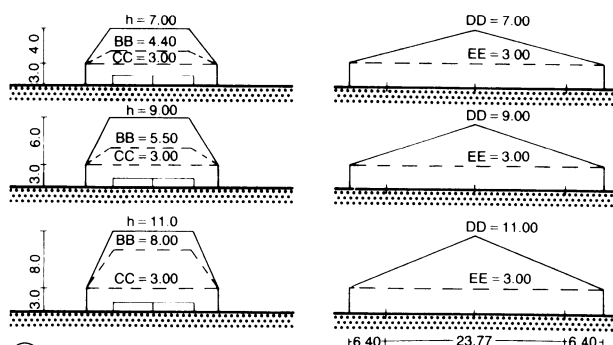
⑥ Training wall: doubles

⑦ Training wall: singles

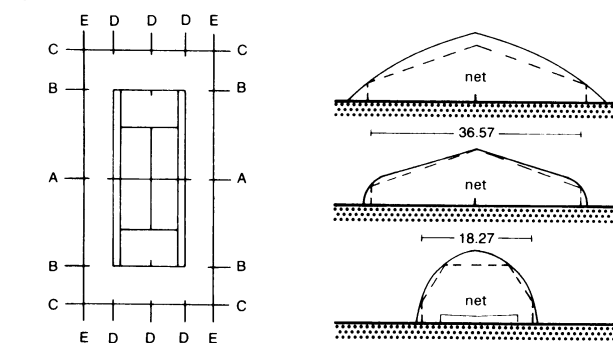
## TENNIS FACILITIES



① Hall heights

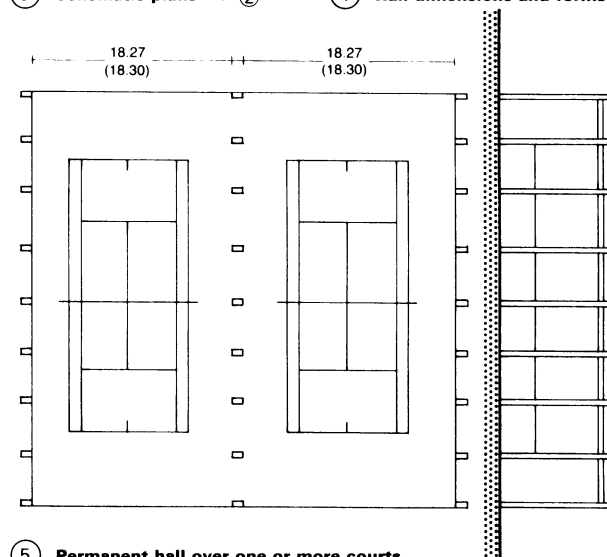


② Longitudinal and cross-sections of hall types → ③

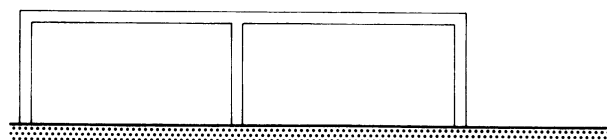


③ Schematic plans → ②

④ Hall dimensions and forms



⑤ Permanent hall over one or more courts



Ceiling heights of halls for indoor competition tennis courts are internationally fixed. A height of 10.67 m is required by the regulations of the Davis Cup. For leisure facilities, a height of 9–11 m is recommended; 9 m is generally sufficient → ①. In gymnasiums and sports centres, it is possible to play tennis with hall heights as low as 7 m. The applicable height of a hall is measured at the net from the floor to the underside of the roof truss. The same height is needed over the full 10.97 m width of the court. The height at the outer limit of the run-out area should be at least 3 m. For a summary of end- and side-section elevations of the different hall types see → ② – ④.

Halls may be permanent → ⑤–⑥, demountable or multipurpose. Based on the court and run-out measurements prescribed in the international regulations for competition-standard facilities, one court requires a hall size of 18.30 m × 36.60 m. Therefore, use the following hall areas:

$$\text{two courts} = (2 \times 18.30) \times (1 \times 36.60) = 36.60 \times 36.60$$

$$\text{three courts} = (3 \times 18.30) \times (1 \times 36.60) = 54.90 \times 36.60$$

These dimensions make the facilities suitable for both leisure and competition use. The possible uses are:

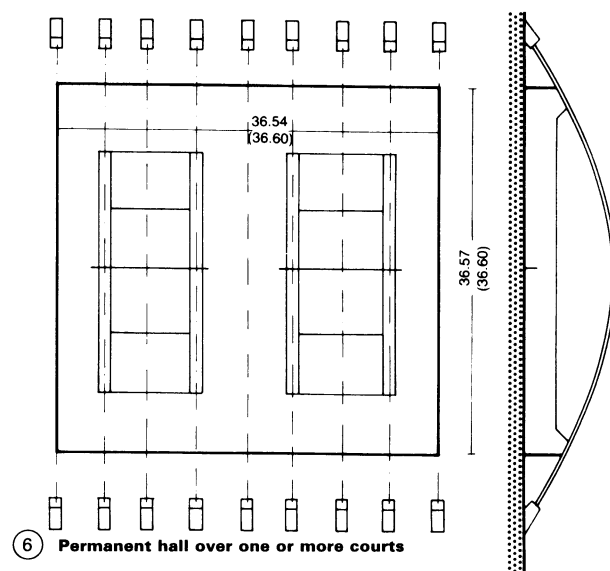
1. courts are competition-level 'singles'
2. courts are competition-level 'doubles'
3. courts are for training/leisure use, singles and/or doubles

If the tennis courts are for recreational use only, it is possible to use a reduced width to make space savings. The minimum size of hall for a two-court recreational facility is 32.40 m × 36.60 m.

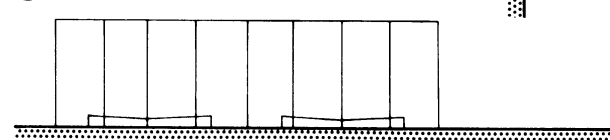
The table below shows some of the possible options.

hall type	courts	S (single)	D (double)	width	length	C* use	not C*
1	1	1	1	18.30	36.60	S/D	–
2	2	2	2	36.60	36.60	2S/2D	–
2 single span	2	2	2	33.90	36.60	2S/1 S/1D	2D or 2S
3	3	3	3	54.90	36.60	3S/3D	–
3 single span	3	3	3	49.50	36.60	3S/2D	3D or 3S
2a	2	1	1	33.90	36.60	1S/1D	–
2a single span	2	1	1	32.40	36.60	1S/1D	–

\* competition level



⑥ Permanent hall over one or more courts



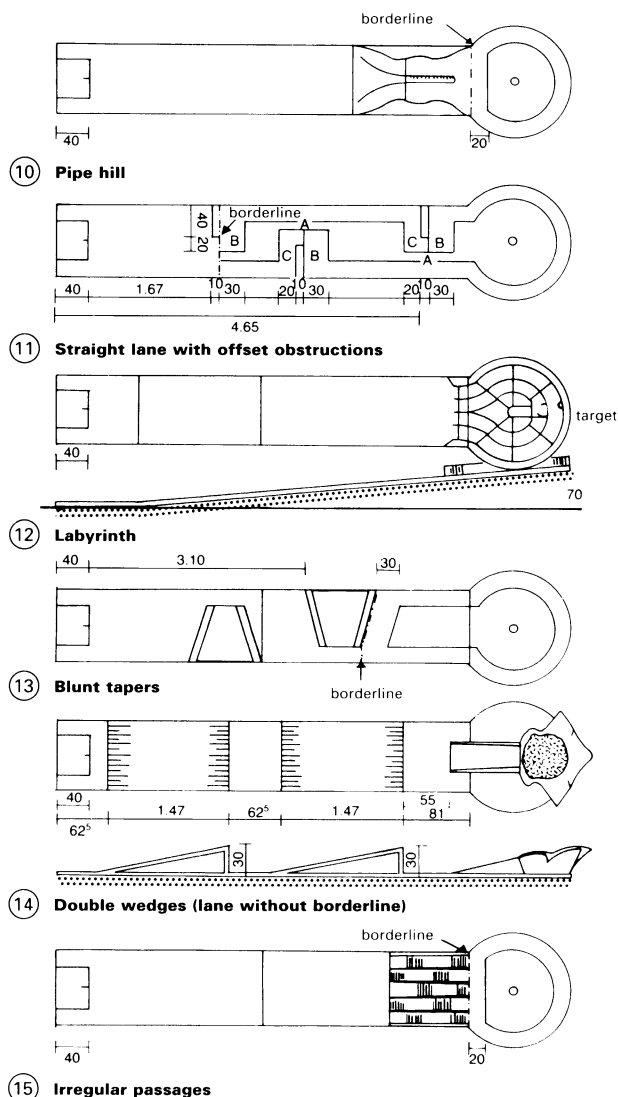
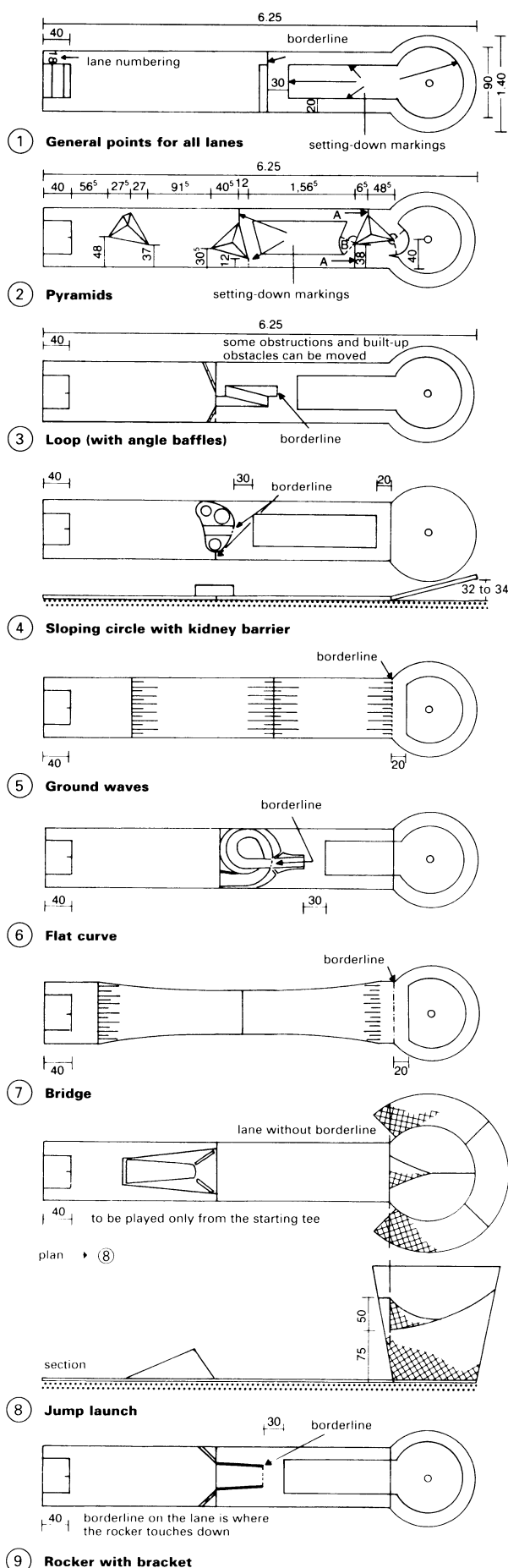
## MINIATURE GOLF

A lane-golf course consists of 18 clearly separated lanes (with the exception of 'long shot') which have to be numbered and to accord with the relevant regulations. A course appropriate for tournaments comprises:

- lane separations (mostly ribbons or tapes)
- tee markings
- one or more hazards (can be omitted)
- borderline (can be omitted)
- setting-down markings (can be omitted)
- hole

Further specified details may need to be considered.

The lane playing area must have a minimum width of 80cm and has to be at least 5.50m long. Lanes designed for level playing must be completely flat, with a surface quality sufficient to guarantee a predictable path of travel of the balls. If lanes are not separated by fixed ribbons or tapes, they have to be marked in some other way (except long shot). Each lane has to have a tee marking and all markings should be standardised throughout the course (i.e. a specific system for all lanes). Hazards are usually fixed in position although, depending on their intended purpose and design, it is acceptable for some to be moveable. Those which are not fixed should be marked. All hazards must be robust in design and construction.





## MINIATURE GOLF

Each hazard has to be different from others on the same course, not just visually but also technically, and it should be possible for players to predict the effect it will have on the path of the ball.

The borderline marks the end of the first hazards. In lanes without built-in hazards, they show the minimum distance the ball has to travel to remain in the game. If the first hazard is the full width of the lane the borderline coincides with the end of the hazard.

Lanes that are only playable from the tee do not have a borderline.

Borderline markings have to be installed in such a way that the edge that marks the tee matches the end of hazard marking.

The setting-down markings indicate where a play-off or movement of the ball is allowed during the game. The markings show where the ball should be placed.

It must be possible to reach the target from the tee marking in one hit. Should the target be a hole, the diameter should not exceed 120mm. For minigolf or star golf 100mm is the limit.

The game does not require any special equipment: normal golf clubs, balls and accessories are permitted. However, the striking area of the club is not allowed to be more than 40cm<sup>2</sup>. All lane-golf and normal golf balls are permissible provided the diameter is between 37 mm and 43mm. Balls made of wood, metal, glass, fibreglass, ivory or other materials are not accepted as lane-golf balls.

Miniature golf lanes are usually designed with the following standard sizes: lane length, 6.25m; lane width, 0.90m; diameter of end circle 1.40m.

### Minigolf

Developed at the beginning of the 50s, these courses consist of 17 concrete pistes (12m long) and a long-range piste (approximate length, 25 m). The concrete pistes are set in a frame made from steel pipes and the hazards are made from natural stone.

### Cobi Golf

This is one of the most difficult lane systems of golf to play. The special characteristics of Cobi golf are the small 'gates' placed in front of the hazards.

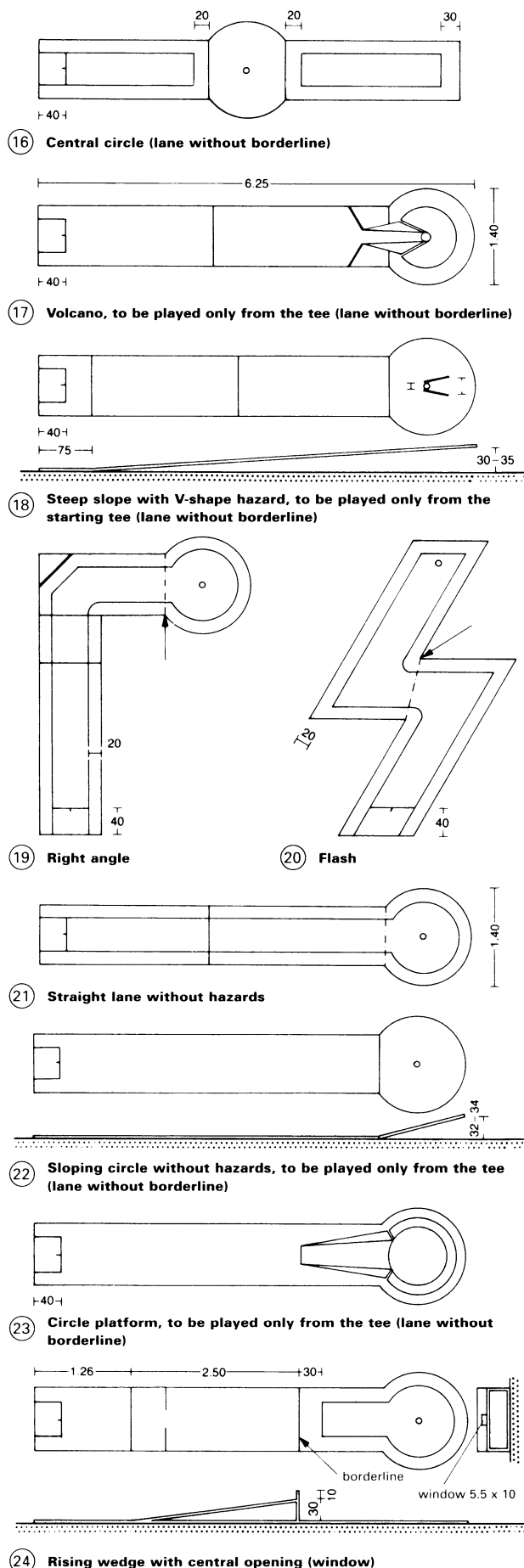
The courses again consist of 18 lanes but they can be in large format (12 to 14m long) as well as in small format (length 6 to 7 m).

### Stargolf

A stargolf course consists of 18 lanes with concrete pistes. The first 17 of these have a circular target area, but on the last lane the hole is in a star-shaped target area, hence the name of the system. The length of the lanes is 8m; the width is 1 m; the diameter of the end circles is 2 m.

The concrete lanes are enclosed in pipe barriers. The tee marker is a circle with a diameter of 30cm. The holes have a diameter of 10cm.

In all miniature golf systems with lanes, the hazards are standardised and constructed according to the criteria dictated by the sport. The aim is to make it possible to play each lane of the course with a single stroke. With all holes being par 1, the golfers' ultimate goal is to complete the course with a total score of 18.

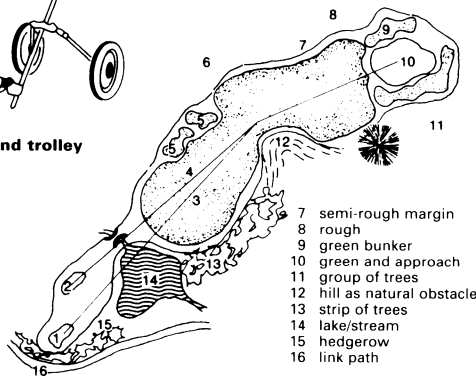


## GOLF COURSES

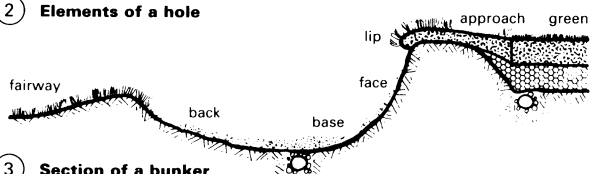


① Golf bag and trolley

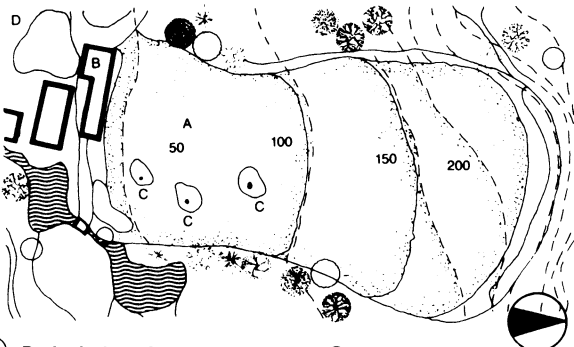
- 1 men's tee
- 2 women's tee
- 3 fairway
- 4 playing line
- 5 fairway bunker
- 6 single area



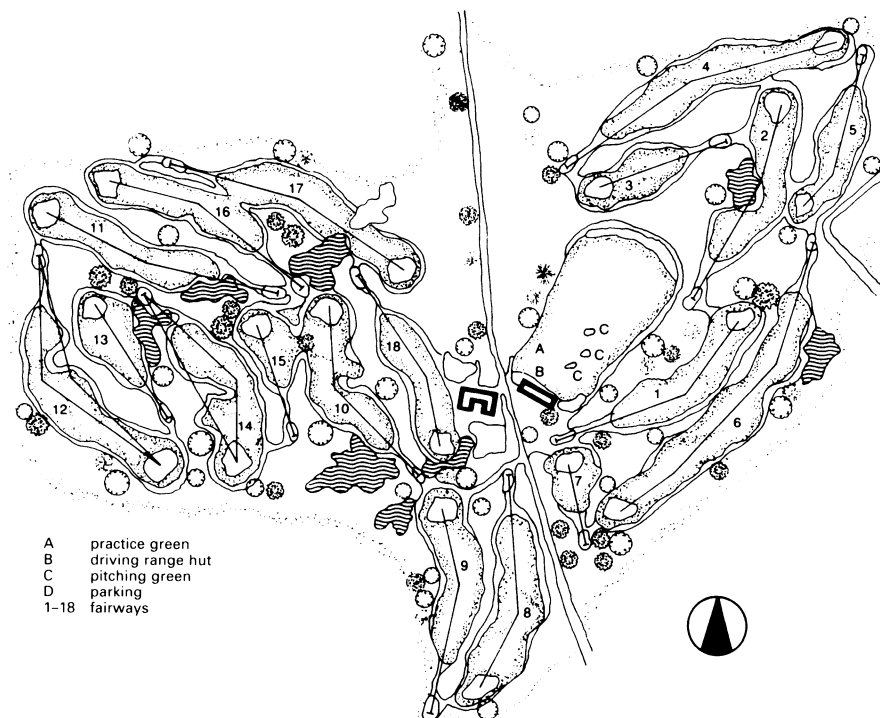
② Elements of a hole



③ Section of a bunker



④ Basic design of a practice area → ⑤



⑤ Eighteen hole course of normal competition size

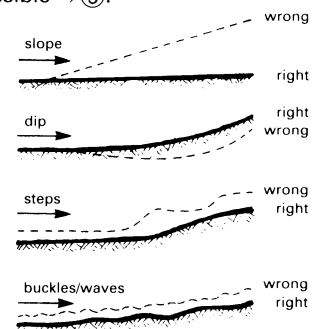
Golf courses are best situated in undulating terrain with gentle gradients, or in dunes if the site is on the coast. Ideally, the course should be surrounded by forest or light tree cover and have natural hazards (e.g. streams, lakes, etc.). The size of the course depends on the number of 'holes' and their length (i.e. the distance from tee to hole). Golf courses cannot be treated in the same way as other 'regulated' and standardised sports facilities.

Nowadays golf courses can be constructed almost only in rural areas, especially in areas previously used for farming or forestry. The planning of a golf course requires the direction of a widely experienced specialist who needs the knowledge of a landscape architect, golf player, landscape ecologist, soil scientist, agronomist, economist etc. Before any planning can commence, a detailed site investigation has to take place.

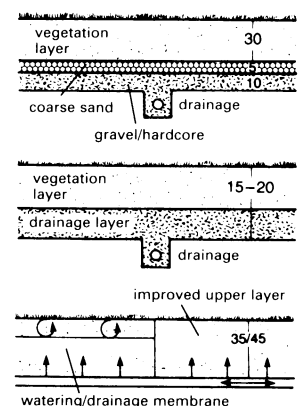
When considering a new course, a population of approximately 100 000 within an area less than 30 minutes away by car is needed for a nine hole course. This should ensure that membership will reach the necessary number for a viable golf club (around 300 members).

An important part of each golf course is the practice area, which comprises a driving range, a practice green and an approach green → ④. The driving range should be as even as possible and have a width of 80m in order to allow 15 golfers to practice at once. The length should be at least 200m, or 225m ideally, and should be arranged in such a way that neighbouring holes are not disturbed. The approach green should have a size of at least 300m<sup>2</sup>. Sand hazards (bunkers) for practice shots should cover at least 200m<sup>2</sup> and should be of various depths. The best place for the practice area is next to the club house.

The plan for a golf course should generally be based on the eventual provision of an 18 hole course, so an area of at least 55 ha, preferably 60 ha, should be available in the long term. To make it possible to play half a round (nine holes) on an 18 hole golf course, the first tee and the ninth green as well as the tenth tee and the eighteenth green should be as near the clubhouse as possible → ⑤.



⑥ Surface modelling of greens



⑦ Customary constructions for golf greens

## GOLF COURSES

Practice areas can provide training either just for the short/approach game or offer instruction in all aspects of the game of golf. It is possible to establish independent golf centre in an area of 10ha, or perhaps less. The centre should contain a driving range, an approach green, a practice green and a nine hole course (par 3) → ①.

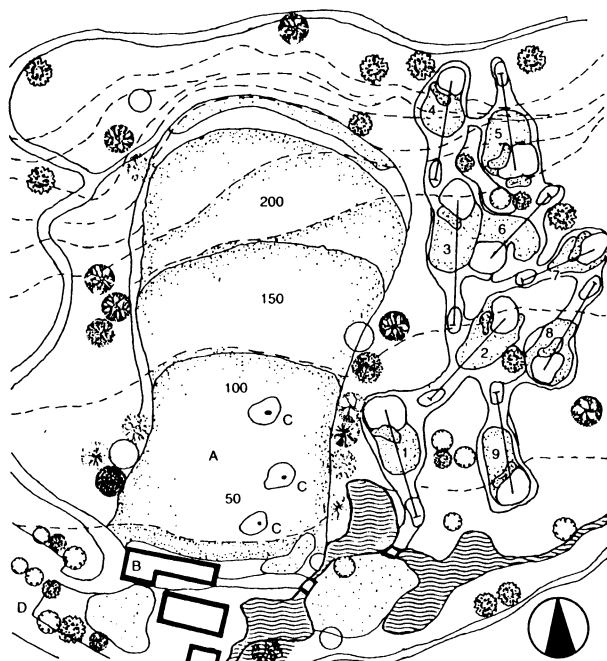
The table below shows the lengths of the holes in relation to the par rating.

par	length of hole	
	for men	for women
3	up to 228m	up to 201m
4	229–434 m	202–382m
5	from 435m	from 383m

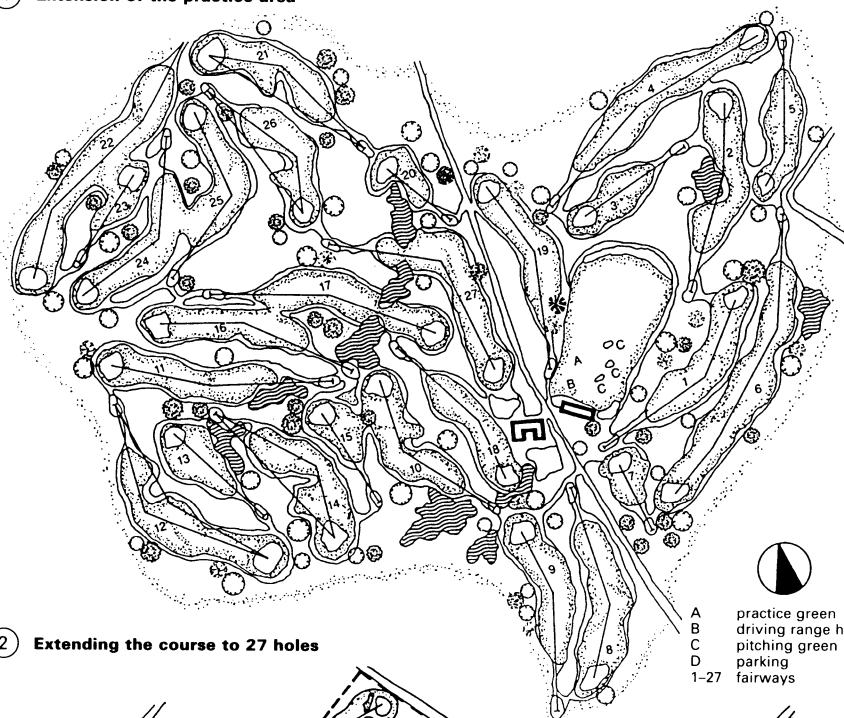
Recognised standard lengths for golf courses range between standard 60 at a normal length of 3749m and standard 74 at a normal length of 6492m.

### Elements of a golf course

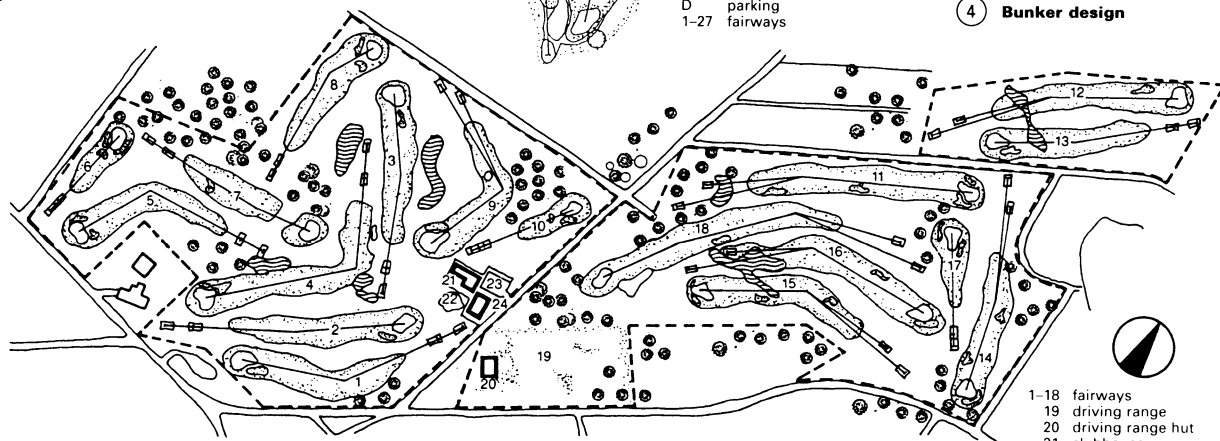
At the start of each hole is the tee, which is not fixed in size but with sufficient width it should measure approximately 200m<sup>2</sup>. Fairways have a width of 30–50m and vary in length from 100m to up to more than 500m. At the end of the fairway is the green, which should be at least 400m<sup>2</sup> and is normally 500–600m<sup>2</sup>. 'Approach greens' are not found everywhere but where they are included they have a minimum width of 2.5m. Rough areas with long grass and shrubs/trees border the edge of the course.



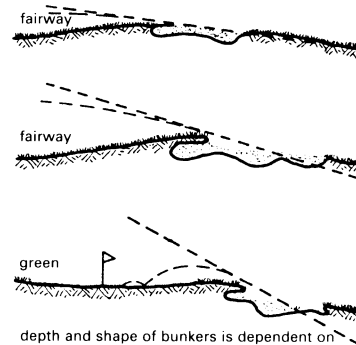
① Extension of the practice area



② Extending the course to 27 holes

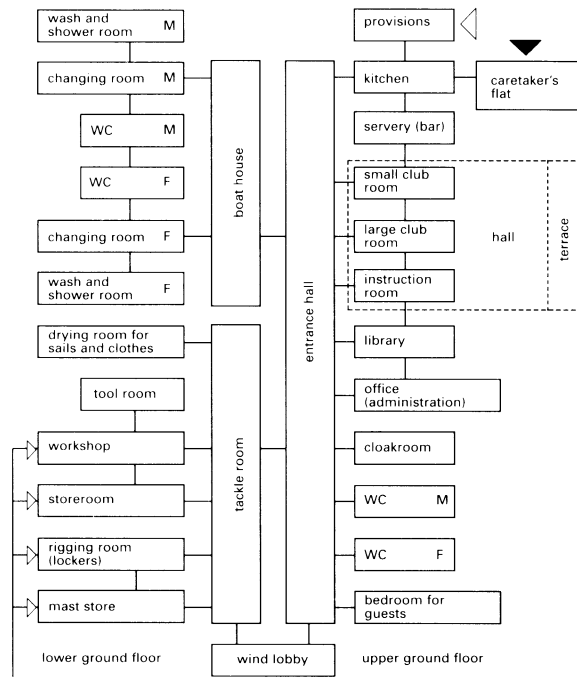


③ Example of an 18 hole course

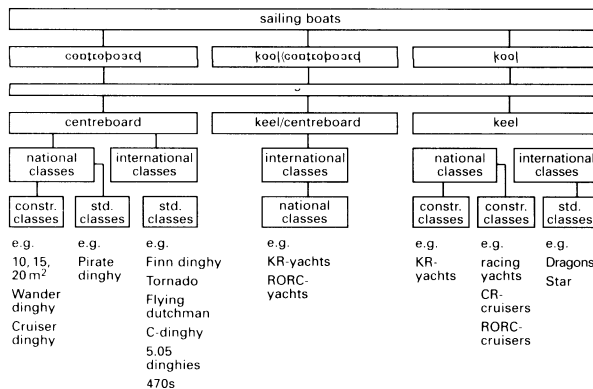


④ Bunker design

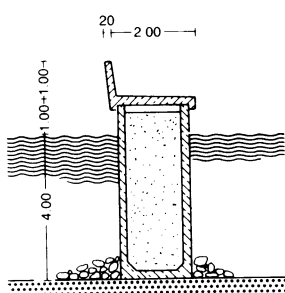
depth and shape of bunkers is dependent on their distance from the green: the nearer the green, the steeper the face



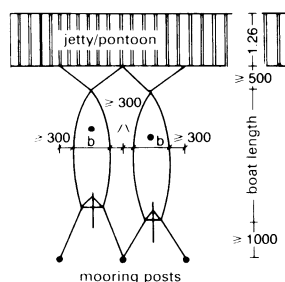
1 Functional diagram of a clubhouse



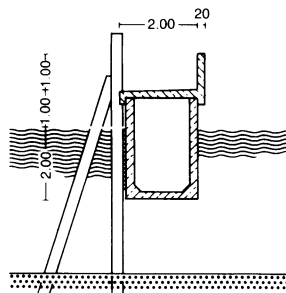
2 Types and classes of sailing boat: overview



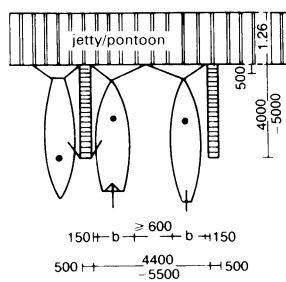
3 Submerged caissons of prefabricated reinforced concrete units filled with sand



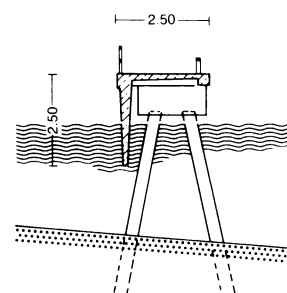
7 Boat mooring: between jetty and mooring posts



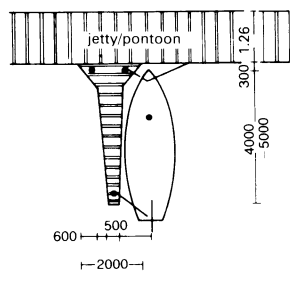
4 Floating pontoon of prefabricated reinforced concrete units



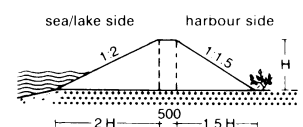
8 Boat mooring: jetty and finger piers



5 Submerged wall of prefabricated reinforced concrete units in the harbour of Insel Riems

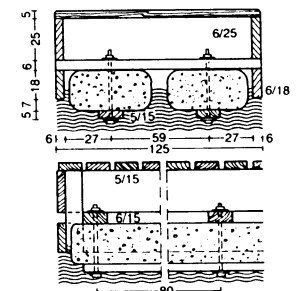


9 Boat mooring: between jetty and Y-shaped finger pier



height H (m)	base width S (m)
1	4.00
2	7.50
3	11.00
4	14.50
5	18.00
6	21.50

6 Mole or dam section (dimensions)



10 Floating jetty: styrofoam floats: cross/longitudinal section

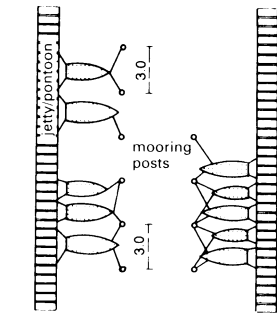
## SAILING: YACHTS AND MARINAS

Mooring spaces for sailing and motor boats have to be planned carefully to make optimum use of the water area available. For reference, allocate 4–5 sailing boats or 6 motorboats per hectare of water area.

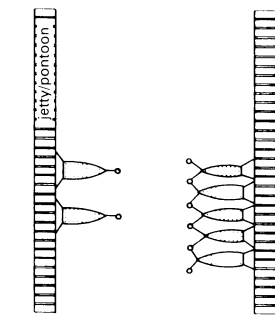
The necessary depth of water in harbours and marinas depends on the types of boats to be accommodated. Usually, dinghies and yachts with centre-boards require a depth of 1250 mm whereas fixed-keel boats need 4000–5000 mm. Constant water levels are obviously preferable for the safety of boats.

boat type (crew: 1–3 persons)	class: std (S), const. (C)	dimensions, length/width (m)	draft (m)	sail area 3 (spinnaker) (m <sup>2</sup> )	sail marking
<b>Olympic classes:</b>					
Finn dinghy <sup>1)</sup> (1)	S	4.50/1.51	0.85	10	two blue wavy lines, one above the other
Flying Dutchman	S	6.05/1.80	1.10	15 (s)	black letters FD
Star (2)	S	6.90/1.70	1.00	26	five pointed red star
Tempest	S	6.69/2.00	1.13	22.93 (s)	black letter T
Dragon <sup>1)</sup> (3)	S	8.90/1.90	1.20	22 (s)	black letter D
Soling <sup>1)</sup> (3)	S	8.15/1.90	1.30	24.3 (s)	black letter Ω (omega)
Tornado <sup>1)</sup> (2)	S	6.25/3.05	0.80	22.5 (s)	black letter T with two parallel lines below
470 <sup>1)</sup> (2)	S	4.70/1.68	1.05	10.66 (s)	black number 470
5.50 m yacht	C	9.50/1.95	1.35	28.8	black number 5.5
<b>Other international classes:</b>					
Pirate (2)	S	5.00/1.62	0.85+	10 (s)	red axe
Optimist (1)	S	2.30/1.13	0.77+	3.33	black letter O
children/youth cadet (2)	S	3.32/1.27	0.74+	5.10 (s)	black letter G
OK dinghy (1)	S	4.00/1.42	0.95	8.50	black letters Ou.K
Olympia dinghy (1)	S	5.00/1.66	1.06+	10	red ring
420 dinghy (2)	S	4.20/1.50	0.95+	10 (s)	black number 420 set slanting

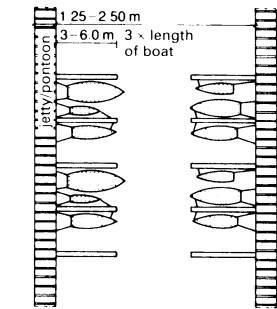
<sup>1)</sup> Olympic classes 1980 in Moscow  
+ with lowered centreboard



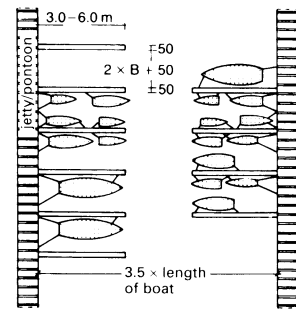
1 Berths for sport boats: in Rotterdam



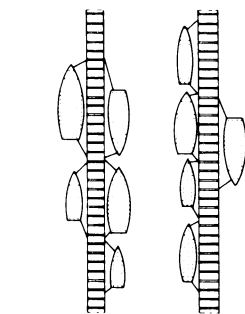
2 in the Mediterranean Sea



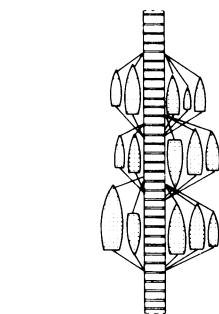
3 in American waters



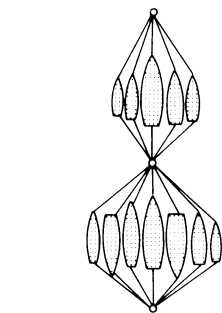
4 in Port Hamble



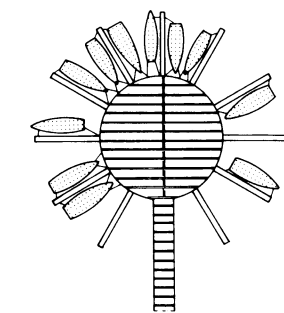
5 in Granville



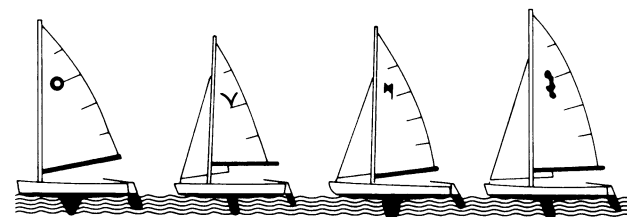
6 in St Rochelle



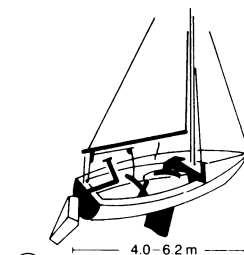
7 in Yarmouth



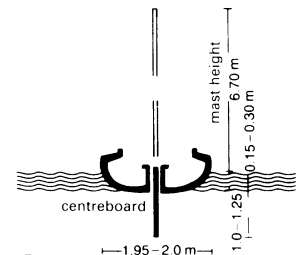
8 in San Francisco



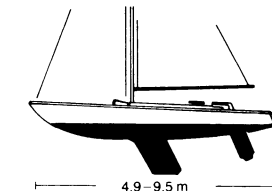
9 Boat classes seen in harbours



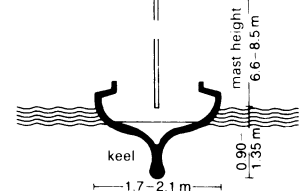
10 Dinghy



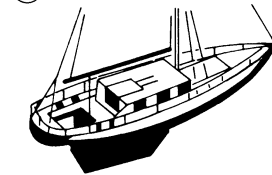
11 Dinghy: section



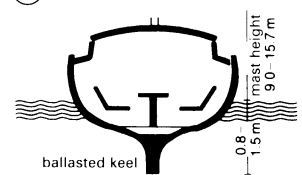
12 Open-keel boat



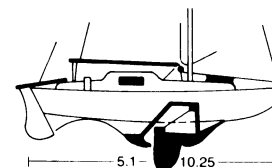
13 Open-keel boat: section



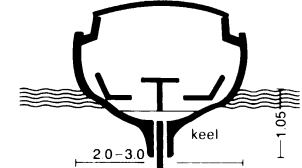
14 Keel cruiser



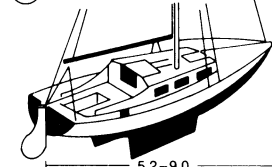
15 Keel cruiser: section



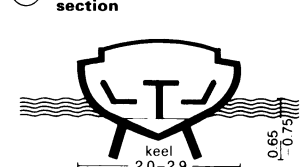
16 Centreboard keel cruiser



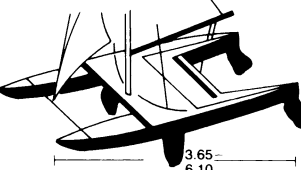
17 Centreboard keel cruiser: section



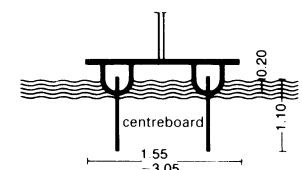
18 Twin keeled cruiser



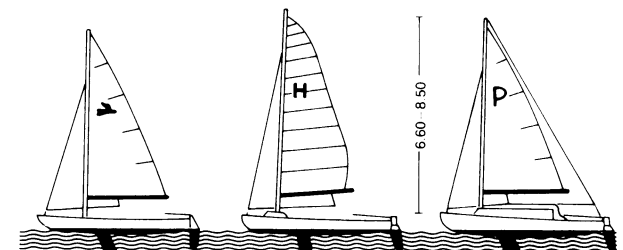
19 Twin keeled cruiser: section



20 Open catamaran



21 Open catamaran: section



22 Boat classes seen in harbours

## SAILING: HARBOURS/MARINAS

The direction of the prevailing wind and waves is an important consideration in determining the position of the harbour entrance and also influences the the design of the breakwaters, which protect the interior of the harbour from waves → ① – ④. Entrances and exits have to be at least equal in width to the length of the mooring spaces for sailing boats or, preferably, one and a half times the maximum boat length.

It should be remembered that boats under sail will approach the harbour entrance from a variety of directions, depending on the prevailing wind on the day. Consequently, the harbour should have a turning area, with a diameter of 35–60m, behind the entrance.

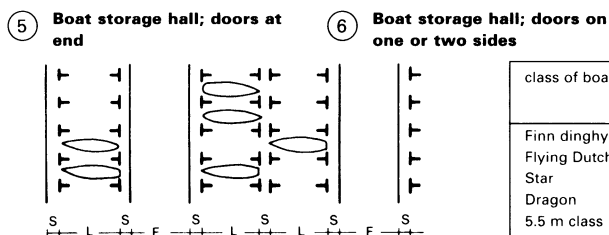
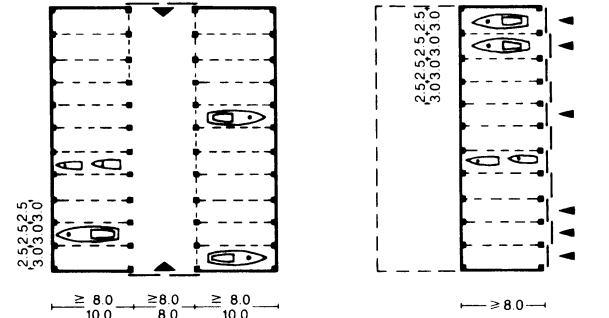
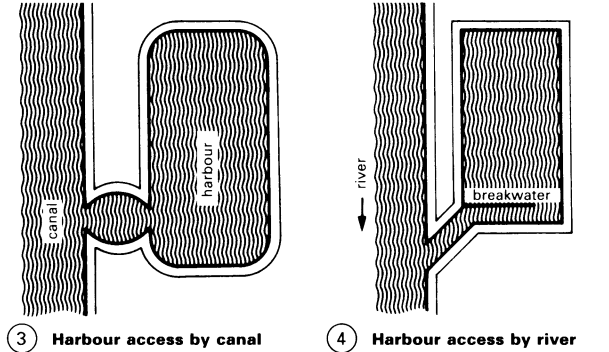
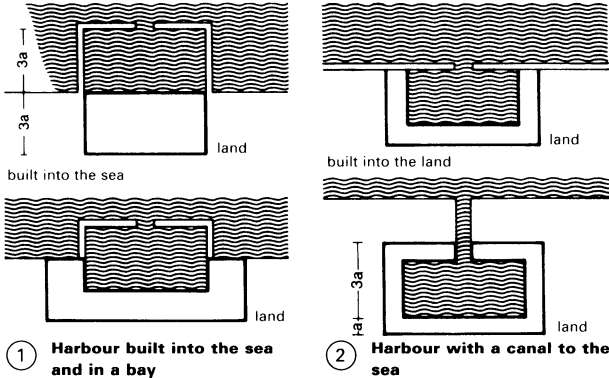
The construction of breakwaters, sea defences and landing stages, and the means of transport and storage for boats, have a fundamental influence on the type of use that can be made of the harbour or marina in different climatic conditions.

As well as offering protection from waves, breakwaters (also called moles) also prevent the harbour from filling up with silt carried by the sea currents. Stone breakwaters are built either from natural stone boulders or pre-cast concrete units in geometrical shapes (e.g. tetrahedron) that interconnect with each other when laid. As well as stone breakwaters, sheet-pile walls are also commonly used. These are made from framed steel sections and have a life expectancy of 20–30 years.

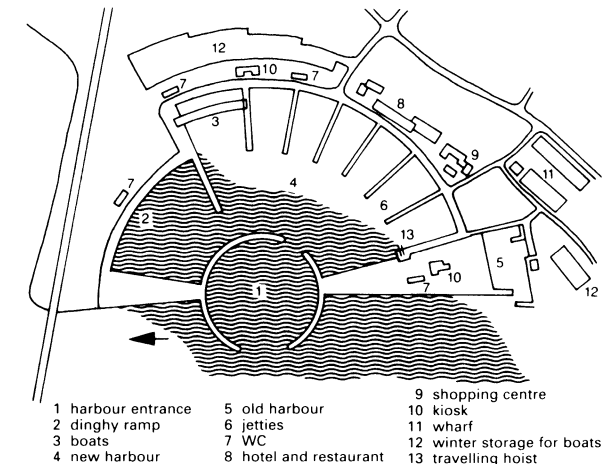
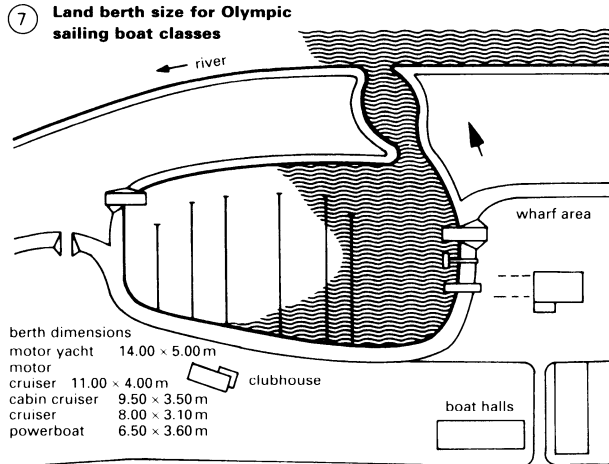
Each boat needs a berth appropriate to its use (e.g. training, weekend, holiday etc.). The options include water berths, land berths or hall/indoor berths and the areas required for boats and associated facilities are: water berths 90–160m<sup>2</sup>; land berths 100–200m<sup>2</sup>. This gives a total area per boat of approximately 200–360m<sup>2</sup>. In addition, at least one family car parking space should be planned for every berth.

In choosing the layout of berths it may be necessary to consider the frequency and shape of ice formation. There may be a risk of damage through the expansion and thrust of pack ice.

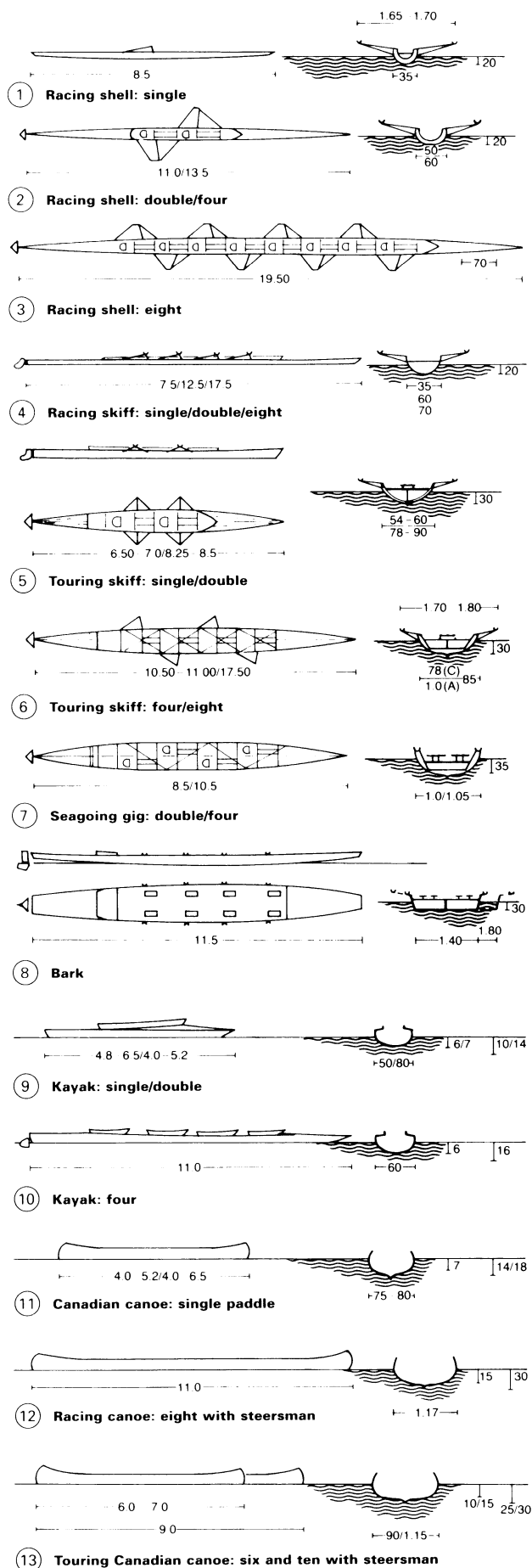
Floating pontoons of steel, reinforced concrete, inflated tubes and floating styrofoam pieces are used both as breakwaters and landing stages. Steel and reinforced concrete pontoons, which sink about 2m, adapt to the particular water level and give the necessary calming of the water. Caissons are prefabricated reinforced concrete units which are sunk and filled with sand or gravel once in position. → Page 512.



class of boat	size of boat (m)		necessary berth size		intermediate safety space (S)	necessary access path width (F)
	length	width	length (L)	width (W)		
Finn dinghy	4.50	1.51	4.50	=3.00	ca. 1.00	5.00
Flying Dutchman	6.05	1.80	6.00	=3.00	ca. 1.00	6.50
Star	6.92	1.72	7.00	=3.50	ca. 1.50	7.50
Dragon	8.90	1.90	9.00	=4.00	ca. 2.00	9.50
5.5 m class	10.40	1.90	10.50	=4.00	ca. 2.00	11.00



## ROWING

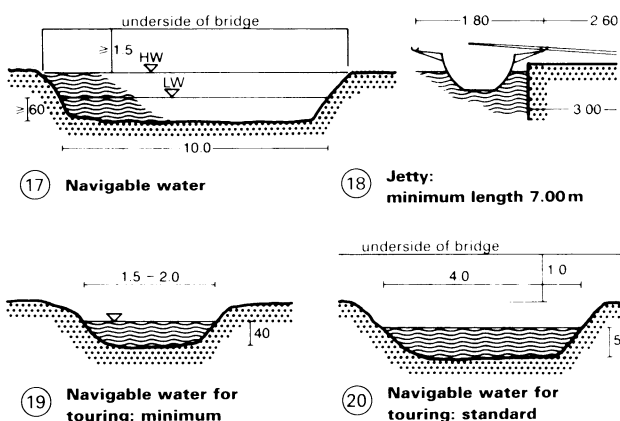
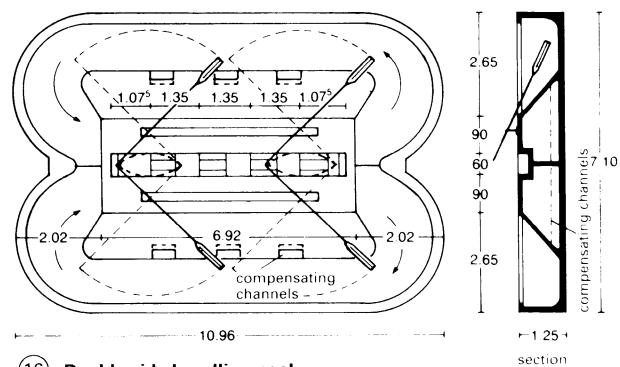
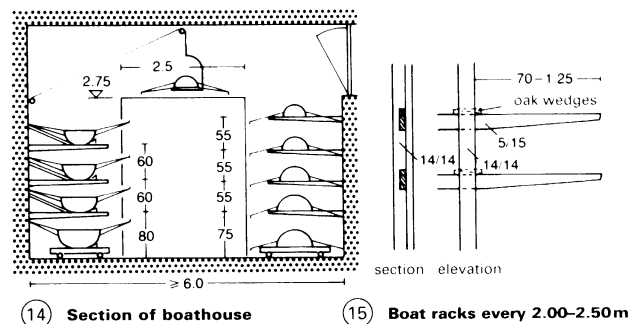


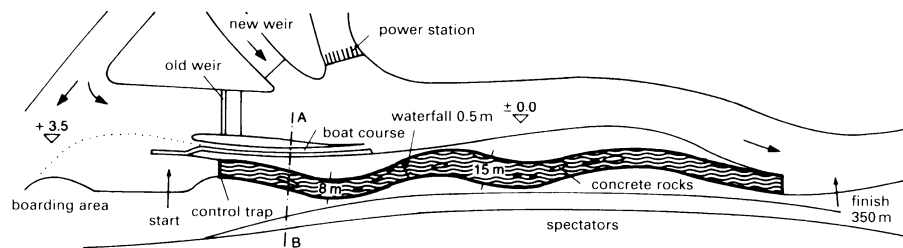
Competition rowing boats are mostly team boats and usually belong to clubs situated on waterways that are flowing and obstacle-free, in pleasant natural settings. Such clubs may also use kayaks and Canadian canoes.

Boathouses with windows or roof-lights should be north facing to keep the sun out. The doors need to be at least  $2.50 \times 2.75$  m to allow crews to carry in the boats held above their heads. The hall should have a width of at least 6.00 m and a length of 30 m or more. The height, if possible, should be 4.0 m  $\rightarrow$  14. Note that oars are 3.80 m long, with a blade width of 15–18 cm. They should be stored near the entrance, either horizontally on shelves or, preferably, suspended from pulleys above a pit (depending on the height of the hall). Between the boathouse and the landing stage, an area of bank with a width of 20–30 m is necessary for cleaning and preparing boats. A water pump and parking/storage space for boat trailers is also needed.

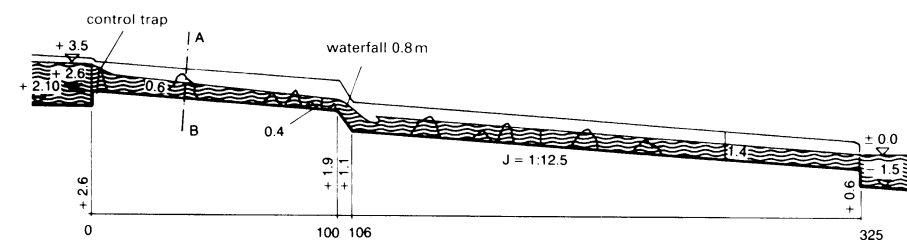
Single or double sided skulling pools for training with short oars  $\rightarrow$  16 might be required. For a full eight, a pool size of  $12.60 \times 7.60$  m is necessary. The water circulation creates current conditions that are similar to open water.

Other facilities to consider in addition to changing rooms include a gymnasium and swimming pool.

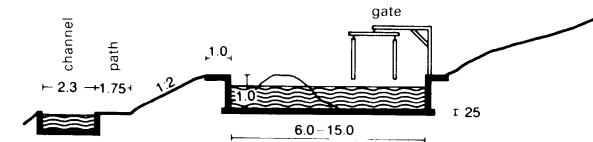




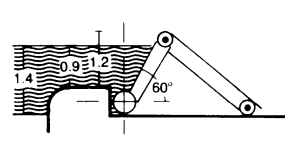
① Regatta course for canoe slalom



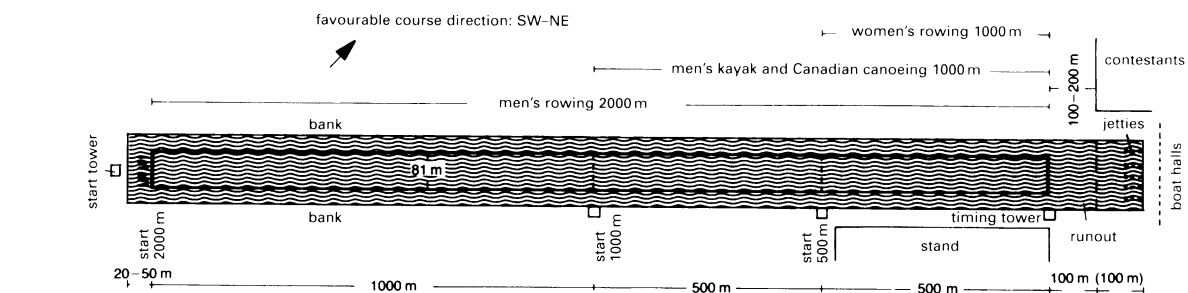
② Horizontal section → ①



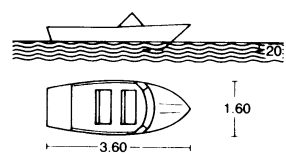
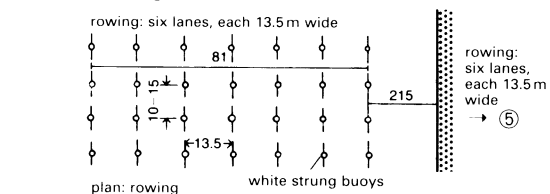
③ Section A-B → ①



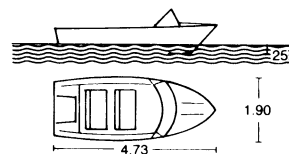
④ Control trap with draining base



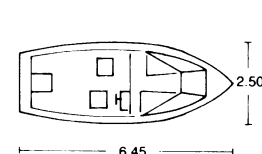
⑤ Regatta course in Munich (international dimensions) for rowing and canoeing events



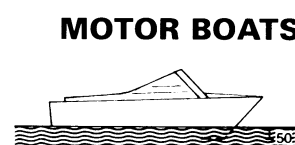
⑥ Leisure boat



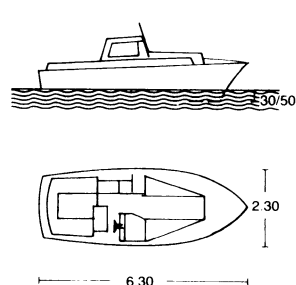
⑦ Runabout



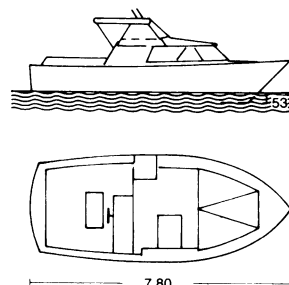
⑧ Speedboat



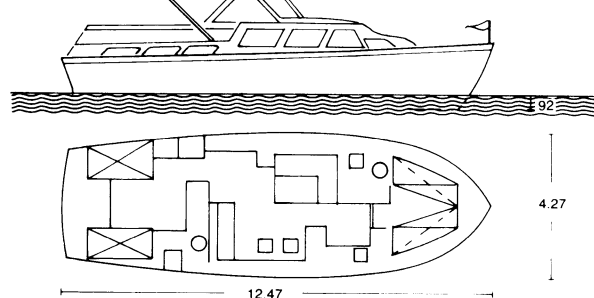
MOTOR BOATS



⑨ Cruiser



⑩ Cabin cruiser



⑪ Motor yacht

Slalom courses can be established in natural settings or in artificial purpose-built facilities (e.g. the international regatta course in Munich → ⑤).

Natural courses require traffic-free stretches of river with a suitable gradient (1:100 or more) and flow rate, which may be natural or controlled by a weir upstream. If they are free of obstacles and at least 8 m wide, mill or power station outflows can also be suitable. Artificial facilities are constructed from suitably inclined reinforced concrete channels with concrete stone obstacles. Consideration must be given to the installation of up to 32 gates → ③ for regattas.



## RIDING FACILITIES

Riding facilities/stables should, if possible, be in the immediate vicinity of land suitable for riding. Areas with high ground and air humidity, as are often found in valleys, should be avoided, as should windless locations, where providing the desired ventilation may be difficult. Ideal sites are in hilly and windy areas. However, slope gradients for buildings and riding arenas should be less than 10%.

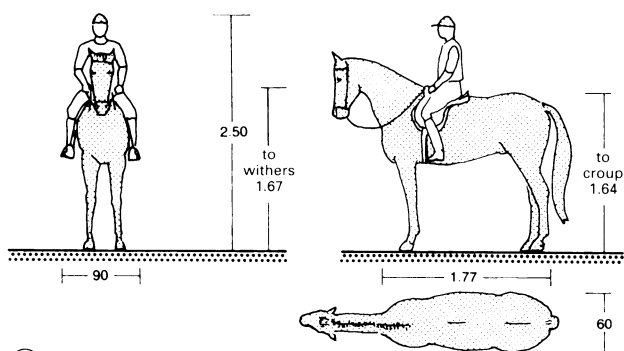
Saddle rooms, as far as possible, should be long and rectangular, with a large wall space and a width of 4.0–4.5 m. Saddles can be hung in rows staggered above each other → ⑧. Saddle rooms and grooming rooms should have heating and be well ventilated.

In riding arenas the minimum headroom for show jumping and horseback acrobatics is 4.00 m → ⑤ + ⑥.

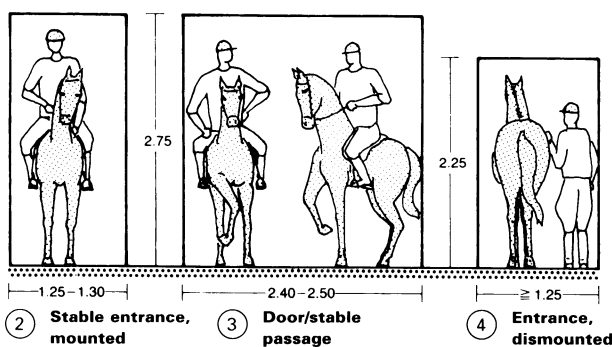
No universal rule can be applied to the space allocated to spectators. In general, though, spectators should not look down too steeply on the horses. An effective solution can be to use a spectator gallery → ⑪, with the first row for seating and the second for standing. Behind this is room for two rows of circulating people. This arrangement will create 200 seated and standing places in a 20 × 40 m arena. The size of the main entrance has to be large enough to allow access for medium sized lorries (3.00 m wide, 3.80 high). Side entrances should be 1.20 m or more wide and a minimum of 2.80 m high. Doors have to open outwards.

Glass windows above the riding arena floor should be protected by a fine mesh grille.

An arena riding area of approximately 1000 m<sup>2</sup> is sufficient for ten horses.



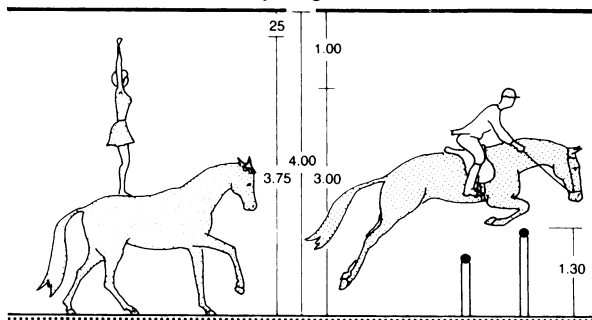
① Dimensions of horse and rider



② Stable entrance, mounted

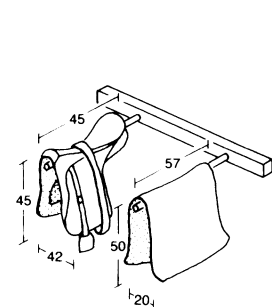
③ Door/stable passage

④ Entrance, dismounted

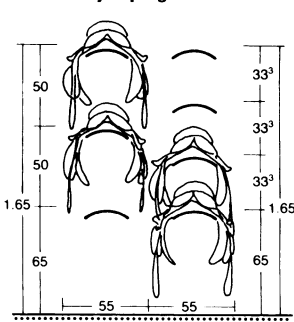


⑤ Space required for acrobatics on horseback

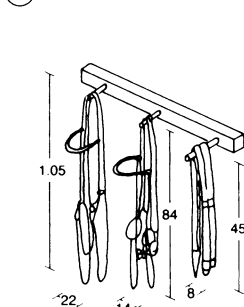
⑥ Space required for showjumping



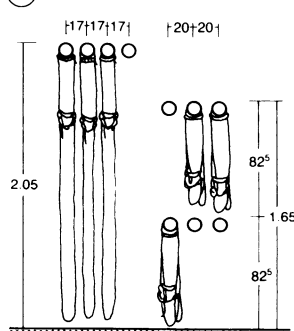
⑦ Saddle with blanket



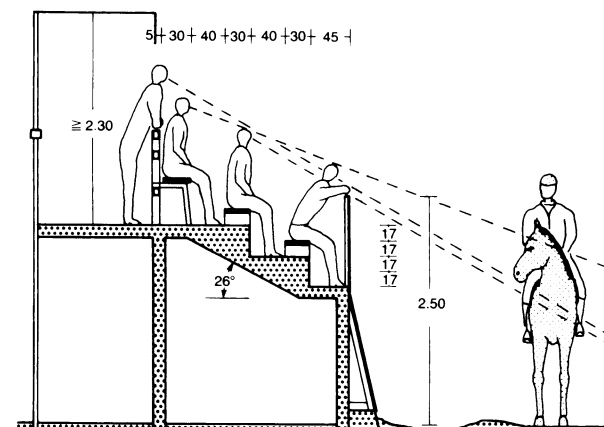
⑧ Saddle rack



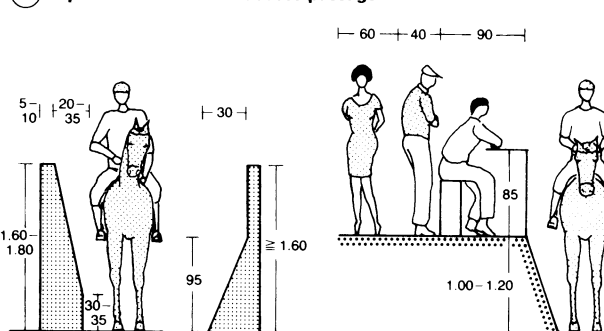
⑨ Tack rack



⑩ Bridle rack



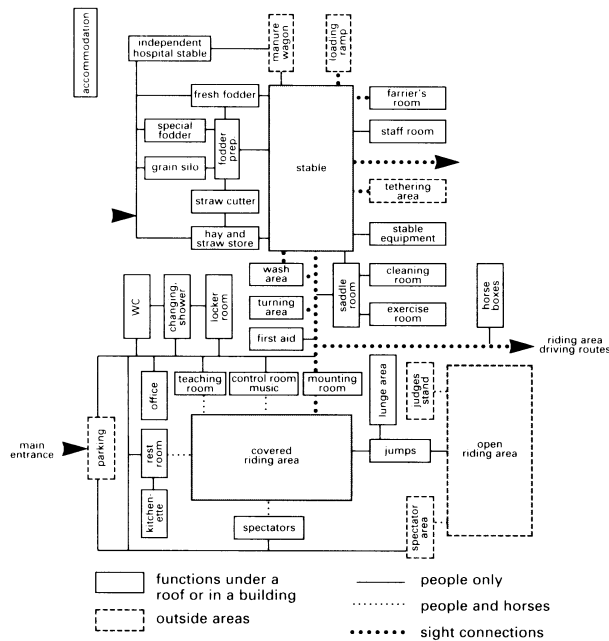
⑪ Spectator stand with access passage



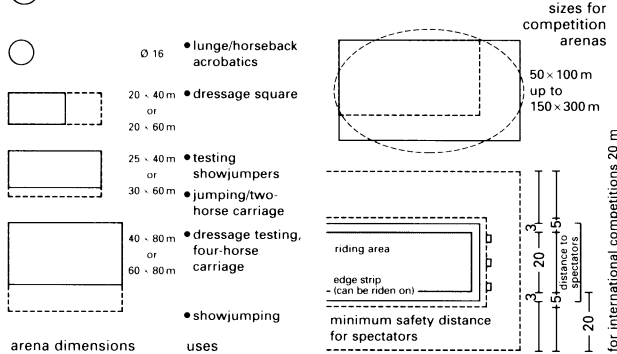
⑫ Profile of barriers

⑬ Simple spectator stand

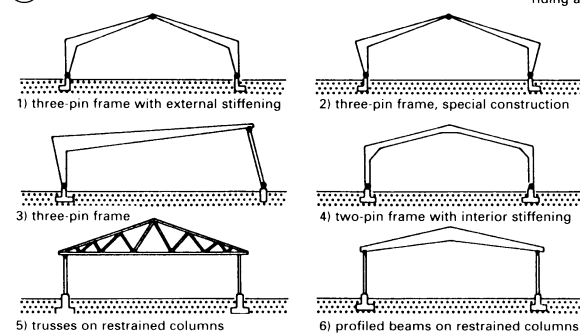
## RIDING FACILITIES



### 1 Internal connections for a riding establishment



### 2 Functional dimensions of open riding areas



### 3 Cross-sections of riding halls

	Ø 14.0 m	lunge/horseback acrobatics: alternative to a hall in the smallest clubs and private stables; used to relieve the main arena in larger establishments
	12.5 x 25.0 m	smallest arena: for private stables only and as an emergency solution for clubs; suitable as a second arena for larger establishments
	15.0 x 30.0 m	private stables and smaller club stables; second arena for larger establishments
	20.0 x 40/45 m	normal size for every type of establishment; dressage exams possible
	20.0 x 60.0 m	for larger establishments and institutions which specialise in dressage
	25.0 x 66.0 m	for large schools providing jumping and dressage training, and boarding establishments; hall dressage exams possible

format of riding halls      arena dimensions      uses

### 4 Dimensions of riding halls

Apart from variations due to organisational specialisms or local conditions, the operational functions of different riding schools are, basically, the same. Building specifications vary primarily in terms of the size of the organisation or number of stable users. This is vital for the organisation of the various rooms, and determines also whether various functions can be combined → ①. Generally, the elements in which the horses are housed and fed should be designed as a self-contained structure. A covered riding hall is indispensable for keeping stable activity going in adverse weather conditions. Accommodation for stable hands, grooms or instructors also needs to be planned.

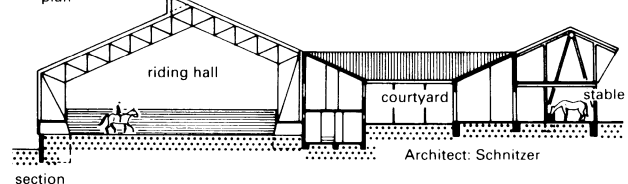
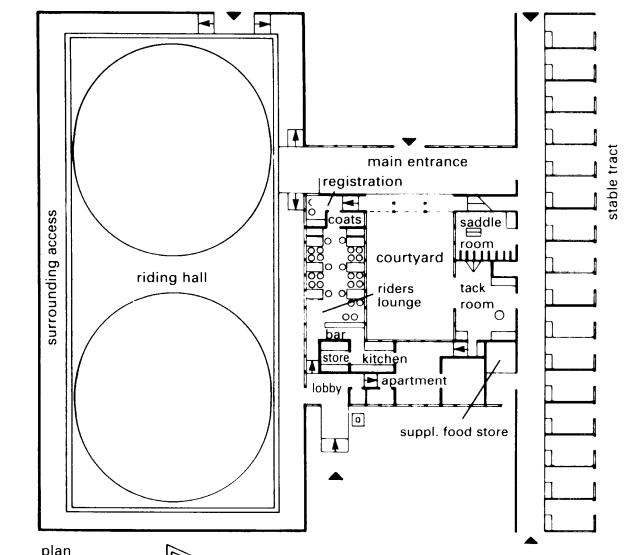
For outdoor tournament facilities the long axis of the arena should be aligned in the north-south direction → ④. The judges' grandstand is positioned on the west side of the arena because most important competitions take place in the afternoon and so the sun will be at the judges' backs.

The minimum size of the riding area in a tournament arena is 20 x 40 m → ②. For dressage from class M and versatility exams a riding area of 20 x 60 m is required. In addition, 3.0 m side strips (5.0 m at the entrance) that can be ridden on should be provided, giving a gross arena size of 26 x 48 m → ⑤. The audience should be no further than 5 m from the riding area.

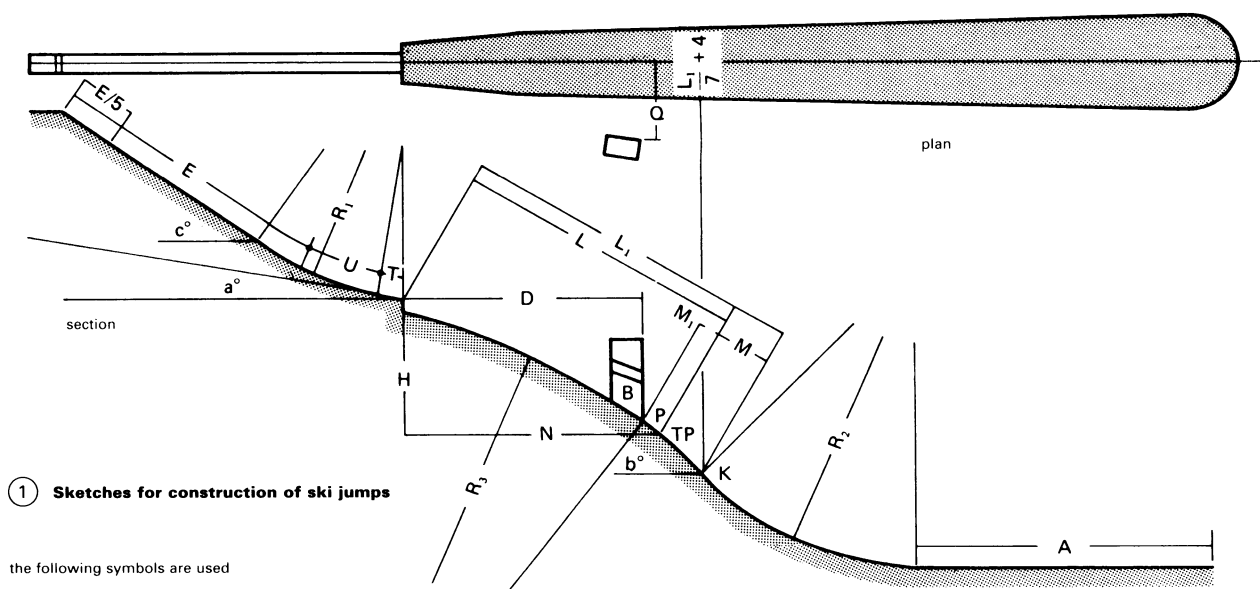
material	volume of 100 kg (m³)	daily requirement per horse (kg)	required store provision per horse		
			number of months	kg	m³
oats (grain)	0.22	5	1	150	0.33
hay	long (stored compressed)	8	12	2.900	29-34
	wired bails			17	17
straw	long (stored compressed)	about 20 (with purely straw bedding in boxes)	3	1.825	29-34
	stringed bails			17	17
	wired bails			17	17
	chopped 100 mm long	about 15		1.375	31-16

useable store area per horse for feeding material

### 5 Store areas



### 6 Riding establishment in Gerolstein/Eifel



### 1 Sketches for construction of ski jumps

the following symbols are used

- P = datum point  
 TP = table point  
 K = critical point (end of the slowing down section and beginning of the run-out curve)  
 B = end of landing run curve  
 M = slowing down section (distance from P to K)  
 M<sub>1</sub> = distance from P to B  
 L = distance from edge of slope to P  
 L<sub>1</sub> = distance of edge of slope to K  
 H = vertical projection of L  
 N = horizontal projection of L  
 H:N = ratio of vertical to horizontal distance  
 a = slope of launch platform  
 b = slope of jump-off track at datum point (P) up to critical point (K)  
 c = run-up slope  
 R<sub>1</sub> = radius of curve from run-up to platform  
 R<sub>2</sub> = radius of curve from jump-off to run-out  
 R<sub>3</sub> = radius of curve from platform to jump-off track  
 T = length of platform  
 U = part of run-up in which speed no longer increases  
 E = part of run-up in which speed increases  
 F = overall length of run up (F = U + E + T)  
 A = length of run-out  
 V<sub>0</sub> = speed at platform edge in m/s  
 D = horizontal distance from the platform edge to lower part of judges tower  
 Q = distance from landing track axis to front edge of judges tower

small jumps													
E		L											
c	c	c	8-10°										
30°	35°	40°	U	T	V <sub>0</sub>	H:N=0.56	0.48	0.46	0.44	0.42	0.40	0.38	b ↓
26	23	21	4.5	3.3	15	20.0	19.5	19.0	18.5	18.0	17.5	17.0	30-34°
32	28	25	5.1	3.5	16	25.5	24.8	24.0	23.3	22.5	21.8	21.0	30-35°
39	32	28	5.8	3.7	17	31.0	30.0	29.0	28.0	27.0	26.0	25.0	33-36°
46	37	32	6.5	4.0	18	36.5	35.3	34.0	32.8	31.5	30.3	29.0	33-36°
52	43	37	7.2	4.2	19	42.0	40.5	39.0	37.5	36.0	34.5	33.0	34-37°
59	49	42	8.0	4.4	20	47.5	45.8	44.0	42.3	40.5	38.8	37.0	34-37°

### 2 Measurements

standards for the most important parts of the ski jump

H:N = 0.48 to 0.56

datum point of jump can be determined:

- P = L<sub>1</sub>-M where standards of M are:  
 M = 0.5 to 0.8V<sub>0</sub> for jumps up to P = 70 m  
 M = 0.7 to 1.1V<sub>0</sub> for jumps up to P = 90 m  
 M<sub>1</sub> = 0 to 0.2V<sub>0</sub>  
 R<sub>1</sub> = 0.12V<sub>0</sub><sup>2</sup> to 0.12V<sub>0</sub><sup>2</sup> = 8 m  
 R<sub>2</sub> = 0.14V<sub>0</sub><sup>2</sup> to 0.14V<sub>0</sub><sup>2</sup> = 20 m  
 R<sub>3</sub> = profile selected for front structure which best meets angle of flight  
 T = 0.22V<sub>0</sub>  
 U = 0.02V<sub>0</sub><sup>2</sup>  
 A = 4 to 5V<sub>0</sub> on horizontal run-out  
 D = 0.5 to 0.7L<sub>1</sub> to lower edge of tower  
 Q = 0.25 to 0.50L<sub>1</sub>

#### example:

according to terrain, the following data apply to L<sub>1</sub> and H:N:  
 for example, H:N = 0.534, c = 35°, K = 87 m;

in the table you will find L = 87 for V<sub>0</sub> = 26, and c = 35°, E = 90 m, U = 14, T = 5.7 at the same level, then F = E + U + T = 90 + 14 + 5.7 = 109.7 m;

a ski jump with dimensions differing from the above may be approved by FIS, but in such cases the designers must give detailed written reasons

medium and large jumps													
E		L											
c	c	c	9-12°										
30°	35°	40°	U	T	V <sub>0</sub>	H:N=0.56	0.54	0.52	0.50	0.48	b ↓	← a	
62	52	44	8.8	4.6	21				53.0	51.0	35-37°		
71	58	49	9.7	4.8	22	65.3	63.0	60.8	58.5	56.2			
80	65	54	10.6	5.1	23	71.5	69.0	66.5	64.0	61.5	36-38°		
89	72	60	11.4	5.3	24	77.7	75.0	72.2	69.5	66.7			
99	80	67	12.5	5.5	25	84.0	81.0	78.0	75.0	72.0	37-39°		
111	90	74	14.0	5.7	26	90.2	87.0	83.7	80.5	77.2			
124	100	81	15.0	5.9	27	96.3	93.0	89.5	86.0	82.5	38-40°		
137	110	88	16.0	6.2	28				91.5	87.7			

### 3 Measurements

The judges' towers should be arranged in a stepped formation parallel to the line from the edge of the launch platform to the end of the landing run curve. Each tower should be skewed by 7° to 10° from the centre-line of the landing run so that the judges can observe the whole flight and the landing clearly. The parapet of the towers should be 1 to 1.20 m above the floor level.

In the run-up, as many starting positions as possible should be evenly distributed on a length E/5. Along this distance is a vertical fall of approximately 1 m. The lowest starting position is at E - E/5.

Note that the minimum width of the landing track at K = L<sub>1</sub>/7 + 4 m.

#### General comments

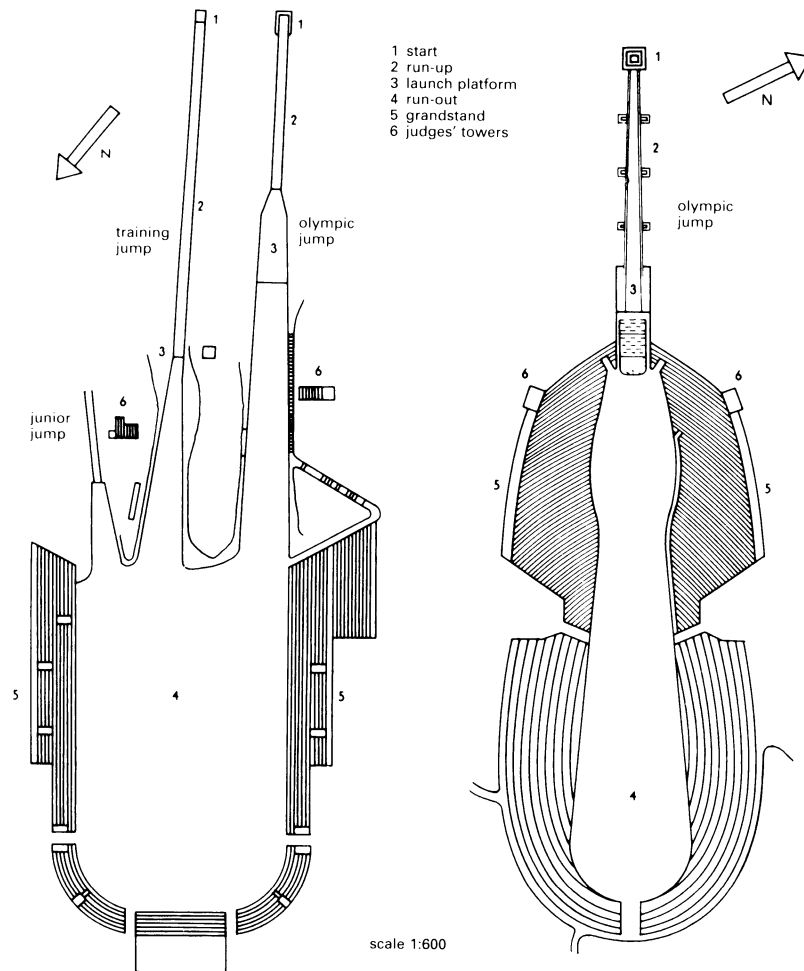
All gradients are given in old divisions based on 360 degrees. Should the transition be parabolic, then R<sub>1</sub>, R<sub>2</sub> and R<sub>3</sub> are the smallest radii of these parabolas.

With natural run-ups the most frequently used areas need to be marked at 2 m intervals in order to simplify the exact fixing of the starting position. The gradient of the launch platform as well as several points along the run-up curve should be indicated permanently on both sides with fixed built-in profiles so that even non-specialists can re-create the exact profile when preparing the ski jump.

It is recommended that profile markers are also installed alongside the landing track up to the run-out. This enables the snow profile to be established precisely, especially when the snow cover is deep.

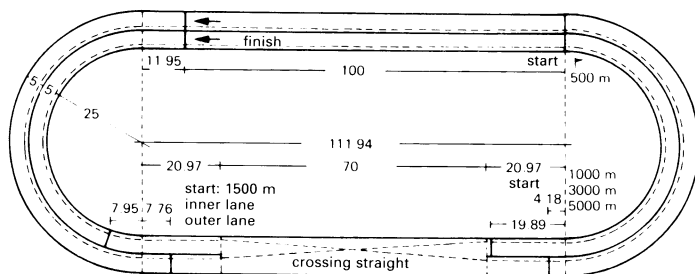
As a rule, ski jumps with L greater than 50 m should not be built with a V<sub>0</sub> of less than 21 m/s. Note that ski jumps with L above 90 m are not approved by the FIS.

## Ski Jumps contd

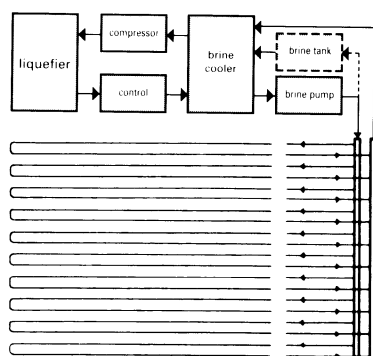


① Garmisch-Partenkirchen

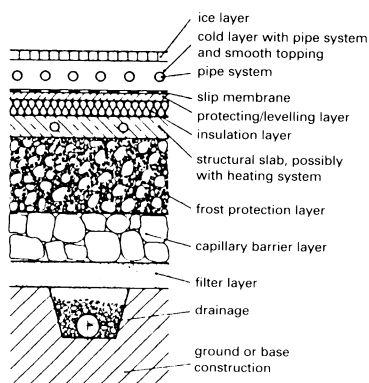
② Holmenkollen



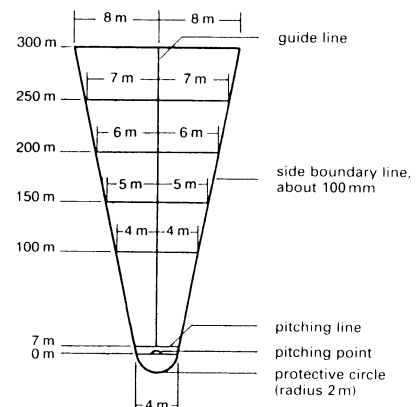
③ Standard race track 400 m long



④ Artificial ice rink: layout of a refrigeration system (brine)



⑤ Detail of surface pipes → ④



⑥ Long curling ground

## ICE RINKS

In cold climates, natural freezing of lakes and rivers provides suitable areas for ice skating, ice hockey and curling. Similarly, frozen lido pools (assuming the edges are strong enough to withstand the pressure of ice) may be used as temporary rinks.

By using 'sprayed ice', skating rinks can be created on tennis courts, roller skating rinks and other large flat spaces. A surrounding embankment or barrier approximately 100–150 mm high is needed and there must be suitable drainage for water run-off. Water is sprayed on to the surface to a depth of 20 mm.

In warm climates or for year-round use, artificial ice rinks are the solution. These consist of a cooling pipe system in a screed floor through which a deep frozen salt solution or cold air (usually a compressed ammonia system) is pumped. The pipes are roughly 25 mm below the screed surface. → ④ + ⑤

**Standard race track:** The track length is usually 400 m (although some can be 300 m or 333.5 m) and should be have two lanes → ③. The distance through the curves is measured 500 mm from the edge of the inside of the track. This gives the race distance of  $(2 \times 111.94) + (25.5 \times 3.1416) + (35.5 \times 3.1416) + 0.18$  (extra through the crossing) = 400 m.

**Bobsleigh and toboggan runs:** Situated on north-facing slopes, these runs require tight curved embankments made from ice blocks. The lengths are 1500–2500 m, with slopes of 15–25% and a minimum run width of 2 m. Spectator places should, if possible, be on the inside of the curves or protected with mounds of snow or straw bales.

## ICE RINKS

**Curling:** There are several types of curling and the lengths and widths of the track vary accordingly → ① – ③. See also ⑥ on page 496/497. In German curling the pitching and target areas require a low frame, which can easily be stepped over, on three sides. The track in Scottish curling is 42m long, with 38.35m between the target centres but this can be shortened to 29.26m if the ice is in bad condition.

**Ice hockey:** The pitch area is  $30 \times 60$  m and it has curved corners. The goals are 1.83 m wide, 1.22 m high, and are positioned such that players can skate around the back of them. The pitch needs to be fully surrounded by a wood or plastic barrier 1.15–1.22 m high  $\rightarrow$  (4).

**Figure skating:** A rectangular ice rink between  $56 \times 26\text{m}$  and  $60 \times 30\text{m}$  in size is suitable for both figure skating and in-line skating, which is becoming increasingly popular. It is possible to create a multipurpose rink: roller skating from March to November and ice skating from December to February. This requires a cooling pipe system  $25\text{--}50\text{mm}$  below the rink surface (note that this is not possible in terrazzo) → ⑥).

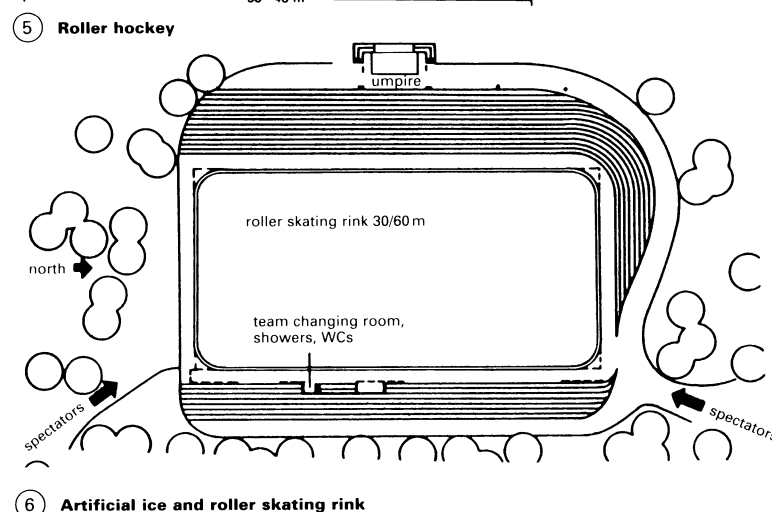
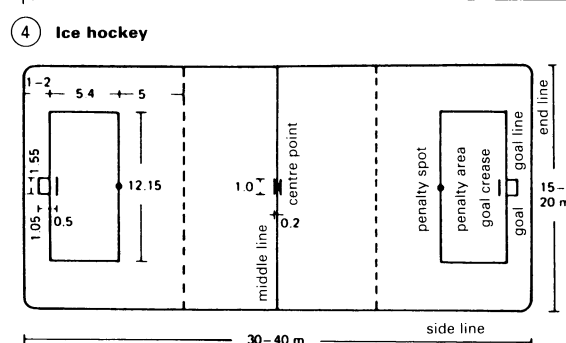
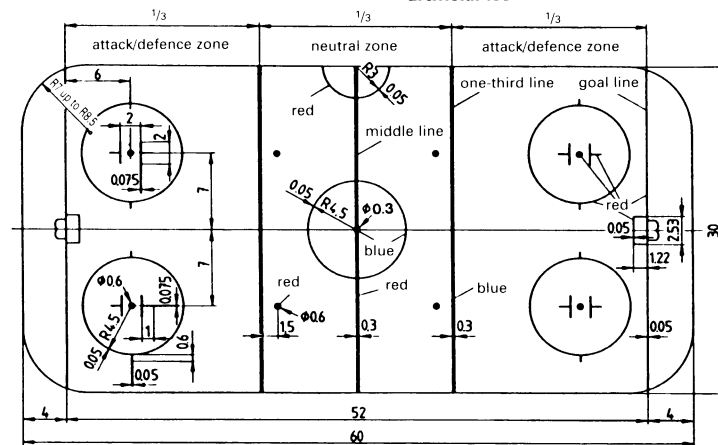
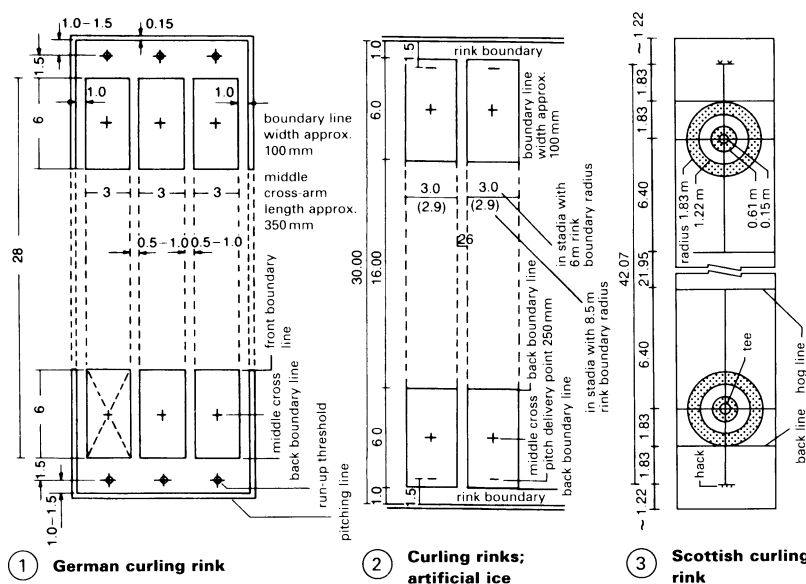
## ROLLER SKATING RINKS

- (1) Sports rinks  
 Roller hockey 15 × 30 to 20 × 40 m  
 Figure roller skating 25 × 50 m  
 (2) Leisure rinks 10 × 10 to 20 × 20 m

An impact board 250mm high, 30mm above the rink surface, and an 800mm solid barrier are required on all sides of the rink. Behind the short edges a 2m high wire netting fence should be installed to catch stray balls. The rink should also have a surrounding walkway 1.2m wide and a channel to collect and disperse surface water. The gradient of the rink surface should not be greater than 0.2%.

## Construction

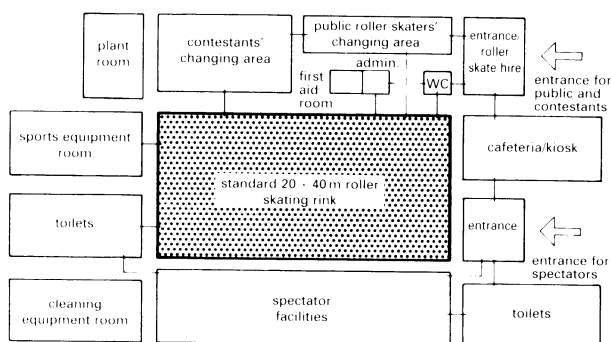
- (1) Fibre reinforced cement sheets, 15 mm thick, laid on squared timber or on sand bedding.
- (2) Concrete tracks, 100–150 mm depending on condition of subsoil, if possible jointless; if necessary cut in false joints 2–3 mm wide, space joints every 25–30 m with a gap width of 15 mm or more.
- (3) Hard concrete screed, minimum of 8 mm thick on fresh concrete slab (20 mm of cement mortar is preferable to take up stress between the screed and the slab).
- (4) Cement composite with additives 1–10 mm.
- (5) Terrazzo, polished, 15 mm or more; joint rails made from brass, metal alloy or plastic should be used only for indoor rinks.
- (6) Cast asphalt rinks on a fixed base.



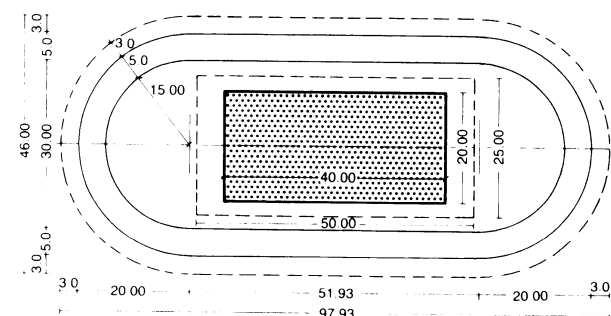
## ROLLER-SKATE RACING

For a standard racing circuit with an enclosed 20 × 40 m rink → ② the following room schedule gives guidance on the requirements.

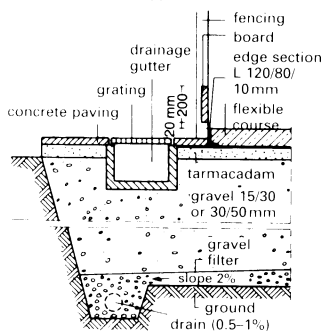
- For competition use: four changing rooms, each with 8 m of benches, clothes hooks and lockers; additional lockers of 3 m<sup>2</sup> for roller hockey equipment; two shower rooms with four showers, two wash basins and separate toilets; and one referee/trainers' room of approximately 9 m<sup>2</sup>.
- For public use: changing and equipment-fitting area with lockers and benches (20 m minimum length); ladies and gents toilets, with two WCs and a separate anteroom with showers and hand basins, connected to the changing area.
- General: entrance area with ticket machines and turnstile or staffed ticket office, approximately 40 m<sup>2</sup>; a 12 m<sup>2</sup> skate hire room (connected to the ticket office); an 8 m<sup>2</sup> supervision and management room (doubles as a control room for light and sound systems); staff changing rooms with shower, hand basins, toilet and lockers; a first aid room of 9 m<sup>2</sup>; equipment stores, 15 m<sup>2</sup> and 6 m<sup>2</sup>; cleaners' room, 12 m<sup>2</sup>; boiler room, 10 m<sup>2</sup>; services room, 4 m<sup>2</sup>; and a meter room, 3 m<sup>2</sup>.



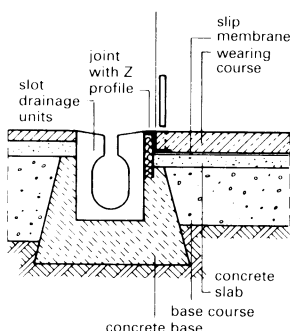
① Function diagram of a roller-skate racing rink



② Dimensions of a 200 m roller-skate racing circuit with standard rink enclosed



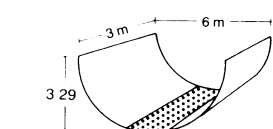
③ Example construction; drainage suitable for cohesive ground



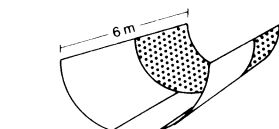
④ Edge detail: floating slab surface, no step down

possible uses	necessary skating area (m)	remarks
public roller skating rink, figure skating, roller dancing, roller hockey	20 × 40 m	<b>standard area</b> for roller hockey 17 × 34 m (min)
public roller skating rink, figure skating, roller dancing, and roller hockey	20 × 50 m	in special situations
public roller skating rink, figure skating, roller dancing, roller hockey, roller-skate racing and ice sports	30 × 60 m	generally only when used also as an ice rink, 110 m sprint track for roller-skate races possible on a rink area 30 × 60 m
roller-skate racing track length	200 m 333 1/2 m 400 m	<b>standard track</b> only when also used for cycle sports and/or ice skate racing tracks
track width	5 m	

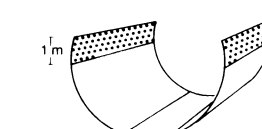
⑤ Types of use and sizes of rinks



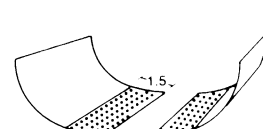
⑥ Movable skateboard 'halfpipe'



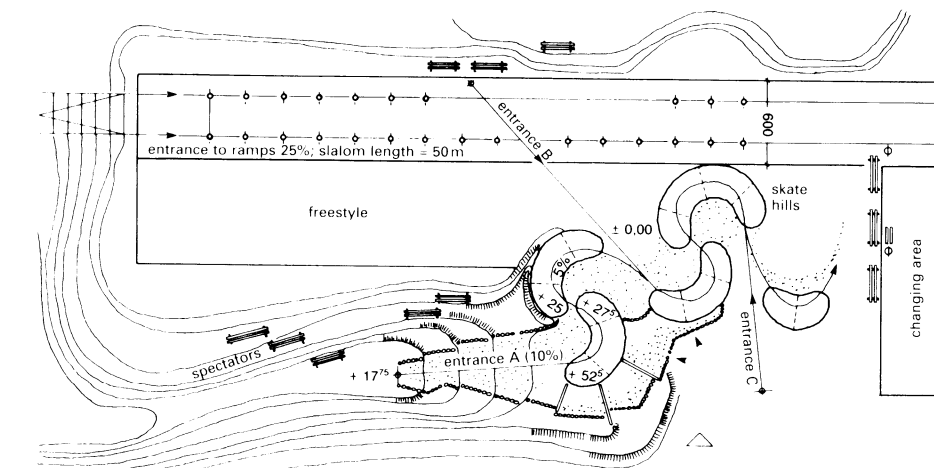
⑦ 'Long halfpipe'



⑧ 'Hot halfpipe' with extended walls



⑨ 'Divided halfpipe' with transition ramps



⑩ Skateboard facilities in Ostpark, Munich

Architects: Architektengemeinschaft Franke/Mühlbauer/Schmidhuber, Munich

## SKATEBOARDING

Since arriving from America in the mid-1970s skateboarding has become popular throughout Europe. Although roller skating rinks of 200 m<sup>2</sup> or more are also suitable for skateboarding, as are playgrounds, car parks and pedestrianised areas in towns, custom-built facilities are preferable → ⑩.

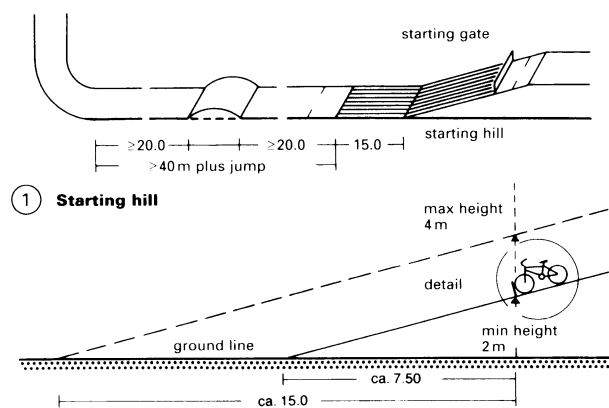
Competition skateboarding makes extensive use of a variety of 'halfpipes' → ⑥–⑨.

## CYCLECROSS/BMX

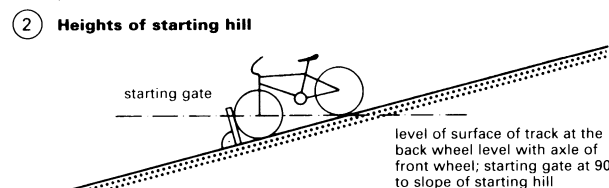
The minimum size of plot that can be used for BMX riding is  $50 \times 60$  m whereas a large-scale competition track with ample space for spectators requires roughly  $100 \times 200$  m. Depending on local conditions four varieties of BMX tracks are possible:

- (1) C-track: length 200m; 5m wide starting hill with four start positions.
- (2) B-track: length 250m; 7m wide starting hill with six start positions; minimum completion time 30 seconds.
- (3) A-track/national: minimum length between 270m and 320m; 9m wide starting hill with eight start positions; minimum completion time 35 seconds.
- (4) A-track/international: minimum length 300m; 9m wide starting hill with eight start positions; minimum completion time 35 seconds.

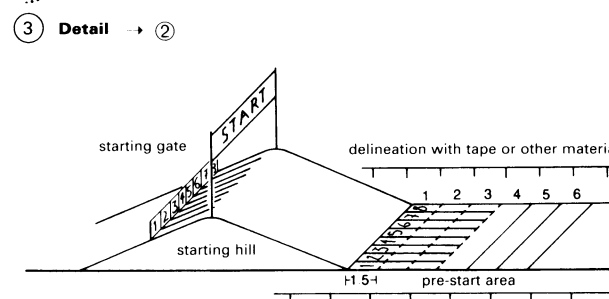
The track can contain any types of curves and jumps, and in any order. For safety, solid materials (i.e. stone, concrete or wood) should not be used to mark the edge of the track; car tyres or straw bales are sufficient. Solid borders and barriers for the spectator areas should be a minimum of 1m from the track. The length and gradient of downhill sections of the track should be such that the maximum attainable speed is 40km/h and the overall completion time has to be within capabilities of an average rider of 15 years of age.



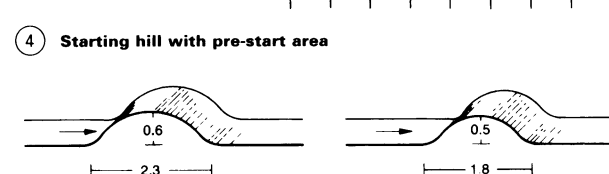
① Starting hill



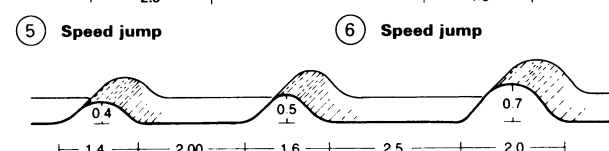
② Heights of starting hill



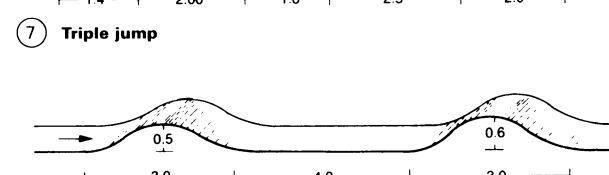
③ Detail → ②



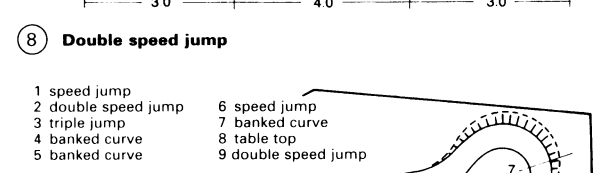
④ Starting hill with pre-start area



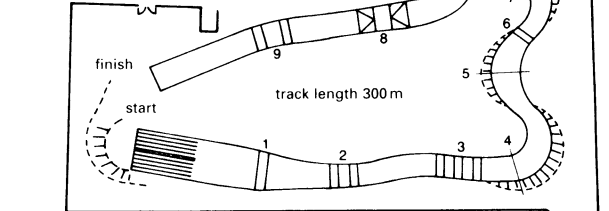
⑤ Speed jump



⑥ Speed jump



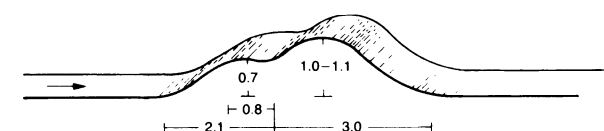
⑦ Triple jump



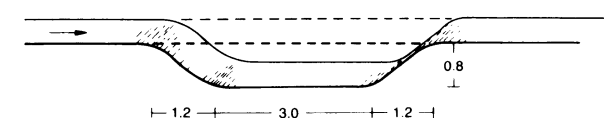
⑧ Double speed jump



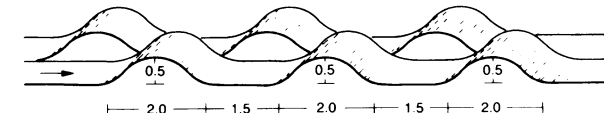
⑨ Track for the '87 World Championship in Bordeaux



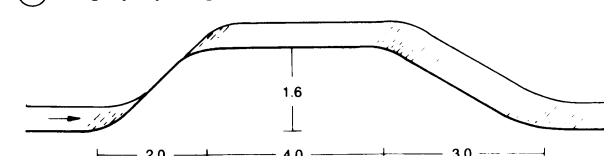
⑨ Step jump



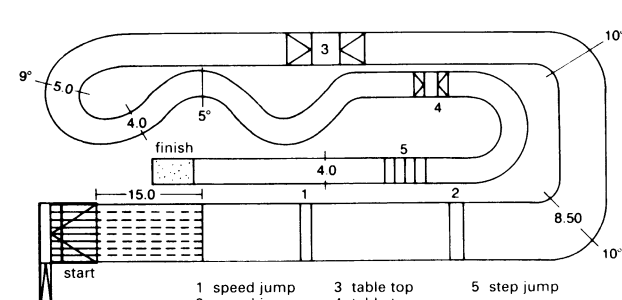
⑩ Canon jump



⑪ Mogul jump (moguls)



⑫ Table top



⑬ BMX track at the IFMA '84 in Cologne

## SHOOTING RANGES

Open shooting ranges should, if possible, be located in gulleys in forested areas, with the slope acting as a natural bullet trap. They must be well away from paths and areas open to the public. Indoor shooting ranges, which can be part of multipurpose sports facilities, provide a venue for air-rifle, pistol and small-bore rifle shooting → ① – ⑤).

In the UK, rifle and pistol ranges (but not air gun ranges) require not only planning permission and building regulation approval, but also the approval and safety certificate issued by the Ministry of Defence.

To gain the necessary approval from the National Small-Bore Rifle Association (NSRA) or the National Rifle Association (NRA), consultation should be made at the earliest stage of design. The local Environmental Health Department and the Health and Safety Executive ought to be consulted on current methods of combating lead pollution.

Safety devices like overhead and side baffles, safety walls and embankments must be built with approved building materials and certified by a specialist.

Objections by 'neighbours' concerned about noise are generally upheld.

## Types of sport shooting

(Olympic competitions: x = for men, xx = for women and men, xxx = for women only.)

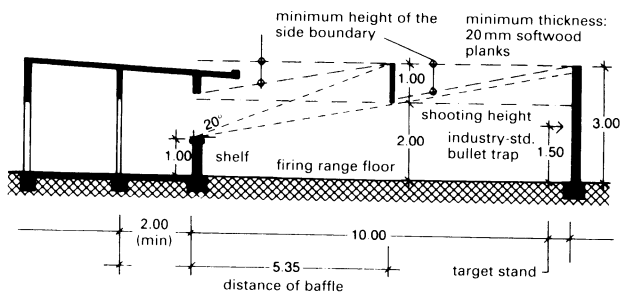
**Rifle shooting:** air rifle, 10m xx; small-bore handguns, 15m; small-bore rifles, 50m x; small-bore standard rifles xxx; target rifle, 100m, large-bore rifle, 300m; large-bore standard rifle, 300m.

**Pistol shooting:** air pistol, 10m xx; olympic semi-automatic pistol, 25m x; sports pistol, 25m xx; standard pistol, 25m; free pistol, 50m x.

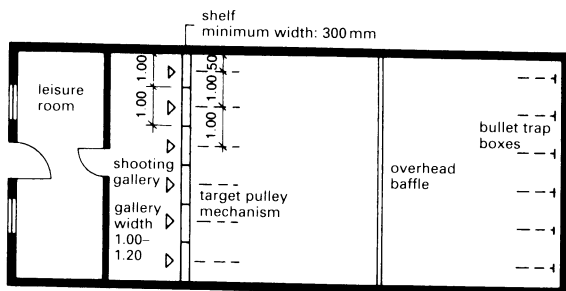
In the UK, handguns are no longer permitted in England, Wales and Scotland. They are, however, still permitted in Northern Ireland, the Channel Islands and the Isle of Man.

**Clay pigeon shooting:** trap shooting x; skeet shooting x.

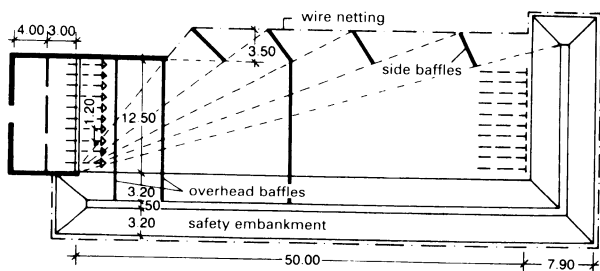
**Moving targets:** 10 m and 50 m x.



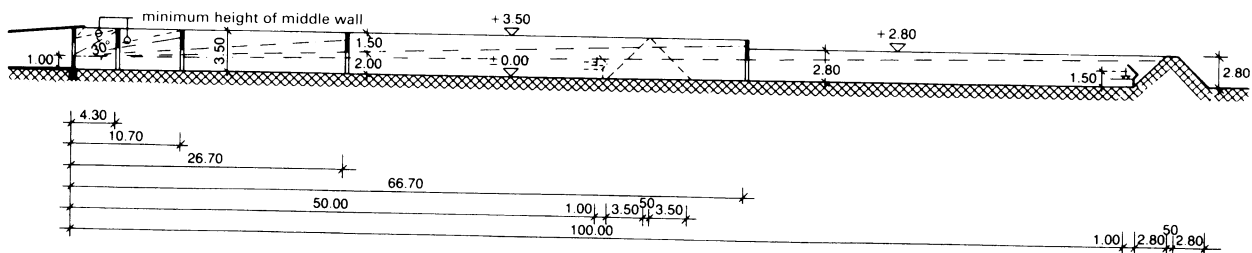
① **Section** → ②



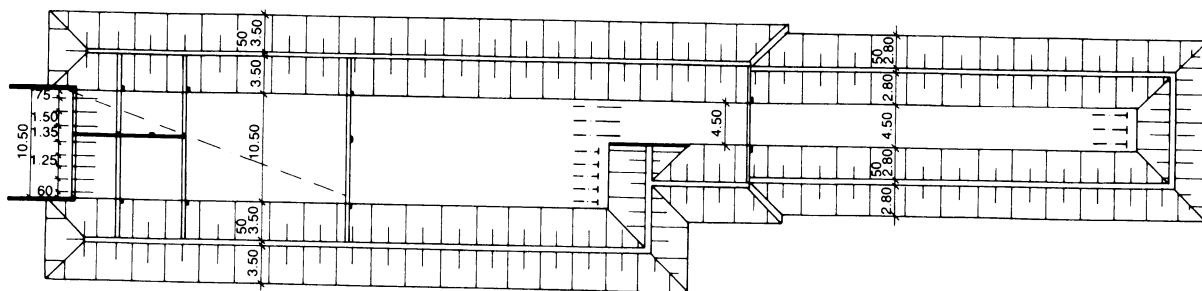
② Shooting range for air and CO<sub>2</sub> guns: covered shooting gallery, range in the open



③ **Small calibre range with target pulleys**



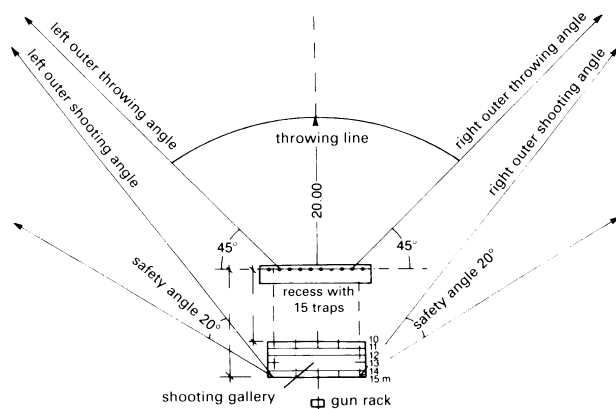
④ **Section** → ⑤



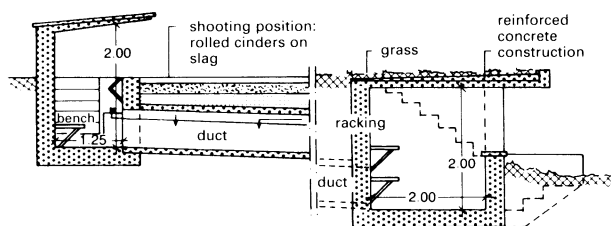
⑤ Combined 100 m range for all calibers and a 50 m small calibre range → ④



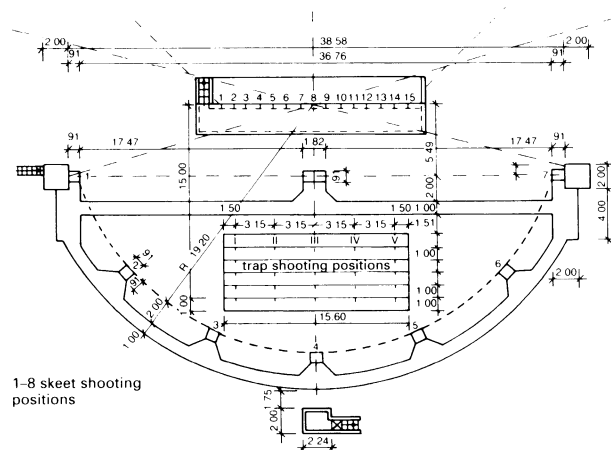
## SHOOTING RANGES



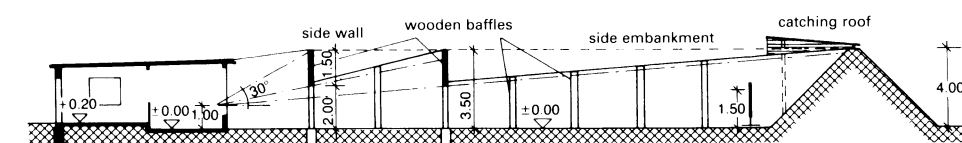
① Clay pigeon shooting range



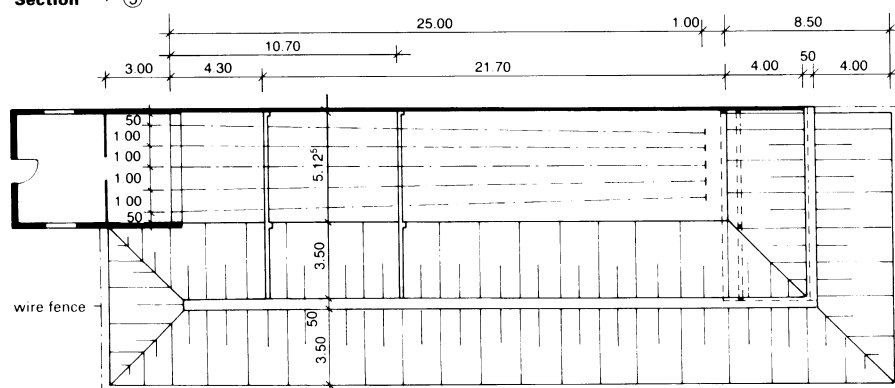
② Section through clay pigeon shooting range



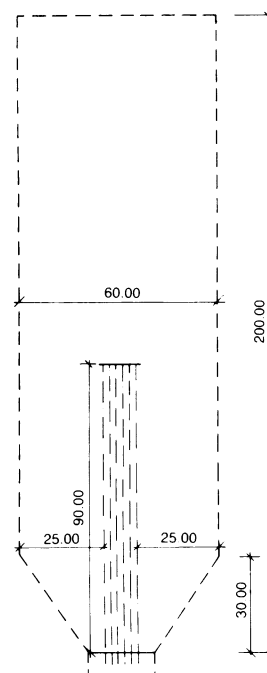
③ Combined trap and skeet shooting range



④ Section → ⑤



⑤ 25 m range for handguns (pistol and revolvers of all calibers): continuous side wall to left; continuous embankment to right (a wall or embankment can be chosen for both sides)



⑥ Safety areas for an archery range with six targets

A shooting range has to be arranged in such a way that it eliminates danger to people on the inside, i.e. those people who are shooting, as well as those in the surrounding area. Safety barriers are constructed to protect all directions within the overall potential firing spread. It has been found that for air and CO<sub>2</sub> guns, barriers must offer protection up to an angle of 20 degrees upwards from the firing point. For rifles and hand guns this angle is 30 degrees → ⑤.

Demands made by local regulations concerning the effects of air pollution, noise, noxious substances, radiation etc. also have to be fully satisfied.

For crossbow and archery ranges different regulations are in force. Areas adjacent to the line of fire need to be shielded through suitable safety constructions such as high baffles, walls or earth embankments along the sides and at the end of the range.

An assessment of the suitability of the chosen plot for the building of a shooting range is fundamental to the calculation of the project's costs. A shooting range specialist should always be consulted to provide the planner with the necessary specialist knowledge. Specific considerations are: distance to existing or planned building areas and to inhabited houses; planned shooting direction; soil conditions; supply arrangements and waste disposal facilities; situation in relation to road and rail links (including future developments), and parking spaces.

It is also important to assess whether it is possible or necessary to deviate from local guidelines. The control of noise pollution is a legal necessity and must be planned from the beginning. For open ranges, in particular, allowance should be made for additional noise reduction measures. These can be built-in in separate building phases. Approval and permission procedures are determined by national and local regulations.

The design and size of a shooting range should facilitate the economic construction of any necessary future additions and extension.

### Wrestling

The basic mat size for competitions is  $5 \times 5$  m; for German championships and international competitions it is  $6 \times 6$  m or greater, preferably  $8 \times 8$  m; and for international championships and the olympic games the size should be  $8 \times 8$  m. The middle of mat needs to be marked with a 1 m diameter ring with 100 mm wide edge strip. The thickness of the mat is 100 mm and it has a soft covering. A protective edge strip, if possible, should be 2 m wide; otherwise, bordering barriers with a slope of 45 degrees can be used. A 1.2 m width of the protective strip should be equal in thickness to the mat and differentiated by use of colour. The protective strips in national bouts are 1 m wide.

If the mat is on a platform the height should be no greater than 1.1 m. There are no corner pillars or ropes.

### Weight-lifting

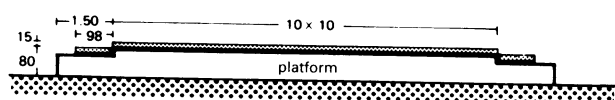
The lifting area should be no smaller than  $4 \times 4$  m and on a strong wooden base, with markings in chalk. The floor must not be sprung because weight-lifters require a solid footing.

The largest diameter of weight plate is generally 450 mm. The weight of plates for one-handed exercises range up to 15 kg; for two-handed exercises, the plates are up to 20 kg in weight.

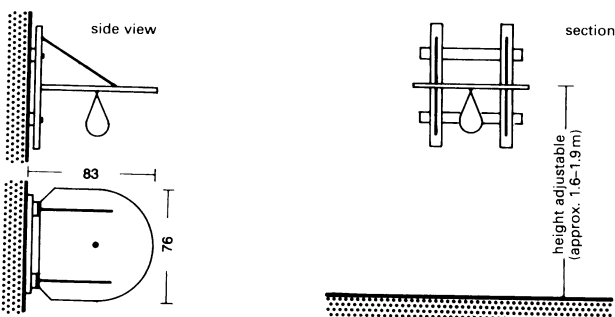
### Judo

The contest area ranges from  $6 \times 6$  m up to  $10 \times 10$  m or  $6 \times 12$  m and is covered with soft springy mat. Upholstered mats are not permitted. For international championship competitions, the contest area can be more than  $10 \times 10$  m.

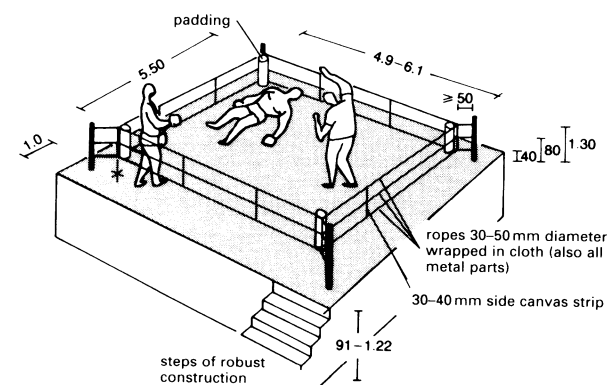
Ideally, the mat should be raised about 15 cm. The boundary between the contest area and the border has to be clearly visible → ①.



① Judo contest area on a platform



② Punch ball



③ Boxing ring

## INDOOR SPORTS

### Boxing

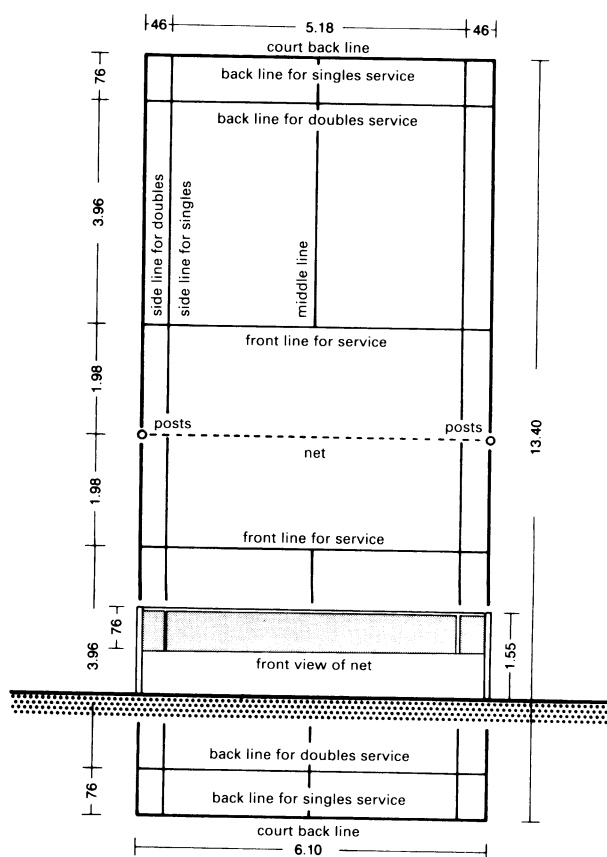
The dimensions of boxing rings are set out in international regulations, and range from  $4.9 \times 4.9$  m up to  $6.10 \times 6.10$  m, although  $5.5 \times 5.5$  m is the size most commonly used. Rings are frequently raised on a podium that is 1 m wider on each side than the ring, giving a total area of between  $7.5 \times 7.5$  m and  $8 \times 8$  m → ③.

### Badminton

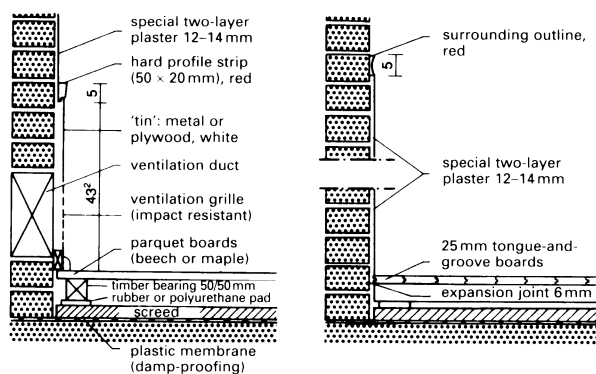
The standard size is that of a doubles court, although a singles court can be used where space is severely restricted. Outside the court area → ④ the appropriate measurements are:

safety strip (sides)	1.25 m
safety strip (front and rear)	2.5 m
side-to-side distance between courts	$\geq 0.3$ m
ene-to-end distance between courts	$\geq 1.3$ m
between court and walls	$\geq 1.5$ m

Spectators must always be accommodated behind the safety strip. For international competitions, the minimum hall height is 8 m, with at least 6 m over the back line of the court. The height of the net at the posts is 1.55 m and is 1.525 m in the middle. The depth of the net is 760 mm. The floor should be lightly sprung. The hall, if possible, should have no windows, the court being lit by roof lights, which should not be dazzling (i.e. 300 lux or less).

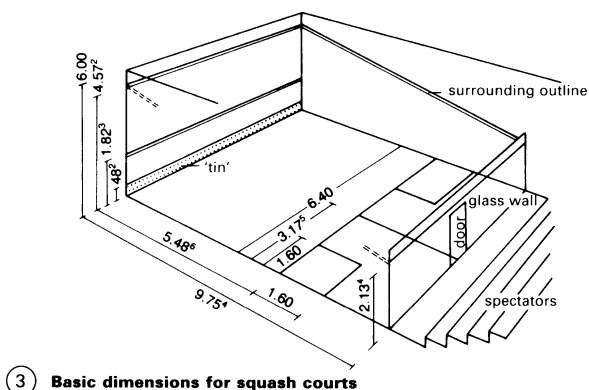


④ Badminton court

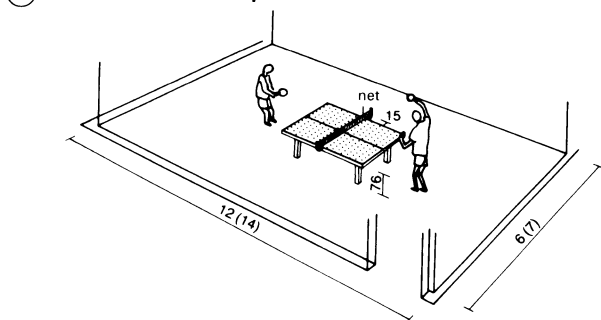


① Squash court end wall

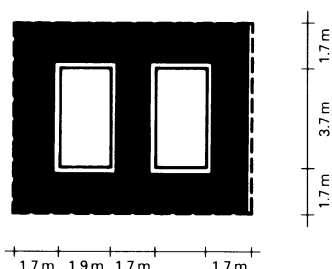
② Squash court side wall



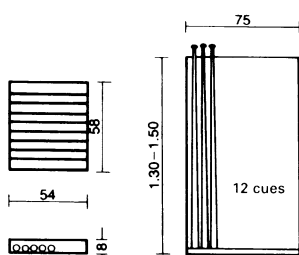
③ Basic dimensions for squash courts



④ Basic dimensions for table tennis



⑤ Billiards and snooker, agreed standards table: 3.50 × 1.75 m playing area



⑥ Ball holder

⑦ Cue rack

⑧ Common billiards table dimensions

table sizes (cm)		I	II	III	IV	v	VI
playing surface area	A	285 × 142 <sup>5</sup>	230 × 155	220 × 110	220 × 110	200 × 100	190 × 95
overall dimension	B	310 × 167 <sup>5</sup>	255 × 140	245 × 145	225 × 125	225 × 125	215 × 120
space required		575 × 432 <sup>5</sup>	520 × 405	510 × 400	500 × 395	490 × 390	480 × 385
weight (kg)		800	600	550	500	450	350

## Squash

Normal construction is used for the building of squash courts. Solid walls of precast concrete units or prefabricated panelled timber framed construction are finished with special white plaster. To improve the view for spectators it is advantageous to use transparent material for the back wall. The dimensions of the court are:

area  $9.75 \times 6.40$  m  
height 6.00 m

The floor needs to be slightly springy and have good surface grip. It is made of light coloured wood (maple or beech) boards running parallel to the side walls. Appropriate grade tongue-and-groove boards 25mm thick and with a sealing coat should be used.

Across the foot of the front wall runs a strip (the 'tin') made of 2.5mm thick sheet of metal or metal covered plywood painted white.

## Table tennis

At championship level, table tennis is played only in halls. The table itself is matt green with white border lines and has the following dimensions:

area  $1525 \times 2740$  mm  
height 760 mm  
thickness of table top  $\geq 25$  mm

The tops of tables used in the open should be made of 20mm thick cement fibre board. The hardness of the table surface needs to be such that a normal table tennis ball will bounce approximately 230mm when dropped from a height of 300mm. A net with the following dimensions runs across the middle of the table:

length 1830 mm  
height (over whole length) 152 mm

The playing area is cordoned off with 600–650mm high canvas screens. The size is generally no less than 6 × 12m, and 7 × 14m for international competition. The spectators are seated beyond the screen. → ④

## Billiards

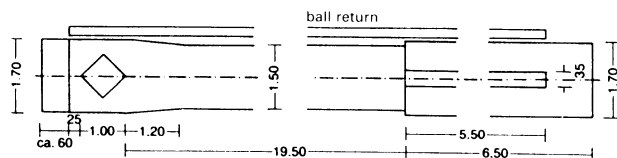
Requirements for billiard rooms depend on the various billiard table sizes involved → ⑧. For normal private purposes, sizes IV, V and VI are used; in bars and clubs, sizes IV and V are most common, while in billiard halls sizes I, II and III will be required.

Billiard halls are usually on upper floors or in a bright basement, rarely on the ground floor. Where there is more than one table the distance between them should be at least 1.70m for sizes I and II and 1.60m or more for sizes III to V. The distance from walls should, if possible, be slightly more. A clear playing space is required all around the table and, if matches are to be televised, extra space must be provided for cameras.

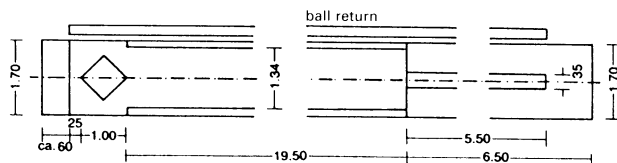
A clear wall space is needed for cue-holders (1.50 × 0.75m for 12 cues), score boards and rule sheets.

The smallest possible light fittings should be used to give full and even lighting of the playing surface. The normal height of the light above the table is 800mm.

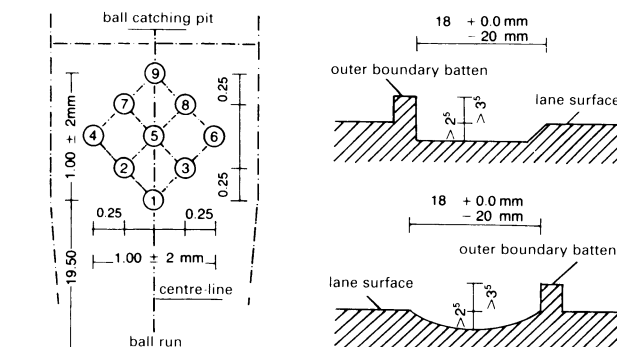
In the UK the Billiards and Snooker Control Council (B&SCC) introduced (with world agreement) the 'B&SCC 3.50m standard table' and for the first time the actual playing area size (3.50 × 1.75m) was specified within the cushion faces instead of the overall table size. However, these metric recommendations are still not often utilised, even in major competitions.



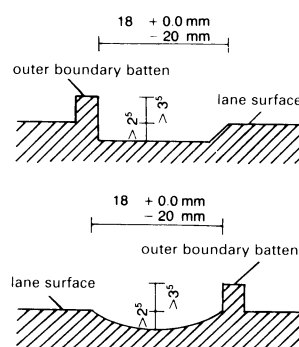
① Skittle alley with boundary lines



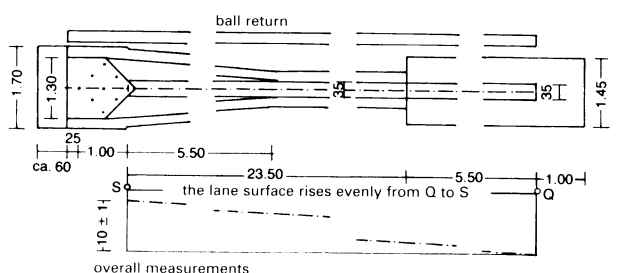
② Skittle alley with side channels



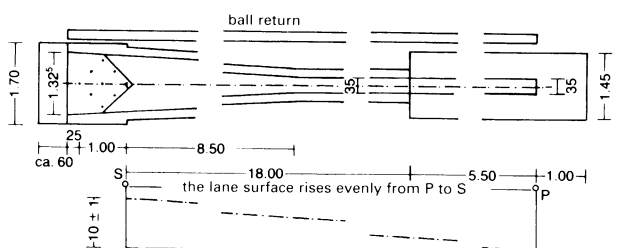
③ Arrangement and numbering of skittles



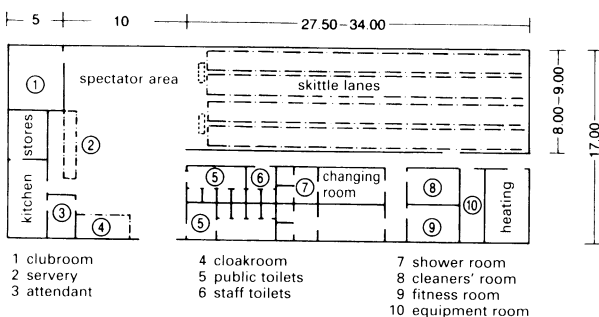
④ Possible designs of side channels



⑤ Alternative skittle alley



⑥ Overall measurements of a scissor alley

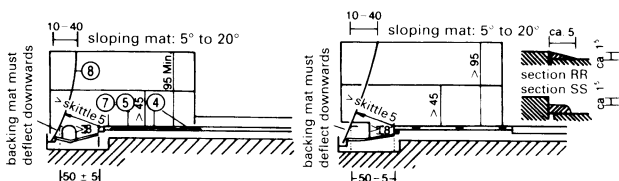


⑦ Example of skittle alley premises

## SKITTLE AND BOWLING ALLEYS

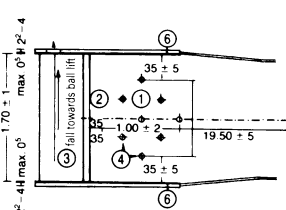
Skittle and bowling alleys can be divided into the following areas:

- (1) The run-up, in which the ball is bowled after a few approach steps;
- (2) The lane, the surface along which the ball rolls;
- (3) The catching pit, in which the fallen skittles/pins and balls are collected. (It is also where skittles/pins can be stored.)



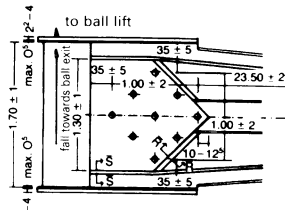
- ① skittles  
② lane end  
③ skittle catching pit  
④ skittle standing area  
⑤ skittle mark  
⑥ impact walls  
⑦ end board  
⑧ backing mat

⑧ Section → ⑨



⑨ Normal arrangement of skittle area

⑩ Section → ⑪



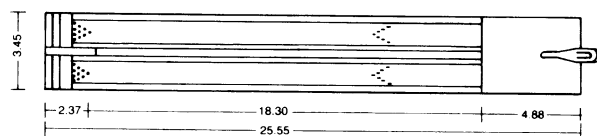
⑪ Skittle area

An asphalt alley puts the highest demands on the skittle players. The lane is 19.50m long and the width is 1.50m (with side boundary batten) or 1.34m (with side boundary channels). The lane surface is made from asphalt or plastic.

→ ① – ④

An important feature of some alternative wooden (or plastic) skittle alleys is the gradient of the lanes. From the edge of the run-up to the front pin of the skittle stand, a distance of 23.50m, the lane rises through 100mm. → ⑤

The scissor skittle alley also has wooden (or plastic) lanes. The lanes are 0.35m wide until 9.5m beyond the end of the run-up, after which they widen up to 1.25m at the mid-point of the skittles. → ⑥

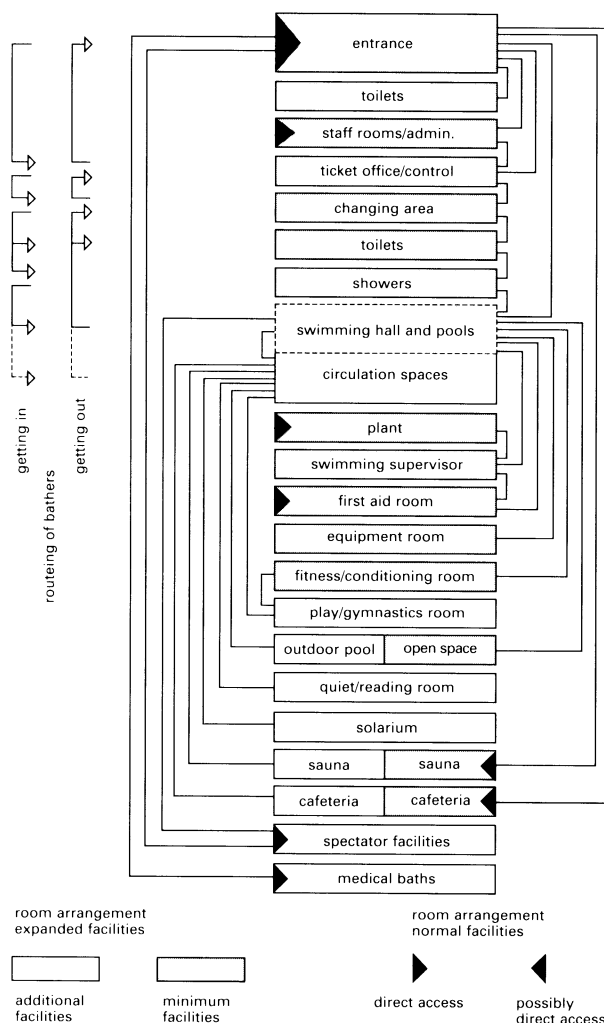


⑫ Two-lane bowling alley

In bowling alleys → ⑫ the run-up area is made from cleanly sanded parquet and the lanes are of polished or varnished parquet. In contrast to skittles the pins are arranged in a triangular formation and there are ten of them.

Bowling balls are 21.8cm in diameter and have a range of weights up to 7257g. They have three finger holes. For asphalt and scissor alleys, the balls have a diameter of 16cm and weigh 2800–2900g. Other balls in use are 16.5 cm in diameter, with weights between 3050g and 3150g. Most modern balls are made of a composite plastic mixture. Skittles are usually made from hardwood (white beechwood); pins are also made of wood but are covered with plastic. All pins and skittles have standardised dimensions.

## INDOOR SWIMMING POOLS



### 1 Indoor swimming pool: organisation of spaces

catchment area (no. of inhabitants)	type of pool	planning unit						diving boards	factors for measuring the volume and area programmes		site area (without ancillary areas)  (m <sup>2</sup> )
		basic unit		alternative 1		alternative 2			standard unit value	training units	
		pool size (m/m <sup>2</sup> )	water area (m <sup>2</sup> )	pool size (m/m <sup>2</sup> )	water area (m <sup>2</sup> )	pool size (m/m <sup>2</sup> )	water area (m <sup>2</sup> )				
1	2	3		4		5		3) 6	7	8	9
up to 5000	depending on local conditions										
5000 up to 10000	GP PP	10.00 × 25.00 up to 15	250 15 265					1B + 3B	150	2	2500
10000 up to 20000	GP TP PP	10.00 × 25.00 8.00 × 12.50 up to 20	250 100 20 370	12.50 × 25.00 10.00 × 12.50 up to 20	313 125 20 395	12.50 × 25.00 8.00 × 12.50 up to 20	313 100 20 433	1B + 3P	300 200	3	up to 3500
20000 up to 30000	GP  TP or DP <sup>4)</sup>  PP	12.50 × 25.00  8.00 × 12.50  up to 25	313  100  25 438	12.50 × 25.00  8.00 × 16.66  up to 25	313  133  25 471	12.50 × 25.00  8.00 × 12.50 10.60 × 12.50  up to 25	313  100 133  25 571	1B + 3P or 1P + 3P + 1P + 3P + 5P  1B + 1P combined + 3P + 3P combined 5P	250	3 or 4	3500 up to 4000
30000 up to 40000	GP TP DP <sup>4)</sup>  PP	21.50 × 25.00 8.00 × 12.50 10.60 × 12.50  up to 30	313 100 133  30 576	12.50 × 25.00 8.00 × 16.66 10.60 × 12.50  up to 30	313 133 133  30 609	16.66 × 25.00 8.00 × 16.66 16.90 × 11.75  up to 35	417 133 147  30 727	1B + 1P combined + 3P + 3P combined 5P	300	4	4000 up to 4500
40000 up to 50000	GP TP DP <sup>4)</sup>  PP	16.66 × 25.00 8.00 × 16.66 12.50 × 11.75  up to 35	417 133 147  35 732	16.66 × 25.00 8.00 × 16.66 16.90 × 11.75  up to 35	417 133 199  35 784			2 × 1B, 2 × 3B, 1P + 3P + 5P	400	4	4500
over 50000	further combinations of the above planning units in relationship to the size of the catchment area can be considered										

<sup>1)</sup> additional requirements may be needed for school use; <sup>2)</sup> PP = paddling pool, TP = teaching pool, GP = general pool, DP = diving pool; <sup>3)</sup> B = board, P = platform; 1 - 10 = diving height (m); <sup>4)</sup> measurements with regard to safety dimensions should be pool size = pool width (diving end) × pool length (in the direction of diving)

<sup>1)</sup> additional requirements may be needed for school use; <sup>2)</sup> PP = paddling pool, TP = teaching pool, GP = general pool, DP = diving pool; <sup>3)</sup> B = board, P = platform; 1-10 = diving height (m); <sup>4)</sup> measurements with regard to safety dimensions should be pool size = pool width (diving end) × pool length (in the direction of diving)

### 2 Planning units for indoor swimming pools

Reference figures for estimating the required size of indoor swimming pools must take into account the demands made by the residents, schools and the sports clubs within the catchment area. As a rough guide, a pool area per inhabitant of between 0.025m<sup>2</sup> (low population density) and 0.01m<sup>2</sup> (high population density) may be used. → ②

#### Plot sizes (without car parks)

When estimating the plot size required for an indoor swimming pool, 6–10m<sup>2</sup> (excluding car parking; see below) should be allowed per square metre of planned pool area. The larger the pool area, the smaller the figure that will be sufficient. If an additional outdoor space (patios, sundecks, garden areas) is planned add 10–20% to the calculated plot size.

Flat and gently sloping (up to 15 degrees) sites simplify the planning of indoor pools on one level, a prerequisite for economically and functionally optimal design. Steeply sloping sites are usually associated with higher building costs and operational disadvantages.

#### Parking

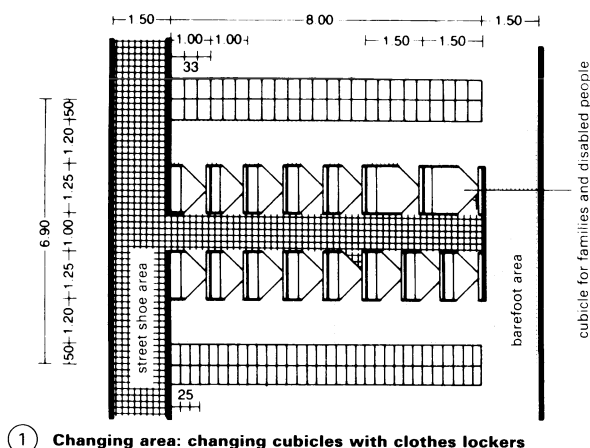
The parking space to allow for each car is 25m<sup>2</sup>, and one space should be planned for every 5–10 changing room lockers in the pool complex. If spectator facilities are included, one additional car parking space per 10–15 spectator places should be added.

Bicycle parking spaces should be planned according to local needs, using an allowance of approximately 1.8m<sup>2</sup> per bicycle.

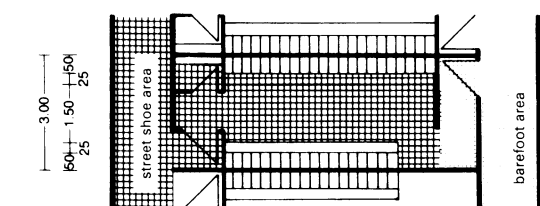
#### Planning basics

A provision analysis should be done to determine whether additional sport and leisure facilities are to be included in the design. Using a needs analysis the types of use and total water area are determined in relation to the catchment area. The location should be chosen to give the best possible access.

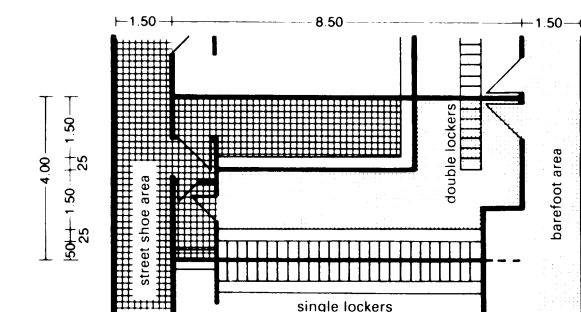
## INDOOR SWIMMING POOLS



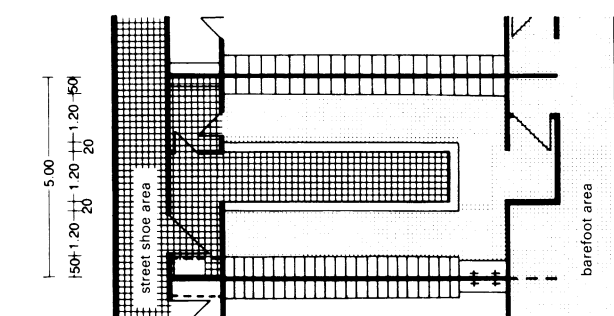
① **Changing area: changing cubicles with clothes lockers**



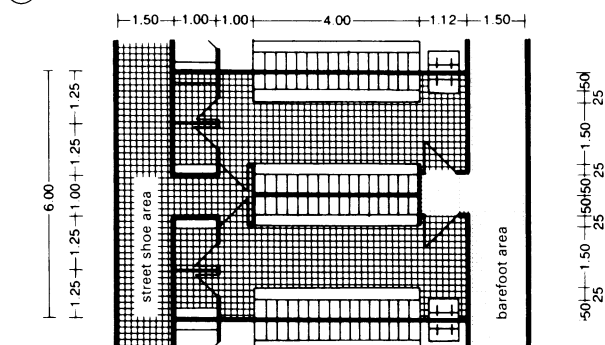
② **Communal changing without supplementary bench**



### ③ Communal changing with supplementary bench



④ **Communal changing with supplementary bench**



⑤ **Changing area, mixed type**

To estimate the required size of the changing room area see the unit data values given in ②, column 7, page 529. All larger pools should contain at least two communal changing rooms. Allow a bathing time of 1.50 hours, except for peak periods.

For the purposes of estimation, the following figures can be used: locker spaces 0.6–0.8 of the standard unit value; number of changing spaces 0.15–0.2 of the standard unit value, of which 0.6–0.08 of the standard unit value are changing cubicles.

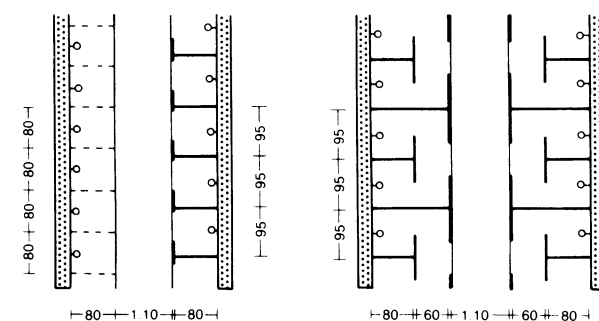
Of the changing cubicles available, 10% should be for families and disabled people. The ratio of cubicles to clothes lockers should be 1:4.

In a communal changing room at least 30 lockers are necessary and there should be no less than 7.50m length of bench. The ratio of changing room spaces to lockers ranges up to 1:8. In holiday resorts it can become necessary to double the amount of locker spaces.

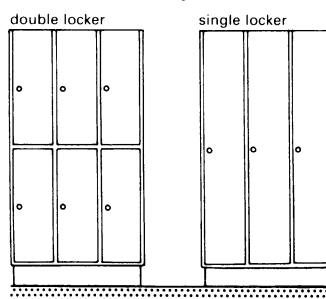
Other facilities per standard unit value are: hairstyling spaces with hairdryers 0.03, foot disinfection baths 0.015 and basins 0.015. A cleaning materials room of 1–2m<sup>2</sup> must be planned within the changing room area. All rooms need a minimum clear height of 2.50m. The minimum size of foot disinfection bath should be 0.75m wide, 0.50m deep.

In the changing room area, for built-in cubicles, the following minimum dimensions are valid: overall measurements 1.00m wide, 1.25m deep, 2.00m high. Cubicles for families should be at least 1.50m wide, 1.25m deep, 2.00m high. → ① Changing rooms for wheelchair users need overall measurements of 2.00m wide, 1.00m deep, 2.00m high, and a clear door width of 0.8m.

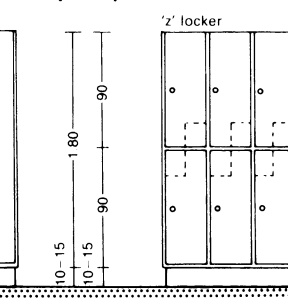
Lockers are 0.25m or 0.33m wide and 1.80 m or 0.90 m high, with a clear depth of 0.50 m. → (8)



⑥ **Open row of showers and showers with splash screens**



⑦ **Row of showers with privacy screens**



⑧ **Clothes lockers**

## INDOOR SWIMMING POOLS

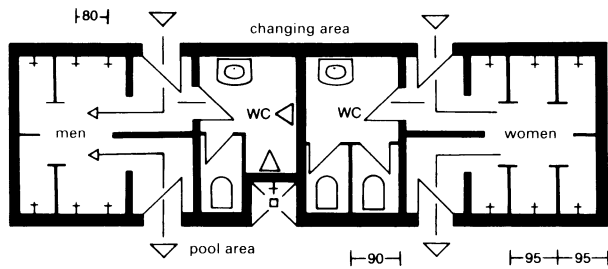
Separate sanitary areas, containing shower rooms and toilets, must be provided for men and women. They should be positioned between the changing rooms and pool area. Toilets are usually positioned in such a way that the pool user has to re-enter the shower room before entering the pool area. Direct access to toilets from the pool area is not allowed. It is recommended that a direct route from the pool to the changing rooms be provided.

→ ① – ⑤

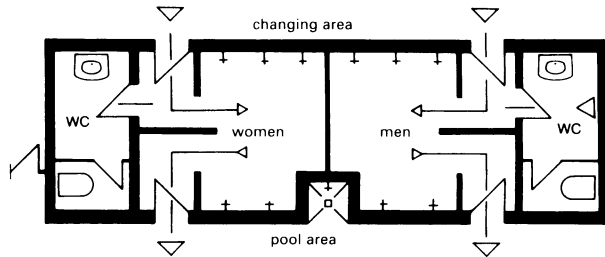
In swimming pools with 100–150m<sup>2</sup> water area, one separable shower room with five showers each for women and men is sufficient → ②. For larger pools, there should be at least ten showers for each shower room. Basic toilet provision in the sanitary area is two toilets for women, one toilet and two urinals for men.

#### Minimum recommended dimensions: → ① – ④

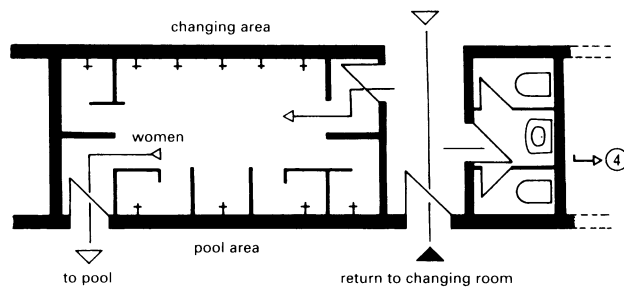
shower place without separating screens (open rows)	overall dimensions 0.80 m wide 0.80 m deep
shower place with separating screens (row showers with splash screens)	overall dimensions 0.95 m wide 0.80 m deep 1.45 m high
shower place with separating screens in double T-shape (with splash and privacy screens)	overall dimensions 0.80 or 0.90 m wide 1.40 m deep 1.45 m high
circulation space between shower rows	1.10 m
toilet cubicle with door: (opening inwards)	0.90 m wide 1.40 m deep 2.00 m high
toilet cubicle with door: (opening outwards)	0.90 m wide 1.20 m deep 2.00 m high
slab urinal: axis measurement	0.50 m wide 0.60 m deep
bowl urinal: axis measurement	0.75 m wide 0.80 m deep
installation height	under 0.70 m
installation height for children	under 0.45 m
hand basin	0.60 m wide 0.80 m deep
installation height	approx. 0.80 m
room height: clear height at least recommended height	2.50 m 2.75 m



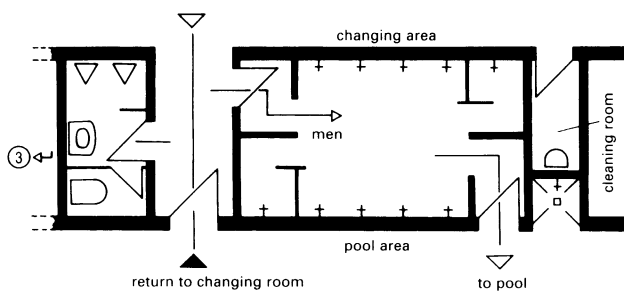
① Shower and toilet area



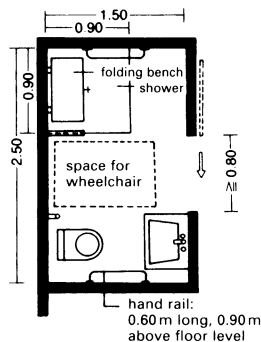
② Shower and toilet area: divided shower room



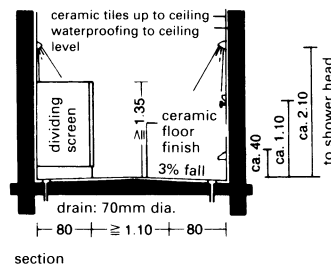
③ Shower and toilet area: women



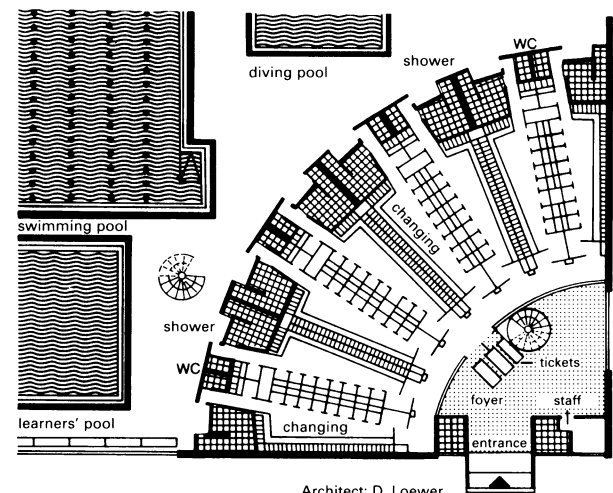
④ Shower and toilet area: men



⑤ Shower and toilet area for disabled people

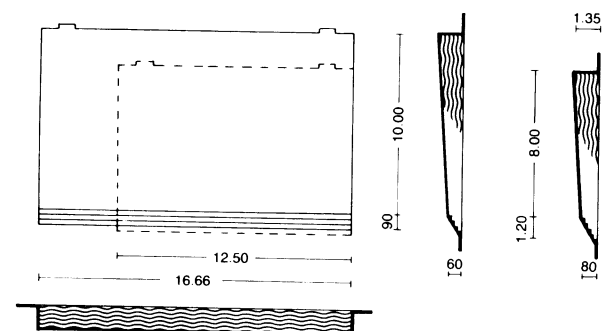


⑥ Shower room

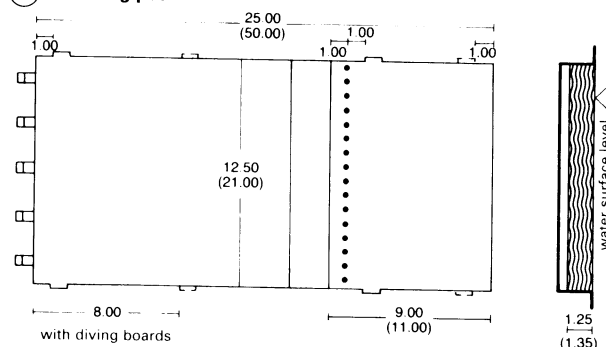


⑦ Changing area with WCs and automatic ticket machine

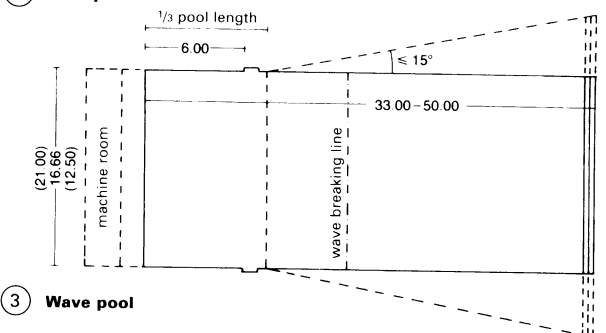
## INDOOR SWIMMING POOLS



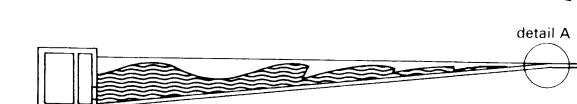
1 Teaching pool



2 Variopool



3 Wave pool



4 Section of wave pool

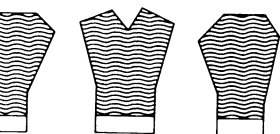


5 Section of combined swimming and wave pool



6 Version of detail A with steps

7 Various pool shapes



8 'Zurich' gutter



9 'Weisbaden' gutter

pool type	width (m)	length (m)	water depth	min room height, clearances (m)
padding pool	15 to	25 m <sup>2</sup>	0.40-0.60	2.50
teaching pool ①	8.00	12.50	0.60/0.80 to	3.20
	10.00	16.66	1.35	
variopool ②	8.00	25.00	in adjustable floor section:	4.00
	10.00	50.00	0.30 to 1.80 m	
	12.50		in swimming section:	
	16.66		1.80 m	
	21.00			
	25.00			
swimming pool	16.66	25.00		4.00
	21.00	50.00		
	25.00			
wave pool ③	12.50	at least	initial depth	4.00
	16.66	33.00	0.00 m (if step, max 0.30 m);	
	21.00		final depth depending on use and type of wave machine	
	to			
	25.00			

pool surround (total area usually equals water area)	width (m)
main entrance area to pool	3.00
main entrance area between pool steps and hall wall	2.50
area around starting blocks	3.00
area around diving boards (clear passageway at least 1.25m wide behind 1 m boards)	4.50
access area to padding pool	2.00
teaching pool (steps side)	2.50
teaching pool (narrow side)	2.00
between pools	3.00-4.00
(note: six swimming lanes = 30 m <sup>2</sup> , eight = 50 m <sup>2</sup> , ten = 70 m <sup>2</sup> )	
rooms next to pool	height (m)
swimming instructor's/attendant's room area at least 6 m <sup>2</sup>	2.50
first aid room area at least 8 m <sup>2</sup>	2.50
accessory room up to 450 m <sup>2</sup> water area, at least 15 m <sup>2</sup>	2.50
above 450 m <sup>2</sup> water area, at least 20 m <sup>2</sup>	2.50
waiting room for contestants	2.50
teaching and club room: 30-60 m <sup>2</sup>	2.50

## spectator facilities

stands: 0.5 seat space per square metre of water area used for sports  
space needed for one seat: 0.5 m<sup>2</sup> including surrounding circulation areas  
cloakroom: space required is 0.025 m<sup>2</sup> per square metre of water area used for sports

toilets: in the entrance hall, two WCs for women and one WC plus one urinal for men will be sufficient for up to 200 spectators. For each further 100 spectators add one WC and urinal, preserving the ratio two WCs (women):one WC, two urinals (men)

## working spaces for the press

good lines of sight to the start and finish are needed (i.e. raised location); 5 to 20 spaces required, each space 0.75 x 1.20 m

## for television

four to six spaces are required, each space 1.20 x 1.50 m

## catering

space requirement for each vending machine, 0.5 to 0.8 m<sup>2</sup>

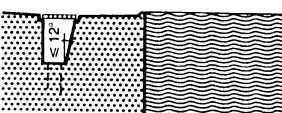
seating area (café/restaurant): at least 50 seating spaces, each space 1-2 m<sup>2</sup>

service and ancillary room area (in addition): for cafes, about 60% of the seating area, for restaurants about 100% of the seating area, of which 20-25% for stores and cold rooms, 15-20% for empties stores, and the remainder for kitchen, servery, office and staff

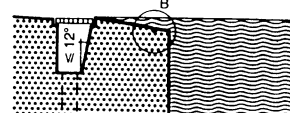
toilets (at least): women, one WC; men, one WC, one urinal

## plant area

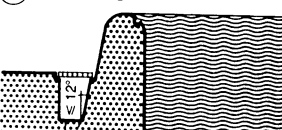
total plant area (without swell water storage, storerooms, transformer room and gas meter room): up to 1 m<sup>2</sup> per square metre of planned water area; in the case of large indoor swimming pools, a reduction to 30% is possible



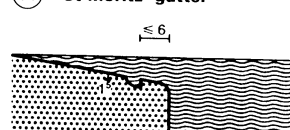
10 'Zurich' gutter



11 'St Moritz' gutter



12 'Finnish' gutter

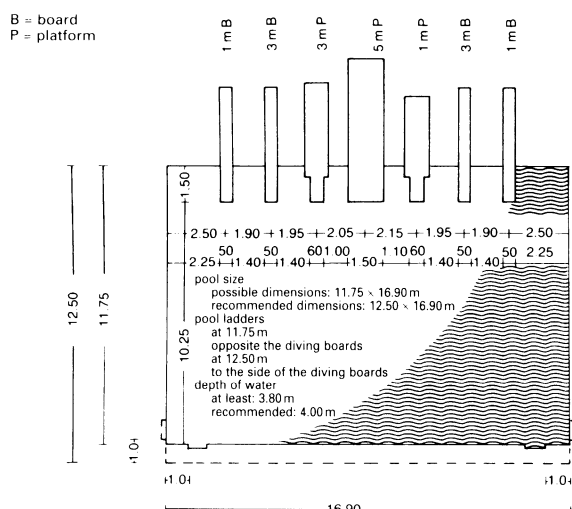


13 Detail B

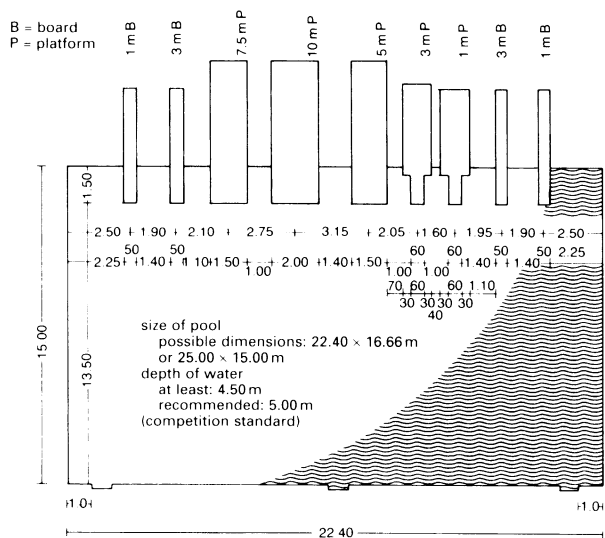


## INDOOR SWIMMING POOLS

B = board  
P = platform



1 Diving facilities (complete): 1 to 5 m



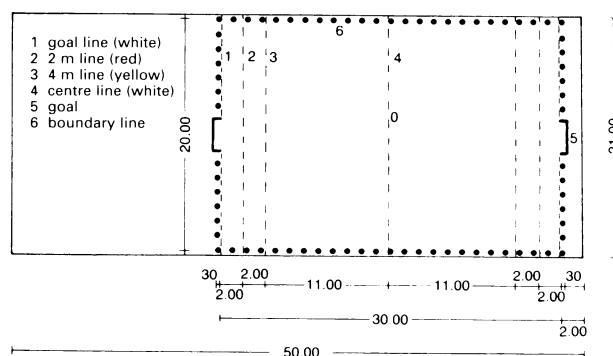
2 Diving facilities (complete): 1 to 10 m

dimension	length/width	1m board	3m board	1m platform	3m platform	5m platform	7.5m platform	10m platform
A: from front edge of board/platform back to pool side	see diagram minimum recommended	1.50 1.80	1.50 1.80	A-1 1.50	A-3 1.50	A-5 1.50	A-7.5 1.50	A-10 1.50
A-A: front edge back to lower platform	see diagram minimum recommended	-	-	-	-	A-A-5/1 1.25	A-A-7.5/3 1.25	A-A-10/5 1.25
B: board/platform edge to pool side	see diagram minimum recommended	B-1 2.50 3.00	B-3 3.50	B-1 2.30	B-3 2.80	B-5 4.25	B-7.5 4.50	B-10 5.25
C: between board/platform centres	see diagram minimum recommended	C-1 1.90 2.40/3.00	C-3 1.90 2.40/3.00	C-3/1 1.90	-	C-5/3B 2.10 2.10	C-7.5/1P 2.45 2.75	C-10/5 2.75 2.65
D: front edge forward to edge of pool	see diagram minimum recommended	D-1 9.00	D-3 10.25	D-1 8.00	D-3 9.50	D-5 10.25	D-7.5 11.00	D-10 13.50
E: from board/platform to ceiling	see diagram minimum recommended	E-1 5.00	E-3 5.00	E-1 3.00	E-3 3.00	E-5 3.00 3.40	E-7.5 3.20 3.40	E-10 3.40 3.40
F: clear ceiling height behind and to each side of edge/centre	see diagram minimum recommended	F-1 2.50 5.00	F-3 2.50 5.00	F-1 2.75 3.00	F-3 2.75 3.00	F-5 2.75 3.00 3.40	F-7.5 2.75 3.20 3.40	F-10 2.75 3.40 4.00/5.00
G: clear ceiling height ahead of front edge	see diagram minimum recommended	G-1 5.00 5.00	G-3 5.00 5.00	G-1 5.00 3.00	G-3 5.00 3.00	G-5 5.00 3.00	G-7.5 5.00 3.20	G-10 6.00 3.40 5.00
H: depth of water below board/platform edge	see diagram minimum recommended	H-1 3.40 3.80	H-3 3.80 4.00	H-1 3.40	H-3 3.80	H-5 3.80 4.00	H-7.5 4.10 4.50	H-10 4.50 5.00
J: safety zone (full depth of water)	see diagram minimum recommended	J-1 6.00 3.30 3.70	J-3 6.00 3.70 3.90	J-1 5.00 3.30	J-3 6.00 3.30 3.70	J-5 6.00 3.70 3.90	J-7.5 8.00 4.00 4.40	J-10 12.00 4.25 4.75
L: safety zone (full depth of water)	see diagram minimum recommended	L-1 2.25	L-3 3.25	L-1 2.05	L-3 2.55	L-5 3.75	L-7.5 3.75	L-10 4.50
P: maximum angle of the ceiling slope								

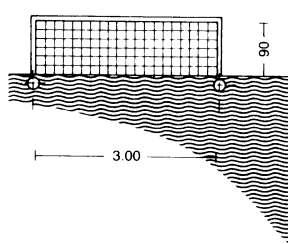
note: if the platforms are built wider than the minimum recommended, then add half of the additional width to the axial spacing dimensions

3 Dimensions of diving facilities → 7 - 8

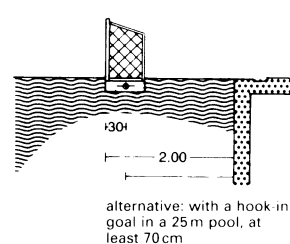
Diving pits are usually equipped with two kinds of diving-off point: rigid platforms, which must be level, (1, 3, 5, and 10 m high) and springboards (1 and 3 m high). The heights are measured from the water surface. Springboards are made of aluminium, wood or plastic. Both platforms and springboards must have non-slip surfaces. Ladders are usually used to reach platforms and boards, although lifts should be considered for large competition facilities. All boards and platforms are situated at one side of the pool → ① - ②. To allow divers to see the water surface better, water surface agitators or sprinklers are used.



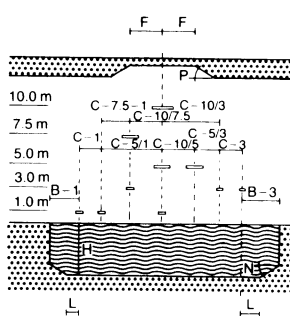
4 Layout for water polo



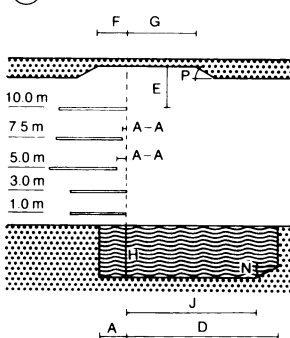
5 Water polo goal: front view



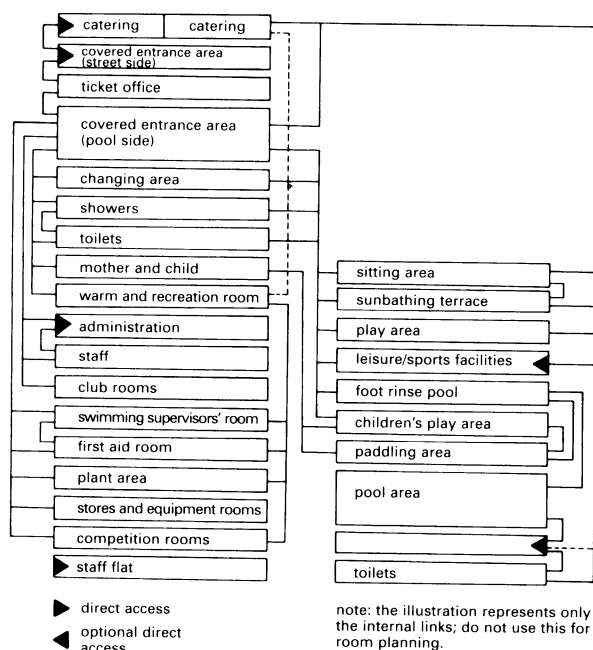
6 Water polo goal: side view



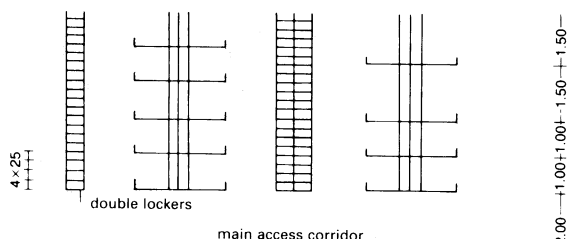
7 Cross-section



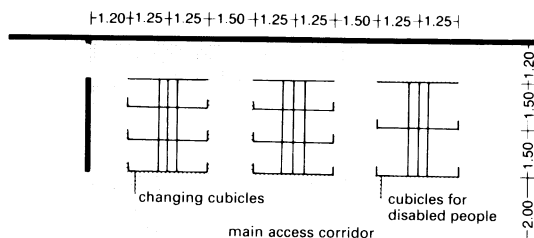
8 Longitudinal section



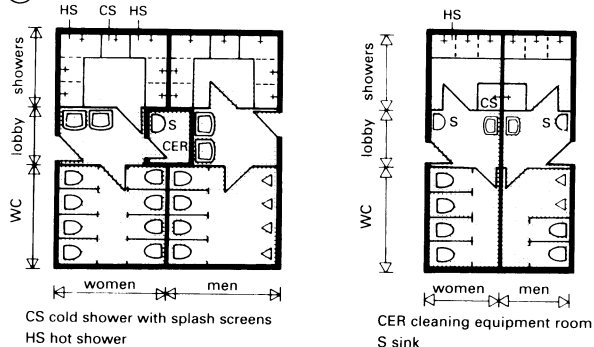
1 Space and area organisation diagram



2 Changing area units (sketch)



3 Changing area units (sketch)



4 Shower/toilet area for 2000 m² water area (sketch)

5 Shower/toilet area for 1000 m² water area (sketch)

## OPEN AIR SWIMMING POOLS

Open air pools are used almost exclusively for leisure activities. The required water area per inhabitant ranges from 0.15m² in low population density catchment areas to 0.05m² where the population density is high. This relationship between the number of inhabitants and the size of the water area ignores any element of tourism.

A site area of 8–16m² per square metre of the planned water area should be planned. Allow parking space for one car and two bicycles for every 200–300m² of the site area.

For the entry area, 200m² should be allocated per 1000m² water area, of which 50m² will be for a covered entrance with a ticket office and some form of entry control.

An area of 10m² should be planned for staff rooms in facilities with water areas up to 2000m²; above this, 20m² should be allowed for staff.

### paddling pools

water area 100 to 400m²; depth of water 0.00 to 0.50m; above 200m² the pool is divided into several sections with varying water depth

### teaching pools

water area 500 to 1200m²; depth of water 0.50/0.60 to 1.35m; possibly divided into several pools of varying depths

### swimming pools

water area 417 to 1250m²; depth of water 1.80m; pool sizes depend on the number of swimming lanes:

lanes	pool width	pool length
6	16.66 m	25.00 m
6	16.66 m	50.00 m
8	21.00 m	50.00 m
10	25.00 m	50.00 m

### wave pool

width 16.66m, 21.00m or 25.00m  
length usually 50.00m, but at least 33.00m  
water depth at the beginning 0.00m  
final water depth depends on pool use and the type of wave machine

catchment area (inhabitants)	type of pool	planning unit		diving boards	factor for volume and area calculation	site area (without ancillary areas)
		pool size (m or m²)	water area (m²)			
1	2	3	4	5	6	
5000 up to 10000	SP DP <sup>2)</sup> TP PP	16.66 × 25.00 12.50 × 11.75 500 100	417 147 500 100	1B + 3B + 1P + 3P + 5P	1000	8000 up to 12000
10000 up to 20000	SP DP <sup>2)</sup> TP PP	16.66 × 50.00 18.35 × 15.00 1050 150	833 275 1050 150	1B + 3B + 1P + 3P + 5P + 10P	2000	20000 up to 25000
20000 up to 30000	SP DP <sup>2)</sup> TP PP	21.00 × 50.00 22.40 × 15.00 1350 200	1050 336 1350 200	2 × 1B + 2 × 3B + 1P + 3P + 5P + 7.5P + 10P	2500	30000 up to 35000
30000 up to 40000	SP DP <sup>2)</sup> TP PP	21.00 × 50.00 22.40 × 15.00 1550 250	1050 336 1550 250	2 × 1B + 2 × 3B + 1P + 3P + 5P + 7.5P + 10P	3000	40000 up to 45000
40000 up to 50000	SP DP <sup>2)</sup> TP WP or 2 TP PP	21.00 × 50.00 22.40 × 15.00 1200 800 300	1050 336 1200 800 300	2 × 1B + 2 × 3B + 1P + 3P + 5P + 7.5P + 10P	3500	50000 up to 55000
over 50000	consider further open air pools of the suggested above units at several sites in a catchment area of 50,000 or more					

<sup>1)</sup> PP = paddling pool, TP = teaching pool, SP = swimming pool, DP = diving pool, WP = wave pool

<sup>2)</sup> B = board, P = platform; 1–10 = diving height in m

<sup>3)</sup> measurements with regard to safety dimensions: pool sizes = pool width (diving end) × pool length (in the direction of diving)

6 Planning units for open air pools (example)

## INDOOR/OPEN AIR SWIMMING POOLS

### General Planning Principles

Large complexes that combine indoor and open air swimming pools, depending on the type of design, offer more flexibility than separate facilities and are ideal centres for family leisure activities. However, the limitations imposed by the local seasonal weather patterns necessitate careful consideration of the allocation of indoor and outdoor water areas. The design must differentiate between the type of use during summer and winter times, as well as the transition periods in between.

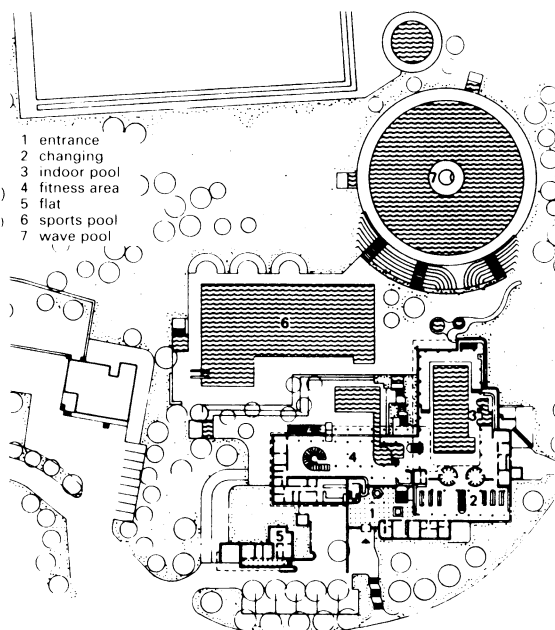
The following types of use can be considered:

- inclusive use of all indoor and outdoor water areas at the same times, with unlimited bathing duration, for a standard admission charge;
- separate use of indoor and outdoor water areas during differing opening times, perhaps with unlimited bathing time only in the outdoor pool, and different admission charges;
- seasonal single use, for instance at times when one of the facilities (indoor or outdoor section) is closed.

Consider the following when deciding on the type of design:

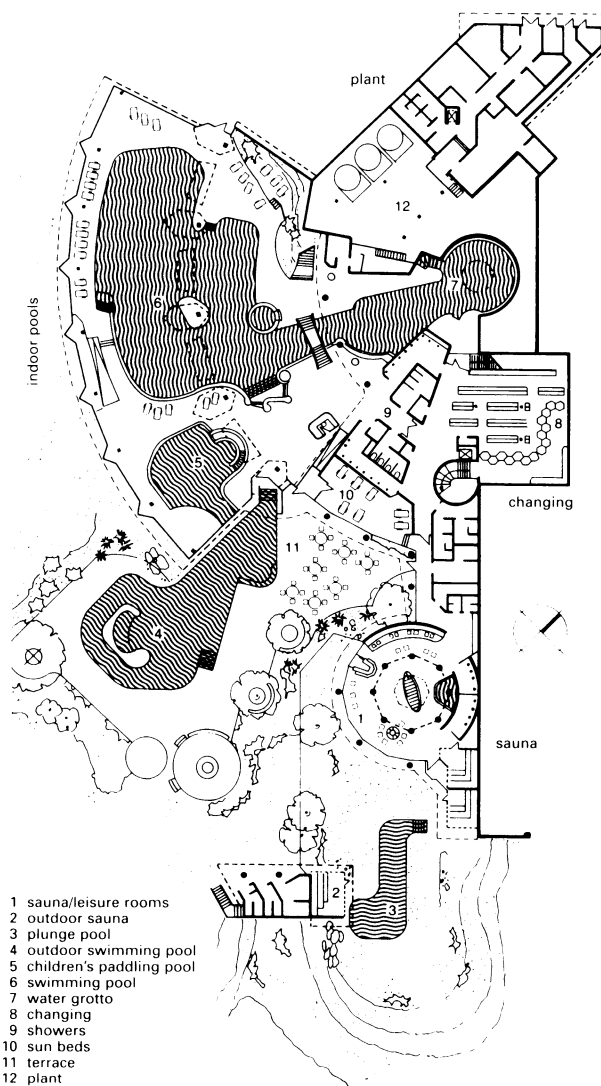
- the area of the indoor and outdoor pools appropriate to the size of the catchment area;
- additional water area in one or both of the sections which may be required to meet increased demand resulting from tourism;
- additional water area in one or both sections necessitated by special circumstances (e.g. in spa resorts or for sporting competitions etc.).

Examples → ① – ③.



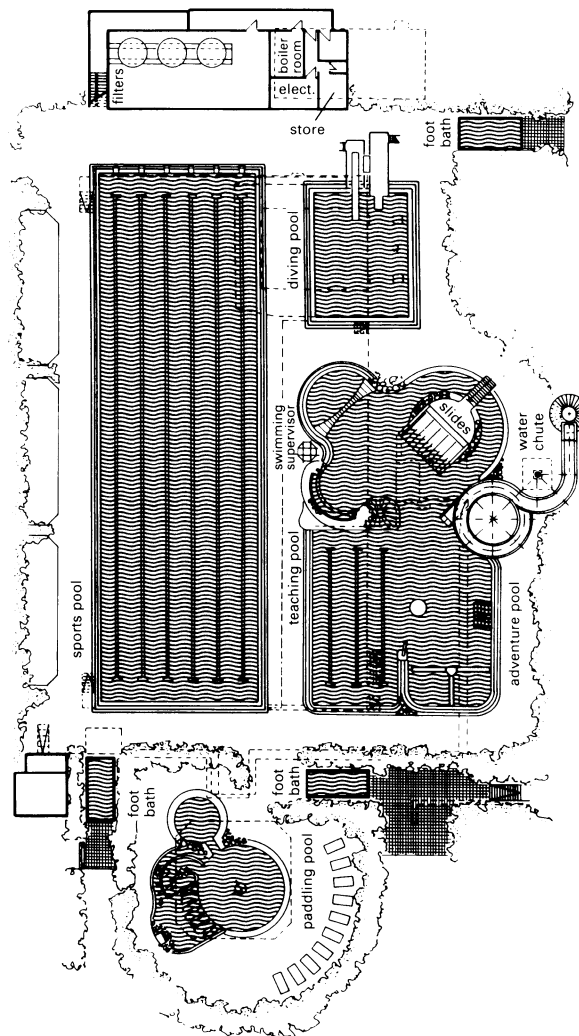
① The Wellenberg Oberammergau

Architect: P. Seifert



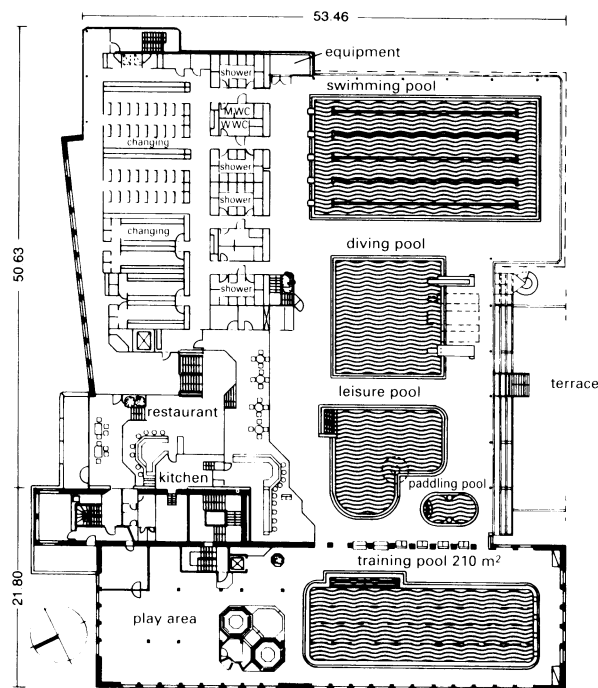
② Heveney open air swimming pool

Architects: Aichele, Fiedler, Heller

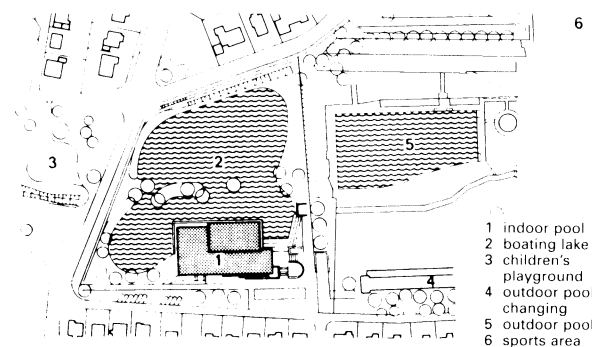


③ Bad Driburg open air pool

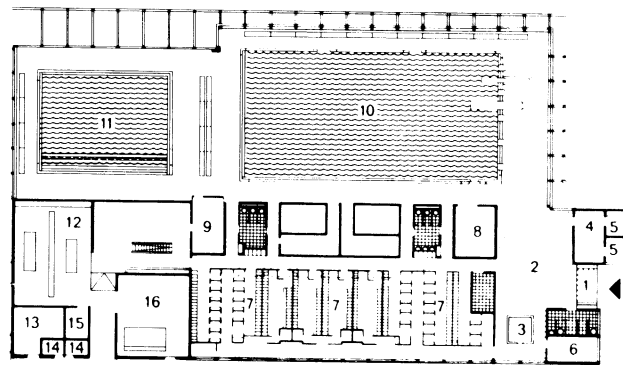
Architects: Geller + Müller



1 Trier municipal baths Architects: Müller, Karnaiz & Bock



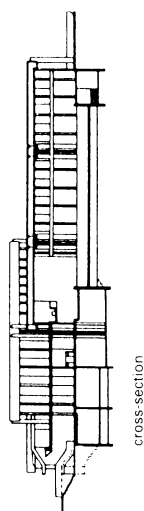
2 Stuttgart indoor pool Architect: J. Wetz



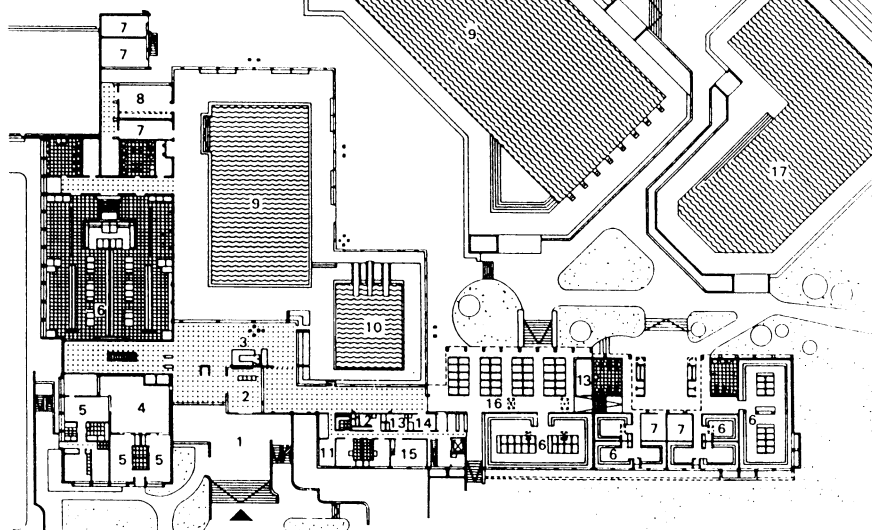
3 Ground floor

ground floor ▶ 5

- |                     |                 |                        |
|---------------------|-----------------|------------------------|
| 1 elevated entrance | 7 equipment     | 13 swimming supervisor |
| 2 draught lobby     | 8 swimming club | 14 first aid           |
| 3 ticket office     | 9 swimming pool | 15 leisure room        |
| 4 atrium            | 10 diving pool  | 16 family cubicles     |
| 5 flat              | 11 office       | 17 non-swimmers        |
| 6 changing          | 12 teacher      |                        |



cross-section



4 Zollikon, indoor and outdoor pools

5 Ground floor

Architects: E. Ulrich + C. Baum

## INDOOR/OPEN AIR SWIMMING POOLS

A combined indoor and open air swimming pool complex can, in certain circumstance, be created by adding an indoor pool or open air pool to an existing facility. However, in new projects, the indoor pool section should be the first to be built.

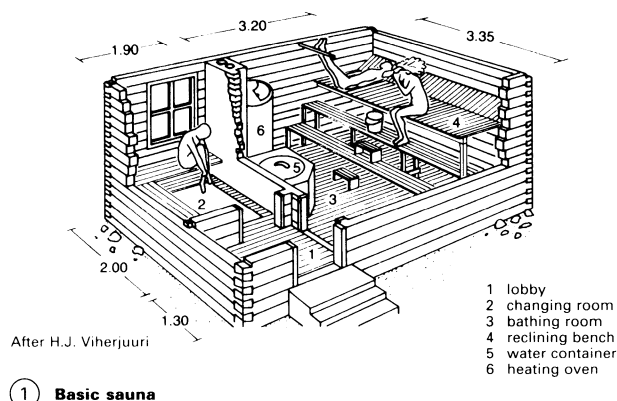
The design should aim to connect the pool area of the open air pool with that of the indoor pool. This leads to better use during out-of-season times and allows central supervision and more economic technical servicing. The close proximity of the indoor and open air pool areas also makes flexible use easier.

Connection between the two pools, preferably linking the shallow ends, can be made through a swimming channel. This should have a covered entrance with a hot air curtain or closing doors. Such a link allows bathers to reach the outdoor pool from indoors without coming into contact with cold outside air.

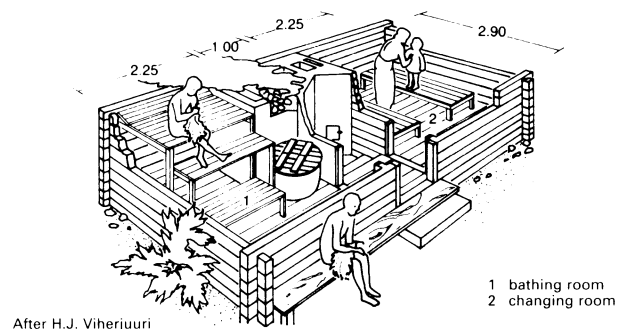
Where the leisure area has catering facilities and a restaurant the diners should be given a good view of both pool sections.

Access to the open air pool should be through the same entrance hall as the indoor pool. However, during peak times access should also be possible through a second covered entrance zone, ideally served by the same ticket offices and control areas as the main entry hall.

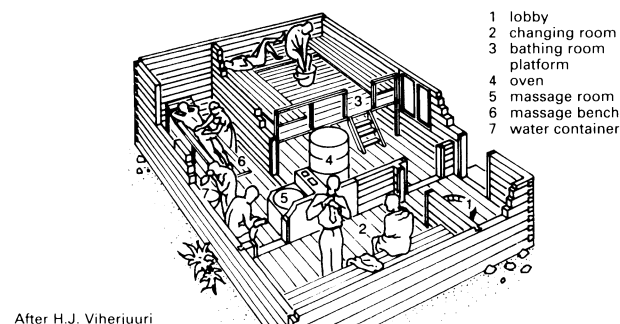
## SAUNA



① Basic sauna

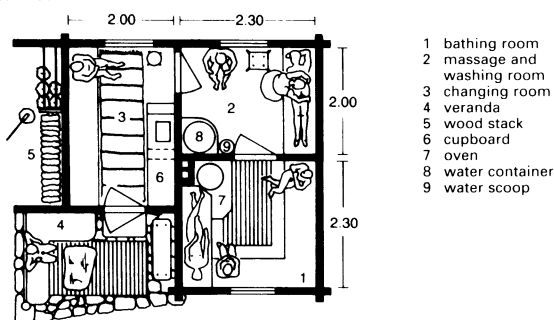


② Sauna with central lobby



③ Larger sauna

Architect: E. Sukonen



④ Sauna with a veranda

The sauna is more than a method of bathing; for many it is a type of physical cleansing, almost a ritual, and it is now an essential part of all modern sports facilities. In Finland there is one sauna for every six people. They are built to a standard traditional design and used once a week, both communally within the family and also in public without segregation of the sexes.

The classic location for saunas is next to a clear lake with woods and meadows for air bathing between sweat baths.

**Bathing sequence**

The principle involves alternating use of hot and cold air. Bathers sweat in dry hot air, and then in hot pure steam emissions, which are created every 5–7 minutes by pouring a quarter litre of water on to heated stones. The cycle between dry and damp results in a strong stimulation of the skin and strengthens resistance to illness. The effect is intensified by periodic cold water treatment, massage and rest.

**Construction**

Wood block or timber construction is by far the most common and good thermal insulation of the exterior is essential because the temperature difference between inside and outside can often be over 100°C in winter.

The bathing room should be as small as possible ( $\leq 16\text{m}^2$ ,  $\leq 2.5\text{m}$  high) and lined with dark coloured timber on the ceiling and walls to reduce heat radiation. Walls are solid softwood timber, with the exception of the oven area. The steps and benches are made of wood battens to give good air circulation and are at various heights, the top bench being about 1m beneath the ceiling. The benches are usually around 2m in length. All of the wood battens are nailed from below so that the body does not come into contact with hot nail heads. Benches should be easy to dismantle to allow easy cleaning. The floor must be made of non-slip material, not wood strips.

**Smoke sauna**

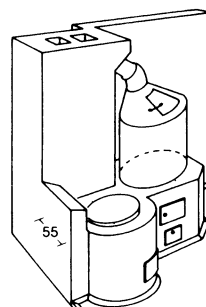
Large stones are piled up and strongly heated on a wood fire, the smoke escaping through the open door. When the stones are glowing the fire is removed and the last of the smoke is expelled by sprays of water. The door is then closed and, after a short time, the sauna is 'ripe' for bathing. Bathers can enjoy the wonderful smell of smoked wood and dependable steam quality. Roughly half of the old Finnish saunas are built in this way.

**End smoke sauna**

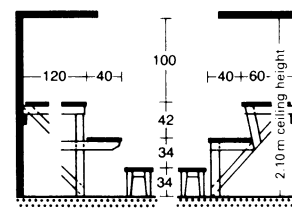
At the end of the heating period, when the stones have reached about 500°C, the oven flue is directed inwards. The combustion gases burn completely without any soot production. The top doors are then closed, even if there are still flames in the combustion chamber, and the temperature quickly rises by tens of degrees. Before bathing the last of the fumes are discharged by opening the door for a short period, and water is then poured over the hot stones.

**Oven sauna**

These use a ceramic or metal clad oven, heated by the flue gases from the combustion chamber. Heating takes place through a fire door from bathing room or lobby. Once the stones are hot, the fire door is closed and the doors at the top of the oven cladding are opened as required in order to let out hot air prior to pouring water on the stones.

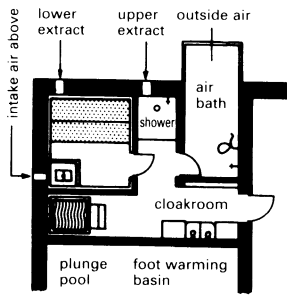


⑤ Finnish sauna oven with water container (also useable for washing clothes)

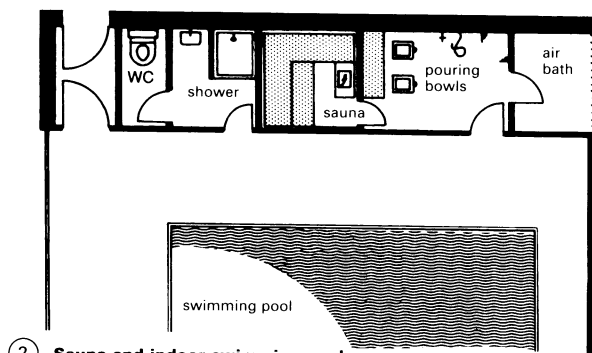


⑥ Finnish standard reclining benches for sweat baths and saunas

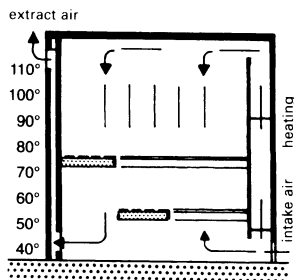
## SAUNA



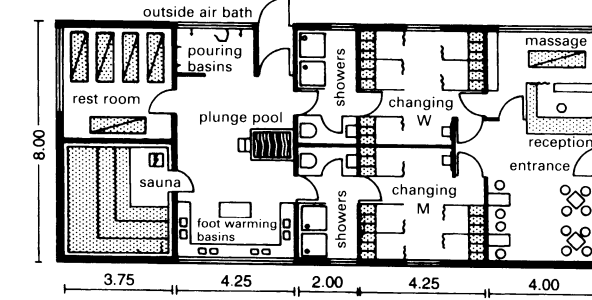
1 Domestic sauna



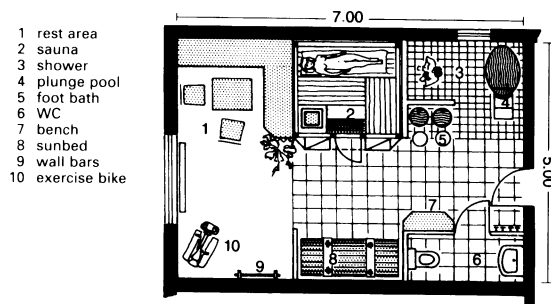
2 Sauna and indoor swimming pool



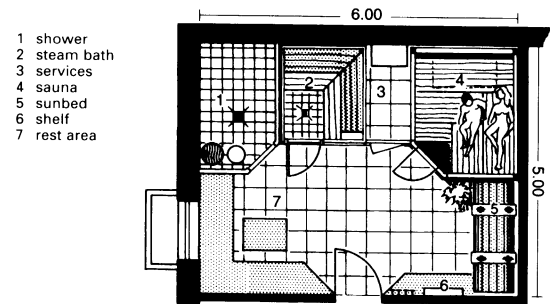
3 Section through a sauna with indirect heating (Bamberg)



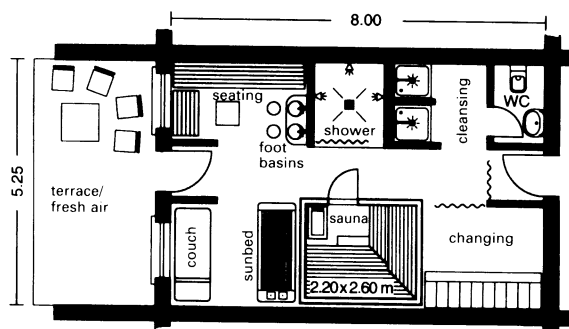
4 Plan of a sauna for 30 people



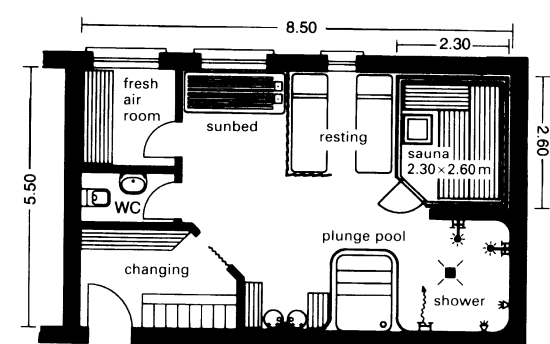
5 Attic sauna (35 m², 4-6 persons)



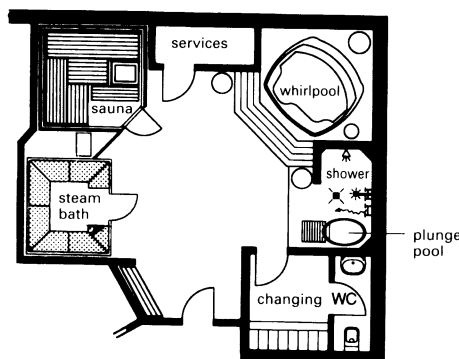
6 Sauna in the basement (35 m², 4-6 persons)



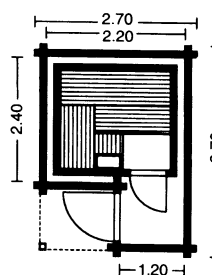
7 Hotel sauna 5.25 x 8.00 m



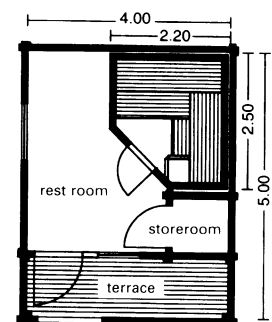
8 Hotel sauna 5.50 x 8.50 m



9 Sauna, steam bath, whirlpool



10 Garden sauna (log hut)

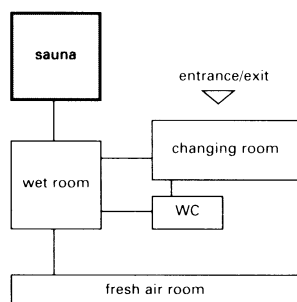


11 Log hut sauna

Bathing involves three periods of 8–12 minutes in the sauna followed by cooling off with pouring bowls, in showers or a plunge pool (although it is nicer to cool off in the natural water of a lake or the sea). The cooling process also includes the air bath, which entails the breathing in of fresh, cool air as a counterbalance to the hot air. The air bathing area should be screened off and seating provided → ①–②.

In public saunas, adequate changing areas must be provided along with additional rest and massage rooms → ④.

## SAUNA



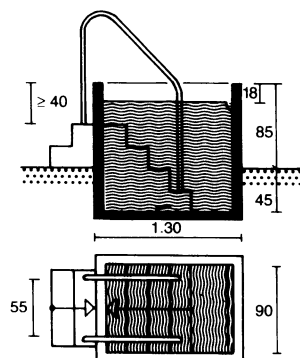
① Functional diagram, private sauna

area required per person	
changing room	0.8–1.0 m <sup>2</sup>
cleansing	0.3–0.5 m <sup>2</sup>
sauna room	0.5–0.8 m <sup>2</sup>
cooling room	1.0–1.8 m <sup>2</sup>
rest room	0.3–0.6 m <sup>2</sup>
fresh air room	> 0.5 m <sup>2</sup>
massage	6–8 m <sup>2</sup> /bench
room sizes (example 30 people)	
changing room	24–30 m <sup>2</sup>
cleansing	9–15 m <sup>2</sup>
sauna room	15–18 m <sup>2</sup>
cooling room	30–45 m <sup>2</sup>
rest room	9–18 m <sup>2</sup>
lobby, toilets	99–144 m <sup>2</sup>
corridors	+21–35 m <sup>2</sup>
air bath (20–50 m <sup>2</sup> )	120–179 m <sup>2</sup>

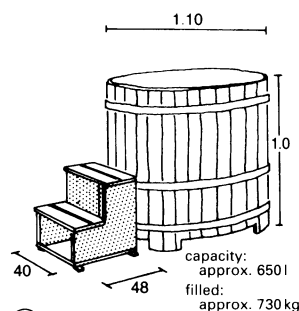
② Area requirements and room sizes

cap- acity	dimensions of heaters (cm)				cable cross- section	sauna room size		
	1		2					
(kW)	W	D	H	W	D	H	(mm <sup>2</sup> )	(m <sup>3</sup> )
3	43	13	50				3 × 2.5	2-3
4.5	43	26	55	51	33	62	5 × 2.5	4-6
6	43	26	55	51	33	62	5 × 2.5	6-10
7.5	43	26	55	51	33	62	5 × 2.5	8-12
9	43	26	55	51	33	62	5 × 2.5	10-16
10.5				51	33	62	5 × 2.5	12-17
12	69	35	62				5 × 2.5	14-18
15	82	35	62				5 × 4	16-22
18	82	35	62				5 × 6	18-24
21	108	35	62				5 × 6	20-28
24	108	35	62				5 × 10	25-40

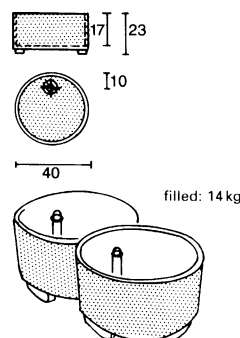
③ Technical data for sauna equipment



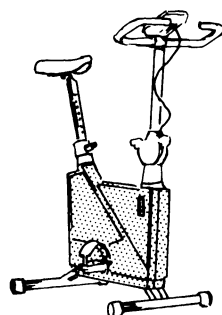
④ Plunge pool



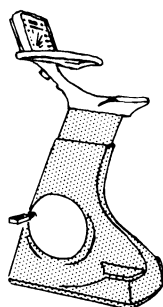
⑤ Plunge tub



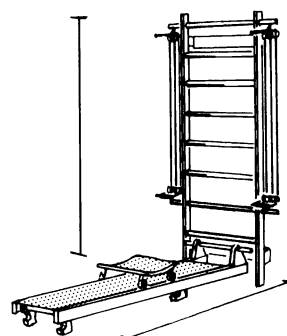
⑥ Foot warming basins



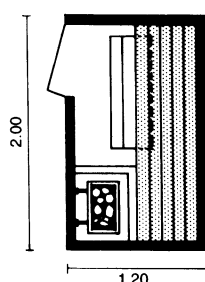
⑦ Electric exercise bike for therapeutic use



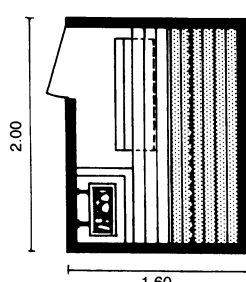
⑧ Electric exercise bike for fitness training



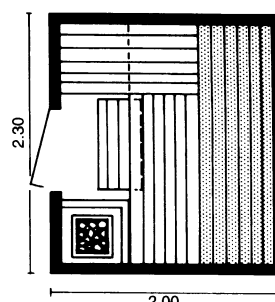
⑨ Combination wall bars



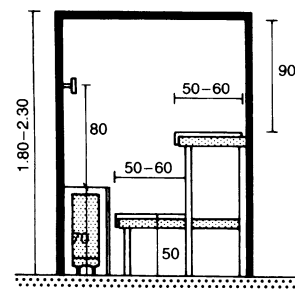
⑩ Sauna: 1 person reclining, 2 sitting



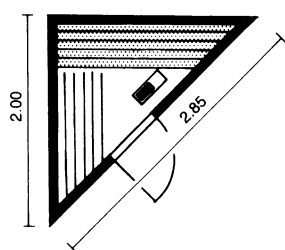
⑪ Sauna: 2 persons reclining, 3 sitting



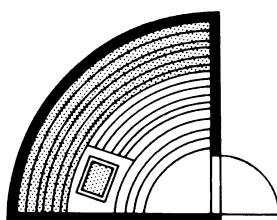
⑫ Sauna: 3 persons reclining, 5 sitting



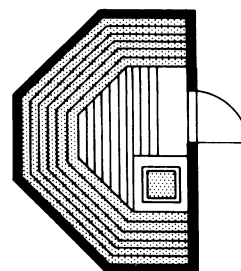
⑬ Section



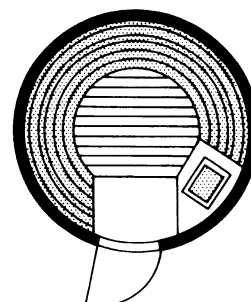
⑭ Corner sauna



⑮ Quarter circle



⑯ Special shape



⑰ Circular

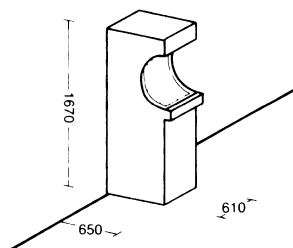
A plunge pool is provided for the necessary 'cooling off' after a sauna → ⑤. The warm footbath is another important component of a properly fitted out sauna bath → ⑥. A 19mm hose, connected only to the cold water supply, and provided with massage and fan shaped nozzles.

Space permitting, an exercise bike (or similar) and a set of wall bars can be included for fitness training. → ⑦–⑨

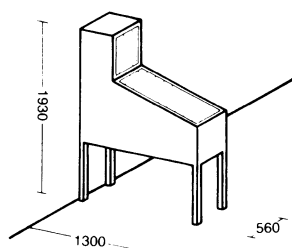
Saunas can be built to any size and shape according to individual wishes (e.g. triangular, round, six sided) → ⑭–⑰ and sauna roofs which are sloped to fit into attic spaces are readily available. Double glazed windows can be incorporated in front wall or door.

#### Room temperatures

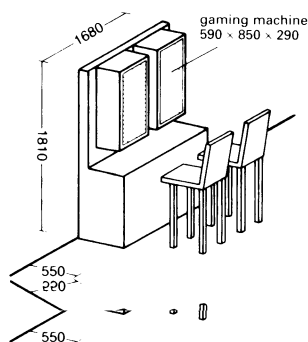
Changing room 20–22°C, cleansing room ≥24–26°C, cooling down (cold water) room ≤18–20°C, rest room 20–22°C, massage room 20–22°C.



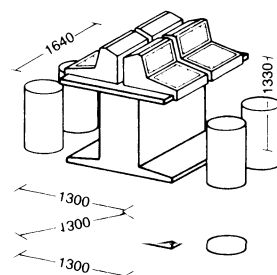
① Video game



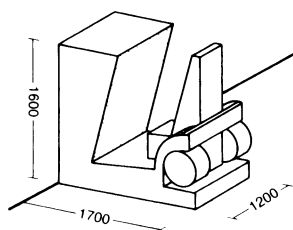
② Pinball machine



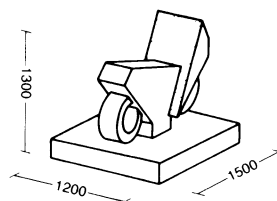
③ Gaming machine stand



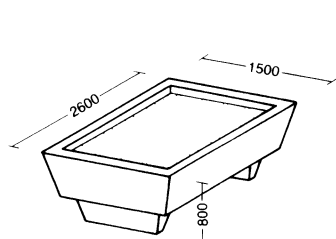
④ Card games



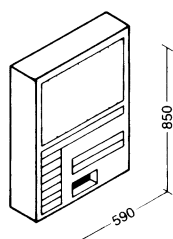
⑤ Driving simulator



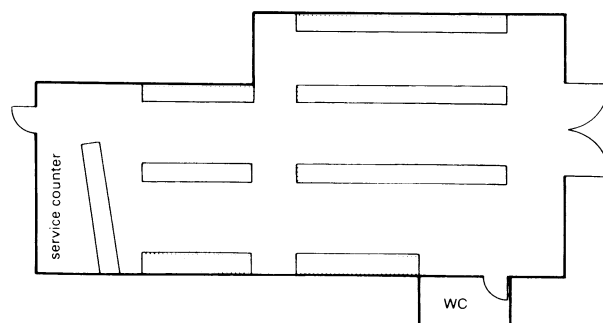
⑥ Driving simulator



⑦ Billiard table



⑧ Gaming machine



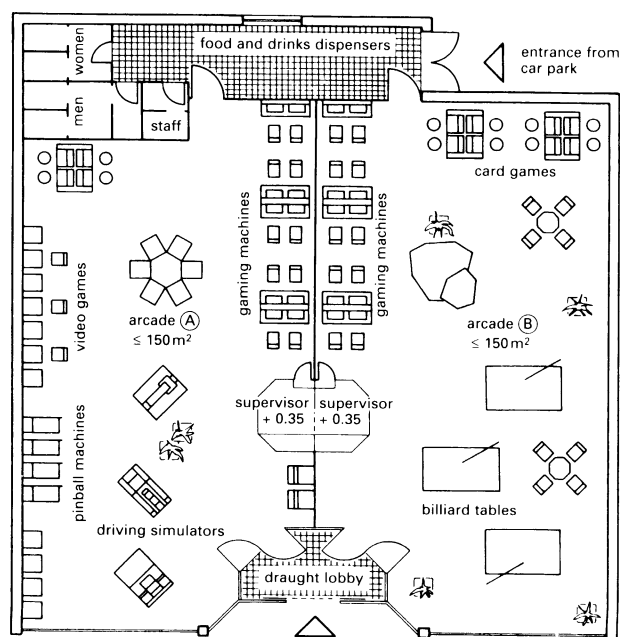
⑩ 'Pachinko' gaming arcade in Japan

The types of machines found in amusement arcades will vary from country to country given that the setting up of games for gambling is subject to regulations and licensing. It is therefore necessary to take into account the licensing policies if it is intended to provide games which produce winnings of money or goods in a games arcade or similar premises.

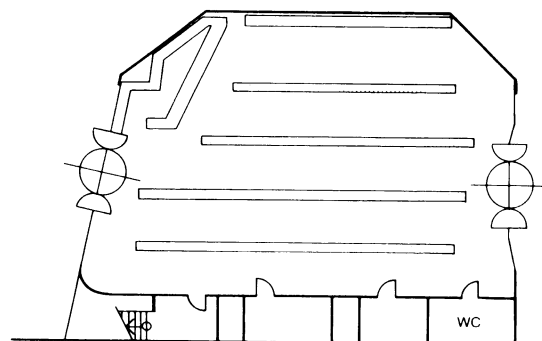
Where machines that provide winnings of goods or money are allowed in gaming halls, they must be separated from the machines which are designed for amusement only. It is permissible, however, for adjacent gaming and amusement arcades to share the same toilet facilities → ⑨.

The 'Pachinko' gaming halls, common in Japan → ⑩ + ⑪ are not permitted in some European countries. Balls won from the machines can be exchanged for goods at the service counter.

In the UK, gaming by means of machines is restricted and is governed by the Gaming Act 1968.



⑨ Plan of an amusement arcade (A + B)



⑪ 'Pachinko' gaming arcade in Japan