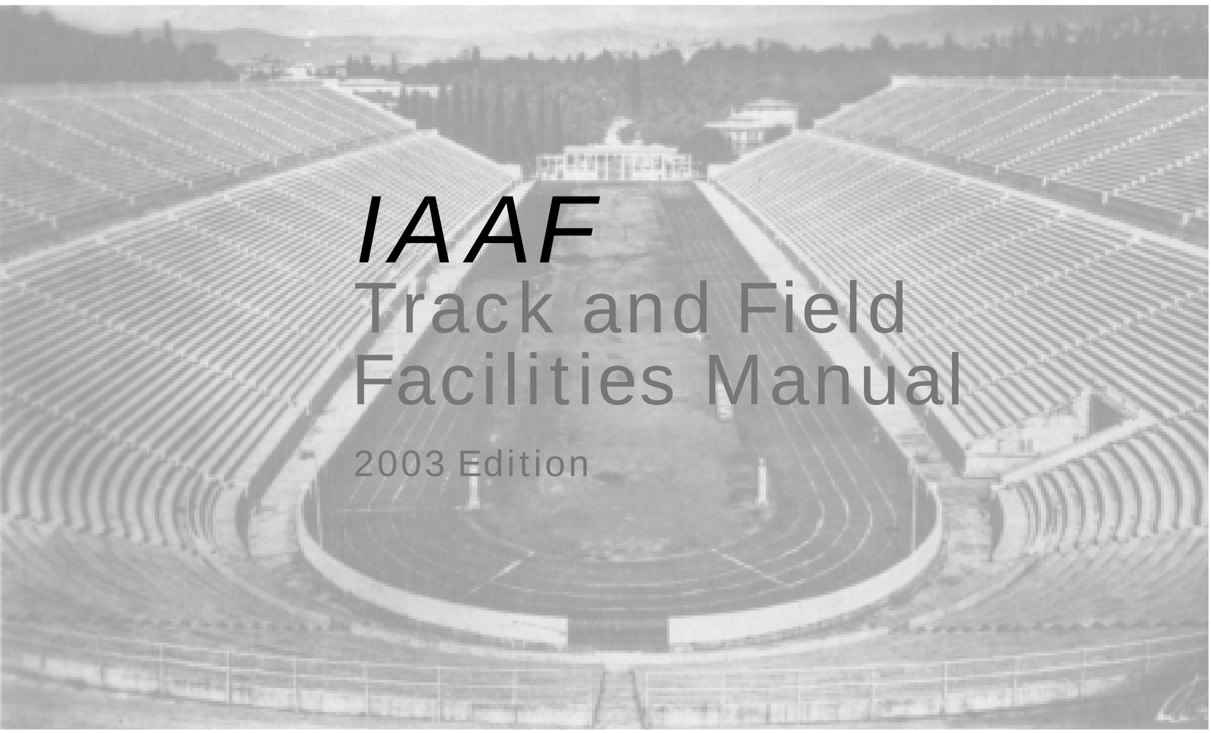

# *IAAF*
# Track and Field Facilities Manual

2003 Edition

Guidelines and Recommendations for Planning, Constructing, Equipping and Maintaining

# IAAF PRESIDENT'S MESSAGE

It gives me a great pleasure, to welcome this updated edition of the IAAF Track and Field Facilities Manual.

With over 300 pages of technical information, tables and clear instructions this volume will serve as a vital tool for all members of our athletics movement by bringing consistency and precision to the general management of track and field facilities. The book covers every aspect of the planning, construction, equipping and maintenance of these facilities, and there are also special sections devoted to Media and TV requirements.

Since the last edition of this book in 1999, the IAAF has launched a new Certification System. This aims to set an international standard for the various products used in athletics - from implements to track surfaces. The IAAF has a world-wide responsibility to guarantee the validity and accuracy of performances and therefore of all products which help athletes achieve these performances. As well as standardised products there is now a specific definition of testing requirements and tighter controls on the use of the designation "Certified Product" by the IAAF.

Finally, I would like to thank the authors for their insight, their research and their practical sense which has helped to make this volume a definiteve reference work.

**Lamine Diack**
*IAAF President*

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# INTRODUCTION

While establishing the IAAF Performance Specifications for Synthetic Surfaces Outdoors in association with the International Association for Sports Surface Sciences (ISSS) it became very clear to the IAAF Technical Committee from discussions with track manufacturers and others in the industry that guidelines for the planning of track and field facilities were very necessary.

At the same time the International Association for Sports and Leisure Facilities (IAKS) had also identified this requirement in respect to the special aspects of athletics.

Based on a proposal submitted by IAKS and funded by the International Athletic Foundation, the IAKS and the IAAF Technical Committee embarked on an exhaustive study aimed at providing a comprehensive reference work.

Thanks to the close co-operation between these two groups and to the invaluable input of many experts, firms involved in the industry and athletics persons throughout the world we are pleased to present this third edition of the IAAF Manual as a comprehensive guide to future construction of Track and Field Facilities.

The Manual is intended for use by stadium planners and as an essential guide to IAAF member federations, national and municipal authorities and all involved in the planning, constructing and running of facilities for Track and Field Athletics.

The Working Group made up of members of the IAAF Technical Committee and the IAKS took advantage of this new edition to revise the contents of the manual. With the cooperation of the authors, chapters 3 (Construction of the Track) and 8 (Facilities for Indoor Athletics) have been extensively revised, and a number of suggestions from readers have been included. At the same time some editorial changes were made and printing errors were corrected.

The third edition reflects the latest knowledge and experience available in this field and introduces new contributors. We would like to dedicate this edition to two of the original team who have died in the recent past. Tony Rottenburg, former Honorary Technical Consultant to the IAAF and the creator of many items of track and field equipment as owner of the firm Cantabrian, and Professor Frieder Roskam the late General Secretary of IAKS each contributed greatly to the original project under the leadership of former Technical Committee Chairman Carl Gustav Tollemar.

**The Editors**

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# CHAPTER 1
# GENERAL ASPECTS OF PLANNING

## 1.1 Competition Rules

### *1.1.1 OFFICIAL HANDBOOK*

Track and field athletics and its disciplines of running, walking, jumping and throwing are governed by the Rules of the International Association of Athletics Federations (IAAF). These are published every two years in the IAAF Handbook. The Rules ensure equal conditions for competition and form the basis for standardization and acceptance of the competition facilities.

### *1.1.2 TRACK AND FIELD FACILITIES MANUAL*

In order to comply with modern standards of construction, the International Association of Athletics Federations decided to publish this "Track and Field Facilities Manual" in addition to the IAAF Handbook. The manual contains detailed and more clearly defined specifications for the planning and construction of track and field facilities than those contained in the IAAF Handbook. The aim is to pay greater attention to technical and performance requirements of track and field facilities.

### *1.1.3 SUITABILITY FOR COMPETITION*

In order to establish the suitability of a sports facility for competition, proof is required of fulfillment of the requirements listed in this Manual by certificates testifying to the construction category, the observance of the measurements and, when relevant, the suitability of the synthetic surface.

### *1.1.4 IAAF CERTIFICATION SYSTEM*

The IAAF has introduced a certification programme based upon the goal that all facilities, synthetic surfaces, implements and equipment built for use in international competitions conform to IAAF specifications and therefore guarantees the validity of the performances and the quality of the product.
It is the IAAF's duty as the sport's world governing body for athletics to ensure that all athletics items used in international competitions are of the requisite standard, manufactured in accordance with IAAF technical requirements, and, most importantly, guarantee the safety of the athletes.
There has been a rapid development in the manufacture of athletics equipment over recent years, including implements and synthetic track surfaces, resulting in an increased number of products on the market. These are not all of the same quality. It also recognises the growing trend towards international standardisation of product specifications, as well as the need to prevent unauthorised usage of the IAAF name.
The Certification Regulations are available on the IAAF Web Site and from the IAAF Competition Division upon request.

# 1.2 Use of Facilites

### *1.2.1 GENERAL*

Sports facilities for track and field athletics are generally used for daily training as well as for staging regional or local competitions. The staging of competitions at higher levels normally entails more extensive requirements for the sports facility, particularly in respect of the infrastructure.

### *1.2.2 UNIFORM SPORTS FACILITIES*

In order to ensure equal conditions for all athletes, uniform facilities are necessary particularly since competitions are held in many different venues. Furthermore, the athletes need the same conditions for training that they will find in competition. This manual is subdivided into different competition categories (1.3) and construction categories (1.5) on the basis of competition requirements.
For training in high-performance training centres, for example, it is possible to deviate from a particular construction category by providing additional opportunities for training such as a special throwing field, two sprint tracks, a special landing mat for high jump or more individual facilities.

### *1.2.3 ADDITIONAL USE FOR SPORTING ACTIVITIES*

It is normal for an athletics track to be used for other sports. Generally, this involves using the interior of the 400m tracks as a pitch for soccer, American football or rugby. Obstacle-free sports areas in the segments at the same level as the playing field without kerbs over which sportsmen could stumble can be included in the safety zones. The dimensions of the area necessary for these additional sporting uses are given in tables 1.2.3a and 1.2.3b for the Standard 400m track (Fig 1.2.3a) and for double bend tracks (Fig 1.2.3b and Fig 1.2.3c).
In the case of double bend tracks in (Fig 1.2.3d, the dimensions apply to American football only.

| ***COLUMN*** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** |
|---|---|---|---|---|---|
| ***Line*** 1 | ***Type of 400m Oval-Track*** | ***Standard Track*** | ***Double Bend Track*** | | |
| | r = Radius | r = 36.50m | r1 = 51.543m<br>r2 = 34.000m | r1 = 48.00m<br>r2 = 24.00m | r1 = 40.022m<br>r2 = 27.082m |
| | g = Straights<br>F = Figure | g = 84.39m<br>F = 1.2.3a | g = 79.995m<br>F = 1.2.3b | g = 98.52m<br>F = 1.2.3c | g = 97.256m<br>F = 1.2.3d |
| ***2*** | Rectangular Interior<br>Width<br>Length | <br>73.00m<br>84.39m | <br>80.000m<br>79.995m | <br>72.00m<br>98.52m | <br>69.740m<br>97.256m |
| ***3*** | Dimension of Segment<br>Width<br>Length | <br>73.00m<br>36.50m | <br>80.000m<br>35.058m | <br>72.00m<br>27.22m | <br>69.740m<br>29.689m |

**Table 1.2.3a - Dimension of Interior of 400m Oval Track**

| ***COLUMN*** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** |
|---|---|---|---|---|---|---|---|---|---|
| ***Line*** | ***Sport*** | ***Pitch Size*** | | | | ***Safety Zone*** | | ***Total Standard Size*** | |
| ***1*** | | ***Under Competition Rules*** | | ***Standard Size*** | | ***Long Sides*** | ***Short Sides*** | | |
| | | Width m | Length m | Width m | Length m | m | m | Width m | Length m |
| ***2*** | Football (Soccer) | 45-90 | 90-120 | 68 | 105 | 1 | 2 | 70 | 109 |
| ***3*** | FIFA matches | 64-75 | 100-110 | 68 | 105 | 6 | 7.5 | 80 | 120 |
| ***4*** | American Football[1] | 48.80 | 109.75 | 48.80 | 109.75 | 1 | 2 | 50.80 | 113.75 |
| ***5*** | Rugby[2] | max.70 | 70-100 | 70 | 100 | 2 | 10-22 | 72 | 120-144 |

*1) In this case, athletics use may be hampered in the segment areas.*
*2) A slight rounding of the corners of the 'touch down' areas by bending the segment arcs will be necessary.*

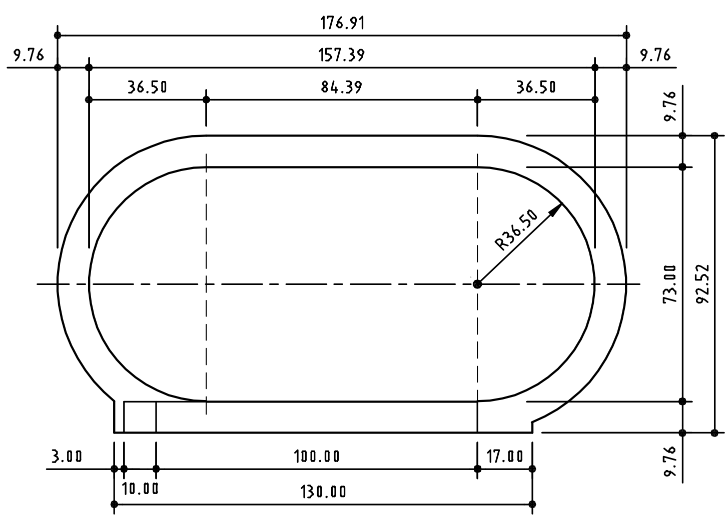



**Figure 1.2.3a - Shape and dimensions of 400m Standard Track (Radius 36.50m)**
(Dimensions in m)

### *1.2.4 ADDITIONAL USE FOR NON-SPORTING ACTIVITIES*

Since track and field facilities for top class competitions are furnished with spectator stands, non-sporting events, such as open-air concerts and public assemblies can also be held in them. In certain circumstances, these may require measures of protection for the track and for the infield (See Chapter 7).

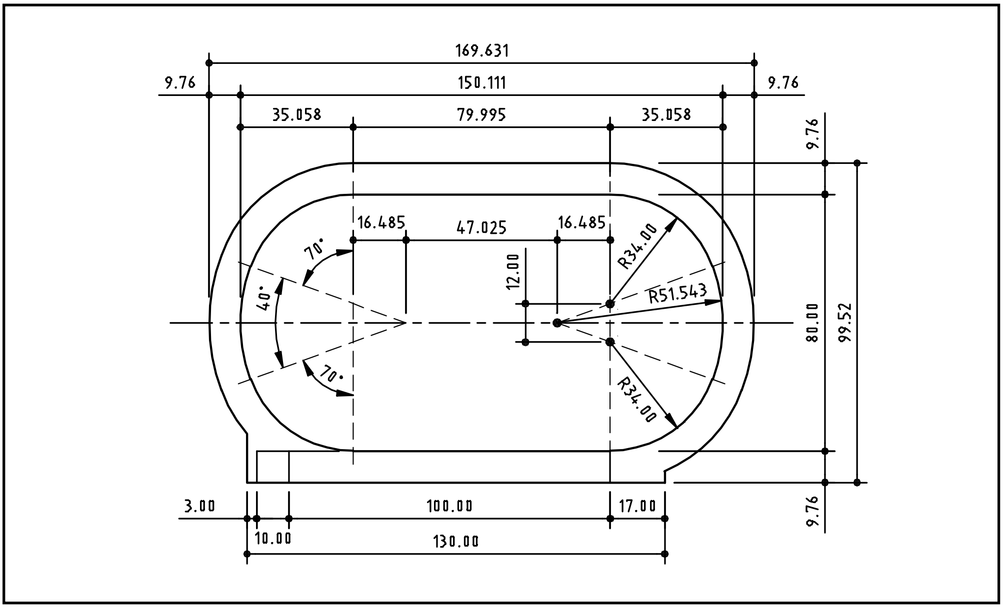



**Figure 1.2.3b - Shape and dimensions of 400m Double Bend Track (Radii 51.543m and 34.00m)**
(Dimensions in m)

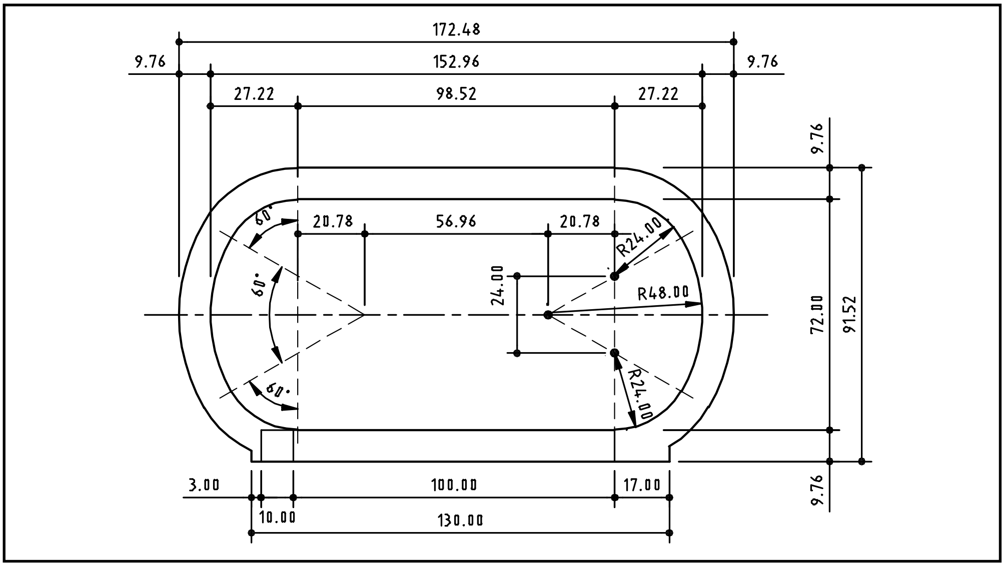



**Figure 1.2.3c - Shape and dimensions of 400m Double Bend Track (Radii 48m and 24m)**
(Dimensions in m)

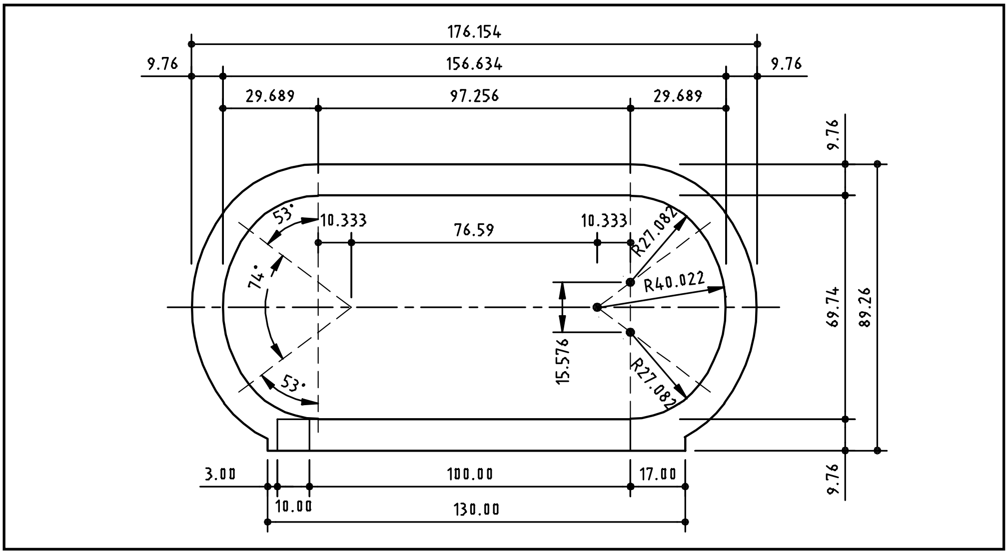



**Figure 1.2.3d - Shape and dimensions of 400m Double Bend Track (Radii 40.022m and 27.082m)**
(Dimensions in m)

# 1.3 Competition Classification

### *1.3.1 GENERAL*

When planning an athletics facility, the types of competition events to be staged there must be taken into account - especially with regard to the type and number of individual facilities, the service rooms and the spectator area.
The ranking of a competition is defined as "competition category". Competition categories have been subdivided under 1.3.2 according to the type of competition, the duration of the competition and reference data in respect of the number of athletes, competition officials, auxiliary personnel and spectators.
Of particular importance for the planning of facilities is whether multi-sports events (such as the Olympic Games) or track and field events only are to be staged.
In the case of the latter, a distinction must be made between those competitions which last several days (for example, World Championships) or those which are concentrated within one or two days (for example, international matches).

### *1.3.2 COMPETITION CATEGORIES*

Table 1.3.2 provides an overview of the various competition categories.
The details in columns 3 to 5 specify the range of ancillary facilities for athletes, competition officials and auxiliary personnel (See Chapter 4).
Column 6 gives the approximate duration of an athletics meeting. The items I to V listed in column 7 "Construction Category" refer to Section 1.5. Finally, column 8 states the authority responsible for allocation and technical control at the international, continental, regional or national level, with the exception of the Olympic Games for which the IOC is responsible for allocation.

| *COLUMN* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* |
|---|---|---|---|---|---|---|---|---|
| *Line*<br>*1* | *Competition Category* | *Event[1)]* | *Approximate maximum number of participants at any one time* | | | *Duration of Competition* | *Recommended Construction Category* | *Technical Control[1)]* |
| | | | *Athletes* | *Competition Officials* | *Auxiliary personel* | *Number of Days* | | |
| *2* | 1 | Olympic Games and World Championships | 75 | 100 | 75 | 9 | I | IAAF |
| *3* | 2 | World Cups | 30 | 60 | 50 | 3 | I | IAAF Rule 12.1a |
| *4* | 3 | Continental, Regional and Area Championships | 75 | 75 | 60 | 4 - 8 | II | Continental, Regional or Area Association |
| *5* | 4 | Continental, Regional and Area Cups | 50 | 60 | 50 | 2 | III | IAAF Rule 12.1b, d |
| *6* | 5 | Group Games e.g. Mediterranean Games | 50 | 50 | 30 | 4 - 5 | II | Group Association IAAF Rule 12.1c |
| *7* | 6 | Matches between two or more Members or Combination of Members | 50 | 60 | 30 | 1 - 2 | III | National Federation IAAF Rule 12.1e |
| *8* | 7 | International Invitation Meetings specifically authorised by the IAAF | 50 | 30 | 30 | 1 | III | IAAF IAAF Rule 12.1f |
| *9* | 8 | International Meetings specifically authorised by an Area Association | 50 Invitation | 30 | 30 | 1 | III | Continental, Regional or Area Association IAAF Rule 12.1g |
| *10* | 9 | Other Meetings specifically authorised by a Member and National Championships | 75 | 60 | 30 | 2 - 4 | IV | National Federation IAAF Rule 12.1h |
| *11* | 10 | Combined events | 50 | 50 | 30 | 2 | IV | As Appropriate |
| *12* | 11 | Other National Competitions | | | | | V | National Federation |

*1) In accordance with IAAF Rule 12.1*

**Table 1.3.2 - Competition Categories; number of athletes, officials and auxiliary personel**

### *1.3.3 OTHER COMPETITIONS*

Each country may modify technical requirements in respect of domestic competitions.

## 1.4 Selection of the Venue

The venue is selected by the organizers. In addition to the construction category for the competition facility required for the respective competition, other factors of importance for the choice of venue are:

- the accessibility for international or national transport network
- the infrastructure
- accommodation and care of participants (Also 1.7).

## 1.5 Construction Categories[1)]

### *1.5.1 GENERAL*

Sports facilities for the staging of competitions at higher levels are subdivided into different construction categories. The rating “Construction Category” is determined by the relevant sports authority (Section 1.3). For this, confirmation of the suitability of the sports facility for competition is required which is documented by:

- a certificate confirming observance of the minimum requirements of the respective construction category (See 1.5)
- a certificate confirming observance of measurements for individual components of the sports facilities (See 2.1 to 2.5)
- a certificate confirming suitability of the synthetic surface
- in special cases a certificate assuring quality in the manufacture of the synthetic surface (See Chapter 3)
- in some cases a certificate for lighting may be necessary

### *1.5.2 CATEGORIES*

In the light of the organizational requirements of the competition categories listed in table 1.3.2, the following five construction categories for track and field facilities are recommended:
Construction category I for the competition categories 1 and 2
Construction category II for the competition categories 3 and 5
Construction category III for the competition categories 4, 6, 7 and 8
Construction category IV for competition categories 9 and 10
Construction category V for competition category 11.

### *1.5.3 REQUIREMENTS OF CONSTRUCTION CATEGORIES*

The requirements of table 1.5.3 are minimum requirements. For exceptions, see Section 1.5.4.

### *1.5.4 EXCEPTIONS*

In agreement with the appropriate athletic authority, the organizers of a competition may (with the exception of construction category I) make exceptions to the respective construction category.

*1) By stipulating Competition Categories and Construction Categories for sports facilities, the aim is to enable an early decision to be reached on the programme when building new track and field facilities or renovating existing ones.*

| ***COLUMN*** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** |
|---|---|---|---|---|---|---|
| ***Line* 1** | ***Construction Category*** | ***I*** | ***II*** | ***III*** | ***IV*** | ***V*** |
| ***2*** | 400m Standard Track as described under section 2.2 with 8 lanes and 8 straight lanes for 100m and 110m hurdles | 1 | 1 | 1 | - | - |
| ***3*** | 400m Standard Track as line 2, but with 6 lanes and 6 Straight lanes | - | - | - | 1 | - |
| ***4*** | 400m Standard Track as line 2, but with 4 lanes and 6 straight lanes | - | - | - | - | 1 |
| ***5*** | Water jump for the steeplechase | 1 | 1 | 1 | - | - |
| ***6*** | Facility for long- and triple jump, with landing area at each end | 2[a)] | 2[a)] | 1 | 2 | - |
| ***7*** | Facility for long- and triple jump as line 6, but runways in the same direction | - | - | - | - | 1 |
| ***8*** | Facility for high jump | 2 | 2 | 1 | 2 | 1 |
| ***9*** | Facility for pole vault with provision for landing area at each end | 2[a)] | 2[a)] | 1 | 2 | - |
| ***10*** | Facility for pole vault with runways in the same direction | - | - | - | - | 1 |
| ***11*** | Combined facility for discus and hammer throw (separate or concentric circles) | 1[b)] | 1[b)] | 1[b)] | 1[c)] | 1 |
| ***12*** | Facility for javelin throw | 2[d)] | 2[d)] | 2[d)] | 1 | 1 |
| ***13*** | Facility for shot put | 2 | 2 | 2 | 2 | 1 |
| ***14*** | Provision of ancillary rooms (Chapter 4) | * | * | * | * | * |
| ***15*** | Full facilities for spectators | * | * | * | * | * |
| ***16*** | Warm-up area, comprising 400m Standard Track with min. 4 lanes and min. 6 straight lanes (similar surface to the competition track); separate throwing field for discus, hammer, javelin; 2 facilities for shot put | * | - | - | - | - |
| ***17*** | Warm-up area, comprising preferably a 200m Oval track each with 4 lanes and 4 straight lanes (similar surface to the competition track); throwing field for discus, hammer, javelin; facility for shot put | - | * | - | - | - |
| ***18*** | Warm-up area, comprising park or playing field in the vicinity for warm-up, preferably with standard track with 4 lanes and min. 6 straight lanes; throwing field for discus, hammer, javelin; facility for shot put | - | - | * | - | - |
| ***19*** | Warm-up area adjacent to the stadium: park or playing field | - | - | - | * | - |
| ***20*** | Ancillary rooms e.g. for conditioning and physiotherapy, adequate space for athletes resting between events, with area of min. $m^2$ | 250 | 200 | 150 | 200 | - |

** Essential Requirement*
*a) The two facilities must be in the same direction and adjacent to allow simultaneous competition by two groups of competitors with similar conditions*
*b) An additional facility for discus only may also be provided*
*c) For large events a second facility outside the stadium but in the same throwing direction is desirable*
*d) One at each end of the area*

**Table 1.5.3 - Requirements of the Construction Categories**

# 1.6 Demand for Sports Facilities

### *1.6.1 GENERAL*

The demand for sports facilities in a town or rural district depends on

- the current sporting activities of the population,
- the sporting interests of the population,
- the appeal of opportunities for sporting activities and the way they are organized and
- the existing sports facilities.

### *1.6.2 SPORTING ACITVITES OF THE POPULATION*

The individual's sporting activities depend on age, profession, financial situation and the local opportunities for sporting activity. The sporting activities of the population as a whole are thus dependent on the organization structures (school sports, sports for all, competitive sports and leisure sports) and on access to the relevant sports facilities.

### *1.6.3 UTILIZATION CAPACITY OF SPORTS FACILITIES*

The degree of utilization capacity of a sports facility depends on

- the time available for use in hours per week in terms of the effects of the weather and periods of maintenance,
- the time of day and day of the week of possible utilization in relation to the user's age and profession,
- the design of the sports facility with respect to varied sports use and the simultaneous practice of different sports and
- the organization of sports activities with respect to the persons supervising the sportspeople and sports facilities.

### *1.6.4 DEMAND BASED ON REQUIREMENTS AND SUPPLY*

The demand for sports facilities is derived from the balance of sporting activities of the population and for physical education on the one hand and the utilization capacity of the existing sports facilities on the other. Demand does not have to be met alone in the form of additional sports facilities at new locations. It can also be covered by reconstructions, further developments, extensions, reallocation of use or intensification of use. This requires intensive checking and assessment of the existing sports facilities and their degree of utilization as well as an investigation of the existing and future requirements for sports of the population. Here it is important not to forget that the respective sporting activities of the population are also subject to the publicity appeal of the local or regional sports federations and that the housing development structure with its population density may reduce or increase the demand on account of problems of distance (distance between home and sports facility) necessarily associated with this.

### *1.6.5 BASIC SPORTS FACILITIES*

Track and field athletics are counted among the basic disciplines of sport and, in addition to spaces for ball games, constitute an obvious component of the sports facility structure. Facilities for running, jumping and throwing therefore are necessary on every sportsground of basic supply and on every school sports facility. However, the demand for them, subject to the utilization structure and to the frequency of use, differs from country to country.

### 1.6.6 KEY SPORTS FACILITIES

Track and field facilities are usually designed as multi-purpose facilities (tracks with playing fields inside). They may be used for sports other than track and field disciplines (See 1.2) and therefore constitute key sports facilities. They should be located in areas with a larger population density and serviced by an effective transport network.

## 1.7 Location of the Sports Facility

### 1.7.1 GENERAL

The location selected for a sports facility depends upon the demand as described under Sections 1.6.2 and 1.6.3, the population density within the catchment area and, above all, upon the availability of adequately large areas of land. It is precisely these relatively large spaces required for sports facilities which make the choice of location considerably more difficult in view of the overall shortage of available land in areas with high population densities. An early development of aims within the framework of area and regional planning and early securing of suitable space is therefore necessary. Only in this way will it be possible to supply sports facilities which both meet demand and are suitably located.

### 1.7.2 SIZE OF LAND

The size of the land shall be at least twice as large and, if possible, three times as large as the required net sports area in order to be able to accommodate suitably landscaped areas between the sports spaces. Only in this way can the desired integration of the sports facility into housing developments and the surrounding natural environment be guaranteed.

### 1.7.3 SOIL CONDITIONS

Prerequisites for economic construction, operating and maintenance costs are adequate load-bearing soil conditions with maximum possible permeability and a topography which is as level as possible because of the need for large horizontal areas for sport.
Filled ground can be very expensive to excavate and recompact to meet the required foundation conditions for a facility.

### 1.7.4 MICROCLIMATE

A favourable microclimate free of troublesome wind, fog and temperature extremes is particularly important for the optimal use of outdoor facilities for sports.

### 1.7.5 ENVIRONMENTAL CONDITIONS

The environmental conditions which are of special importance for outdoor sports facilities shall be balanced to ensure either that no troublesome smells, noises, vibrations or dust nuisances will occur or that measures of protection can be implemented to prevent them. Neighbourhoods sensitive to the effects of lights and noise (vehicles, spectators, sports apparatus, floodlighting) should be avoided or only accepted if suitable measures for protection are implemented.

The impairment to, or destruction of, natural or typical elements of the landscape (including biotopes) must be precluded or suitable measures must be implemented to compensate for this.

### *1.7.6 TRANSPORT NETWORK*

An adequate and economically justifiable transport network, including necessary parking spaces, must be feasible. Consideration must be given to the parking requirements of both private and public transport and sufficient spaces should be allocated to each.
The extent of the provision of public transport (e.g. buses, trains) will determine the area needed for parking for private vehicles (e.g. private buses, cars, motorcycles).
In addition to parking spaces for VIPs, press, athletes, competition officials, auxiliary personnel and attendants, there should be 1 car parking space, (approx. $25m^2$) for every 4 spectator spaces or, in the case of an optimal public transport network, 25 spectator spaces and 1 bus park (approx. $50m^2$) for every 500 spectator spaces.

### *1.7.7 SUPPLY AND WASTE DISPOSAL*

Adequate and economically justifiable systems of supply for water, energy, telecommunications and waste disposal must be feasible.

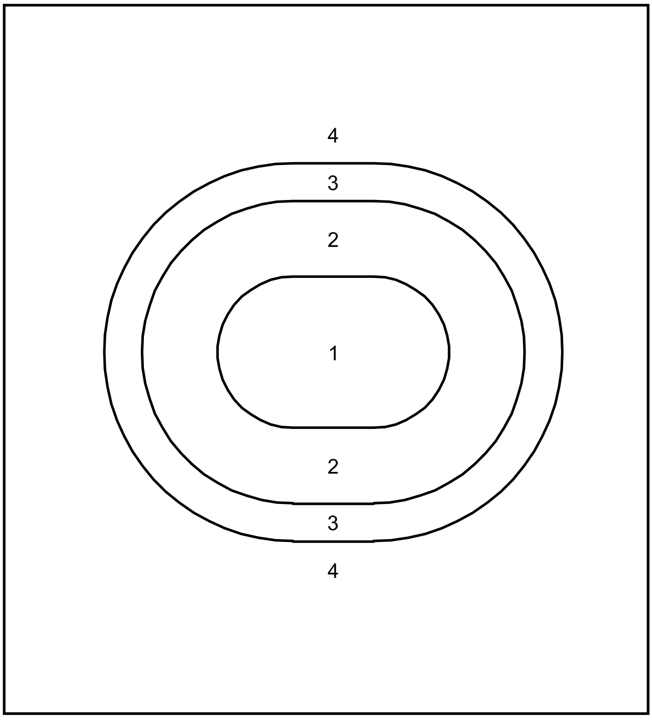



**Figure 1.8.1a**
**Subdivision into zones**
1 Central sports/events area
2 spectator area
3 perimeter zone
4 approach/public area

*Source: Planning Principles for Sportsgrounds/Stadia, IAKS Series Sports and Leisure Facilities No. 33*

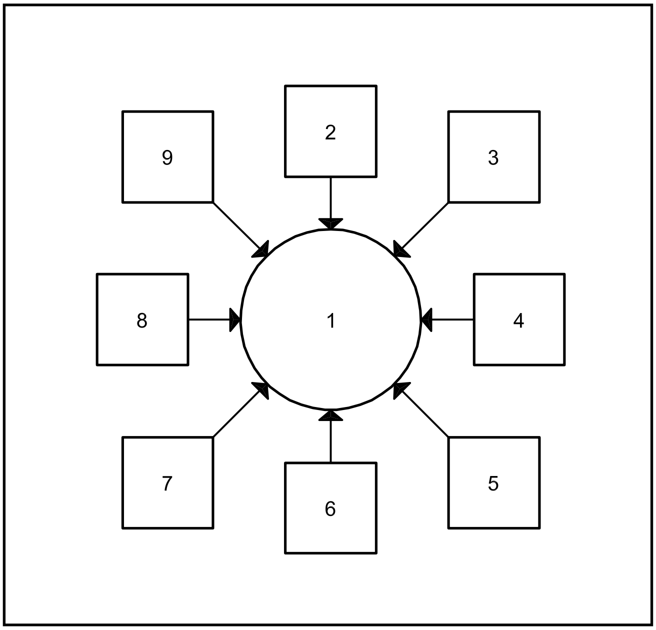



**Figure 1.8.1b**
**Subdivision into individual sections**

1 Sports/event area
2 sports participants
3 leisure-orientated users
4 persons involved in non sporting events
5 spectators
6 media
7 event organization
8 stewards and security services
9 administration maintenance

*Source: Planning Principles for Sportsgrounds/Stadia, IAKS Series Sports and Leisure Facilities No. 33*

# 1.8 Safety of Spectators and Athletes

### *1.8.1 CIRCULATION*

A strict division of the circulation systems for spectators and for athletes is of particular importance to the safety of the athletes.
For facilities with larger spectator capacities, a separation system between the spectator and the sports areas is essential. (Fig 1.8.1a and 1.8 1b)

### *1.8.2 SURFACE OF TRACK AND LANDING AREAS*

The safety of the athletes and their protection against injury in training and competition is an aspect of special significance for the requirements for the sports surface. Long-term maintenance is therefore of exceptional importance.
This requires more than ever the specification and control of technical data particularly in the case of artificial surfaces as described under Chapter 3 including their constant monitoring during installation.
High jump and pole vault landing areas require constant control of their condition.
The sand in the landing pits for long and triple jump must be loose and in hygienic condition. Unsuitable sand, for example with a high content of clay which hardens upon load, must not be used.

### *1.8.3 PROTECTIVE CAGES*

The protective cage prescribed for the discus and hammer throws must be checked before each competition to ensure correct assembly and condition to suit its function. It must also be properly operated throughout the competition.

#### *1.8.4 SAFETY MARGINS*

Due to the integration of various facilities for sports into one large complex which is common today and necessary for economic reasons, the provision of certain safety margins between areas for individual disciplines of sports to preclude any dangerous activities, has become particularly important. The same also applies to the keeping of safety areas free from obstructions of all types. Organizers as well as officials, judges and athletes must pay very special attention to these aspects.

# CONTENTS - CHAPTER 2
# COMPETITION AREA

# CHAPTER 2
# COMPETITION AREA

## 2.1 General Remarks

Track and Field athletics include competition areas for running, walking, jumping and throwing events. These are normally integrated into an arena, the design of which is dictated by the 400m oval track. The competition areas are first dealt with individually and then regarding their integration into the arena. The dimensions given are to be adhered to. Permissible deviations are given as tolerances (+ or ± or -) after each figure.

### *2.1.1 TYPES OF COMPETITION FACILITIES*

#### 2.1.1.1 Competition Area for Track Events

The Competition area for track events includes:

- Oval Track with at least 4 lanes (400m + 0.04 x 1.22m ± 0.01) and safety zones measuring not less than 1.00m on the inside and preferably 1.00m on the outside.
- Straight with at least 6 lanes (100m + 0.02 x 1.22m ± 0.01 for sprints and 110m + 0.02 x 1.22m ± 0.01 for hurdles)
  Starting area: 3m minimum
  Run-out: 17m minimum
- Steeplechase Track as for oval track with a permanent water jump (3.66m x 3.66m x 0.70m) placed inside or outside the second bend.

#### 2.1.1.2 Competition Area for Jumping Events

The competition area for jumping events includes:

- Facility for Long Jump with runway (40m min. x 1.22m ± 0.01), take-off board (1.22m ± 0.01 x 0.20m ± 0.02 x 0.10m ± 0.01), placed between 1 and 3 metres from the nearer end of the landing area, and the landing area (2.75m min. wide with the far end at least 10m min. from the take-off line)
- Facility for Triple Jump as for Long Jump except for a take-off board placed 13m for men or 11m for women from the nearer end of the landing area for international competitions. For any other competition this distance shall be appropriate for the level of competition
- Facility for High Jump with a semi-circular runway (radius 20m min.) and landing area (6m x 4m min.)
- Facility for Pole Vault with a runway (40m min. x 1.22m ± 0.01), a box for inserting the pole and landing area (6m x 6m min.) with an additional forward extension.

#### 2.1.1.3 Competition Area for Throwing Events

The competition area for throwing events includes:

- Facility for Discus Throw with throwing circle (2.50m ± 0.005 diameter), protective cage and landing sector (80m radius, 48m chord)

- Facility for Hammer Throw with throwing circle (2.135m ± 0.005 diameter), protective cage and landing sector (90m radius, 54m chord)
- Facility for Javelin Throw with runway (30m to 36.5m x 4m), arc with a radius of 8m and landing sector (100m radius, 50.00m chord)
- Facility for Shot Put with throwing circle (2.135m ± 0.005 diameter) stop board (1.15m ± 0.01 x 0.112 x 0.10m ± 0.02) and landing sector (25m radius, 15m chord)

## *2.1.2 POSITIONING FOR COMPETITION*

### 2.1.2.1 Standard Positions

When installing all Track and Field facilities, careful consideration must be given to the position of the sun at critical times of day and the wind conditions.
To avoid the dazzling effect of the sun when it is low, the longitudinal axis of arenas should lie along the north-south axis, although it is possible to deviate to the north-north-east and north-north-west.
The strength and direction of local winds should also be taken into consideration.

### 2.1.2.2 Exceptions to Standard Positions

Departures from the standard positions for specific facilities (eg high jump, pole vault) are permissible if the stadium is situated in a location where the sun's rays do not reach those facilities.
Where deviations from the standard positions are necessitated by the local conditions (eg steep hill position, unfavourable layout of the land, existing developments), any possible disadvantages this may cause the athletes must be carefully considered. Particularly serious disadvantages may necessitate the selection of an alternative site.

### 2.1.2.3 Positioning of Spectator Facilities

Spectator facilities should, if possible, be positioned to face east. Where there are two stands opposite each other, or all-round spectator facilities, this shall apply to the main stand.

## *2.1.3 GRADIENTS FOR TRACKS AND RUNWAYS*

### 2.1.3.1 Competition Area for Track Events

For the competition area for track events the following maximum gradients shall apply:
- 0.1% downward in the direction of running. Should the gradient of the sprint track as part of a Standard Track vary, the inclination is measured in a straight line between start and finish line.
- 1.0% across the width of the track towards the inside lane. The transverse 1.0% gradient is primarily to ensure quick drainage of rainwater from the track surface. In very dry desert climates it might be appropriate for the track to be flat.

### 2.1.3.2 Competition Area for Jumping Events

For the competition area for jumping events, the following maximum gradients shall apply:
- 0.1% downward in the running direction for long jump, triple jump and pole vault. Should the gradient of the competition area as part of a Standard Track vary, the inclination is measured in a straight line between start of the runway and take-off line.

- 0.4% downward in the running direction for high jump
- 1.0% across the width of the runway for long jump, triple jump and pole vault.

**2.1.3.3 Competition Area for Throwing Events**

For the competition area for throwing events, the following maximum gradients shall apply:

- 0.1% downward in the running direction for javelin. Should the gradient of the competition area as part of a Standard Track vary, the inclination is measured in a straight line between start of the runway and throwing arc.
- 1.0% across the width of the runway for javelin
- 0.1% downward in the throwing direction for shot put, discus, javelin and hammer landing sectors
  Circles for shot put, discus and hammer shall be approximately level.

### *2.1.4 ARRANGEMENT OF THE FACILITIES*

When deciding upon the arrangement of facilities, consideration must be given to the necessary movement of athletes during competition. The routes between ancillary rooms and competition areas should be as short as possible and not interfere with events in progress. Since optimum arrangement is almost impossible for competition, the use of facilities must be well planned to ensure the most practical and safe conduct of the competition.
In the same manner entrances to and exits from the arena must be planned. One must be located immediately after the finish line in order to bring the athletes out of the arena to the mixed zone and post-competition activities.
Other entrances should be placed in the other corners of the arena and preferably at the starts of sprint events to facilitate the entry of the athletes to the arena and to accommodate the preparation of the sites for competition. Provision must also be made for transport of competition equipment and implements.
For the marathon and other events taking place mainly outside the stadium a suitable connecting passage linking the track with the road course must be provided. The slope of the passage should not be too steep as this will affect the athletes particularly walkers. The passage should be wide enough to take the mass of athletes at the start of the marathon and road walk.

## 2.2 Facilities for Track Events

Track events include sprint, middle and long-distance, hurdle and steeplechase events. The direction of running is anti-clockwise. The 400m oval track usually forms the basis of a multi-sports arena. Its dimensions are, therefore, dependent on the requirements of other sports. When integrating the straight and the steeplechase into the oval track, deviations from Section 2.1.3 will arise in the longitudinal slopes in some areas. Although there are a number of different layouts for the 400m oval track, it is IAAF's objective to create uniform criteria, not only with a view to improving the performance parameters necessary for equal opportunities for all athletes and for the suitability for competition but also to simplify the principles of construction, surveying and certification of facilities. Recent experience has shown that the most suitable 400m oval tracks are

constructed with bend radii of between 35m and 38m, with an optimum of 36.5m. IAAF now recommends that all future tracks are constructed to the latter specification and will be referred to as the “400m Standard Track”.
For further details see 2.2.1 to 2.2.3. For details of other layouts for the 400m track, see 2.2.1.8.

## *2.2.1 THE 400M STANDARD TRACK*

### 2.2.1.1 Layout of the 400m Standard Track (Fig 1.2.3a and 2.2.1.1a)

The 400m Standard Track has the advantages of a simple construction, straight and curved sections of almost equal length and uniform bends which are most suitable to the running rhythm of athletes. Furthermore, the area inside the track is large enough to accommodate all throwing events and also a standard football pitch (68m x 105m).
The 400m Standard Track comprises 2 semi-circles, each with a radius of 36.50m, which are joined by two straights, each 84.39m in length (Fig 1.2.3a). This diagram indicates the inside edge of the track which must have a kerb with a height of 0.05m to 0.065m and a width of 0.05m to 0.25m. The inner edge of the track is 398.12m in length (36.5m x 2 x $\pi$+ 84.39m x 2) where $\pi$ = 3.1416. This length for the inner edge gives a length of 400.00m (36.8m x 2 x $\pi$ + 84.39m x 2) for the theoretical line of running (measurement line) at a distance of 0.30m from the kerb. The inside lane (lane 1) will, therefore, have a length of 400.00m along its

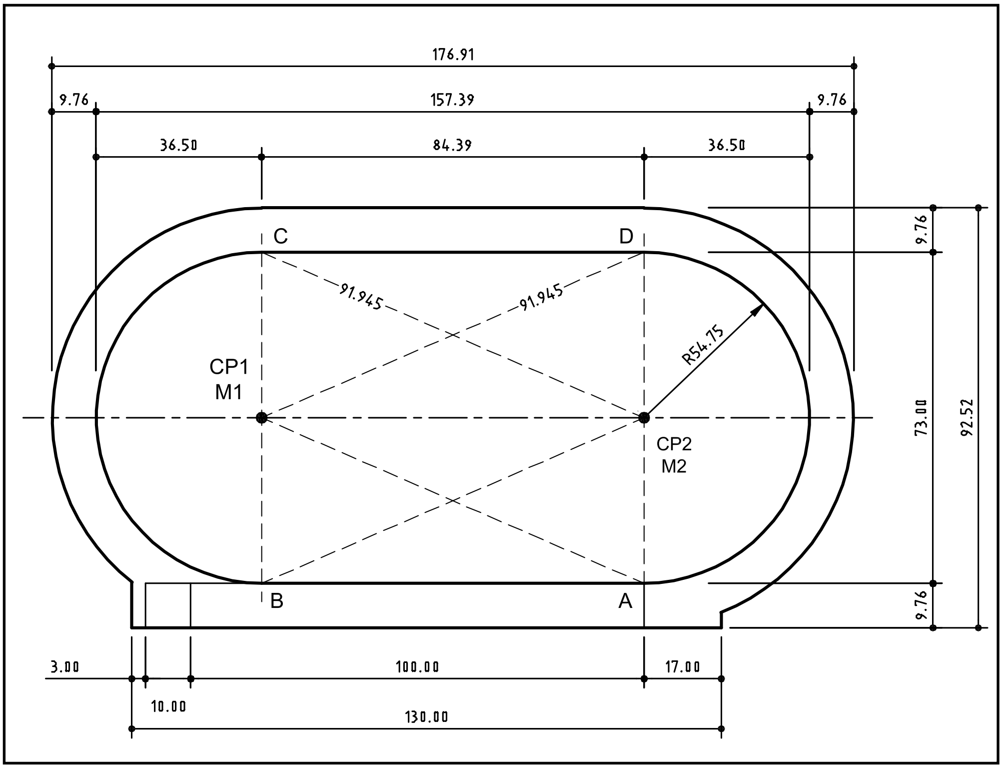



**Figure 2.2.1.1a - Setting out plan and dimensions of 400m Standard Track**
(see Appendix Chapter 2)

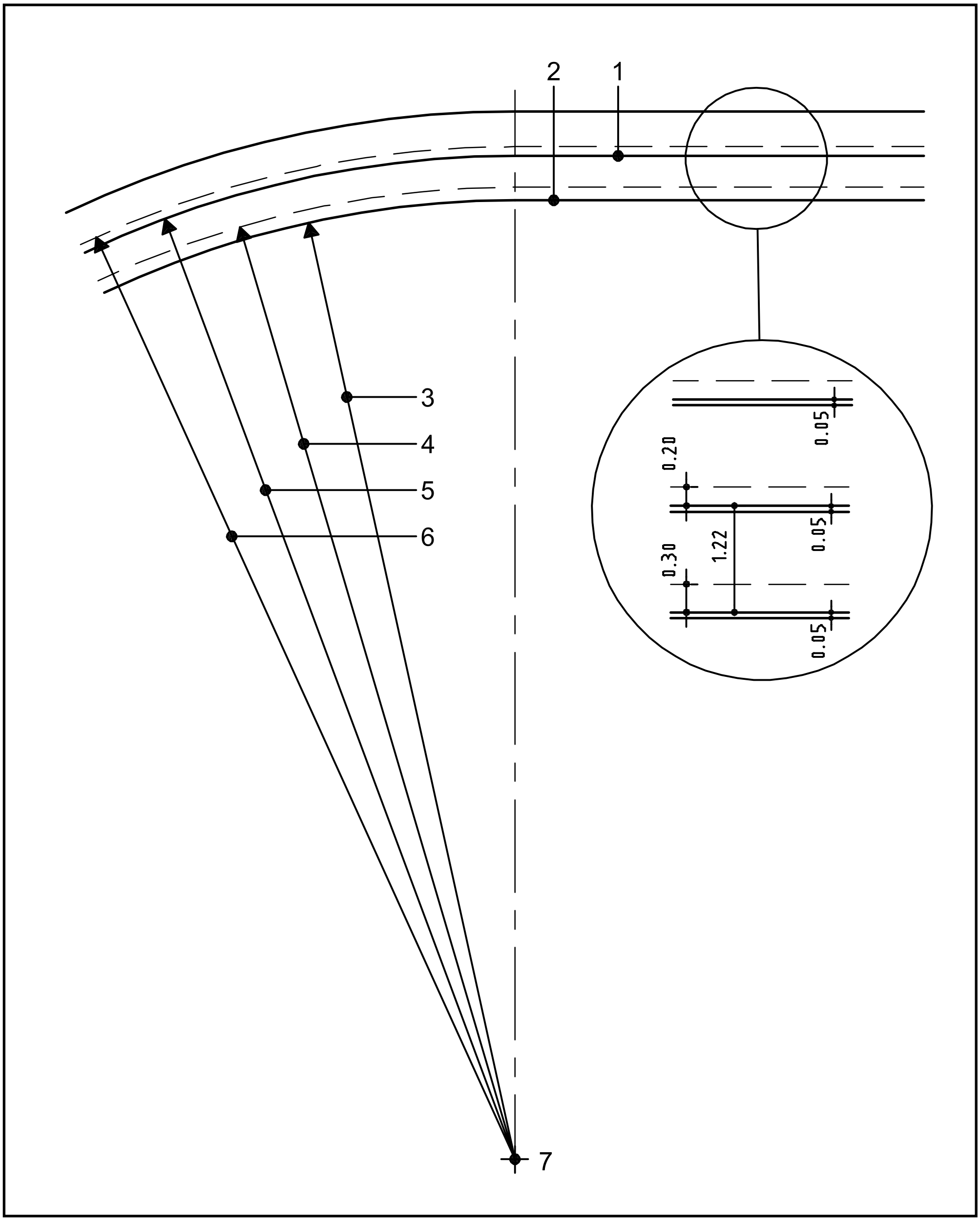



**Figure 2.2.1.1b - Calculation of the track length of the 400m Standard Track**
(Dimensions in m)

1 Lane marking, 2 kerb, $3_{r1}$ 36.50m outside edge of kerb, $4_{r'1}$ 36.80m line of running of inside lane (axis), $5_{r2}$ 37.72m outside edge of track marking, $6_{r'2}$ 37.92m line of running of 2nd. lane (axis),
7 centre point semi-circle

Length of 400m Standard Track

| | | |
|---|---|---|
| 2 straights of 84.39m each | = | 168.78m |
| 2 semi-circle bends (line of running) of 36.80m x 3.1416 = 115.61m each | = | 231.22m |
| Total | | 400.00m |

theoretical line of running. The length of each of the other lanes is measured along a theoretical line of running 0.20m from the outer edge of the adjacent inside lane (Fig 2.2.1.1b). All lanes have a width of 1.22m ± 0.01. The 400m Standard Track has 8, 6 or occasionally 4 lanes.

#### 2.2.1.2 Gradients of the 400m Standard Track

The kerb of the 400m Standard Track must be laid horizontally throughout.
The lateral inclination of the track shall not exceed 1.0% inwards and the overall inclination in the running direction shall not exceed 0.1% downwards. It is recommended that the design lateral inclination be slightly less than 1% to ensure that, because of construction inaccuracies, the 1% inclination is not exceeded.

#### 2.2.1.3 Drainage of the 400m Standard Track

For drainage of the 400m Standard Track, see 3.5.

#### 2.2.1.4 Dimensional Accuracy of the 400m Standard Track

The dimensional accuracy required for all classes of competition is deemed fulfilled if the following set values are attained in the "28 Point Control Readings" (Fig 2.2.1.4a) on the outside edge of the inner track border:

- 84.39m ± 0.005m for each of the two straights (2 readings)
- 36.50m ± 0.005m for 12 points per semi-circle (including kerb) on the arc of the circle approximately 10.42m apart (24 readings)
- Alignment of the kerb in the area of the two straights: no deviations greater than 0.01m (2 readings).

The 28 point control measurement should be carried out and the readings recorded.The average of the deviations must not exceed + 0.04m nor be less than 0.00m (Table 2.2.1.4).

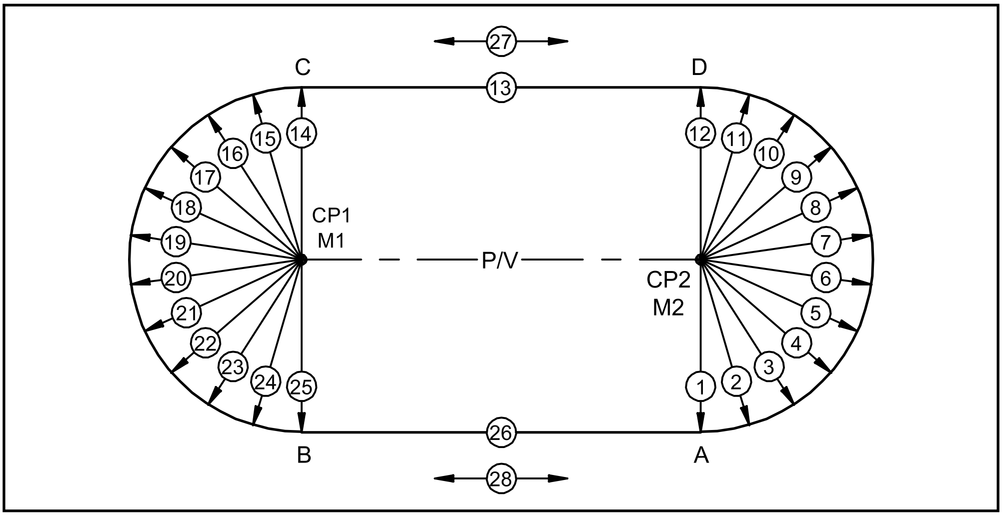



**Figure 2.2.1.4a - 28 point control measurement of 400m Standard Track**
P/V = Prerequisite: Distance from the centres of the semi-circles (CP/M): 84.39m (± 0.005)
Measurement 1-12 and 14-25: 36.50m resp. (± 0.005 recommended)
Measurement 13 and 26: 84.39m resp. (± 0.005 recommended)
27 and 28: alignment of the straights (permissible deviation of 0.01m)
The readings ascertained for 1-12 and 14-27 must be equalized in the light of the record of 28 point control measurement (Table 2.2.1.4). The track length calculated after equalization may not be less than 400.00m or more than 400.04m.

These control readings also form the basis of the layout of the kerb on whose dimensional accuracy the dimensional accuracy of all markings for the 400m Standard Track depends.

| ***COLUMN*** | ***1*** | ***2*** | ***3*** | ***4*** |
|---|---|---|---|---|
| ***Line 1*** | ***Measurement in accordance with Fig 2.2.1.4a*** <br> ***Number*** | ***Measuring result*** <br> ***m*** | ***Deviation from the desired value[1)]*** <br> ***± mm*** | ***Calculation of the running length based on average deriation*** <br> ***m*** |
| ***2*** | 1 | 36,502 | + 2 | |
| ***3*** | 2 | 36.503 | + 3 | |
| ***4*** | 3 | 36.502 | + 2 | |
| ***5*** | 4 | 36.501 | + 1 | |
| ***6*** | 5 | 36.499 | - 1 | |
| ***7*** | 6 | 36.497 | - 3 | |
| ***8*** | 7 | 36.500 | ± 0 | |
| ***9*** | 8 | 36.501 | + 1 | |
| ***10*** | 9 | 36.505 | + 5 | |
| ***11*** | 10 | 36.502 | + 2 | |
| ***12*** | 11 | 36.500 | ± 0 | |
| ***13*** | 12 | 36.500 | ± 0 | |
| ***14*** | Average of measurements 1 to 12= | | +12:12=+1 | 1.Semi-circle 0.001m x 3.1416= + 0.0031416m |
| ***15*** | 14 | 36.498 | - 2 | |
| ***16*** | 15 | 36.497 | - 3 | |
| ***17*** | 16 | 36.500 | ± 0 | |
| ***18*** | 17 | 36.502 | + 2 | |
| ***19*** | 18 | 36.503 | + 3 | |
| ***20*** | 19 | 36.505 | + 5 | |
| ***21*** | 20 | 36.505 | + 5 | |
| ***22*** | 21 | 36.504 | + 4 | |
| ***23*** | 22 | 36.501 | + 1 | |
| ***24*** | 23 | 36.503 | + 3 | |
| ***25*** | 24 | 36.504 | + 4 | |
| ***26*** | 25 | 36.502 | + 2 | |
| ***27*** | Average of measurements 14 to 25= | | +24:12=+2 | 2.Semi-circle 0.002m x 3.1416 = + 0.0062832m |
| ***28*** | 13 | 84.393 | + 3 | |
| ***29*** | 26 | 84.393 | + 3 | |
| ***30*** | 27 | 0.005 | - | |
| ***31*** | 28 | 0.008 | - | |
| ***32*** | Total deriation of measurements 13 and 26 = | | + 6 | 2 Straights + 0.006m |

*1)Desired value for 1 to 12 and 14 to 25: 36.500m*
*Desired value for 13 and 26: 84.390m*
*Desired value for 27 and 28: Alignment*
*Permitted deviation from desired value for 1 to 26: ± 0.005m*
*Permitted deviation from alignment for 27 and 28: 0.01m*
*Permitted tolerance of the running length: + 0.04m max.*

Deviation from the running length

| | |
|---|---|
| 1.Semi-circle | + 0.0031416m |
| 2.Semi-circle | + 0.0062832m |
| 2 Straights | + 0.0060000m |
| Total: | + 0.015400m |
| permitted max. | + 0.0400000m |

**Table 2.2.1.4 - Record of 28-Point-control-measurement (Example with readings)**

These control readings can also be used for other 400m oval tracks if the relevant measurements for the straights and radii are included (See 2.2.1.8).
For the construction of the arcs and for the 28 point control readings, the centres of the two semi-circles must be marked by permanent non-corrodable metal tubes placed 84.39m apart.
Tube diameter approximately12mm, clear height above foundation 0.15m, foundation diameter min 0.20m, min 1.0m depth down to frost free soil, top edge 0.15m beneath the finished surface. Second tube with diameter of 0.04m to protect the “measuring tube” (Fig 2.2.1.4b).

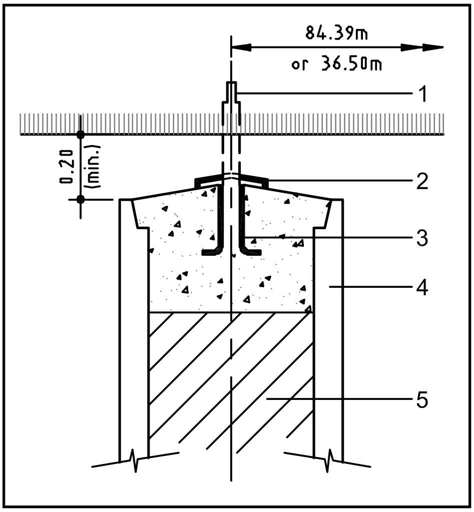



**Figure 2.2.1.4b - Marking of centre of semi-circle**
(Proposal for construction)
(Dimensions in m)

1 Stainless steel bolt
2 socket covered with stainless steel lid
3 stainless steel socket inserted into mortar in exact vertical position
4 steel tube in concrete foundation
5 gravel sand

### 2.2.1.5 The Safety of the 400m Standard Track

The 400m Standard Track must have an obstacle-free zone on the inside at least 1.00m wide and should have on the outside an obstacle-free zone at least 1.00m wide. Any drainage system positioned under the kerb must be flush with the surface and level with the track.
The outer obstacle-free zone must also be flush with the outer edge of the track.

### 2.2.1.6 Marking for the 400m Standard Track (Fig 2.2.1.6a)

All lanes shall be marked by white lines. The line on the right hand of each lane, in the direction of running, is included in the measurement of the width of each lane.
All start lines (except for curved start lines) and the finish line shall be marked at right angles to the lane lines.
Immediately before the finish line, the lanes may be marked with numbers with a minimum height of 0.50m.
All markings are 0.05m wide.
All distances are measured in a clockwise direction from the edge of the finish line nearer to the start to the edge of the start line farther from the finish.
The data for staggered starts for 400m-Standard Track (constant lane width of 1.22m) is listed in table 2.2.1.6a.

| *DISTANCE ON RUN-NING LINE* | *MARKING PLAN AREA* | *BENDS RUN IN LANES* | *LANE 2* | *LANE 3* | *LANE 4* | *LANE 5* | *LANE 6* | *LANE 7* | *LANE 8* |
|---|---|---|---|---|---|---|---|---|---|
| 200 | C | 1 | 3.519 | 7.352 | 11.185 | 15.017 | 18.850 | 22.683 | 26.516 |
| 400 | A | 2 | 7.038 | 14.704 | 22.370 | 30.034 | 37.700 | 45.366 | 53.032 |
| 800 | A | 1 | 3.526 | 7.384 | 11.260 | 15.151 | 19.061 | 22.989 | 26.933 |
| 4x400 | A | 3 | 10.564 | 22.088 | 33.630 | 45.185 | 56.761 | 68.355 | 79.965 |

**Table 2.2.1.6a - Staggered start data for the 400m-Standard Track only (in m)**

All lanes and start lines shall be measured as indicated in 2.2.1.4. The deviation from the running length of all start lines must not exceed +0.0001xL nor be less than 0.00m where L is the length of the race in metres.
All track markings shall be in accordance with “IAAF 400m Standard Track Marking Plan” (Fig 2.2.1.6a inserted in the inside back cover of this Manual).

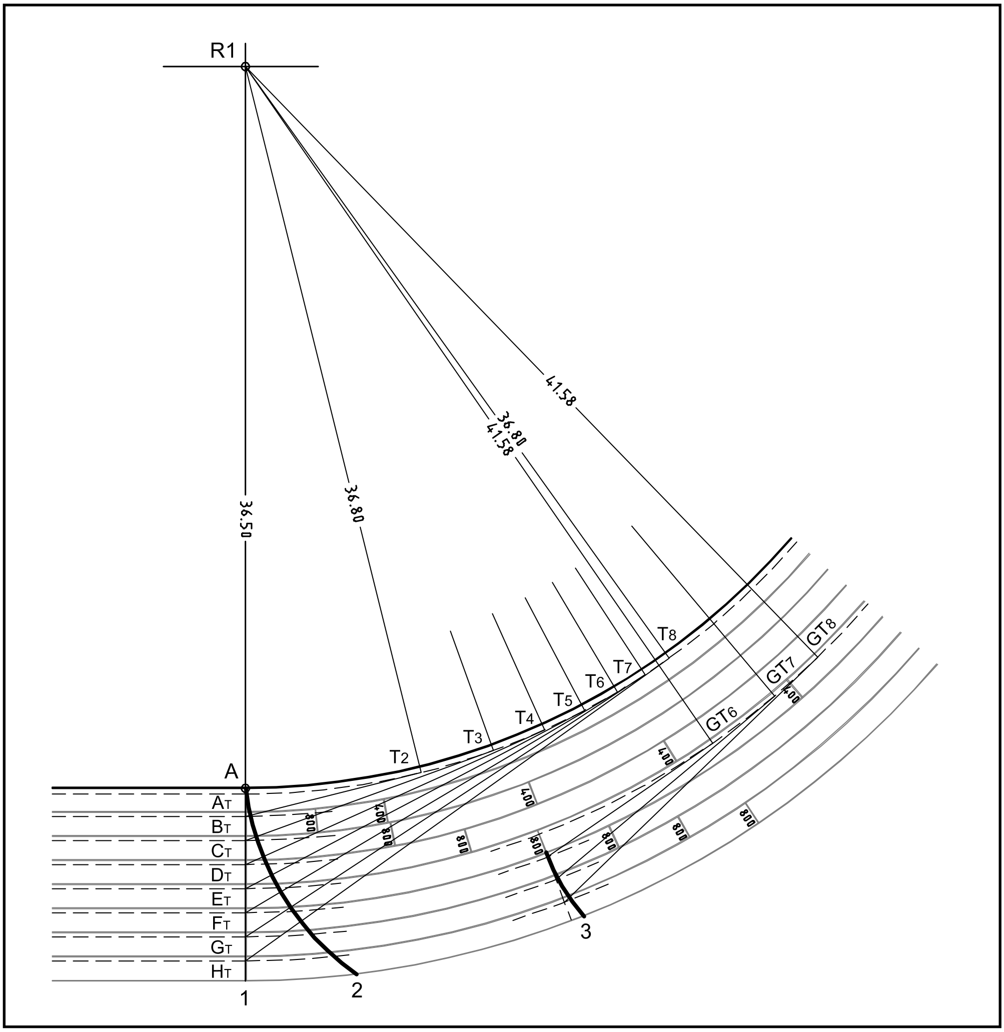



**Figure 2.2.1.6b - Start and Group start marking for 2000m and 10,000m in the first curve**

| | |
|---|---|
| R1 to A | construction line 36.50m |
| R1 to AT | construction line 36.80m |
| R1 to BT | construction line 36.80m + 1.12 |
| R1 to CT ... HT | construction line 37.92m + 1.22 each |
| T2 to T8 | tangent points |
| GT6 to GT8 | tangent points for group starts |

1 Finish line
2 start line 2000m and 10,000m
3 start line group starts 2000m and 10,000m

*Source: Swedish Athletic Federation*

Except where their use may interfere with the photofinish equipment, two white posts may be placed along the prolongation of the finish line at least 0.30m from the edge of the track. They should be of rigid construction and approximately 1.40m high, 0.08m wide and 0.02m thick.
To assist alignment of the photo-finish equipment and to facilitate the reading of the photo finish the intersection of the lane lines and the finish line shall be painted black in a suitable design.
The essential requirement for all start lines, straight, staggered or curved, is that the distance for every athlete, when taking the shortest permitted route, shall be the same, and not less than the stipulated distance, i.e. no negative tolerance.
For races of 800m or less, each athlete shall have a separate lane at the start.

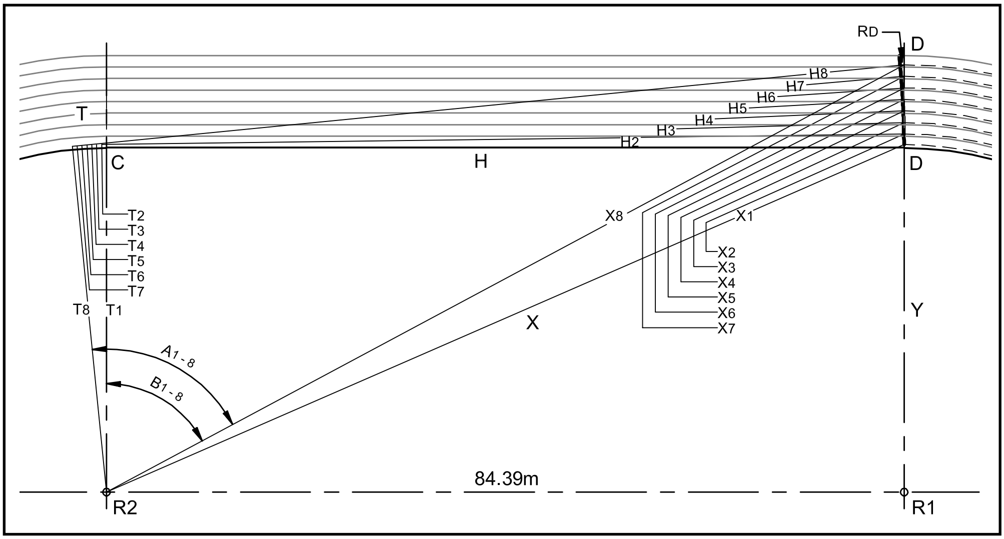



**Figure 2.2.1.6c - Break line marking for 800m races (see also Table 2.2.1.6b)**

| | | | |
|---|---|---|---|
| X | distance R2 to D1/D8 | T | tangent points T2/T8 |
| Y | distance R1 to D1/D8 | RD | deviation of break line from B/B line |
| H | distance H2/H8 to T2/T8 | C and D | points on the kerb of the track |

*Source: Swedish Athletic Federation*

| *LANE* | *X R2 TO B* | *Y R1 TO B* | *ANGLE A* | *ANGLE B* | *A - B = ARCANGLE* | *ARC-LENGTH* | *84.39 + ARCLENGTH* | *HYPOTE-NUSE H* | *REDUC-TION** |
|---|---|---|---|---|---|---|---|---|---|
| *1* | 92.06 | 36.80 | 73.82 | 73.82 | 0 | 0 | 84.39 | 84.39 | 0 |
| *2* | 92.5181 | 37.92 | 73.958 | 73.115 | 0.843 | 0.487 | 84.877 | 84.884 | 0.007 |
| *3* | 93.02 | 39.14 | 74.106 | 72.358 | 1.748 | 1.01 | 85.40 | 85.431 | 0.031 |
| *4* | 93.545 | 40.36 | 74.26 | 71.601 | 2.659 | 1.537 | 85.927 | 86.002 | 0.075 |
| *5* | 94.077 | 41.58 | 74.414 | 70.856 | 3.558 | 2.0567 | 86.447 | 86.581 | 0.134 |
| *6* | 94.623 | 42.80 | 74.569 | 70.118 | 4.451 | 2.573 | 86.963 | 87.174 | 0.211 |
| *7* | 95.18 | 44.02 | 74.728 | 69.389 | 5.339 | 3.086 | 87.476 | 87.778 | 0.302 |
| *8* | 95.75 | 45.24 | 74.886 | 68.672 | 6.214 | 3.592 | 87.982 | 88.396 | 0.414 |

** Not measured in the theoretical running-line but in the H-line!*

**Table 2.2.1.6b - Calculation figures for breakline marking for 800m races for the 400m-Standard Track only (in m, angles in gon)**

*Source: Swedish Athletic Federation*

Races of up to, and including 400m shall be run entirely in lanes. Races of 800m shall start and continue in lanes (Fig 2.2.1.6b) until the end of the first bend (Fig 2.2.1.6c and Table 2.2.1.6b).
The exit from the first bend shall be marked distinctively with a 0.05m wide line (break line) across the track and by a flag at least 1.50m high positioned on each side of the track to indicate when the athletes can break from their lanes (Fig 2.2.1.6c). To assist competitors identify the breakline, small cones or prisms (5cm x 5cm) and no more than 15cm high of the same colour as the breakline may be placed on the intersection of each lane and the breakline. Races over 800m shall be run without lanes using a curved start line.

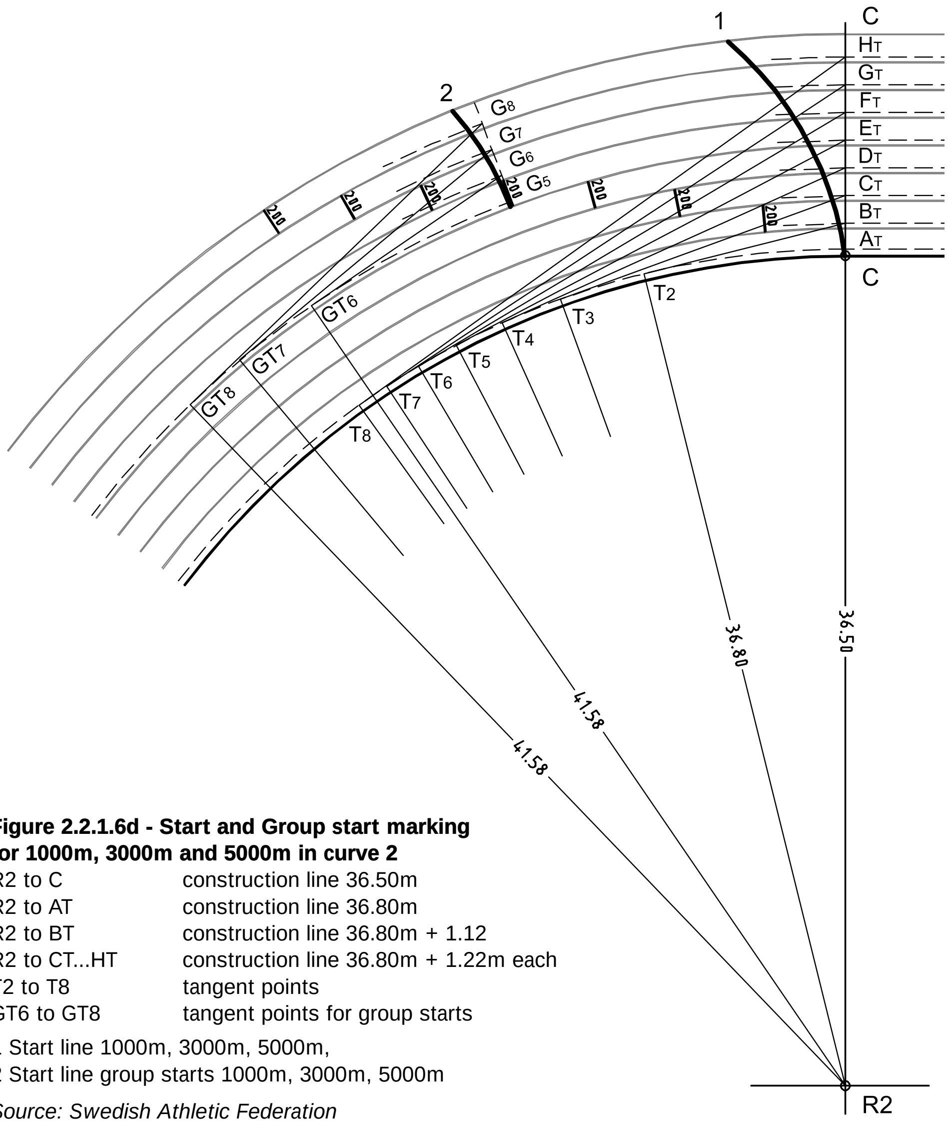



**Figure 2.2.1.6d - Start and Group start marking for 1000m, 3000m and 5000m in curve 2**

| | |
|---|---|
| R2 to C | construction line 36.50m |
| R2 to AT | construction line 36.80m |
| R2 to BT | construction line 36.80m + 1.12 |
| R2 to CT...HT | construction line 36.80m + 1.22m each |
| T2 to T8 | tangent points |
| GT6 to GT8 | tangent points for group starts |

1 Start line 1000m, 3000m, 5000m,
2 Start line group starts 1000m, 3000m, 5000m

*Source: Swedish Athletic Federation*

For the 1000m, 2000m, 3000m, 5000m and 10,000m, when there are more than 12 competitors in a race, they may be divided into two groups with one group of approximately 65% of the competitors on the regular arced start line and the other group on a separate arced start line marked across the outer half of the track. The other group shall run as far as the end of the first bend on the outer half of the track (Fig 2.2.1.6b and 2.2.1.6d).

The separate arced start line shall be marked in such a way that all the competitors shall run the same distance. A cone or other distinctive mark shall be placed on the inner line of the outer half of the track at the beginning of the following straight to indicate to the athletes of the outer group where they are permitted to join the runners using the regular start line. For 2000m and 10,000m this point is at the intersection of the 800m break line and the inner line.

For the 4 x 400m relay races, the echelon starting positions for the first runners in each lane should be marked as shown in the IAAF 400m Standard Track Marking Plan.

The scratch lines of the first take-over zones are the same as the start lines for the 800m.

Each take-over zone shall be 20m long of which the scratch line is the centre.

The zones shall start and finish at the edges of the zone lines nearest the start line in the running direction.

The take-over zones for the second and last take-overs shall be marked 10m either side of the start/finish line.

The arc across the track at the entry to the back straight showing the positions at which the second stage runners are permitted to leave their respective lanes, shall be identical to the arc for the 800m event.

#### 2.2.1.7 Official Acceptance of the 400m Standard Track

All tracks to be used for IAAF competition must have a current IAAF Certificate. Such certificates will only be issued upon submission of full details including actual measurements of all lanes, staggers and take over zones. Application forms are available from IAAF.

#### 2.2.1.8 Other Layouts for the 400m Oval Track (Fig 1.2.3b to d and Table 1.2.3a)

Radii other than between 35.00m and 38.00m should not be used, except for double bend tracks where the dimensions of which ensures an infield size adequate for rugby. In this case the minimum radius must not be less than 24.00m.

### *2.2.2 THE STRAIGHT AS A COMPONENT OF THE 400M STANDARD TRACK*

#### 2.2.2.1 Layout of the Straight Integrated within the 400m Standard Track

(Fig 2.2.2.1). The straight with a minimum of 6 lanes is integrated into the 400m oval track. As for all distances, it is measured from the edge of the finish line nearest to the start line backwards. The straight shall incorporate a starting area, 3m min., and run-out, 17m min.

If the track has an unbound mineral surface (See 3.2), it is recommended that the straight should have one lane more than the oval track in order to conserve the more frequently used inside lane.

#### 2.2.2.2 Gradients of the Straight Integrated within the 400m Standard Track

The uniform radial inclination from the track kerb shall be 1% or less across the track and that inclination shall be continued to the outer extremities of any chutes. The result is that the kerb at the outer edge of the chute parallel to the straight curves upwards at an increasing rate. Whilst the inclination on the outer lanes between the 110m and 100m starts exceeds 1 in 1000, the inclination from the 110m start to the finish line does not (Fig 2.2.2.2). Also the gradient between the 110m start and the tangent point is not straight but curved.

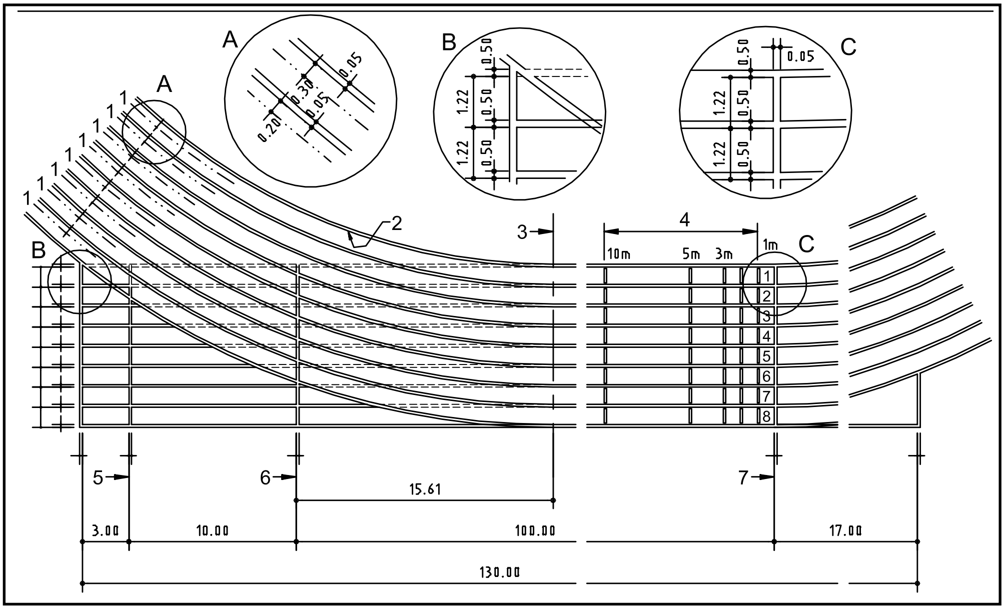



**Figure 2.2.2.1 Marking of the straight incorporated within the 400m Standard Track Layout plan Kerb width min. 5cm** (Dimensions in m)

1 Measurement line (line of running) for oval track
2 inside edge of the track
3 axis through semi-circle centre
4 distance determination lines (optional)
5 start line for 110m
6 start line for 100m
7 finish line

## *2.2.3 THE HURDLE RACE TRACK INTEGRATED WITHIN THE 400M STANDARD TRACK*

### 2.2.3.1 Layout, Gradients and Marking of the Hurdle Race Track Integrated within the 400m Standard Track

The standard 400m track (2.2.1) and the sprint track with 100m and 110m (2.2.2) can be used for hurdle races. The hurdle positions shall be marked on the track by lines 100mm x 50mm so that the distances measured from the start to the edge of the line nearest the approaching athlete are in accordance with table 2.2.3.1.
The hurdles shall be placed so that the edge of the bar nearest the approaching athlete coincides with the edge of the track marking nearest the athlete.

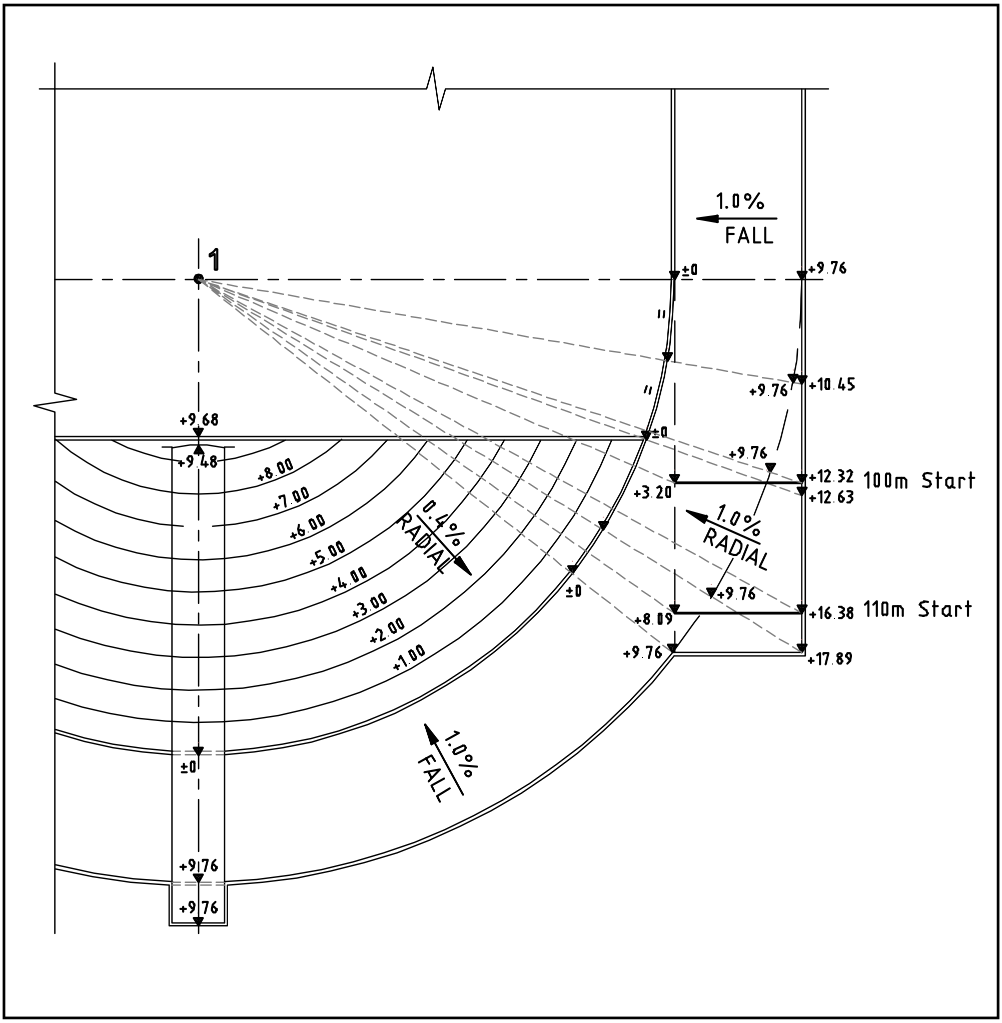



**Figure 2.2.2.2 - Segment of 400m Standard Track at start area with radial slope of 1.0% (dimensions of heights in cm)**

| *COLUMN* | *1* | *2* | *3* | *4* | *5* | *6* |
|---|---|---|---|---|---|---|
| *Line* | | | | | | |
| *1* | *Distance of Race* | *Height of Hurdle*[2)] | *Distance from Startline to first Hurdles* | *Distance between Hurdles* | *Distance from last Hurdle to Finishline* | *Number of Hurdles* |
| *2* | 100m women | 0.838m | 13.00m | 8.50m | 10.50m | |
| *3* | 110m men | 1.067m | 13.72m | 9.14m | 14.02m | 10 |
| *4* | 400m women | 0.762m | 45.00m | 35.00m | 40.00m | |
| *5* | 400m men | 0.914m | | | | |

*1)The staggering of the hurdle positions in the outer lanes of the standard 400m track for 400m hurdle races can be seen in Figure 2.2.1.6a.*
*2)Tolerance of ± 0.003m*

**Table 2.2.3.1 - Hurdle number, height and position[1)]**

## *2.2.4 THE STEEPLECHASE TRACK INTEGRATED WITHIN THE 400M STANDARD TRACK*

### 2.2.4.1 Layout of the Steeplechase Track Integrated within the 400m Standard Track

The steeplechase track is integrated into the 400m Standard Track .
For the steeplechase track, a total of 5 hurdles is required, if possible at equal distances apart. One of them forms part of the water jump.
The water jump (3.66m x 3.66m x 0.70m - Fig 2.2.4.1c) is permanently installed inside the Standard Track in the 2nd segment (Figs 2.2.4.1a and 2.2.4.1d) or outside the Standard Track outside the 2nd bend (Figs 2.2.4.1b and 2.2.4.1e). The water jump track inside the segment is connected to the main track by a transitional arc (radius 16.00m), and the water jump outside the segment by a transitional straight (17.22m) followed by a transitional arc (radius 29.04m) and a straight (length 11.26m). If the water jump bend is located inside the track, the kerb of the Standard Track must be removable at the beginning and end of the water jump bend.
If the steeplechase track inside the bend is not bordered by a fixed kerb, it must be marked by a white line. Measurement of the track must be taken from a theoretical distance of 0.20m outward from this line. The same applies to the running line for water jumps outside the segment. The theoretical running line for the steeplechase track is 3.916m shorter in the segment containing the water jump than along the adjacent Standard Track (Fig 2.2.4.1a), for example the length of the steeplechase lap with the water jump inside the segment is 396.084m.
The theoretical running line for the steeplechase track outside the segment is 19.407m longer than along the adjacent Standard Track (Fig 2.2.4.1b), giving a steeplechase lap with the water jump outside the segment of 419.407m.
The top of the water jump pit shall be level. The crossfall of the adjoining synthetic shall be warped so as to provide a smooth transition.

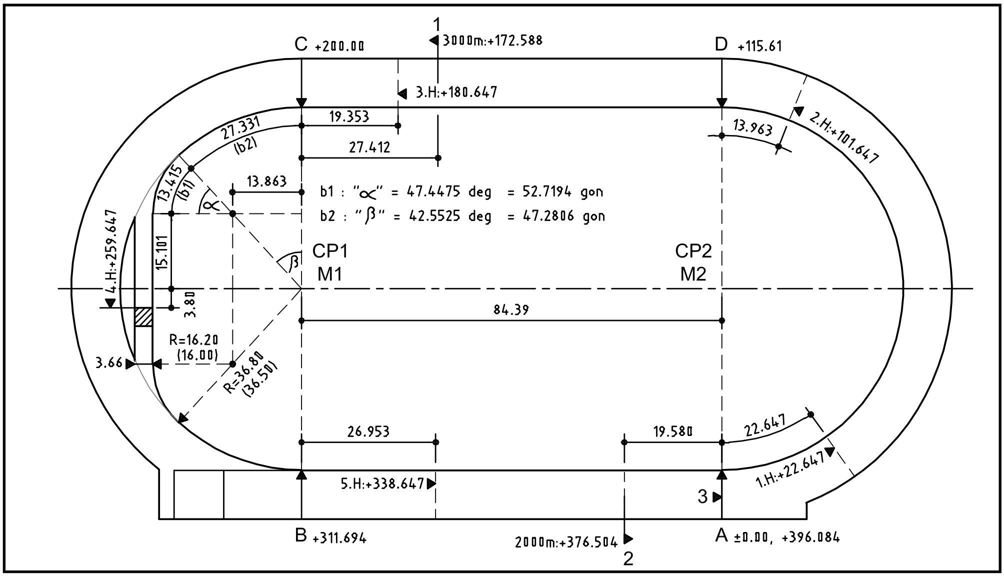



**Figure 2.2.4.1a - Steeplechase track with water jump inside the bend of 400m Standard Track without a fixed kerb** (Dimensions in m) (see Appendix Chapter 2)

1 Start for 3000m: + 172.588, 2 Start for 2000m: + 376.504
3 Finish line, also start and finish of steeplechase lap A ± 0.00 and + 396.084

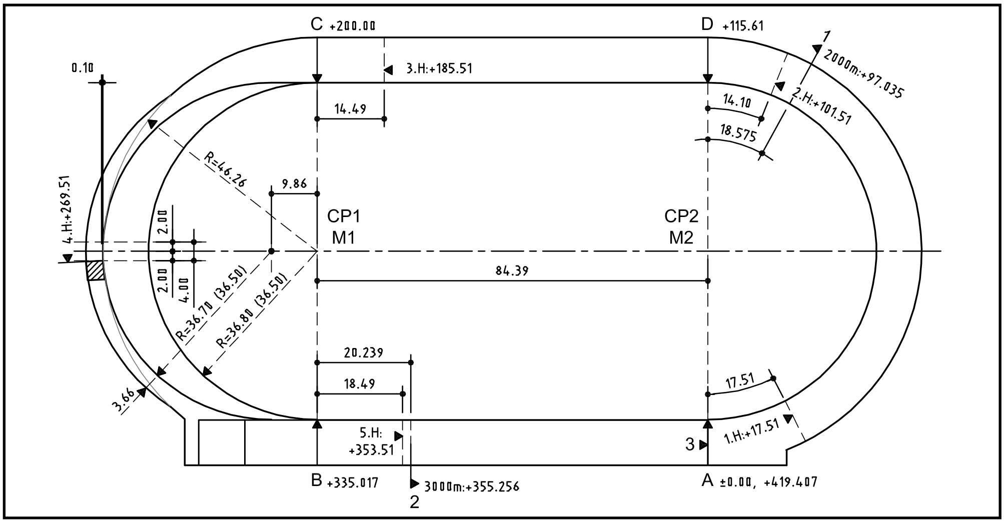



**Figure 2.2.4.1b Steeplechase track with water jump outside the bend of 400m Standard Track**
(Dimensions in m) (See Appendix Chapter 2)
1 Start for 2000m: + 97.035m 2 Start for 3000m: + 355.256m
3 Finish line, also start and finish of steeplechase lap A ± 0.0 and + 419.407

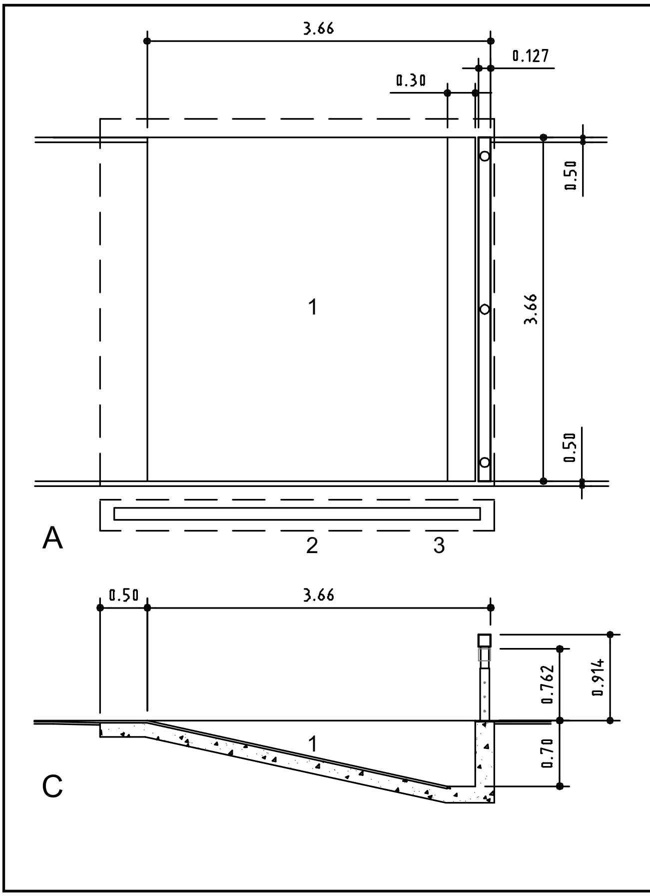



**Figure 2.2.4.1c Water jump for steeplechase track**
(Dimensions in m)
A Layout plan
B Cross Section
C Longitudinal Section

1 Synthetic surface, 20 to 25mm
2 drainage gutter
3 closeable drain

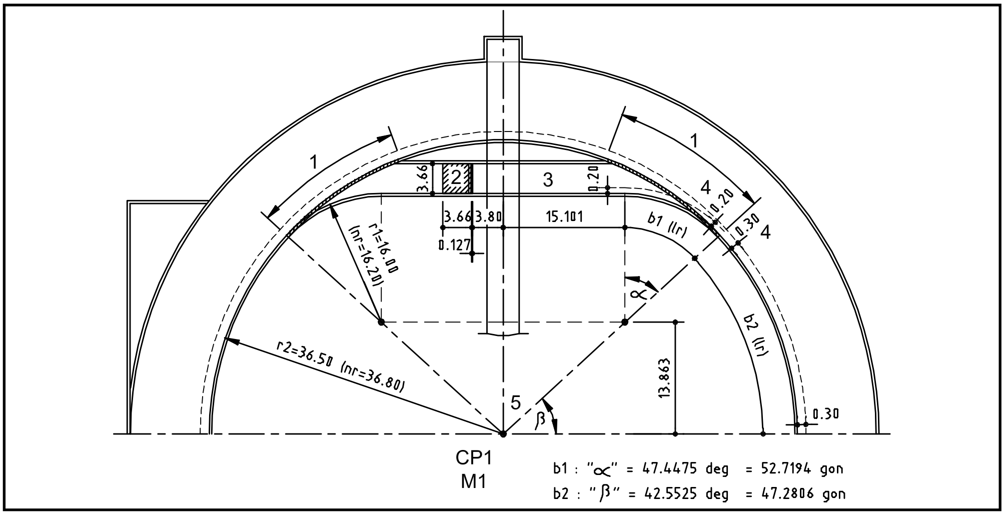



**Figure 2.2.4.1d - Water jump on inside bend** (Dimensions in m)
The length of running of the water jump bend is 3.916m shorter than the bend of the semicircle

$$b = r \times \pi \times \frac{\alpha°}{180°}$$

(For the calculation of the length of running of the steeplechase track in the segment: Distance between the line of running and the marking: 0.20m)

$$b_{1\ lr} = 16.20 \times 3.1416 \times \frac{47.4475}{180} = 13.415m$$

$$b_{2\ lr} = 36.80 \times 3.1416 \times \frac{42.5525}{180} = 27.331m$$

Straight = 2 x 15.101 = 30.202m

length of running of water jump bend
2 x 13.415 + 2 x 27.331 + 2 x 15.101 = 111.694m
length of running of semi circle bend
36.8 x 3.1416 = 115.61m
Transition bend with 16 m radius

1 Removeable track border, 2 water jump, 3 straight,
4 distance between line of running and track inside edge,
5 centre point semicircle

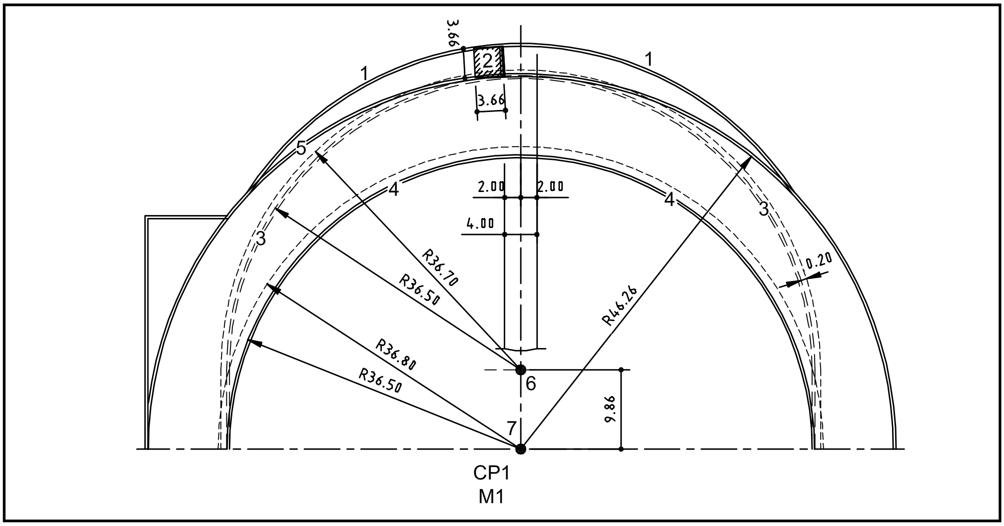



**Figure 2.2.4.1e - Water jump on outside bend** (Dimensions in m)
Distance of the line of running from the inner track marking: 0.20m (r = 36.70)
Length of the line of running of the water jump bend 19.407m longer than the semi circle bend of the Standard Track (115.61m)
Length of running : 9.86 x 2 + 36.7 x 3.1416 = 135.017m

1 Outer track border (flush mounted), 2 water jump, 3 marking (track surface), 4 inner track border (0.05m high),
5 outer track border (flush mounted), 6 centre point additional circle, 7 centre point semi circle

#### 2.2.4.2. Safety of the Steeplechase Track Integrated within the 400m Standard Track

When not in use, the water jump should be completely covered level with the surrounding surface.

#### 2.2.4.3 Marking for the Steeplechase Track Integrated within the 400m Standard Track

For the marking, apply Section 2.2.1.6 analogously. The position of the starting lines and the hurdles depends on the position of the water jump. This is shown in figures 2.2.4.1a, 2.2.4.1b, 2.2.4.1d and 2.2.4.1e. The dimensions given apply to the running line of the respective steeplechase laps. The positions of the hurdles should be marked on the inside perimeters of the track.

#### 2.2.4.4 Suitability for Competition and Official Acceptance of the Steeplechase Track Integrated within the 400m Standard Track

The suitability for competition and official acceptance of the track are established within the inspection of the 400m Standard Track.

## 2.3 Facilities for Jumping Events

The Jumping events are long jump, triple jump, high jump and pole vault. The facilities required for these are described in Section 2.1.1.2. Further details are given in Sections 2.3.1 to 2.3.4.

### *2.3.1 FACILITY FOR LONG JUMP* (See 2.1.1.2)

**2.3.1.1 Layout of the Facility for the Long Jump** (Fig 2.3.1.1a and b)

The long jump facility includes a runway, a take-off board and a landing area. Usually, it is placed outside the track along one of the straights with two adjacent runways with a landing area at each end, thus allowing competition in either direction.

**2.3.1.2 Runway for the Long Jump** (Fig 2.3.1.1a and b)

The length provided for the runway shall be 40m min. and is measured from the beginning of the runway to the take-off line. The runway shall be 1.22m ± 0.01 wide. It shall be marked by white lines 0.05m wide or broken lines 0.05m wide, 0.10m long and 0.50m apart.
The runway is usually covered with the same surface as the track.

**2.3.1.3 Take-off Board for the Long Jump** (Fig 2.3.1.1a and Chapter 6)

The take-off board shall be rectangular and shall measure 1.22m ±0.01 long, 0.20m ±0.002 wide and 0.10m ±0.01 deep. It shall be painted white.
The surface of the take-off board must be flush with the surface of the runway.
In the case of a runway with a permanent surface, this requires a built-in installation tray made of corrosion-protected metal in which the take-off board can be correctly positioned. During sport-free periods, the take-off board can be removed. If it has a track surface on its reverse side, it can be turned over and used as part of the runway. This makes it possible to combine long and triple jump with two or three take-off boards (which can be used on both sides) on a triple jump runway.
(For the take-off board itself, see also Chapter 6.)

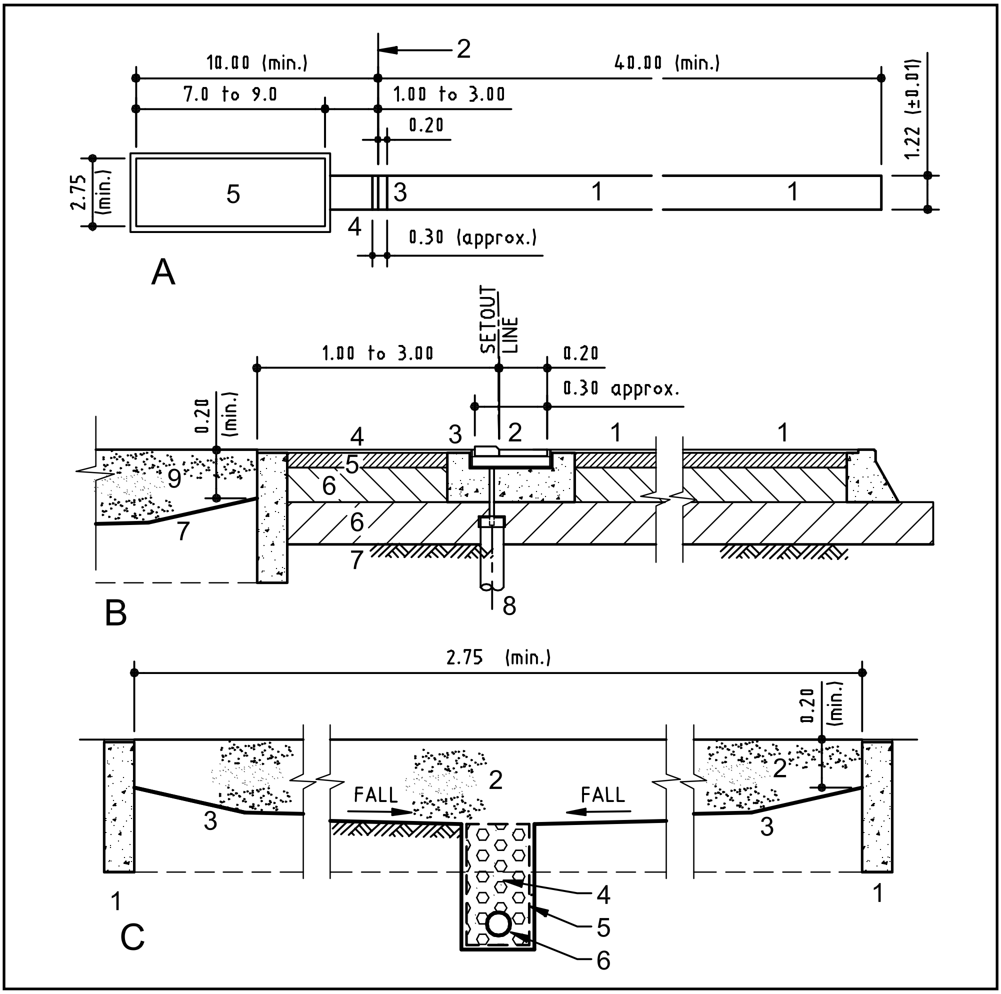



**Figure 2.3.1.1a Facility for the long jump**

A Layout plan (Dimensions in m)

1 Runway 40m (min.)
2 take-off line
3 take-off board
4 built-in tray
5 landing area

B Longitudinal section of built-in tray for take-off board (Dimensions in m)

1 Runway
2 removeable take-off board with adjustable legs
3 built-in tray
4 synthetic surface
5 asphaltic concrete layer
6 gravel base layer
7 subgrade
8 tray drainage
9 landing area

C Cross section of landing area (Dimensions in m)

1 Pit edge
2 washed river sand 0 to 2mm graining, no organic components, max. 5% of weight upto 0.20mm
3 subgrade, 3cm
4 drainage gravel
5 geo fabric material
6 subsoil drainage pipe

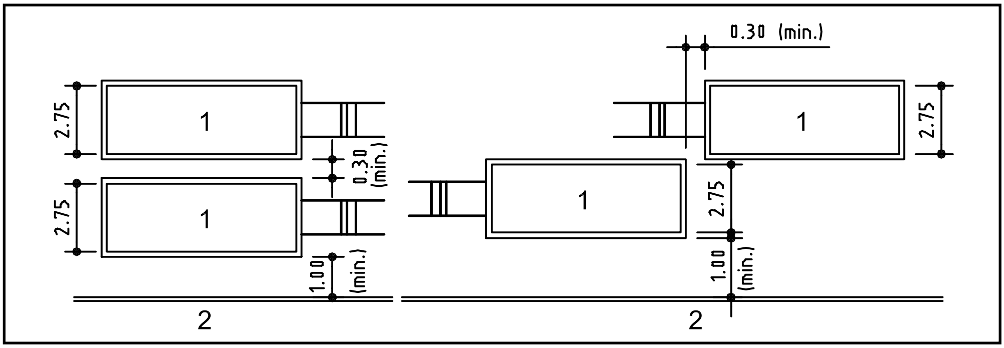



**Figure 2.3.1.1b Minimum distance of parallel adjacent long and triple jump facilities**
(Dimensions in m) 1 Landing area 2 outer track

### 2.3.1.4 Landing Area for the Long Jump (Fig 2.3.1.1a)

The landing area must be 7m to 9m long depending on the distance between its nearer end and the take-off line and shall be 2.75m min. wide. Generally, a landing area length of 8m placed 2m from the take-off line is recommended. The landing area shall, if possible, be so placed that the middle of the runway coincides with the middle of the landing area. If two landing areas are situated parallel side by side, the distance between them must be at least 0.30m. If two landing areas are staggered, the separation between the two areas must also be at least 0.30m (Fig 2.3.1.1b).
The landing area should have a border not less than 0.05m wide and 0.20m high, rounded off towards the inside and level with the ground (e.g. wooden plank or concrete border with soft covering).
The landing area must have a water permeable substructure or a suitable drainage system (draining well or canal connection) and be filled with sand to a depth of not less than 0.20m at the edges and 0.30m in the centre.
The top edge of the border of the landing area, which also dictates the height of the sand, must be level with the take-off board.

### 2.3.1.5 Safety of the Facility for the Long Jump

For the safety of the athletes, the sand must (to avoid hardening as a result of moisture) consist of washed river sand or pure quartz sand, without organic components, maximum 2mm granules, of which not more than 5% in weight is less than 0.2mm.
It is also important to ensure that the top edge of the board of the landing area is designed using flexible material and rounded off. Take-off boards installed permanently in synthetic runways are often the cause of accidents because the unevenness which necessarily occurs in the surface between them and the runway cannot be levelled out. This can be alleviated by using adjustable take-off boards placed in metal trays.
On all occasions the overall distances between the take-off board and the far end of the landing area must be complied with.

### 2.3.1.6 Suitability for Competition and Official Acceptance of the Facility for the Long Jump

Long Jump facilities must conform to the specifications. Confirmation of this can be established within the inspection of the 400m Standard Track.

## ***2.3.2 FACILITY FOR TRIPLE JUMP*** (See 2.1.1.2)

### **2.3.2.1 Layout of the Facility for the Triple Jump** (Fig 2.3.2.1)

Except for the placement of the take-off board, the same facilities are used for Triple Jump as for Long Jump. For international competition, it is recommended that the take-off board shall be not less than 13m for men and 11m for women from the nearer end of the landing area. For other competitions, this distance shall be appropriate for the level of competition.

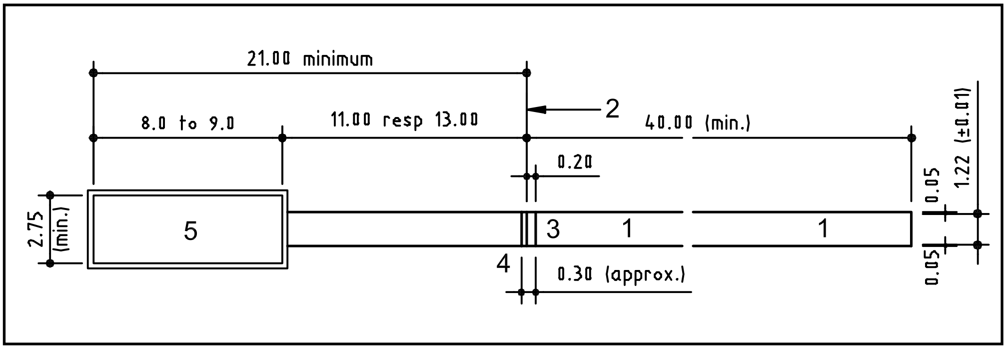



**Figure 2.3.2.1 - Facility for the triple jump** (Dimensions in m)
Layout plan
1 Runway 40m (min.), 2 take-off line, 3 take-off board, 4 built-in tray, 5 landing area

### **2.3.2.2 Runway for the Triple Jump** (Fig 2.3.2.1)

Section 2.3.1.2 also applies to the runway for the triple jump with the exception of the position of the take-off line.

### **2.3.2.3 Take-off Board for the Triple Jump** (Fig 2.3.1.1a and Chapter 6)

Section 2.3.1.3 also applies to the take-off board for the triple jump.
The integration of the triple jump into the facility for long jump requires a removable take-off board as described under Section 2.3.1.3.
For Triple Jump, Sections 2.3.1.4 to 2.3.1.6 also apply.

## ***2.3.3 FACILITY FOR HIGH JUMP*** (See 2.1.1.2)

### **2.3.3.1 Layout of the Facility for the High Jump** (Fig 2.3.3.1)

The high jump facility includes a semi-circular runway, a take-off area, two uprights with cross bar and a landing area. By removing sections of the kerb, it is possible to use the oval track as part of the runway. For major championships the high jump facility must be large enough so that two high jumps can be conducted simultaneously.

### **2.3.3.2 Runway for the High Jump** (Fig 2.3.3.1)

The semi-circular runway, with a radius of at least 20m, will permit approaches from every direction. If it is necessary to remove the kerb in order to be able to use the oval track as a runway, care must be taken to ensure that the heights of the surfaces of the oval track and the segment are the same along the track border.
The runway and take-off areas are usually covered with the same surface as the track.

### 2.3.3.3 Uprights for the High Jump (See Chapter 6)

They must be installed 4.02m ±0.02 apart.

### 2.3.3.4 Landing Mats for the High Jump (Fig 2.3.3.1 and Chapter 6)

The landing mats shall measure not less than 6m x 4m and shall be covered by a spike proof protective mat. The overall height shall be minimum 0,7 m. It should be placed on a 0.10m high grid which, on all sides shall be boarded to the ground with its front edge 0.1m behind that of the mat.

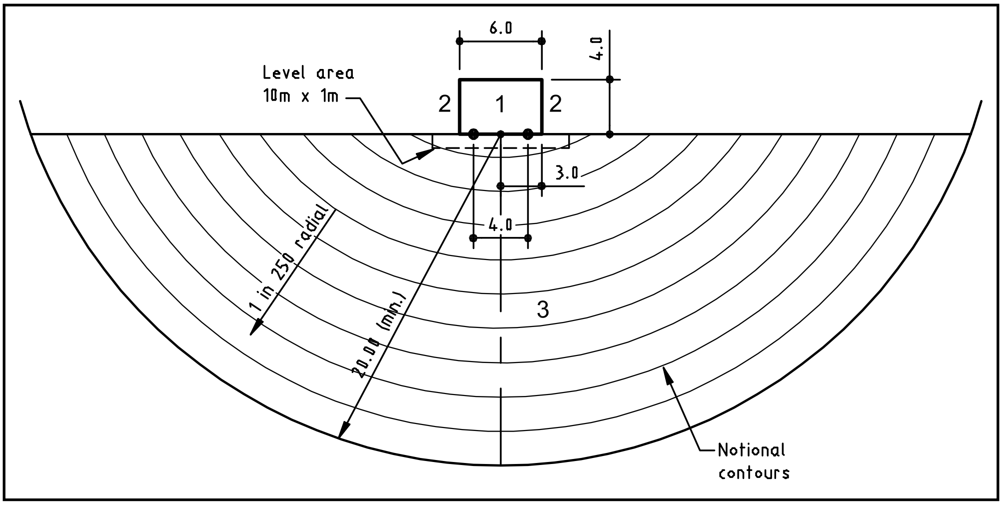



**Figure 2.3.3.1 - Facility for the high jump**
(Dimensions in m)
Layout plan 1 Landing mat, 2 uprights, 3 runway area

### 2.3.3.5 Safety of the Facility for the High Jump

Of particular importance for the safety of the high jump is a suitable landing mat which will allow both sufficient absorbtion of the impact energy from the fall of the athletes and gives adequate resilience when compressed.
If the oval track is included in the runway, a removable kerb is essential.

### 2.3.3.6 Suitability for Competition and Official Acceptance of the Facility for the High Jump

High Jump facilities must conform to the specifications. Confirmation of conformity of the runway can be established within the inspection of the 400m Standard Track.

## *2.3.4 FACILITY FOR POLE VAULT* (see 2.1.1.2 )

### 2.3.4.1 Layout of the Facility for the Pole Vault (Fig 2.3.4.1)

The pole vault facility includes a runway, a box for inserting the pole, two uprights with crossbar and a landing area. It can be located either outside the track, parallel to one of the straights or within one of the segments. When located outside the track, it is usually constructed as a “symmetrical facility” with one landing area in the middle of two run-ways. When located within a segment, it is usually

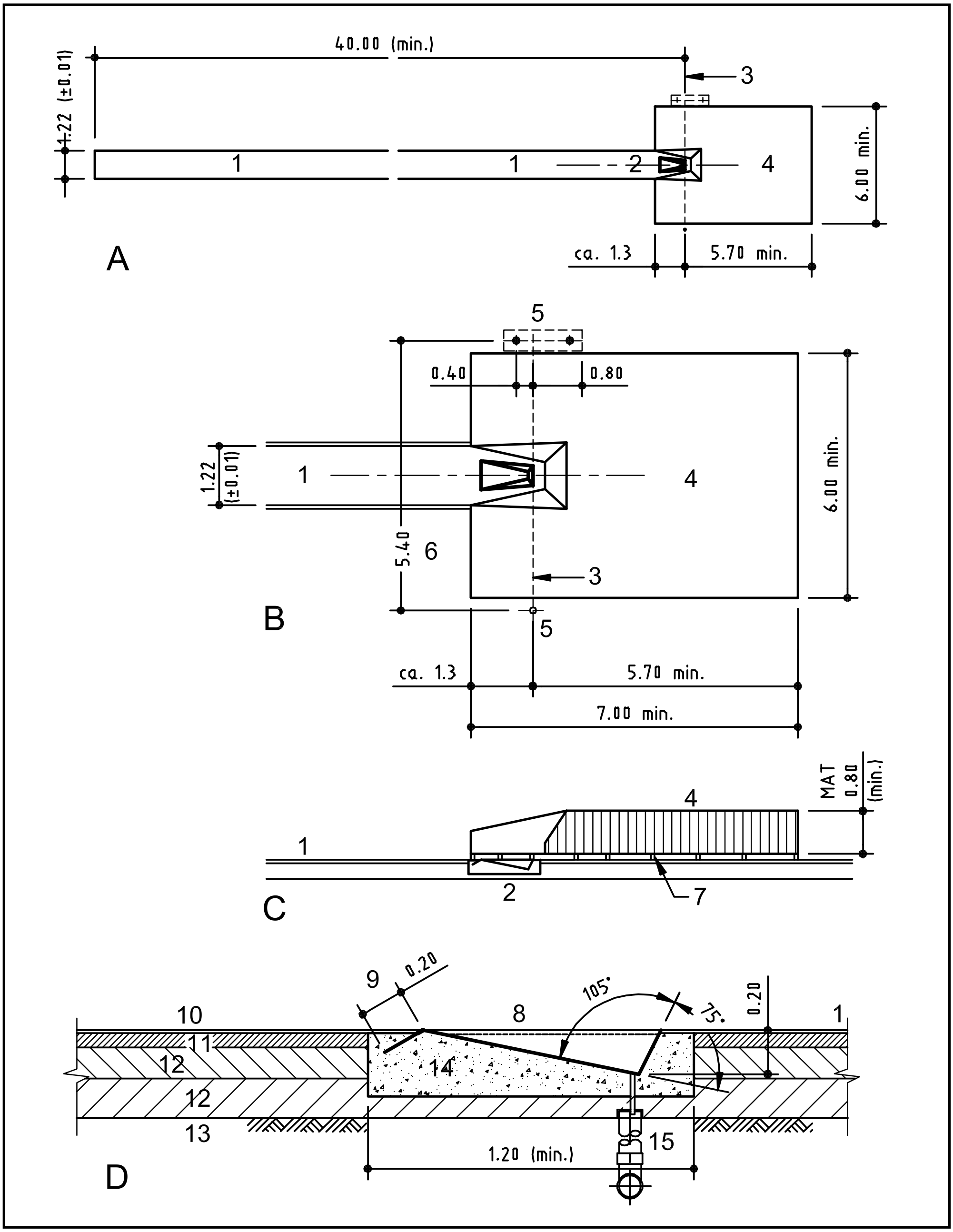



**Figure 2.3.4.1 - Facility for the pole vault** (Dimensions in m)
A Layout plan
B Detailed layout plan
C Longitudinal section
D Longitudinal section of the take-off box

1 Runway, 2 take-off box, 3 0-line, 4 landing mat, 5 installation zone or ground sockets for uprights, 6 uprights distance, 7 grid, 8 cover plate, 9 flange, 10 synthetic surface, 11 asphaltic concrete, 12 gravel base layer, 13 subgrade, 14 concrete, 15 drainage pipe

constructed with two parallel runways with positions for landing areas at each end. For major championships the pole vault facility must provide for two pole vaults to be conducted simultaneously.

**2.3.4.2 Runway for the Pole Vault with Box** (Fig 2.3.4.1)
The length provided for the runway shall be 40m min. The runway is measured from beginning of the runway to the O-line. The runway shall be 1.22m ±0,01 wide. It shall be marked by white lines 0.05m wide or broken lines 0.05m wide with a length of 0.1m and a distance of 0.5m. At the end of the runway, the box must be mounted flush with the runway and installed such that the top inside edge of its end board lies on the O-line and at the same height. The O-line shall be marked by a white line, 0.01m wide which extends beyond the outside edges of the uprights.
The dimensions of the box must comply with figure 2.3.4.1. For convenience, it should be fitted with a drainage pipe and a cover which is level with the ground. The runway is usually covered with the same surface as the track.

**2.3.4.3 Uprights for the Pole Vault** (See Chapter 6)
The two uprights must be able to be installed on horizontal bases, level with the O-line, such that each can be moved from the O-line not more than 0.40m in the direction of the runway and not more than 0.80m towards the landing area (e.g. on a built-in double rail) or in fixed sockets with movable cross bar supports.
They must be not less than 5.20m apart with approximately 0.10m between each upright and the landing mat.

**2.3.4.4 Landing Mats for the Pole Vault** (See Chapter 6)
With the exception of the dimensions, Section 2.3.3.4 shall apply for the landing mats. It shall be approximately 7.00m long, of which approximately 1.30m is in the form of a bevelled primary mat with a recess for the box, 6.00m wide.

**2.3.4.5 Safety of the Facility for Pole Vault**
For the safety of the pole vault, Section 2.3.3.4 relating to the landing mat shall apply. The uprights must be mounted such that they are not easily tilted. The pole vault box should have a cover which is level with the ground when not in use.

**2.3.4.6 Suitability for Competition and Official Acceptance of the Facility for the Pole Vault**
Pole vault facilities must conform to the specifications. Confirmation of the conformity of the runway, the arrangement of the uprights and the pole vault box can be established within the inspection of the 400m Standard Track.

## 2.4 Facilities for Throwing Events

The throwing events are the discus, the hammer, the javelin and the shot put. The facilities required for these are described under Section 2.1.1.3. Further details are listed in the Sections 2.4.1 to 2.4.5.

## *2.4.1 FACILITY FOR DISCUS THROW* (See 2.1.1.3)

### 2.4.1.1 Layout of the Facility for the Discus Throw (Fig. 2.4.1.1)

The facility for discus throw includes a throwing circle, a protective cage and a landing sector.
Usually two facilities for discus are constructed within the arena.
They are located within the segments near the ends of the back straight.
In each case, the landing sector is located in the grass area inside the track.
The facility for discus throw near the 1500m start is usually combined with a facility for hammer throw, the only difference being the diameter of the throwing circle is 2.50m for discus and 2.135m for hammer and the protective cage must meet the more stringent requirements for hammer throwing.

### 2.4.1.2 Throwing Circle for the Discus Throw (Fig 2.4.1.2)

The throwing circle shall be made of band iron, steel or other suitable material, the top of which shall be flush with the ground outside. The interior of the circle shall be constructed of concrete and must not be slippery.
The surface of the interior shall be level and 0.02m ±0.006 lower than the upper edge of the rim of the circle. The inside diameter of the circle shall be 2.50m ±0.005. The rim of the circle shall be at least 6mm thick, 70mm to 80mm deep and painted white. The centre of the circle through which all performances are measured shall be marked. (This is best done using a brass tube with a 4mm inside diameter laid flush with the surface of the circle). In addition, at the edge of the throwing circle, three evenly distributed, non-corrodable drainage pipes (e.g. brass pipe with a 20mm diameter) should be laid flush with the surface of the circle and in such a way that they reach down to the water permeable substructure or can be connected to a drainage system.
The throwing circle can be made of a minimum 0.15m thick welded wire mesh reinforced slab of 25 MPa compressive strength concrete which lies on a frost-proof supporting layer.
The throwing circle should be fixed when the concrete slab is laid. It must be radially braced. The surface of the concrete slab (= throwing area) must be finished with a smooth wood float for sufficient traction. For 1m$^3$ of 25 MPa compressive strength concrete the following quantities are required: 300 kg of cement, 135 l of water and 1865 kg of 0-20mm natural coarse aggregate. This yields a raw concrete weight of 2300 kg/m$^3$. If a material other than concrete is used for the slab, its surface properties must be equivalent to those of concrete. A white line 0.05m wide and 0.75m min. long shall be marked on either side of the circle. The rear edge of the white line shall form a prolongation of a theoretical line through the centre of the circle at right angles to the centre line of the landing sector.

### 2.4.1.3 Protective Cage for the Discus Throw (Fig 2.4.1.2 and Chapter 6)

Frequently discus and hammers are thrown from a combined facility. Therefore in those instances the higher standards required for hammer throwing apply to the protective cage design. As this Rule may be reviewed, the current edition of the IAAF Handbook should be checked.

### 2.4.1.4 Landing Sector for the Discus Throw (Fig. 2.4.1.1)

The surface of the landing sector must allow for the discus to make a mark upon landing. It may be of natural grass or other suitable material. The landing sector must be

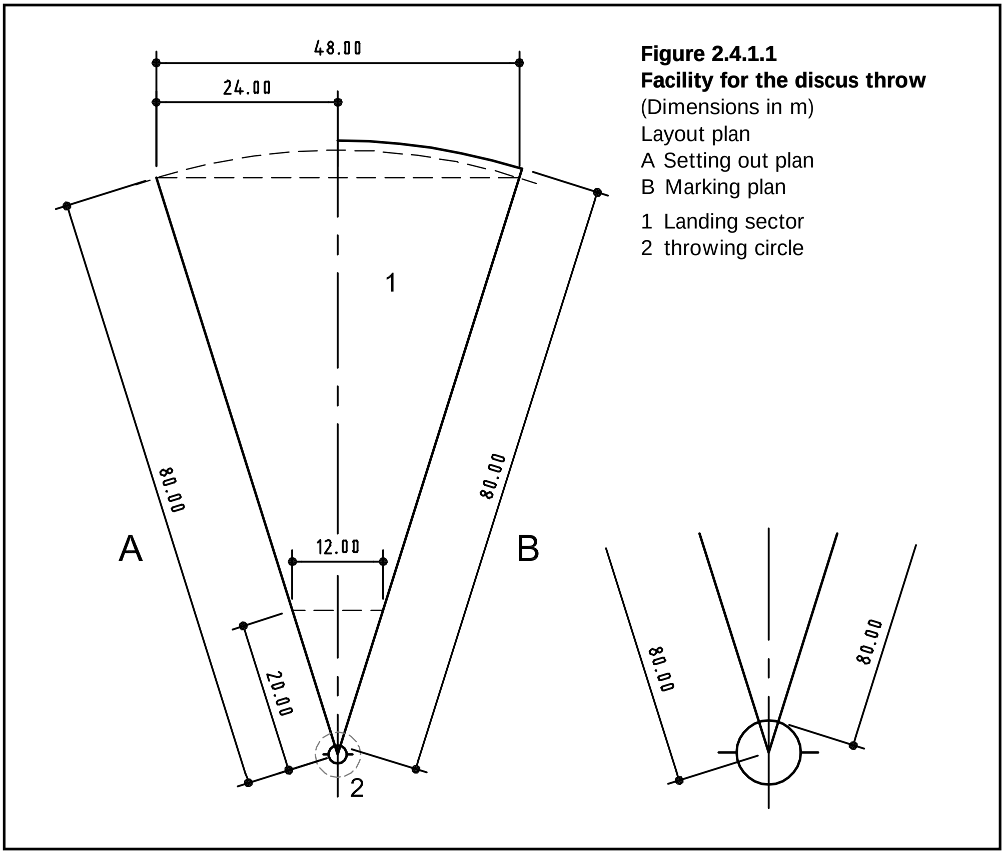



**Figure 2.4.1.1**
**Facility for the discus throw**
(Dimensions in m)
Layout plan
A Setting out plan
B Marking plan
1 Landing sector
2 throwing circle

laid from the middle of the circle with an angle of 34.92 degrees and shall be marked by 0.05m wide white lines, the inside edges of which form the boundary of the sector. The length of the sector shall be 80m. Its angle of 34.92 degrees will be attained if the two sector lines at a distance of 80m are spaced 48m apart.
The maximum allowance for the overall downward inclination of the landing sector, in the throwing direction, shall not exceed 0.1%.

#### 2.4.1.5 Safety of the Facility for the Discus Throw

The layout and erection of the protective cage are especially important for the safety of the facility for discus throw. It is important to ensure the correct position of the axis of the landing sector in relation to the opening of the cage. For the safety of the facility for the discus throw, care must be taken to ensure that nobody enters the landing sector during the throw. Therefore additional fencing at least 1.00m outside the sector lines is recommended. This fence also arrests skidding implements.

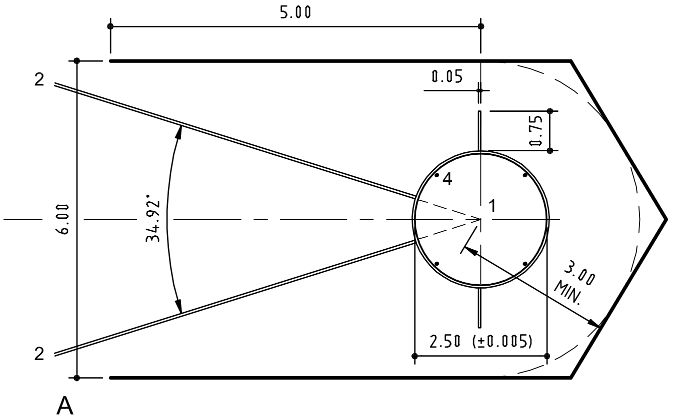
#### 2.4.1.6 Suitability for Competition and Official Acceptance of the Facility for the Discus Throw

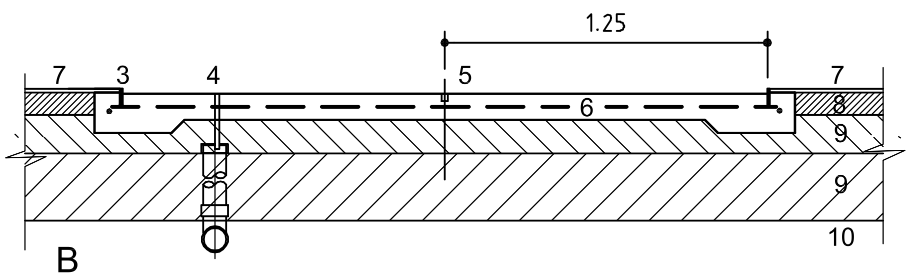
Discus throw facilities must conform to the specifications. Confirmation of this can be established within the inspection of the 400m Standard Track .

**Figure 2.4.1.2**
**Detail plan of throwing circle and cage siting for the discus throw**
(Dimensions in m)

A Layout plan
1 Centre point (intersection point of setting out plan)
2 marking for the landing sector

B Section through throwing circle
3 circular metal rim
4 drainage pipe
5 centring hole 4mm diameter (brass tube)
6 concrete ase with reinforcing mesh
7 synthetic surface
8 asphaltic concrete
9 gravel base layer
10 subgrade




***2.4.2 FACILITY FOR HAMMER THROW*** (See 2.1.1.3)

**2.4.2.1 Layout of the Facility for the Hammer Throw** (Fig 2.4.2.1)

The facility for hammer throw includes a throwing circle, a protective cage and a landing sector. It is usually combined with the facility for discus throw. Section 2.4.1 applies.

**2.4.2.2 Throwing Circle for the Hammer Throw** (Fig 2.4.2.2)

For the throwing circle Section 2.4.1.2 shall apply in general with the following exceptions:
The diameter of the throwing circle is 2.135m ± 0.005.
For a combined facility for discus and hammer throw, the diameter of the throwing circle is 2.50m ± 0.005. It is reduced in size to 2.135m ± 0.005 for hammer throw by

inserting a 0.1825m wide and 0.02m high ring of suitable construction. The inserted ring must be fixed into the throwing circle such that it is level with the outer ring and constitutes no risk to the athletes. It must be painted white. For the throwing circle for hammer throw, a shot put circle (without stop board) may also be used if it is furnished with a suitable protective cage in accordance with Section 2.4.2.3.
The surface finish to the concrete circle should be slightly smoother for hammer throwing than for discus throwing. When a circle is used for both discus and hammer throwing a compromise finish is required.

**2.4.2.3 Protective Cage for the Hammer Throw** (Fig 2.4.2.2 and Chapter 6)
It is essential that the protection cage installed, conforms with the requirements of Chapter 6 and is properly erected and operated.
The necessary equipment for erecting and anchoring the protective enclosure should be installed together with the throwing circle.
As this Rule may be reviewed, the current edition of the IAAF Handbook should be checked.

**2.4.2.4 Landing Sector for the Hammer Throw** (Fig 2.4.2.1)
For the landing sector Section 2.4.1.4 shall apply in general with the following exceptions:
The lenght of the landing sector shall be 90m. Its angle of 34.92 degrees will be attained if the two boundary lines at a distance of 90m are spaced 54m apart.

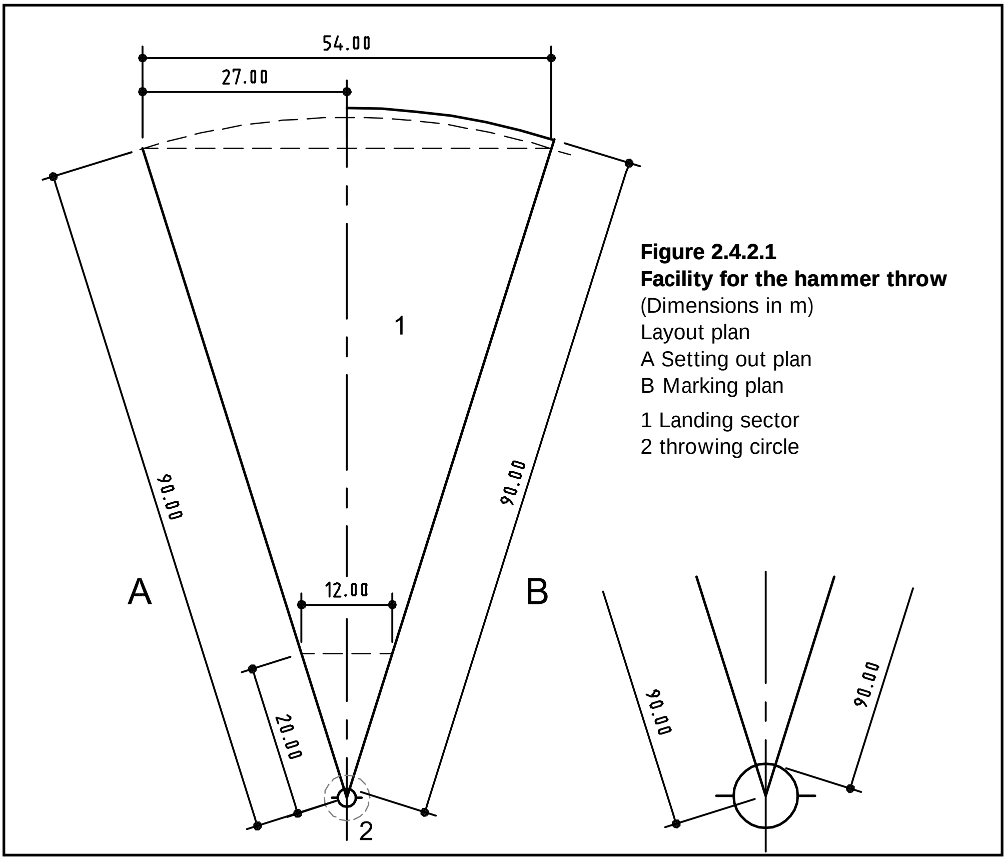



**Figure 2.4.2.1**
**Facility for the hammer throw**
(Dimensions in m)
Layout plan
A Setting out plan
B Marking plan
1 Landing sector
2 throwing circle

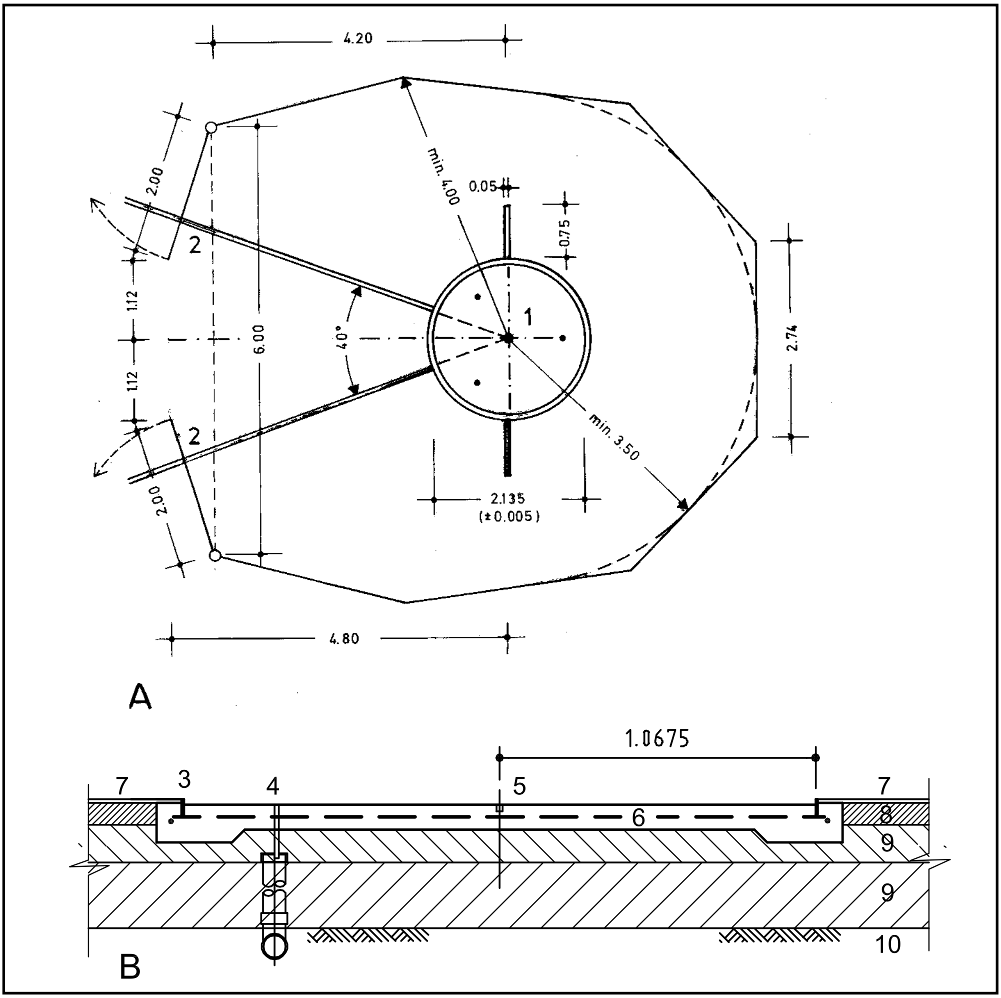



**Figure 2.4.2.2 - Detail plan of throwing circle and cage siting for the hammer throw**
(Dimensions in m)
A Layout plan
1 Centre point (intersection point of setting out plan), 2 marking for the landing sector

B Section through throwing circle
3 circular metal rim, 4 drainage pipe, 5 centring hole 4m diameter (brass tube),
6 concrete base with reinforcing mesh, 7 synthetic surface, 8 asphaltic concrete,
9 gravel base layers, 10 subgrade

### 2.4.2.5 Safety of the Facility for the Hammer Throw

Section 2.4.1.5 shall also apply to the safety of the facility for the hammer throw.

### 2.4.2.6 Suitability for Competition and Official Acceptance of the Facility for the Hammer Throw

For the suitability for competition and official acceptance of the hammer throw, Section 2.4.1.6 shall apply.

## ***2.4.3 FACILITY FOR JAVELIN THROW*** (See 2.1.1.3)

### **2.4.3.1 Layout of the Facility for the Javelin Throw** (Fig. 2.4.3.1)

The facility for the javelin throw includes a runway, a throwing arc and a landing sector. Usually, two facilities are constructed with a runway parallel to the straights located through the centre of each of the segments. Since the length of the runway exceeds the space available in the segment, it is usually extended across the track and track border. In such cases, it is necessary to have a removable kerb and the height of the surfaces of the oval track and the segment must be the same along the track border. For a runway in either segment, the landing sector is located in the grass area inside the track.

### **2.4.3.2 Runway for the Javelin Throw** (Fig 2.4.3.2)

The length of the runway shall be 30.00m to 36.50m and is measured from the beginning of the runway to the rear edge of the side markings outside the runway

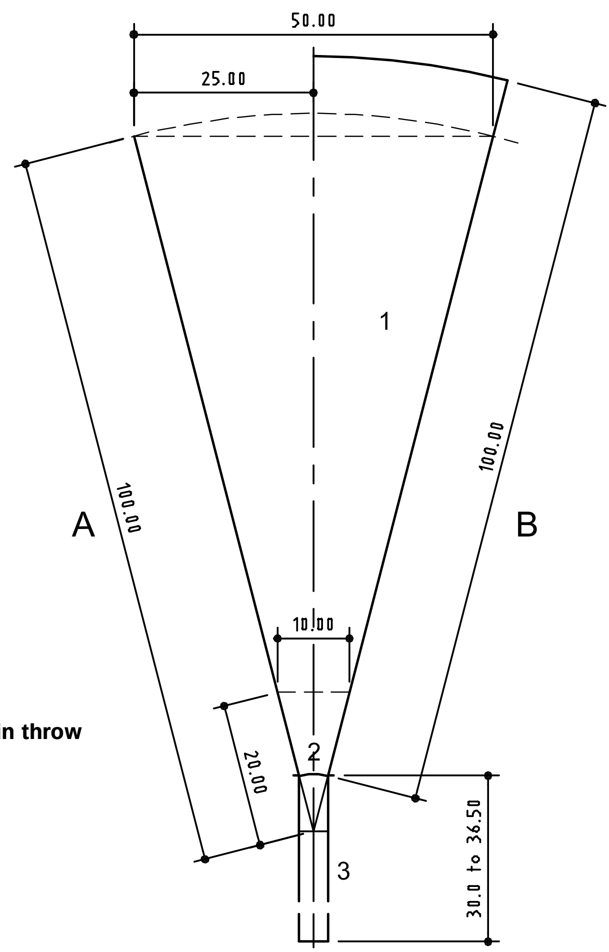



**Figure 2.4.3.1**
**Facilitiy for the javelin throw**
(Dimensions in m)
Layout plan
A Setting out plan
B Marking plan
1 Landing sector
2 throwing arc
3 runway

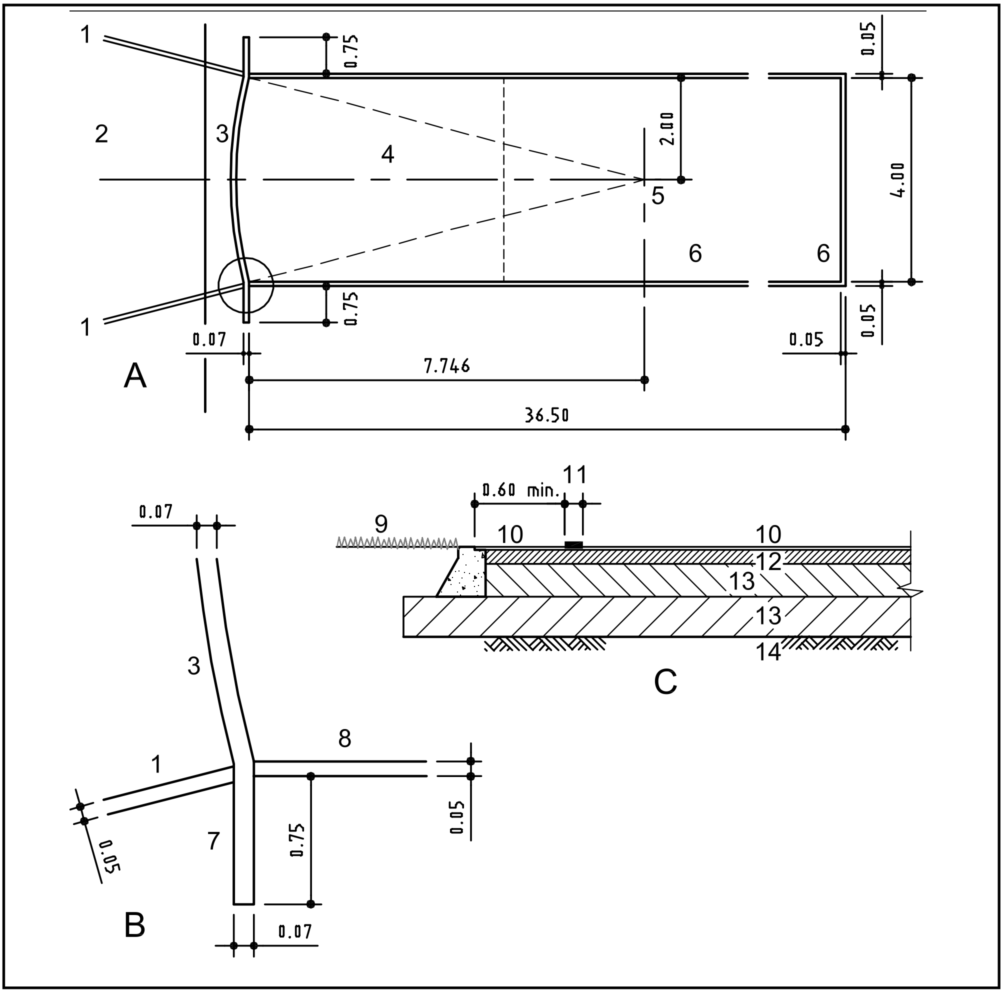



**Figure 2.4.3.2 - Runway and throwing arc for the javelin throw** (Dimensions in m)
A Layout plan
B Detail
C Section

1 Marking for throwing sector, 2 landing area, 3 throwing arc, 4 reinforced area of runway, 5 centre point = intersecting point of setting out plan, 6 runway, 7 marking of extension of throwing arc, 8 marking of lateral border of runway, 9 turf surface, 10 synthetic surface, 11 throwing arc marking, 12 asphaltic concrete, 13 gravel base layers, 14 subgrade

at the same level as the throwing arc. It shall be marked by two parallel white lines 0.05m wide and 4.00m ± 0.01 apart.
The runway is covered with the same surface as the track.

#### 2.4.3.3 Throwing Arc for the Javelin Throw (Fig 2.4.3.2 and Chapter 6)

The throwing arc is situated at the end of the runway. It may be painted or made of wood (3 to 5 weather-proof, bonded layers), non-corrodable metal or any other suitable material. If not marked with paint, it must be installed flush with the surface of the runway.

The throwing arc shall be 0.07m wide, white and curved with a radius of 8.00m from the centre point in the middle of the runway, in the throwing direction. It is advisable that the centre point is marked with a synthetic plug of a different colour to the surface, with a diameter and surface thickness of 20mm to 30mm. Lines shall be drawn from the extremities of the arc at right angles to the parallel lines marking the runway. These lines shall be white, 0.75m in length and 0.07m wide.

#### 2.4.3.4 Landing Sector for the Javelin Throw (Fig. 2.4.3.1)

For the landing sector, Section 2.4.1.4 shall apply in general with the following exceptions:
The sector lines shall be laid from the centre point on the runway through the crosspoints of the throwing arc and the lines of the runway.
The length of the sector shall be 100m. At this distance the inner edges of the sector lines shall be 50.00m apart.
The marking of the sector lines shall extend to a distance appropriate to the competition.

#### 2.4.3.5 Safety of the Facility for the Javelin Throw

For the safety of the facility for javelin throw, an even-surfaced transition must be guaranteed between segment and oval track in the area around the removeable kerb.
For the safety of the facility for javelin throw see 2.4.1.5.

#### 2.4.3.6 Suitability for Competition and Official Acceptance of the Facility for the Javelin Throw

Javelin throw facilities must conform to the specifications.Confirmation of this can be established within the inspection of the the 400m Standard Track.

### *2.4.4 FACILITY FOR THE SHOT PUT* (See 2.1.1.3)

#### 2.4.4.1 Layout of the Facility for the Shot Put (Fig 2.4.4.1)

The shot put facility includes a throwing circle, a stop-board and a landing sector.
At least two facilities are usually constructed. The circles are located within the segments dependent upon the location of other field event facilities.
The landing sector is usually located in the grass area inside the track.

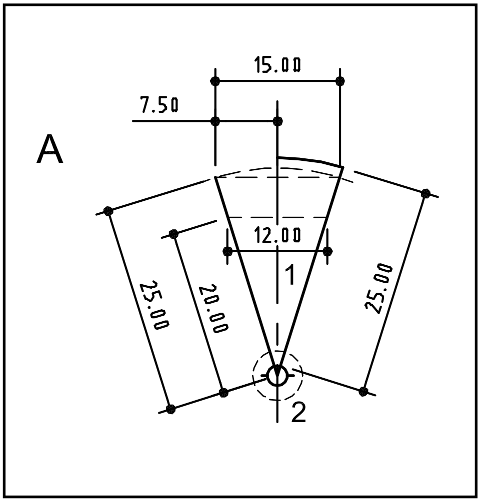



**Figure 2.4.4.1**
**Facility for the shot put**
(Dimensions in m)
Layout plan
A Setting out plan
B Marking plan
1 Landing sector
2 throwing circle

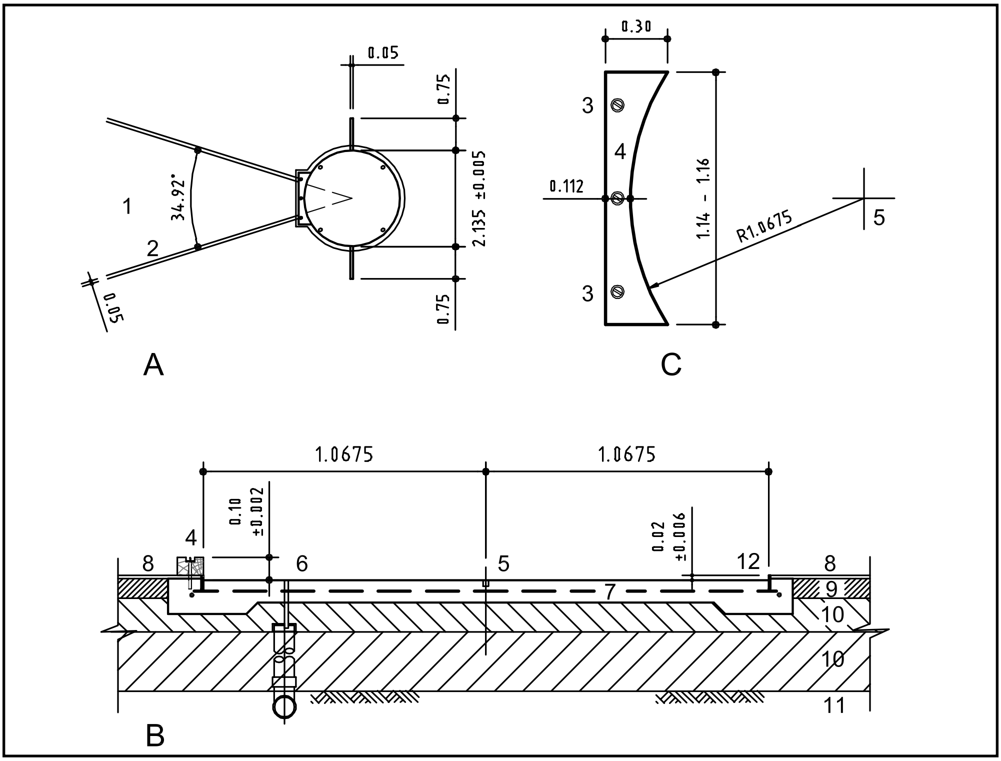



**Figure 2.4.4.2 - Shot put circle** (Dimensions in m)
A Layout plan
B Detail section
C Stop board

1 Landing sector, 2 marking for the landing sector, 3 fastening attachment, 4 stop board,
5 centring hole 4m diameter (brass tube), 6 drainage pipe, 7 concrete base with reinforcing mesh,
8 synthetic surface, 9 asphaltic concrete, 10 gravel base layer, 11 subgrade, 12 circular metal rim

### 2.4.4.2 Throwing Circle for the Shot Put (Fig 2.4.4.2)

For the throwing circle, Section 2.4.1.2 shall apply in general with the following exception:
The inside diameter of the throwing circle is 2.135m ±0.005.

### 2.4.4.3 Stop Board for the Shot Put (Fig 2.4.4.2 and Chapter 6)

The stop board shall be painted white and made of wood or other suitable material in the shape of an arc so that the inner edge coincides with the inner edge of the circle. It shall be placed midway between the sector lines and be firmly fixed to the ground. It shall be 1.22m ±0.01 long on the inside. The width is 0.112m ±0.002 and the height is 0.10m ±0.002 when firmly in position.

### 2.4.4.4 Landing Sector for the Shot Put (Fig 2.4.4.1)

For the landing sector, Section 2.4.1.4 shall apply in general with the following exceptions:
The length of the sector is 25.00m. The angle of 34.92 degrees will be attained if the two sector lines, at a distance of 25.00m, are spaced 15m apart.

#### 2.4.4.5 Safety of the Facility for the Shot Put

For the safety of the facility for the shot put, care must be taken to ensure that nobody enters the landing sector during the throw.

#### 2.4.4.6 Suitability for Competition and Official Acceptance of the Facility for the Shot Put

Shot put facilities must conform to the specifications. Confirmation of this can be established within the inspection of the 400m Standard Track.

## 2.5 Layout of the”Standard Competition Area”

This area corresponds to the categories given in table 1.5.3, Chapter 1, Construction Category I, and is recommended by the IAAF as the Standard Competition Area.

The field events are evenly distributed over the arena to avoid congestion and to satisfy the needs of the spectators.
This layout avoids undue disruption of events by ceremonies and counterbalances the concentration of interest in the finish area.

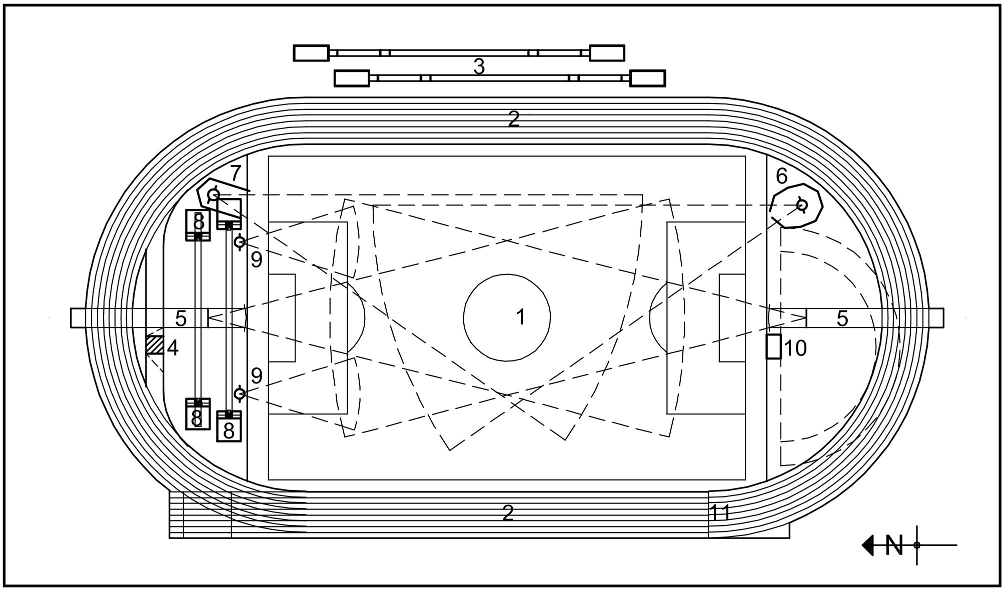



**Figure 2.5a - Standard layout of competition facility**

1 Football pitch
2 Standard Track
3 long jump and triple jump facility
4 water jump
5 javelin runway
6 discus and hammer throw facility
7 discus throw facility
8 pole vault facility
9 shot put facility
10 high jump facility
11 finish line

The layout is, of course, flexible. Local climatic conditions particularly wind conditions and the effects of the rays of the sun on jumpers/vaulters must be considered. Figures 2.5b and 2.5c show the slope of the northern segment (radial and lean-to slopes), figures 2.5d and 2.5e the slope of the southern segment (radial and lean-to slopes).

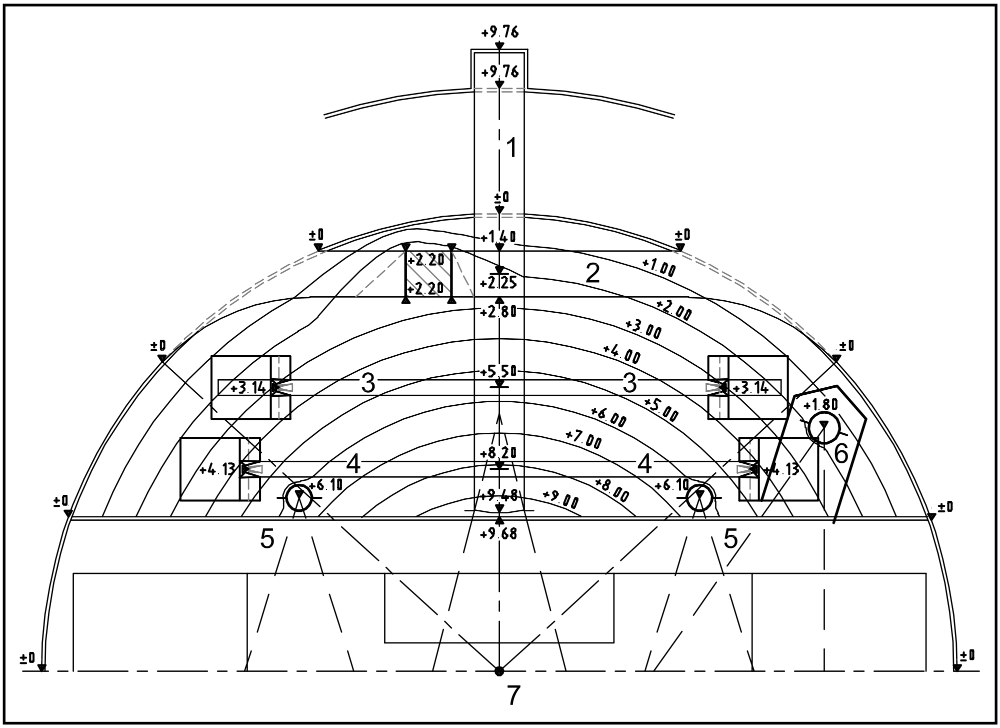



**Figure 2.5b - North segment of 400m Standard Track with radial slope of 0.4%**
(Dimensions of distance in m; dimensions of height in cm)

1 Javelin runway
Start of runway: + 9.76cm
Throwing arc surface: + 9.48cm
2 Steeplechase track
3 Pole vault facility
Start of runway: + 3.14cm
Centre: + 5.50cm
End: + 3.14cm
4 Pole vault facility
Start of runway: + 4.13cm
(+ 4.45cm resp.)
Centre: + 8.20cm
End: + 4.13cm
5 Shot put circle: + 6.10cm
6 Discus circle: + 1.80cm
7 Centre of semi-circle

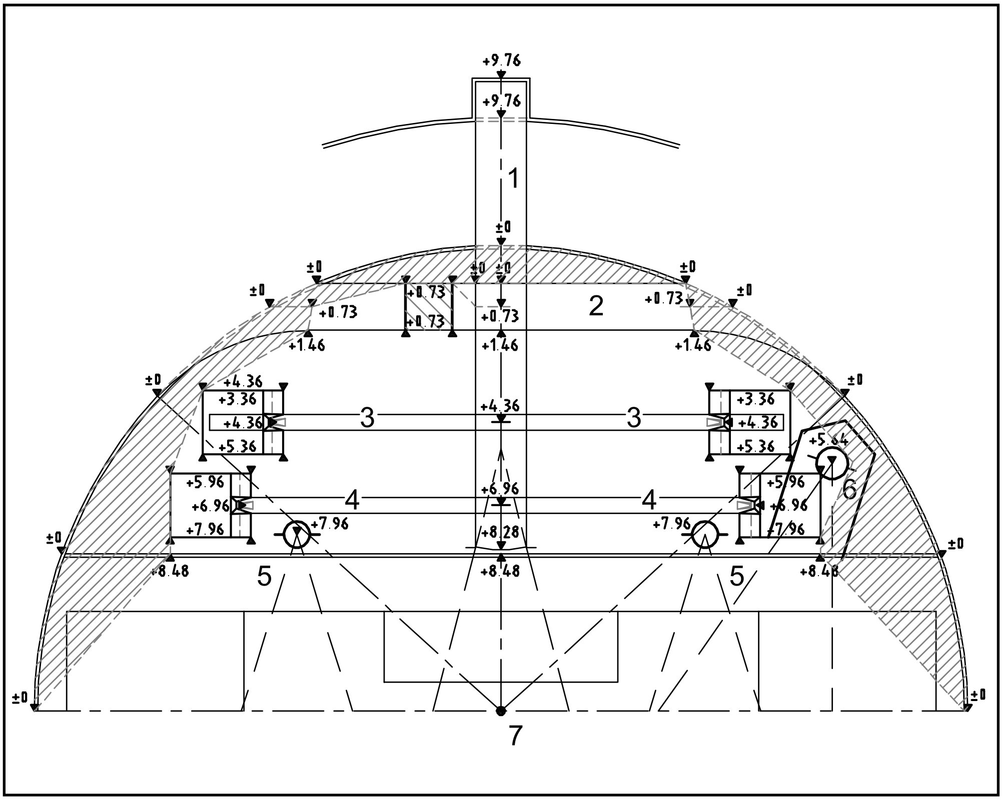



**Figure 2.5c - North segment of 400m Standard Track with lean-to-slope of 0.4%**
(Dimensions of distance in m; dimensions of height in cm)

1 Javelin runway
Start of runway: + 9.76cm
End of runway: + 8.48cm
2 Steeplechase track
3 Pole vault facility
Start of runway : +4.36cm
Centre : +4.36cm
End : +4.36cm
4 Pole vault facility
Start of runway : +6.96cm
Centre : +6.96cm
End : +6.96cm
5+6 Shot put and discus circle: +9.975cm/+7.475cm
7 Centre of semi-circle

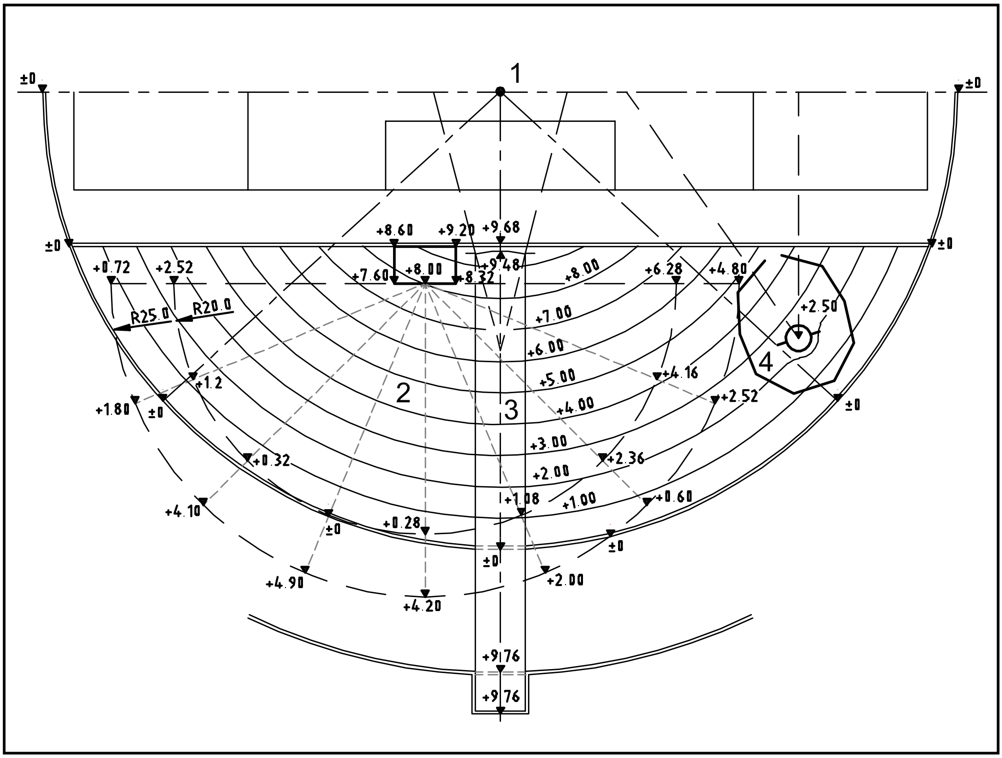



**Figure 2.5.d - South segment of 400m Standard Track with radial slope of 0.4%**
(Dimensions of distance in m; dimensions of height in cm)

1 Centre of semi-circle
2 High jump facility
Take-off point: + 8.00cm
Start points on runway length
20 m: + 6.28cm to + 2.52cm
Start points on runway length
25 m: + 4.80cm to + 0.72cm
3 Javelin runway
Start of runway: + 9.76cm
End of runway: + 9.48cm
4 Discus/Hammer circle:+2.50cm

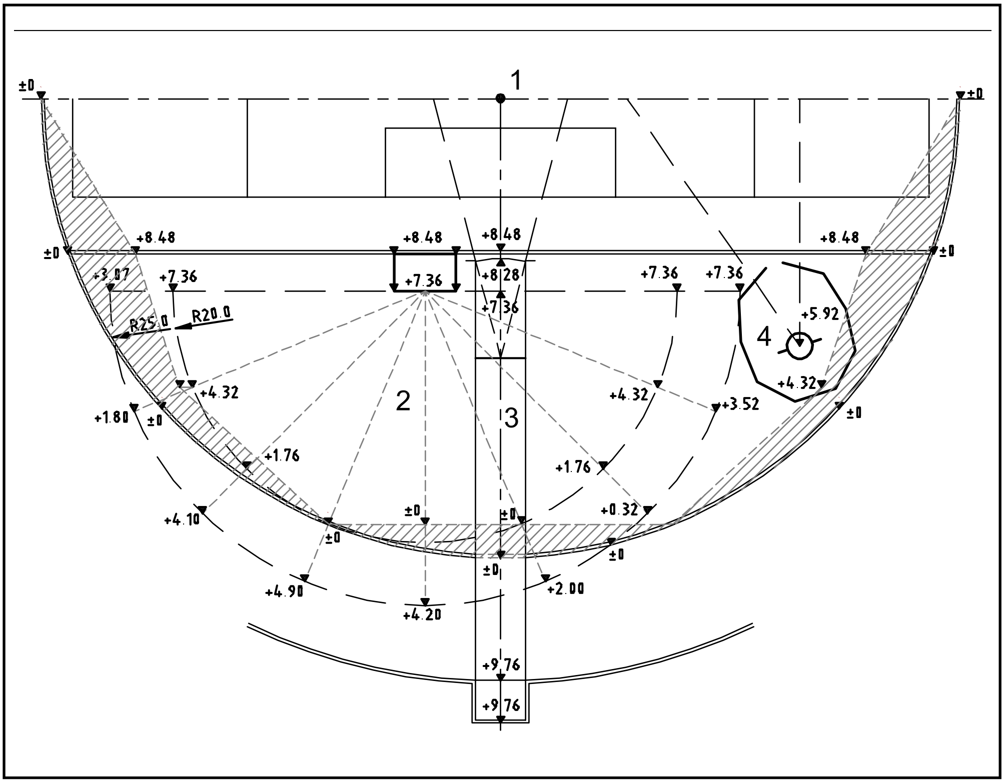



**Figure 2.5e - South segment of 400m Standard Track with lean-to-slope of 0.4%**
(Dimensions of distance in m; dimensions of height in cm)

1 Centre of semi-circle
2 High jump facility
Take-off point: + 7.36cm
Start points on runway length 20m: + 7.36cm to + 7.36cm
Start points on runway length 25m: + 7.36cm to + 3.07cm
3 Javelin runway
Start of runway: + 9.76cm
End of runway: + 8.28cm
4 Discus/Hammer circle: + 5.92cm

# 2.6 Alternatives for Training Facilities

During the planning and construction stages for competition facilities, full consideration must be given to the stipulations listed in Sections 2.1 to 2.5. For training facilities, a variety of alternatives are permissible. Long jump facilities, for example, may have several runways next to each other. High jump training facilities may be arranged to allow for run-ups from both sides of the landing mats. Shortened runways may also be considered - especially for school sports. However, a prerequisite for all facilities is the observance of safety aspects.
Generally, training facilities cater for several disciplines of track and field and, where the facilities for track and field are combined with small pitches, for ball games.
Of course, this type of design will normally preclude a simultaneous use of the facilities for the individual sports available there. Organizational measures can be

implemented to overcome this disadvantage (e.g. scheduling of training times).
On the other hand, this type of design will result in considerable savings in terms of space and building costs.
Concepts and combinations for training facilities may differ considerably from country to country. The examples shown in Sections 2.6.1 to 2.6.6, therefore, in no way claim to be complete.

### *2.6.1 TRAINING FACILITIES FOR THE STRAIGHT*

If necessary, the Standard Track can be supplemented along the finishing straight by a second straight, so that several groups will have an opportunity to practise simultaneously. The second track can also save time in qualifying rounds at mass events (e.g. school sports competitions).
It can serve as a runway for the long and triple jump and the pole vault, provided that landing areas and landing mats adjoin the starting or run-out area.

### *2.6.2 TRAINING FACILITIES FOR THE LONG AND TRIPLE JUMP* (Fig 2.6.2a to c)

Long and triple jump facilities may be accommodated with two or three runways positioned alongside each other and one common landing area in the north segment of a Standard Competition Arena with direction of jump towards the west (Figs 2.6.2a and b) or on a multi-purpose pitch for ball games and track and field events (Fig 2.6.2c). The possibility of an arrangement in the extension of the finishing straight of a standard arena is discussed under Section 2.6.1.

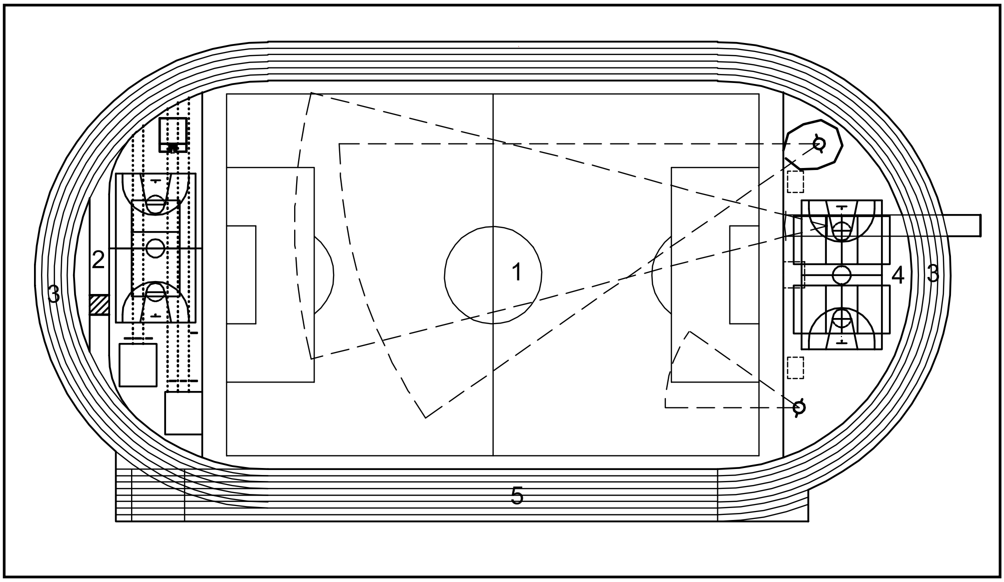



**Figure 2.6.2a - 400m Standard Track as a warm-up and training area**
1 Track interior (playing field and landing area for throwing disciplines), 2 segment with water jump, pole vault, long and triple jump, and ball games area for basketball and volley-ball, 3 six-lane oval track, 4 segment with discus/hammer circle, shot put circle, high jump, javelin throw, ball games area for volleyball (2 courts) and basketball, 5 eight-lane straight (for details of segments, see figures 2.6.2b and 2.6.3)

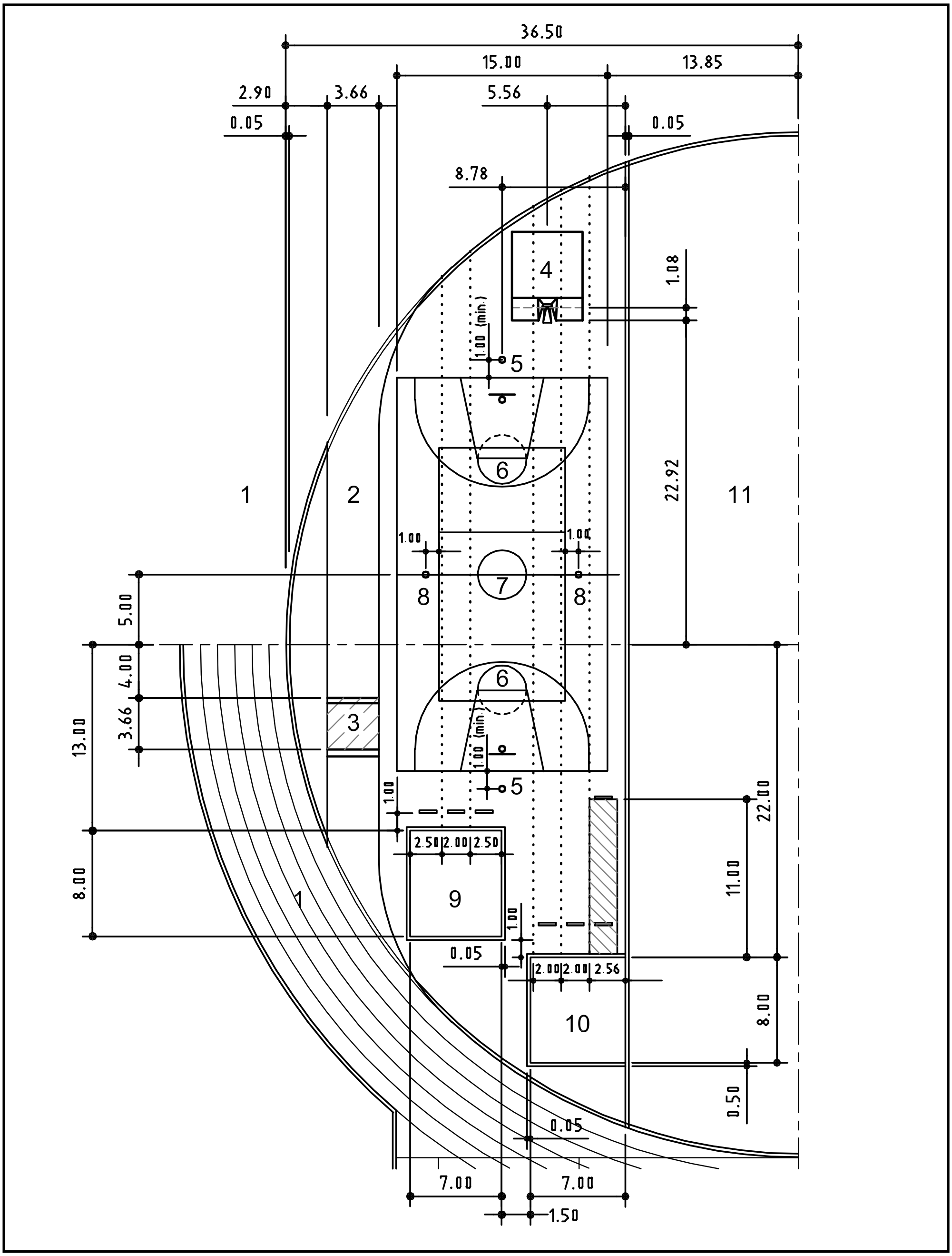



**Figure 2.6.2b - Detail of the northern segment of the plan shown in figure 2.6.2a**

1 Six-lane oval track, 2 steeplechase track,
3 water jump (surface with extra elasticity), 4 pole vault,
5 ground anchor for basketball backboard support, 6 basketball court, 15m x 28m,
7 volleyball court, 9m x 18m, 8 socket for volleyball net post,
9 three-lane long jump with shortened runway, 10 three-lane long jump and single-lane triple jump with competition-length runway (with extra thick surface between triple jump take-off board and landing area),
11 grass playing field

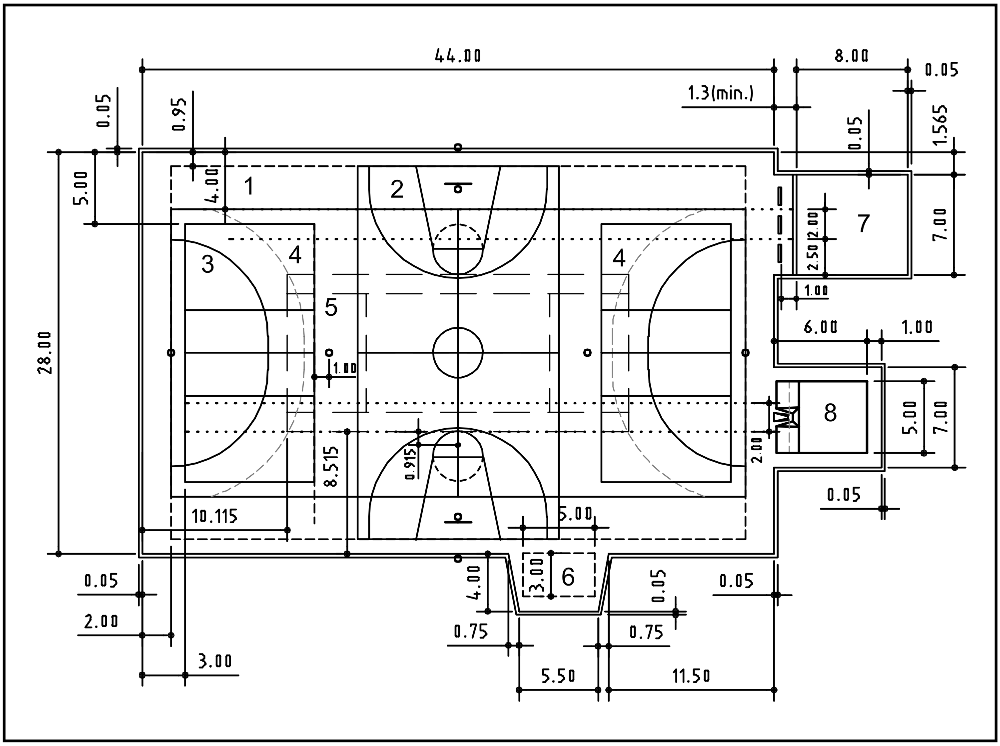



**Figure 2.6.2c - Multi-purpose facility for ball games and athletics**
1 rectangular field, 26.10m x 40m
2 basketball court, 14m x 26m
3 handball court, 20m x 40m
4 volleyball court, 9m x 18m
5 tennis court, 10.97m x 23.77m
6 high jump
7 long jump
8 pole vault

In multiple jumping facilities for training, a single 4.00m wide synthetic runway will be more economical than two separate 1.22m runways. In such a training facility a landing area of total width 5.00m will accommodate two landing areas and a 7.00m width will be adequate for a single 6.00m wide runway.

***2.6.3 TRAINING FACILITIES FOR THE HIGH JUMP*** (Fig 2.6.2a, 2.6.2c and 2.6.3)

Two high jump training facilities can be arranged simultaneously in the south segment of a 400m-Standard Track . These will allow for training with shortened run-ups with track kerb in place or with full run-ups with the kerb removed (Fig 2.6.2a and 2.6.2c). A facility for training with a landing mat suitable for competition can equally be accommodated on the north side of a small pitch (Fig 2.6.3).
There is also a possibility of temporarily placing landing mats 5.00m x 5.00m or 5.00m x 6.00m in the centre of a small pitch, in order to allow two practice areas to be in use at the same time, even if with shortened run-ups.

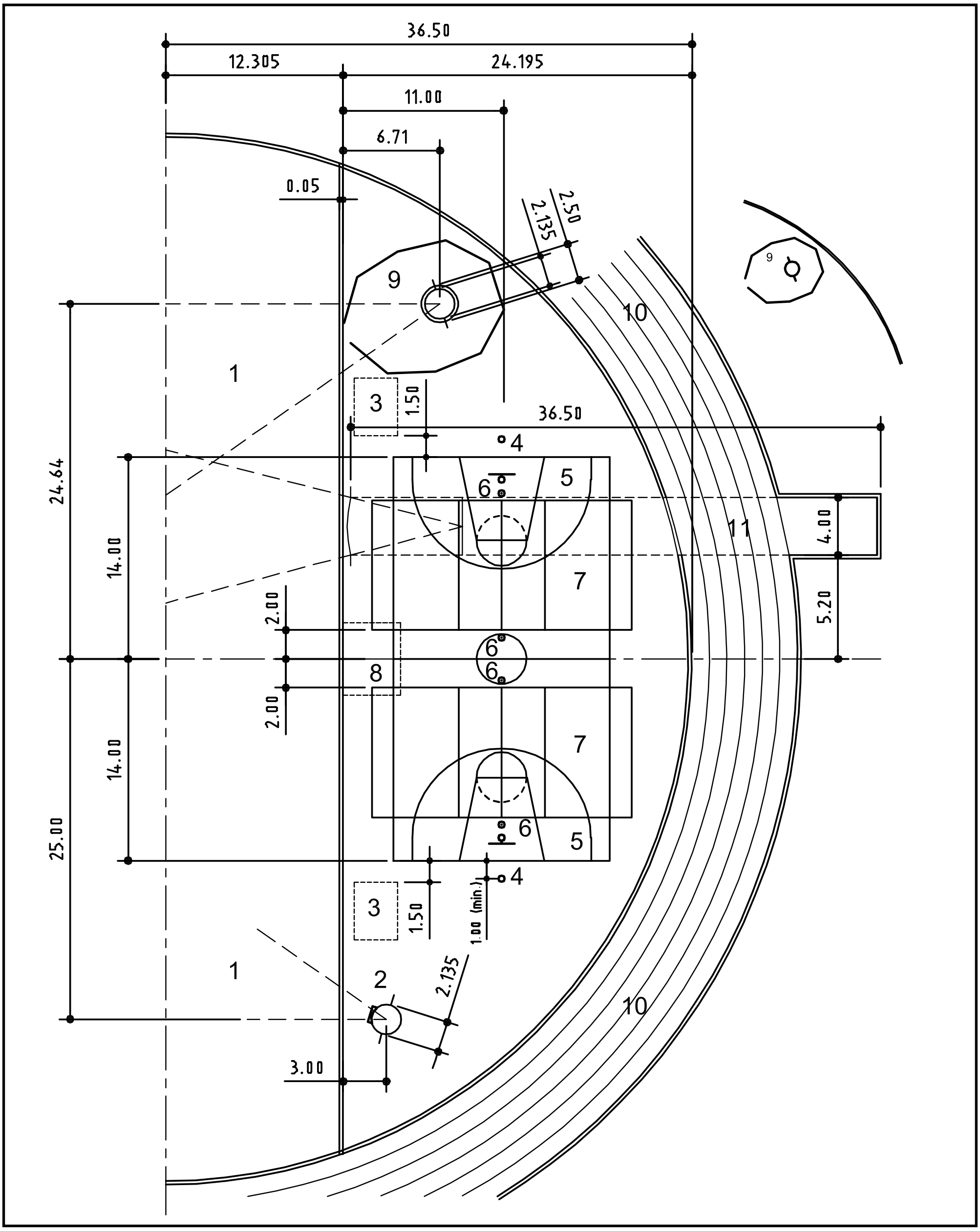



**Figure 2.6.3 - Detail of the southern segment of the plan shown in figure 2.6.2a**

1 Grass playing field
2 shot put
3 high jump training area with 4m x 3m landing mat
4 ground anchor for basketball backboard support
5 basketball court, 15m x 28m
6 sock-et for volleyball net post
7 volleyball court, 9m x 18m
8 competition high jump with 5m x 4m landing mat
9 discus/hammer throw
10 six-lane oval track
11 javelin runway

### *2.6.4 TRAINING FACILITIES FOR THE POLE VAULT* (Fig 2.6.2a and 2.6.2b)

A facility for the pole vault (direction of jump towards east) can be accommodated, especially in combination with the facility for long jump described under 2.6.2 (direction of jump towards west), in the north segment of a standard arena.

Other possibilities are demonstrated in figures 2.6.2c, 2.6.6a, 2.6.6c to 2.6.6d.

### *2.6.5 TRAINING FACILITIES FOR THROWING AND SHOT EVENTS*

(Fig 2.6.2a and b, 2.6.3, 2.6.5a and b)

Facilities for discus, hammer and javelin are combined at one end of a large pitch into one "throwing field" (Fig 2.6.5a).The training facility for shot can be provided by laying a concrete foundation with two or more marked throwing circles (without stop board) or by a lowered throwing circle (with stop board) and adjoining sandpit or unbound mineral surface as landing area (Figs 2.6.5b and 2.6.6a to d).

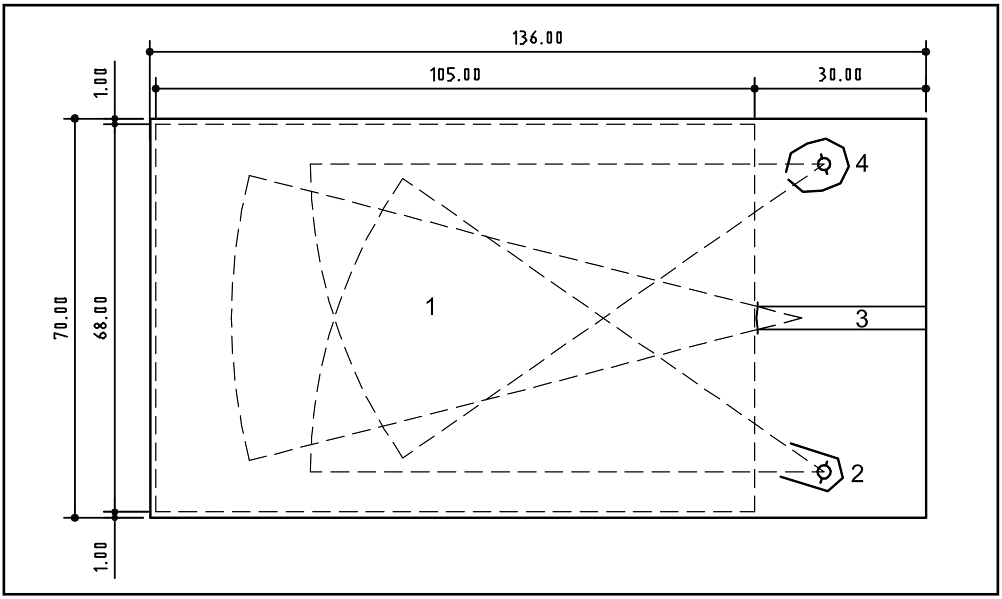
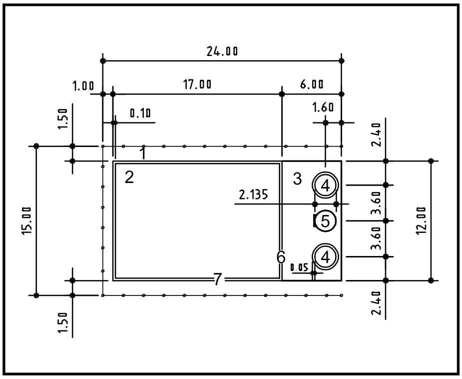



**Figure 2.6.5a - Warm-up and training area for throwing disciplines**
1 Playing field and landing area, 2 discus circle with safety cage,
3 javelin runway, 4 hammer circle with safety cage

**Figure 2.6.5b - Shot put training area**
1 Periphery with safety barrier and shot-resistant surface
2 landing area (unbound mineral surface)
3 concrete area with three shot put circles
4 marked circle
5 recessed competition circle with stopboard
6 separation between concrete slab and landing areas
7 landing area surround with soft covering for safety



***2.6.6 OTHER COMBINED TRAINING FACILITIES*** (Fig 2.6.6a to e)

If the surface of a large pitch is suitable for use as a runway, it will also be possible to combine this area with training facilities for sprints, long and triple jump, high jump, pole vault and shot put (Fig 2.6.6a).

Figure 2.6.6b shows a training facility which can be regarded as a first phase of development of a 400m standard arena. Here, a large pitch (grass surface) is combined with synthetic surfaces installed on two sides for sprints, high and long jump, shot put and discus throw. The oval track can then be added in a further phase of construction.

Figure 2.6.6c shows a training facility in the second phase of a standard arena. The facilities for long and triple jump and for high jump and pole vault have been accommodated in the segments of the four-laned oval track. This facility can be used as as a warm-up facility in compliance with table 1.5.3, Chapter 1.

Figures 2.6.6d and 2.6.6e offer suggestions for warm-up facilities in compliance with table 1.5.3, Chapter 1, in park-like or wooded areas.

However, the arrangement of the facilities for shot and throwing events requires a safe enclosure or close-set surrounding hedge with additional warning notices.

The layout as shown in figure 2.6.6e offers limited facilities for running on sprint tracks, bend training and relay baton practice.

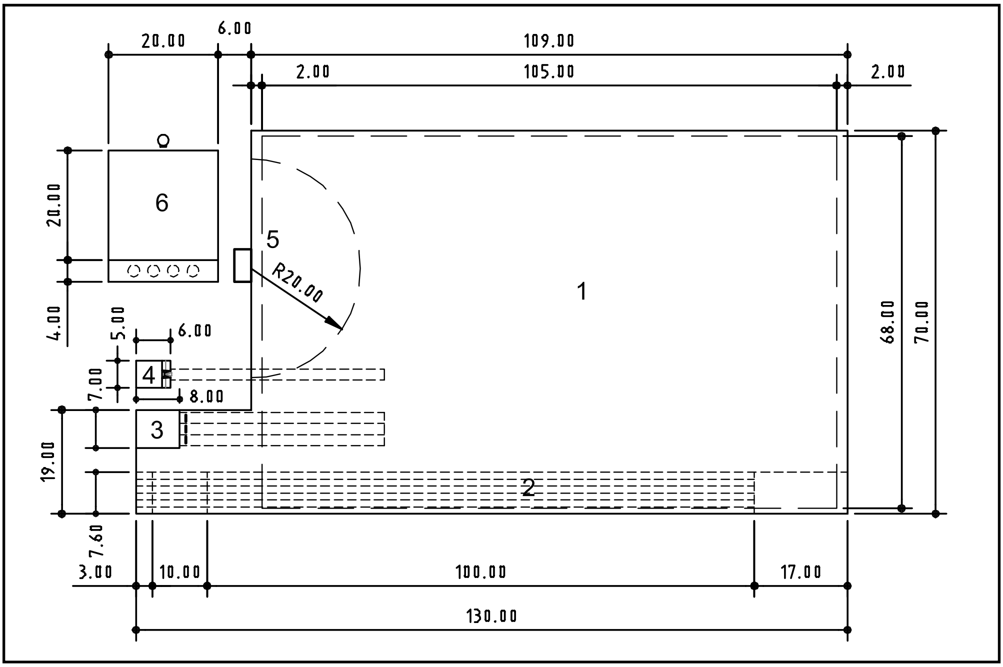



**Figure 2.6.6a - Multi-purpose facility for ball games and athletics**

1 Playing field, 68m x 105m (unbound mineral surface)
2 six-lane straight marked on the playing field
3 three-lane long jump
4 pole vault
5 high jump
6 shot put with four painted circles on concrete slab and one competition circle

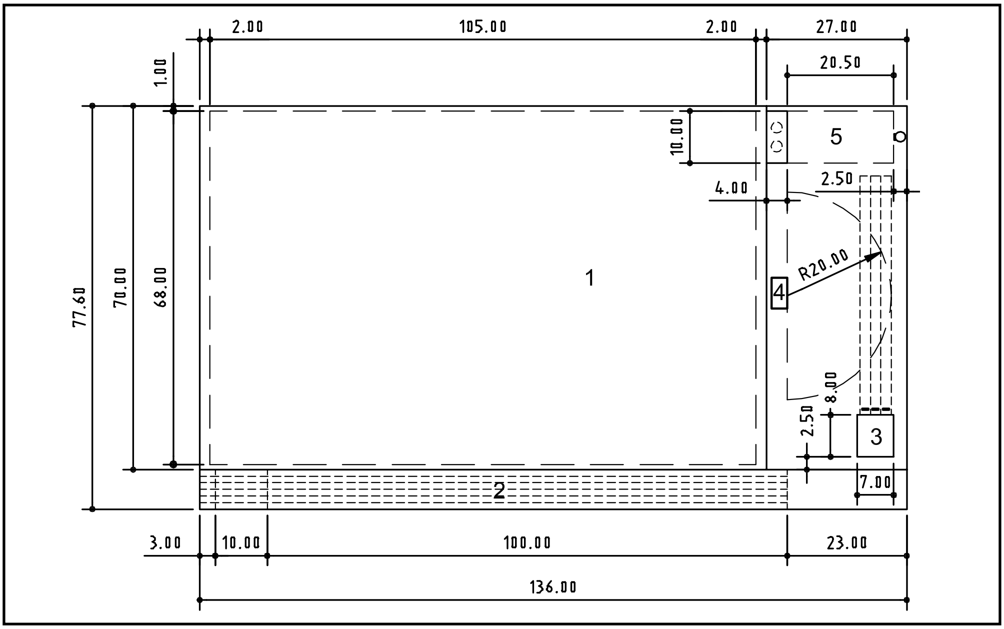



**Figure 2.6.6b - Multi-purpose facility for ball games and athletics**

1 Playing field, 68m x 105m (grass surface)
2 six-lane straight
3 three-lane long jump
4 high jump
5 concrete area with two painted circles and one competition circle

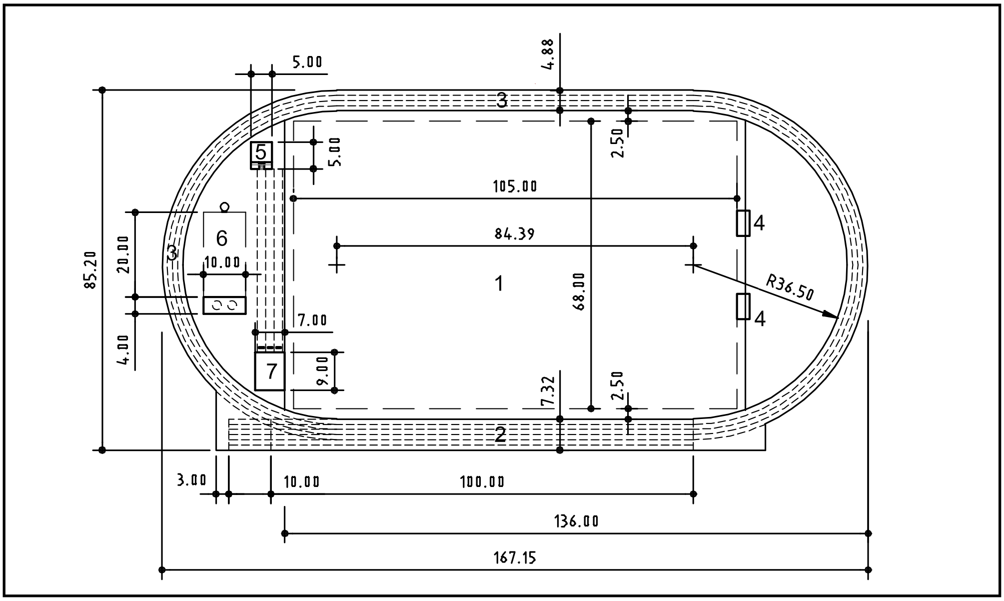



**Figure 2.6.6c - Warm-up area with a 400m Standard Track and large playing field**

1 Playing field, 68m x 105m
2 six-lane straight
3 four-lane oval track
4 high jump
5 pole vault
6 concrete area with two painted circles and one competition circle
7 long and triple jump

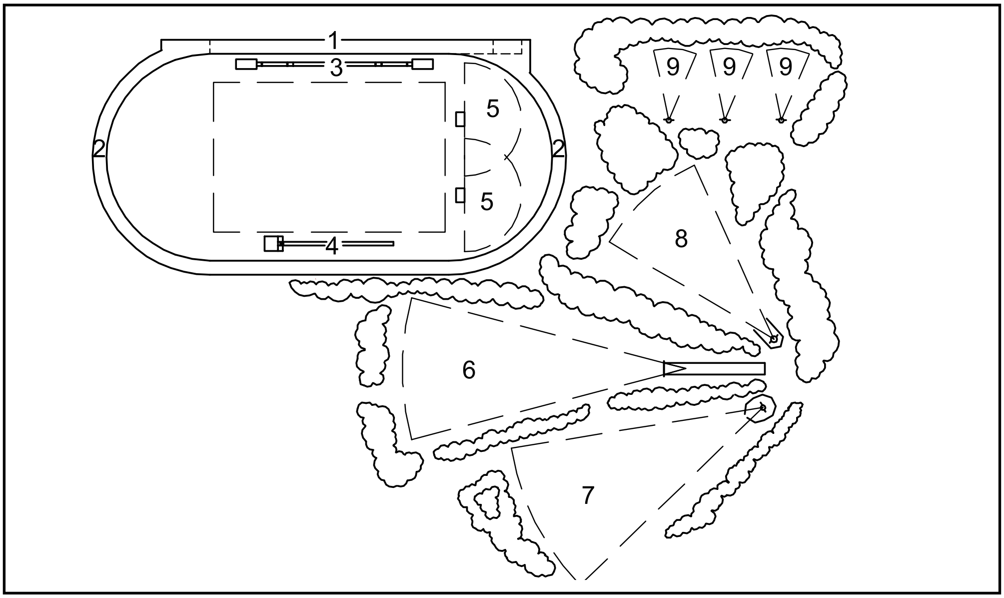



**Figure 2.6.6d - Warm-up area with separate areas for throwing disciplines**
1 Four-lane straight, 2 four-lane oval track, 3 long and triple jump, 4 pole vault, 5 high jump, 6 javelin throw, 7 hammer throw, 8 discus throw, 9 shot put

*Source: Stades et terrain de sports, Henri Cettour, Editions du Moniteur, Paris*

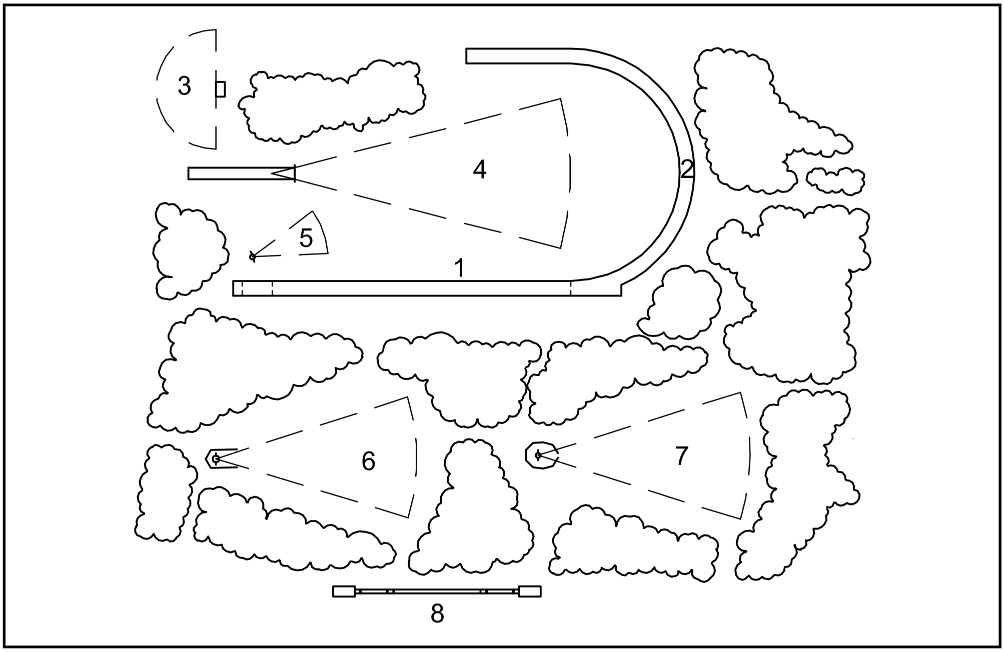



**Figure 2.6.6e - Warm-up area, alternative to figure 2.6.6d**
1 Four-lane straight, 2 four-lane training bend, 3 high jump, 4 javelin throw, 5 shot put, 6 discus throw, 7 hammer throw, 8 long and triple jump

*Source: Stades et terrain de sports, Henri Cettour, Editions du Moniteur, Paris*

# APPENDIX
# TO CHAPTER 2

## Comments on figure 2.2.1.1a

***SETTING OUT PLAN AND DIMENSIONS OF 400M STANDARD TRACK (RADIUS 36.50M)***

(Dimensions in m)
When determining the basic rectangle (A,B,C,D) with measuring tape and theodolite:

1. Distance between CP1 - CP2 resp. M1 - M2 using measuring tape:
   84.390m (± 0.002)
2. Place one theodolite on each of CP1/M1 and CP2/M2:
   angle a = 25.9881 gon;
   CP1/M1 - A or D and CP2/M2 - B or C = 91.945m
3. A,B,C,D are in line with the inner track border.

When using tapes, the following points must be observed:

1. Standard steel measuring tapes only, with temperature equalization table.
2. Immediately before and after measuring (position measuring tape with 50 N tensile load for 30m tapes and 100 N for 50m and 100m tapes) read temperature of measuring tape using a contact thermometer.*
3. Correct reading based on the temperature of the measuring tape and the temperature equalization table.
4. In the absence of a temperature equalization table: Calculate the change in length of the measuring tape caused by temperature using a reference temperature of 20°C as follows:
   Temperature of the measuring tape in degrees Celsius of the deviation from 20°C x length of the measuring distance in m x 0.0115mm.
5. If the temperature of the measuring tape is more than 20°C, subtract the change in length of the measuring tape calculated from the reading or alternatively add it on if the temperature is under 20°C.
6. Example:
   Temperature of measuring tape 15°C and measuring distance 36.50m;
   Change in measuring tape: 5 x 36.50 x 0.0115mm = 2.09mm;
   Increase reading of 36.500mm to 36.502mm.

| | |
|---|---|
| Measurement of 400m Standard Track | |
| Length of the parallel straights | 84.390m |
| Construction radius of the semicircle bend (including raised inner track border or outer edge of end markings of running track) | 36.500m |

| | |
|---|---|
| Construction length of the semicircle bend (inside edge of the track) | 114.668m |
| Measuring distance from the raised inner track border to the nominal measuring line (line of running) of the semicircle bend | 0.300m |
| Radius for the nominal measuring length of the semicircle bend for raised track border | 36.800m |

**If an invar measuring tape (36% nickel content) is used, the temperature control may be dispensed with.*

| | |
|---|---|
| Nominal measuring length (length of line of running) of the semicircle bend | 115.610m |
| Nominal measuring length (length of line of running) of the oval track | 400.000m |
| Construction length of the track border (inside edge of the track) | 398.120m |

# Comments on figure 2.2.4.1a

***STEEPLECHASE TRACK WITH WATER JUMP INSIDE THE BEND INTEGRATED INTO THE 400M STANDARD TRACK***

(Dimensions in m)

1. Length of steeplechase lap measured along the line of running (from A to A) over the water jump on the inside bend :

| | |
|---|---|
| Semicircle bend (r = 36.80) | 115.610m |
| 2 straights of 84.390m each | 168.780m |
| Water jump bend (middle straight 30.202m<br>2 transition bends b1 of 13.415m each<br>2 semicircle bend sections b2 of 27.331m each) | 111.694m |
| | 396.084m |

2. Number of hurdles per steeplechase lap :
   5 (4 hurdles + 1 water jump)
   For 1st lap of the 2000m (1st and 2nd hurdles are not used)
3. Number of hurdles per steeplechase race :
   For 3000m: 35 (28 x hurdle + 7 x water jump)
   For 2000m: 23 (18 x hurdle + 5 x water jump)
4. Number of steeplechase laps (396.084m each) per steeplechase race :
   For 3000m:7 laps with a total length of running of 2772.588m
   and prior to the start of the first full lap an additional stretch without hurdles of 227.412m
   For 2000m:5 laps with a total length of running of 1980.420m
   and prior to the start of the first full lap an additional stretch without hurdles of 19.580m
5. Spacing of the hurdles along the line of running of the steeplechase lap
   5.1 Assumptions :
   Ideally, four equal spacings with the distance rounded to the nearest whole metre. Alternatively five equal spacings.

5.2 Spacing calculated:

396.084m : 5 = 79.2168m

5.3 Spacing selected:

4 x 79.00m (= 316.00m) + 1 x 80.094m (= total 396.084m)

6. Position of the start lines for 3000m and 2000m steeplechase race along the steeplechase lap :

6.1 Assumptions :

Length of the steeplechase lap in compliance with No. 1 above; normal finish line; additional stretches in compliance with No. 4 above: 227.412m or 19.58m respectively.

6.2 Position for 3000m:

227.412m before the finish line, measured against the direction of running from the finish line along the normal track without water jump bend (84.390 + 115.610 + 27.412)

6.3 Position for 2000m:

19.580m before the finish line, measured against the direction of running from the finish line

7. Position of the hurdles along the steeplechase lap :

7.1 Assumptions:

Length of the steeplechase lap in compliance with No. 1 above; spacing of the hurdles in compliance with No. 5.3; fixed points: finish line and water jump

7.2 Position of the 1st hurdle:

237.00m (3 spacings of 79.00m each in compliance with No. 5.3) prior to the water jump, measured against the direction of running from the water jump along the line of running or 22.647m after the finish line in the direction of running

7.3 Position of the 2nd hurdle:

101.647m after the finish line (22.647m + 79.00m)

7.4 Position of the 3rd hurdle:

180.647m after the finish line (101.647m + 79.00m)

7.5 Position of the 4th hurdle (water jump) :

259.647m after the finish line (180.647m + 79.00m)

7.6 Position of the 5th hurdle:

338.647m after the finish line (259.647m + 79.00m)

8. The positions of the hurdles are calculated along the line of running of the steeplechase lap and are each marked with their distance from the finish line in the direction of running. They are the same for both the 3000m and 2000m steeplechase race.

The hurdle positions must be marked on the inner track border accordingly.

# Comments on figure 2.2.4.1b

***STEEPLECHASE TRACK WITH WATER JUMP OUTSIDE THE BEND INTEGRATED INTO THE 400M STANDARD TRACK***

(Dimensions in m)

1. Length of steeplechase lap measured along the line of running (from A to A) via the water jump on the outside bend :

| | |
|---|---|
| Semicircle bend (r = 36.80) | 115.610m |
| 2 straights of 84.390m each | 168.780m |
| Water jump bend (r = 36.70m 2 transition straights of 9.86m each) | 135.017m |
| | 419.407m |

2. Number of hurdles per steeplechase lap :
   5 (4 hurdles + 1 water jump)
   For 1st lap of the 2000m only 3 hurdles (1st and 2nd hurdles are not used)
3. Number of hurdles per steeplechase race :
   For 3000m : 35 (28 x hurdle + 7 x water jump)
   For 2000m : 23 (18 x hurdle + 5 x water jump)
4. Number of steeplechase laps (419.407m each) per steeplechase race :
   For 3000m: 7 laps with a total length of running of 2935.849m and prior to the start of the first full lap an additional stretch without hurdles of 64.151m
   For 2000m: 4 laps with a total length of running of 1677.628m and before the start of the first full lap an additional stretch without hurdles 1 and 2 of 322.372m
5. Spacing of the hurdles along the line of running of the steeplechase lap
   5.1 Assumptions:
   Ideally four equal spacings with the distance rounded to the nearest whole metre. Alternatively five equal spacings.
   5.2 Spacing calculated:
   419.407m ÷ 5 = 83.8814m
   5.3 Spacing selected:
   4 x 84.00m (= 336.00m) + 1 x 83.407m (= total 419.407m)
6. Position of the start lines for 3000m and 2000m steeplechase race along the steeplechase lap
   6.1 Assumptions:
   Length of the steeplechase lap in compliance with No. 1 above; fixed point: finish line; additional stretch in compliance with No. 4 above : 64.151m for 3000m (or first lap shortened by 97.035m for 2000m)
   6.2 Position for 3000m:
   64.151m before to the finish line, measured against the direction of running from the finish line along the line of running or 355.256m after the finish line in the direction of running over the water jump.
   6.3 Position for 2000m:
   97.035m after the finish line, measured in the direction of running from the finish line along the line of running over the water jump.

7. Position of the hurdles along the steeplechase lap

   7.1 Assumptions:

   Length of the steeplechase lap in compliance with No. 1 above; spacing of the hurdles in compliance with No. 5.3; fixed points: finish line and waterjump.

   7.2 Position of the 1st hurdle:

   17.51m after the finish line in the direction of running
   (corresponds to 3 distances in compliance with No. 5.3)
   (3 x 84.0m = 252m) from the water jump against the direction of running

   7.3 Position of the 2nd hurdle:

   101.51m after the finish line in the direction of running
   (17.51m + 84.00m)

   7.4 Position of the 3rd hurdle:

   185.51m after the finish line in the direction of running
   (101.51m + 84.00m)

   7.5 Position of the 4th hurdle:

   269.51m after the finish line in the direction of running
   (185.51m + 84.00m)

   7.6 Position of the 5th hurdle:

   353.51m after the finish line in the direction of running
   (269.51m + 84.00m)

   7.7 Control Measurement up to 1st hurdle:

   353.51m + 83.407m = 436.917m - 17.51m = 419.407m

8. The Positions of the hurdles are calculated along the line of running of the steeplechase lap and are each marked with their distance from the finish line in the direction of running. They are the same for both the 3000m and 2000m steeplechase race.

   The hurdle positions must be marked on lane 1 and 4 in accordance with the IAAF Marking Plan.

9. Circular 9 lane track : the distance from the finish line to the first barrier should not be less than 12m. The distance from the $5^{th}$ barrier to the finish line should not be less than 40m. The distance from the start line to the $1^{st}$ barrier to be jumped should not be less than 70m.

# CONTENTS - CHAPTER 3
# CONSTRUCTION OF THE TRACK

# CHAPTER 3
# CONSTRUCTION OF THE TRACK

There are three principal types of surface available for athletics. Until the early 1960’s, most top-class competitions were held on unbound mineral surfaces (porous water-bound systems), although in many parts of the world national competitions were (and still are) held on natural grass tracks. Today, modern synthetic surfaces have displaced the other two types of surface for all major international events. Such synthetic systems are not only designed for superior dynamic characteristics, but need minimal maintenance compared to the surfacing systems they have displaced. Nevertheless, unbound mineral and natural grass surfaces are still widely used, the latter not only for the track but also of course as the in-field area.

## 3.1 Synthetic Surfaces

### *3.1.1 DESCRIPTION*

Modern synthetic surfaces for athletics tracks are high performance systems formulated to be durable and designed to offer the best combination of dynamic properties for athletes. Obviously the surface requirements of sprinters are different to those of the long-distance runners. The technology exists to vary the dynamic characteristics of the surface to favour one type of event against another. Clearly with major athletics meetings involving all disciplines, such “tuning” of the track to favour one particular group of athletes is not acceptable. For this reason, all surfacing systems should offer a “balance” of dynamic properties which represents a compromise between the various needs of the different athletes using the facilities. The performance requirements stipulated by the IAAF are based on the needs of all athletes. Where facilities are intended for major international competitions, the surface of any “warm-up” track provided should have the same dynamic characteristics as the surface on the track in the main arena. There are two different construction solutions (Fig 3.1.1) and a number of different synthetic surfacing system types available for athletics.

Most of these systems are offered by a considerable number of different manufacturers and installers. It therefore follows that the number of surfacing products is very large. All synthetic surfaces rely on a good standard of base construction, which is an essential pre-requisite for the successful installation of the surface and for its long-term performance (See 3.4).

There are several sub-divisions of synthetic surface type, some of which are illustrated in table 3.1.1. Some systems are prefabricated in the factory and delivered to site as rolls of material which are adhesive bonded to the base.

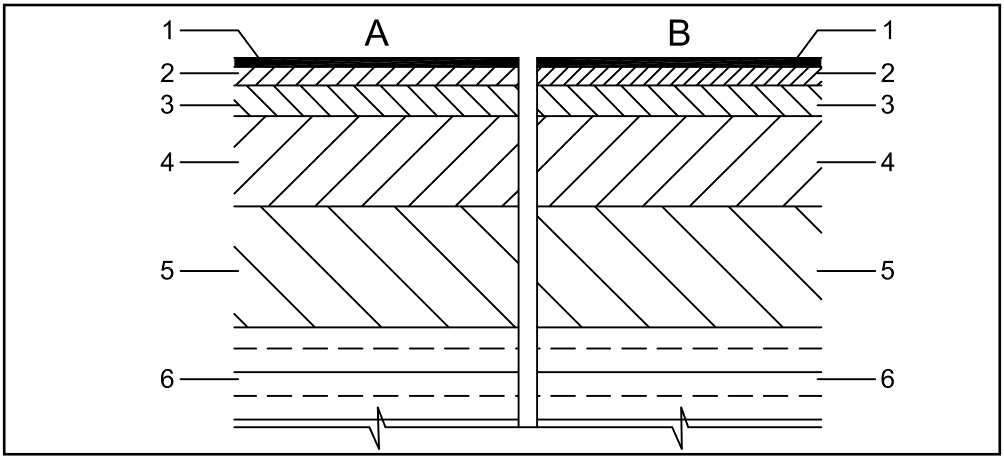



**Figure 3.1.1**
**Standard cross section of water-permeable (left) and non-permeable (right) synthetic surfaces**

A Denotation of the layer
1 Synthetic surface, 2 upper bound support layer
3 lower bound support layer, 4 unbound support layer
5 filter layer, 6 substrate or base

B Denotation of the building material
1 Elastomer, 2 bitumen concrete
3 bitumen binder, 4 crushed stone or gravel
5 gravel, 6 substrate or base

| ***A1*** | ***A2*** | ***A3*** | ***B1*** | ***B2*** | ***B3*** |
|---|---|---|---|---|---|
| Structurally coated covering | Rumble covering | Rumble covering, one layer | Cast-coated covering | Cast covering, two layers | Cast covering or prefabricated cover, one layer |
| ***Surface layer*** | | | | | |
| EPDM-granules and PUR, sprayed | EPDM-granules and PUR, cast or prefabricated | EPDM-granules and PUR, cast or prefabricated | PUR, cast-coated and EPDM-granules, spread | | PUR, cast-coated and EPDM-granules, spread, or prefabricated rubber |
| ***Basic layer*** | | | ***Basic layer*** | | |
| Rubber granules or rubber fibre and PUR, cast or prefabricated | | | Rubber granules or rubber fibre and PUR, cast or prefabricated | EPDM-granules or rubber granules and PUR, cast coated | |
| ***Main spheres of application*** | | | | | |
| Tracks, runways | Small playing fields, tracks and runways for physical education facilities and for combined facilities | | Tracks, runways (higher demands on life span) | | |

**Table 3.1.1 - Widely used surface types and their main spheres of application**

Some are fabricated on site by machine mixing and laying the raw material ingredients. Others are composites of these two systems.
Each type has certain advantages and disadvantages.

### 3.1.1.1 Prefabricated Sheet

This type of system is made from a rubber compound, processed by calendering followed by curing and rolling. It is largely non-porous and has an embossed or textured surface finish to improve traction and slip resistance. Obviously by producing the surfacing material in the controlled conditions of a factory, its performance properties should be very uniform. Also because the thickness of the sheet can be controlled very accurately, possible problems due to thin areas on the completed facility are avoided. However, the installation of the material requires a high degree of skill and accuracy. The sheet must be bonded to the base of the track with adhesive. The butt joints must be soundly executed, both between adjacent sheets of surfacing and between the surface and the perimeter edges of the track or runway. The durability of the surface is only as good as the integrity of the bond between itself and the base. Furthermore the material will obviously conform to any contours and irregularities in the base to which it is bonded. It is therefore vitally important that the base fully conforms to the stipulated shallow gradients and levels requirements in order to avoid the formation of standing water.

The installation of this type of system involves the use of weather-sensitive adhesives, although the laying of all synthetic surfaces is to some extent a weather-dependent operation. Finally, all prefabricated sheet products can contain residual stress within the material. Should any movement occur within the sheet, after installation, the result will be shrinkage away from edges or at joints, or delamination of the surface from the base, or both. Correct selection and careful application of adhesive can help to minimise this problem.

Composite systems are also available in which a prefabricated base layer is delivered to site in roll form, bonded with adhesive to the base and then coated with a top layer mixed from raw materials and applied on site.

#### 3.1.1.2 In-situ Systems

The other main group of surfacing systems, comprises those products which are fabricated on site from their raw materials. The majority of outdoor tracks is surfaced with these systems. These may be sub-divided into three principal types: cast elastomers, resin-bound rubber crumb and composite systems.

For all such systems, the compatibility of the raw material ingredients is of vital importance. All reputable manufacturers and installers of in-situ prepared surfacing systems should ensure by constant monitoring and sample testing that each component does not have an adverse effect on another forming part of the same surfacing product. It is advisable to have a consistent supply of each ingredient, and test data to confirm the performance of each combination. Because the end properties of such systems are very dependent on the nature of the raw materials delivered to site, their mixing and laying, the operation of a comprehensive quality control scheme is a vital prerequisite to a satisfactory completed facility. All reputable installers willingly submit to independent quality monitoring by experienced test laboratories, and a number of the larger companies also operate their own “in-house” monitoring schemes.

##### *3.1.1.2.1 Cast Elastomers*

These products are laid as free-flowing liquid polyurethane. The cast polyurethane resin is prepared by mixing two components, one a liquid polyol and the other an

isocyanate in the correct proportions. From this stage, there are two principal methods of installation. The first requires the addition to this mix of chopped rubber crumb to give a viscous liquid compound. This is then spread on to the base of the track by paving machine, to the full thickness required, which is controlled by screeding bars. The liquid resin mix is then given a textured finish by broadcasting specially formulated coloured EPDM rubber granules on to the surface and allowing the polyurethane to cure. Following cure, the excess surfacing granules are removed.
The second method involves the application of the mixed polyurethane resin to the track base by spreading to a lower thickness, typically 4mm, and broad-casting the chopped rubber crumb on to the uncured surface. After cure, the excess crumb is removed, and another layer applied in the same way. Following cure of this second layer, a third and final application is made, finishing with the broadcasting of the final coloured EPDM granule textured finish.

Obviously the second method involves the application of more layers, and with each operation dependent on good weather, the possibility of delays to the installation are increased.

Some products utilise a different method of forming the upper surface texture. Instead of using partly embedded EPDM granules, the final cast polyurethane surface is allowed to cure to an appropriate consistency and then given a ‘stippled’ finish using a roller covered with a suitable material. The textured resin is then allowed to fully cure.

All cast elastomer systems are non-porous and hence it is of paramount importance that the stipulated gradients and levels requirements are met, other-wise water ponding may occur in “low” areas. The final surface is largely free from joints, and should adhere well to the base. Such surfaces are strong and durable, provided they are correctly formulated using compatible raw material ingredients, properly mixed and installed under satisfactory environmental conditions.

#### *3.1.1.2.2 Resin-bound Rubber Crumb*

These products comprise a principal layer of polyurethane resin-bound rubber crumb, finished with a texturised surface coating of polyurethane paint. The crumb is mixed with a one-component moisture-curing polyurethane resin in the correct proportions. This very viscous mix is then spread by paving machine on to the base of the track, with the thickness controlled by screeding bars. After cure, two coats of a coloured polyurethane paint containing a fine rubber aggregate, is spray applied to this rubber base mat, in order to give the finished surface the correct traction and slip resistance.

Because the polyurethane resin used in this type of system is moisture curing, their installation is slightly less weather-critical. Although it would not be sensible to attempt the operation in wet conditions, a shower of rain after the rubber base mat is laid will not prove detrimental, and indeed may actually accelerate the cure of the resin. However, the spray application of the texturising finishing coats requires not only dry conditions, but also low wind speeds.

These systems have many of the advantages of the cast elastomers, although it is recognised that they are less durable. One advantage is their porosity, which means that even areas slightly out-of-tolerance for levels, will not water pond. In particularly high wear areas such as at the end of javelin runways, at the high jump take off point, and where the starting blocks are fixed, it is common to "reinforce" the surface with cast resin material, prior to spray applying the finishing coats. These systems probably comprise the most widely installed group of synthetic surfaces for athletics.

##### *3.1.1.2.3 Composite Systems*

As the name implies, these systems are a hybrid of the cast elastomer and the resin-bound rubber crumb products. They are sometimes known as "sandwich" or "double-decker" systems. They are formed from a base mat of resin-bound rubber crumb, typically about 9mm in thickness. After cure, the open textured mat is grouted with a very fine rubber crumb, and then a cast elastomer layer is applied as the top surface. The thickness of this cast layer can be increased to improve the durability of the surface and make it easier to repair by allowing the top of the surface to be ground off before retopping with cast elastomer. The appearance of the finished facility is exactly as for a cast elastomer system, but the surfaces are obviously not as expensive because they utilise less of the expensive cast polyurethane resin.

The durability of these composite systems lies in between that of the two other in-situ systems above. The performance of the surface is similar to that of the cast elastomer systems except that the force reduction and the vertical deformation would tend to be slightly higher (softer) than the full depth cast resin products.

### *3.1.2 PERFORMANCE REQUIREMENTS*

The requirements of a synthetic surface for an athletics track are two-fold:

- Is it effective as an athletics surface?
- Is it durable - that is will it retain its effectiveness over a reasonable period of time?

An athletics facility should meet these requirements at the time of a competition. However, it is obvious that surfaces must retain their characteristics in the long-term, both because of the need to ensure a wide network of good quality facilities around the world, and as a matter of commercial prudence on the part of the owners of the facilities. Synthetic surfaced athletics tracks represent a considerable financial investment and it is only natural that they should be put to the best possible use. This means that their use for training purposes should be actively encouraged. To achieve a reasonable return on their investment, owners should expect the synthetic surface to last at least eight to ten years before requiring major repairs. Obviously the life of a surface is dependent on the level of usage.

#### 3.1.2.1 Durability

The durability of synthetic surfaces relates to how well they withstand mechanical wear as well as their resistance to environmental factors. Outdoor athletics

probably represents the most severe allround test for synthetic surfaces. The surface must withstand the combined effects of compaction, abrasion, spike-damage, UV light, water, and variations in temperature. Indoor surfaces have somewhat less to contend with in that generally there would be no effects due to water and UV. It is hardly surprising that in the long-term
synthetic surfaces do sustain mechanical damage and in addition they may discolour and they may change in resilience. Mechanical damage would mainly take the form of loss of texture from the surface layer, together with cutting from the athletes spiked footwear. Obviously these effects would be most apparent in the heavily used areas such as the inside two lanes of the track,
the end of the javelin runways, the high jump and the pole vault take off points. Loss of adhesion to the base or edge kerbings might occur, as might loss of adhesion between individual layers of multi-layer systems. This adhesion loss would result in delamination of the surface from the base or from itself.
All mechanical breakdown of the surface will be exacerbated by the influence of the environment to which the surface is exposed.

Examples of this “accentuation” of wear are:

- In colder climates, freeze/thaw cycling of entrapped water can have an adverse effect on the physical integrity of spike-damaged areas, can further weaken areas of surface delamination, and can have a generally debilitating effect on areas of a porous surface where through-drainage is not as good as it should be.
- In hotter climates, spike damage creates larger surface areas over which UV attack can occur. This can be further exacerbated in the case of composite surfaces such as sandwich systems and texturised paint coated resin-bound rubber crumb systems, by the fact that mechanical damage can often expose the lower layer of the surface. These lower layers may not necessarily have been formulated for prolonged exposure to weathering.
- Hot and high humidity environments can progressively weaken the bond between the synthetic surface and the base or edge kerbings.

Discolouration and changes in resilience, if they occurred at all, would tend to occur over the entire surface area of the facility. These were fairly common problems in the early life of the synthetic surfaces industry, in the late 1960"s. However, modern formulations and the attention now paid by reputable manufacturers and installers of the raw materials to quality control, compatibility and consistency of the products, has meant that the synthetic surface is likely to retain its performance properties within reasonable limits, for its full anticipated service life.

#### 3.1.2.2 Effectiveness

The effectiveness of the surface is a matter of prime concern to all users of a facility. Certain performance requirements must be met if athletics is to take place on the surface with comfort and safety for the athletes.
These fundamental requirements have been laid down by the IAAF, and are as follows:

*a) Imperfections*

It is obvious that serious surface imperfections such as bubbles, fissures, delamination etc are unacceptable on grounds of safety and because of the effect they may have on durability and on dynamic performance of the surface. Wherever they occur, they must be rectified as a matter of priority.

*b) Flatness*

The very tight tolerances for overall gradients permitted by the IAAF are well known, because of the need to ensure that the slope of the surface gives no assistance to athletes. On a localised level, there shall be no bumps or depressions beneath a 4m straightedge exceeding 6mm, or beneath a 1m straightedge exceeding 3mm, at any position and in any direction. There shall be no step-like irregularities greater than 1mm in height, for instance at bay joints in in-situ surfaces or at seams in prefabricated sheet.

These limits are laid down not only to ensure safety for the athletes, but also to minimise standing water after rainfall, on non-porous surfaces. The presence of large areas of standing water, or of water ponding to any significant depth in key areas of the facility such as the high jump take off point, can lead to serious delays in the scheduling of events. The possible effect of such delays on major international events which are being televised world-wide, can easily be imagined. Even for smaller national competitions, such delays can create severe difficulties for competitors, officials and spectators.

*c) Thickness*

The thickness of a synthetic surface is of fundamental importance to the characteristics exhibited by the surface. To a certain extent, the durability of the surface is dependent on its thickness, particularly with respect to mechanical wear.

It is also quite apparent that if the IAAF Rules permit athletes to use footwear with spikes of a certain length, the surface must be of a thickness which will be adequate to take that length of spike, plus an excess of thickness to allow for wear and weathering. It is obviously for this reason that certain areas on a facility, such as at the throwing end of the javelin runway, are of greater thickness than most areas of the synthetic surface. Not only do the longer spikes permitted for this particular event, penetrate deeper into the surface, but the degree of damage which they inflict on the surface is that much greater (Fig 3.1.2.2 and Table 3.1.2.2).

| ***COLUMN*** | ***1*** | ***2*** | ***3*** |
|---|---|---|---|
| ***Line*** ***1*** | ***Runway*** | ***Thickness (mm)*** | ***Length*** |
| ***2*** | High Jump | 20 | Last 3m |
| ***3*** | Triple Jump | 20 | Last 13m |
| ***4*** | Pole Vault | 20 | Last 8m |
| ***5*** | Javelin | 20 | Last 8m plus overrun |
| ***6*** | Steeplechase water jump | 25 | Water jump landing |

**Table 3.1.2.2 – Thicker layers of synthetic surface for runways**

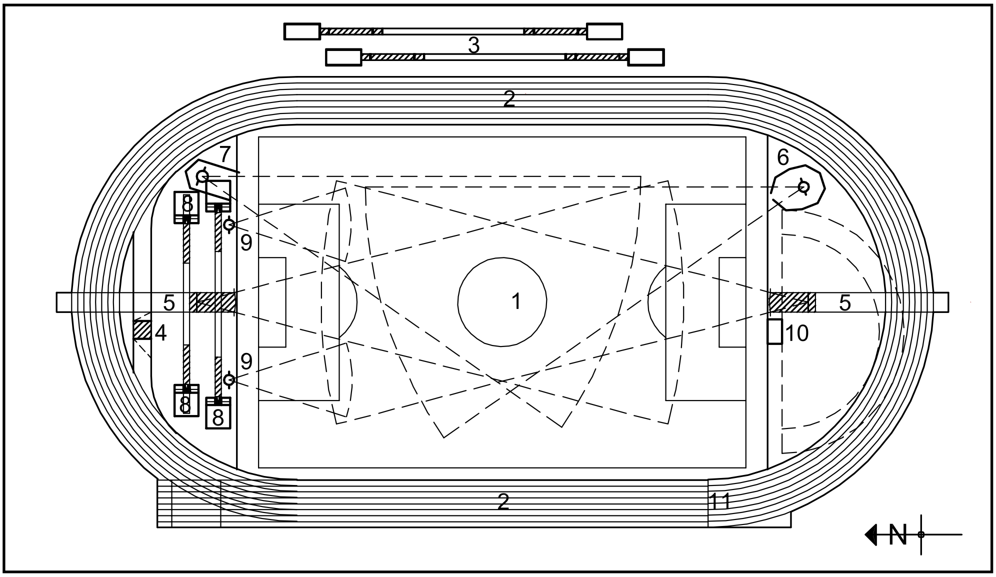



**Figure 3.1.2.2 - Areas with thicker layers of synthetic surface (shaded)**
1 Football pitch, 2 Standard Track, 3 long jump and triple jump facility, 4 water jump,
5 javelin runway, 6 discus and hammer throw facility, 7 discus throw facility,
8 pole vault facility, 9 shot put facility, 10 high jump facility, 11 finish line

By far the most important reason why a minimum thickness must be stipulated is that the dynamic characteristics of the synthetic surface are critically dependent on its thickness. If the surface is too thin, its force reduction and deformation properties will be adversely affected, for example it will feel hard and unyielding to athletes. However, if it is over thick, the converse does not usually apply, that is it will not necessarily feel too soft and compliant. It is for this reason that it is not necessary to stipulate a maximum thickness of synthetic surface.

The thickness of the surface shall be determined to meet force reduction and vertical deformation requirements hereunder. The IAAF Product Certificate for a synthetic surface material indicates the thickness at which a sample of the material, tested in a laboratory, complied with the IAAF Performance Specifications. The average thickness laid will probably have to be greater to ensure that no in-situ test result will fail. The total area over which the thickness falls more than 10% below the thickness given in the IAAF Product Certificate for the material used shall not exceed 10% of the total surface area. The high stress areas with a deliberately thickened surface shall not be taken into account in computing these percentages. The IAAF website contains details of all IAAF Certified Products and the thickness at which they meet the dynamic characteristics required by the IAAF. Note that force reduction and vertical deformation performance requirements take precedence over the thickness requirements. It is important to remember that the thickness values quoted are not determined to the very top of the surface crumb or texture, but to a point somewhat below that as laid down in a precise method of test.

*d) Force reduction*

The dynamic behaviour of athletics track surfaces is complex. Two of the major components of the interaction between an athlete and the surface are the deformation under load, or compliance, of the surface and the ability of the material to either absorb or reflect the energy of impact of the foot. Biomechanical studies over many years have confirmed the complexity of the foot/surface “model” and have revealed the extent of the variation in loading and duration of load between not only different sports, but different athletics events.

As has been explained elsewhere in this chapter it is possible to formulate synthetic surfaces which favour, or are more suitable for, one type of event against another. All current surfacing systems therefore represent a compromise between the various needs of the different athletics events.

The force reduction of the surface is measured using an “artificial athlete”, in which an impact load is applied via a spring to a test foot with a spherical base resting on the synthetic surface. The foot is fitted with a force transducer which enables the peak force during the impact event to be recorded. This peak force is compared with the result obtained on a rigid (concrete) floor, and the percentage force diminution calculated for the synthetic surface.
Force reduction, like all dynamic properties of elastomeric surfaces, is temperature dependent. Most major athletics competitions take place with a surface temperature in the range of 10° C to 40° C. The IAAF stipulates that the force reduction of the surface at any temperature within this range shall be between 35% and 50%.

It should be remembered that the force reduction values obtained on the synthetic surface might vary according to the type of base employed. Concrete is essentially a completely non-resilient base. However, the more commonly used bitumen-macadam or asphalt bases have a certain amount of compliance, and therefore might influence the force reduction of the surface laid above it.
The stipulated values are those for the installed facility. Where greater thicknesses of synthetic surface are installed, such as at the ends of runways, the force reduction values may fall outside the range quoted.

*e) Vertical Deformation*

Deformation is a second major component of the foot/surface interaction. If the deformation of the surface under foot load is too high, it represents a waste of kinetic energy and impairs the athlete’s performance. In addition, high deformations lead to instability of the foot, especially for athletes running around bends.
Conversely, if the surface deformation beneath the foot is too low, because of a very low compliance or because the synthetic surface is of inadequate thickness, then the deceleration forces experienced by the athlete’s foot on impact with the surface will be high, and injuries might result.
Once again, therefore, it is necessary to arrive at a compromise range of values which will retain the advantages of a surface which stores and reflects energy imparted to it, without imposing excessive deceleration forces.

The vertical deformation of the surface is measured by another "artificial athlete" in which an impact load is applied via a spring to a test foot with a flat base resting on the synthetic surface. The foot is fitted with a force transducer which enables the peak force during the impact event to be recorded. Simultaneously, the deformation of the test foot is measured by means of movement transducers mounted either side of the foot.

As for force reduction, the deformation of the surface will vary with temperature. Therefore the range of deformation values stipulated by the IAAF, of between 0.6mm and 2.2mm, is with the surface at a temperature between 10° C and 40° C. The comment about areas of greater thickness giving values outside the stipulated range, also applies for this parameter.

*f) Friction*

An important requirement of an athletics track is the need to ensure that no undesirable slip occurs between the surface and the competitor's foot. This requirement should be maintained irrespective of whether the surface is wet or dry. The correct friction value is achieved by giving the surface a textured or embossed finish. Friction is a characteristic of not just one surface but of two surfaces in contact. Because of the complications which this fact introduces, it is normal for test measurements of friction to standardise on one particular type of foot on the test apparatus.

There are two widely used items of test equipment for the measurement of the frictional properties of athletics tracks. One is a pendulum device fitted with a spring-loaded foot shod with a standard grade of rubber. The other apparatus utilises a standard leather foot which operates under a fixed load and is allowed to rotate down on to the surface under test. Both tests yield a coefficient of dynamic friction, which the IAAF stipulates shall be no less than 0.5 under wet conditions. All synthetic athletics surfaces yield higher coefficient of friction values when dry than when wet, and so it is only necessary to specify a minimum under wet conditions.

*g) Tensile Properties*

The tensile strength and elongation at break of a synthetic surface is a vitally important "screening" test for surfaces, to ensure that the correct raw materials are used, in the correct proportions, properly laid, consolidated and cured.
The minimum values which are stipulated can be met by quality systems from reputable manufacturers and installers.

There are a number of situations in which a surface might fail to meet the requirements:

- If the rubber has not correctly cured such as for reasons of incorrect mixing or proportioning of raw materials, incompatibility of raw materials, or adverse weather conditions during the period allowed for cure.
- If the raw materials are substandard in any way, for instance if the rubber granules are incorrectly graded for particle size, if their source is inadequately controlled, or if the resin contains too high a proportion of inert filler.

Any of the above problems are likely to result in a surface which might fail to meet certain other key performance requirements. Such a failure could, of course, be identified by testing the completed facility. However, if the formulation is "adjusted" only to a lesser extent, the far more insidious situation might arise where the surface meets the dynamic requirements when newly completed, but deteriorates by mechanical wear and under the action of weathering, more rapidly than it should. The long-term effectiveness of the surface is therefore compromised.

Conducting tensile tests on samples of the surface should give a useful indication that its strength and likely durability are as they should be for that type of system. The minimum values stipulated by the IAAF for tensile strengh are 0.5MPa for non-porous surfaces and 0.4MPa for porous surfaces. For all surfaces, the minimum elongation at break shall be 40%.

*h) Colour*

The actual colour of a synthetic surface for athletics is not important provided the line markings are easily discernible. In practice, most outdoor athletics tracks have red surfaces. If colour changes occur as a result of weathering of the surface, these should also be uniform. If they are not, for reasons perhaps of differing effects on different batches of the materials used, and hence on different areas of the facility, then it may be necessary to resurface the track.
There are a number of different assessment systems for colour. Most utilise some form of colour chart or series of colour cards or plates. Any system used for assessing colour must be capable of identifying and if necessary quantifying, the consistency of the colour of the surface over the facility.

*i) Drainage*

The very slight gradients which are permitted for athletics facilities, make the shedding of water from non-porous surfaces difficult, although not impossible.
It has already been explained that the presence of large areas of standing water, or of small areas in key locations such as the high jump take-off point, can seriously delay the schedule of a major competition. It is for this reason that the IAAF stipulates that when completely covered with water and allowed to drain for 20 minutes, there shall be no area of synthetic surface where the depth of residual water exceeds the texture depth of the surface. Porous surfaces should rarely give problems of this nature. If such problems do occur, they are invariably the result of either the excessive application of the texturised paint coating, or of inadequate porosity in the sub-base foundations for the facility or in the drainage system taking water away from the base construction.

### 3.1.3 TESTING

Systems developed for athletics tracks should always undergo a programme of laboratory testing before being introduced by manufacturers and installers. These tests would have the following principal aims:

- to ensure the compatibility of all the raw materials in the formulation

- to ensure that the system can be successfully installed in most normal climatic conditions
- to ensure that the surface has satisfactory durability
- to ensure that the performance characteristics of the surface are satisfactory for athletics
- to ensure that the formulation has no unsatisfactory environmental characteristics with respect to its raw materials ingredients, method of installation, or long-term performance

All of these aspects may be investigated by suitable laboratory tests. The likely durability can be predicted by accelerated tests for abrasion, spike resistance, compaction, the effects of UV, water and varying temperatures, etc.
However, most of the tests which have been developed will only assess one aspect of durability. In practice, of course, these surfaces deteriorate under the action of combined wear and environmental factors. For this reason, observations on actual installations of products, preferably several years old, are invaluable.

The performance of the surface for athletics is obviously of paramount concern to the IAAF, and the requirements which they stipulate in this respect are detailed earlier in this Chapter. The precise methods by which an athletics track is tested for these various parameters is given below. It cannot be stressed too highly that the testing and investigation of these facilities is a very specialised activity, requiring complicated test apparatus and considerable experience in its use and the interpretation of the results generated. It is for this reason that the IAAF have enlisted the assistance of a network of test laboratories around the world, all suitably equipped and experienced in athletics track testing. The list of current IAAF accredited laboratories for testing synthetic track surfaces can be found on the IAAF website.

The best check of the quality of the finished track facility is to have an in-situ performance test undertaken by an IAAF accredited laboratory. Such a test is mandatory for a facility seeking an IAAF Class 1 certificate. Where an in-situ test is not being undertaken, it is recommended that for quality assurance purposes the surfacing installer is instructed to prepare control samples at the rate of one sample per 600m$^2$ of installed surface. The samples should be cast beside the track using the same materials and techniques. The thickness of the samples should be the same thickness as listed on the IAAF Product Certificate for the synthetic material. The size of the samples should not be less than 600mm x 600mm. If the completed facility is undergoing full testing, the quality assurance samples should still be prepared to enable the tensile properties to be measured without the need to cut out areas of new surface. In this case, each sample size can be 300mm x 300mm.

#### 3.1.3.1 Imperfections

*Requirement*

No surface imperfections such as bubbles, fissures, delamination, uncured areas etc., shall be acceptable.

*Method*

A thorough visual examination of all areas of synthetic surface should be conducted, and the positions of all imperfections noted on a plan of the facility. Where appropriate, photographs may be taken of any imperfections, in order to illustrate the test report.

Note: in some cases uncured areas may not be identified until the thickness survey is undertaken (see 3.1.3.3). For instance uncured material might only be detected for the first time when a thickness probe is withdrawn from the surface and is found to be smeared with sticky resin. This may happen with multi-layer systems where one or more of the lower layers is uncured but the upper layer appears sound. It is important that the extent of any area of uncured material is fully identified.

#### 3.1.3.2 Surface Flatness

*Requirement*

The surface shall be installed so that on a localized level, there shall be no high spots or depressions beneath a 4m straightedge exceeding 6mm. Depressions beneath a 1m straightedge shall not exceed 3mm. There shall be no step-like irregularities greater than 1mm in height. Particular attention is to be paid to seams and joints in the surface. The intent is to ensure the safety of the athlete and provide an even running surface.

*Method*

Place the 4m straightedge on the surface over lanes 1-3 at 90° to the kerb and drag it around the entire circuit. Move it out to the next three lanes and repeat the drag around the entire circuit. For circuits with more than 6 lanes, continue until all lanes have been dragged. Turn the straightedge through 90°, place on the surface in lane 1 (parallel to the kerb) and drag it to the outer kerb. Move it along 4m and drag it back to the inner kerb. Move it along 4m and drag it back to the outer kerb. Repeat until the entire circuit has been dragged.

On runways, place the 4m straightedge on the surface parallel to the kerbs and in the centre of the runway and drag it from one end to the other.

On fan areas, drag the 4m straightedge across its width, move it along 4m and repeat the drag back across its width. Repeat again until the full width of the fan has been dragged. Repeat the entire process along its length.

Use continual visual observation to determine if a gap exists under the straightedge. Should a gap exist, verify that both ends of the straightedge rest on the surface, moving the straightedge if necessary, then use a calibrated wedge to determine the actual size of the gap.

The intention is that the entire area of surface should be dragged with the 4m straightedge. Placing the straightedge on a regular ‘grid’ of individual locations is not an appropriate method for assessing the entire surface.

Whenever, during the 4m straightedge survey, a step-like or other irregularity is visually identified which gives a wedge reading below the maximum permitted, but which is considered to be likely to give a wedge reading above the 1m straightedge maximum, the 1m straightedge should be placed across the irregularity and its exact height measured using the calibrated wedge.

Any location where a gap is found exceeding the maximum permitted, is recorded on a plan of the facility. The record should also identify whether the deviation is a high spot or a depression.

Note: sometimes in moving the straightedge slightly to find the maximum gap, it becomes clear that the irregularity is a high spot rather than a depression. In order to find the magnitude of the high spot, place the centre point of the 4m straightedge on the high spot and rotate the straightedge through 360° until the maximum gap is obtained under one end of the straightedge by pressing the other end down against the surface. Measure the gap beneath the elevated end of the straightedge and then divide this figure by two to give the magnitude of the high spot.

#### 3.1.3.3 Thickness

*Requirement*

The durability of the surface and the safety of the athlete can be affected by the thickness of the surface. The use of spikes enhances this requirement for a minimum thickness. There will be specifically designed areas such as in the javelin runway or other high stress areas where the safety of the athlete and the durability of the surface will dictate that the thickness be greater than the minimum. This additional thickness shall not affect the flatness of the surface.
The thickness of the surface shall be determined to meet force reduction and vertical deformation requirements hereunder. The IAAF Product Certificate for a synthetic surface material indicates the thickness at which a sample of the material, tested in a laboratory, complied with the IAAF Performance Specifications. The thickness laid will probably have to be greater to ensure that no in-situ test result will fail. The total area over which the thickness falls more than 10% below the thickness given in the IAAF Product Certificate for the material used shall not exceed 10% of the total surface area. The high stress areas with a deliberately thickened surface shall not be taken into account in computing these percentages. Note that force reduction and vertical deformation performance requirements take precedence over the thickness requirements.
The thickness shall not be determined to the top of the surface crumb or texture but by the method of test given below.

*Method*

A calibrated 3-prong depth-measuring probe is used to determine the thickness of the surface. Care must taken not to penetrate the asphalt or bitumen-macadam base beneath the surface. The thickness is measured by starting at the finish line and taking sets of readings at 10m intervals around the circuit. The first set of readings is to be taken in the even lanes (2, 4, 6, 8) and the next set in the odd lanes (1, 3, 5, 7), alternating between even and odd lanes every 10m around the circuit. Readings shall be taken in the centre of each lane. At the 110m start position on each straight, readings shall be taken in the centre of each lane. Runways including the steeplechase lane on the circuit shall be probed at 3m intervals centred along the length. The fan areas shall be probed at 5m intervals along parallel axes in two directions.

Where thin areas are detected, additional probe readings shall be taken in all directions until an acceptable thickness is measured. Additionally, the exact extent of over-thickness (reinforced) areas shall be determined by probe readings in the same way as above. All measurements taken are recorded (but see next paragraph) and the test points listed in the test report.

At a number of locations a core (10mm to 25mm in diameter) is removed and measured using the following method to make the final determination as to the actual thickness. At least four cores shall be removed, but more than this number are required if the surface is thin over large areas. All core holes to be repaired immediately. The surface texture of the core is abraded with a grade 60 abrasive for approximately 50% of the surface area of the core. The thickness of the abraded area of the core is measured using a thickness gauge fitted with a 0.01mm accuracy dial, a plunger with a flat measuring surface of 4mm diameter and with a measurement force between 0.8N and 1.0N. The measurement is recorded to the nearest 0.1mm.
The difference in thickness between the actual surface and the abraded surface is calculated and the difference deducted from all of the actual probe measurements. These amended figures are recorded as the thickness of the surface for the purpose of the report.

All readings should be noted on a plan of the facility.

#### 3.1.3.4 Force Reduction

*Requirement*

The dynamic interaction between the athlete and the surface is significant to the performance and safety of the athlete. Therefore the ability of the surface to reduce force (absorb energy) is important. The force reduction shall be between 35% and 50%, at any surface temperature between 10°C and 40°C. If, at the time of measurement, the temperature of the surface is outside this range, it shall be permissible for the results obtained to be corrected for temperature, by interpolation from a graph of force reduction against temperature for the precise surfacing system installed, previously obtained by laboratory testing.

Because of the fact that it is usual to install greater thicknesses of synthetic surface at take-off areas and at the ends of runways, it is possible that results obtained in these areas may fall outside the above range.

*Method*

The force reduction of the installed synthetic surface may be measured using the apparatus described below and shown schematically in figure 3.1.3.4.

This method utilises the ‘Artificial Athlete’ BAA. A mass of 20kg is allowed to fall onto an anvil, which transmits the load via a spring to a test foot with a spherical base resting on the surface. The foot is fitted with a force transducer that enables the peak force during the impact event to be recorded. The peak force is compared with the result obtained on a rigid (concrete of at least 150mm thickness) floor, and the percentage force reduction calculated for the synthetic surface.

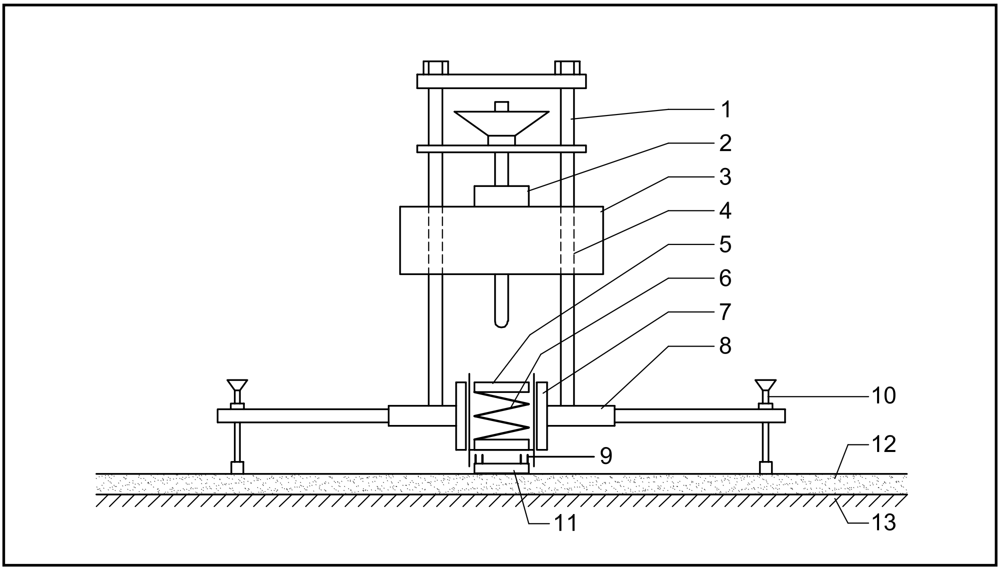



**Figure 3.1.3.4 - Force Reduction Test Apparatus**
1 Bars, 2 lifting/release facility, 3 drop weight, 4 guidance, 5 anvil, 6 spring, 7 tube, 8 support, 9 load cell, 10 foot of support, 11 test foot, 12 synthetic surface, 13 base

The BAA must have a current valid Certificate of Compliance from the International Association for Sports Surface Sciences (ISSS), obtained under their BAA Certification Programme procedures. The apparatus consists of the following essential components:

a) Falling weight, 20 ± 0.1kg with a hard striking surface, which is guided so as to fall smoothly and vertically with minimum friction.
b) Spiral spring, whose characteristic, when mounted in the assembly described below, is linear with a spring rate of 2000 ± 60N/mm over the 0.1 kN to 7.5 kN range. The spring is fitted with a hard upper plate (anvil) and has an outer diameter of 70.0 mm or less. It is recommended that the spring be manufactured by milling from the solid.
c) Adjustable supporting feet, no less than 250 mm from the point of application of the load.
d) Steel base plate, with the rounded lower side having a radius of 500mm, radius of the edge 1 mm, diameter 70.0 ± 0.1 mm, thickness 10mm minimum.
e) Metal guide tube, interior diameter 71.0 ± 0.1mm.
f) Electrical force-sensing device, with a capacity of 10kN, class 0.2.
g) Test foot, consisting of the flat and round (diameter of 70 ±01 mm) steel base plate (see above), force sensing device, spring and upper plate, funnelled into the guide tube. The total weight of the testing foot (without guide tube) should be 3.0 ± 0.3 kg.
h) A means of supporting the weight, allowing it to be set to the fall height with an uncertainty no greater than ± 0.25mm.
i) A means of conditioning and recording the signal from the force sensing device and the sensors, and a means of displaying this signal. The ISO 6487 channel frequency class of the conditioning amplifier shall be ≥ 1kHz.

Care shall be taken to ensure anti-aliasing does not occur. This may be achieved by applying an analogue prefilter with a cut-off frequency of approximately 500 Hz, to prepare the signal for final filtering.

The conditioning amplifier shall be followed by or shall incorporate a low-pass filter having a 9th order Butterworth characteristic with a -3 dB frequency of 120 Hz. Filtration may be implemented in hardware or software. The response of the system at any given frequency shall be within ± 0.5 dB of the expected response, calculated on the basis of the Butterworth function.

Where digital recording means are employed, the word length shall be ≥ 12 bits, the amplitude of the signal shall be no less than 25 % of the equipment full scale and the sampling frequency shall be ≥ 2 kHz or twice the upper frequency response limit of the amplifier/filter system preceding the digital system, whichever is greater.

j) A rigid, non-vibrating, smooth, level and even concrete floor on which a peak force (Fmax) of between 6.60 ±0.25 kN is achieved.

The apparatus is set vertically. The drop height of the weight on to the anvil is set to 55mm plus or minus 0.25mm. The weight is allowed to fall on to the force measurement assembly and the peak force applied to the surface in the course of the impact is recorded. After a not-recorded pilot test, two further measurements are taken. Each individual test procedure is repeated at intervals of 60 ±10 seconds. It is important to lift the weight from the anvil within five seconds after impact, in order that the surface is not loaded for too long.
The force reduction is calculated as follows:

$$\text{Force Reduction (\%)} = \left(1 - \frac{Fs}{Fc}\right) \times 100$$

where Fs = measured maximum peak force on synthetic surface, in Newton (N)
Fc = measured maximum peak force on concrete, in Newton (N)

Calculate the mean of the force reduction results from the second and third impact. Report the initial and mean results to the nearest whole percentage, e.g. 37%.

The accuracy of this method is calculated at plus or minus 1%.

At least one measurement shall be made for every $500m^2$ of normal thickness synthetic surface, with a minimum of twelve (12) measurements over the facility. The test positions shall be as follows:

At the discretion# of the test laboratory in any lane around the first radius*
In the centre of lane 2 at the 130m mark on the back straight
In the centre of lane 5 at the 160m mark on the back straight
At the position of lowest thickness on the back straight*

At the discretion# of the test laboratory in any lane around the final radius*
In the centre of lane 1 at the 320m mark on the main straight
In the centre of lane 4 at the 350m mark on the main straight
In the centre of the outer lane at the 390m mark on the main straight
At the position of lowest thickness on the main straight*
At the discretion# of the test laboratory at any position (except the high-jump take-off point) over the semi circular area. Where there are two semi circular areas, a test shall be performed on each of them.
At the discretion# of the test laboratory at any position (except the reinforced areas) on each of the runways (long jump/triple jump, pole vault, javelin) and in the steeplechase lane.

#Whenever the selection of the test location is left at the discretion of the laboratory, that location must be close to the average thickness of the track as a whole.

*For the purposes of testing, the first radius is defined as 10m to 100m, the back straight as 110m to 200m, the final radius as 210m to 300m, and the main straight as 310m to 400m.

If the area of synthetic surface is exceptionally large (for example 10 or 12 lane straights), any necessary additional tests shall be at locations selected by the test laboratory.

At each location, the temperature of the surface shall be measured with a needle temperature probe and recorded. Each test position shall be recorded on a plan of the facility with the results recorded in the report.

Note: if the surface temperature is outside the permitted range of 10°C to 40°C, temperature correction of the results may be employed on the basis of interpolation from laboratory results as described in the first paragraph. However, it is sometimes possible to avoid the need for this, by conducting the testing at a different time of day. For instance, if the facility is in a hot region, testing early in the morning or in the evening can result in the surface temperature falling to within the above range.

#### 3.1.3.5 Vertical Deformation

*Requirement*

The dynamic interaction between the athlete and the surface is significant to the performance and safety of the athlete. Therefore the ability of the surface to deform under load is important. Too high a deformation can affect the safety of the athlete through instability of the foot, while the inability of the surface to deform can cause injuries due to impact forces. The vertical deformation shall be between 0.6mm and 2.2mm, at any surface temperature between 10°C and 40°C. If, at the time of measurement, the temperature of the surface is outside this range, it shall be permissible for the results obtained to be corrected for temperature, by interpolation from a graph of vertical deformation against temperature for the precise surfacing system installed, previously obtained by laboratory testing.

Because of the fact that it is usual to install greater thicknesses of synthetic surface at take-off areas and at the ends of runways, it is possible that results obtained in these areas may fall outside the above range.

*Method*

Vertical deformation is measured using the apparatus described below and shown schematically in figure 3.1.3.5. The apparatus consists of the following essential components:

a) Falling weight of 20 ±0.1 kg with a hard striking surface guided in such a way as to fall smoothly and vertically with minimum friction.
b) Single coil spring which, when mounted in the assembly described below, is linear with a spring rate of 40 ± 2.5N/mm over the 0.1kN to 1.6kN.
c) Adjustable supporting feet, no less than 250mm from the point of application of the load.
d) Steel base plate, with a flat lower side; radius of the edge 1 mm, diameter 70.0 ±0.1mm; thickness 10 mm min.
e) Test foot, consisting of the flat and round (diameter of 70.0 ±0.1 mm) steel base plate, two horizontal projections attached to the testing foot for the sensors, force sensing device, spring, and upper plate. The total weight of the testing foot (without guide tube) shall be 3.5 ±0.35kg.
f) Metal guide tube, interior diameter 71.0 ±0.1mm.
g) Two sensors e. g. electronic pick-ups with a measuring range of no less than 20 mm and an uncertainty no greater than 0.05 mm. The distance between the sensors shall be less than or equal to 300 mm. The sensors shall be mounted on a separate stand from the falling weight, etc.
h) A means of supporting the weight, allowing it to be set to the fall height with an uncertainty no greater than ±0.5 mm.
i) A means of conditioning and recording the signals from the force sensing device and the sensors, and a means of displaying these signals.

The ISO 6487 channel frequency class of the conditioning amplifier for the force signal shall be ≥ 500Hz. It shall be followed by or shall incorporate a low-pass filter having a 9th order Butterworth characteristic with a -3 dB frequency of 120 Hz. Filtration may be implemented in hardware or software. The response of the system at any given frequency shall be within ± 0.5 dB of the expected response, calculated on the basis of the Butterworth function.

The signal conditioner for the deformation signal shall have a –1 dB measuring range of min. 100 Hz (-1 dB upper frequency response). The individual signals of the two deformation sensors shall be superposed before calculating the vertical deformation.

Where digital recording means are employed, the word length shall be ≥ 12 bits, the amplitude of the signal shall be no less than 25 % of the equipment full scale and the sampling frequency shall be ≥ 0.5 kHz.

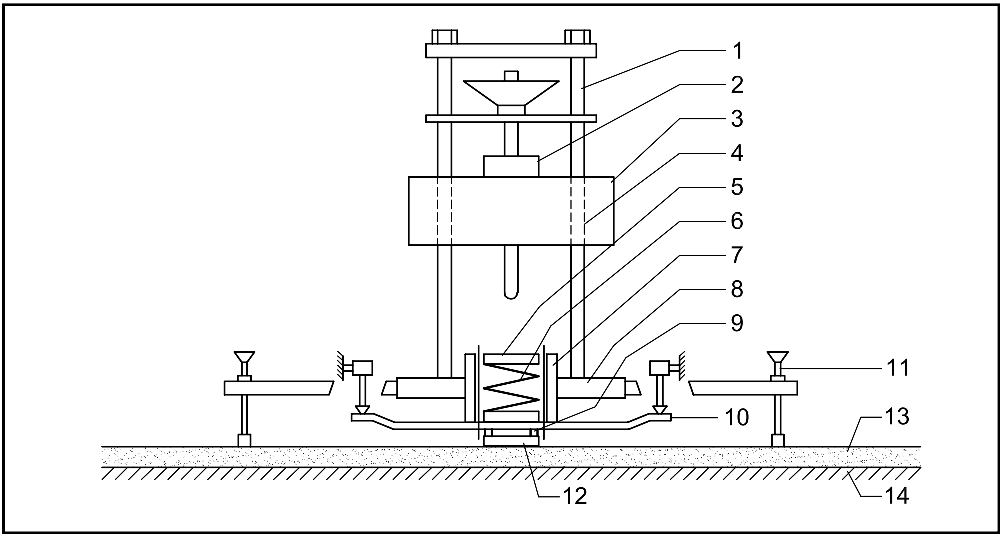



**Figure 3.1.3.5 - Vertical Deformation Test Apparatus (IAAF artificial athlete)**
1 Bars, 2 lifting/release, 3 drop weight, 4 guidance, 5 anvil, 6 spring, 7 tube, 8 support, 9 load cell, 10 transmitter for deformation, 11 foot of support, 12 test foot, 13 synthetic surface, 14 base

Set the apparatus so that it is vertically positioned on the surface.

Adjust the sensors (deformation pick-ups) so they are equi-spaced either side of the falling weight axis. Under this condition the force measurement assembly shall give a constant pressure of 0.009 ±0.001 N/mm$^2$ and a corresponding deformation of the surface which equates to the zero position.

Adjust the deformation pick-ups so they contact the horizontal projections on the test foot.

Set the height of the lower face of the impact mass so that it is 120 ±0.5 mm above the top plate of the spring.

Allow the mass to fall onto the testing foot. Catch the weight as it rebounds to prevent a second impact of the test foot and the surface.

Record the force applied to the surface and the resulting deformation of the initial impact.

Repeat the procedure three times at intervals of 60 ±10 seconds without moving the test apparatus, giving a total of four impacts on the same spot, catching the mass after the first impact of each measurement.

Calculate the vertical deformation VD from the expression:

$$VD = \left( \frac{1\,500}{F_{max}} \right) . d_{max}$$

where
dmax is the maximum deformation of the surface in the axis of impact, in millimetres (mm), calculated from the mean of the two sensors (electronic pick-ups).
Fmax is the maximum force (peak value) in Newton (N).

The test result is the mean value of the last three impacts.

Report the result to the nearest 0.1mm e.g. 1.5mm. The accuracy of this method is calculated at plus or minus 0.1mm.

At least one measurement shall be made for every 500m$^2$ of normal thickness synthetic surface, with a minimum of twelve (12) measurements over the facility. The test positions shall be as follows:
At the discretion# of the test laboratory in any lane around the first radius*
In the centre of lane 2 at the 130m mark on the back straight
In the centre of lane 5 at the 160m mark on the back straight
At the position of lowest thickness on the back straight*
At the discretion# of the test laboratory in any lane around the final radius*
In the centre of lane 1 at the 320m mark on the main straight
In the centre of lane 4 at the 350m mark on the main straight
In the centre of the outer lane at the 390m mark on the main straight
At the position of lowest thickness on the main straight*
At the discretion# of the test laboratory at any position (except the high-jump take-off point) over the semi circular area. Where there are two semi circular areas, a test shall be performed on each of them.
At the discretion# of the test laboratory at any position (except the reinforced areas) on each of the runways (long jump/triple jump, pole vault, javelin) and in the steeplechase lane.

#Whenever the selection of the test location is left at the discretion of the laboratory, that location must be close to the average thickness of the track as a whole.

*For the purposes of testing, the first radius is defined as 10m to 100m, the back straight as 110m to 200m, the final radius as 210m to 300m, and the main straight as 310m to 400m.

If the area of synthetic surface is exceptionally large (for example 10 or 12 lane straights), any necessary additional tests shall be at locations selected by the test laboratory.

At each location, the temperature of the surface shall be measured with a needle temperature probe and recorded. Each test position shall be recorded on a plan of the facility with the results recorded in the report.
Note: if the surface temperature is outside the permitted range of 10°C to 40°C, temperature correction of the results may be employed on the basis of interpolation from laboratory results as described in the first paragraph. However, it

is sometimes possible to avoid the need for this, by conducting the testing at a different time of day. For instance, if the facility is in a hot region, testing early in the morning or in the evening can result in the surface temperature falling to within the above range.

#### 3.1.3.6 Friction

*Requirement*

When measured using either the British Transport and Road Research Laboratory Portable Skid Resistance Tester or the apparatus and method described below, the synthetic surface friction shall be nowhere less than 0.5 when wet.

Note: This corresponds to a scale reading of 47 on the TRRL machine.

*Method*

Two methods are considered suitable for measuring the friction of installed synthetic track surfacing.

Method A involves the use of the portable skid resistance tester illustrated in figure 3.1.3.6a. A standard smooth rubber slider, spring-loaded beneath a foot mounted on the end of a pendulum arm, is allowed to swing down from a fixed position at 90° to the surface, slide along the surface for a pre-set distance, and swing through taking a “lazy pointer” with it, which remains at the top of the swing against a fixed scale.

The apparatus is set level on the surface, with the legs supported on “spreader” plates to prevent localised deflection of the surface beneath the legs as the pendulum swings through its arc. The head is raised so that the pendulum swings clear of the surface. The arm is allowed to swing freely from its normal release position and the scale reading noted. If this is not zero, the friction rings are adjusted and the process repeated until a zero reading is consistently obtained.

Lower the arm and adjust the height setting until the slider just touches the surface, from one side of the vertical to the other side, a distance of between 125mm and 127mm. Lock the height setting in this position and re-check the distance of travel. Place the pendulum in the release position.

Flood the test area with clean water, release the pendulum and ignore the first reading. Release the pendulum five further times and record the scale reading obtained after each swing. Calculate the mean of all five readings. This is the wet result.

If the surface appears to have a directional pattern or texture, additional results should be obtained with the apparatus set in such a way that the slider traverses the same area of surface at 90° and at 180° to the original direction of travel used for the first set of readings.

Method B involves the use of the sliding test apparatus shown in figure 3.1.3.6b. A vertical shaft of diameter 20mm is arranged in a frame, the lower part of which is

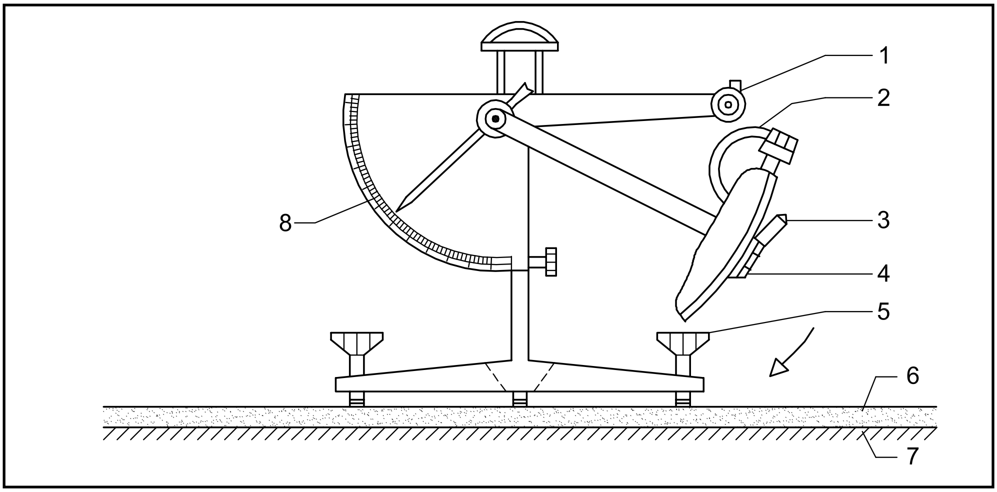



**Figure 3.1.3.6a - Portable Skid Resistance Tester**
(Friction Method A)
1 Release catch, 2 lifting handle, 3 pin F, 4 rubber slider,
5 foot of support, 6 synthetic surface, 7 base, 8 scale

designed as a threaded spindle (of pitch 12mm/turn). The shaft is guided at the top by a plain bearing and at the bottom by a ball bearing having a radial and axial action so that the shaft moves downwards when turned clockwise and upwards when turned anticlockwise. At the lower end of the shaft a test foot is mounted on a pivoted mound (ball joint) such that rotation of the shaft is transferred to the test foot.

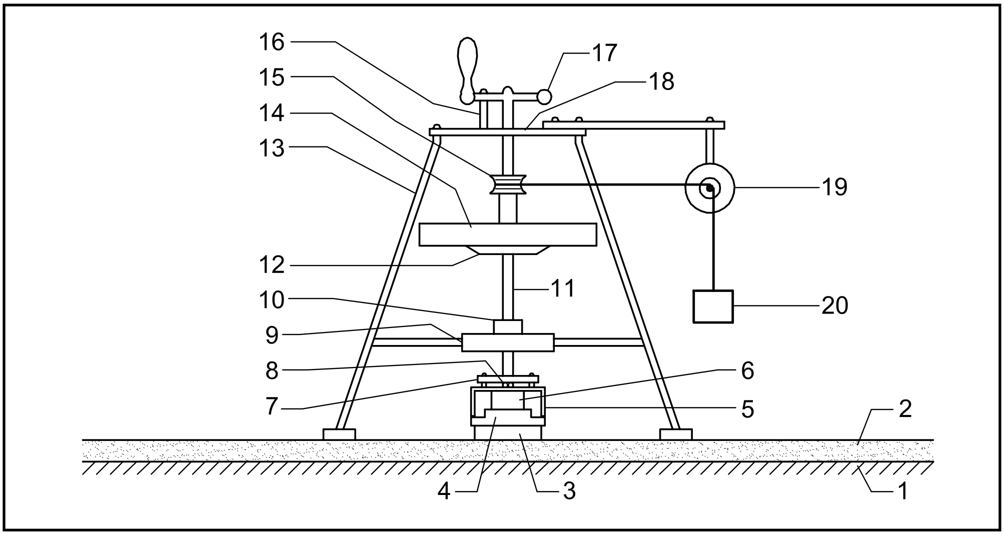



**Figure 3.1.3.6b - Sliding Resistance Tester**
(Friction Method B)
1 Base, 2 synthetic surface, 3 bottom plate, 4 lower part of test foot, 5 upper part of test foot,
6 electrical detector, 7 soft rubber disc, 8 ball joint, 9 ball bearing holder, 10 ball bearing, 11 threaded spindle, 12 support flange, 13 frame, 14 weights, 15 winding drum, 16 catch lever, 17 handwheel,
18 plain bearing, 19 potentiometer for measuring the speed of rotation, 20 freely suspended weight

The ball bearing is arranged in a bracket on the frame, so as to permit vertical movement of the ball bearing, downward movement being limited by a stop. A circular flange is fixed to the middle part of the shaft, on which weights can be placed. A constant torque is applied to the shaft by means of a steel wire wound on the shaft by means of a winding drum of 63mm diameter, and which runs over a guide pulley and is tensioned by a freely suspended 5kg weight. This torque drives the shaft.

The test foot contains a strain gauge or piezo-electric device for measuring the torque. The test foot consists of a lower and an upper part, between which the measurement sensors are arranged. The lower surface of the test foot has three skids, in the form of segments of a 100mm diameter, 20mm high, cylinder, arranged as shown. These skids are covered with leather which is finished with 100 grade abrasive paper (grinding procedure with the sliding direction).
The leather shall be old tanned with a Shore D hardness of 60 plus or minus 5.
The leather skid soles should be 2mm thick.

The weight and the polar moment of inertia of the shaft, of the weights and of the test foot, must be as follows:

weight = 20 plus or minus 1 kg
moment = 3000 plus or minus 200 kg $cm^2$

Required measurement range for torque is 0 to 4 Nm with an accuracy of 0.5%

The apparatus is placed on the synthetic surface, and the shaft is raised causing the steel wire to wind on to the drum. The synthetic surface is thoroughly wetted with clean water. The shaft is then released so that the weights drive the shaft downwards. As the test sole contacts the surface, the rotation of the shaft is braked by the frictional resistance between the sole and the surface and this is measured as torque, which is continuously plotted with a recording device (Fig 3.1.3.6b).

The total weight of the shaft, weight and test foot is set to 20kg. The shaft is turned far enough upwards before the measurement to ensure that the test foot contacts the surfacing after one rotation. Three measurements are carried out at each test position, and the test sole and the surface must be cleaned of abraded material between each test.

The measurement plots consist of a curve of torque against time and a curve of normal load against time. To determine the coefficient of sliding friction, the friction resistance at the transition from the initial sliding to steady sliding is used. The sliding friction coefficient is determined from the friction resistance at the point of intersection as follows:

$$E = 0.30 \frac{D}{V}$$

where D = relevant friction resistance (N cm)
and V = normal force in N

In each case, the arithmetic mean is calculated from the three individual measurements made at each location. The results must be reported to two decimal places.

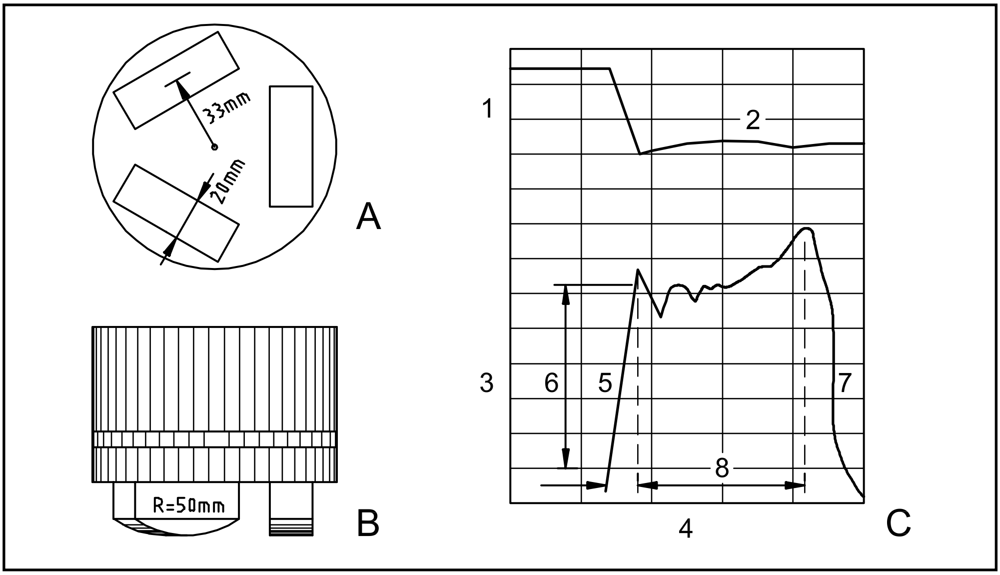



**Figure 3.1.3.6c - Detail of Test Foot, Test Example**
A Bottom side of test foot
B View of test foot
C Example: Manner of representation of test results
1 Normal force in N, 2 sliding curve V, 3 torque in Ncm
4 time in s, 5 initial sliding phase, 6 value used for determining µ
7 sliding curve D, 8 constant sliding phase

Using either method, at least one measurement should be made for every 1000m$^2$ of normal thickness synthetic surface, with a minimum of six measurements over the facility. The test positions shall be as follows:
At the discretion of the test laboratory in any lane around the first radius*
At the position of apparent lowest texture in any lane on the back straight*
At the discretion of the test laboratory in any lane around the final radius*
At the position of apparent lowest texture in lane 1 on the main straight*
At the discretion of the test laboratory at any position (except the high jump take-off point) over the semi circular area. Where there are two semi circular areas, a test shall be performed on each of them
At the discretion of the test laboratory at any position on one of the runways

If the area of the facility is exceptionally large (for example 10 or 12 lane straights), any necessary additional tests shall be performed at locations selected by the test laboratory.

Each test location shall be marked on a plan of the facility with the results recorded in the report.

### 3.1.3.7 Tensile Properties

*Requirement*

When determined using the method described below, the synthetic surface shall have a minimum tensile strength of 0.5MPa for non-porous surfaces and 0.4MPa for porous surfaces. For all surfaces, the elongation at break shall be a minimum of 40%. The test shall be conducted on a minimum of four specimens and the result quoted is the average of the four results.

*Method*

In the case of newly installed tracks, it is sometimes acceptable to conduct this test on sample “trays” of synthetic surface prepared by the contractor as work proceeds, or in the case of prefabricated surfaces on samples cut from individual rolls of material on site. However, in the event of dispute or if the quality of the installed surfacing is suspect, samples must be taken from the track itself.

If it is necessary to cut samples of surfacing from the track for this test, these should obviously be removed, where possible, from non-critical areas of the facility such as run-outs at the ends of straights, at the corners of fan areas etc. In the event that samples must be removed from a specific location because a defect is suspected, these samples should be cut from a low-wear area within that location.

In the case of prefabricated products, it is recommended that samples are removed across a number of the bonded seams, in order that the strength of the bond can be assessed.

It may prove necessary to remove some of the wearing course of the macadam base, if a cohesive sample of the synthetic surface is to be obtained.
All areas from which samples have been removed, should be repaired immediately with fresh synthetic surfacing.

The tensile strength and elongation at break shall be determined on dumbell bars stamped or cut from a full thickness sample of the surfacing. The shape of the specimens shall be as shown in figure 3.1.3.7 sample A, although specimens shaped as sample B may be used in some circumstances. The bars shall be conditioned at 23°C for 24 hours and then stretched at a constant strain rate of 100mm/minute until they break. A stress/strain curve may be plotted during the test.

In the case of synthetic surfacing formed with the use of single-component, moisture-curing polyurethanes, at least 14 days curing time should be allowed before conducting tensile strength tests. If such a system fails to meet the stipulated limits, repeat tests should be conducted on further samples after another 14 days, or after a period of accelerated curing in the laboratory.

Each test location shall be marked on a plan of the facility and the results obtained on samples from each location included in the test report.

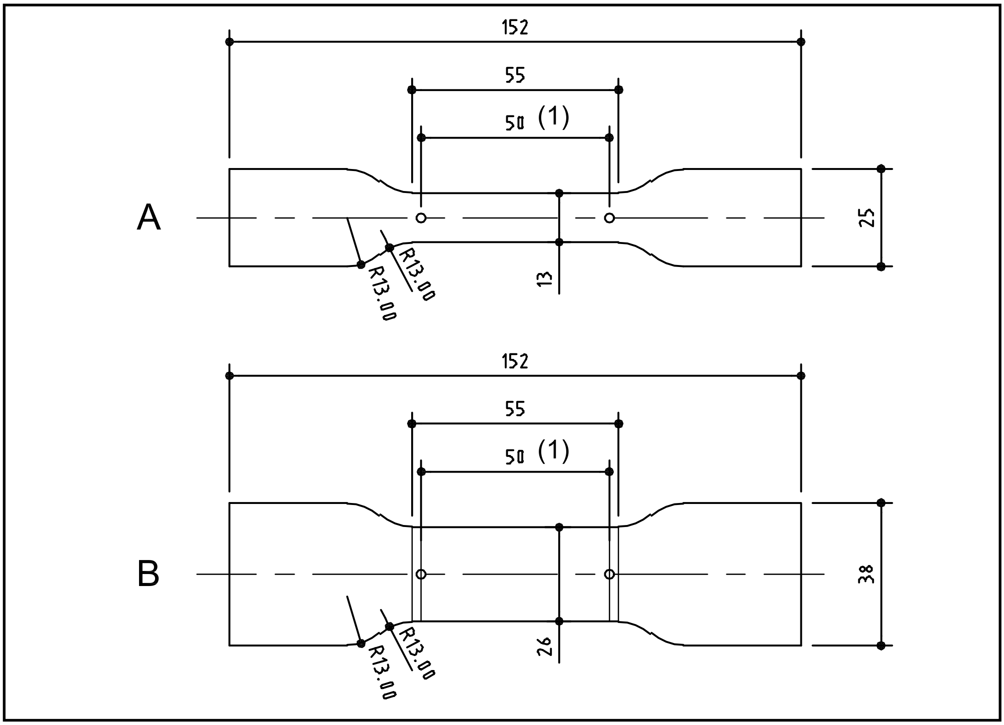



**Figure 3.1.3.7 - Tensile Specimens** Dimensions in mm
Sample A, Sample B, Gauge length

### 3.1.3.8 Colour

*Requirement*

The evenness of the colour of the running surface assists in the concentration of the athlete and provides a focus in relation to the line and event markings. The colour must be consistent within the design of the surface and when fading occurs, this must occur evenly. The colour shall be uniform to within one position on the recognised colour reference card or plate system used. For deliberately designed multi-colour facilities each discrete colour shall be similarly uniform.

Method

There are a number of different assessment systems for colour. Most utilise some form of colour chart or series of colour cards or plates. Any system used for assessing colour must be capable of identifying and if necessary quantifying, the consistency of the colour of the surface over the facility.

Areas of inconsistent colour shall be marked on a plan of the facility.

### 3.1.3.9 Drainage

*Requirement*

Water in excess of the height of the texture of the running surface can effect the safety and performance of the athlete. When completely covered with water and allowed to drain for 20 minutes, there shall be no area of synthetic surface where the depth of residual water exceeds the texture depth of the surface.

*Method*

The synthetic surface is flooded with water by any appropriate means and the 20 minutes is measured from the time the flooding stops. After that time, the surface is examined for standing water. Locations with standing water exceeding the top of the surface texture of the synthetic surface are noted on a plan of the facility and included in the report.

Note: It is sometimes difficult to deliver the necessary quantities of water to the surface, from a hose supply. In this event, it may be necessary to evaluate this parameter just after heavy rainfall, if at all possible. Alternatively, selective watering from a hose supply should be applied to those areas of the facility which are particularly susceptible to water run-off problems, such as the fan areas.

#### 3.1.3.10 General

The above programme of testing is considered adequate for a facility in good condition. Where the surface is showing evidence of problems, it may be necessary to extend the testing to other areas, to increase the frequency of tests, or to modify the procedures employed to properly identify the nature and extent of the surfacing defects. These are matters best left to the professional judgement of an IAAF accredited test laboratory.

### *3.1.4 REPAIRS AND REFURBISHMENT*

No facility lasts for ever, but it is entirely reasonable to expect the foundation of an athletics track to continue to function effectively over a time period that may encompass several replacements of the synthetic surface. To do this it is necessary to ensure that a very good standard of road construction is employed. The total depth of base necessary to ensure long term stability of the finished track surface will depend upon the nature of the site on which it is to be built. It should be noted that, even on the most ideal site, a minimum of 150mm of free-draining aggregate below a minimum of 60mm bitumen/macadam will prove to be necessary. The macadam would typically comprise a base course 40 to 60mm thick and a wearing course 25 to 30mm thick. Great attention must be paid to the accuracy of the final macadam layer because of the very strict requirements for surface flatness and minimum thickness of the synthetic surface .
It is recommended that a geotechnical survey of the ground conditions over the site is carried out at an early stage, and the results of such a survey should be made available to an independent consultant engineer in order that an adequate base to the track can be designed. It is important that, during construction, quality control of ALL aspects of the work is rigorously adopted. This should extend from the installation of the drainage system, through the entire project, to the application of the finished synthetic surface and line markings. The assistance of an independent, suitably experienced and competent test laboratory should be sought, in particular for the quality control of the synthetic surface and to conduct a comprehensive inspection of the finished facility in order to ensure compliance with the performance parameters. When selecting such a laboratory, the specialised requirements of this IAAF Specification must be carefully considered.

After a number of years of use, typically somewhere between 5 and 12 years, it would be expected that an athletics surface would be in need of some repair, or even complete renovation if usage levels have been high. Naturally the extent of wear which the synthetic surface experiences will depend upon the degree and type of usage. Use levels vary enormously from one facility to another.
In the case of porous surfaces, wear will be most apparent as a loss of the textured surface coating, leading to the resin-bound rubber crumb base mat showing through and becoming more exposed to increased spike damage and weathering effects. Naturally this will first become apparent in the high wear areas of the track. If identified early enough, it may be possible to reduce the rate of further wear by the spray application of an additional textured paint coating. The areas to be repaired should be thoroughly cleaned and if necessary high pressure washed and allowed to dry before the application of further textured coating. If significant damage to the base mat has already occurred then at this stage it would best to cut out all those damaged areas down to the bitumen/macadam and reinstate with fresh base mat before applying the new textured coating.

Non-porous systems tend to have a superior resistance to abrasive and spike wear. Composite systems with an upper surface of cast elastomer also have this characteristic, although once this upper layer is penetrated by spikes, wear occurs more rapidly in the underlying base mat than it would if the system was solid rubber. This is one of the reasons why a thickness of at least 4mm is preferable for the upper cast layer of a composite surface. When loss of texture has reached a point where the surface is in need of repair, the usual way of doing this is to grind off the upper rubber layer and granular texture and apply a fresh flood-coat layer of polyurethane resin with overcast granules in the usual way. If this is done on a patch repair basis it is inevitable that the appearance of the surface will be very noticeably different on the repaired areas compared to the existing surface.
Eventually the time will come when the condition of the majority of the upper surface over the facility has deteriorated to the point where it is necessary to completely re-top all the synthetic surfacing. In this case the entire track surface down to a depth of perhaps 3 or 4 mm would be ground off, and then a new flood-coat surface applied in the usual way. When applying overcoats of fresh poured resin, it is most important that a minimum thickness of new material is maintained otherwise delamination becomes a significant possibility. In order to avoid this potential problem of inter-layer delamination, any cast resin layer should be a minimum of 4mm thick.
For a composite system, such re-topping is also possible provided care is taken not to grind off so much of the upper surface that the base mat is exposed. Naturally the risk of this happening is much reduced if the originally installed upper cast layer is at least 4mm thick.

Not all repairs that are necessary will be due to wear. A surface may ‘harden’ over a period of time to an extent where it no longer meets the dynamic properties laid down by the IAAF. In such a case, grinding off some of the thickness and over-topping with fresh surfacing may be an option. It is recommended that a trial area is installed first to demonstrate the acceptability of the technique in bringing the dynamic properties back within the specified range.

Another problem that can occur in tracks of some age is slight shrinkage of the synthetic surface away from the edge kerbing to leave a gap. If this occurs to any significant extent, the full thickness of the surface should be cut back from the kerb a minimum distance of 75mm and fresh material re-instated to full thickness after the application of a suitable primer to the kerb edgings.

Eventually the synthetic surface will have deteriorated to the point where patch repairs or a complete overcoat of cast resin or spray-applied textured paint are no longer adequate to bring the facility back into good condition. When this time comes it is necessary to undertake the complete removal of the old synthetic surface and its replacement with new. An adequate budget should always be allowed for such a major resurfacing operation, with a significant contingencies sum for possible extras. When removing the old synthetic surface it is quite likely that damage will be caused to the wearing layer of the underlying bitumen/macadam. If this occurs over large areas, it will be necessary to plane off the wearing course and reinstate with new before the replacement synthetic surface is installed. If much disturbance to the edge kerbings occurs during this operation, it may also be necessary to re-set these or to install new edge kerbings to the facility. The usual care must be taken during this process to ensure the maintenance of levels and gradients as specified by the IAAF. It is best to employ all the usual quality control and key stage checks during such an operation to ensure a successful job.

## 3.2 Unbound Mineral Surfaces

### *3.2.1 DESCRIPTION*

Unbound mineral surfaces are water permeable, multi-layer, waterbonded surfaces made of mixtures of minerals.

Figures 3.2.1a to 3.2.1d show different examples of construction in relation to the quality of the subgrade (waterpermeable or non permeable) and of the availability of construction material for the intermediate layers.

#### 3.2.1.1 Important Factors

For an unbound mineral track the essence of a well-keyed and stable construction is the progressive grading and layering of materials, from very coarse at the base to fine on top. Particle shape, which should be angular rather than rounded, helps to ensure a good mechanical bond throughout. The nearer to the surface, the more careful should be the grading.

The majority of unbound mineral athletics tracks are made up of two to three layers:

a) Foundation layer without or with drainage

b) Middle layer(s) of progressively finer material to blind the bottom layer and act as a key to the surface

c) Running surface relying on moisture holding capacity and particle shape and grading for stability

**Figure 3.2.1a**
**Method of construction**
Example 1:
Non-permeable
subgrade difficult to work
1 Unbound mineral layer
2 dynamic layer
3 support layer
4 filter layer
5 subgrade
6 drainage

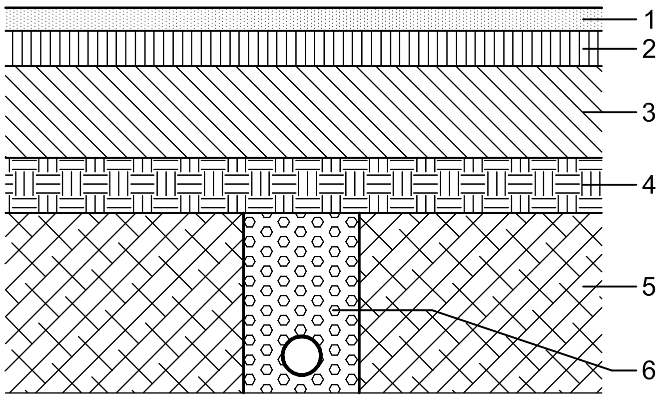



**Figure 3.2.1b**
**Method of construction**
Example 2:
Non-permeable subgrade;
lava available as
construction material
1 Unbound mineral layer
2 dynamic layer
3 support layer
4 subgrade
5 drainage

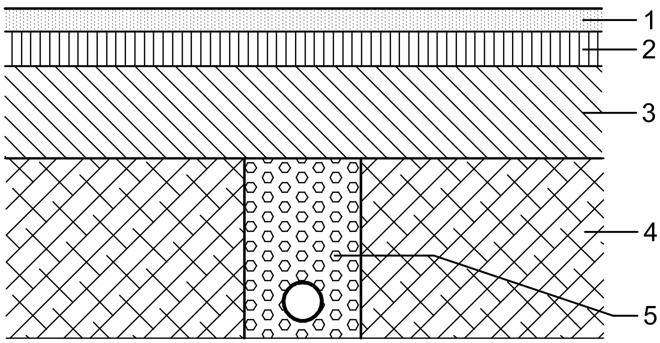



**Figure 3.2.1c**
**Method of construction**
Example 3:
Less water-permeable,
load-bearing subgrade;
lava available as
construction material
1 Unbound mineral layer
2 dynamic support layer
3 subgrade
4 drain slit

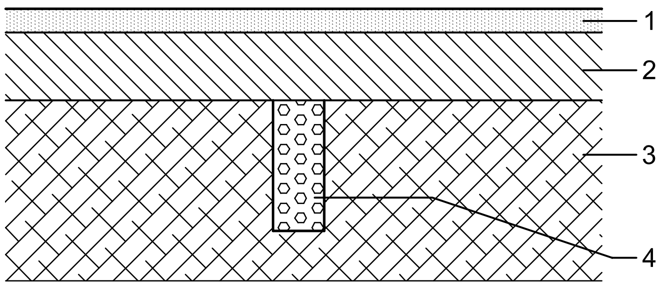
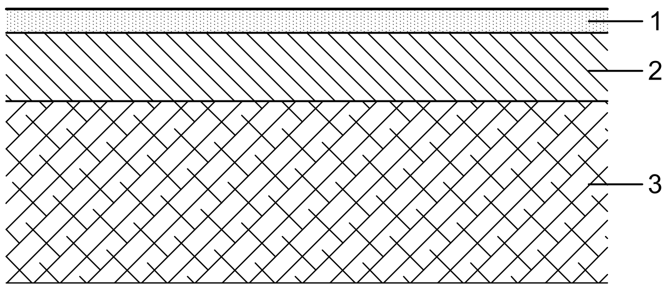



**Figure 3.2.1d**
**Method of construction**
Example 4:
Water-permeable,
load-bearing subgrade
1 Unbound mineral layer
2 dynamic support layer
3 subgrade



Although (a) and (b) have much to do with the “feel” of the track, the question of whether a unbound mineral track appears fast or heavy to athletes depends to a large extent on the nature of the actual running surface, e.g. tightness and water content.

It is possible that at some future date the need may arise for an unbound mineral track to be converted to one with a synthetic surface. It is important that it should be so constructed that the conversion can be carried out with the minimum of structural alteration.

To prevent water reaching the track from surrounding areas, it is desirable, wherever possible, for the track to be laid so that no part of its surface is less than 50mm above the finished level of the surrounding ground.

To lay the intermediate and surface layers of the track and maintain the latter properly a copious supply of water is essential. An irrigation system with an adequate water supply is important.

It may be necessary to treat the formation with a total weed killer in accordance with the manufacturers instructions. On ground infested with tap-rooted weeds such as thistle, dandelion and dock, it is imperative that complete elimination should be effected before the foundation is laid.

#### 3.2.1.2 Foundation or Drainage Layer

The material for the foundation of the track and runways should be clean, hard, dry material such as clinker or broken stone, to pass 75mm mesh and be retained on 19mm mesh screens, in even proportions. It should be accurately laid to a uniform depth on a dry and firm formation and firmly consolidated by rolling. The weight of the roller should be just sufficient to wedge the material firmly into place. Too heavy a roller may tend to force the subsoil, particularly if this is clay, up into the filling and so prevent efficient drainage. Also, if the base is too solid it cannot be resilient.

The required depth for the foundation will depend upon the nature of the subsoil and the likelihood of later conversion to a synthetic surface. The minimum recommended depth for an unbound mineral track foundation is 150mm on well drained subsoil. On clay soils, or where conversion to synthetic is a probability, a depth of at least 300mm is generally necessary (See 3.4).

Where the formation is on soft clay, it might be desirable to excavate a further 50 or 75mm and put down a blinding layer of graded stone or clinker ash 19mm gauge to fine, in order to dry up and firm the clay before laying the foundation. Alternatively, a proprietary filter membrane may be used.

#### 3.2.1.3 Intermediate Layers

The purpose of the intermediate layer(s) is to bind the drainage base course and act as a key to the running surface. It should be sufficiently porous to enable water to flow through it during periods of heavy rainfall. Sharp changes in the grading of

materials, particularly in the upper layers, should be avoided as they tend to weaken the mechanical bond between particles and make the surface unstable.
Two or more carefully graded intermediate layers are advantageous from the point of view of improved drainage, stability and resilience. To have only one intermediate layer keeps costs down to a minimum, but cannot provide an optimum construction. If only one layer, this should be of crushed stone, or clinker and ash, graded 19mm to 3mm spread to a consolidated depth of 25mm minimum and well watered and rolled.
The intermediate or blinding layer(s) should be accurately laid either by machine or with the aid of screed strips and straight-edge. Consolidation should be by watering and rolling, a 250kg roller (round edged) across a rolling width of between 600/700mm or its equivalent being sufficient. Except for the first pass, rolling must not take place on a dry surface and must be carried out in transverse directions to avoid waving or rippling. Any hollows apparent after rolling should be scarified and made good with the same material and watered and rolled until a true surface is obtained.
Where there is more than one intermediate layer, the previous layer should be lightly scarified when dry and then dampened, before placing the next layer, so that, when the final rolling takes place, pressure is exerted throughout the entire depth of the structure and a good mechanical bond achieved from the base upwards.

#### 3.2.1.4 Surfacing

The material for the actual running surface should be graded 4.5 or 3mm to fine laid to a consolidated depth of 50mm. Apart from the essential granular texture of the surface, cohesive material should be included, not only to ensure the stability necessary to give the runner a good firm grip with the minimum of surface displacement but also to facilitate maintenance. Care should be taken not to include too great a proportion of cohesive material as this tends to impede surface drainage and makes for heavy going in wet weather. Lack of sufficient binder, on the other hand, is likely to necessitate constant watering in dry weather to prevent rapid disintegration when in use, and wasteful dispersal of the surface material in the form of windblown dust. To obtain the right balance, a careful selection of material is necessary.
Although an approximate ratio for the mixing of materials can be suggested as a guide, it is not advisable to attempt to lay down specific proportions as a standard for all tracks. Not only do climatic conditions vary considerably in different countries, but the properties of the materials available differ greatly according to the source of supply. The use of a proprietary surface should therefore be considered.

The granular materials commonly used in the composition of the running surface include crushed granite or limestone and occasionally hard clinker ash (when available). Other material such as blaes and shale from colliery tips can also be used, provided the particles are sufficiently hard and well shaped. Particles in laminated form are not suitable. A well-balanced mixture should not only bind well, hold moisture and retain resilience, but never get sticky in any weather. It is important that all cohesive substances used should be thoroughly mixed with the granular materials.

Mixtures found to give satisfactory results are:

a) 50-75% of a good binding ash, mixed with 25-50% hard fine ash, crushed limestone or suitable crushed rock
b) Hard fine ash and crushed granite or limestone (ratio approx. 50:50) and binder
c) Crushed granite or limestone and binder
d) Hard fine ash and binder
e) Burnt red shale (blaes) and binder
f) An appropriate proprietary material

When considering the choice of surface, the availability of local materials should be considered. For colouring effect brick dust may be applied to the surface. The surface should be laid as described earlier for the intermediate layer(s). It is important that immediately prior to laying the surface, the previous section is lightly scarified when dry and then damped to provide a good key. Special care must be taken to ensure that the surface is evenly laid to a uniform depth when compaction is complete. The final consolidation of the track should be carried out with a heavier roller of about 600kg across a rolling width of 900mm. Constant rolling with this, accompanied by copious watering for at least a week, should help to firm the track ready for handing over. It does, however, take some time of use and maintenance to create the right surface. On no account should rolling be carried out on a dry surface.

#### 3.2.1.5 Runways

The construction of the edging, foundation and surfacing for the runways should be similar to that of the track except that the surface material on take-off areas should be given special treatment in order to counter the excessive wear and tear from spikes and help to keep the surface firm during use. This may be done by increasing the depth of the surface layer (and the formation) by about 25mm and increasing the proportion of cohesive material in the mixture by doubling the quantity of clay or marl. The treatment should apply to the last 3m before the take-off for the long jump, triple/jump, pole vault, the last 6m before the javelin scratch line and the final 3m of the high jump fan.

On clay soils, underdrainage with outfall to the perimeter drainage system may be necessary to prevent flooding.

The edging to the pole vault runway should be flush with the runway surface for the final 6m and for the javelin 3m.

#### 3.2.1.6 Steeplechase

The running surface and foundation immediately before and after the water jump should be on the same level and to the same specification as the track foundation and surface. If the water jump is situated on the inside of the track, the edging where the steeplechase track leaves and rejoins the main track must be removable. As for the runways to the jumps, the special surface treatment described in the previous section should be given to the final 3m of the approach to the water jump to ensure a firm surface during use.

#### 3.2.1.7 Supervision

It is emphasised that a good specification does not necessarily result in a good job unless the work is efficiently supervised. Whether carried out by contract or direct labour, the work should be planned and directed by somebody with specialised knowledge of track construction. In the case of contract work, the employer's engineer, surveyor, architect or landscape architect should exercise close supervision to ensure that all the operations are carefully carried out in accordance with the specification. Each stage of the work should be aproved by him before the next
stage is allowed to proceed.

The person in charge should be capable of correctly interpreting the specification and it is essential that they should have had previous experience of track construction. Faulty workmanship or materials, or wrong methods, cannot be rectified after the track has been made except at considerable expense. There is no doubt that extra trouble taken at the time of construction can do much to avoid maintenance difficulties later on and to keep down the annual cost of upkeep.

### *3.2.2 PERFORMANCE REQUIREMENTS*

#### 3.2.2.1 Introduction

These guidelines for the requirements for sport surfaces with unbound mineral surfaces are intended to provide a uniform interpretation of the concepts, the creation of clearly defined requirements and the preconditions for their testing. The criteria are based on the one hand on national standards, and on the other, on internationally recognised values established by experience. They are recommendations for planning and construction but are also the framework for national standards.

These requirements are based on aspects relating to safety, playing performance and to the technical characteristics of the material. The intention of the safety performance is to offer optimum prevention of injury and consequential damage. The playing performance is aimed at providing the best possible application of the different techniques of each individual sport, distinguishing between championship and casual sport.

These guidelines describe the current state of the art in order to ensure that further development of sports surfaces is not inhibited. Deviations are possible in the course of time and may even be necessary. In such cases it is necessary to check that the intended deviations do in fact represent improvements in the safety and playing performance and in the technical characteristics of the material.

Keeping to the guidelines alone is no guarantee for the success of the design and does not exclude the liability of the planner and installer. The construction of a durably flawless sports surface requires sufficient experience and continuous quality control during manufacture.
For the planning and construction, local conditions (climate, substratum, available materials) must be taken into account as well as the special requirements of the sports facility.

#### 3.2.2.2 Properties Pertaining to Protection and Sport Functions

*a) Protection and sport functions*

Safety aspects are understood to be the properties of a sports surface which reduce the danger of injury from a fall and which relieve the strain on the biomechanism of the athlete when running or jumping. Sports aspects are the properties of the sports surface which contribute to the best possible application of the techniques of the different sports by the most economic utilisation of the energy expended by the athlete.

*b) Resilience*

Resilience is the deformation of a sports surface under load. The degree of deformation depends on the particle shape, the particle size distribution and the water content of the surface. The resilience is achieved when the sports surface complies with the requirements for these various parameters.

c) Slope formation, flatness and nominal height requirement

Slope: For athletics tracks and runways, the slopes should be in accordance with the competition regulations.

Flatness: Deviation under a 4m straightedge may not exceed 10mm.

Nominal height: Deviation may not exceed 5mm.

Note: The individual layers of the sports surface above the subsoil must be produced with the same slope.

#### 3.2.2.3 Material Properties

*a) Particle size distribution*

On running tracks the grading curve of the surface material shall be between the limiting grading curves according to figure 3.2.2.3. If it is outside these, the following percentages shall not be exceeded:
Particle fraction = 3.15mm and larger, maximum 5% by weight
Particle fraction = 0.02mm and smaller, maximum 16% by weight

*b) Water permeability*

The surface material shall have a minimum water permeability of 0.06 mm/min for 0 - 3mm particle mixture.

*c) Wear*

The surface material shall be highly resistant to wear. When determining the wear resistance, using the method of test described in 3.2.3.3.3 (Method of Test for Abrasion), the area beneath the limiting particle curve shall be at least 70% of the initial value.

*d) Weathering resistance*

The surface material shall be highly resistant to weathering. When determining resistance to weathering, using the method of test described in 3.2.3.3.4 (Method of Test for Resistance to Frost), the area beneath the limiting particle curve shall be at least 95% of the initial value.

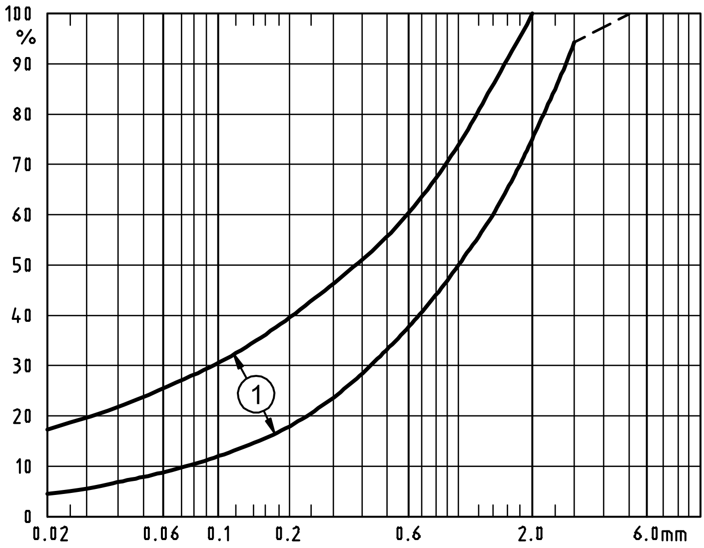



**Figure 3.2.2.3 - Particle distribution limits for unbound mineral surface materials**
1 Limiting particle curves

e) *Surface shear resistance*

Surface shear resistance is the resistance of the surface to the shear stress from its use in sport. The surface shear resistance shall reach a minimum value of 50kN/$m^2$.

f) *Contents of pollutants*

The content of pollutants shall not exceed the values stipulated in national regulations.

### 3.2.2.4 General

a) *Tendering, placing of order, execution and acceptance*

The following points are recommended as preventive measures by the customer to avoid incurring damage to the sports surface.

- Preliminary examination of the construction ground
- Observing the rules for tendering, placing of order, execution and acceptance
- Checking the qualifications of the supplier before placing the order
- Tendering for the sports surface including substrate and foundation as a package
- Placing of order in general for surface, substrate and foundation with a single installer
- Storage of retained samples in a suitable location
- Retention of the test certificates of the supplier as well as the tender and order documents

b) *Utilisation*

For the retention of the optimum water content it is generally necessary to provide irrigation systems depending on the precipitation conditions at the respective location. “Pop-up” installations are recommended. The water should contain as few insoluble mineral components (e.g. iron) as possible.

*c) Marking*

The markings must be made in accordance with the regulations of the IAAF.
The marking materials to be used may be in powder form, dissolved colours or plastic profiles. The marking agents shall not have an etching effect and they shall not alter the sports function of the surface.

*d) Inspection and maintenance*

Regular inspection and maintenance of surfaces is necessary to maintain their properties. As a rule the following maintenance work is necessary:

- Levelling the surface with a levelling frame or screen after every intensive use to re-establish the flatness (Before this operation the worn surface areas must be filled in with moist material by hand and compacted.)
- Irrigation if the surface is too dry (Care must be taken to prevent material being washed away. During prolonged dry periods a soaking irrigation of 20 litres/$m^2$ is necessary over a period of 10 to 18 hours.)
- Maintaining the compactness of the surface by occasional rolling (On overused surfaces after the levelling operation or after the effect of frost.)
- Maintaining the grain composition by mixing the surface with a spiked harrow or other revolving implement while protecting the dynamic layer
- Removing hollows or bumps in the surface

Depending on the frequency of use, surfaces have to be skimmed, levelled and rolled. Overused areas must be corrected by the addition of material. With regard to water permeability a constant check must be made on changes in the proportion of fine particles as a result of wear and the effect of the climate.

## *3.2.3 TESTING*

### 3.2.3.1 Support Layer

#### *3.2.3.1.1 Method of Test for Water Permeability*

*a) Apparatus (Fig 3.2.3.1.1a)*

- Test cylinder with a diameter of 150mm with slip-on ring, bottom plate and steel plate
- Counterfloor (Fig 3.2.3.1.1b)
- Sintered bronze filter plate, SIKA B 200, 200 mm in diameter and with a thickness of 4mm
- Compression device with a drop weight of 4.5 kg and a drop height of 450mm.
- Stop watch
- Metal ring approx. 40mm in diameter to which two test prods are fastened perpendicular to its level (Length of the test prods above the test surface shall be 55mm and 45mm.)
- Weighing scales with an error margin of ±1.0g
- Vessel with a diameter of ±400mm and a height of ±150

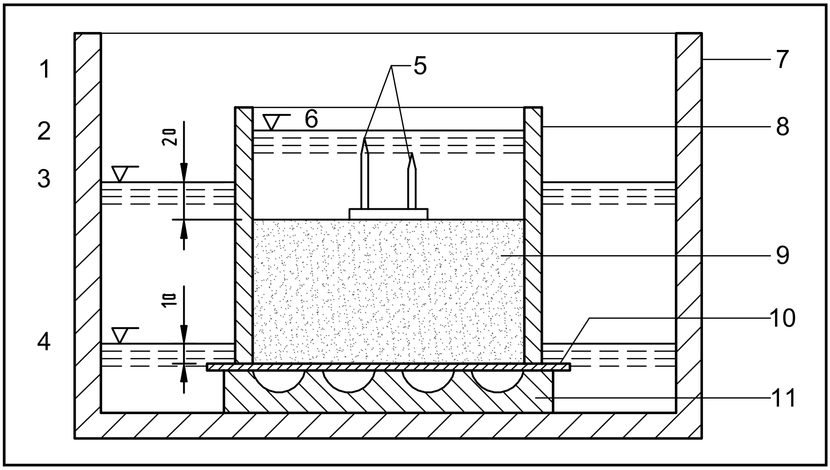



**Figure 3.2.3.1.1a Method of test for water permeability**
(Measurements in mm)
1 External water level
2 position C
3 position B
4 position A
5 test prods
6 internal water level
7 vessel
8 test cylinder
9 test piece at height h
10 filter plate
11 support for the filter plate

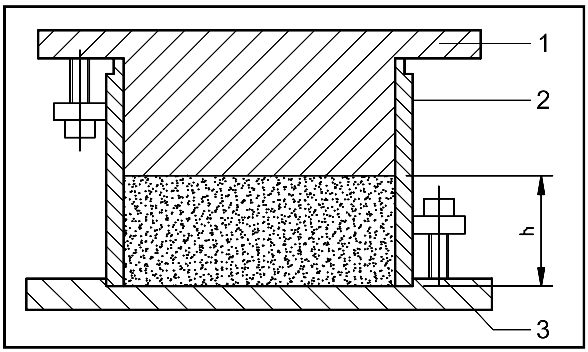



**Figure 3.2.3.1.1b Method of test for water permeability, counterfloor for swaying the test**
1 Counterfloor
2 cylinder for proctor test
3 bottom plate

*b) Test Procedure*

Prior to testing remove all granules with a diameter of d>22mm from the sample and ascertain proctor values from the granule mixture 0/22 mm in the form of reference values.

Prepare the test piece as instructed under Section 3.2.3.3.1 b. Place test piece with a water content of w=0.7 WPr into the test cylinder and compress to Q=0.95 Qr±0.02g/cm$^3$. To do this, place the steel plate, on which the impacts of the compressor are evenly distributed, onto the surface of the uncompressed test piece. Select the quantity required so that after compression the height of the layer amounts to 60 mm. Calculate the quantity required for this on the basis of the following formula:

$$Gn = 0.95\,QPr\left(1 + 0.7\,\frac{WPr}{100}\right) \times h \times A$$

where:

| | | |
|---|---|---|
| Gn | = weight of the wet sample in g |
| QPr | = Proctor density in g/cm$^3$ |
| WPr | = optimum water content in % |
| A | = area of compressed sample in cm$^2$ |
| h | = height of compressed test piece measured in cm |

After compression, place the counterfloor on top, turn the test cylinder, remove the floor plate and replace with the filter plate. Turn the test cylinder again and place into the vessel. Fill the vessel with water until a level of 20mm above the surface of the compressed test piece is attained outside the test cylinder (external water level, water level position B). When a water level has formed on the test piece surface, place the ring with the test prods onto this, taking care to avoid any scouring, fill the test cylinder with water until the test prods are covered with water (internal water level, water level position C). After this, drain the water from the vessel until the external water level has sunk to a height of 10mm above the filter plate (water level position A) at which it is held constantly. The internal water level must be kept at the height of the top test prod until the measurement is taken. Measure in seconds the time it takes for the internal water level to drop from the top to the lower test prod. For each test three readings are required.

*c) Results*

The water permeability is expressed in terms of k*. It is calculated by the following formula:

$$k^* = \frac{\Delta h}{t} \times \frac{h}{h + 4.0}$$

| | | | |
|---|---|---|---|
| where: | k* | = | water absorption factor in cm/s |
| | $\Delta h$ | = | difference in water levels between the test prods measured in cms |
| | t | = | time it takes for the water level to drop between the test prods measured in seconds |
| | h | = | height of compressed test piece measured in cm |

Note the mean value of three tests.

### 3.2.3.2 Dynamic Layer

#### *3.2.3.2.1 Method of Test for Water Permeability*

The test shall be carried out as instructed under Section 3.2.3.1. Select the quantity required so that after compression the height of the layer amounts to 60mm.

#### *3.2.3.2.2 Method of Test for Shearing Resistance*

*a) Apparatus (Fig 3.2.3.2.2a to 3.2.3.2.2c)*

Shearing resistance device, consisting of:

- Torque spanner or shear force transducer with indicator (calibrated) (A suitable motor operated apparatus for measuring the moment of torsion may also be used.)
- Yoke
- Holding device
- 121mm diameter shear plate, weighing 1.5 kg with 8 spikes of 18mm in length (Fig 3.2.3.2.2b )
- 250mm diameter test cylinder with bottom plate and steel plate

Compression device with a drop weight of 15 kg and a drop height of 600 mm.
Built-in gauge (Fig 3.2.3.2.2c)
Indenter approx. 100 mm in diameter
Wooden ram approx. 250 g in weight
Weighing scales with an error margin of ±1.0 g

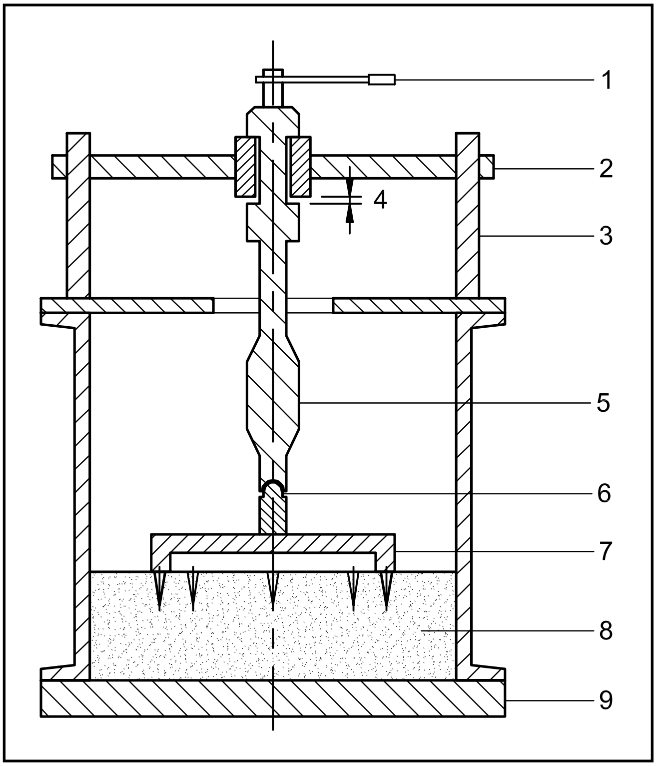
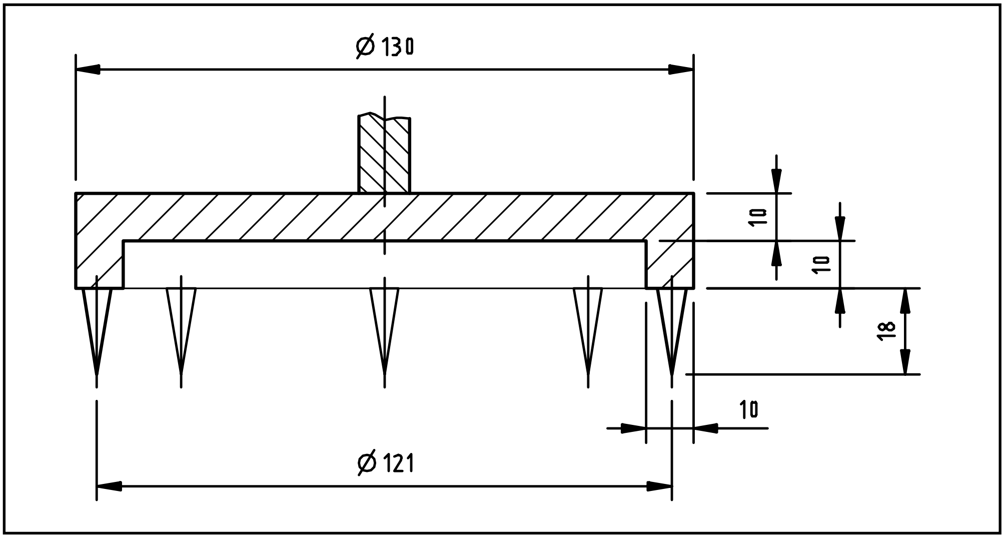



**Figure 3.2.3.2.2a - Method of test for shearing resistance**
(Test appliance)
1 Torque spanner
2 yoke
3 holding device
4 opening, 0.3mm to 0.5mm
5 shaft possibly with instrument for measuring torsion
6 joint with torsion-proof connection
7 shearing plate after pressing in
8 test piece
9 test cylinder

**Figure 3.2.3.2.2b - Measurements for the shear plate**
(Measurements in mm)



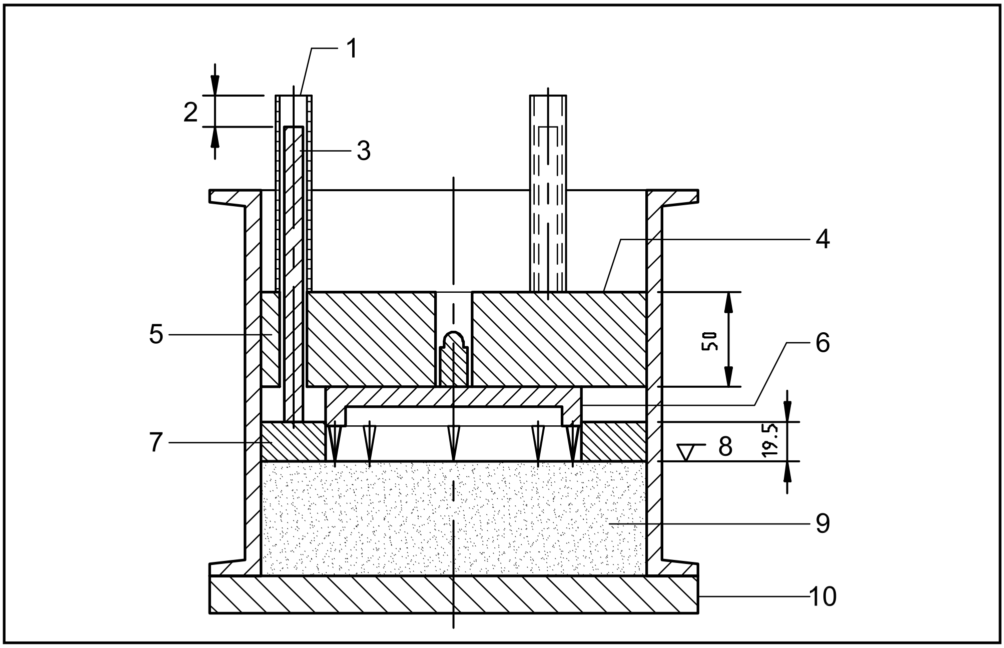



**Figure 3.2.3.2.2c - Built-in gauge for the surface shearing device**
(Measurements in mm)

1 Tube (copper - zinc -plating)
2 depth of penetration of the shearing plate
3 guide bolts, 3 pcs. displaced by 120°
4 surface of the built-in gauge for hammering and pressing
5 top part of built-in gauge
6 shearing plate prior to pressing in
7 lower part of built-in gauge
8 test piece surface
9 inserted test piece
10 test cylinder

*b) Procedure*

Moisten the test piece until it has a water content of W = 0.7.WPr and compress in the test cylinder to Qd = QPr. To do this place the test piece in one position, distribute uniformly and evenly and gently press down with an indenter. Then place the steel plate, on which the impacts of the compression device are evenly distributed, onto the surface of the uncompressed test piece. Select the quantity so that after compression the height of the layer is 60mm. Calculate the quantity required for this by using the following formula:

$$Gn = QPr\ (1 + 0.7\ \frac{WPr}{100})\ x\ h\ x\ A$$

where: Gn = moisture content of the test piece in g
QPr = Proctor thickness in g/cm$^3$
WPr = optimum water content in %
h = height of compressed test piece in cm
A = area of compressed test piece in cm$^2$

After compression, turn the steel plate and lift off. Remove any granules which may be lying loose on the test piece. Then insert the lower part of the built-in gauge and the shear plate attached to its recess. Finally, place the upper part of the built-in gauge on top. Apply manual pressure to the upper part causing the spikes to penetrate the test piece. By hammering gently in addition with the wooden ram, the upper part, and hence the shear plate, are driven down until the guide bolts of the lower part are flush with the copper tubes of the upper part.

Remove the built-in gauge and mount the holding device with yoke and measuring apparatus and connect to the shear plate (Fig. 3.2.3.2.2b).

The shear plate may not be subjected to any additional vertical load. Therefore, prior to shearing off, a vertical means of escape of 0.3 mm to 0.5 mm must be available for the shear plate. Rotate the shear plate with the torque spanner evenly so that after one second the moment of torsion corresponds to a shearing tension of Ts = 50 kN/$m^2$. Maintain this load constantly for 2 s and then increase steadily up until breaking point. Record the maximum moment of torsion.

A minimum of three tests must be conducted. The test piece may not be used repeatedly. Record the mean reading of three tests.

*c) Results*

Calculate the shearing resistance of the surface using the following formula:

$$Ts = \frac{M_{max}}{\pi \frac{D^2}{2} \left(H + \frac{D}{8}\right)}$$

where:

| | | |
|---|---|---|
| $T_S$ | = | shearing resistance in kN$m^2$. |
| $M_{max}$ | = | maximum moment of torsion in kN$m^2$, whereby the bearing friction must be deducted from the reading |
| D | = | diameter of the shear plate in mm |
| H | = | length of the spikes in mm |

### 3.2.3.2.3 Method of Test for Abrasion

*a) Apparatus*

Abrader 150 mm diameter test cylinder with slip-on ring, base plate and steel plate
Compression device with a drop weight of 4.5.kg and a drop height of 450 mm
Apparatus for dry sieving Weighing scales with an error margin of ±1.0 g

*b) Test Procedure*

In all, 16kg of test material is required for the test. Add sufficient water until the water content for the whole material reaches 0.7WPr. Then divide the test material into two parts weighing approx. 6 kg each for the abrasion tests and one part of approx. 4kg. in weight to determine the base granulation line.

Fill the test cylinder with one part in three layers of uniform thickness. Select a height for the layers so that the test cylinder is filled by the compressed material and any projection of not more than 10mm extends into the slip-on ring. Compress each layer with 22 impacts from the compressor.
To do this, place the steel plate, onto which the impacts of the compression device are evenly distributed, onto the surface of the uncompressed test piece.
After compression, remove the vessel and mix the extracted material well with the remaining test piece. Conduct this procedure five times in all.
Finally, wash the test piece over the 0.125 mm sieve, dry and mechanically sieve for a duration 10 minutes to establish the grain size distribution.
The test must be conducted on at least one further test piece of 6 kg in weight, Also wash the uncompressed material over a 0.125 mm sieve, dry and sieve to determine the base granulation line (mechanical sieving for duration of 10min).

*c) Results*
The tests will produce 1 grain size distribution in its initial state and 2 grain size distributions after compression. Calculate the differences between the proportions of the base granulation line and those after the test load. This will also produce the grain sizes for which the greatest differences have been established. Record the mean of three differences to establish the resistance to abrasion. This will be found among the grain sizes with the largest difference in proportions and among the neighbouring grain sizes.

### 3.2.3.3 Unbound Mineral Surface

#### *3.2.3.3.1 Method of Test for Water Permeability*

*a) Apparatus*
Compression device (Fig 3.2.3.3.1), consisting of:
- Frame with dial gauge holder
- Supports
- Compression apparatus with a drop weight of 2.5 kg and a drop height of 300mm, the base of which is spread to a diameter of 70mm
- Dial gauge, graduated to scale 0.01mm
- Acrylic glass cylinder with an internal diameter of approximately 70mm and a height of ±100mm; which may be used at each end for a maximum of 10 times.
- Sintered bronze filter plate, SIKA B 200, 100mm in diameter and 4mm thick

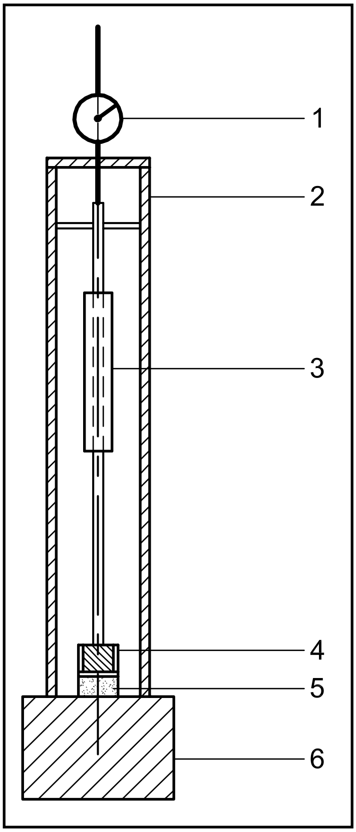



**Figure 3.2.3.3.1**
**Method of test for water permeability**
1 Dial indicator
2 ram frame
3 drop weight
4 acrylic glass cylinder
5 test piece
6 support

Stop Watch
Metal ring of approx. 40mm diameter, on which two test prods are attached perpendicular to its plane; length of the test prods above the surface of the test piece 55mm and 45mm
Weighing scales with an error margin of ±0.1g
Vessel of ±200mm diameter and ±110mm height
Pippette with a nominal volume approx. 25cm$^3$
Air tight container with 5000cm$^3$ content
Spray bottle
Stirring apparatus with 100 to 250 revolutions/min; stirring tools must ensure a minimum possible fragmentation of grains.
Rubber roller, Shore-A-Hardness 60 to 80.
Apparatus for determining the content of water

*b) Preparation of Test Piece*

*b.1) Types of Test Pieces*

A distinction must be made in the test between the following types of test pieces:

a) building materials in unprocessed state, not previously subjected to compression
b) building materials already installed in tamped surfaces and subjected to compression.

In the event of case a), dry preparation as instructed below in b.2) will only be required, whereas for case b), a structural preparation as described below in b.3) will be needed.

*b.2) Dry Preparation*

Dry the approx. 4000 g test piece which will be used to determine the water permeability at a temperature of 70°C until a constant weight is attained and then moisten to 0.7 WPr. To do this, place the test piece into a stirring apparatus, the container of which shall be moistened beforehand with a sponge, and mix with the quantity of water required. The quantity of water required is applied using a spray bottle, whereby the quantity of water may not exceed 60 g/min. After moistening, remove the test piece from the apparatus and from this sever a part of the sample in order to record the water content. Pack the main test piece air-tight and store for a minimum of 16 hours; record the water content of the severed sample.

Store the main test piece for a further 16 hours. As soon as the actual water content reaches a level which is distinguishable from the target value by no more than W=0.5%, the main test piece can be used for producing the test sample. The quantity of material required for this Gn is calculated on the basis of the precise dimensions of the apparatus and the fixed data.

Dimensions of the acrylic glass cylinder:

| | |
|---|---|
| D | = Diameter in cm |
| h | = Height of compressed test piece = 40mm |
| $W_e$ | = Test water content 0.7 WPr +/- 0.5% |

Fixed data:

= Proctor thicknesses in g/cm³

= Optimum water content in %

$$G_n = Q_{Pr} \left(1+ \frac{We}{100}\right) \cdot h \frac{D2}{4} \cdot \pi \text{ in g}$$

Remove three test samples $G_n$ from the main test piece according to weight and place in air-tight containers ready to be manufactured into test samples. Clamp the acrylic glass cylinder into a frame (Fig. 3.2.3.3.1). Before filling with the test substance, moisten all surfaces which will come into contact with this with a damp sponge.

*b.3) Structural Preparation*

Divide the samples into the grain groups > 0.5mm and < 0.5mm by washing in a sieve with a mesh width of 0.5mm. The siftings ( < 0.5mm ) are concentrated by filters, dried at 60°C to 70°C and finally crushed so finely that they can pass through the 0.63mm sieve. A rubber roller serves this purpose well.

The grain group >0.5mm is also dried at 60°C to 70°C after which it is mixed with the dried and crushed grain group < 0.5.mm and moistened evenly to a water content of W = 0.7 WPr. The water must be applied by spraying. After the water has been added, store the test piece air-tight for a minimum period of 16 hours until it is ready for use for the water permeability test.

For material prepared in this way, the grain size distribution is determined by means of wet sieving. The content of fine parts < 0.063mm may not deviate by more than 2% from the corresponding value for the untreated material.

*c) Manufacture of Test Specimen*

Divide the sample for a test piece into four approximately equal parts and fill one after the other evenly into the sample mould, level out and press down using a wooden stamper. Before placing the compression device, make sure that the thickness of the test piece is homogenous; its surface shall be horizontal and even.

For the compression, place the filled test mould onto a base with at least 50 kg of mass. Prior to compression determine the original height of the uncompressed test piece; afterwards, compress the test piece until the required end height has been acquired (40 ±0.05) mm.

*d) Method of Test*

Once the test piece has been compressed, remove the acrylic glass cylinder from the compression device and place onto the filter plate which has been saturated with deaerated water and place into the vessel described previously (Fig 3.2.3.3.1). This is then filled within a period of 8 to 10min. with deaerated water so that the external water level lies 20mm above the surface of the test piece (water level position B). The test piece must remain in this condition for a minimum period of 16 hours. Place the ring with the test prods onto the surface of the test piece and fill the acrylic glass cylinder with deaerated water until the test prods are sufficiently covered (water level position C). Keep the water level at this height until measurement. A method of test using suspended prods is permissible.

Lower the external water level (water level position B) to a height of 10mm above the filter plater (water level positon A) and keep constant. Then record the time in full it takes for the internal water level to drop from the top to the lower test prod. The water must have a temperature of (20 ±2)°C.

Take this reading at least three times per test and record the mean value. At least three tests are required.

*e) Results*

The water permeability is expressed in terms of the water absorption k*. It is calculated by the following formula:

$$k^* = \frac{\Delta h}{t} \cdot \frac{h}{h + 4.0}$$

where: k* = water absorption factor in cm/s
$\Delta h$ = difference in water levels between the test prods measured in cms
t = time it takes for the water level to drop between the test prods measured in seconds
h = height of compressed test piece measured in cm

#### *3.2.3.3.2 Method of Test for Shearing Resistance of the Surface*

See 3.2.3.2.2.

#### *3.2.3.3.3 Method of Test for Abrasion*

*a) Apparatus*

Abrasion device, consisting of:

- Abrasion testing machine with horizontal-eccentric rotation on 4 rubber metal connections of types A, B or C, 40mm in diameter, 30mm in height, Shore-A-hardness 55, suspended and attached to a rigid concrete abutment, 15mm eccentricity, 300 revolutions/min
- Steel plate with a diameter of 148mm and 16mm thick, with rounded edges r =1mm, made of hardened steel.

Cylindrical shell of hardened steel (Fig 3.2.3.3.3)

5 test sieves with a mesh width of 0.09mm, 0.125mm, 0.25mm, 0.71mm and 2.0mm Weighing scales with an error margin of ±0.1g

*b) Test Procedure*

First wash the building material in the 0.09mm sieve. Dry the sieve retainings, divide by means of mechanical sieving ( duration of 10min) into individual grain groups and then compose into test specimens in compliance with the Table 3.2.3.3.3:

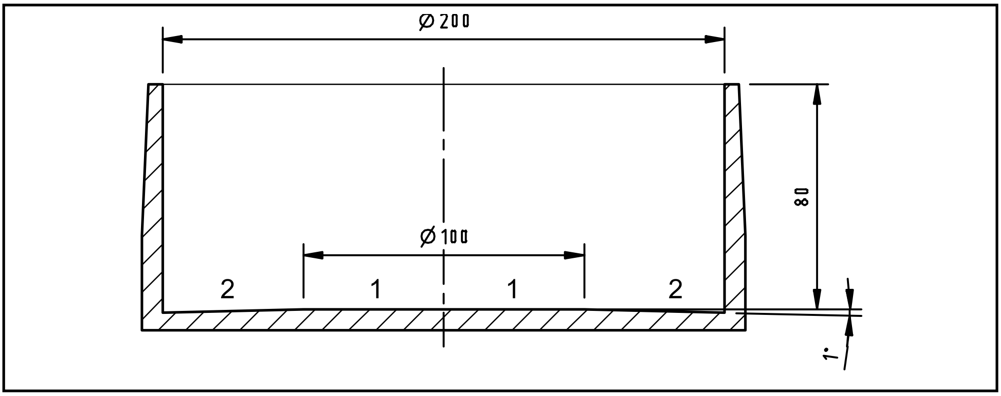



**Figure 3.2.3.3.3 - Cylindrical shell of abrading device** (Measurements in mm)
1 Even surface, 2 sloped surface

| ***COLUMN*** | ***1*** | ***2*** |
|---|---|---|
| ***Line*** | | |
| ***1*** | ***Grain Group (mm)*** | ***Weight (g)*** |
| ***2*** | 0.09/0.125 | 20 |
| ***3*** | 0.125/0.25 | 65 |
| ***4*** | 0.25/0.71 | 160 |
| ***5*** | 0.71/2.0 | 255 |

**Table 3.2.3.3.3 - Composition of Test Specimens**

Heat the dry test piece immediately before the test to a temperature of 105°C for a minimum of 2 hours. Place in hot condition into the shell and spread out evenly. Place the steel plate onto the test piece and agitate in the abrading machine with 2400 revolutions for 8 minutes.

After the abrasion test, determine the grain size distribution again (duration of sieving 10 minutes).

At least three tests shall be conducted using new test pieces each time.

*c) Results*
The size reduction of the grains is described by the ratio of the distribution of retainings before and after the abrasion test. The distribution of retainings is equal to the area which is enclosed on the semi-logarithmic granulation line diagram, by the perpendicular through d = 0.09mm and the granulation line.

#### *3.2.3.3.4 Method of Test for Resistance to Frost*

*a) Apparatus*
5 test sieves with mesh widths of 0.09mm, 0.125mm, 0.25mm, 0.71mm, 2.0mm.
Weighing scales with an error margin of ±0.1g.
3 tin cans, content approx. 1000 $cm^3$

3 plastic bags
Air-conditioning cupboard
Dry cupboard

*b) Procedure*
First wash the building material in the 0.09mm sieve. Dry the sieve retainings, divide into individual grain groups by sieving and then compose into test specimens in compliance with the Table in 3.2.3.3.3 above.

Place the dry test piece into a can, fill with 300cm$^3$ of distilled water, pack air-tight into a plastic bag and place into the air-conditioning cupboard. Lower the temperature in the air-conditioning cupboard step by step until the sample has reached a temperature of -20°C. The cooling phase lasts around 18 hours in all. Finally allow the can to thaw at a temperature of +70°C for 6 hours.

This freezing-thawing process must be carried out overall 25 times.

After the freezing-thawing process, dry the test piece at a temperature of 105°C and determine the grain size distribution again (duration of sieving 10min).
At least three tests must be carried out using new test pieces each time.

*c) Results*
The size reduction of the grains is described by the ratio of the distribution of retainings before and after the abrasion test. The distribution of retainings is equal to the area which is enclosed on the semi-logarithmic granulation line diagram, by the perpendicular through d = 0.09mm and the granulation line.

# 3.3 Natural Grass

### *3.3.1 DESCRIPTION*

Since the arrival of “all-weather” synthetic running track surfaces in the nineteen sixties, their use has increased substantially and they are now accepted as the best available surfaces for athletics competition. However the use of natural grass is still permissible and often forms the only achievable surface for the many locations unable to secure the substantial finance necessary for a synthetic track or a track with an unbound mineral surface. Also grass surfaces are ideal for intensive repetitive training by middle and long distance athletes.

For warm-up areas grass is still, in many instances, the only surface available, although athletes naturally prefer the same surface as the competition track.

The central arena has always required a surface able to receive and most importantly dampen the impact of implements whilst minimising the possibility of rebound. Throughout the developing period of synthetic surfaces and their fore-runners, unbound mineral surfaces, grass has retained its position as the major acceptable central arena surface. Indeed many arena managers require that the central area offers capacity for alternative sporting events and grass satisfies such requirements admirably.

Whilst initially there may appear to be many disadvantages in the use of grass for athletic events, the flexibility that this surface offers is substantial. Many sites do not require, or are unable to provide, permanently marked out facilities for athletics, for example educational campuses, which because of their hostel accommodation and extensive playing fields, are often utilised for major international events. They are frequently required to expand their existing athletic facilities out of proportion to their normal usage. Grass surfaces give this flexibility, combining the all important training opportunities with scope for setting out tracks for preliminary rounds on areas normally used for other sports.

#### 3.3.1.1 Lifespan

In comparison to other types of athletic surfaces, grass surfaces offer significant advantages in that, with careful maintenance, they will, at very low capital cost, last a very long time.

#### 3.3.1.2 Climate

In many parts of the world varieties of grass are substantially different to those in Europe and Northern America. Their use is similar, however, in that they use their root system and rhizomes layers to act as soil stabilisers ensuring a firm yet flexible surface. The grass surface or sward acts as an adjustable running surface that may be tuned, by adjusting the height at which it is cut, for specific activities.

Specialist construction and irrigation techniques are partly able to alter the firmness or resilience of the running surface by adjusting the amount of water retained within the overall construction. Such techniques, often used for American football and baseball events, indicate the adaptive nature of grass constructions. Grass is not an “all-weather” surface and is affected by adverse weather conditions. If events continue under these conditions, the important top running surface and complicated growing medium may be permanently destroyed.
This can require major reinvestment and, more importantly, the loss of substantial periods of time until the rejuvenated area is again ready for use. Such reestablishment periods can be as much as six to twelve months depending on climatic and soil conditions.

Differing climates, top soils and subsoils all require differing construction techniques according to local conditions and no one specification or indeed seed mixture is suitable for worldwide use. In each case the advice of regional sports field construction experts should be taken.

#### 3.3.1.3 Construction Considerations

The types of grass used should be selected for their surface durability and for suitability as a stabilising medium. The type chosen for tracks should endure 1.5cm to 2cm high cutting, and for the in-field 3cm to 4cm high cutting. Careful analysis is necessary but types used regionally for football or similar activities are often suitable.

One of the most important factors in many grass running surfaces is the drainage. The capacity to perform during periods of inclement weather is imperative, as heavy rainfall can quickly turn an idyllic green sward into a wet, muddy and unusable surface.

Sports field land drainage techniques have now advanced to the stage where highly accurate drainage designs can be installed to cater for anticipated rainfall and required dispersion rates. Although these techniques are commonly utilised on many sports field activities, additional care is required on their application for athletics.

Such systems often incorporate sand slits or sand grooves to transfer surface water down and away to subsurface dispersion drains. Unless the grass surface is adequately top dressed with sand and the slits or grooves properly filled at the time of installation, ruts and trip points may occur through settlement of the sand. Regular re-application of sand will be required to ensure that good drainage is preserved and hazards avoided. Such settlements will be especially noticeable in climates that experience high fluctuations of moisture and temperature causing large soil movements through expansion and contraction.

#### 3.3.1.4 Usage

The programming of athletic events on grass surfaces with large numbers of competitors, or over a long period experiencing difficult climatic conditions, can be crucial. Abuse will often result in a destroyed running surface. This may well be the case if the grass is poorly laid or not properly maintained. It may be necessary for a number of preliminary rounds to take place on areas away from the main arena to ensure the suitability of the track for the prestigious final events. The programming of preliminary rounds should, wherever possible, use adjacent grass surfaces that are still accessible to the viewing spectators.

#### 3.3.1.5 Marking out

In common with all types of tracks not provided with a raised kerb, grass tracks are measured in lane one along a theoretical line of running calculated at 0.20m from the inside running edge of a marked white line. (See “Construction of the Standard Oval Track” in Chapter 2). Often plastic road cones or marker flags (inclined towards the central arena) are provided to visually increase the definition of the inside running edge. Unless these are provided for the continuous length of the track (they are often only provided to divert the runner towards the steeplechase water jump) the 0.20m distance continues to be used.

### *3.3.2 PERFORMANCE REQUIREMENTS*

Natural grass should be viewed as the basic surface for athletics. The natural constraints implicit within its make-up mean that the strict tolerances normally associated with synthetic running track surfaces are not fully appropriate.

#### 3.3.2.1 Grass Coverage

Grass must be seen as the top, biological layer of the sports surface and, because of its root zone, as the biological stabiliser of the top soil. As for sporting activities such as football, hockey or cricket the grass surface has to interact with the athletes through their footwear and in addition has to allow the javelin, discus or hammer to travel through the grass sward before embedding itself in the ground beneath. The movement of a football for example will be affected to a great degree by the height, density and types of grass present on the playing surface. In the same way, athletics will be influenced.

Whilst weed or undesirable plant types can adversely affect the overall appearance of the running surface they do not always directly interfere with the athlete. It is important to ensure a good quality surface and to operate the same maintenance methods as for other sporting grass surfaces. Otherwise undesirable plant types that may seriously affect the durability of the grass sward will take over.

#### 3.3.2.2 Cutting Height

The grass should be maintained at its most appropriate height (3cm to 4cm) to ensure the maximum durability of the running surface. Before a competition, it must be cut to 1.5cm to 2cm, in order that it does not physically restrict the progress of the athlete. For a similar reason, excessive grass clippings must be removed.

In order to facilitate the judging in the throws, the grass height in the field should not exceed 2.5cm.

#### 3.3.2.3 Constructions

The ground or soil structure can significantly affect the athlete in a number of ways. These are normally through particles of an undesirable size and the flatness of the ground (See 3.3.2.4) and as a less durable or excessively soft surface due to the impermeability of the track's upper layer rather than the evenness of the height or the way the grass has been cut.

It is essential that the top layer (root zone of the soil layer) is porous so that excess water can be carried off into the underlying drainage layer or ground.
This means that the soil layer must be of a suitable composition and thickness.
Moreover, the ground must be sufficiently flat, for example local settling and grooves must be eliminated. Great care must be taken during construction if both requirements are to be fulfilled. (See 3.5 for the drainage of excess water.)

For the construction of the grassed surface, the methods explained below are recommended, and take into account on the porosity of the ground and the extent of local precipitation.

*a) Applicable on sufficiently porous ground for example sand and gravel (Fig 3.3.2.3a).*
After creation of the foundation, soil is laid to a uniform depth of 8cm to 12cm. The bottom of the soil layer is mixed with the surface of the underlying ground to key the two layers. The soil is then levelled and grass is sown.

*b) Applicable on ground which is less porous yet capable of improvement (Fig 3.3.2.3b).*
After creation of the foundation, granular materials (sand, gravel) with particles of 0/2mm to 0/4mm are applied to improve porousness. The necessary quantity depends on the porosity of the underlying ground.

The ground can then be mixed to a coarse tilth with the layer of granular material. Pipe drains are then laid at intervals of 4m to 6m according to the porosity of the improved ground. When the soil is then laid on the improved ground, the performance of the drains must not be impaired. The soil is laid to a standard depth

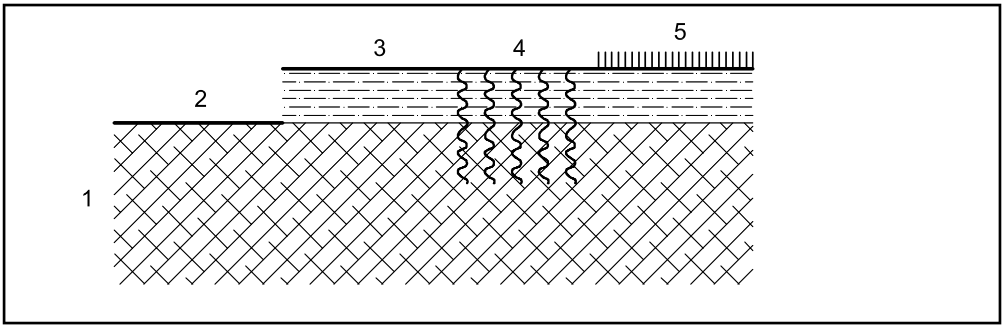



**Figure 3.3.2.3a - Method of construction**
Example 1: Sufficiently porous subgrade
1 Porous subgrade, 2 preparing of construction ground, 3 applying the grass-supporting layer, 4 loosening/keying, 5 sowing

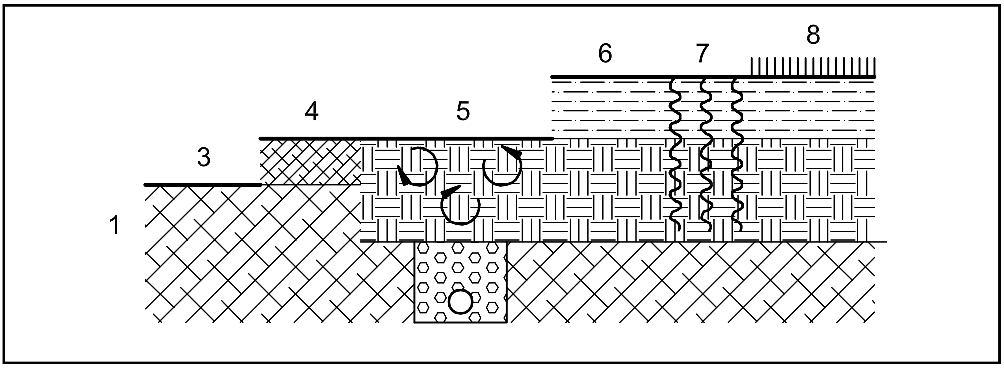



**Figure 3.3.2.3b - Method of construction**
Example 2: Less porous subgrade yet capable of improvement
1 Subgrade, 2 drain, 3 preparing of construction ground, 4 applying sand, 5 mixing, 6 applying the grass-supporting layer, 7 mixing/keying, 8 sowing

of 8cm to 12cm. After the soil and improved ground have been loosened to key the two layers, the soil is levelled and grass is sown.

c) *Applicable on ground capable of improvement for enhanced porosity or load-bearing capacity (Fig 3.3.2.3c and 3.3.2.3d).*

This system consists of combined pipe and slit drainage. Slits are installed parallel, and the drains at 90°, to the layout of the track.

After creation of the foundation, drains are laid at intervals of no more than 12m at 90° to the inside edge of the track (at right-angles to the slits). The drain filling of gravel or suitable chippings has a particle size similar to that of the slits (See below). The slit-drains are then created at intervals appropriate to the porosity of the ground and the thickness of the top-soil (usually 1.0m to 1.5m). The slit drains should be 5cm to 8cm wide and at least 25cm deep, and connected in to the drain runs. The slit drains are filled with gravel or suitable chippings with a particle size of 2/8mm.

If necessary, the ground fitted with the combined drainage system may then have to be worked further. After this the soil is laid to a uniform depth of 8cm to 12cm. The thickness of the layer depends on the porosity of the underlying ground and the distance between slits. After the soil and ground are loosened to key them, the surface is levelled and grass is sown.

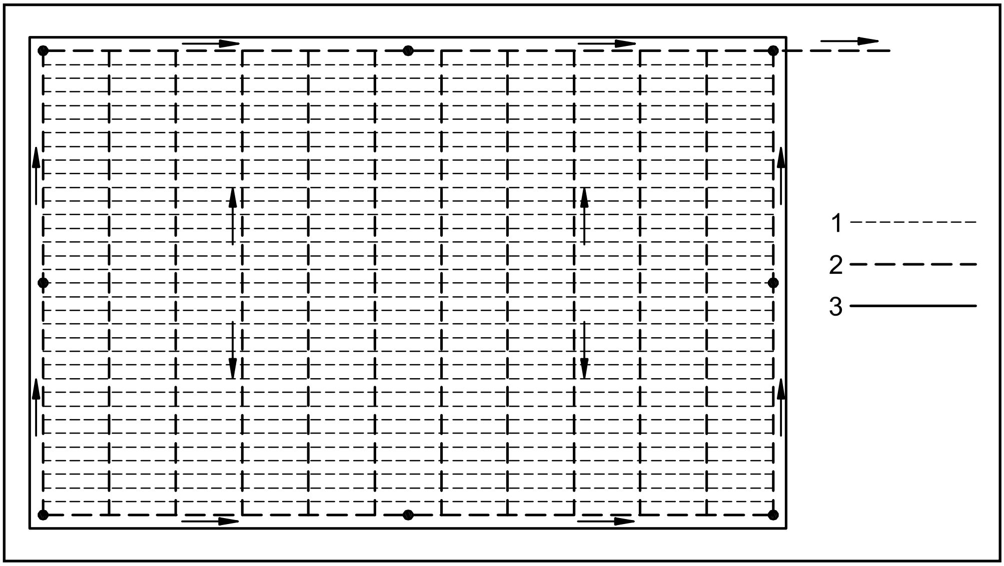



**Figure 3.3.2.3c - Method of construction**
Example 3: Less porous subgrade
Combined slit drain and drainage system - 1 Drain slit, 2 drain, 3 pitch

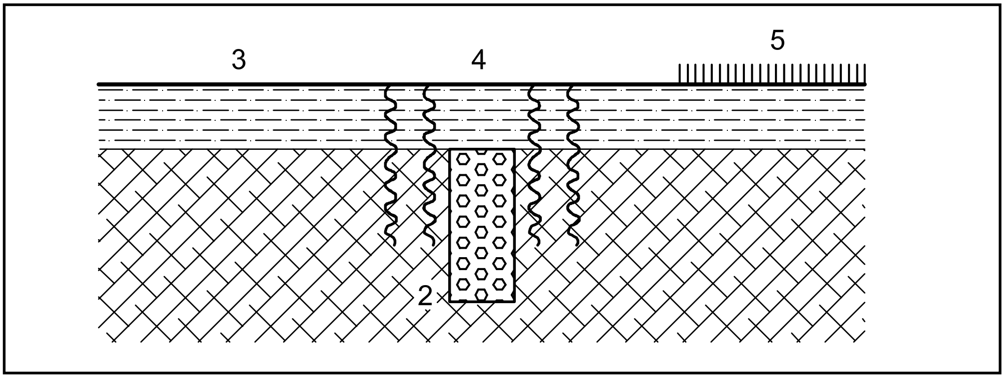



**Figure 3.3.2.3d - Method of construction**
Example 3: Less porous subgrade
Combined slit drain and drainage system - 1 Subgrade, 2 drain slit , 3 applying the grass-supporting layer, 4 mixing/keying, 5 sowing

Ground of insufficient load-bearing capacity must be stabilised before installation of the drainage system.

d) *Applicable on ground of insufficient porosity and limited capacity for improvement, e.g. water-sensitive or unstable ground, rock, or in areas of high precipitation and valley sites at risk from flooding (Fig 3.3.2.3e).*

After creating the foundation, drains are laid at intervals of 5m to 8m depending on the porosity of the ground. The drainage layer is then applied to a uniform depth of 12cm to 15cm. After this the soil is laid, also to a uniform depth of 12cm to 15cm. After mixing the soil with the drainage layer to key them, the surface is levelled and grass is sown.

The maintenance of athletics facilities is described in Chapter 7. In addition, attention has to be directed to checks that must be undertaken to remove all stones prior to the surface's use for athletic events. The presence of such stones would adversely affect an athlete's spikes or create a hazard by deflecting a field event implement.

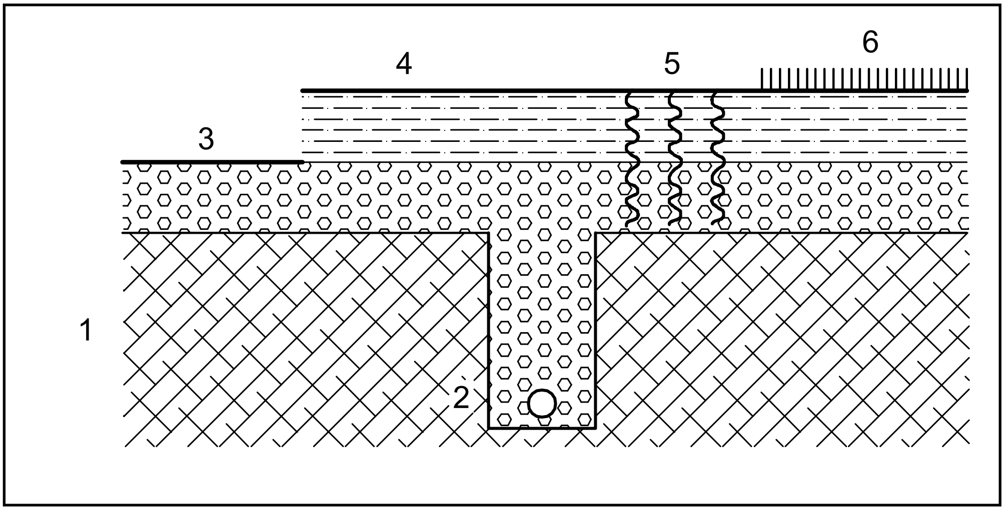



**Figure 3.3.2.3e - Method of construction**
Example 4: Subgrade with insufficient porosity and limited capacity for improvement
1 Subgrade, 2 drain, 3 drainage layer
4 applying the grass-supporting layer, 5 loosening/keying, 6 sowing

### 3.3.2.4 Flatness

The overall gradient tolerances of IAAF Rules shall be adhered to. However the flatness of the grass surface cannot be to the same tolerances as synthetic surfaces. Settlement, maintenance operations such as spiking and slitting and the important additions of top dressings will all result in minor local differences of level. However, reasonable tolerances are achievable and must be observed to remove trip hazards and problems of water ponding.

On a localised level there shall be no bumps or depressions beneath a 3m straight edge exceeding 10mm, and beneath a 0.50m straight edge exceeding 8mm. Surface changes caused by the actions of burrowing animals, worms or insects shall be “made good” prior to any athletic event. It must always be recognised however that many such actions have important and beneficial effects upon the overall soil structure and are therefore necessary to promote good grass growth.

#### 3.3.2.5 Thickness

The upper layer should have a minimum consolidated depth of 8cm prior to seeding, turfing or commencement of the grass layer. This is necessary to ensure good root establishment, ground stability and penetration of the spike of the athletes’ shoe without meeting any solid item.

#### 3.3.2.6 Drainage

The recommendations and proposals in Sections 3.5 and 3.6 will enable the facility to meet the IAAF Specification for synthetic tracks, that no standing water should be present twenty minutes after rainfall has stopped.
This requirement is normally achievable with natural grass.

### *3.3.3 TESTING*

Some of the dynamic tests which have been developed can be applied to natural grass surfaces, and there are proprietary items of equipment which have been developed for such ground, in the form of “impact hammers” which give readings of loading and penetration of test cylinders into the surface. However, these procedures have not been routinely applied to natural grass for athletics tracks, and it is not possible therefore, at this stage, to define their use or set limits for the various surface characteristics which they measure.

## 3.4 Foundation Requirements

The extremely strict tolerances for gradients and flatness which are stipulated by the IAAF, mean that the construction of an adequate foundation is of supreme importance. These tolerances are required to be met not only by the newly completed facility, but also over the life of the track. This life would be expected to extend over two or three times the expected life of the synthetic surface. That is, the base construction should be adequate for at least 25 or 30 years without showing signs of movement in the form of settlement or heave.

### *3.4.1 SYNTHETIC SURFACED TRACKS*

#### 3.4.1.1 Essential Criteria

The foundation to any athletics track should be designed to meet the following criteria:

- It should be capable of supporting and transmitting to the existing ground, the loads of all vehicles, plant, machines and materials to be used in the construction, without causing deformation of the site, or exceeding the ground-bearing capacity.
- It should be capable of supporting and transmitting all the loads on the surface from athletes and maintenance equipment, without permanent deformation of the surface.
- It should provide protection to the surface from the effects of ground water, subsoil ground movement and frost.

- It should ensure that water, whether rainwater or natural groundwater, will drain away freely, either into the subsoil, or into a drainage system.
- It must guarantee porosity to rainfall in excess of the heaviest likely rainstorm and ensure that no standing water remains on the track surface which could impair the use of the facility. Porous surfaces must permit such rainwater to seep away freely.
- It should contribute towards providing suitable performance characteristics of the surface, in respect of athlete/surface interaction.
- It should ensure that the above criteria are retained throughout the life of the installation.
- It should provide all the above at the most economical costs, in terms of initial capital outlay and subsequent maintenance costs.

#### 3.4.1.2 Foundation Construction Techniques

*General*

The basic construction for all foundations will be similar and may be likened to road construction. The differences being in the overall thickness and nature of the layers of stone.

The procedure adopted for the foundation construction will normally consist of the following operations.

- Excavation to remove vegetable matter, soil, loose or frost susceptible material down to a firm, load-bearing strata.
- Rolling or other treatment, to identify any weak or soft spots which should be dug out and replaced with suitable compacted hard, non-degradable filling. On some subsoils, compaction only may be necessary.
- Drainage installation for subsoil or sub-base, in accordance with sub-section 3.5.
- Laying and compacting of first stone base. A crushed, hard, frost-resisting layer of stone is the normal material, but clean crushed brick, concrete or clinker may be suitable. This layer should not exceed about 200mm thickness and if the subsoil is frost-resistant gravel, this may be the only stone layer required. It should be graded to falls and checked for accuracy of finished level within the tolerances specified.
- Laying and compacting second (and subsequent, if necessary) stone layer(s) as above, to provide total construction height of the unbound base layers.
- Blinding with small, angular crushed stone (sand or ash may be acceptable, depending on the wearing course).
- Laying and compacting bitumen-bound base and wearing courses. There are a number of alternative forms of wearing course on offer. The choice is determined in consultation with the surfacing installer, in the light of the particular synthetic surfacing system to be used. The bitumen binder in bituminous bases should be "straight run", unfluxed, unless the wearing course is intended to be left exposed for sufficient time to allow all solvents to evaporate.

A bitumen-bound two-layer build-up at least 60mm thick will be required, typically comprising a lower layer, 40 to 60mm thick, and an upper layer, 20 to 30mm thick. Great attention must be paid to the accuracy of the final layer because of the very strict requirements for surface flatness and gradients, and the requirements for minimum thickness of the synthetic surface. It is quite likely that, in order to achieve the required tolerances, corrective work to the final layer will be necessary. Time should be allowed for this in the construction programme.

*Deliberations about investigation of the sub-soil*

It is apparent from these criteria that the foundation in its precise construction and thickness is dependent upon the location. The ground conditions existing beneath each site must be accurately determined by means of a comprehensive geotechnical investigation. It is important to ascertain the strata at depths down to approx. 2.5m, the load bearing capacity of the soils, their shear strength and their permeability. Some of the tests necessary to generate this information must be conducted in the laboratory on samples removed from site. Certain tests need to be undertaken in-situ, at various depths below the surface. All sub-soil investigation should be undertaken at design stage, in advance of tender period and construction.

*Summary*

Because of the complexity of the topic, it is not possible to lay down comprehensive guide-lines for the base foundation necessary. The considered judgement of experts in this field is necessary, for every new installation, in the light of the geotechnical information available. It is important to remember that the construction and tolerances required involve a good standard of road-making.

Even on the most ideal site, a minimum of 150mm of free-draining aggregate below a minimum of 60mm of bitumen/macadam will prove necessary. On less than ideal sites, a build-up of 400mm or 500mm is quite likely to be needed. In latitudes where winter temperatures below zero are regularly encountered, construction depths greater than this may be needed to avoid problems of frost “heave”.

Due to the high cost, extremely troublesome sites, such as old landfill areas, should be avoided due to the risk of ground movements and the greater number of structural measures then needed to ensure stability.

### *3.4.2 UNBOUND MINERAL SURFACED TRACKS*

As indicated in Section 3.2, the method of construction used for this type of track comprises several layers of crushed stone installed in varying degrees of thickness.The top layer consists of a suitable natural stone material.

With respect to the requirements and essential criteria, in principle the observations made under Section 3.4.1 apply.

#### 3.4.2.1 Requirements

*Subsoil, filter layer*

The quality of the sub-soil must be, or be constructed to be, such that any subsequent deformations or changes to the surface can be eliminated. For this reason, compaction of the soil is generally necessary once the earthwork required for preparation of the sub-base has been completed. The subsoil is graded, usually to correspond to the slope of the top surface of the track. The sub-base must be sufficiently even to allow for optimum drainage. The prescribed nominal heights may only deviate minimally from the planning data. Compliance with the requirements listed in table 3.4.2.1a will ensure the quality required.

In the event of the subsoil containing any cohesive components, a suitable filter layer must be installed in order to prevent any penetration of fine parts into the base layer.

*Drainage*

If the water permeability of the subsoil is inadequate, a drain must be installed to carry the seepage and ground water away. For further information see 3.5.

| ***COLUMN*** | ***1*** | | ***2*** | ***3*** |
|---|---|---|---|---|
| ***Line*** ***1*** | ***Characteristics*** | | ***Requirements for*** | |
| | | | ***Fine grained soils*** | ***Coarse grained/ mixed soils*** |
| ***2*** | Degree of compaction | DPr | > 0,92 | > 0,95 |
| ***3*** | Deformation module | Ev2 $MN/m^2$ | > 20 | > 30 |
| ***4*** | Slope | % | 0.8 to 1 | 0.8 to 1 |
| ***5*** | Nominal height deviation | ± mm | < 30 | < 30 |

**Table 3.4.2.1a - Requirements for foundation soil and filter layer**

*Base Layer*

If the subsoil does not satisfy the requirements for the load bearing capacity of a track, a base layer made up of crushed stones, sand and gravel or similar material will be needed. A single layer of material comprising corresponding degrees of thickness is used.

Compaction of this layer is necessary in order to satisfy the requirements for the load bearing capacity. Furthermore, it must be constructed to achieve an adequate water permeability and water retention. The material must also be resistant to wear and tear, and in cold or moderate climatic zones, frost-resistant as well.

The base layer is installed with the same slope as the top layer of the sports surface. The prescribed nominal heights and the required slope may only deviate minimally from the requirements listed in table 3.4.2.1b. The values listed have proved useful.


| ***COLUMN*** | ***1*** | | ***2*** | ***3*** |
|---|---|---|---|---|
| ***Line*** ***1*** | ***Characteristics*** | | ***Requirements for*** | |
| | | | ***Fine grained soils*** | ***Coarse grained/ mixed soils*** |
| ***2*** | Degree of compaction | DPr | > 0,92 | > 0,95 |
| ***3*** | Deformation module | Ev2 $MN/m^2$ | > 20 | > 30 |
| ***4*** | Slope | % | 0.8 to 1 | 0.8 to 1 |
| ***5*** | Nominal height deviation | ± mm | < 30 | < 30 |

**Table 3.4.2.1a - Requirements for foundation soil and filter layer**

#### 3.4.2.2 Work Steps (Preparation)

Once the building site has been cleared, the following work steps will be necessary.

*Earthwork*

The sub-base is prepared by excavating and filling, whereby the mass of soil should be spread out as evenly as possible. Filled areas and fillings from additional soil masses must be compacted evenly in continuous layers and may not adversly affect the characteristics of the existing soil.

When compacting, consideration must be given to the type of soil and its water content. No working or compaction of the soil is permitted during frost or following longer periods of rainfall.

*Drainage*

Particulate mineral surfaced tracks must be furnished with a drainage system to suit the type of soil. For further details see 3.5.

*Filter Layer*

If a filter layer is required, it must be installed with a minimum thickness of 60mm. The building material primarily used for this purpose is sand and gravel.
No detrimental changes to the top surface of the subsoil may result from the installation.

*Base Layer*

The base layer which should have a minimum thickness of 150mm is laid onto the sub-base or the filter layer. The installation should not adversly affect the evenness or water retention properties of the layers below.

Compaction must be carried out evenly over the entire area. Statically active equipment should be used.

### *3.4.3 NATURAL GRASS SURFACED TRACKS*

The substructure of athletics facilities with a top surface of natural grass must be constructed so that a water permeability, stability and surface shearing strength can be attained which is suitable for the performance characteristics of athletics.

The statements under Section 3.4.1 in respect of the requirements and essential criteria shall also apply.

#### 3.4.3.1 Requirements

*Subsoil*

The subsoil must be prepared so that the top surface will not be affected by any subsequent deformations.The areas required for preparing the sub-base with soil filling and, in the case of unstable ground, the excavation areas will therefore need to be compacted. The scope of this compaction should be determined by soil analysis. Generally there are no requirements in respect of degree of compaction or deformation module for the top surface of the subsoil. However a

loaded lorry on a test run with a wheel load of 5 ton should not leave any track marks greater than 30mm.
The slope of the subsoil should match the top surface of the track.

*Drainage*

A subsoil with an inadequate water permeability must be fitted with a drainage system to carry the seepage water away. In the case of this special type of surface, the drainage required can be guaranteed by the means described below.

Drain conduits (drains with drop pipes) should be installed every 4m to 6m.
The spacing depends on the type of soil and the rainfall conditions (See also 3.5).

If a drainage layer is needed, it should be installed with a minimum thickness of 100mm, and a maximum of 150mm. The slope of this layer must also correspond to the slope of the top surface of the track.
After preparation, drainage layers must be keyed into the subsoil.

*Turf Base Layer*

Turf base layers must possess the characteristics listed in the introduction, i. e. adequate water permeability, stability and surface shearing strength.
The prescribed values for nominal heights and evenness may only deviate negligibly from those agreed upon in the contract.

The slope to the inside track may not exceed 1%.

After their preparation, turf base layers must also be keyed into the subsoil or to the drainage layer.

Compliance with the requirement data listed in table 3.4.3.1 will achieve the quality required for the turf base layer.

| ***COLUMN*** | ***1*** | | ***2*** |
|---|---|---|---|
| ***Line*** | | | |
| ***1*** | ***Characteristics*** | | ***Requirement*** |
| ***2*** | Water permeability mod kf | mm/min | > 0.03* |
| ***3*** | Proportion of organic substance | % in weight | > 10 - 30 |
| ***4*** | Soil reaction | pH | 5.5 - 7.0 |
| ***5*** | Nominal height deviation | ± mm | < 20 |
| ***6*** | Evenness deviation | mm | < 20 |
| ***7*** | Slope | % | < 1 |
| ** for LK 100* | | | |

**Table 3.4.3.1 - Requirements for the turf base layer**

### 3.4.3.2 Work Steps

*Earthwork and Compaction*

Earthwork required for preparation of the sub-base must be conducted without reducing the water permeability of the subsoil or otherwise adversly affecting the structure of the ground. If compaction is needed, statically active compacting machines must be used for this purpose. Compaction must be conducted uniformly over the entire surface.

*Drainage Layer*

The installation of the drainage layer may not give rise to any negative impact on the sub-base described above. In particular, the evenness and the water permeability must be guaranteed.

*Turf Base Layer*

Supporting building materials (sand, local unworked soil with low fine part content) and additional materials (peat) used for this layer must be mixed together homogeneously. No equipment may be used which will cause the building materials to wear at the edges. The water content at installation should not be too high.

Suitable equipment must be used for keying the drainage layer into the sub-base to a minimum of 50mm.

# 3.5 Surface Drainage

### *3.5.1 GENERAL REMARKS*

With the exception of the water needed for bonding the unbound mineral surface or for maintaining the grass of the turf surface, water is disruptive of sports training and competition facilities and can even cause damage to the sports areas of unbound mineral and turfed surfaces. Water in or on sports surfaces considerably alters the performance properties of the surface. For example, on synthetic surfaces a hindrance may occur as a result of a kind of aquaplaning. Unbound mineral surfaces can become plastic and lose their sureness of tread.

The removal of any surface water from sports areas by means of a drainage system is therefore vital.

Surface water mainly accumulates from precipitation, such as rain, mist, dew and snow. In rare cases, which are mostly attributable to planning error, surface water may also be derived from extraneous sources originating from surface or ground and stratum water which develops from outside areas and has a hydraulic slope to the sports area. In this case, special measures have to be considered.

The surface water which has to be removed accumulates not only on the sports surface, but also in the spectator areas, adjacent traffic areas and on other neighbouring sports surfaces and ancillary areas.

Figure 3.5.1 shows the direction of flow of the surface water and indicates the discharge coefficients of the respective surfaces.

Generally, a distinction is drawn between the following systems of drainage.

- Drainage of the surface water into suitable intakes, such as gutters or individual inlet channels, which carry the water through drain pipes to the recipient.

- Drainage of the water through the installation in the form of seepage water which is passed into a porous subsoil or carried through a draining system to the recipient.

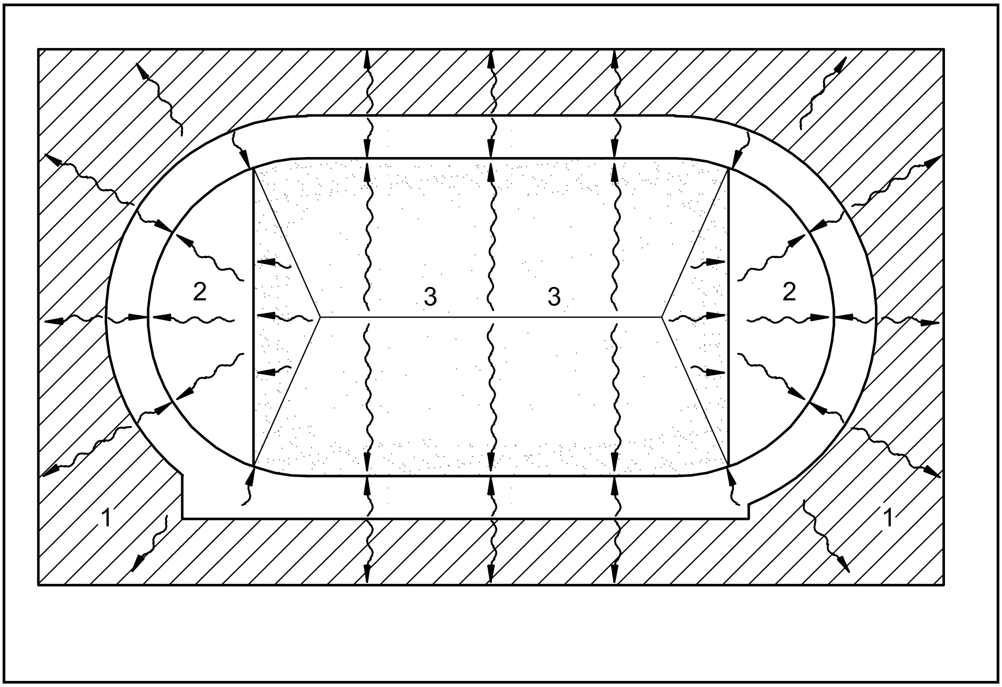



**Figure 3.5.1 - Direction of flow of the surface water and discharge coefficients of the respective surfaces (in brackets)**

1 Groundwater, vegetation areas (0.25), paved paths (0.60), asphalted paths (0.80), waterbound paths (0.30)

2 unbound mineral surface (0.50), non-permeable synthetic surface (0.90), permeable synthetic surface (0.50), turf (0.25), 3 turf (0.25), synthetic turf (0.60)

## *3.5.2 DEFINITIONS*

### 3.5.2.1 Extraneous Water

Extraneous water is water which develops from outside areas in the form of surface or ground and stratum water and which has a hydraulic slope to the sports area. Extraneous water can be removed via drainage channels, ditches or gutters which catch the water before it reaches the sports area and divert it to a recipient.

### 3.5.2.2 Recipient

The recipient is an existing body of water, the drainage network or a draining well.

### 3.5.2.3 Water Outlet

An outlet is a structural component responsible for collecting the surface water and discharging it into a drain. This may be in the form of
- gutter constructions such as running track surrounds designed as hollow sections
- individual inlet channels within the running track surrounds
- open gutters

### 3.5.2.4 Ring Mains/Collection Lines

Ring mains or collection lines are pipelines comprising closed (watertight) pipes or part-perforated pipes which collect the water from the outlets and the drain pipes in the sports ground and carry it off to a recipient.

## *3.5.3 REQUIREMENTS AND CONSTRUCTION*

### 3.5.3.1 Track Surround Gutters

(covered or in the form of hollow section gutters)

Surround gutters are installed in lengths of 33m to 35m and connected to the collection line via 6 to 8 feed boxes. The feed boxes should be fitted with sand traps. The feed boxes usually have a length of 0.5m and must have the same width as the cover of the intake gutter.

If the water enters these gutters from the top, the slit must have a width of at least 10mm but no more than 15mm. If the water enters from the side, the slit width must be at least 10mm but no more than 25mm. Such gutters are mostly polyester hollow section gutters. They have removable covers and they usually have a cross section of 125mm. They are designed as mirror-gradient gutters.

If the top edge of the gutter cover does not lie flush with the adjoining surface, the free edge must be rounded off with a radius of at least 20mm, to prevent accidents. When installing drainage gutters as track surrounds, the dimensional requirements of the track border must be complied with.

Figures 3.5.3.1a and 3.5.3.1e show examples of gutters between the track and the grassed field (a and b), the track and segment with track surround (c) and without (d), and the design of a feed box (e).

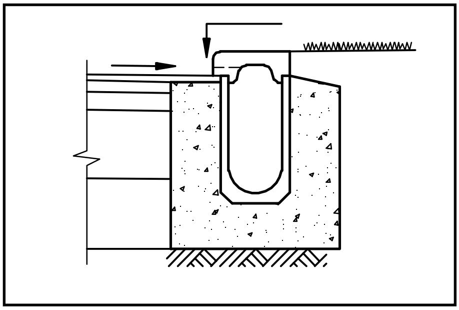


**Figure 3.5.3.1a**
**Example of a gutter fed from one side**

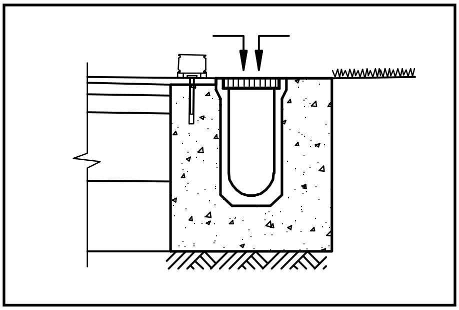


**Figure 3.5.3.1b**
**Example of a gutter fed from above with a top-mounted kerb**

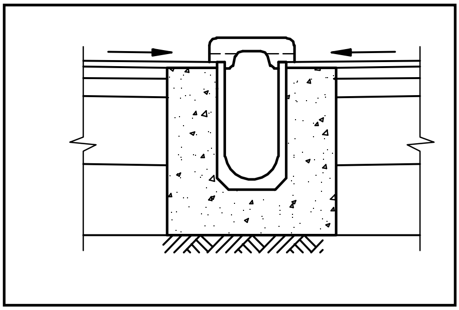


**Figure 3.5.3.1c**
**Example of a gutter fed from two sides**

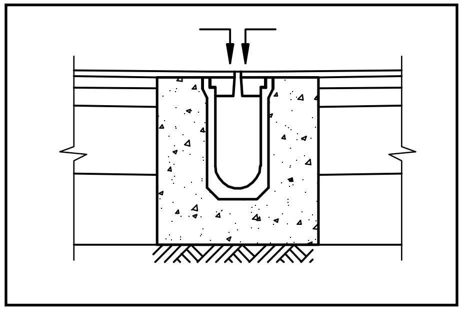


**Figure 3.5.3.1d**
**Example of a gutter fed from above**

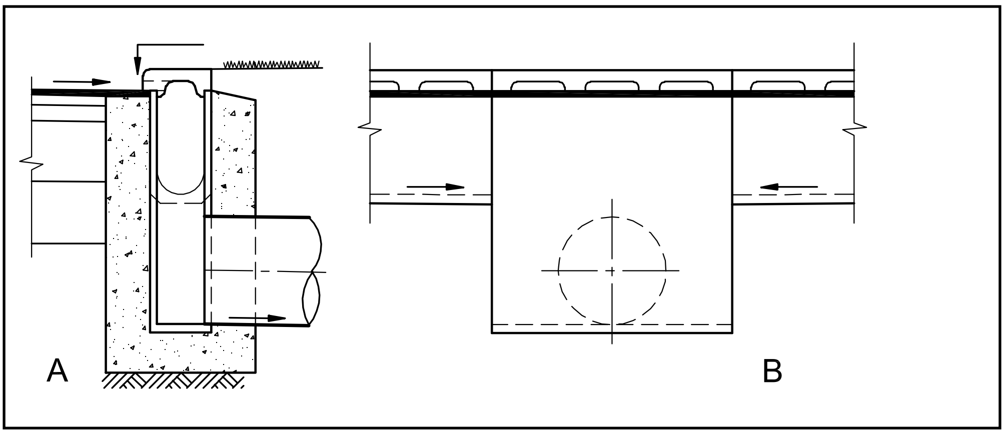



**Figure 3.5.3.1e - Example of a feed box with a gutter fed from one side and connected to a drain line A**
A Cross section
B Longitudinal section

Surround gutters are usually laid in a concrete foundation (compressive strength 15 N/mm$^2$ minimum). The thickness beneath the gutters must be at least 200mm and the requisite back supports must be at least 80mm thick.

The required discharge from gutters is determined by the formula

$$D_r = 0.012 \times G_g$$

where $D_r$ = required discharge in l/s
$G_g$ = gathering ground of the gutter up to the gutter discharge in m$^2$.

The required cross-section of the gutter for discharging is determined for gutters without bed slopes by the formula:

$$CS_r = 18 \times D_r$$

for gutters with bed slopes by the formula:

$$CS_r = 1.5 \times \frac{D_r}{\sqrt{BS}}$$

where $CS_r$= required cross-section for the type of gutter selected at the end of the gutter track (before the gutter discharge) in $0.01m^2$
BS = bed slope

The absorption capacity of feed boxes is determined by the formula

$$A_c = 0.15 \times TCS$$

where Ac= absorption capacity of the gutter discharge in l/s
$T_{cs}$= narrowest throughflow cross-section of the discharge in $0.0001m^2$

### 3.5.3.2 Individual Inlet Channels Within Track Surrounds

If individual inlet channels are used, they are usually inserted in the track surround of the running track. They are connected to the ring main and must be fitted with a sand trap.

The slit height of the individual inlet channels must be at least 10mm, but no more than 25mm. The water intake surfaces must be at least $0.001m^2$. On non-porous synthetic surfaces, the distance between the individual inlet channels must not exceed 2.5m, and for permeable synthetic surfaces and unbound mineral surfaces must be no more than 5.5m. The individual inlet channels (Fig 3.5.3.2.a and 3.5.3.2b) are made of polyester concrete or metal which are inserted as hollow section gutters into a concrete bedding.
Individual inlet channels have not proved successful for competition tracks.

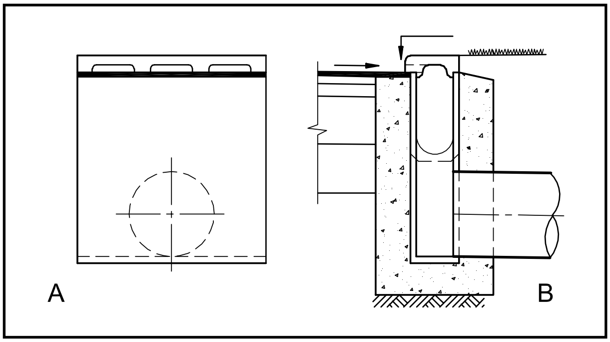



**Figure 3.5.3.2a**
**Individual inlet channel fed from one side**
A Cross section
B Longitudinal section

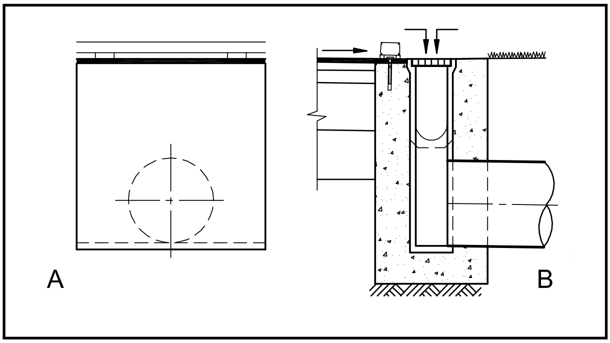



**Figure 3.5.3.2b**
**Individual inlet channel fed from above and top-mounted kerb**
A Cross section
B Longitudinal section

#### 3.5.3.3 Open Gutters

Open gutters are used for surface water drainage of ancillary areas (Fig 3.5.3.3a to 3.5.3.3c). They are open channels and are made of concrete or concrete polyester. These gutters are fitted with drains in the form of individual inlet channels or feed boxes at fixed intervals.
The gutters are inserted as surround gutters in the concrete bedding.

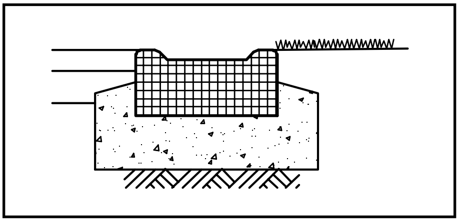


**Figure 3.5.3.3a - Open gutter made of concrete or polyester concrete**

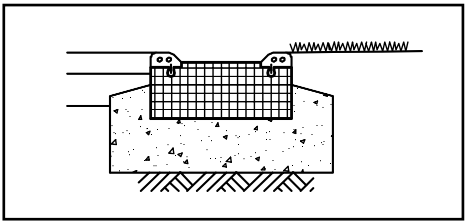


**Figure 3.5.3.3b - Open gutter, bordered by rubber or plastic edging**

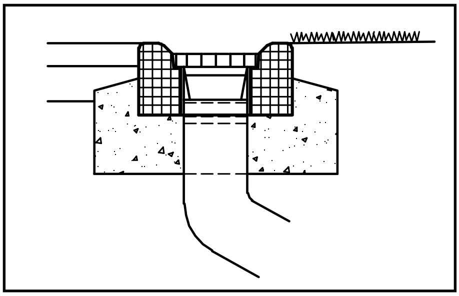


**Figure 3.5.3.3c**
**Discharge of an open gutter with a sand trap**

#### 3.5.3.4 Ring Main/Collection Lines

They consist of

- enclosed pipes made of plastic, concrete or reinforced concrete with a minimum flow rate of 0.5 m/s and a maximum of 3m/s or
- drain pipes, mainly in the form of part-perforated pipes with a closed bottom. When using such types of pipe for the ring main, the calculation of the pipe diameter is based on the assumption that there will be a 50% reduction of the total water supply due to the accumulation of water in the drain.
  Ring mains designed to carry off surface water must have a minimum gradient of 0.3% and a maximum of 0.5+%. For their construction, the recommendations given in Section 3.6 should be followed.

### *3.5.4 CALCULATION AND DESIGN*

#### 3.5.4.1 Hydraulic Dimensioning of the Surface Water Drainage System

The quantity of water which needs to be carried off depends on

- the estimated level of rainfall which may vary greatly owing to local precipitation conditions, but as a norm 120 litres per second per hectare (120l/s/ha) can be assumed

- the discharge coefficient Psi($\Psi$) which depends on the running track surface (porous or non-porous) and on the type of adjacent sports surfaces as far as rain water is discharged onto the track area
- the type of adjacent traffic areas when these have any effect on the drainage of water from the track
- the adjacent ancillary areas when water is discharged from these onto the track area

The discharge coefficients can be incorporated into the calculation of the total quantities of water to be discharged as follows:

| | |
|---|---|
| Synthetic surfaces, non-porous | 0.9 |
| Synthetic surfaces, porous | 0.5 |
| Unbound mineral surfaces | 0.5 |
| Synthetic turf surfaces | 0.5 |
| Natural turf surfaces | 0.25 |
| Paths, paved | 0.6 |
| Paths, water bound | 0.3 |
| Paths, asphalted | 0.8 |

### 3.5.4.2 Pipe Cross Sections

To calculate the pipe widths for draining surface water, the discharge coefficients under 3.5.4.1 are referred to. The estimated rainfall r is taken as 120 l/s/ha. The area being drained is given as F ($m^2$). However, the drainage of surface water from adjacent paths is only permissible if the path width does not exceed 2.50m. Otherwise special drainage installations have to be provided and calculated for separately.

Tables 3.5.4.2a and 3.5.4.2b indicate the necessary pipe cross sections for the determination of ring mains for draining the water supplied by the feed boxes relative to the chosen bed slope.

| *1* | *2* | *3* | *4* | *5* | *6* | *7* |
|---|---|---|---|---|---|---|
| ***Pipe diameter mm*** | ***Bed slope*** | | | | | ***Type of pipe*** |
| | 1.0 % 1:100 | 0.75 % 1:133 | 0.50 % 1:200 | 0.40 % 1:250 | 0.33 % 1:300 | |
| 65 | 1.47 | 1.28 | 1.04 | 0.93 | 0.81 | D |
| 80 | 2.56 | 2.21 | 1.81 | 1.62 | 1.40 | D/PP |
| 100 | 4.64 | 4.02 | 3.28 | 2.94 | 2.54 | D/PP |
| 125 | 8.42 | 7.30 | 5.95 | 5.32 | 4.61 | D |
| 150 | 13.68 | 11.87 | 9.68 | 8.66 | 7.50 | PP |
| 160 | 16.25 | 14.09 | 11.49 | 10.29 | 8.91 | D |
| 200 | 29.47 | 25.56 | 20.84 | 18.64 | 16.15 | D/PP |
| 250 | 53.44 | 46.34 | 37.79 | 33.80 | 29.27 | PP |

*D= Drainage pipe*
*PP= Part-perforated pipe*

**Table 3.5.4.2a - Discharge volume (l/s) of drainage pipes/part-perforated pipes**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| ***Pipe diameter mm*** | ***Bed slope*** | | | | | | |
| | 1.0% 1:100 | 0.66% 1:150 | 0.50% 1:200 | 0.40% 1:250 | 0.36% 1:275 | 0.33% 1:300 | 0.30% 1:333 |
| 100 | 5.11 | 4.17 | 3.61 | 3.23 | 3.08 | 2.95 | 2.80 |
| 125 | 9.26 | 7.56 | 6.56 | 5.85 | 5.58 | 5.34 | 5.07 |
| 150 | 15.05 | 12.29 | 10.64 | 9.52 | 9.08 | 8.69 | 8.25 |
| 200 | 32.42 | 26.47 | 22.92 | 20.50 | 19.55 | 18.72 | 17.77 |
| 250 | 58.78 | 47.99 | 41.56 | 37.18 | 35.45 | 33.94 | 32.21 |
| 300 | 95.58 | 78.04 | 67.59 | 60.45 | 57.64 | 55.18 | 52.38 |
| 350 | 144.18 | 117.72 | 101.95 | 91.19 | 86.94 | 83.24 | 79.01 |
| 400 | 205.85 | 168.08 | 145.56 | 130.19 | 124.13 | 118.85 | 112.80 |

**Table 3.5.4.2b - Discharge volume (l/s) of closed pipes**

### 3.5.4.3 Surface Water Drainage Systems

*Running track*

Figure 3.5.4.3a shows the slope and the direction of drainage from the outer edge of the track to the drainage gutters on the inside.

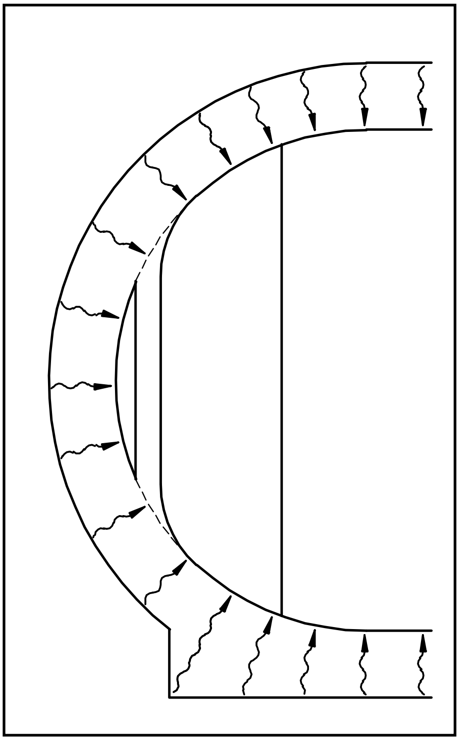


**Figure 3.5.4.3a**
**Slope and direction from outer edge of the track to the drainage gutters**

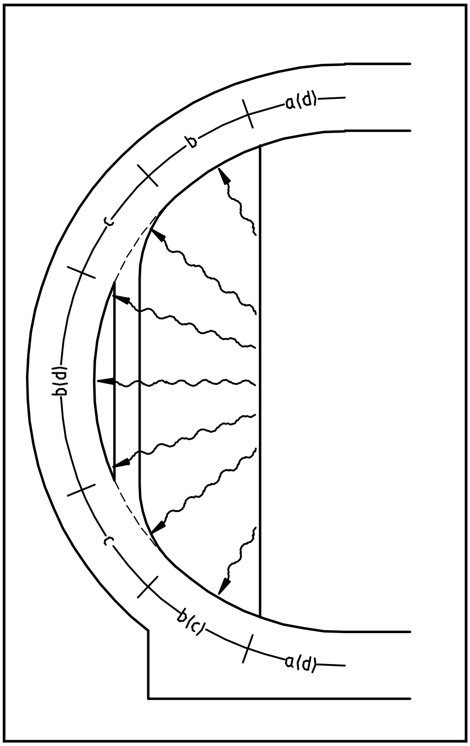
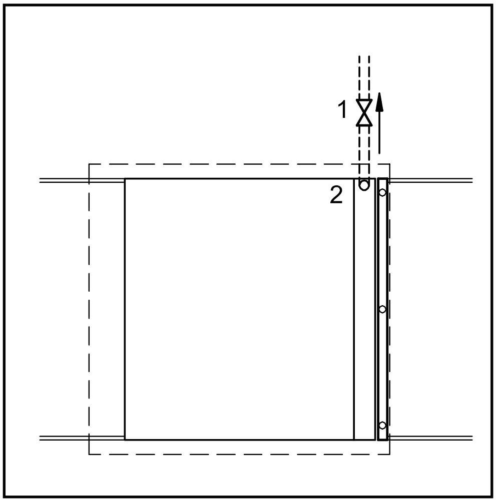



**Figure 3.5.4.3b**
**Drainage of a segment**




*Segment*

The discharge of the surface water from the segments to the inside of the track can be seen in figure 3.5.4.3b. In this figure, a, b, c and d refer to the gutter types described in Section 3.5.3.1.

**Figure 3.5.4.3c**
**Draining the water jump pit**
1 Stop-cock
2 discharge pipe
(cast or synthetic)

*Water jump*

Figure 3.5.4.3c shows the connection of the water jump to the drainage system. The outlet made of cast iron or plastic pipe (diameter 100 mm) is controlled by a slide valve.

*Landing areas for Long and Triple jump*

The drain situated in the middle of the landing area receives, via the drainage layer beneath, the surface water from the surrounding grid (Fig 3.5.4.3d).

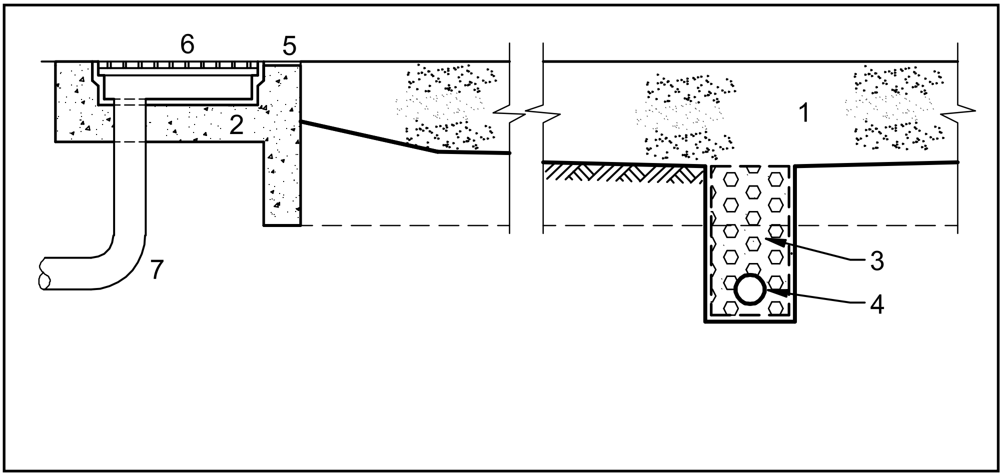



**Figure 3.5.4.3d - Draining long and triple jump pits and adjacent sand scraping grid Cross Section**
1 Sand, 2 concrete, 3 drainage layer, 4 drainage ditch and drain pipe,
5 soft protective surround, 6 sand scraping grid, 7 cast or synthetic pipe

*Landing areas for Field Events*

Figure 3.5.4.3e shows the two alternative drainage methods for the javelin, discus, hammer and shot put landing areas at a training facility. Along the left-hand side is a gutter with a slit-type grid whilst along the right-hand side the water is collected in an open gutter and discharged via outlets.

*Shot put circle*

The floor plan and cross section in 3.5.4.3f show the drainage of a shot put circle which also applies to discus and hammer circles. The 3 outlets in the concrete slab are
connected to the drainage system by means of drain pipes (diameter 65mm).

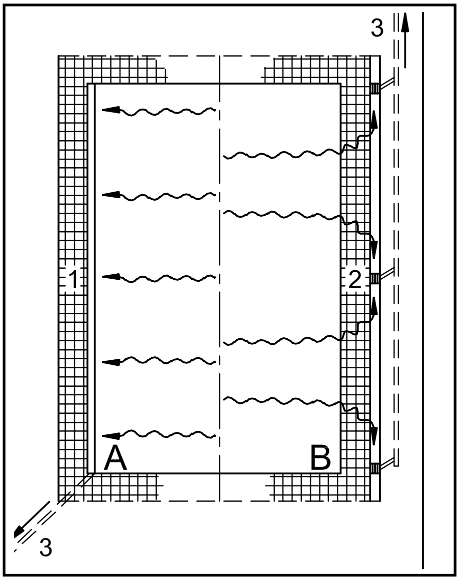



**Figure 3.5.4.3e**
**Alternative drainage methods for landing areas for javelin, discus, hammer, shot put**
A Drainage system with gutter covered with grid
B Drainage system with open gutter and gulleys
1 Paved passage with grid gutter, 2 paved passage with open gutter, 3 seepage line (canal)

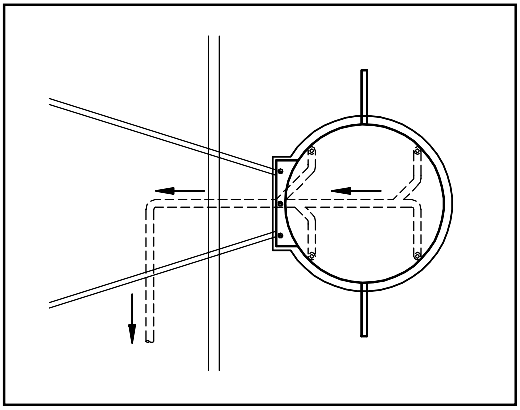


**Figure 3.5.4.3f - Drainage of shot put circle (also applies to discus and hammer)**

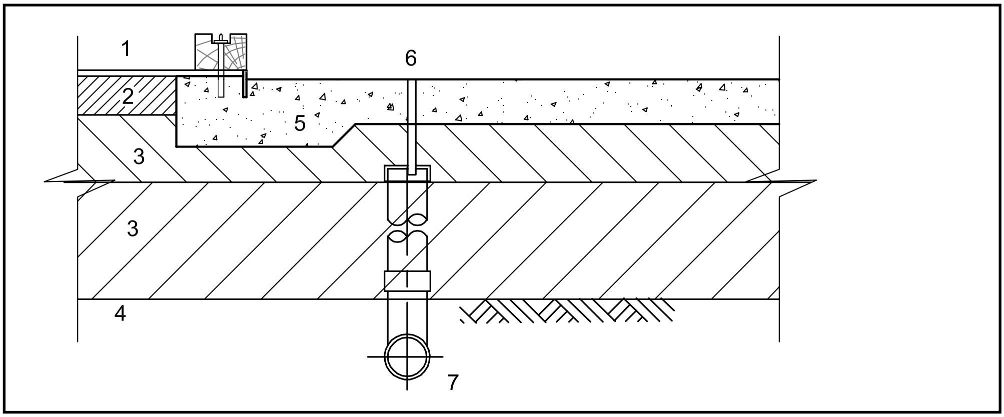



**Figure 3.5.4.3g - Drainage of shot put circle (also applies to discus and hammer)** Section
1 Unbound mineral surface, 2 frost protection layer, 3 concrete layer, 4 drainage hole, 5 drain pipe

### *3.5.5 DESIGN EXAMPLES*

#### 3.5.5.1 Standard track with 8 lanes (synthetic surface), in-field (turf), with spectator facilities

This example shows the calculation of the pipe diameter of the draining installations for a stadium facility with an 8-lane track which is enclosed by a surrounding path and a grandstand. Figure 3.5.5.1 shows the individual areas being drained (1 to 88), the open ring mains (collection lines) closed mains, the drainage gutters between the field and track with their feed boxes, inspections shafts and directions of discharge (slope directions).

Table 3.5.5.1 shows the respective calculations.

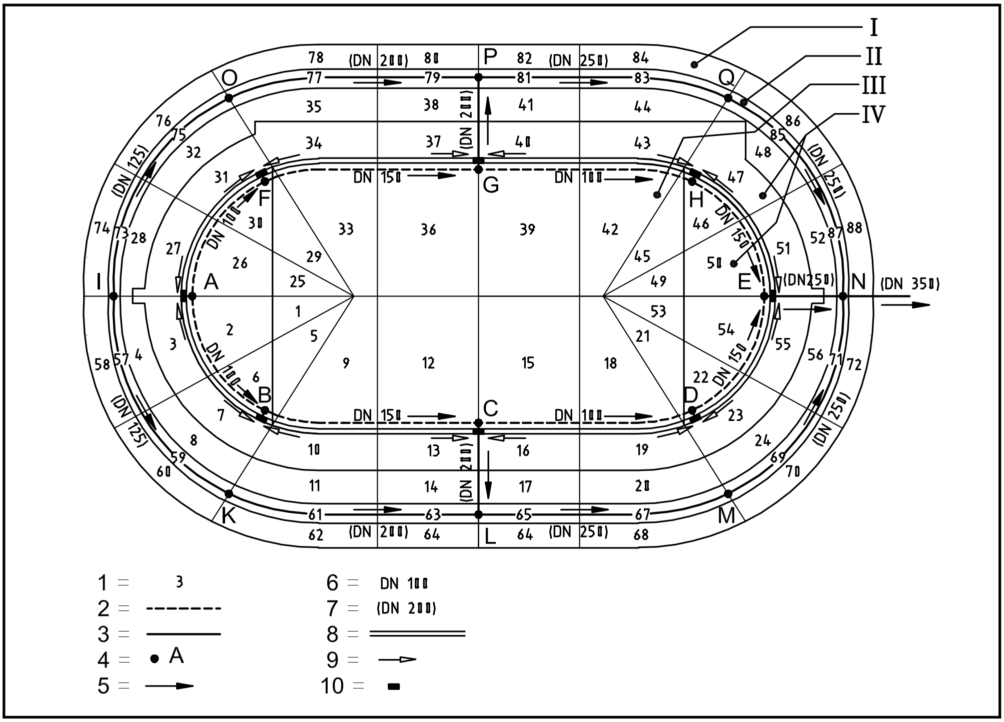



**Figure 3.5.5.1 - Example for drainage calculation of the in-field of a competition facility (see also table 3.5.5.1)**

I Grandstand, II surrounding path, III grassed area, IV synthetic-surfaced area

1 Individual areas being drained, 2 ring main (collection line), 3 closed main, 4 inspection shaft, 5 direction of ring main discharge, closed main, 6 pipe diameter for seepage lines, 7 pipe diameter for closed pipelines, 8 drainage gutter, 9 direction of gutter discharge, 10 feed box

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| ***Denotation of surface part*** | ***Surface area*** | ***Discharge coefficient*** | ***Discharge volume (l/s)*** | | | ***Bed slope*** | ***Denotation of ring part mains*** | ***Pipe diameter*** |
| | ***m²*** | | ***Surface part*** | ***Gutter segment*** | ***Reduced volume**** | ***%*** | | ***mm*** |
| ***1*** | 120 | 0.25 | 0.4 | | | | | |
| ***2*** | 405 | 0.90 | 4.4 | | | | | |
| ***3*** | 245 | 0.90 | 2.6 | | | | | |
| ***4*** | 240 | 0.25 | 0.7 | | | | | |
| | | | 8.1 | 8.1 | 4.1 | 0.5 | A - B | 100 |
| ***5*** | 300 | 0.25 | 0.9 | | | | | |
| ***6*** | 200 | 0.90 | 2.2 | | | | | |
| ***7*** | 245 | 0.90 | 2.6 | | | | | |
| ***8*** | 240 | 0.25 | 0.7 | | | | | |
| ***9*** | 565 | 0.25 | 1.7 | | | | | |
| ***10*** | 305 | 0.90 | 3.3 | | | | | |
| ***11*** | 260 | 0.50 | 1.6 | | | | | |
| | | | 13.0 | 21.1 | 10.6 | 0.5 | B - C | 150 |
| ***12*** | 980 | 0.25 | 2.9 | | | | | |
| ***13*** | 272 | 0.90 | 3.0 | | | | | |
| ***14*** | 240 | 0.50 | 1.4 | | | | | |
| ***15*** | 980 | 0.25 | 2.9 | | | | | |
| ***16*** | 275 | 0.90 | 3.0 | | | | | |
| ***17*** | 240 | 0.50 | 1.4 | | | | | |
| | | | 14.6 | 35.7 | 17.9 | 0.5 | C - L | 200 |
| ***18*** | 565 | 0.25 | 1.7 | | | | | |
| ***19*** | 305 | 0.90 | 3.3 | | | | | |
| ***20*** | 260 | 0.50 | 1.6 | | | | | |
| ***21*** | 300 | 0.25 | 0.9 | | | | | |
| ***22*** | 200 | 0.90 | 2.2 | | | | | |
| ***23*** | 245 | 0.90 | 3.0 | | | | | |
| ***24*** | 240 | 0.25 | 0.7 | | | | | |
| | | | 13.4 | 13.4 | 6.7 | 0.5 | C - E | 150 |
| ***25*** | 120 | 0.25 | 0.4 | | | | | |
| ***26*** | 405 | 0.90 | 4.4 | | | | | |
| ***27*** | 245 | 0.90 | 2.6 | | | | | |
| ***28*** | 240 | 0.25 | 0.7 | | | | | |
| | | | 8.1 | 8.1 | 4.1 | 0.5 | A - F | 100 |
| ***29*** | 300 | 0.25 | 0.9 | | | | | |
| ***30*** | 200 | 0.90 | 2.2 | | | | | |
| ***31*** | 260 | 0.90 | 2.8 | | | | | |
| ***32*** | 240 | 0.25 | 0.7 | | | | | |
| ***33*** | 565 | 0.25 | 1.7 | | | | | |
| ***34*** | 300 | 0.90 | 3.2 | | | | | |
| ***35*** | 260 | 0.25 | 0.8 | | | | | |
| | | | 12.3 | 20.4 | 10.2 | 0.5 | F - G | 150 |
| ***36*** | 980 | 0.25 | 2.9 | | | | | |
| ***37*** | 275 | 0.90 | 3.0 | | | | | |
| ***38*** | 240 | 0.50 | 1.4 | | | | | |
| ***39*** | 980 | 0.25 | 2.9 | | | | | |
| ***40*** | 275 | 0.90 | 3.0 | | | | | |
| ***41*** | 240 | 0.50 | 1.4 | | | | | |
| | | | 14.6 | 35.0 | 17.5 | 0.5 | G - P | 200 |

** When calculating the diameter of drainage pipes the cumulative discharge volume of the gutter segment will be reduced by 50%.*

**Table 3.5.5.1 - Calculation example in respect of Fig 3.5.5.1**

| ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** |
|---|---|---|---|---|---|---|---|---|
| ***Denotation of surface part*** | ***Surface area*** | ***Discharge coefficient*** | ***Discharge volume (l/s)*** | | | ***Bed slope part mains*** | ***Denotation of ring*** | ***Pipe diameter*** |
| | | | ***Surface part*** | ***Gutter segment*** | ***Reduced volume**** | | | |
| | ***$m^2$*** | | | | | ***%*** | | ***mm*** |
| ***42*** | 565 | 0.25 | 1.7 | | | | | |
| ***43*** | 300 | 0.90 | 3.2 | | | | | |
| ***44*** | 260 | 0.50 | 1.6 | | | | | |
| ***45*** | 300 | 0.25 | 0.9 | | | | | |
| ***46*** | 200 | 0.90 | 2.2 | | | | | |
| ***47*** | 260 | 0.90 | 2.8 | | | | | |
| ***48*** | 240 | 0.25 | 0.7 | | | | | |
| | | | 13.1 | 13.1 | 6.6 | 0.5 | H - E | 150 |
| ***49*** | 120 | 0.25 | 0.4 | | | | | |
| ***50*** | 405 | 0.90 | 4.4 | | | | | |
| ***51*** | 245 | 0.90 | 2.6 | | | | | |
| ***52*** | 240 | 0.25 | 0.7 | | | | | |
| ***53*** | 120 | 0.25 | 0.4 | | | | | |
| ***54*** | 405 | 0.90 | 4.4 | | | | | |
| ***55*** | 245 | 0.90 | 2.6 | | | | | |
| ***56*** | 240 | 0.25 | 0.7 | | | | | |
| | | | 16.2 | 26.4 | 13.2 | | | |
| ***18/27*** | | | | | 6.7 | | | |
| ***42/48*** | | | | | 6.6 | | | |
| | | | | | 26.5 | 0.5 | E - N | 250 |
| ***57*** | 80 | 0.60 | 0.6 | | | | | |
| ***58*** | 205 | 0.90 | 2.2 | | | | | |
| ***59*** | 80 | 0.60 | 0.6 | | | | | |
| ***60*** | 205 | 0.90 | 2.2 | | | | | |
| | | | 5,6 | | 5.6 | 0.5 | I - K | 125 |
| ***61*** | 100 | 0.60 | 0.7 | | | | | |
| ***62*** | 250 | 0.90 | 2.7 | | | | | |
| ***63*** | 70 | 0.60 | 0.5 | | | | | |
| ***64*** | 170 | 0.90 | 1.8 | | | | | |
| | | | 5.7 | | 11.3 | 0.5 | K - L | 200 |
| ***01/17*** | | | 17.9 | | | | | |
| ***65*** | 70 | 0.60 | 0.5 | | | | | |
| ***66*** | 170 | 0.90 | 1.8 | | | | | |
| ***67*** | 100 | 0.60 | 0.7 | | | | | |
| ***68*** | 250 | 0.90 | 2.7 | | | | | |
| | | | 23.6 | | 34.9 | 0.5 | L - M | 250 |
| ***69*** | 80 | 0.60 | 0.6 | | | | | |
| ***70*** | 205 | 0.90 | 2.2 | | | | | |
| ***71*** | 80 | 0.60 | 0.6 | | | | | |
| ***72*** | 205 | 0.90 | 2.2 | | | | | |
| | | | 5.6 | | 40.5 | 0.5 | M - N | 250 |
| ***73*** | 80 | 0.60 | 0.6 | | | | | |
| ***74*** | 210 | 0.90 | 2.3 | | | | | |
| ***75*** | 80 | 0.60 | 0.6 | | | | | |
| ***76*** | 210 | 0.90 | 2.3 | | | | | |
| | | | 5.8 | | 5.8 | 0.5 | I - O | 125 |
| ***77*** | 195 | 0.60 | 1.4 | | | | | |
| ***78*** | 250 | 0.90 | 2.7 | | | | | |
| ***79*** | 145 | 0.60 | 1.0 | | | | | |
| ***80*** | 170 | 0.60 | 1.8 | | | | | |
| | | | 6.9 | | 12.7 | 0.5 | O - P | 200 |

**Table 3.5.5.1 - Continuation 1**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| ***Denotation of surface part*** | ***Surface area*** | ***Discharge coefficient*** | ***Discharge volume (l/s)*** | | | ***Bed slope*** | ***Denotation of ring part mains*** | ***Pipe diameter*** |
| | | | ***Surface part*** | ***Gutter segment*** | ***Reduced volume**** | | | |
| | ***m²*** | | | | | ***%*** | | ***mm*** |
| ***25/41*** | | | 17.5 | | | | | |
| ***81*** | 145 | 0.60 | 1.0 | | | | | |
| ***82*** | 170 | 0.90 | 1.8 | | | | | |
| ***83*** | 195 | 0.60 | 1.4 | | | | | |
| ***84*** | 250 | 0.90 | 2.7 | | | | | |
| | | | 24.4 | | 37.1 | 0.5 | P - Q | 250 |
| ***85*** | 90 | 0.60 | 0.6 | | | | | |
| ***86*** | 210 | 0.90 | 2.3 | | | | | |
| ***87*** | 90 | 0.60 | 0.6 | | | | | |
| ***88*** | 210 | 0.90 | 2.3 | | | | | |
| | | | 5.8 | | 42.9 | 0.5 | Q - N | 250 |
| ***M/N*** | | | | | 40.5 | | | |
| ***Q/N*** | | | | | 42.9 | | | |
| ***E/N*** | | | | | 26.5 | | | |
| | | | | | 109.9 | 0.5 | Recipient | 350 |

**Table 3.5.5.1- Continuation 2**

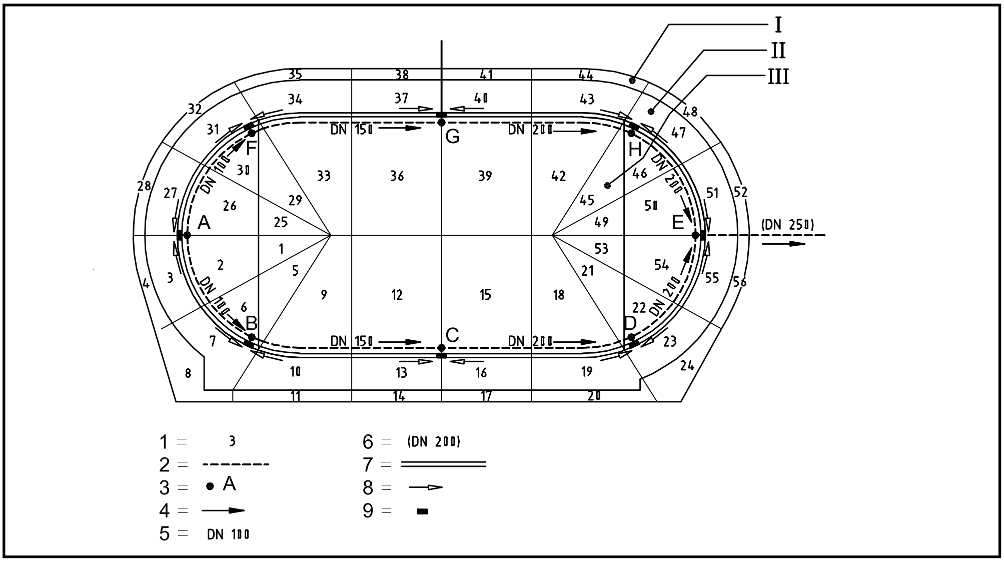



**Figure 3.5.5.2 - Example for drainage calculation of the in-field of a training and warm-up facility (see also table 3.5.5.2)**

I Surrounding path, II synthetic-surfaced area, III grassed area

1 Individual areas being drained, 2 ring main (collection line), 3 inspection shaft, 4 direction of ring main discharge, 5 pipe diameter for seepage lines, 6 pipe diameter for closed pipe-lines, 7 surround gutter, 8 direction of gutter discharge, 9 feed box

### 3.5.5.2 Standard track with 6 lanes (synthetic surface), in-field (turf), with 2.50m wide surrounding path

This example shows the calculation of the pipe diameter of the drainage installations for a training and warm-up facility with a 6-lane track which is enclosed by a surrounding path. Figure 3.5.5.2 shows the individual areas being drained (1 to 54), the open ring mains (collection lines), closed mains, the drainage gutters between the field and track with their feed boxes, inspections shafts and directions of discharge (slope directions).

Table 3.5.5.2 shows the respective calculations.

| ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** |
|---|---|---|---|---|---|---|---|---|
| ***Denotation of surface part*** | ***Surface area*** | ***Discharge coefficient*** | ***Discharge volume (l/s)*** | | | ***Bed slope*** | ***Denotation of ring part mains*** | ***Pipe diameter*** |
| | | | ***Surface part*** | ***Gutter segment*** | ***Reduced volume**** | | | |
| | ***m²*** | | | | | ***%*** | | ***mm*** |
| ***1*** | 120 | 0.25 | 0.4 | | | | | |
| ***2*** | 405 | 0.50 | 2.4 | | | | | |
| ***3*** | 135 | 0.50 | 0.8 | | | | | |
| ***4*** | 50 | 0.60 | 0.4 | | | | | |
| | | | 4.0 | 4.0 | 2.0 | 0.3 | A - B | 100 |
| ***5*** | 300 | 0.25 | 0.9 | | | | | |
| ***6*** | 200 | 0.50 | 1.2 | | | | | |
| ***7*** | 280 | 0.50 | 1.7 | | | | | |
| ***8*** | 180 | 0.60 | 1.3 | | | | | |
| ***9*** | 565 | 0.25 | 1.7 | | | | | |
| ***10*** | 280 | 0.50 | 1.7 | | | | | |
| ***11*** | 90 | 0.60 | 0.6 | | | | | |
| | | | 9.1 | 13.1 | 6.6 | 0.3 | B - C | 150 |
| ***12*** | 980 | 0.25 | 2.9 | | | | | |
| ***13*** | 260 | 0.50 | 1.6 | | | | | |
| ***14*** | 70 | 0.60 | 0.5 | | | | | |
| ***15*** | 980 | 0.25 | 2.9 | | | | | |
| ***16*** | 260 | 0.50 | 1.6 | | | | | |
| ***17*** | 70 | 0.60 | 0.5 | | | | | |
| | | | 10.0 | 23.1 | 11.6 | 0.3 | C - D | 200 |
| ***18*** | 565 | 0.25 | 1.7 | | | | | |
| ***19*** | 260 | 0.50 | 1.6 | | | | | |
| ***20*** | 90 | 0.60 | 0.6 | | | | | |
| ***21*** | 300 | 0.25 | 0.9 | | | | | |
| ***22*** | 200 | 0.50 | 1.2 | | | | | |
| ***23*** | 280 | 0.50 | 1.7 | | | | | |
| ***24*** | 180 | 0.60 | 1.3 | | | | | |
| | | | 9.0 | 32.1 | 16.1 | 0.3 | D - E | 200 |
| ***25*** | 120 | 0.25 | 0.4 | | | | | |
| ***26*** | 405 | 0.50 | 2.4 | | | | | |
| ***27*** | 135 | 0.50 | 0.8 | | | | | |
| ***28*** | 50 | 0.60 | 0.4 | | | | | |
| | | | 4.0 | 4.0 | 2.0 | 0.3 | A - F | 100 |
| ***29*** | 300 | 0.25 | 0.9 | | | | | |
| ***30*** | 200 | 0.50 | 1.2 | | | | | |
| ***31*** | 245 | 0.60 | 1.5 | | | | | |
| ***32*** | 60 | 0.60 | 0.4 | | | | | |
| ***33*** | 565 | 0.25 | 1.7 | | | | | |
| ***34*** | 235 | 0.50 | 1.4 | | | | | |
| ***35*** | 80 | 0.60 | 0.6 | | | | | |
| | | | 7.7 | 11.7 | 5.9 | 0.3 | F - G | 150 |
| ***36*** | 980 | 0.25 | 2.9 | | | | | |
| ***37*** | 200 | 0.50 | 1.2 | | | | | |
| ***38*** | 70 | 0.60 | 0.5 | | | | | |
| ***39*** | 980 | 0.25 | 2.9 | | | | | |
| ***40*** | 200 | 0.50 | 1.2 | | | | | |
| ***41*** | 70 | 0.60 | 0.5 | | | | | |
| | | | 9.2 | 20.9 | 10.5 | 0.3 | G - H | 200 |

* *When calculating the diameter of drainage pipes the cumulative discharge volume of the gutter segment will be reduced by 50%.*

**Table 3.5.5.2 - Calculation example in respect of Fig. 3.5.5.2**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| ***Denotation of surface part*** | ***Surface area*** | ***Discharge coefficient*** | ***Discharge volume (l/s)*** | | | ***Bed slope*** | ***Denotation of ring part mains*** | ***Pipe diameter*** |
| | | | ***Surface part*** | ***Gutter segment*** | ***Reduced volume**** | | | |
| | ***m²*** | | | | | ***%*** | | ***mm*** |
| ***42*** | 565 | 0.25 | 1.7 | | | | | |
| ***43*** | 235 | 0.50 | 1.4 | | | | | |
| ***44*** | 80 | 0.60 | 0.6 | | | | | |
| ***45*** | 300 | 0.25 | 0.9 | | | | | |
| ***46*** | 200 | 0.50 | 1.2 | | | | | |
| ***47*** | 245 | 0.50 | 1.5 | | | | | |
| ***48*** | 65 | 0.60 | 0.5 | | | | | |
| | | | 7.8 | 28.7 | 14.4 | 0.3 | H - E | 200 |
| ***49*** | 120 | 0.25 | 0.4 | | | | | |
| ***50*** | 405 | 0.50 | 2.4 | | | | | |
| ***51*** | 135 | 0.50 | 0.8 | | | | | |
| ***52*** | 50 | 0.60 | 0.4 | | | | | |
| ***53*** | 120 | 0.25 | 0.4 | | | | | |
| ***54*** | 405 | 0.50 | 2.4 | | | | | |
| ***55*** | 135 | 0.50 | 0.8 | | | | | |
| ***56*** | 50 | 0.60 | 0.4 | | | | | |
| | | | 8.0 | 8.0 | 4.0 | | | |
| | | | | | 16.1 | | | |
| ***01/24*** | | | | | 14.4 | | | |
| ***25/48*** | | | | | | | | |
| | | | | | 34.5 | 0.5 | Recipient | 250 |

**Table 3.5.5.2 - Calculation example in respect of Fig. 3.5.5.2**

# 3.6 Ground Drainage

## *3.6.1 GENERAL REMARKS*

The ground drainage of running tracks and other athletics facilities includes drainage of the surface located above it. When draining the top surface, the water which has infiltrated by seepage (seepage water) is collected and, on impermeable ground, is fed through drainage channels to the recipient (See 3.6.2.6). In the case of porous ground, the seepage water is carried off into lower layers of the ground. The ground must be drained so that the load-carrying ability can be maintained. Penetrating stratum water is also carried away to the recipient through the ground drainage system.

For ecological reasons, the possibility of seeping the surplus water which accumulates from the sports areas on site instead of into the sewage system should always be checked. This will only be possible if the ground has a seepage capability. If the gathering grounds are sufficiently large, the installation of a cistern is recommended.

The drainage system usually consists of a surface drain comprising a porous, unbound base layer of gravel and crushed stones and drainage channels which carry the surplus water to the recipient.

## *3.6.2 DEFINITIONS*

### 3.6.2.1 Surface Drains

A surface drain is the unbound base layer of the surface which absorbs seepage loss water through its cavities and carries it on to the nearest drainage channel.

### 3.6.2.2 Drainage Channels

A drainage channel consists of a ditch, drain pipes and drain filling. It absorbs the surplus water from the surface and the substrate or substructure and carries it off to the recipient.

### 3.6.2.3 Drain Filling

Drain filling is the filling used for the ditch. It is made up of mineral mixtures which are highly permeable to water.

### 3.6.2.4 Catch Water Drain

A catch water drain absorbs the seepage water from the top surface and the water outlets and feeds it to the recipient. Catch water drains have water permeable sides. They may be used as flexible pipes with or without filter casing or as rods with closed flumes (part-perforated pipes). Catch water drains without filter casings are normally used for athletics facilities if the drain fillings have stable filters.

### 3.6.2.5 Closed Pipes

Closed pipes take in the water from the catch water drains and carry it to the recipient. The sides are impermeable to water.

### 3.6.2.6 Recipient

The recipient is an existing body of water, the drainage network or a draining well.

### 3.6.2.7 Inspection Shaft, Deposit Shaft, Draining Well

An inspection shaft is a shaft construction with a closed bottom.
This is located at the same height as the supply and discharge pipeline.

A deposit shaft is installed at the transition between catch water drain and closed pipelines. It has a closed bottom which lies at least 0.50m below the bottom of the discharge pipe. On ground with a seepage capability, a seepage shaft permits quantities of water to trickle away from the catch water drain.
It has an open porous bottom and a porous pipe casing in the area of seepage.

## *3.6.3 REQUIREMENTS AND CONSTRUCTION*

### 3.6.3.1 Surface Drains

Surface drains consisting of unbound base layers must satisfy a minimum water absorption rate k* 0.01cm/s (See 3.2.3.1.1 c). Otherwise, the recommendations given in Chapter 3 (Track construction) relating to the quality of the building materials should be followed.

### 3.6.3.2 Drainage Channels

Drainage channels must be laid at right angles to the gradient of the soil plane.
If running tracks are more than 5m wide, they are located in the centre of the track.

The bed width of the ditch must be at least the diameter of the pipe and be spaced at a distance of 70mm from the ditch wall. The width is determined by the formula

$$b = d + 2 \times 70$$

where

b = bed width
d = diameter of the pipe

The distance between drainage channels depends on the local precipitation and the water permeability of the ground, but should be between 6.0m and 7.0m. However, if the ground-water level has to be lowered, it may be advisable to reduce the distance between them.

Catch water drains should be made of plastic. They must have a water intake area of more than $250m^2/m$. The minimum gradient is 0.3% and the maximum 0.5%.

Care must be taken to ensure that no fine particles are washed in with the intake of surface water. A regular cleansing of the pipes is essential.

The catch water drains must be covered up to the soil plane with drain filling materials of at least 0.20m.

The drain filling must be sufficiently permeable to prevent any water build up infiltrating from the layer above. The water absorption value must satisfy $k^* > 0.0001$ m/s. Mineral mixtures used for building materials must be frost-resistant and have a grain size of between 0.06mm and 32mm. 8/32 grain mixtures have the advantage over the latter in that they are resistant to subsidence and are not affected by frost.

#### 3.6.3.3 Closed Pipelines

The size of the closed pipelines must be calculated so that a flow rate of 0.5 m/s is guaranteed and a maximum flow rate of 3 m/s is not exceeded.

The pipes should be made of plastic, concrete or reinforced concrete.

#### 3.6.3.4 Inspection Shaft, Deposit Shaft, Draining Well

An inspection shaft must be placed along the course of drain collection lines and closed pipelines, spaced not more than 110m apart and at any point where there is a change in gradient or direction. The shaft bottom must be furnished with a flume. Inspection shafts must be man-sized and have a minimum diameter of 1000mm. They must be fitted with stirrups if the depth so requires.

A deposit shaft has a similar construction to an inspection shaft, but the bottom of the deposit shaft lies at least 0.50m below the base of the discharge pipe.

A draining well must have a diameter of between 1000mm and 2500mm depending on the amount of seepage water. It contains a filter packing capable of seeping the water.

Covers for inspection and deposit shafts and for draining wells must be designed flush with the adjacent areas. Where shafts are arranged within safety zones of adjoining playing fields, they must be covered by a soft surface if they are not located below the top surface (blind shafts).

### *3.6.4 CALCULATION AND DESIGN*

#### 3.6.4.1 Hydraulic Dimensions of the Ground Drainage System

If pipelines are to be used simultaneously for carrying off surface water, then the formulae given in Section 3.5.4.2 are to be used.

If only seepage water from the top surface or ground and stratum water has to be carried away, hydraulic calculations are not needed due to the comparatively small area of gathering ground of sports facilities. The following pipe diameters have proved adequate:

- Drainage channels within the sports areas (suction) 65mm
- Collection lines, ring mains for carrying off volumes of water from playing field drainage channels for a sports area of up to 3500m² 100mm
- Collection lines, ring mains for carrying off volumes of water from playing field drainage channels for a sports area of between 3501m² and 5000m² 125mm
- Collection lines, ring mains for carrying off volumes of water from playing field drainage channels for a sports area of between 5001m² to 7500m² 150mm
- Collection lines, ring mains for carrying off volumes of water from playing field drainage channels for a sports area of between 7501m² and 15000m² 200mm

# 3.7 Irrigation of Sports Surfaces

The water supply for sports surfaces has the task of ensuring the growth of grass if the sports surface is turfed and establishing sufficient cohesion and surface shear strength of the mineral aggregates in unbound mineral constructions.

Sports surfaces can be irrigated from above (sprinkling) or below (capillary irrigation), for example from the underlying layers. In the case of irrigation from above, the water is pressurized and applied to the surface by sprinklers. In the case of underground irrigation, the water is accumulated in a sealed reservoir from which it seeps by capillary action through the substructure to the layers requiring the water:

- the root zone of the grass surface
- the dynamic layer and surface of the unbound mineral surface

The latter system is not suitable for watering artificial grass surfaces. For sports surfaces, preference should be given to sprinkling, preferably with stationary systems using pop-up sprinklers.

Non-stationary irrigation systems are also used where the water is supplied to the sprinkler along temporarily laid feed lines in the form of hoses or connectable metal pipes laid above ground. The sprinklers are attached to tripods to the temporarily laid pipes or to a mobile undercarriage driven by a hydraulic motor, pulled across the surface by a rope.

The water can be taken from the mains supply, natural water sources (rivers, streams, ponds, lakes) or from the water table (See 3.7.5). In certain circumstances, water for industrial use can be used.

## *3.7.1 REQUIREMENTS OF SPRINKLER SYSTEMS*

### 3.7.1.1 Uniform Distribution

A sprinkler system should ensure a uniform water distribution of ± 50% of the water required for the growth of grass and the consistency of the sports surface. Uniform distribution is affected by wind and pressure conditions. Such effects can be lessened by positioning the sprinklers closer together.

### 3.7.1.2 Sprinkling Periods

Sprinkler systems must supply the necessary quantity of water in a period of 12 to 18 hours for grassed surfaces and 15 to 20 hours for unbound mineral surfaces.

## *3.7.2 SPRINKLING PROCEDURES*

### 3.7.2.1 Grass Surfaces

Grass surfaces have to be sprinkled during prolonged rain-free periods. The water sprinkled must be sufficient to saturate the construction, for example the grass-supporting layer must be fully moistened. Between 15l and 25l per $m^2$ are required for this.

Grass must be sprinkled, at the very latest, when it shows the first signs of wilting. If this occurs, the grass surface shows patches measuring 0.10m to 0.30m in diameter with a dark, grey-green grass colour and rolled grass blades.

The intervals between sprinkling intervals (water cycles) depend on the maximum day-time temperatures on which the guide values in table 3.7.2.1 are based.

| ***COLUMN*** | ***1*** | ***2*** |
|---|---|---|
| ***Line*** | | |
| ***1*** | ***Maximum day-time temperature (°C)*** | ***Sprinkling interval (days)*** |
| ***2*** | Over 30 | Approx. 5 |
| ***3*** | 25 to 30 | 6 to 8 |
| ***4*** | 20 to 25 | 8 to 12 |
| ***5*** | Under 20 | Over 12 |

**Table 3.7.2.1 - Relation between maximum day-time temperature and sprinkling intervals**

### 3.7.2.2 Unbound Mineral Surfaces

Unbound mineral surfaces are sprinkled with water at a rate of 10l to 15l per $m^2$. Such action is necessary to combat the first signs of dust generation and the deterioration of surface shear strength which manifests itself in a loosening of the sports surface.

## *3.7.3 SPRINKLER SYSTEMS*

### 3.7.3.1 Non-stationary Sprinkler Systems

Temporarily laid sprinkler systems with tripod-mounted sprinklers or pressure pipes with built-on sprinklers must be stable. Feed lines and connections must be watertight. The sprinkler equipment may only be moved when the ground is firm underfoot and no longer sodden.

By permitting a running speed independent of water pressure, mobile sprinklers must permit as high a water output as possible. Experience has shown that even with an ideal water pressure this is well below the quantity actually required, so the sprinkling of each area may have to be repeated.

Because of the high costs of labour, low uniformity of water distribution and the insufficient water output of mobile sprinklers, non-stationary sprinkler systems are not recommended.

The most common non-stationary sprinkling methods are shown in figures 3.7.3.1a to 3.7.3.1c.

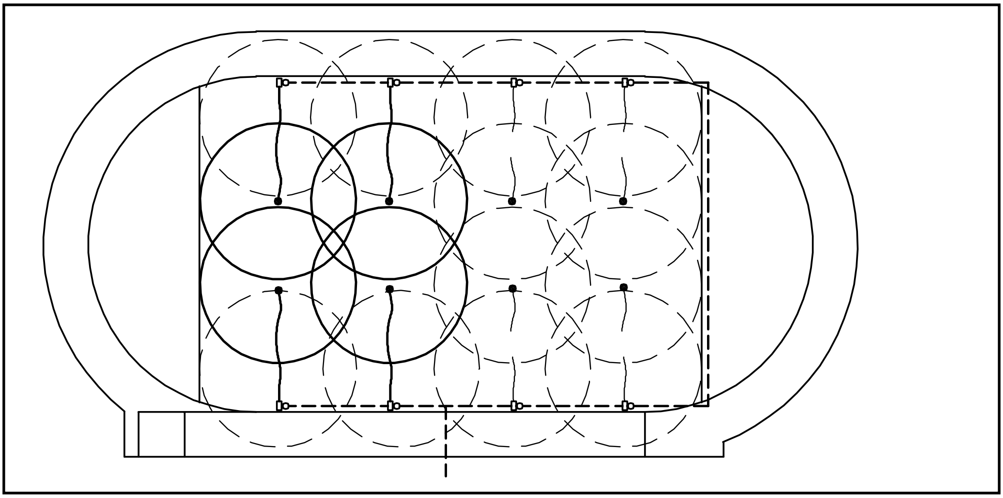


**Figure 3.7.3.1a - Sprinkling with hose-fed tripod-mounted sprinklers**

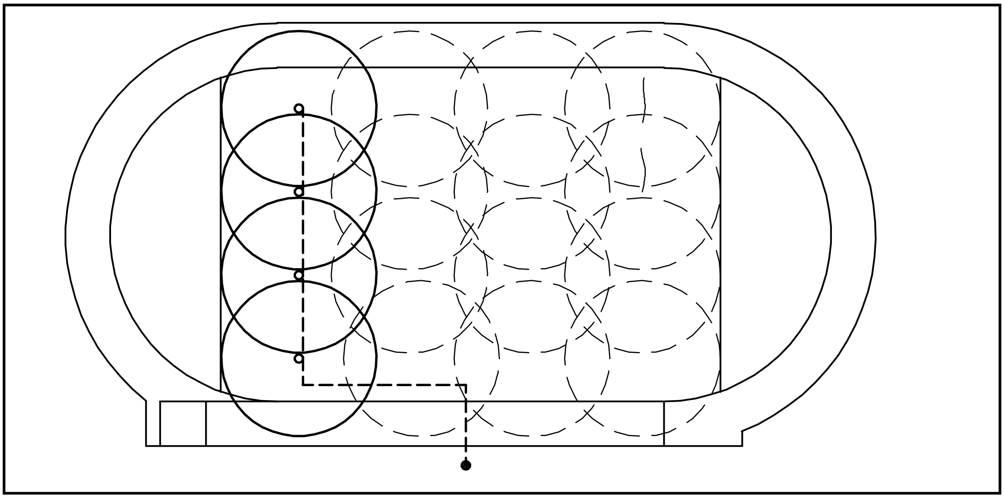


**Figure 3.7.3.1b - Sprinklers on temporarily laid pressure pipes**

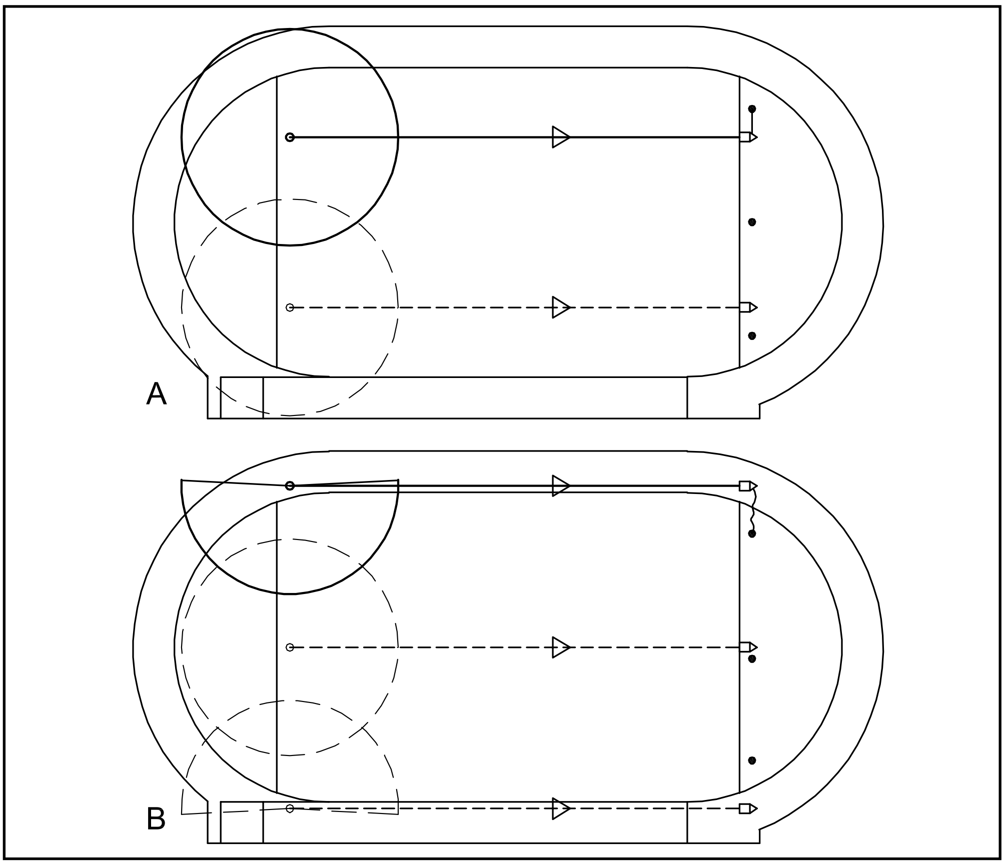



**Figure 3.7.3.1c - Sprinkling with trolley-mounted sprinklers**

A = used as full-circle sprinklers on the field

B = used as full-circle sprinklers in the centre of the field and as semicircle sprinklers at the sides, positioned on the track

#### 3.7.3.2 Stationary Sprinkler Systems

Stationary sprinkler systems consist of feed lines made of plastic or steel, laid in trenches, which supply the sprinklers with pressurized water. The diameter of the pipes must exceed 65mm.
The pipe trenches should be 0.30m wide and 0.30m to 0.50m deep.

To prevent frost damage, it should be possible to drain the feed lines, e.g. by laying the pipes on a gradient or by using compressed air.

Sprinklers for irrigating sports surfaces are available in the form of swing-arm sprinklers which turn mechanically, driven by the force of the water jet, and geared sprinklers on which the jet is turned by a turbine gear.

The sprinkler covers are flush with the sports surface when closed. The covers pop-up under the pressure of the water when the sprinklers are switched on.
The water is distributed by 360° sprinklers situated within the playing area, 180° sprinklers at the edge of the playing area or on the inside of running tracks, and 90° sprinklers in the corners of the playing area.

A sprinkler system is subdivided with hydraulic or electric control lines into sprinkling areas so as to make efficient use of the available quantity of water and water pressure. The valves on the sprinkler, which regulate the discharge of water, are opened and closed by hydraulic or electrical pulses. Occasionally, the valves are installed outside the playing area in the feed lines, in which case each sprinkler must have its own feed line.

The sprinkler operating period is usually controlled via the control line with timers.

Depending on the type of sports surface and the required uniformity of distribution, the following arrangements are recommended:

- Large playing field with artificial grass surface and a track with a synthetic surface (Fig 3.7.3.4a)

- Large playing field with a grass surface and a track with a synthetic surface, sprinkling with a distribution of high uniformity (Fig 3.7.3.4b)

- Large playing field with a grass surface and with an unbound mineral track, separate sprinkling of playing field and track (Fig 3.7.3.4c)

### *3.7.4 WATER SUPPLY RATE AND WATER PRESSURE*

The necessary water supply rate for a sprinkler system must be at least 20m3 per h. Non-stationary sprinkler systems require lower water supply rates, although the quantity delivered is usually insufficient. If the required rate of water cannot be supplied, a sufficiently large water reservoir should be provided.

The sprinkling range depends on the flow pressure at the sprinkler. On stationary systems this must be at least 5.5 bar at the sprinkler. Depending on the pipe lengths, at least 6.5 or 7 bar is necessary at the point where the the feed lines are

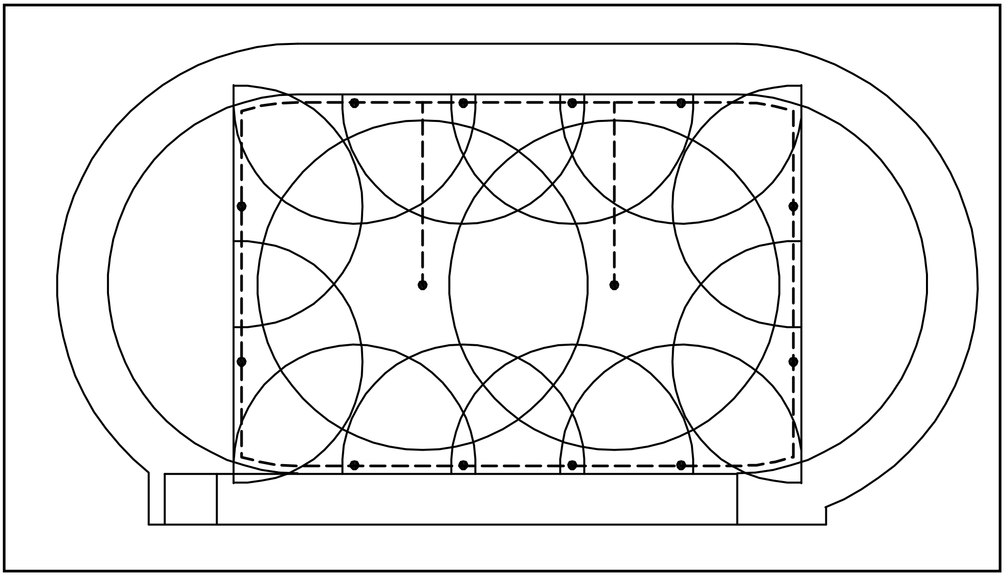


**Figure 3.7.3.4a - Stationary sprinkler system for playing fields with artificial grass surface and a track with synthetic surface**

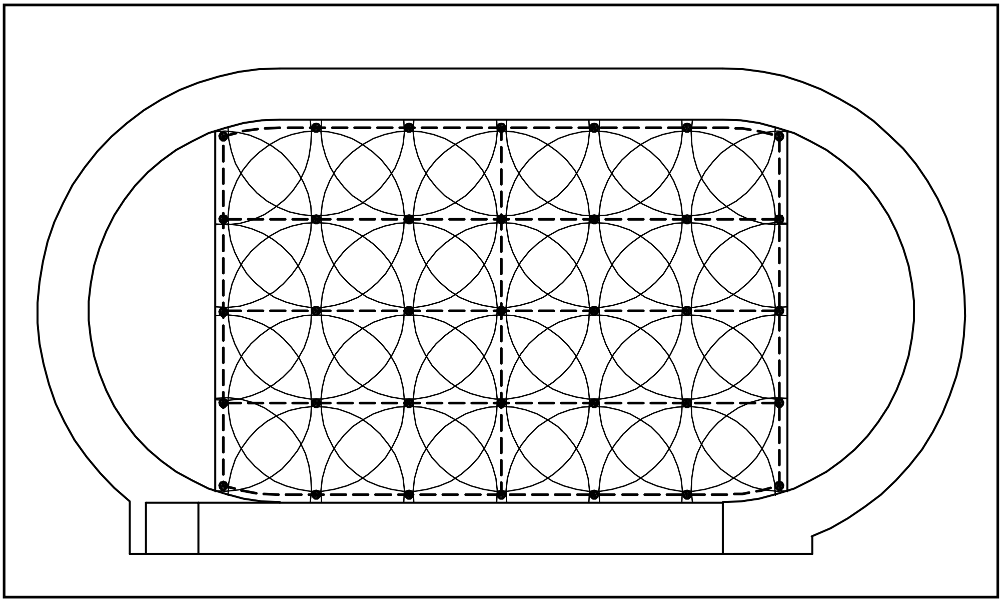


**Figure 3.7.3.4b**
**Stationary sprinkler system for playing field with a grass surface and a track with a synthetic surface, sprinkling with a distribution of high uniformity**

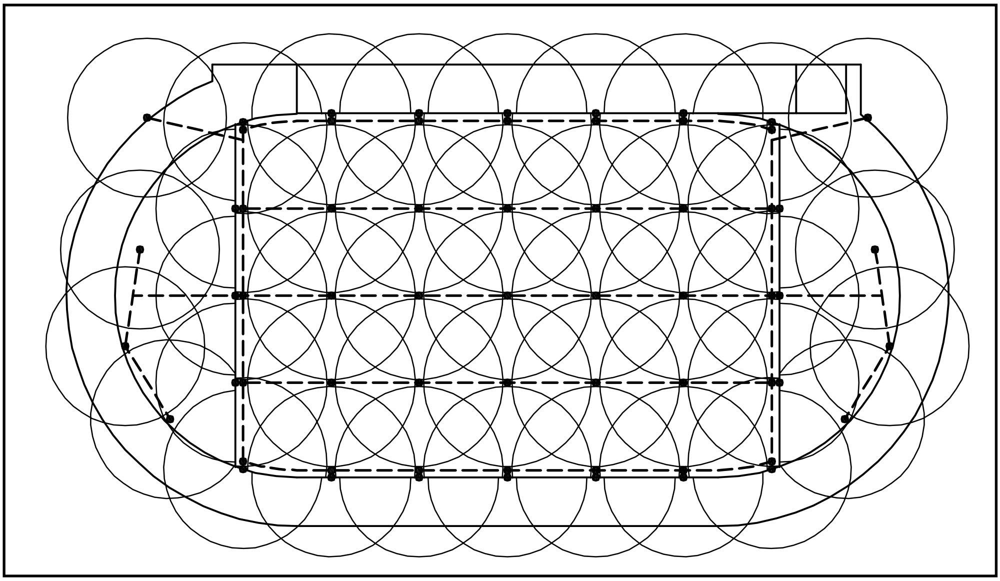


**Figure 3.7.3.4c**
**Stationary sprinkler system for playing field with a grass surface and with an unbound mineral track**

connected to the mains supply. If this water pressure is not available, a pressure booster is necessary.

### *3.7.5 WATER SUPPLY*

The tapping of water, from whatever source, requires approval from the relevant authorities.

#### 3.7.5.1 Mains Supply

Water is usually supplied from the mains water supply. A non-return valve should be fitted to prevent contamination of the drinking water by a backflow of water from the sprinkler feed lines or through storage tanks.

The locally-available water pressure and supply sources, which should be ascertained before planning the system, determine whether pressure boosters or storage tanks need to be installed.

The variation in water prices affects the maintenance costs of sports surfaces.

#### 3.7.5.2 Open Water Bodies

Water is tapped from streams, rivers and lakes by means of an underwater pump with a suction tube. The pumps, pipe network and sprinklers must be protected from contamination. Before using any of these sources, the water should be checked for its suitability in terms of plant-compatibility, degree of contamination and the seasonal fluctuations in water availability.

These sources of water are usually cheaper.

#### 3.7.5.3 Wells

If there is sufficient groundwater, water can be obtained from drilled wells with submersible pumps suspended in filter pipes. Cost-effectiveness depends on the drilling depth and water delivery rate. Test bores are, therefore, recommended.

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# CHAPTER 4
# ANCILLARY ROOMS

## 4.1 Rooms for Sport

### *4.1.1 AREA AND ROOM SCHEDULE*

#### 4.1.1.1 Rooms for Athletes and Coaches

The equipment of sportgrounds and stadia with ancillary rooms, such as showers, wash-rooms and toilets, must be based on the needs of the user and therefore may have to satisfy very different requirements. On the one hand there are the minimum requirements for school, leisure and mass participation sport which have to be realized with limited funds, and, on the other hand, there are the demands of top-level sport for rooms, area requirements per athlete and equipment which may require a high degree of comfort.

The following area and room schedule is primarily concerned with the minimum of space, but also gives an indication for higher standards.

Consideration should be given to the possibility of using rooms at competitions which are normally used for other purposes.

Space requirements of wheelchair athletes have to be taken into account in accordance with national regulations. Amount of space should be provided in accordance with appropriate demand.

The size of the foyer and reception area for this category of users depends on the number of persons using the rooms in this area. The foyer size is usually calculated on the basis of $15m^2$ per 30 users. This is supplemented by a reception room with counter, $10m^2$ to $15m^2$ in size, a women's toilet (1 lavatory, 1 washbasin) and a men's toilet (1 lavatory, 1 urinal, 1 washbasin).

##### *4.1.1.1.1 Changing Room*

The type of use of a sports area (number of users, mode of operation, sequence of use) determines the necessary number, size and equipment of the changing and sanitary areas and rooms. This use can only be efficient if the structure of the changing area permits a continuous sequence of sports times[1)]. This inevitably means that sports time is dependent on changing time[2)] and clothes position time[3)] and, to be cost-effective, needs the following system of utilization.

*1) Time available to the user on the sports area for his sports activity (usually governed by a timetable).*
*2) Time available to the user in the changing and sanitary area for changing and showering/dressing after his sports activity (usually three periods of 15 minutes each).*
*3) Time in which the clothes of the user occupy a clothes position (preferably in a closed clothes locker).*

For an athletics facility with a large field enclosed by the track, this type of utilization demands at least 2 changing rooms, each of which is equipped with 2 clothes lockers per changing position. If the sports time is equal to or longer than the changing time, (usually 45 minutes) the sports areas can be used continuously. This ensures the full utilization of the sports areas.

*Elements of the changing room*

• Changing position as a portion of a changing bench: 0.66m wide (reducible to 0.40m for school sports use) and 0.50m deep with a 0.75m deep changing zone in front of the bench.

Clothes position in the form of a clothes locker: 0.33m wide, 0.50m deep and 1.80m tall (in cold and temperate regions, preferably single-door; in general two-door, 0.90m each).

Clothes positions are also possible in the form of clothes pegs (0.66m wide with double pegs). Since the changing room cannot then be put to variable use and because of the lack of protection from theft, this provision frequently adopted for school sports is not recommended.

• Traffic area between changing zone and changing zone or changing zone and clothes locker or wall: at least 0.75m. (In the access area of the changing room, a screen is necessary.)

• *Number of changing positions*

This depends on the number of simultaneous users of the athletics facility. At multifunctional sports facilities (athletics facilities combined with pitches), the largest user group in each case is decisive, and in team sports both teams must always be provided for. (See 4.1.3.3 with 4 planning examples, offering 12, 18, 24 or 36 changing positions per changing room.)

• *Massage area*

At sports facilities for high-performance and top-level sports, 1 massage area (2.40m x 1.80m) is recommended in each changing room or in an adjoining room.

#### *4.1.1.1.2 Showers/Toilets*

As part of changing time (4.1.1.1.1), the sanitary area is always used after sports time. If this area can be assigned alternately to each changing room, one sanitary area is sufficient for 2 changing rooms.

*Elements of the sanitary area:*

• *Shower position*

Open rows of showers: 0.80m wide and 0.80m deep
Open rows of showers with splash screens: 0.95m wide and 0.80m deep
Open rows of showers with privacy partitions: 0.95m wide and 1.40m deep

- *Washing position*

0.60m wide and 0.80m deep

- *Toilets*

WC: 0.90m wide and 1.20m deep (doors opening outwards) or 1.40m deep (doors opening inwards)
Slab urinal: 0.50m x 0.60m
Bowl urinal: 0.75m x 0.80m
Washbasin: 0.60m x 0.80m

- *Traffic area*

between shower positions or between washing positions: at least 1.10m
all other traffic areas at least 1.00m wide

- *Number of shower positions, washbasins and toilets*

At least 1 shower position per 2.5 changing positions
At least 1 WC per 20 shower positions
At least 1 washbasin per 2 shower positions

The 4 planning examples mentioned in Section 4.1.1.1.1 and published in Section 4.1.3.3 are based on these figures.

If a therapy pool is supplied, a space requirement of 2.00m x 0.60m per user should be provided. The beds (with head supports) should be 0.60m beneath the surface of the water. Resting areas with deck chairs should be 2.50m x 1.00m per user; passage areas at least 1.20m wide.

#### *4.1.1.1.3 Unit for Coaches*

1 room, approximately 15 m$^2$ large, including shower, toilet, washbasin and 1 to 3 lockers for 1 to 3 coaches.

#### *4.1.1.1.4 Call Room/Lecture Room*

Sports facilities used for athletics competitions must be furnished with control areas in which athletes assemble to await their call. The area requirement is determined and specified on site based on the number of sports participants. Generally one can expect athletes for up to 3 different events (for example long jump, shot put, 110m hurdles) at the same time. The space required should be calculated on the basis of 1.2m$^2$ per athlete. If this room is used for lectures it should be between 30m$^2$ and 50m$^2$.

#### *4.1.1.1.5 Room for Victory Ceremony Preparation*

Seating, exercise space and make-up room for up to 12 athletes, 8 protocol persons and 2 officials. Changing area for protocol persons is advisable. Room size between 30m$^2$ and 45m$^2$.

#### *4.1.1.1.6 Weight Training Room*

Modern athletic training systems recommend the use of weight lifting and other body building devices.

A weight training facility can range from a relatively small room (approximately 24m²) to a fairly large hall (approximately 240m²). Its equipment may range from a common weight lifting platform to specialized training machines and up to 12-station training machines. (See also 8.5.2)

#### *4.1.1.1.7 Sauna/Relaxation Area*

The use of a sauna by an athlete after athletic training has a positive effect on his stressed muscles and on his general well-being.

The functional sequence of the sauna bath (changing - cleansing - sauna dry steam - chilled water shower or dive - warm up - drying) should strictly be observed in layout of rooms and in actual use (Table 4.1.1.1.7).

| ***COLUMN*** | ***1*** | ***2*** | ***3*** |
|---|---|---|---|
| ***Line*** | | | |
| ***1*** | ***Room*** | ***Size (m²)*** | ***Equipment Installation*** |
| ***2*** | Changing Room | min. 8 | Benches, lockers |
| ***3*** | Shower/ Drying-up Room | min. 5 | Shower, hooks shelf |
| ***4*** | Sauna Chamber | min. 6<br>max. 12 | Heating unit<br>("Oven"), benches |
| ***5*** | Cooling down Area | min. 10 | Showers, cold water plunge bath |
| ***6*** | Rest Room | min. 10 | Lounges |
| ***7*** | Outdoor Relaxation Area | min. 15 | Lounges, benches |

**Table 4.1.1.1.7 - Size of, and installations in, saunas**

### 4.1.1.2 Rooms for Officials

#### *4.1.1.2.1 Changing Rooms for Judges and Referees*

- *Judges*

2.50m² each for 30 or less judges
2m² for more than 30 judges each and 1m² each for over 50 judges
including adequate locker space; minimum 2 showers, 2 washbasins and 1 toilet cubicle for women and 1 for men

- *Referees*

1 room, approximately 15 m², including shower and toilet, as changing and lounge area for referees and linesmen during team sport competitions. For events at which at least two competitions are consecutive without a break, a further room of similar type is required in rotation for the subsequent team of referees and linesmen.

##### *4.1.1.2.2 Shower/Toilets*
At least 5m$^2$ of sanitary zone for 5 judges (at least 1 shower position and 1 toilet with washbasin) up to maximum of 20m$^2$ for 20 officials (at least 2 shower positions and 2 toilets with washbasin).

##### *4.1.1.2.3 Meeting Room*
Stadia, at which important athletics competitions are staged, must have an adequate room for meetings of competition officials. This room can be used at other times for teaching purposes.

#### 4.1.1.3 First Aid Room and Station for Medical Services
##### *4.1.1.3.1 First Aid Room*
1 room at least 15m$^2$ including washbasin and toilet, for first aid and for treating minor injuries

##### *4.1.1.3.2 Station for Medical Services*
Minimum requirements waiting room (10m$^2$ to 15m$^2$), consultation and examination room (15m$^2$), treatment room (15m$^2$) and toilets

In training centres and large facilities, one room or one group of rooms for athletes' physiotherapy in accordance with their special needs

#### 4.1.1.4 Doping Control Rooms
The rooms for doping control depend on the number of sports participants who have to be controlled.

##### *4.1.1.4.1 Waiting Room*
Room for up to 15 athletes with controlled access, allowing for approximately 2m$^2$ per person

##### *4.1.1.4.2 Working Room*
Room with work place for the doping control officer, furnished for storing test samples; room size approximately 18m$^2$.

##### *4.1.1.4.3 Toilets*
Room with at least 2 toilet cubicles for giving samples. Cubicles must be mimimum 4.50m$^2$.

#### 4.1.1.5 Rooms and Space for Distinguished Guests, VIPs and Sponsors
##### *4.1.1.5.1 Distinguished Guests*
In considering the design of the main tribune it should be noted that the highest level of competition will attract distinguished guests of international and national standing. Space, dignity, comfort and security are of vital importance. It is not necessary for this area to be permanently prepared for a royal occasion, but space and requisite services should be available if the need arises. The tribune should be in the centre of the main stand with direct access from the rear for guests without the need to pass through public and media areas. Provision for 20 to 25 seated guests should be considered.

#### *4.1.1.5.2 VIP Seating*

Designation of VIP seating can be problematic and must be handled with diplomacy. However, in preparing a stadium it is advisable to cater for more guests rather than less. Position and quality of seating are important. If the stadium configuration allows, the VIP seating should be divided into three sections. These three blocks should be arranged to the left, right and below the royal box tribune. There should be 200 seats available in each block. For small events the VIP seating below the royal box should take precedence in priority seating.Directly behind the VIP seating should be provision for a hospitality area which provides relaxation, refreshments and TV monitors.

It is judicious to provide a room/rooms for presidential presence near to the VIP area. This permits a relevant president to be close to key guests but also have working facilities.

#### *4.1.1.5.3 Sponsors' Seating*

Marketing programmes have increased the importance of hospitality at major athletics meetings, and it is therefore necessary to provide high quality service. The key personnel of major sponsors should be included in the VIP/honorary guests section of seating. Blocks of seating immediately to the left of the left-hand VIP seating block should be reserved for sponsors. Additional hospitality services directly behind this area should be provided with all requisite facilities and services.

Car parking and car-drop areas for VIPs, guests and sponsors must be provided.

#### *4.1.1.5.4 Hospitality Facilities*

Hospitality facilities within the stadium for the next level of VIPs, guests and sponsors are important. Space, lighting, air-conditioning and decor should be considered. Protection from the elements and full services including TV monitors must be provided. A regular and rapid delivery of results is an appreciated service. Catering facilities to a reasonably high standard are expected. The size of facilities will be dictated by expected numbers and the level of competition, but the maximum peak flow should be catered for in forward planning.

### 4.1.1.6 Other Areas

#### *4.1.1.6.1 Display Areas*

The host city, the venue management and sponsors are usually keen to have an opportunity to display their attributes and/or goods. Display areas should be provided in the main entrance to the stadium,the hospitality area(s) and public franchise areas. Display areas must not cause congestion in key areas of flow, particularly in case of an emergency, and should never be placed on or near stairways, escalators or moving walkways. Provision of display areas should be restricted to approved authorities and sponsors.

#### *4.1.1.6.2 Franchises*

The rights to sell (food, drink, merchandising) in a sports venue are of a commercial nature. The need for food and drink is essential, and the stadium layout must provide for easy public access to franchise areas, room to relax, adequate litter receptacles, etc. Dangerous congestion near stairways and

dead-ends must be avoided. Many countries now impose very strict health and safety regulations at all sports venues, and these must be adhered to.
Delivery of goods to franchise areas must be considered when designating points of sale.

#### *4.1.1.6.3 Advertising Boards*

Size, numbers, wording and placement of advertising boards in and around stadia is clearly defined in the IAAF Advertising Regulations.

### *4.1.2 FURNISHING AND EQUIPMENT*

If possible, the ancillary rooms for sports participants should always be arranged at the same level as the sports areas. If differences in levels cannot be avoided, stairs should be installed or, where differences in level are small, ramps.

National and local building regulations must be observed. This applies, above all, where aspects of safety and the interests of disabled persons, are concerned.

Air-conditioning or mechanical ventilation systems are needed in all rooms without sufficient natural ventilation.

All energy-saving measures and, in particular, heat recovery from the outgoing air of ventilation systems and shower water, should be investigated with a view to efficient operation.

All floor coverings should be resistant to abrasion, easy to clean and anti-slip.
Walls should generally be designed shockproof, smooth and easy to clean.
In wet areas, floors and walls must be waterproof up to a minimum height of 2m and furnished with a water-resistant surface. Windows in changing and shower rooms etc. should not permit any view into these rooms from the outside. Ceilings should be resistant, for example to balls and, if possible, sound absorbing.

Wall and ceiling lights must be protected against damage and in wet areas against water spray and humidity.

*Entrance area*

Behind the entrance doors, special dirt removing mats should be installed.

Signposts and information boards to guide sports participants and visitors are essential. A generously sized notice board will enable information provision on matters of current interest.

*Corridors*

Corridors must be at least 1.20m wide and for wheelchairs not less than 1.50m.
A clear line of direction should be established. In addition information boards and signposts should facilitate the orientation of the visitor.

*Changing room*

A bench length of at least 0.66m and a width of 0.50m must be provided per sports participant. The minimum distance between benches on opposite sides of the room and between bench and wall is 1.50m. A distance of 1.80m will allow greater freedom of movement for faster changing. Changing room benches should be easy to clean and designed with as few floor supports as possible. Clothes hooks should be recessed to avoid accidents.

Lockers are 0.33m wide, 0.50m deep and 1.80m high (See 4.1.1.1.1).

The furnishings comprise wall mirrors with shelves. Hairdryers and safe deposits for valuables may be considered.

For ventilation systems, a fresh air capacity of $25m^3$ to $30m^3$ is needed per person per hour.

*Drying area*

In terms of its characteristics, the drying area is a wet area. Accordingly, it is usually open towards the shower room, opposite the changing room separated by a door.

The floor covering should be designed such that no water can flow into the adjoining rooms (tub-like floor design, 2% slope, floor drains). Plastic or rubber gratings are recommended in this area. Wooden gratings are not suitable for reasons of hygiene.

Walls must be fitted with robust hand towel hooks or rails and shelves or boards for depositing washing utensils.

*Shower room*

The distance between shower heads is at least 0.80m. Only slanted showers with non-adjustable shower heads 1.80m above the floor level should be used.
An automatic cut-off to limit the duration of the shower is recommended.

In the washbasin area the distance between the taps is at least 0.60m, installation height above floor level 0.75m.

Further advice relevant to installation:
- Safety thermostat to limit temperature,
- Tap with hose connection for cleaning the room,
- Water treatment system for therapy pool as required.

Shelves and boards for soap and other washing utensils must be suitably placed.

Basis of calculation for hot water supply:
- Withdrawal temperature of hot water maximum 40°C
- Water consumption per shower 10 litres per minute
- Duration of shower per person 4 minutes
- Heating up period for hot water preparation: for school operation 50 minutes, for team sports 100 minutes
- Hot water storage temperature maximum 50°C

The floor of the shower room has the same design as that of the drying area. For ventilation systems, a fresh air capacity of 25 to 30m$^3$ is required per person per hour.

To avoid the moist air passing into the changing room and then outside, the ventilation system in the drying and shower area should be operated on low pressure.

Electrical switches and sockets must be placed outside the shower room.

*Toilets*

For reasons of hygiene, toilets should be accessible from the changing room and not from the drying area of the shower room.

To facilitate room cleaning, wall-mounted water closets are recommended.
In addition to the washbasin, roll-shaped holders, clothes hooks, hand towel holders, paper towels or electrical hand-dryers are desirable.

*Room for Coaches*

This room, which is located close to the changing rooms of the sports participants, should be furnished with a desk, 1 to 3 chairs, filing cabinet, lockers, notice board and clothes hooks. A socket for room cleaning and for a PC should be provided. Switchboard units may also be considered. For details of shower and toilet see the respective data given in this Section.

*Room for Judges*

The furniture of this room comprises 1 working desk and 2 chairs per 5 judges, 1 locker per official and clothes hooks. (Shower and toilet as above.)

*Room for Referees*

The furniture for this room comprises a working desk, 3 chairs, 3 lockers and clothes hooks (shower and toilet as above).

*First-aid room*

The furniture comprises a work desk, 2 chairs, first-aid equipment, medicine cupboard and examination bed. A telephone connection is needed with direct outside access or with an emergency connection.

*Massage room*

Massage beds must be accessible from 3 sides. The distance between beds is 1.20m.

This room is furnished with massage bed(s), stools, cupboard for massage utensils and laundry, clothes cupboard and hooks. A washbasin may also be needed. Electrical fittings comprise 2 double sockets for each bed for massage and therapy equipment.

*Doping control rooms*

The waiting room should be furnished with 2 to 4 clusters of seating (each comprising 3 to 4 armchairs and side-tables), clothes hooks, refrigerator for drinks, television set and magazines board.

The working room contains 1 work desk with 3 chairs, a filing cabinet, a clothes cupboard, a cupboard for urine bottles and packaging material and a lockable refrigerator.

Toilet cubicles are equipped with a water closet, clothes hooks and shelving, anteroom with washbasin.

*Room for weight training*

The type of apparatus for heavy exercise must be decided upon at an early stage. The access (door or gate) must be sufficiently large to allow all equipment to be moved in and out.

For the floor, either a cross-grained wooden or polyurethane covering on cast asphalt or a very durable PVC surface is advised.

The equipment consists of freestanding and wall-mounted weight training machines, wall bars and hand apparatus.

If heavy dumbbells are available for free use, part of the floor area must be fitted with additional protective surface.

For ventilation systems, a fresh air capacity of at least $30m^3$ is needed per person per hour.

*Team Sports equipment room*

Gateways must be at least 2.20m wide and have a clear through height of 2.20m.

This room is fitted with mountings for storing apparatus, shelves and roll-shaped ball containers and a small compressor for ball inflation. Subject to the type of design selected for the floor and the wall, a hose connection is required for cleaning the room and apparatus as well as a tap with washbasin and cleaning water basin.

The electrical fittings comprise 2 to 4 sockets.

*Further advice*

If sports halls, gymnastics rooms or suchlike are to be integrated into the facility, the IAKS Principles of Planning for Sports halls are generally applicable.

### *4.1.3 FUNCTIONAL GROUPING*

The individual sections listed in the area and room schedule must be grouped together in the overall design of the facility to enable a smooth operation of the facility. The more diverse and comprehensive the schedule for the individual areas is, the more difficult it is on the one hand to group the individual sections properly within their respective areas and, on the other, to integrate the different areas functionally into the facility as as whole.

#### 4.1.3.1 Allocation of Areas and Rooms for Athletes

Figures 4.1.3.1a and 4.1.3.1b show diagrams of the layout of rooms and the traffic routes to and within the areas and rooms for athletes. Figure 4.1.3.1a refers to training and 4.1.3.1b to competition.

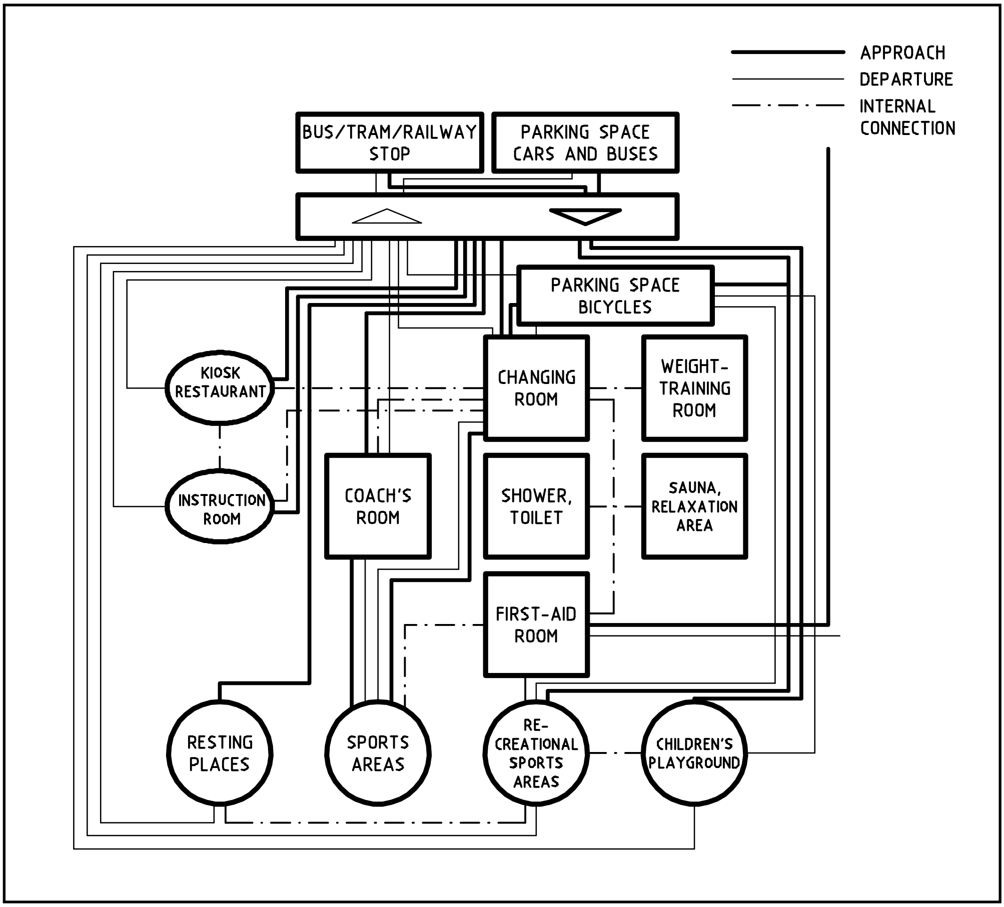



**Figure 4.1.3.1a - Allocation of areas and rooms for athletes in the stage of training**

*Source: Planning Principles for Sportsgrounds/Stadia, IAKS Series Sports and Leisure Facilities No. 33*

After reaching the facility by public or private transport, the athlete proceeds to the changing room and from there to the sports areas (thick access lines) or to the weight training room (dotted lines marking internal routes). On returning from the sports areas (thin return lines) he proceeds to the sanitary area with showers and toilets, in some cases via the sauna and relaxation area, again via the internal routes marked with dotted lines.

It should be stressed at this point that the diagram does not represent a site plan or ground plan of a facility. The sole purpose of this drawing is to show the organizational relationship between the various areas and rooms used by the athlete.
When designing such a sports facility, such diagrams (and the same applies to other illustrations of the same kind in this chapter) are used as a planning aid and as a means of checking the organization of installations and rooms.

Figure 4.1.3.1b illustrates the allocation of rooms and areas for athletes and officials at a competition.

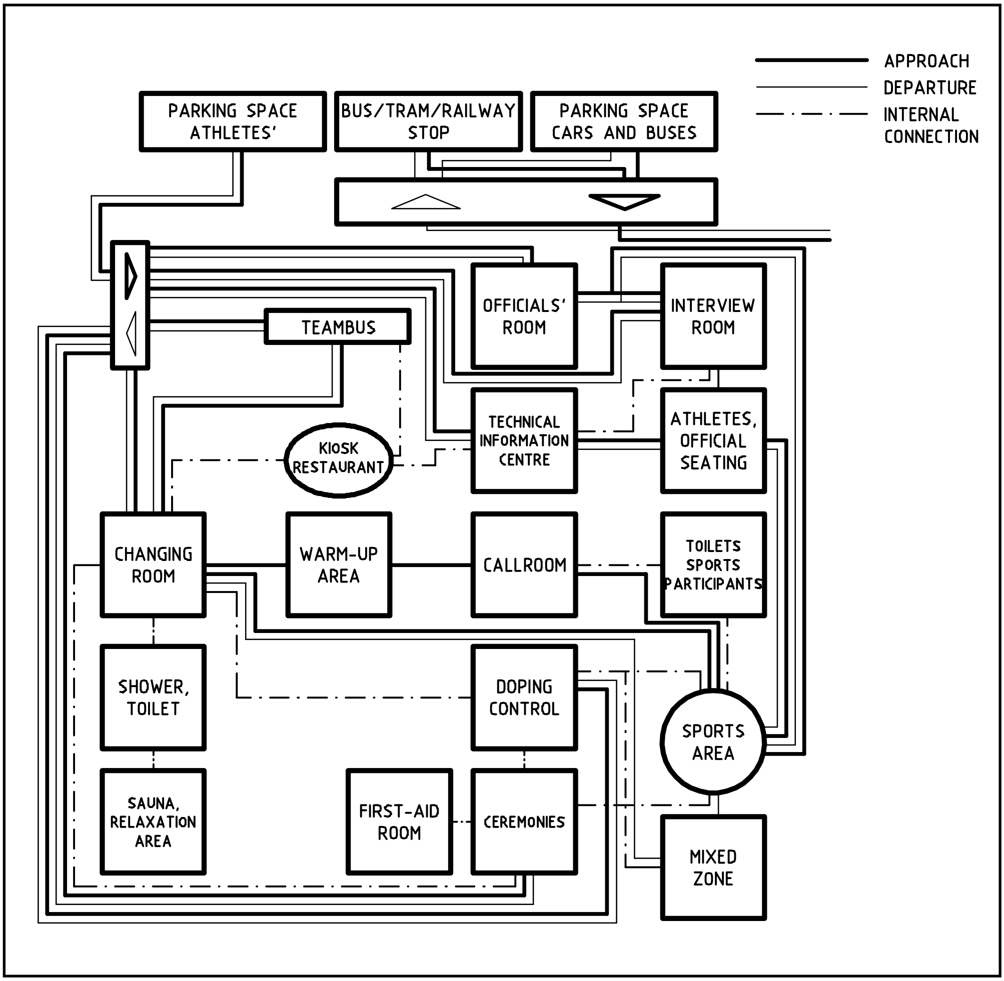



**Figure 4.1.3.1b - Allocation of areas and rooms for athletes, officials, first-aid and doping control in the stage of competition**

*Source: Planning Principles for Sportsgrounds/Stadia, IAKS Series Sports and Leisure Facilities No. 33*

In this case, access to the relevant areas and rooms is afforded along routes strictly separated from those used by spectators (including distinguished guests) and the media. By referring to the above introductory explanation of the diagram's purpose, the reader will understand the interrelationships indicated by the different lines representing the access route, return route and internal routes.

As an example, the athlete's route from the car park (or team bus) is : he proceeds to the changing room and, depending on how the event is organized, goes to the sports area directly or via the warm-up area and call room. After competing, the route takes him via the mixed zone back to the changing room or from the sports area to the doping control area and from there to the changing room. There he will find, as in the training set-up, the usual sanitary installations and possibly a sauna and relaxation area. The route from the changing room then leads back to the team bus or straight to the exit from the athletes' area.

The doping control area shown simply as a square in Figure 4.1.3.1b (with the internal routes between the sports area and changing room) is broken down into its various functional rooms in Figure 4.1.3.1c. The athlete proceeds past the entrance control to the waiting room where he awaits his call to the working room, and from there to the toilets.

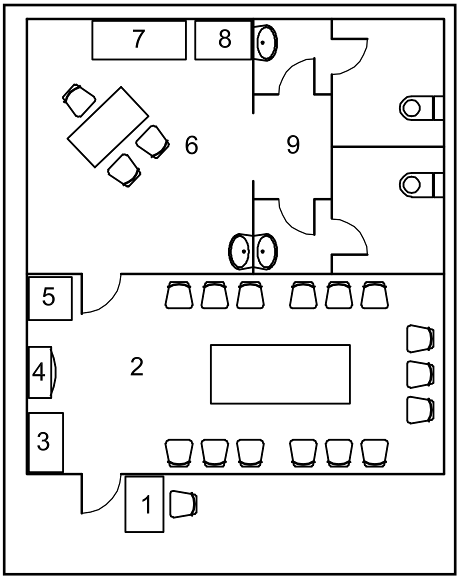



**Figure 4.1.3.1c**
**Allocation, installation and furnishing of doping control rooms**

1 Access control
2 waiting room
3 magazines
4 television
5 refrigerator/drinks
6 doping control officers' room
7 equipment table and cupboard
8 lockable refrigerator
9 toilets

Where both males and females are to be tested, it would be preferable to have two separate toilet areas leading off the working room.

In selecting accommodation for doping control security, privacy, cleanliness and relative comfort should be the priorities.

Where, due to lack of an alternative, it is not possible to have a suite comprising all three areas (working, waiting and WC) it is permissable to use a nearby area for waiting but there must be a tight security screen on that area and athletes selected for doping control must be accompanied when passing from one area to the other.

### 4.1.3.2 Allocation of Areas and Rooms for Distinguished Guests, VIPs and Sponsors

The diagram in figure 4.1.3.2a shows how the areas for distinguished guests, VIPs and the sponsors' lounges (boxes) fit into the overall concept of spectating facilites in a stadium. There are separate arrival and departure routes and car parks for each visitor category, and distinguished guests may have a helicopter pad at their disposal. They also have their own routes to the restaurant.

Figure 4.1.3.2b shows the arrangement of the various groups of distinguished guests in the main grandstand.

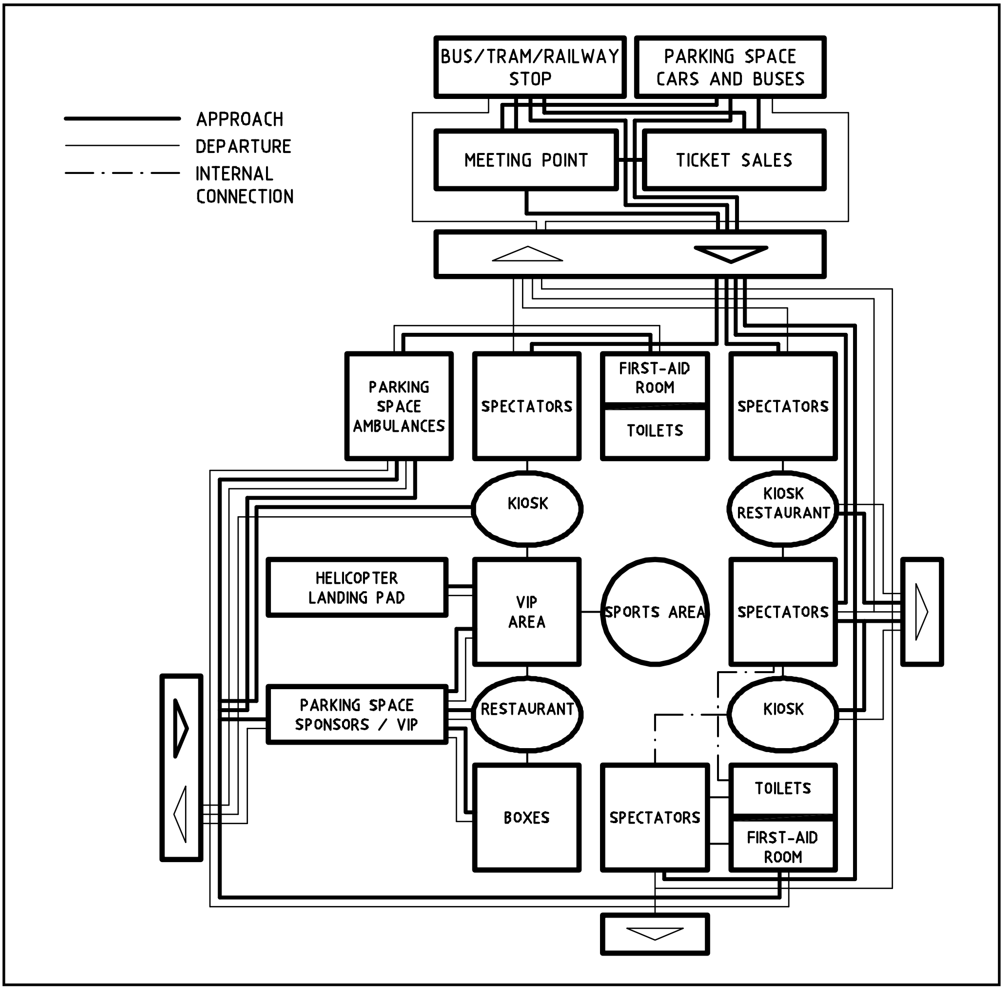



**Figure 4.1.3.2a - Integration of areas and rooms for VIPs into the overall concept**

*Source: Planning Principles for Sportsgrounds/Stadia, IAKS Series Sports and Leisure Facilities No. 33*

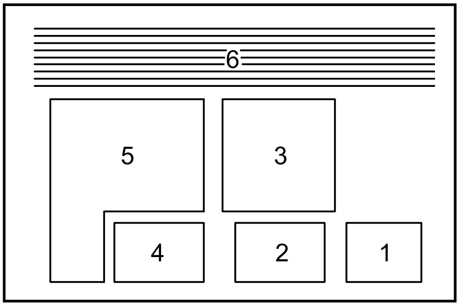



**Figure 4.1.3.2b**
**Arrangement of seating areas on the grand-stand**

1 VIP-seating B-group
2 royal box
3 VIP-seating A-group
4 VIP-seating C-group
5 sponsor seating
6 finish straight

### 4.1.3.3 Diagram of Planning Examples of Changing and Sanitary Areas for Sports Users

The following planning examples outline in each case the alternate use of the sanitary area with 2 changing rooms and its capability to be partitioned into 2 separate rooms if the changing rooms can be subdivided for use by teams.

The planning examples differ in offering 12, 18, 24 or 36 changing positions per changing room, each equipped with 2 clothes lockers per changing position, and with 6, 8 10 or 14 shower positions and each with 1 sanitary room for 2 changing rooms.

#### *4.1.3.3.1 Planning Example 1*

This example shows 2 changing rooms, each of them partitionable, each containing 12 changing positions (0.66m), 8m of changing bench (2 x 4m), 24 clothes lockers and each with 1 divisible sanitary area containing 6 shower positions, 2 toilets and 4 washbasins.
The required space of about 75m$^2$ is composed of 2 x 27.50m$^2$ + 1 x 22.50m$^2$.

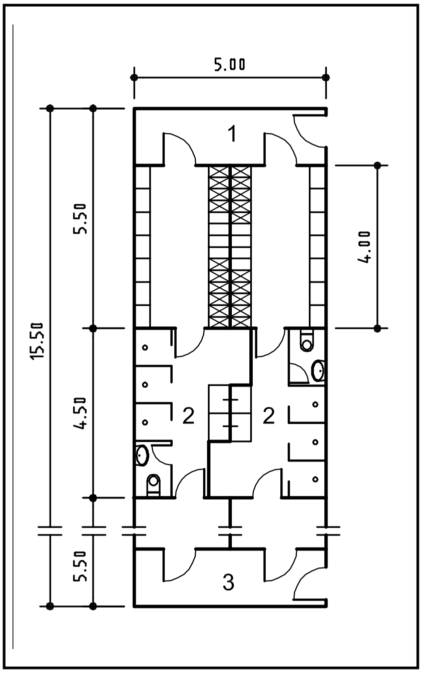



**Figure 4.1.3.3.1**
**Planning example 1 for changing and sanitary areas with 2 x 12 changing positions**
1 Changing room I with lockers, subdivisible
2 shower room with wash basins and toilet
3 changing room II, equipment as for I

*Source: Basic Data for Sports Facilities, IAKS*

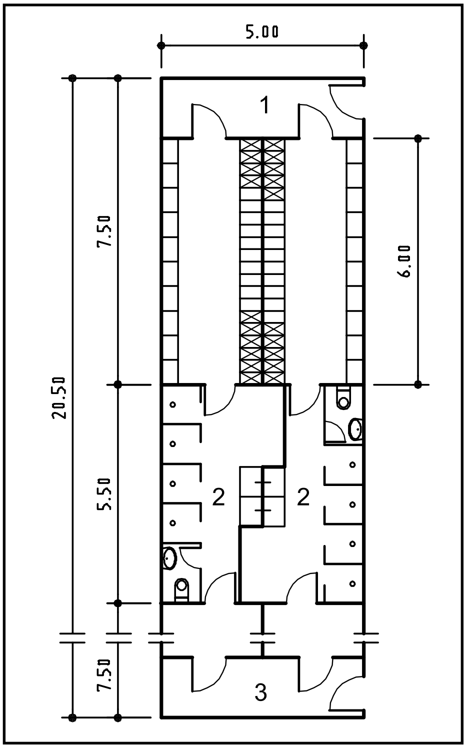



**Figure 4.1.3.3.2**
**Planning example 2 for changing and sanitary areas with 2 x 18 changing positions**
1 Changing room I with lockers, subdivisible
2 shower room with wash basins and toilet
3 changing room II, equipment as for I

*Source: Basic Data for Sports Facilities, IAKS*

#### *4.1.3.3.2 Planning Example 2*

This example shows 2 changing rooms each containing 18 changing positions (0.66m), 12m of changing bench, 36 clothes lockers and one sanitary area containing 8 shower positions, 2 toilets and 4 washbasins.
The required space of about 100m² is composed of 2 x 37.50m² + 1 x 27.50m².
The changing room provides 30 changing positions (0.40m) at a time for 1 class of school children.

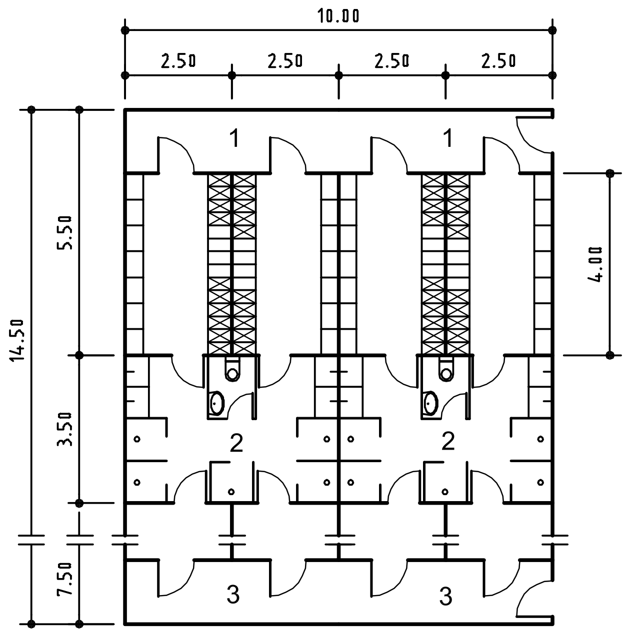
#### *4.1.3.3.3 Planning Example 3*

This example shows 2 changing rooms, each containing 24 changing positions (0.66m), 16m of changing bench, 48 clothes lockers and one sanitary area containing 10 shower positions, 2 toilets and 6 wash-basins.
The required space of about 145m² is composed of 2 x 55m² + 1 x 35m².

**Figure 4.1.3.3.3**
**Planning example 3 for changing and sanitary areas with 2 x 24 changing positions**

1 Changing room I with lockers, subdivisible
2 shower room with wash basins and toilet
3 changing room II equipment as for I

*Source: Basic Data for Sports Facilities, IAKS*




#### *4.1.3.3.4 Planning Example 4*

This example shows 2 changing rooms, each containing 36 changing positions (0.66m), 24m of changing bench, 72 clothes lockers and one sanitary area containing 14 shower positions, 2 toilets and 8 wash-basins.
The required space of about 195m² is composed of 2 x 75m² + 1 x 45m².

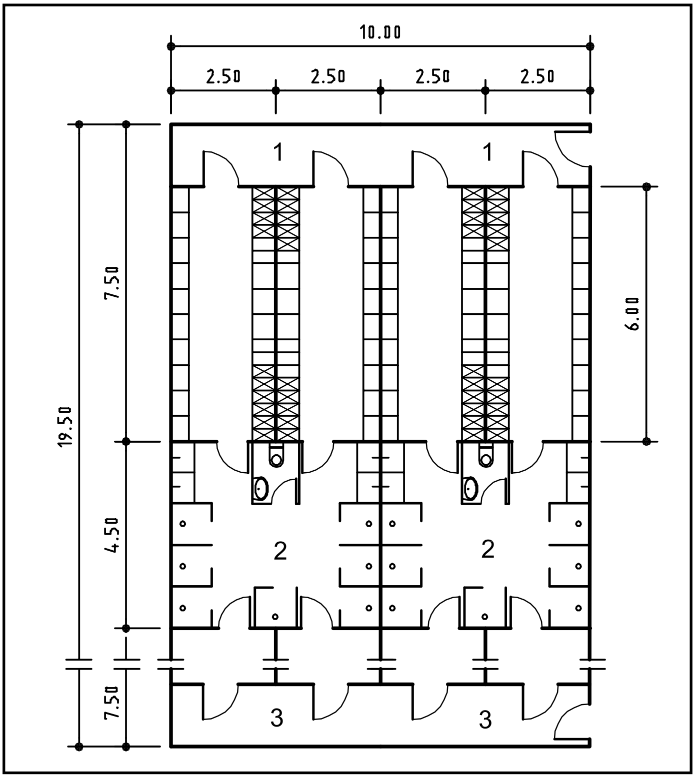



**Figure 4.1.3.3.4**
**Planning example 4 for changing and sanitary areas with 2 x 36 changing positions**
1 Changing room I with lockers subdivisible
2 shower room with wash basins and toilet
3 changing room II equipment as for I

*Source: Basic Data for Sports Facilities, IAKS*

# 4.2 Rooms for the Media

## *4.2.1 AREA AND ROOM SCHEDULE/EQUIPMENT*

### 4.2.1.1 Media Centre

#### *4.2.1.1.1 Reception Area, Entrance hall*

| | |
|---|---|
| Entrance Hall | as required |
| Reception/Information | as required |
| Telephone exchange | as required |
| Telephones | as required |
| Cloak-room | if required |
| Toilets | as required |

#### *4.2.1.1.2 Administration Secretariat, Press Office*

| | |
|---|---|
| Director | 20m² |
| Other members of staff | 12m²/person |
| Secretariat | 12m² |
| Temporary press office | 20m² |

#### *4.2.1.1.3 Room for Press Conferences*

For major competitions the media centre should have a large press conference room capable of dealing with up to 500 to 600 seated persons with full TV facilities.

| | |
|---|---|
| ***4.2.1.1.4 Catering Facilities*** | as required |
| ***4.2.1.1.5 Lounge Area*** | 1m$^2$ of equipment space for every 2 persons |
| ***4.2.1.1.6 Cloak Room*** | if required |
| ***4.2.1.1.7 Toilets*** | as required |
| ***4.2.1.1.8 Store for Cleaning Equipment*** | as required |

### 4.2.1.2 Press

The four main working areas of the journalists in the stadium are the main stand seating, the main press centre for major games/championships, the working area within the stadium and the formal interview room. (For some details see table 4.2.1.2)

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| ***1*** | ***Function*** | ***Equipment*** | ***National Competitions*** | ***Regional Competitions*** | ***Olympics/World Competitions*** |
| ***2*** | Main Stand Seating | Seat (with desk) | 50 | 350 | 800-850 |
| ***3*** | | Seat (only) | 30 | 100 | 200-400 |
| ***4*** | TV Monitors (written press) | | - | 150 | 250-400 |
| ***5*** | Phones (dedicated lines) | | 15 | 100 | 300 |
| ***6*** | Main Press Centre | Desks in Working Area | 40-50 | 200-250 | 500-650 |
| ***7*** | TV Monitors | | 5 | 20-25 | 50-85 |
| ***8*** | Personal Computers | | 5 | 15-20 | 30-40 |
| ***9*** | Phones (Operator) | | 3 | 15-20 | 30-35 |
| ***10*** | Phones (Card) | | 5 | 30-35 | 60-70 |
| ***11*** | Telefax | | 3 | 5-10 | 10-15 |
| ***12*** | Pigeon Holes | | 75-100 | 150-200 | 250-300 |
| ***13*** | Formal Interview Room | Seat | 50 | 150 | 200-300 |

**Table 4.2.1.2 - Press equipment for competitions at different levels**

#### *4.2.1.2.1 Main Stand Seating*

The amount of seating required will be dictated by the size of the competition. The amount of technical service required will rise in proportion to expected numbers, whilst the principles of service remain the same regardless of numbers. Numbers to be expected at a national competition vary, but as a broad estimate 50 seats with desks and 30 seats only (observers) can be anticipated.

Numbers of journalists to be expected to attend a regional or World/Olympic competition are regional 500 (350 with desks), international 1250 (850 with desks).

#### *4.2.1.2.2 Main Press Centre*

This is the nerve centre of the entire media operations. It should be located as near as possible to the press stands and accommodate all the necessary facilities and services.
The main press centre (MPC) should ideally be located within the stadium.
If the MPC is not inside the stadium but within 200 to 250 metres of the press stands, a small working room with telecommunication facilities will also be needed in the stadium itself. If the MPC is further away, the size of the working area in the stadium will have to be considerably increased.

The working area in the MPC should cater for working places for 50-60% of the expected number of journalists.
At World Championships/Olympics, technical needs would be:

- Working places for 500-650 journalists
- TV monitors: 50-65 in common working area + additional ones in private offices
- Telephones: 60-70 card phones + 30-35 (operator and collect calls) in addition to private lines ordered by the journalists
- Mobile telephone services (rental and repair)
- Telefaxes: 10-15
- Personal Computer with internet access: 30-40 (a limited number, with different keyboards, to be available in emergencies).

An area should be set aside for the photo centre, ideally adjacent to the MPC but seperate. This area should be as near as possible to the track.
Facilities to be provided are as follows:

- Lockers: 250-300 for storage of photographic equipment
- Private offices for major photo agencies and newspapers
- Telephones: 10-20 public telephones in addition to private lines ordered by the media organisation
- Telephoto transmission facilities

#### *4.2.1.2.3 Working Area within the Stadium*

Unless the MPC is located within the stadium, a working area directly behind the main press stand must be provided, allowing for complete working facilities for 10% to 30% of the expected number of journalists, depending on the distance between the MPC and the press stands.

Full telecommunication facilities should be available at the main press centre (if such exists), but limited facilities should be provided at this working area at regional and world competitions. For national events, operator assisted facilities with 6 to 10 telephones and 2 to 3 telefaxes should be provided.

#### *4.2.1.2.4 Formal Interview Room (see Television and Radio)*

There are few technical services required in the formal interview room, other than simultaneous translation at major games/championships. The interviews should be fed by the host broadcaster to all TV monitors in the media working positions in the stadium and in the working room.

For World/Olympic competitions an additional conference room with 80 to 100 seats should be provided.

#### *4.2.1.2.5 Results Preparation and Delivery*

The urgent and accurate delivery of hard copy information to journalists is of paramount importance. It is therefore essential to consider the procedure for delivery of start lists and results information to the press area, and their immediate printing and distribution to the journalists. An on-line link to the official computer service is recommended, with the requisite number of fast-speed photocopiers available in the working room directly behind the journalists stand. Results should not take more than 10 minutes to be delivered, with an absolute limit of 20 minutes in case of extreme difficulties. When such major difficulties arise it is imperative that journalists are informed as to the reason for the delay. Back-up facilities in case of failure are essential.

A priority distribution must be prepared to ensure that those journalists with the tightest deadlines working for the most important agencies and publications get first service.

Because of the number and size of photocopiers required for this task, consideration must be given to air conditioning to ensure that machine failure and human mistakes are kept to a minimum. Collating needs should also be given consideration when preparing and allocating space, as it is not always possible to depend on machine collation.

The link to the computer service is the most important link for this working area. Telecommunication requirements are linked to computer requirements and cabling needs should be considered accordingly.

As an example, 4.2 million sheets of A4 paper were processed at the 1997 World Championships in Athletics, 90% of which was for the media.

A pigeon-hole system for the distribution of information sheets must be prepared and placed in a position which is within convenient reach of the journalists' working places and the print services representatives who will be required to feed the system. Congestion in an area of high traffic must be avoided.

#### *4.2.1.2.6 Photo Laboratory*

For competitions at a regional or World/Olympic level, a photo laboratory is required. The following free service was offered at the Olympic Games in Barcelona, 1992:

- Colour (C-41) and black and white negative development
- Colour Printing
- Electronic black and white printing
- K-12 process
- E-6 process
- Transparency mounting
- Video-editing

Self-service facilities will also be required necessitating two light-proof rooms with tables, chairs, sinks, cold water and electricity supply, safety curtain and general lighting. An emergency dark room (light proof) should be available close to the finish line area.

Given the limited occasions when provision of the above facilities would be required, the design/planning of rooms on a multi-functional basis is recommended. Provision of the requisite lighting, power and water supply are the vital elements.

#### *4.2.1.2.7 Camera Repair Service*
At major competitions at regional or World/Olympics level, where photographic equipment is subjected to considerable wear and tear, provision of a camera repair service is required. The service will be performed by the official camera sponsor of the event (if such exists), and only space is required. Safe storage units are essential for expensive photographic equipment.

#### *4.2.1.2.8 Lockers*
As technology improves, photographers' equipment becomes more sophisticated and diverse. The value and range of such equipment must be considered when providing storage facilities for photographers. Individual lockers of suitable size should be provided in the media working area/main press centre: national (30-40), regional (125-150) and World/Olympic (250-300). 24-hour access is required and constant security essential.

#### *4.2.1.2.9 Press Agencies*
International press agencies take priority over all other journalists in the allocation of stadium seating and working areas. It is a common practice for agencies to require independent working rooms within the press working area/press centre of the stadium. Size will be dictated by the competition and the agency itself. Access will be 24 hours a day and will be limited to agency representatives and those serving them within the media department plus main press centre service staff.
Key telecommunication requirements are direct telephone and telefax links with international lines.

### 4.2.1.3 Television and Radio
All television and radio activities are conducted in five main areas: commentary positions, camera positions, formal interview room, international broadcast centre (IBC) and outside broadcast (OB) van compound.

Each area has its own specific technical service requirements.

#### *4.2.1.3.1 Commentary Positions*
The number of positions required will be dictated by the size of the event, but the following figures can be expected: national (5 to 6), regional (20 to 30), international (80 to 100), World Championships and Olympic Games (150).

Minimum space required per position is 1.50m front and 1.60m depth for two announcers.

#### *4.2.1.3.2 Camera Positions*
The number of camera positions will vary from event to event. The final decision of number and placement of cameras will be decided by the host broadcaster and the Organisation Committee.

#### *4.2.1.3.3 Formal Interview Room*
This room is where the medalists of each event should be brought to meet the media in a controlled environment.

The size of the room will depend upon the size of the competition but should be planned for the largest possible attendance, i.e. for national events 50/75, regional events 250 and international events 350 persons. Figure 4.2.1.3.3a shows, as an example, a suitable room shape and the grouping of those persons involved.

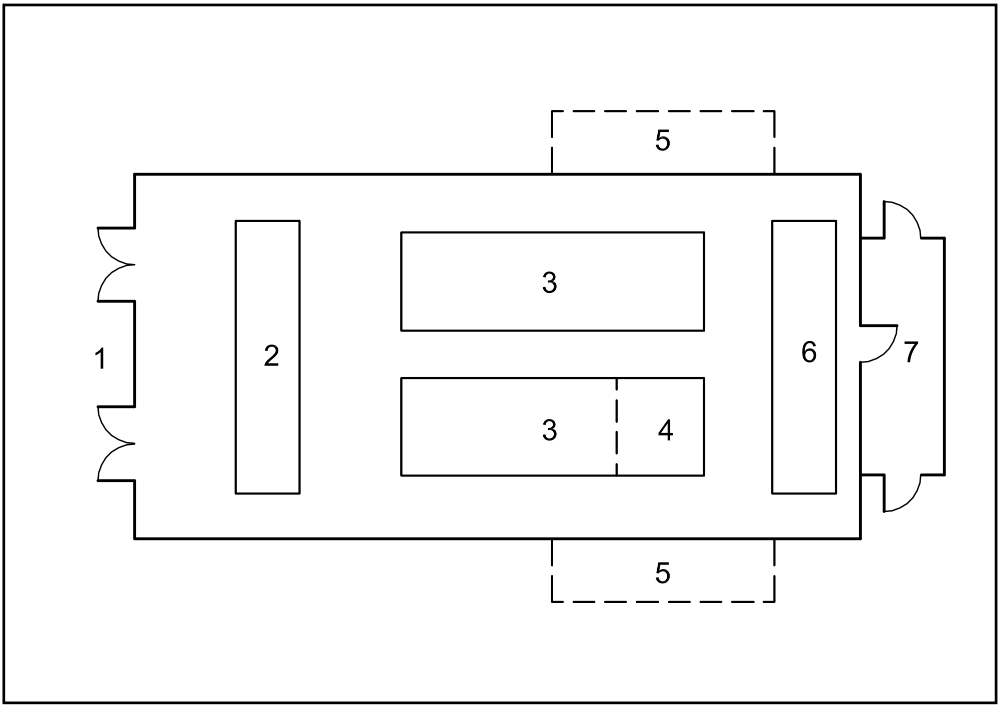



**Figure 4.2.1.3.3a - Scheme of formal interview room**
1 Entrance/exit, 2 TV and photographers, 3 journalists
4 radio, 5 simultaneous translation, 6 interviewees, 7 holding room

At major games and championships consideration must be given to simultaneous translation facilities in the formal interview room. Advanced thought to cabling needs is therefore required.

Consideration should be given to any backdrop prepared for the interview room to ensure its colour receptivity to the television camera.

Access must be in close proximity to the journalists' working areas with a minimum of two doors that allow entry and exit without congestion. A holding room behind the raised dais for athletes' entry is ideal if the stadium configuration allows.

Because it is impossible to schedule formal interviews exactly, a constant flow of people in and out of the room is inevitable, and it is therefore recommended that doors are placed at the back of the room for minimum disturbance. Every effort should be made to keep the front of the room and the raised dais area as clear as possible in order to ensure a clear view to all participants.

The formal interviews should be relayed to the journalists' stand monitors by use of a dedicated TV channel.

Details of the next formal interview can be conveyed simply to the media by use of an information board (60cms x 100cms) which is carried aloft by a representative of the media services division along the front of the media stand (Fig 4.2.1.3.3b).

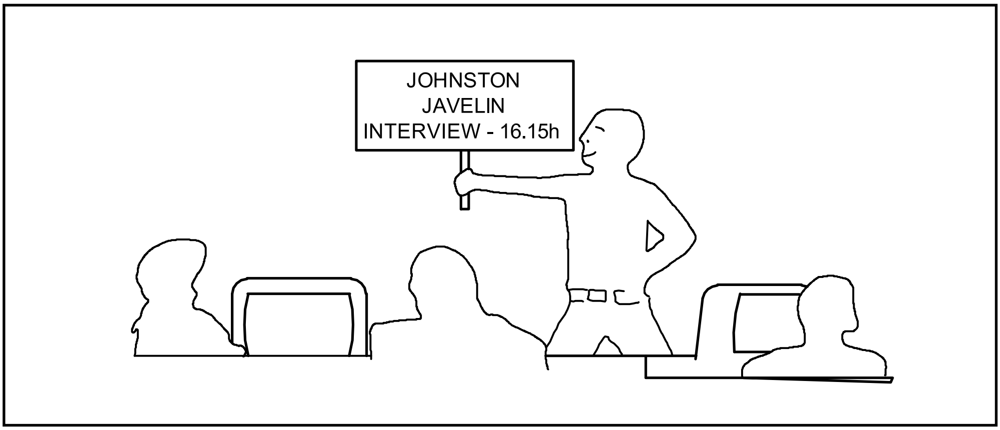



**Figure 4.2.1.3.3b - Interview information board along the front of the media stand**

### 4.2.1.3.4 International Broadcast Centre

For major games/championships the host broadcaster will be required to prepare an international broadcast centre (IBC). This is a separate entity from the press centre and functions solely for television and radio. Facilities provided are as follows:

- Host broadcast signal edit and distribution
- Unilateral edit rooms
- Television studios
- Administration offices
- Commentary switching centre
- Highlights programme production
- Archive
- Catering, bank information, etc.

Size is determined by the type of competition. Access is for television and radio personnel and those serving them only and is for 24 hours per day with maximum security. The telecommunication requirements of the IBC are extensive for major games/championships, and extend to sub-sites for a multi-sport competition. Principal needs are telephone, telefax, portable cellular phones, pagers and walkie talkies.

For the Olympic Games in Barcelona (1992) a vanda contribution network was established to transport all international television and radio signals and unilateral vandas from venues to the IBC. (Note: A vanda circuit is a one-way circuit with one video channel and associated audio channel(s)). Television signals produced in the IBC by world broadcasters were routed to the world via optic fibre and radiolink earth network. Outward-bound signals were uplinked to communication satellites from earth stations in Spain

#### *4.2.1.3.5 Outside Broadcast Vans Compound*

The host broadcaster and those TV companies who have undertaken unilateral coverage will require space adjacent to the stadium for positioning of their OB vans. All unilateral camera feeds will be collected within the OB vans, edited and transmitted via satellite to various domestic audiences.

The size of compound required will depend upon the scale of the event. A national competition will require space for 2 to 3 vans, i.e. 800m$^2$ (max.) including administration and services. A major regional/international competition must cater for 10 to 12 vans within an area of 1500m$^2$, whilst an event on the scale of the World Championships in Athletics must provide for 20 to 25 vans and will require 3000m$^2$. The average size of an OB van is 16.00m in length, 2.50m in width and 4.50m in height.
The overall weight is approximately 30 metric tons.

The OB van compound requires 24 hour security and only TV personnel should have access.

The OB van compound should be positioned as close to the finish line area as possible to keep cable runs to the minimum. Access portals for cabling into the stadium must be considered. These should avoid all public/vehicular passages.

The power requirements of an OB van are enormous and separate power substations with back-up generators must be installed for major competitions. An output of 600kW was provided for the world broadcast compound at the last World Championships.

### *4.2.2 FUNCTIONAL GROUPING*

Like the athletes, officials and distinguished guests, the media reach their working areas within the stadium via a separate entrance and exit area.
The diagram in figure 4.2.2 illustrates the allocation of rooms and areas including the areas for the outside broadcast vans and camera platforms.
Detailed information on the requirements of the press (and photographers), radio and television can be obtained from the following text sections and figures in this chapter.

#### 4.2.2.1 Media Centre

It is the focal point for all the media services. The access from the stadium entrance and from the parking area must be clearly signposted and quickly reachable. The representatives of the different media will be led from the entrance hall with reception desk to the various functional areas described in Sections 4.2.2.2 and 4.2.2.3.
The offices of the press administration are situated in the vicinity of the reception desk. The press conference room must be within easy reach of the reception area. It is useful to group the necessary catering facilities in this area.

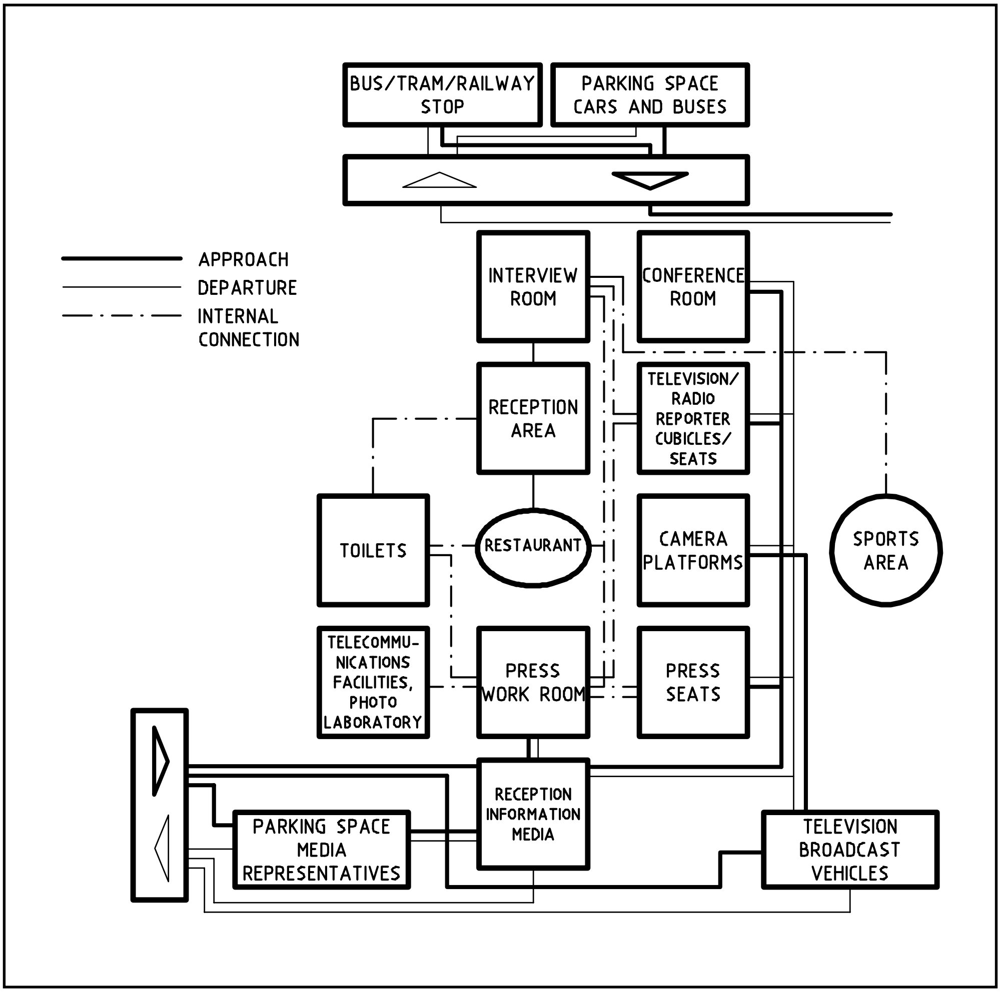



**Figure 4.2.2 - Allocation of areas and rooms for the media**

*Source: Planning Principles for Sportsgrounds/Stadia, IAKS Series Sports and Leisure Facilities No. 33*

### 4.2.2.2 Press

#### *4.2.2.2.1 Main Stand Seating*

This is the primary working area for journalists where they will be seated for the majority of the competition period.

The seating area should be placed on the finish straight side of the stadium and should extend not further than 30m before and 50m after, the finish line. It should be no lower than the fifth row of the stadium seating and should not extend into second level seating in a major stadium (Fig 4.2.2.2.1).

This area directly above the finish line is of high priority to the media and must be shared with television and radio. Because of the live nature of television and radio they shall have priority on direct finish line positions but every effort should be

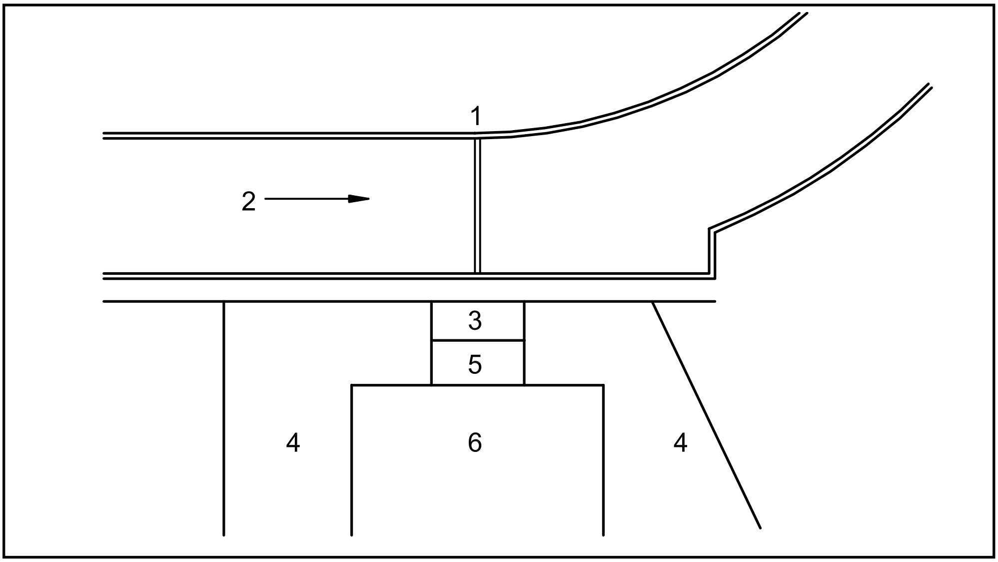



**Figure 4.2.2.2.1 - Scheme of functional grouping of press and TV on the grandstand**
1 Finish-line, 2 direction of running, 3 competition officials, 4 media, 5 photo, 6 priority media and TV
If the photographers' position is adopted, standing photographers must not obstruct the eye-level view of the lowest row of priority media and TV section.

made to provide agencies and major newspapers with the equivalent. Journalists representing small publications, without deadlines, or purely observing should be allocated seating on the outer limits of the working area.

The seating area should be within easy reach of the media centre, working areas within the stadium, interview rooms and mixed zone.

With the need to move regularly throughout the competition between seating area, mixed zone, interview room and the media centre, access is of prime importance. Consideration must be given to constant movement in and out of the stadium by journalists and those serving them. In this respect, passageways, doors and steps should be wide and well lit. Directional signage is of particular importance, as is rigorous imposition of accreditation and access checks.
Strenuous efforts must be made to enforce this as a working area. Therefore, accreditation should be judiciously provided and every effort should be made to stop people loitering in doorways, passageways and stairs.

The other groups with whom journalists will require interface are media services, athletes, catering, computer services, printing and transport.

Telecommunication requirements (See 5.6) are telephones, telefaxes, TV monitors and acoustic couplers.

Cabling of telephones and TV monitors at the journlists desks is an important aspect that requires planning and consideration.

### *4.2.2.2.2 Working Area*

Prior to, and at the conclusion of, each competition session, journalists require a working area in which they can prepare their copy for filing to their respective publications.

The working area should be within the stadium, preferably behind the seating area of the journalists. It should be in close proximity to the mixed zone and the interview room in order to facilitate easy movement, in the immediate post event period. Seating within the working room is without priority and is on a “first come, first served” basis. Size is dependent on the numbers but should allow for comfortable working conditions, be well lit, well ventilated and, if necessary, heated or air conditioned. Access should be such that constant movement in and out by large numbers of people will not cause congestion in doorways.

Because of the considerable movement in and out of the working room throughout a competition session, but particularly immediately afterwards, multiple entry and exit points are recommended and must be well controlled to avoid entry by those without accreditation.

Access to this area for computer services, telecommunication staff and catering is essential.

Full telecommunication services are required in the working room or immediately adjacent to it. These should include telephone and telefax facilities. A number of PCs are required, although it should be noted that many journalists carry their own portable equipment with which they are more familiar. Cabling of telecommunication equipment must be considered well in advance as well as ancillary power needs should the printing of start lists and results sheets be generated in this area or close by.

### *4.2.2.2.3 Mixed Zone*

The mixed zone is a designated area immediately after departure from the track through which all athletes, including those taking part in field events, heats and qualifying rounds, must pass upon leaving the stadium (Fig 4.2.2.2.3a). Journalists have access to this area and may make contact with the athletes.

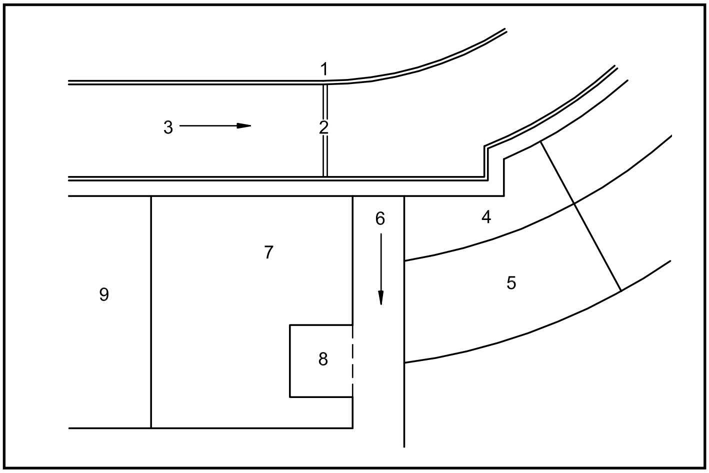



**Figure 4.2.2.2.3a**
**Scheme of functional grouping of athletes’ exit point**
1 In-field
2 finish-line
3 direction of running
4 photographers
5 athletes seating
6 exit for athletes to mixed zone
7 media positions
8 mixed zone for athletes and media
9 VIP area

The mixed zone should be placed at the point of exit from the track, and should be the point at which athletes retrieve their track suits and competition bags. Priority in the mixed zone is to live unilateral broadcast cameras, followed by ENG cameras and live radio and, finally, journalists and photographers. The size and layout should be sufficient to avoid congestion for both athletes and media. A waist-high barrier should delineate a passage through which athletes pass and to which the journalists do not have access. Provision must be made for photographers and ENG crews to get clear shooting access above the heads of journalists. A limited number of team representatives should have access to this area, but it should not be seen as the point of team assembly. Public should definitely not have access. The athletes should pass through this area unimpeded and reasonably swiftly. Provision should be made for athletes' welfare in this area, for example first aid and water. Media service must have access to this area, particularly those responsible for flash interviews. There are minimal telecommunication requirements but consideration of lighting is imperative. 1 or 2 TV monitors should be provided to allow media representatives to follow the action in the stadium.

The various services required to interface with the media at ground level and level one of the main stand are illustrated in figure 4.2.2.2.3b.

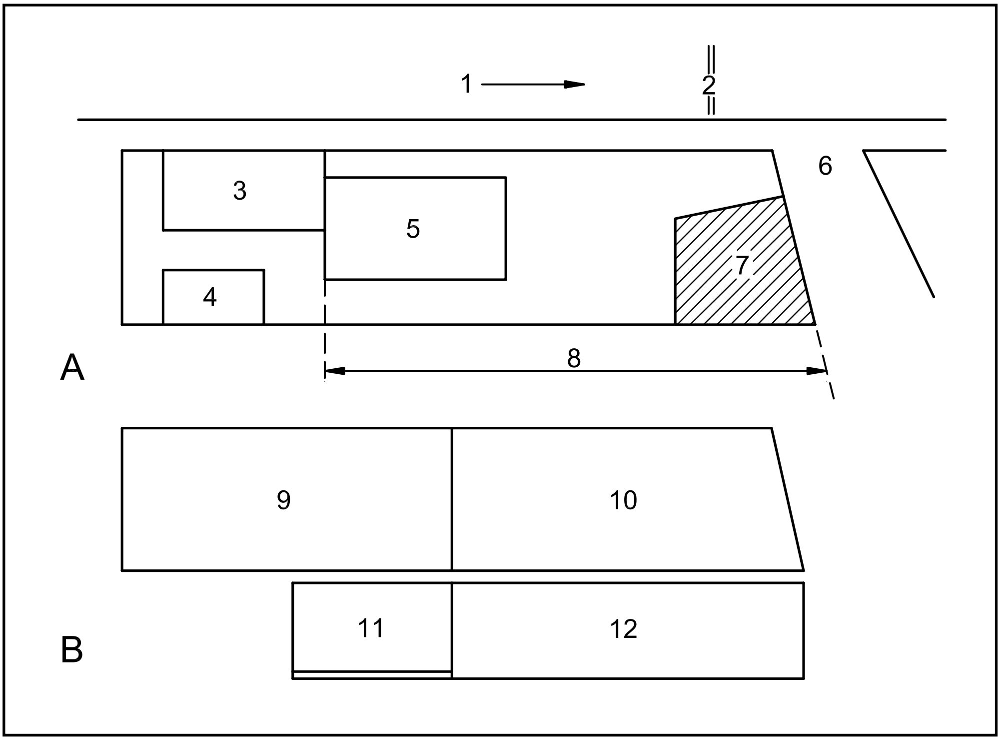



**Figure 4.2.2.2.3b - Scheme of services at ground level and level 1 of the main stand**

A Ground floor plan

1 Direction of running, 2 finish-line, 3 ceremonies, 4 doping control, 5 interview, 6 exit for athletes to mixed zone, 7 mixed zone, 8 limits to media access

B Level 1 plan

9 grandstand, 10 media seating, 11 results and printing, 12 media working area

#### *4.2.2.2.4 Interview Room*

The interview room should be in a convenient area of the stadium en route from the medal ceremony to either doping control (if required) or back to the athletes stand. A minimum detour should be required to reach this room. Similarly, it should not be a great distance from the journalists' working area within the stadium. Priority of seating and questions should be given to the media representatives of the athletes' nation, who should therefore be seated towards the front of the room. Journalists and TV commentators should share the front seating, whilst cameramen and photographers should be arranged to the sides and rear of the room. Sufficient space must be provided to allow easy movement around the room for camera crews and photographers (Fig 4.2.1.3.3a).

Lighting, acoustics and air conditioning need full consideration.

#### *4.2.2.2.5 Photographers*

The key photographers' positions within the stadium are shown in figure 4.2.3.2.5a.

The angle of these positions in relation to the track, and in particular the finish line, is critical. Of equal importance is the elevation which should be neither too high nor too low. Potential for a number of photographers to operate within a narrow sector must be considered.

At the finish line, limited space must be shared with television to ensure all representatives get a good opportunity for the key shot (Fig 4.2.2.2.5b)

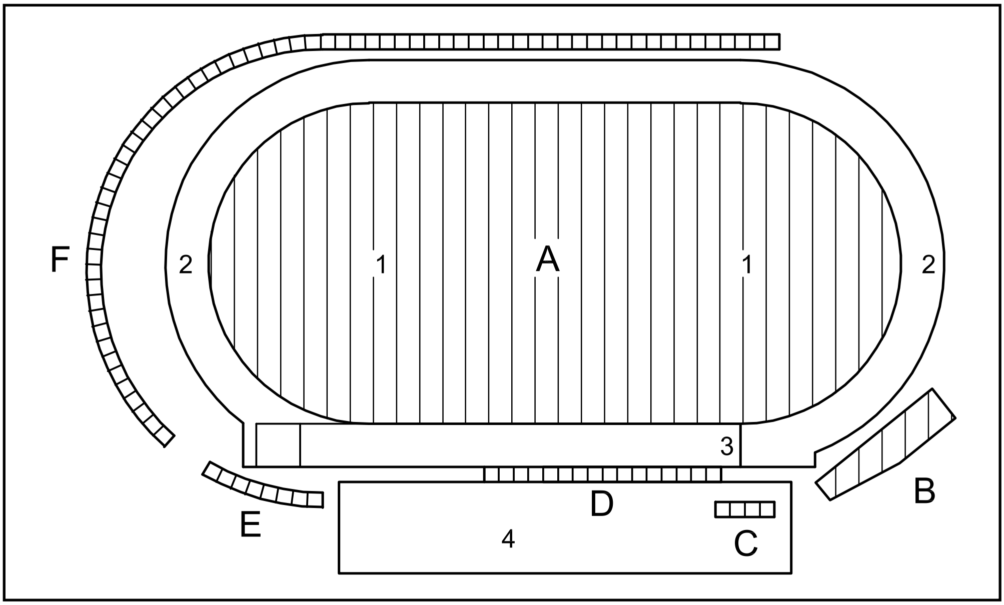



**Figure 4.2.2.2.5a - Key positions for photographers**
1 In-field, 2 track, 3 finish-line, 4 main grandstand
A In-field, B head-on finish-line, C side-on finish-line, D finish-straight moat/several positions,
E 100/110 m start, F back straight moat/several positions

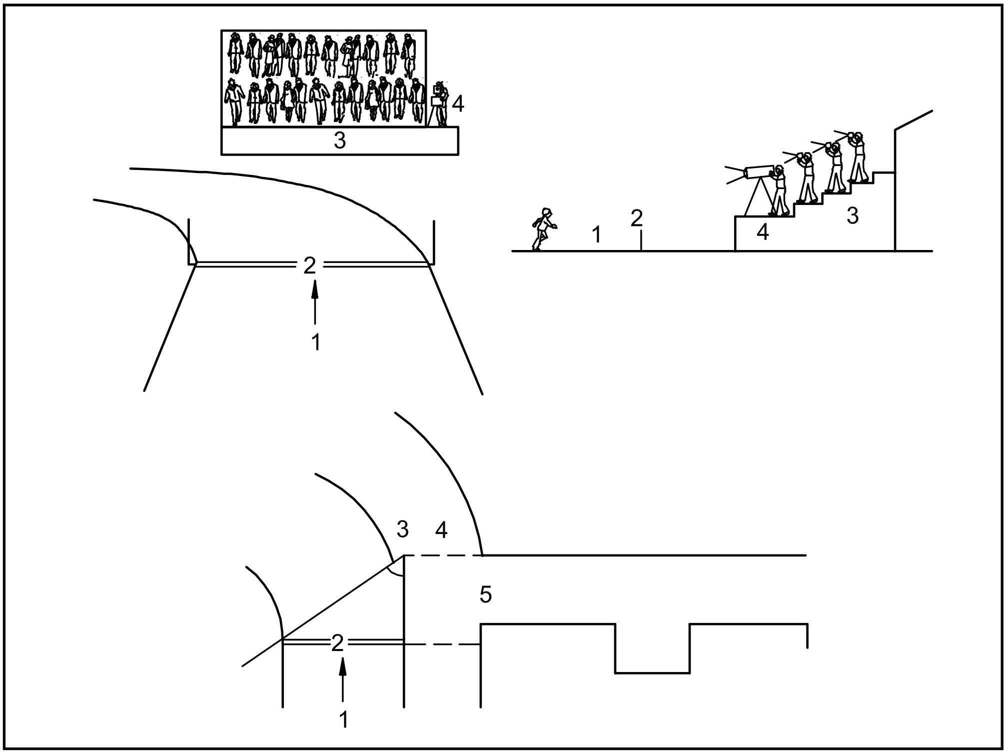



**Figure 4.2.2.2.5b - Positioning at finish-line**
1 Direction of running, 2 finish-line, 3 photographers' platform, 4 TV, 5 exit for athletes to mixed zone

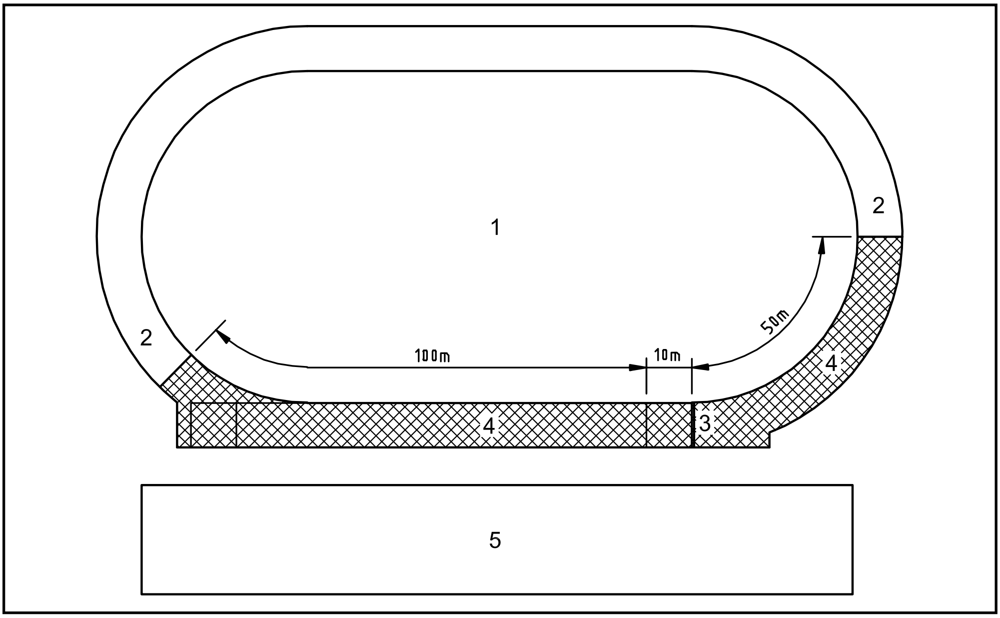



**Figure 4.2.2.2.5c - "No go-"zone on the track**
1 In-field, 2 track, 3 finish-line, 4 "no go"-zone, 5 main stand

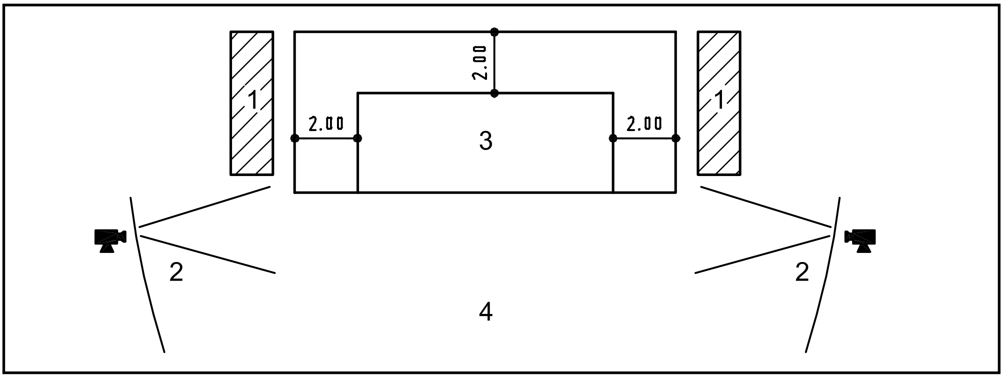



**Figure 4.2.2.2.5d - Photographers' position on the in-field (example high jump)**
1 Photographers' position, 2 TV position, 3 landing mat, 4 runway

It is quite common for photographers to work independently and they therefore need access to a number of positions. Swift and easy movement between positions which allows for transportation of bulky equipment without disturbing other stadium users must be considered.

Figures 4.2.2.2.5c and 4.2.2.2.5d deal with the in-field access. Accreditation should be very limited (a total of 16 photographers for outdoor competition and 12 for indoor is stipulated in the IAAF Media Guidelines). "no go" zones must be respected. The "no go" zone should be restricted to a limited number of designated officials only. No mobile TV cameras or pool photographers should be allowed. There should be minimal crossing of the track by photographic personnel.

### 4.2.2.3 Television and Radio

#### *4.2.2.3.1 Commentary Positions*

The commentary positions provided to television and radio are the areas in which commentary is principally added to all television coverage of a competition. Unlike the written press, the electronic media representatives will remain seated in the commentary positions throughout the competition.

The seating must be directly above the finish line area and should extend no further than 30m either side of the finish line. It should begin no lower than the fifth row of the stadium seating and should never extend into upper tiers of the main stand.

Television and radio shall have priority on finish line seating. Those with live transmission schedules shall take priority over those broadcasting on a delayed basis.

#### *4.2.2.3.2 Camera Platforms*

The important principle of coverage for athletics is not the total number of cameras used as much as their positioning. However,the complexity of athletics coverage compared to other sports requires the employment of numerous cameras, the majority of which are cabled. It is often necessary to build a certain number of camera platforms and consideration must be given to seats lost by construction and viewing impaired once the structures are built. Certain key camera positions for athletics must be guaranteed no matter how small the competition or corresponding TV production (for example finish line camera). Platforms in the grandstands should be part of the permanent construction of the stadium.

Figure 4.2.2.3.2a shows the minimum requirements for minor events, figure 4.2.2.3.2b is an example for a major athletics competition.

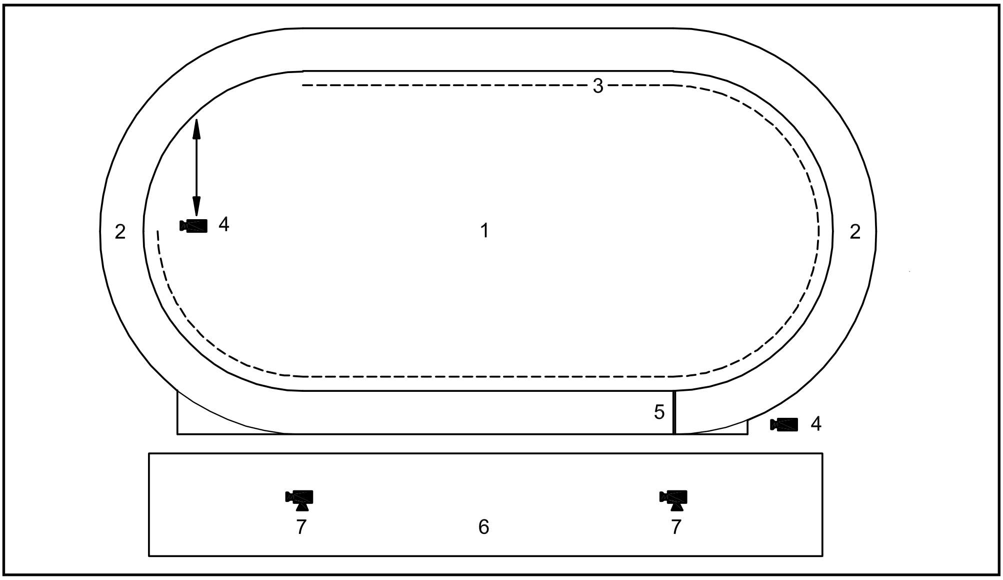



**Figure 4.2.2.3.2a - Minimum key camera positions for minor events**
1 Infield, 2 track, 3 cable, 4 hand-held camera, 5 finish-line, 6 main stand, 7 fixed camera position

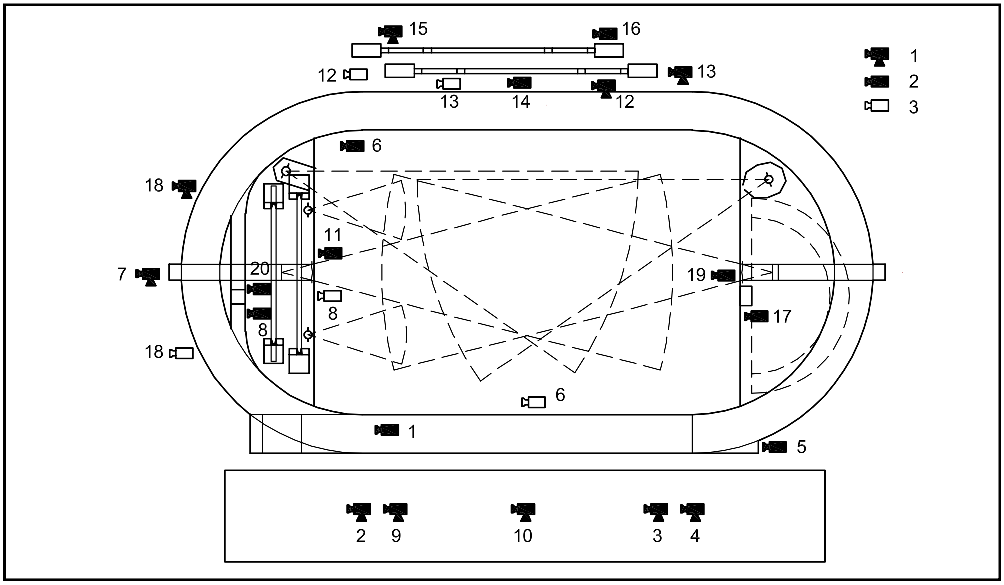



**Figure 4.2.2.3.2b - Camera positions for major events**
1 Fixed camera, 2 hand-held camera, 3 alternative position

Cabling ducts to known camera positions should be foreseen in the stadia construction. Access to camera positions and cables is required at all times. Cameras and cable connectors must be protected from the elements, in particular flowing water (rain/flood). Every effort should be made to ensure that human and vehicular traffic over cables is kept to a minimum.

In-field connection points for TV cameras are of critical importance.
Channelling inside the track kerb is required for circulation of television, computer, timing and general electrical cabling. Access to the channel at regular intervals is a necessity.

Individual camera positions which are cabled require constant power supply from the OB van through a suitable connector. Up to 15 cameras can be connected to one OB van.

#### *4.2.2.3.3 Unilateral Facilities*

Whilst the majority of participating television networks at major competitions will rely exclusively on the host broadcaster signal, some major networks will wish to supplement the host broadcaster coverage with their own feed. This will require additional cameras (and possibly platforms/platform space) particularly at the finish line, interview area and editing facilities. At major games/championships reservable studio facilities and equipment are required within the international broadcast centre.

To sustain a major unilateral operation requires huge staffing and will impact on accreditation considerations. Independent security measures are often arranged for a major unilateral operation and responsibility for this must be agreed in advance.

Major telecommunication requirements include the reservation of satellite channels and up-links from the IBC to the relevant satellite. Unilateral operations will have a major requirement for international telephone and telefax facilities within the TV compound and the IBC.

#### *4.2.2.3.4 Finish Line Positions*

Any television network undertaking unilateral coverage will seek a minimum of one camera position head-on to the finish line. From this platform the camera will concentrate on individual athletes, particularly where national interest arises.
The same camera will be employed for post-event interviews. Access is therefore required for cameramen, sound recorders, interviewers and technicians/engineers but not necessarily all at the same time.

The post-event interview area/mixed zone is the most pressurised zone in any athletic stadium. It therefore needs careful planning as to distribution of space, priority, security and control.

#### *4.2.2.3.5 Interview Area*

Television requires the earliest opportunity to interview participants in the moments after completing an event. To achieve this end in a controlled, dignified manner, a unilateral interview area must be created beyond the finish line en route to the exit point from the track into the stadium and the mixed zone. Radio interviews will take priority over those by journalists in the mixed zone area. Space must be provided at the finish line camera point for the conduct of interviews with individual athletes.

Figure 4.2.2.3.5 illustrates the finish line positions and interview area.

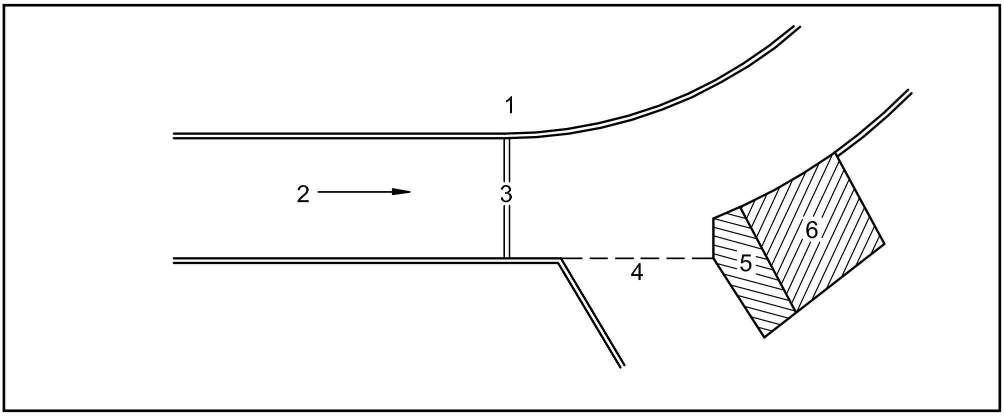



**Figure 4.2.2.3.5 - Television finish-line positions and interview areas**
1 In-field, 2 direction of running, 3 finish-line, 4 exit for athletes to mixed zone
5 unilateral television interview area, 6 unilateral television finish-line positions

#### *4.2.2.3.6 In-Field Positions*

In providing television coverage for participating broadcasters, the host broadcaster requires presence on the in-field. This is particularly relevant for field events. Maximum use can be made of hand-held RF cameras for flexibility but some use of cabled cameras will be necessary. It is essential therefore to plan for the necessary cabling and relevant channelling/ducts and power points beneath the track and in-field.

#### *4.2.2.3.7 Mixed Zone*

After the unilateral television area, priority in the mixed zone must be given to ENG cameras and radio interviews. Space, lighting and accessibility are considerations of importance for all involved.

# 4.3 Operational Rooms and Rooms for Competition Organisation

### *4.3.1 AREA AND ROOM SCHEDULE*

Area and room schedules for the operational rooms and for the competition organisation are variable due to the differences in the location, standard, type and size of sports facilities. A schedule can only be arranged once all details of the facility are known.

The schedule should be arranged into permanent rooms for temporary use. The latter may be provided either by assigning sections of the building temporarily for this purpose or by means of provisional arrangements. Buildings or tents erected temporarily must be suitably sized and well positioned allowing easy access to areas in permanent use.

The lists of rooms shown below serve only as a check list and may be achieved by multiple use of areas and larger rooms.

#### 4.3.1.1 Rooms for Operation and Technical Installations

| | |
|---|---|
| Box for competition director | 4 x 3m |
| Box for stadium announcers | 4 x 3m |
| Box for scoreboard operator | 2 x 3m |
| Box for security/police | 4 x 3m |
| Box for monitor surveillance | as required |
| Box for public address system | 2 x 2m |
| Box for lighting control | 2 x 2m |
| Box for time-keeping | 3 x 5m |
| Toilets | as required |
| Store for Cleaning equipment | as required |

#### 4.3.1.2 Stewards and Public Order Services

| | |
|---|---|
| Assembly and lounge for police, fire brigade and stewards | 1m$^2$ per person |
| Toilets | as required |
| Security cells | as required |

#### 4.3.1.3 Rooms for Organizers/Sports Federations

| | |
|---|---|
| International president's office | 24m$^2$ |
| International secretary general's office | 18m$^2$ |
| National president's office | 24m$^2$ |
| National secretary general's office | 18m$^2$ |
| Competition secretariat | as required |
| Computer room | 30 to 35m$^2$ |
| Technical information centre | as required |
| Rooms for statisticians | as required |
| Conference room (among others for the jury of appeal and for video monitoring) | 20 to 30m$^2$ |
| Small kitchen | min 8m$^2$ |
| Toilets | as required |

### *4.3.2 FURNISHING AND EQUIPMENT*

Generally, the same requirements apply for the furnishings and equipment of the operational rooms and rooms for competition organization as for the rooms for administration (See 4.4.2).

An adequate number of connections for telephone, fax and EDP systems should be supplied.

### *4.3.3 FUNCTIONAL GROUPING*

Figure 4.3.3a shows the layout of the operational rooms and rooms for competition organization in the overall stadium set-up. At large facilities, a separate access and departure area is necessary for these user groups, with parking space for police organizers and for stadium administration staff.

Whilst the rooms for competition organization and administration are situated beneath the stand (or in the immediate vicinity of the stand in a separate building), the operational rooms for competition director, announcers and scoreboard operator are situated in a high, central location of the main stand with a clear view over the whole competition area. It must be ensured that a clear, unbroken line to scoreboards will not be disturbed by cantilever roofing or support pillars.
Whilst acoustically separated from each other, visual contact between these parties is of great assistance (Fig 4.3.3a and Fig 4.3.3b)

Section 4.3.1 also applies to these areas and rooms.

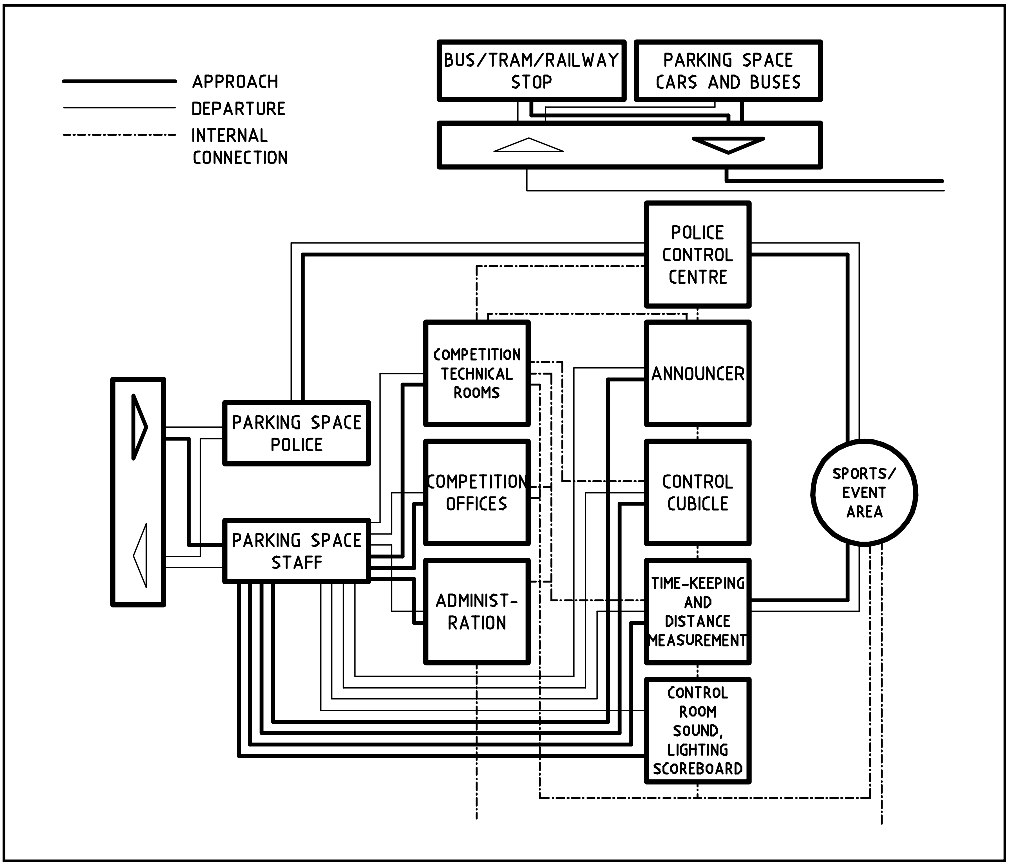
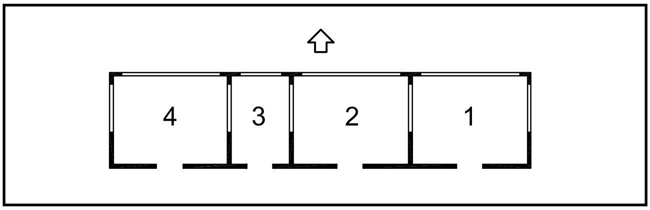



**Figure 4.3.3a**
**Integration of operational rooms and rooms for competition organization into overall concept**

*Source: Planning Principles for Sportsgrounds/Stadia, IAKS Series Sports and Leisure Facilities No. 33*

**Figure 4.3.3b**
**Arrangement of the strategically important positions**
1 Announcers
2 videoboard/scoreboard operators
3 competition director
4 security




# .4.4 Rooms for Administration and Maintenance

## *4.4.1 AREA AND ROOM SCHEDULE*

### 4.4.1.1. Administration

#### *4.4.1.1.1 Reception Area*

| | |
|---|---|
| Entrance hall | as required |
| Reception/Information | as required |
| Telephone exchange | as required |
| Telephones | as required |
| Cloakroom | as required |
| Toilets | as required |

#### *4.4.1.1.2 Offices*

| | |
|---|---|
| Director | $20m^2$ |
| Secretariat | $12m^2$ |
| Other members of staff | $12m^2$/person |
| Accounts dept./entrance tickets administration | $12m^2$ |
| PR and marketing | $12m^2$ |
| Competition organization | $12m^2$ |

#### *4.4.1.1.3 Conference Area*

| | |
|---|---|
| Conference room | 20 to $30m^2$ |
| Small kitchen | |
| possibly also provisions room for administration staff | as required |
| Toilets | as required |
| Store for cleaning equipment | as required |

### 4.4.1.2 Maintenance

#### *4.4.1.2.1 Office for Maintenance Manager*

| | |
|---|---|
| possibly with briefing room | 15 to $20m^2$ |

#### *4.4.1.2.2 Offices for the Technicians*

| | |
|---|---|
| Room for building maintenance | $10m^2$ |
| Room for heating, ventilation, sanitary enginers | $10m^2$ |
| Room for electrical engineers | $10m^2$ |
| Room for groundsmen | $10m^2$ |

#### *4.4.1.2.3 Personnel Rooms*

| | |
|---|---|
| Changing and sanitary room | as required |
| Lounge with small kitchen | min. 8m² |
| or | 1.20m²/person |

#### *4.4.1.2.4 Store Rooms and Workshops*

Ideally these facilities should be located on the eastern side of the arena with separate drive in and drive out entrances. There should be differentiation between those areas controlled by the stadium operator and those rooms under the control of the technical officials e.g. technical implement measurement and storage.

*Sports equipment room*
General requirement:
1m² of equipment space for every 500m² to 700m² of usable sports area.
Additional space may be required for storing landing mats in winter.

| | |
|---|---|
| Maintenance and cleaning room (Lawn mowers, sweepers, high-pressure cleaners, attachments for the sports areas, vegetation and pedestrian areas) | as required |

General requirement for facilities in which maintenance machines are housed:
1m² of equipment space for every 400m² to 500m² of usable sports area;
maintenance is centralized, and machines are transported to and from:
1m² of equipment space for every 700m² and 900m² of usable sports area.

| | |
|---|---|
| Room for fertilizers, cleaning agents and spare parts | as required |
| Storeroom for electrical equipment | as required |
| Workshop | min. 15m² |
| Garage for tractor | 15m² |
| Garage for small pick-up vans, lorries | 15 to 20m² |
| Fuel store | as required |

#### *4.4.1.2.5. Plant Rooms*

The plant required for the adequate functioning of an athletic hall can be situated in different plant rooms. All plant can be controlled from a centrally located control room.

- *Heat plant*
  For a heat plant with gas-fired boilers, a gas-pressure check-room and a gas metering station are needed. For oil-fired boilers tanks are needed.

- *Refrigeration plant*
  The chilled water needed for air conditioning is produced by a refrigeration plant installed indoors and by cooling towers situated outdoors.

- *Ventilation plant system*
  For the individual functional units of a stadium, self contained ventilation plants are needed, positioned near to each functional unit.

- *Transformers and power distributors*
  The incoming high voltage electrical power will be transformed and then distributed through appropriate installations, control panels and switchboards to its destination.

- *Fire fighting water network and water reservoir*
  The requirements of the local Fire Brigade are to be taken into consideration.

- *Mains Room* as required

***4.4.1.2.6 Waste Disposal Area*** as required

### *4.4.2 FURNISHING AND EQUIPMENT*

These rooms must be designed, constructed and equipped to the required standard.

A good orientation system (overview plan, signposting, pictograms, emergency information) should be provided in the entrance area. It should contain glass cases and notice-boards and should impart an impression of clarity and safety to visitors. User-friendly design and furnishing (for example with seating clusters) are recommended.

Corridors, passages etc. should be adequately dimensioned and clearly arranged; doors to administration areas should be uniformly signposted.

Staff rooms are subject to the same requirements as changing rooms, shower rooms and washrooms for sports participants. Lockers should be supplied.
The small kitchen should be equipped with refrigerator/freezer facilities for ready-prepared food, tables and chairs.

The office rooms should normally be equipped with the following furniture:
1 or 2 work desks and accompanying chairs, 2 chairs for visitors, shelving and cupboards.

The dimensions of doors or gates to storage areas, sports equipment areas and garages should be appropriate for the vehicles used. Easily cleaned, oil and impact-resistant, hard-wearing materials should be selected for the floors, for example concrete covering or slab-stone paving. Walls should be impact-resistant and smooth.

Shelving, mountings for equipment, and mobile containers should be provided.

Garages must be provided with sinks, hydrants with hose connections and floor drains with, if necessary, separators.

National regulations concerned with storage of fuel and lubricants must be observed.

The access openings in the workshop must measure at least 1.50m x 2.00m but if vehicle access is possible the above recommendations apply.
Workshops must be equipped to meet all technical demands.

### *4.4.3 FUNCTIONAL GROUPING*

The allocation of areas and rooms for administration and maintenance is shown in figure 4.4.3. The staff has its own entrance and parking space for cars and bicycles. Access is gained to the administrative area, social rooms and workshops, which are interlinked to the sports areas.

It is preferable that equipment and implements should be transported into and out of the infield through a dedicated entrance/exit not used by athletes.

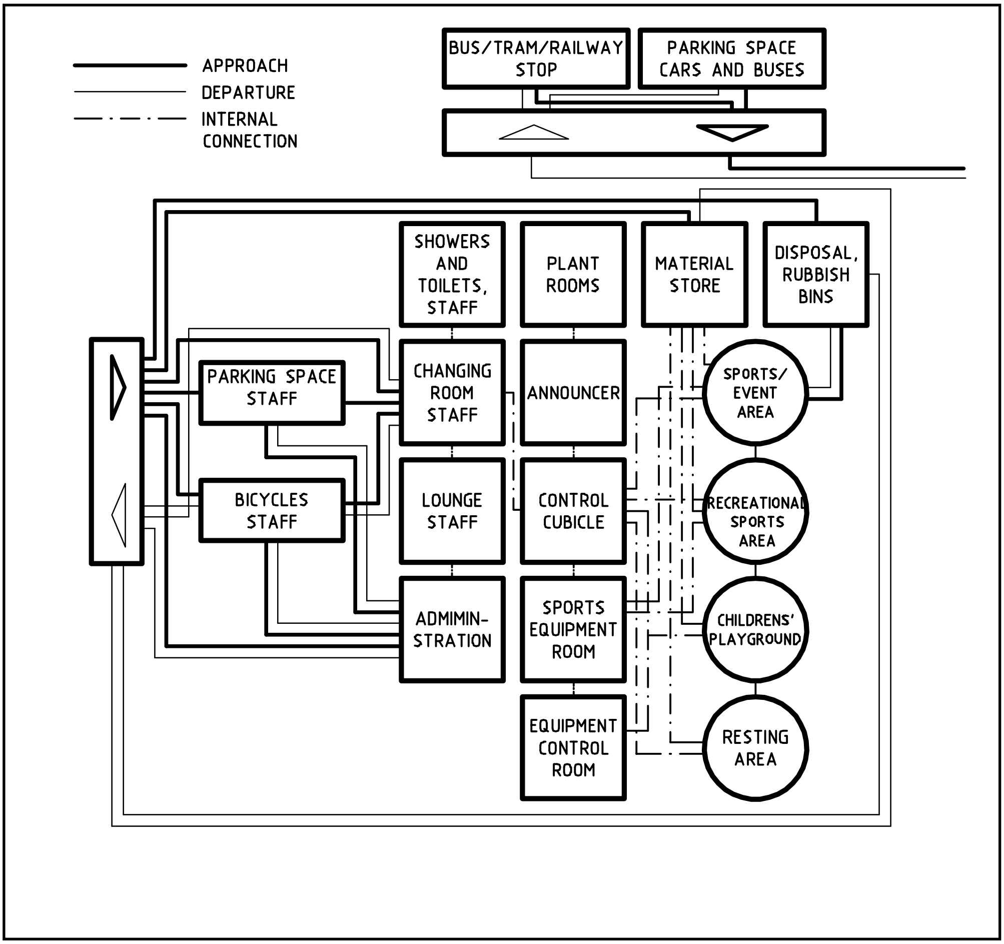



**Figure 4.4.3 - Allocation of areas and rooms for administration and maintenance**

*Source: Planning Principles for Sportsgrounds/Stadia, IAKS Series Sports and Leisure Facilities No. 33*

# CONTENTS - CHAPTER 5
# TECHNICAL SERVICES

# CHAPTER 5
# TECHNICAL SERVICES

# 5. Technical Services

## *5.1. LIGHTING*

### 5.1.1. User Requirements

The users of Track & Field facilities can be categorized according to their activities:

- *Athletes, competition and team officials*
  They must be able to see clearly all that is going on in the competition area so that they can produce their best possible performances, and/or make accurate decisions.

- *Spectators*
  They should be able to follow the performances of the athletes and other action in an agreeable environment. It follows that they must be able to see not only the competition area but also its immediate surroundings. The lighting should also enable spectators to safely enter and leave the sports facility.

- *Television crews and photographers*
  For television and/or film coverage, the lighting must be sufficient to ensure that high quality colour images can be obtained, not only of the overall action but also close-ups of both athletes and spectators. Close-up images are important to convey the excitement and atmosphere in a stadium to viewers watching at home.

As the competence level of athletes increases, so too does the speed of the action and consequently visual task becomes more difficult, requiring more light of a higher quality. Therefore, the artificial lighting for athletics is grouped into five classes reflecting the levels of activity:

- *Non-televised competitions*
  - o Recreation and training
  - o Clubs
  - o National and international

- *Televised competitions*
  - o National
  - o International

## *5.1.2. LIGHTING CRITERIA*

### 5.1.2.1. Horizontal Illuminance (Eh)

It is the illuminance (measured in Lux) on this horizontal plane, at ground level, that chiefly serves to establish the adapted state of the eye, by creating a stable visual background against which people and objects will be seen.

### 5.1.2.2. Vertical Illuminance (Ev)

Vertical planes are used to simulate the light falling on the body of athletes and objects. Generally, Vertical Illuminance is calculated on a vertical plane 1.5 m above the competition area (orientated towards each relevant camera). However, the height chosen could also differ to ensure that athletes taking part in e.g. high jump (around 2.5m) and pole vault (around 6m) are well lit at all times.

#### *5.1.2.2.1. Ev towards fixed cameras*

For the coverage of athletic events, it is usual for there to be a main fixed camera position located close to the finish line of the athletics track. This camera is used to maintain an overall view and continuity of the action over the entire area and for the coverage of specific track events. In addition, additional fixed cameras are commonly used around the competition area. (see sections 4.2.2.3.2 and 8.8.3.2 for camera positions) For cameras used in this way the calculations should be made specifically for them as described in figure below.

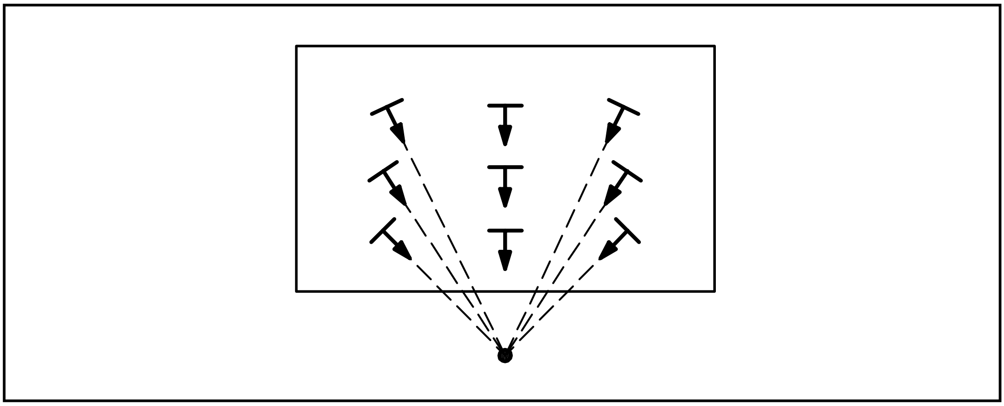


**Figure 5.1.2.2.1 – Vertical planes perpendicular to camera axis at each grid point**

#### *5.1.2.2.2. Ev towards mobile and ENG cameras*

It is now common for many cameras to be distributed around the arena to obtain close-up action shots from alongside each event area. However, each camera is only required to cover a small area of the total competition area. It is therefore not necessary to make calculations for each camera over the whole competition area.

In these situations where unrestricted camera positions are used, it is recommended to calculate the vertical illuminance toward all four sides of the competition area and assess the situation for each camera for the appropriate viewing area.

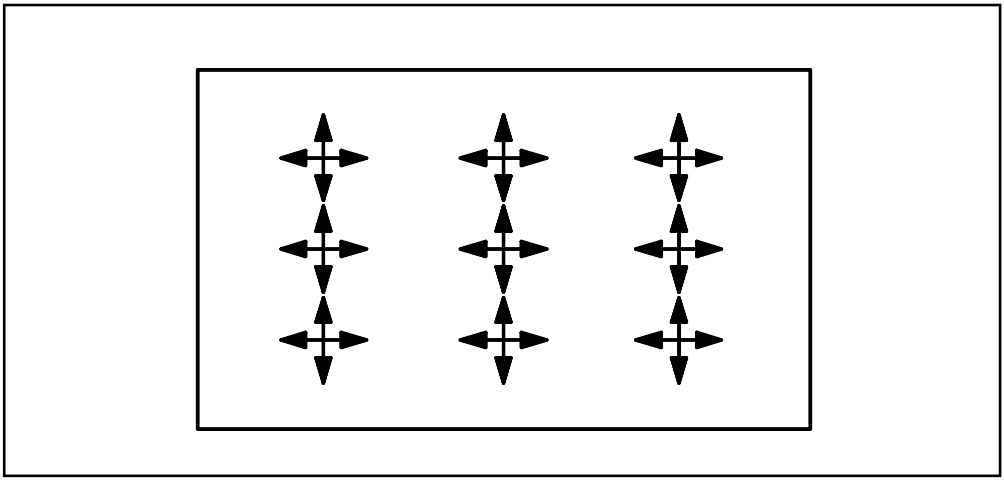


**Figure 5.1.2.2.2 – Vertical planes in four orthogonal directions at each grid point**

When this type of calculation is used, the uniformity (Ev.min/Ev.max) between the four vertical calculations at a single grid point should not be lower than 0.3. This ensures that the modelling for the television camera will be sufficiently high.

#### *5.1.2.2.3. Ratios*

To ensure the television picture has a well balanced brightness, the ratio between the average vertical and horizontal illuminance should be as closely matched as possible, but should not exceed the ratio of 0.5 to 2 times.

To ensure that the reactions of spectators can be captured, it is necessary that the spectator areas immediately adjacent to the competition area (around 15 first rows) be adequately lit. The vertical illuminance level on these spectators should be around but not be less than 25% of that provided for the competition area.

### 5.1.2.3. Illuminance Uniformity

Good Illuminance Uniformity is important in order to avoid adaptation problems for both athletes and spectators. If the uniformity is not adequate, there is a risk that an implement and/or an athlete will not be clearly seen at certain positions on the competition area.

Uniformity is expressed as the ratios of the minimum to maximum illuminance (also called U1) and of the minimum to average illuminance (also called U2):

- U1 = Emin/Emax
- U2 = Emin/Eave

In order to guarantee a visually acceptable illuminated field, a Uniformity Gradient (also called UG) is calculated for all grid points (spaced 5m apart). UG is the ratio in percentage of the Illuminance at the grid point to the Illuminance at every adjacent grid point.

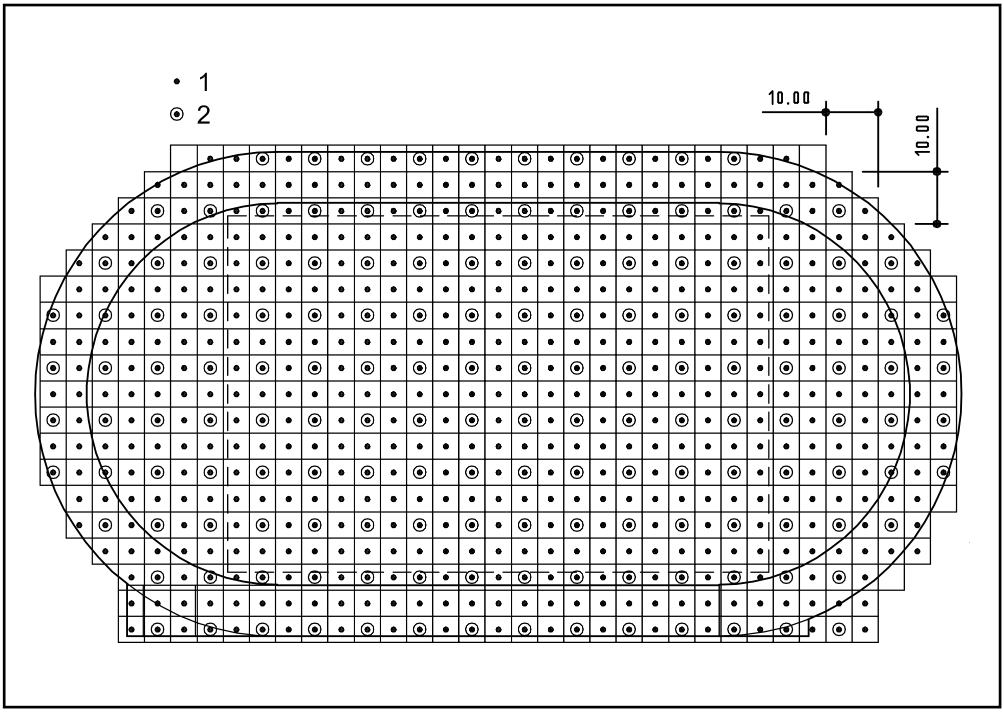



**Figure 5.1.2.3 – Calculation and measurement grid for 400 m Standard Track**

### 5.1.2.4. Glare

Glare is caused by the difference (contrast) between the direct brightness of the lighting installation and the brightness of the competition surface. When the ratio of these two brightness is too high, this will cause visual discomfort or disability.

A method of calculating glare has been defined, resulting in a "Glare Rating" also called GR. GR is assessed on a practical scale of 10 (un-noticeable glare) to 90 (unbearable glare) and should not exceed 50 for any position on the competition area. GR should in principle be calculated for the athlete (observer) positions indicated in figure 5.1.2.4. However, lighting designers may add positions where they believe particular attention is needed (e.g. pole vault or high jump).

### 5.1.2.5. Colour properties of lamps

Good colour perception is appreciated even at recreational and club levels, though becomes more critical for televised events, where natural colour reproduction is expected by today's broadcasters. There are many types of light sources available and many names used to describe them, however light sources can be characterised by two key parameters.

#### *5.1.2.5.1. Colour Temperature*

Colour temperature (also called Tk) describes the feeling or appearance of how warm (red) or cool (blue), a certain type of lighting appears to be; it is measured in "Kelvin" (K).

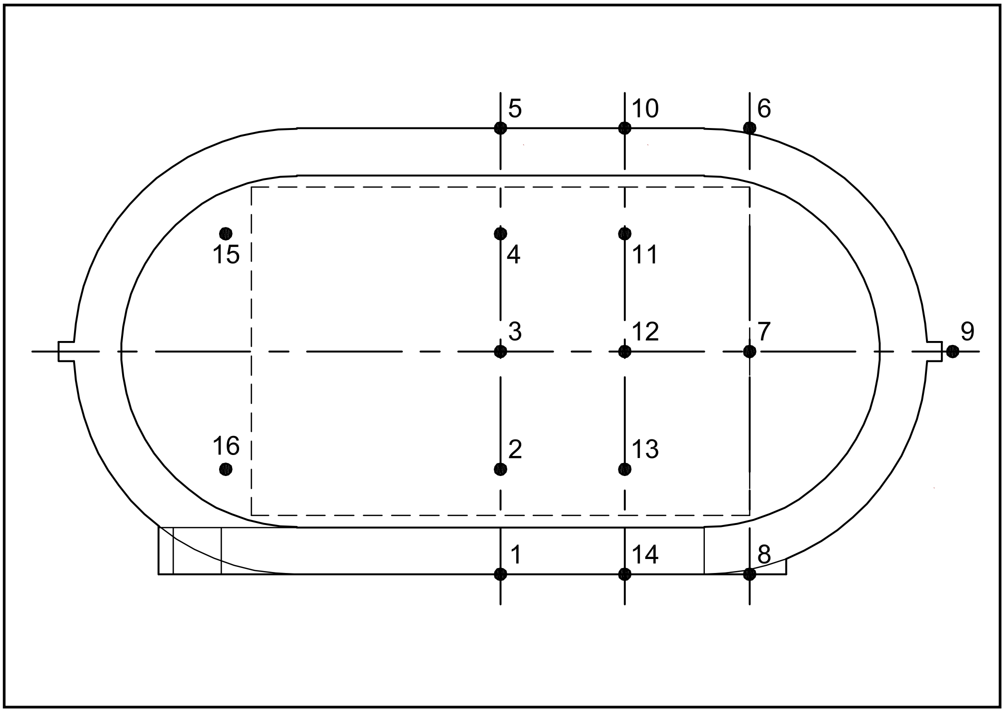



**Figure 5.1.2.4 – Observer positions for calculation of glare rating GR**

A suitable range of colour temperature lies between 2000 K and 6500 K for outdoor facilities and 3000 K to 6500 K for indoor facilities.

Lighting systems used in combination with daylight should have a colour temperature close to that of daylight. A camera system can only adapt to one colour temperature at a time. In addition the preferred photographic films for sports usage are daylight balanced to around 5500 K. For televised events, a colour temperature range between 4000 K and 6500 K shall be used.

#### *5.1.2.5.2. Colour Rendering Index*

Colour rendering (also called Ra or CRI) describes the ability of a light source to faithfully reveal and reproduce the natural colours. Colour rendering is ranked on a practical scale from Ra 20 to 100. Where the higher the index the better the colour accuracy.

The degree of colour accuracy of a sports lighting system depends upon the purpose of the installation. For instance, recreational activity is less demanding than that of televised events where promotional materials must be reproduced accurately. High colour rendering contributes to the quality of televised and photographic images.

## *5.1.3. LIGHTING RECOMMENDATIONS*

### 5.1.3.1. Non-televised events

Where athletics facilities are to be used for non-televised activities, it is only necessary to provide a horizontal illuminance suitable for the required level of activity.

| ***Activity level*** | ***Horizontal Illuminance*** | ***Uniformity*** | | ***Colour properties of lamps*** | |
|---|---|---|---|---|---|
| | Eh ave (lux)* | U1<br>Emin. / Emax. | U2<br>Emin. / Eave. | Colour Temperature Tk (K) | Colour Rendering Ra |
| Recreational & training | 75 | 0.3 | 0.5** | > 2000 | > 20 |
| Club competitions | 200 | 0.4 | 0.6 | > 4000 | ≥ 65 |
| National & International competitions | 500 | 0.5 | 0.7 | > 4000 | ≥ 80 |
| Notes:<br>* Illuminance values are minimum maintained average values ; initial values are 1.25 times higher.<br>** When only the track is to be used and the in-field lights are switched off, U2 should be ≥ 0.25 | | | | | |

| | |
|---|---|
| Glare Rating (GR) | ≤ 50 |
| Uniformity Gradient (UG) per 5 m<br>(only for national & international competitions) | ≤ 20% |

**Table 5.1.3.1 - Minimum requirements for non-televised events**

### 5.1.3.2. Televised events

Where colour television broadcasting is a requirement, it is necessary to provide an adequate vertical illuminance across the scene viewed by the camera. If the vertical illuminance toward cameras is not sufficient, good quality broadcast pictures will not be possible.

| ***Activity level*** | ***Camera position for calculation*** | ***Vertical Illuminance toward cameras*** | ***Minimum Uniformity*** | | ***Colour properties of lamps*** | |
|---|---|---|---|---|---|---|
| | | Ev ave (lux)* | U1<br>Emin / Emax | U2<br>Emin / Eave | Colour Temperature Tk (K) | Colour Rendering Ra |
| National & international competitions + Emergency TV lighting | Fixed camera | 1000 | 0.4 | 0.6 | > 4000 | ≥ 80 |
| Competition of major international importance such as Word championships and Olympic Games | Slow motion camera | 1800 | 0.5 | 0.7 | > 5500 | ≥ 90 |
| | Fixed camera | 1400 | 0.5** | 0.7** | > 5500 | ≥ 90 |
| | Mobile camera | 1000 | 0.3 | 0.5 | > 5500 | ≥ 90 |
| Notes:<br>* Illuminance values are minimum maintained average values ; initial values are 1.25 times higher.<br>** For Finish Line cameras U1 and U2 should be ≥ 0.9 | | | | | | |

| | |
|---|---|
| Ev point over 4 planes (see § 5.1.2.2.2.) | ≥ 0.3 |
| Eh ave / Ev ave (see § 5.1.2.2.3.) | ≥ 0.5 and ≤ 2 |
| Ev ave first rows of spectators (see § 5.1.2.2.3.) / Ev ave | ≥ 0.25 |
| Glare Rating (GR) | ≤ 50 |
| Uniformity Gradient (UG) per 5 m | ≤ 20% |

**Table 5.1.3.2 - Minimum requirements for televised events**

#### 5.1.3.3. Anti-panic lighting

For the purpose of safety and orientation for the spectators, in the event of a main power failure or emergencies, it is recommended to maintain an illumination of at least 25 lux in the stands.

#### 5.1.3.4. Modelling and shadows

To limit the length and hardness of the shadows caused by the athlete, the distribution of the total flux installed should be no greater than 60% for the main camera side and no less than 40% for the opposite side. The design of the lighting system should be based on light coming from at least two directions (side lighting) or, ideally, from as many directions as possible to create good visibility and modelling in all directions.

### *5.1.4. INSTALLATION RECOMMENDATIONS*

The lighting design for an athletics facility can be based on a number of basic floodlight arrangements. The mounting system employed may be either masts, columns or the structure of the stadium itself such as the roof.

#### 5.1.4.1. Permitted longitudinal positioning of the floodlights

In the majority of cases, athletics facilities will have limited, or no, spectator capacity and can be illuminated using floodlights mounted on columns arranged around the perimeter of the competition area. Where columns are used to support the floodlights, these columns should be positioned at least 4m from the edge of the track to prevent obstruction for athletes using the competition area.

Where the in-field is also used for other sports such as soccer at a competitive level, it will be necessary to position columns so that to maintain good visual conditions for the goalkeepers and attacking players from the corners, lighting equipment shall not be placed within a zone of 15° either side of the goal line for televised competitions and 10° for non-televised competitions. (See figure 5.1.4.2.)

#### 5.1.4.2. Pre-determination of tower height

Tower height must be selected so that all parts of the field can be illuminated to the required standard for the number of cameras to be used. Column heights can initially be estimated by ensuring that the angle subtended at the centre of the competition area to the head-frame centre shall be not less than 25° (h = d x tan ?), while ensuring that no luminaire is aimed above 70° from the downward vertical. (See figure 5.1.4.2.)

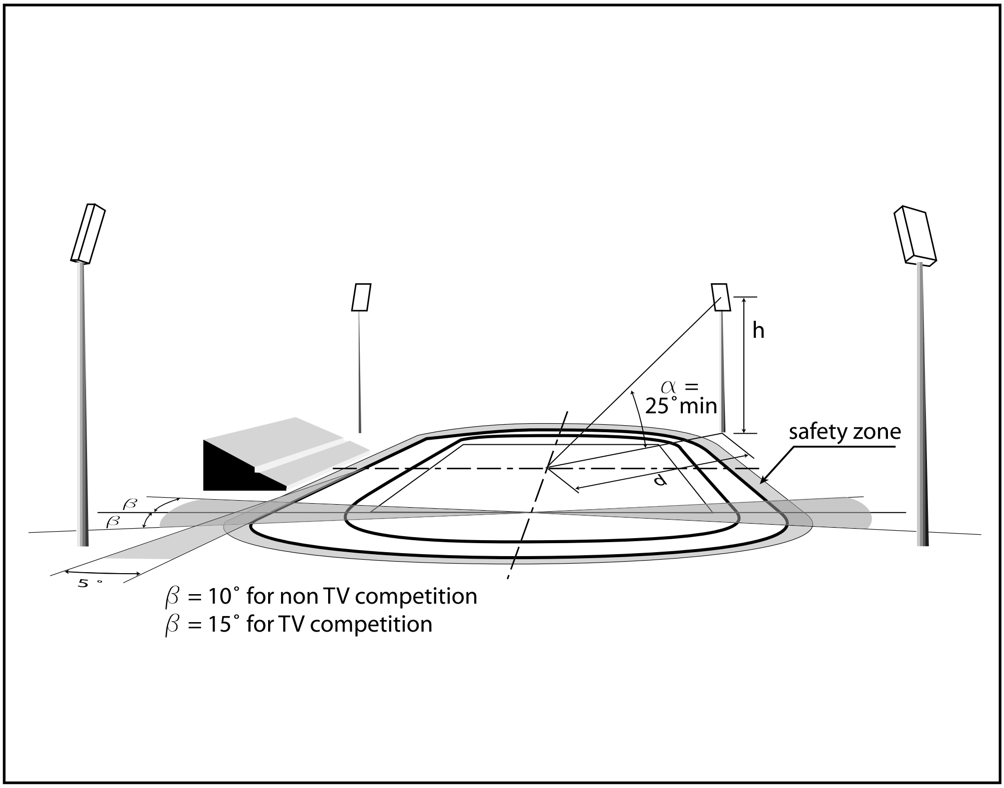



**Figure 5.1.4.2 – Floodlights positioning**

### 5.1.4.3. Stroboscopic Effect

All high intensity discharge (HID) lamps, operating on an alternating voltage will exhibit a fluctuating lighting output. This effect is referred to as "flicker" or stroboscopic effect. It is particularly disturbing to television cameras and photo-finish equipment and can cause loss of pictures at a critical moment. It can be minimised by ensuring that the illumination is provided by groups of three luminaires with overlapping beams. Each group of luminaires should be balanced across the three phases whether the individual luminaires are designed for connection between a phase and neutral or between two phases.

## 5.2 Measurements

The measurement of time, distance and wind speed today demand maximum objectivity and accuracy. The instruments employed must be geared to the needs of the discipline. So that the spectator's need for information is satisfied, scoreboard systems have to be available in stadia as field boards and time elapsed clocks for the field events and as boards for the running times in track events and as large scoreboards for displaying the results.

### *5.2.1 TIMING*

Because of the intensity of top-level competition in today's sprint events, timing has to be more accurate than in the past. In the early years of track events the hand-operated stop-watch was sufficient. When new methods of timing were developed (including devices controlled by the starter's gun) it was also essential to be able to determine precisely the order of finishing. With time differences measured to the nearest 1/1000 of a second, it is often impossible for the human eye to determine the respective positions. As a consequence, other methods of recording were sought. The slit camera seemed a suitable alternative. Here the slit is aimed at the finish line and records it in relation to time. It thus facilitates the identification of a definite finishing order with the allocation of the respective times.

The video-based timing system more recently introduced is also a slit camera which records the finish line over a period of time. The advantage of this system over the photo finish system is that the pictures are immediately available for scrutiny and they can be relayed directly to the spectators in the stadium (via monitors or colour video matrix scoreboards) or to the television viewers. Furthermore, no chemicals are required for developing the pictures.

For video timing a vertical CCD line is aligned with the edge of the finish line. This line is significantly narrower than the slit of the slit cameras previously used. As a result the contours are never blurred. However, it is essential to ensure that the resolution meets the requirements (approximately 1,000 pixels in height). The minimum number of columns for the smallest measured unit should be 10 as otherwise the last decimal cannot be guaranteed (if times are measured to the nearest hundredth of a second, the resolution should be 1,000 pixel/s, i.e. 10 in 1/100s).

### *5.2.2. DISTANCE AND HEIGHT*

#### 5.2.2.1 Distance for Throws

The beginning of the 1970s saw the introduction of the measurement of throwing distance by tacheometer, a method long in use in land measurement. This system is faster than by measuring by tape. The accuracy of the measured distance is ± 0.005m and of the measured angle ± 10 angular seconds, which is equivalent to an average error for thrown distances of ± 0.005m.
A direct measurement of a performance with an electro-optical angle and distance measuring instrument is not possible as the instrument cannot be set up beyond the centre of the throwing circle or arc during competition. The throwing distance is, therefore, measured from an eccentric point by means of combined distance and angle measurement.

Figure 5.2.2.1 gives an example for measurement of a throw distance.

Before the start of competition, the base line B (tacheometer position to centre of the throwing circle) and the direction are measured and, including the radius of the circle, stored. With the aid of an inbuilt microprocessor, the horizontal distance A and the direction to the reflector inserted by the judge at the impact mark left by the implement are measured after each throw. The throwing distance C then is calculated from the stored data in fractions of a second using the following formula:

$$C = \sqrt{A^2 + B^2 - 2AB \cos \alpha} - R$$

It takes only about 10 seconds from the insertion of the reflector to the automatic indication of the distance on the field boards.

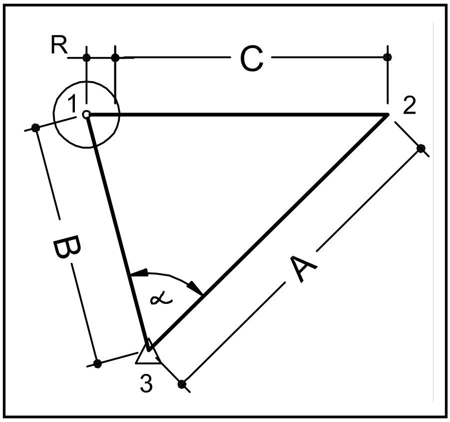



**Figure 5.2.2.1**
**Principle of measuring distance**
**(Example: Shot put)**
1 Shot put circle
2 point of landing
3 electronic tacheometer

### 5.2.2.2 Distance for Long and Triple Jumps

The technical equipment and trigonometry for calculation of length of jump are the same as for the throws with the base line B (see Fig. 5.2.2.2) being measured from the tacheometer to the take-off line.

### 5.2.2.3 Height

For the control measurement of the height of the crossbar for high jump and pole vault, the tacheometer mentioned in 5.2.2.1 can be employed with sufficient measurement accuracy provided that

- the instrument is set up at least 35m from the perpendicular beneath the crossbar;
- the instrument's position deviates no more than 2m from the vertical axis of the runway, and
- when installing the measuring system for the pole vault, it has been checked that the position of the uprights and crossbar coincide with the zero line.

For the pole vault facility it is also essential to ensure that to change the crossbar distance from the zero line (0.80m or 0.40m) the slides of the uprights on the ground or the supporting structure of the crossbar displacement of uprights in ground sockets are completely horizontal.
For the pole vault for example, the height (H) of the crossbar above the runway level is calculated with the following formula:

$H = A + B + C$
where
$C = Bl \tan ß$

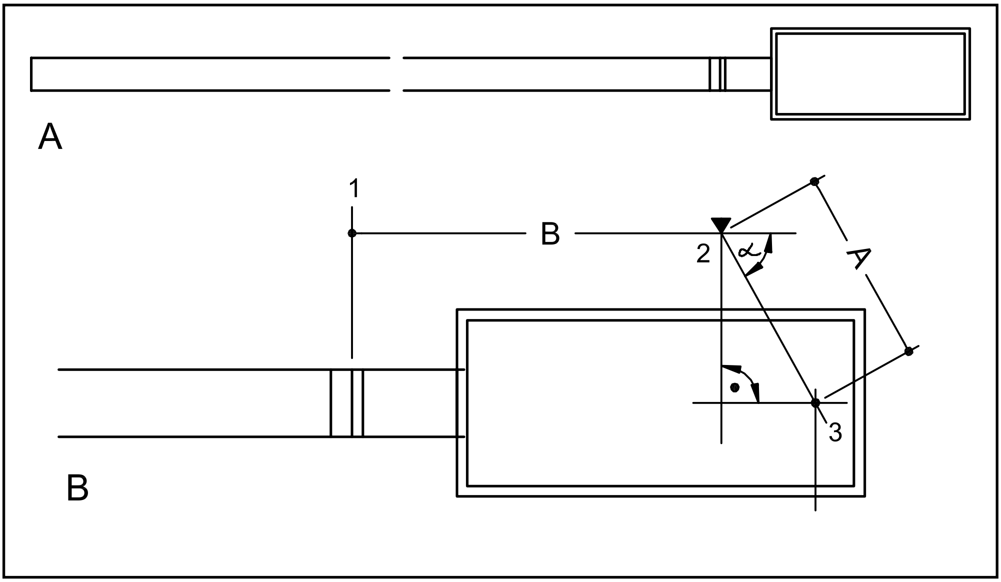



**Figure 5.2.2.2 - Principle of measuring distance (Example: Long jump)**
A Top view of a Long jump facility
B Detail
1 Take-off line, 2 electronic tacheometer, 3 point of landing (reflector at the impact mark)

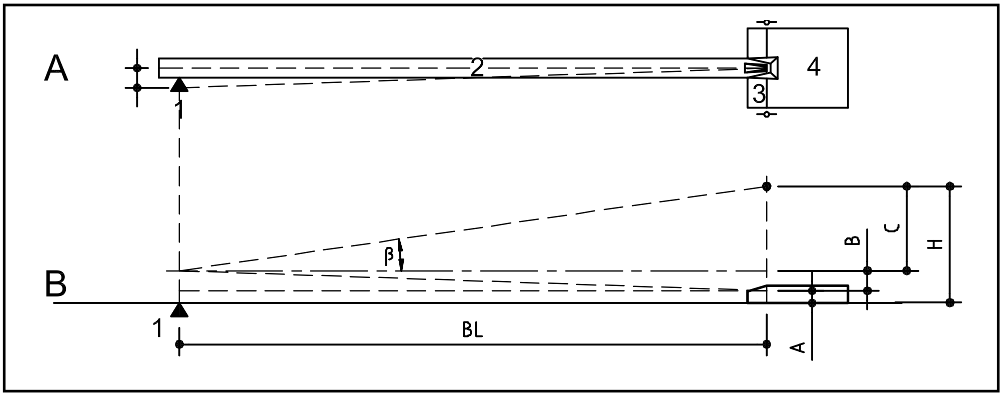



**Figure 5.2.2.3 - Principle of checking height**

### *5.2.3 WIND SPEED*

Any type of wind gauge may be used to measure wind velocity, provided it is certified as accurate by an appropriate authority. Gauges currently available measure wind velocity either by mechanical means (moving propellers) or by the use of ultra-sonic technology.

Because there are no moving parts as in propeller wind gauges and as the effect of air properties is eliminated, ultrasonic wind gauges are inherently more accurate and reliable.

Wind gauges shall be used in the following events:
100m, 100m Hurdles, 110m Hurdles, 200m, Long Jump, Triple Jump.

They shall be positioned 1.22m high and not more than 2.00m away from the track or runway.

For Track Events they shall be placed besides the straight, 50m from the finish line, adjacent to lane 1.

For Long and Triple Jump they shall be placed 20m from the take-off board.

The wind gauge may be linked to the start/timing system and electronically activated or manually operated.

The periods for which wind velocity shall be measured in Track Events shall be:

| | |
|---|---|
| for 100m from the flash of the starter’s gun | 10 seconds |
| for 100m Hurdles | 13 seconds |
| for 110m Hurdles | 13 seconds |
| for 200m from when the first runner enters the straight | 10 seconds |

In the Long Jump and Triple Jump, it shall be measured for a period of 5 seconds from the time the athlete reaches a mark on the runway placed 40m from the take-off board for the long jump and 35m for the triple jump.

If a competitor runs less than these distances the wind shall be measured from the time he commences his run up.

All wind velocities shall be read, and recorded, in metres per second, rounded to the next higher tenth of a metre per second in the positive direction.
Digital gauges shall be constructed so as to comply with this.

### *5.2.4 CABLES*

To connect up the timing, distance measurement and data processing equipment, permanently laid cables should be provided. They enable the equipment to be swiftly installed and significantly reduce the risk of accidents caused by loose cables (figures 5.2.4a to 5.2.4c). Cable ducts for permanent cables should have a minimum diameter of 0.30m. Depending on the design of the stadium, there should be 4 to 7 manholes with connection points for the field boards.

Not only the control cables should be permanently laid but also the feed cables. Depending on the applicable national standards or guidelines, two cable ducts, tubes or racks have to be provided. As TV cables are rarely permanently laid owing to their infrequent use, the ducts should be dimensioned to enable the cables and plugs to be pulled with ease.

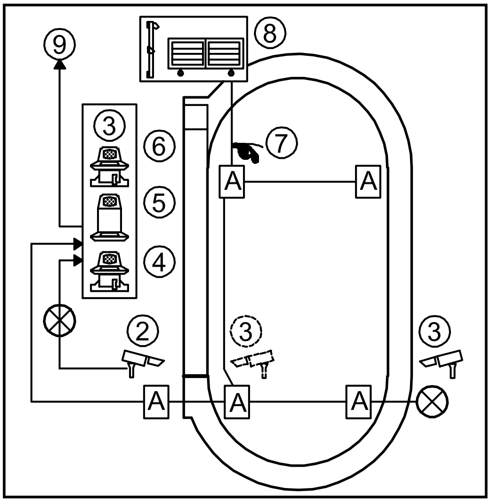



**Figure 5.2.4a - Timing installation**
1 Control room with feed to television, scoreboard and data processing
2 video finish camera I
3 video finish camera II
4 camera I evaluation point
5 computer for processing the information
6 camera II evaluation point
7 starter's gun
8 false start system
9 exit to TV, connection to data processing and exit to scoreboard
A Manhole with connection points for permanent cables for track and field events.

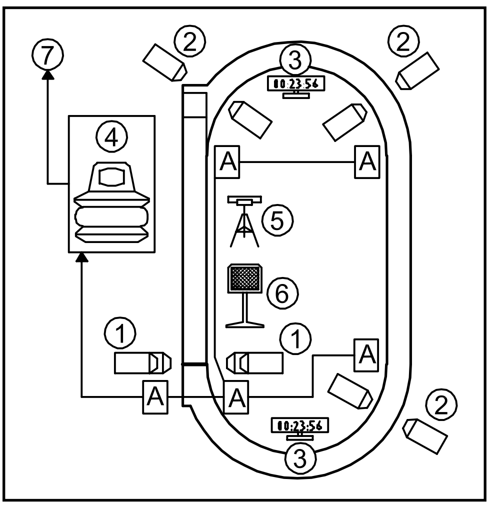



**Figure 5.2.4b**
**Cables and auxiliary equipment for timing**
1 Double photoelectric cell at the finish line
2 photo electric cells for the intermediate times
3 numeric board for the running time
4 timing instrument for intermediate times
5 wind gauge, measurement for track events
6 lap counter
A Manhole with connection points for permanent cables for track and field events.

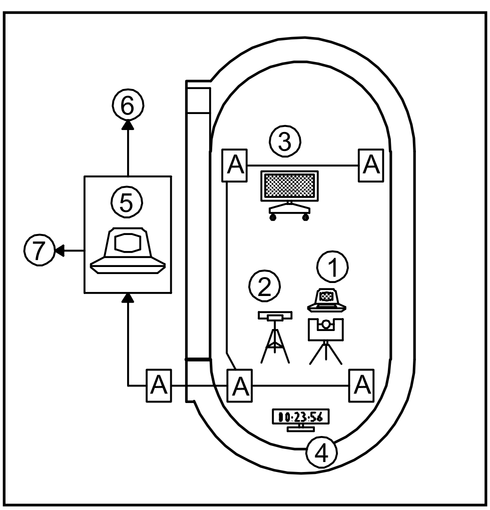



**Figure 5.2.4c**
**Cables and auxiliary equipment for field events**
1 Tacheometer; for measuring distance and checking height for high jump and pole vault
2 wind gauge
3 field board with computer
4 time elapsed clock (concentration clock)
5 control room for data processing
6 exit to scoreboard and television
7 exit to main data processing station (only for major events)
A Manhole with connection points for permanent cables for track and field events.

### *5.2.5 FIELD BOARDS*

Each board should provide as much information as possible including athlete's name, competitor's number, nationality, details of the performance and the current position of the athlete. To be able to display such information, the boards should have at least 3 lines of 10 characters or 2 lines of 10 characters if the information is displayed sequentially.

## 5.3 Scoreboards

Modern sports facilities require information systems which will keep spectators, sports participants, officials and media representatives fully informed of what is happening in the arena. If required, these installations can also promote the safety of spectators and athletes.

At major sportsgrounds, the spectator should not only be kept informed about what is happening in the sports arena, but also be given the opportunity to familiarize himself with the athletes (features on individuals or entire teams), or to watch live recordings of the actual event or action replays (including slow motion recordings) of special phases of the competition. These information systems can also be used in the intervals for blending in up-to-date news or advertisements.

The following scoreboard technologies are available:
- Scoreboards with incandescent lamps (for colour and black and white)
- Electromechanical scoreboards (split dots, rotating cylinders or others)
- LCD scoreboards
- LED scoreboards
- Cathode ray tubes (one tube per pixel or several pixels)
- Fluorescent tubes (special version of the conventional tube)

The advantages and disadvantages of these technologies are shown in Table 5.3.

| *TYPE OF SYSTEM* | *ADVANTAGES* | *DISADVANTAGES* |
|---|---|---|
| ***Incandescent lamps*** | - Proven technology<br>- Lamps obtainable everywhere<br>- Visible day and night<br>- Ease of maintenance<br>- Relatively inexpensive | - High power consumption<br>- Medium colour quality<br>- High reaction time (after-glow)<br>- Expensive to operate<br>- Lamp reliability at bottom limit in continuous use |
| ***Electromechanical (flip-dot)*** | - Low power consumption<br>- Proven technology<br>- Comprehensible even to non-technically minded<br>- Data remain displayed during power failures<br>- Reflections on protective screen | - Slow (high reaction time)<br>- Limited number of colours (6 maximum, 2 normal)<br>- Not video-compatible<br>- Reliability at bottom limit<br>- Requires mechanical protection |

**Table 5.3 - Advantages and disadvantages of the various scoreboard technologies**

| ***TYPE OF SYSTEM*** | ***ADVANTAGES*** | ***DISADVANTAGES*** |
|---|---|---|
| ***LCD*** | - Basic technology familiar<br>- Low control effort | - Bleeding through is not under control<br>- Continuous power consumption even for black backgrounds (relatively high)<br>- Limited viewing angle<br>- Grid structure not always acceptable (gap between elements)<br>- Contrast at bottom limit of acceptability<br>- High switching time at low temperatures (requires heating)<br>- High reflection |
| ***LED*** | - Inexpensive<br>- Viewing angle of at least 160 degrees horizontally<br>- Short reaction time<br>- Long service life<br>- High reliability<br>- Lower power consumption and heat output<br>- Good luminance of red | |
| ***Cathode ray tubes*** | - Good reliability<br>- Good colour quality<br>- Familiar technology<br><br>- No limit to size | - Expensive<br>- High power consumption<br>- Strong electrostatic field, attracts dust<br>- Visibility impaired in direct sunlight<br>- High voltage<br>- Frequent adjustment<br>- Cleaning of front<br>- 50% decline in luminance after 8,000 hours of service |
| ***Fluorescent tubes*** | - Good visibility in direct sunlight<br>- Good legibility<br><br>- Good colour quality<br><br>- No limit to size<br>- Very short reaction time<br>- High luminance<br>- Visible day and night<br>- Familiar technology<br>- High contrast<br>- No sunlight reflection<br>- No scanning<br>- 25% decline in luminance after 7,000 hours of service<br>- Pixel simple to replace | - High power consumption<br>- Heating necessary at low temperatures<br>- Small pixels are difficult and expensive to replace |

**Continuation of Table 5.3**

Since 2000 LED devices have become the dominant technology for large screen display. LCD, Cathode Ray Tube and Fluorescent Discharge displays are still in use and can offer good performance if well maintained however no manufacturers are currently offering this technology for new applications.

### *5.3.1 BOARD TYPES*

The technology allows the realization of large colour video matrix boards (huge monitors) of up to 200m$^2$. The size to be chosen depends on the size of the stadium and the position of the board inside the facility.

#### 5.3.1.1 Numeric boards
They only permit the indication of numeric results without names or other alphanumeric information.

#### 5.3.1.2 Alphanumeric boards
They permit a full display of results in capital and small letters, like matrix boards, but only in one character size. The display of graphics is very limited.

#### 5.3.1.3 Matrix boards (2-tone)
They permit a full display of results and the presentation of graphics and line drawings. A rapid succession of graphics also permits the display of animations and cartoons in black and white.

#### 5.3.1.4 Colour video matrix boards
These are similar to large TV screens although the resolution is less fine. For an acceptable picture quality, the boards must have at least 100 and if possible 200 lines. The boards are also used for displaying results. Each pixel must be driven either directly by the computer or for video images by the control unit including the digitizer.

### *5.3.2 CHOICE OF BOARD*

#### 5.3.2.1 Legibility of alphanumeric information
The legibility distance of a text is generally accepted as 500 times the character height. With normal computer text, this entails a matrix of 7 x 5 dots. In an athletics stadium, the maximum viewing distance is 150m to 250m, depending on the size of the stadium and the position of the boards. Therefore, a character height between 0.35m and 0.52m must be used.

#### 5.3.2.2 Pixel size on video matrix boards
On colour video matrix boards, only the approximate pixel size taking into consideration the size of the board and the required solution can be defined. There are no generally applicable standards for video images as it exists for texts. Today the minimum required resolution is 120 to 200 lines. Current technology outdoor displays are likely to have a pixel pitch of between 10mm and 30mm. Therefore in a giant athletics stadium with an average viewing distance of 120m and a maximum distance of 250m, 30mm pixels can be used with a minimum of 192 lines and the height of the board should be about 6m.

#### 5.3.2.3 Board size
The height of the board should be 3% to 5% of the maximum viewing distance. For an athletics stadium with a maximum viewing distance of 250m, this yields a height of 7.5m to 12.5m. A height of 7.5m permits 11 lines of a 0.52m high text. The minimum length of the board is dictated by the widescreen television screen for aspect ratio of 16:9. However as a compromise programmes are often made/broadcast in 14:9 so that the images are viewable on both types of TV set. Accepting that the display height is the critical factor boards have to increase in overall size and cost by 20% to accommodate the new format without compromising on effectiveness for both text and Video images.If the alphanumeric information requires a longer board than that demanded by the television format, either the height should be increased, a non-TV-standard format should be accepted, or a combined board consisting of colour and and black and white sections should be employed.

#### 5.3.2.4 Luminance and contrast

Good legibility depends not only on the luminance, but also, and above all, on a strong contrast. On matrix boards (2-tone), the contrasts in extreme conditions (direct sunlight) must be at least 4 but preferably 6. On colour video matrix boards, on the other hand, the contrast must be higher (8 or 10). This contrast is defined by the ratio of the sum of reflected and emitted light to the reflected light. The reflected light of a scoreboard with a black background varies from 3% to 15% of the solar reflection of a white sheet of paper. Good boards have low reflection values. The reflection of a white paper exposed to the sun varies from 10,000 NIT to 15,000 NIT (candles per $m^2$) and on snow it may be as high as 25,000 NIT. The calculations of most manufacturers are based on 5,000 NIT as this value is rarely exceeded. Reflection may increase by 4% to 5% due to the accumulation of dirt on the front over a period of time.

With a reflection of 5%, the boards must have the following minimum luminance:

2,000 NIT for 2-tone matrix boards
4,000 NIT for colour video matrix boards

Assuming the above conditions, the luminance of 4,000 NIT for colour video matrix boards when new and clean yields a contrast of 11. At the end of the lifetime of the element luminosity decreases at least 25 and often 50% therefore the contrast decreases to 8.5 or even 5 as long as the frontface is clean. With a dirty frontface the contrast is reduced to 7 from 8.5 and to 4 from 5. This shows clearly that the original luminosity has to be chosen in accordance with the reflection and the loss of luminosity due to aging. A boards nominal luminosity is the value which it has after at least 100 hours of service.

#### 5.3.2.5 Choice of board size

A matrix board allows not only text with 7 x 5 dots, but many other matrices as well. However, as soon as a matrix with more than 7 x 5 dots is selected, the quantity of information is reduced. If, for example, 10 lines of 32 characters can be displayed on a given board size (with a matrix of 7 x 5 dots), only 5 lines of 16 characters are possible with a matrix of 14 x 10 dots.

At major athletics meetings, at least 10 lines of 32 characters are required to display the position, name, nationality (3 characters) and performance. In a stadium with a viewing distance of 200m to 250m, the character height must thus be at least 0.52m. This yields a distance between the dot centres of 0.075m, given a matrix of 7 x 5 pixels. The distance between the lines should, preferably, be 3, but a minimum of 2 dots. The distance between the characters should be 2, but 1 dot minimum. A matrix board must therefore have 90 to 100 vertical dots and 192 to 210 dots horizontally. In most cases, boards with 192 horizontal and 100 vertical dots are used. The matrix field thus has a height of 7.5m and a length of 14.4m. This height thus corresponds to the given minimum height of 3% of the maximum viewing distance.

A portable colour video board of 32m2 area with an aspect ratio of 4:3 would have an image height of 4.8m. With the height as 3% of the maximum viewing distance would give a maximum viewing distance of 160m. The size of the board would increase to 40m2 for an aspect ratio of 14:9 for widescreen format. The basic writing matrix is 11 x 7 pixels.

### *5.3.3 FUNCTIONS*

All functions are controlled by the video or computer system. The information must be displayed at the speed or in the sequence demanded by the control system. For video signals, the board must be capable of indicating 25 or 30 or, alternatively, 50 or 60 frames per second. If fast-reacting display elements are employed, the display frequency must be increased so that no flicker is perceived by the human eye. The number of frames in this case must be 75 per second or more. This is achieved by repeating each frame 3 times.

Traditionally video boards have been used to show TV picture and matrix boards for results and timing information. There are now products available capable of displaying television and also accepting information direct from the sports timing /results system. Thus these boards can function as both scoreboard and video display. Specialist interfaces are required to ensure that the alphanumeric information has sufficient clarity.

## 5.4 Public Address Systems

Stadium facilities built to Category I - III standards should be equipped with public address systems used to transmit speech (messages related to anything from event programmes and competition results to safety control announcements) as well as music. Effective safety control announcements require a maximum loudness and good speech intelligibility.

### *5.4.1.REQUIREMENTS AND CRITERIA FOR THE TRANSMISSION OF SPEECH AND MUSIC*

Speech intelligibility is a subjective criterion difficult to quantify. While general-purpose announcements require only a low level of intelligibility, advertising must be fairly easy to understand. The highest degree of intelligibility is required for safety control announcements made by the stadium announcer or the police, as such announcements may be vital to the spectators.The parameter determining the intelligibility of spoken messages is the percentage of consonants correctly received by the listener. These sounds are primarily transmitted in the upper frequency range.

90% of all speech intelligibility is achieved in the range between the 500 Hz and 4 kHz octaves. This corresponds to a frequency range of approximately 350 to 6000 Hz, which can be delivered by fairly basic public address systems.

For transmission of music, however, the situation is different. In order to achieve an appropriate reproduction quality, it is necessary to add both the lower frequency band from 50 to 100 Hz upwards and, even more importantly, the higher range up to 10 kHz and beyond (Fig 5.4.1). The transmission of music will therefore require a more sophisticated loud-speaker system than a facility designed only to transmit spoken messages (See 5.4.5).

### *5.4.2. REQUIRED TRANSMISSION VOLUMES*

In the absence of interfering background noise, speech is easily intelligible even when whispered. However, as we are permanently surrounded by background noise

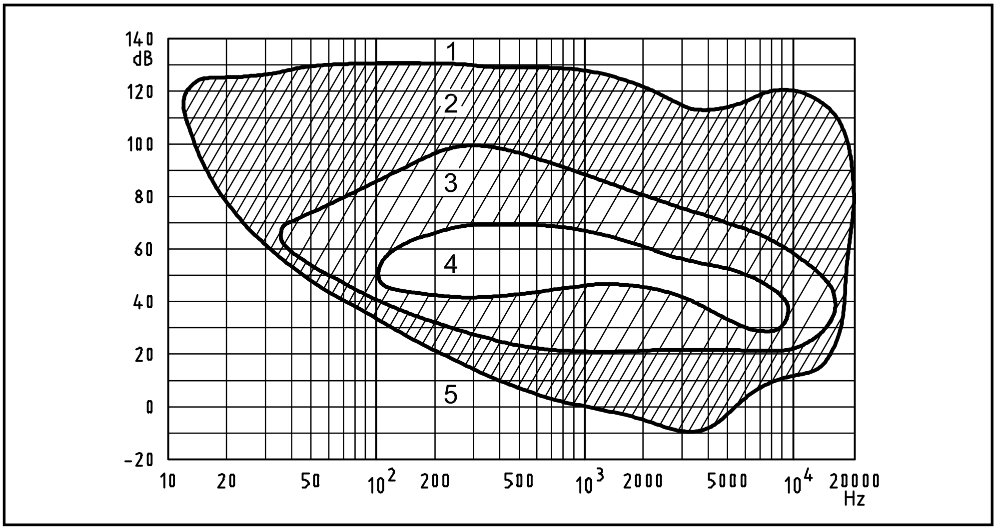



**Figure 5.4.1 - Frequency and dynamic ranges of speech and music within the overall audible range**

1 Pain threshold, 2 audible range, 3 orchestra range, 4 language range, 5 audible threshold

*Source: Handbuch der Elektroakustik, Boye/Herrmann, Hüthig Buchverlag, Heidelberg*

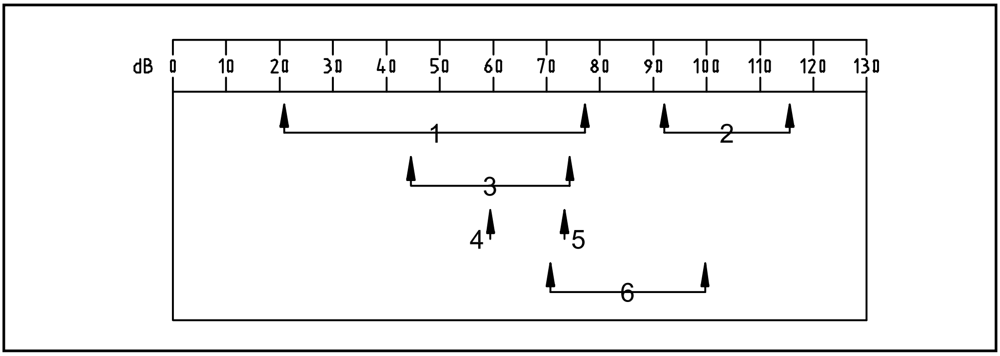



**Figure 5.4.2 - Loudness levels and dynamic ranges of various interference noise sources**

1 Street noise, 2 thunderstorm, 3 traffic, 4 passenger car, 5 truck, 6 motor bicycle

*Source: Handbuch der Elektroakustik, Boye/Herrmann, Hüthig Buchverlag, Heidelberg*

from the environment (wind, traffic, spectator noise in sports facilities, etc.), the useful information signal must at all times remain above this noise level. An illustration of the loudness levels and dynamic ranges of various noise sources is given in figure 5.4.2.

Loudness is measured in phons or decibels (dB). Whereas phon is the unit of the frequency-related loudness perceived by the human ear, dB is a technical unit of loudness related to the intensity-level scale (at 1000 Hz, phon and dB measurements coincide). Both units are logarithmically defined. Zero phons is the lower human audibility threshold. At approximately 120 phons, noise begins to be associated with pain (the noise level of a normal conversation is approximately 65 to 70 phons). Loudness levels are predominantly indicated in terms of the dB(A) scale, which is essentially identical to the phon scale. The index “A” denotes a frequency-related evaluation curve.

The intelligibility of speech deteriorates as background noise increases. According to an accepted general rule, the useful signal level at the listener’s ear should exceed the background noise by at least 10 dB.
The necessary useful signal levels to be produced in the spectator’s plane of hearing by a loudspeaker system are shown in table 5.4.2. The design of public address facilities should always be based on a ‘least favourable case’ hypothesis, i.e., assuming the highest expected level of interference.

| ***COLUMN*** | ***1*** | ***2*** |
|---|---|---|
| ***Line*** | | |
| ***1*** | ***Interference noise source*** | ***Loudness*** |
| ***2*** | Spectators watching silently | 60 - 70 db(A) |
| ***3*** | Spectators in conversation | 70 - 80 db(A) |
| ***4*** | Wind/traffic | 40 - 70 db(A) |
| ***5*** | Cheers or applause | 95 - 100 db(A) |
| ***6*** | Unrest or panic | up to and over 105 db(A) |

**Table 5.4.2 - Typical spectator and background noise levels in sports stadiums (empirical values)**

In a panic situation involving a maximum spectator noise level of 105 dB(A), the public address system would have to produce a useful signal of 115 dB(A) to ensure the required 10 dB(A) signal-to-noise gap. This would certainly place a severe strain on the economic efficiency of any system. In a large stadium, the fulfillment of the above requirement would necessitate an amplified and loud-speaker output substantially in excess of 100 kW. The need to install such high power levels is avoided by transmitting an attention signal (i.e. a bell or similar tone) some 2 to 3 seconds after an emergency is detected and making the appropriate announcement immediately afterwards. In this case, a loudness level of approximately 100 to 105 dB(A) will be sufficient, especially if an electronic volume compressor/limiter unit is employed to compress the natural speech volume range near the upper modulation/power threshold of the system, which results in a perceived loudness increase of approximately 6 dB.

In athletics competitions, the required loudness level in the inner stadium area (e.g., for calling up or introducing athletes) is less dependent on spectator noise. Here it will generally suffice to design for a useful signal loudness between 75 and 90 dB(A).

The loudness level needed for music transmissions is much lower. For an adequate perception of music it is sufficient to provide a volume approximately equal to the noise level. Depending on the type of music and the purpose of the transmission, the music volume may even be below the noise threshold (background music).

### *5.4.3. ENVIRONMENTAL IMPACT OF PUBLIC ADDRESS SYSTEMS*

Stadium PA systems operating in the immediate vicinity of residential areas may be considered a nuisance by nearby residents. The standard objective, therefore, is to achieve maximum loudness levels inside the stadium while minimizing the emission of sound towards the outside. The conflict of goals imposed by this is difficult to resolve. Loudness is known to decrease in proportion to distance squared, but technically speaking, doubling the distance from the source will attenuate the sound level by a mere 6 dB. In other words, a source generating a sound level of 80 dB(A) at a distance of 20m is still perceived as producing 74 dB(A) at 40m, 68 dB(A) at 80m, etc.

Some countries have set statutory maximum thresholds for facilities situated near residential areas. These specifications must be taken into account in the planning and calibration of public address systems.

A valuable technical aid is the automatic electronic volume limiter. This device can reliably prevent sound level overruns exceeding the statutory thresholds (noise emission in residential areas), even if the announcer speaks very loudly.

### *5.4.4. LOUDSPEAKER ARRANGEMENT*

Sound approaching the ear from the front is perceived more easily than that at the listener's side or behind his back. A good loudspeaker system must therefore be designed to ensure that most of its signal output reaches the spectator from the front, or at least from an overhead location.

With covered spectator stands it is generally a good solution to mount the loudspeaker units near the front edge of the roof structure. This will ensure the desired frontal exposure for the majority of spectators, while only those seated in the lower stands will be reached vertically from above.

In sport facilities without roof structures, the frontal sound reception requirement can be met by erecting masts near the outer perimeter of the track and aiming the loudspeakers at the spectators' plane of hearing. However, this may cause problems if residential areas are located along the extended loudspeaker axis (See 5.4.3). In most cases these difficulties can be satisfactorily overcome by using high-directivity loudspeakers focused on the spectator area.

The optimum loudspeaker arrangement will always depend highly on the overall design of the facility and the distance to nearby residential areas. As a result, requirements will vary for each project.

### *5.4.5. SUITABLE LOUDSPEAKER SYSTEMS*

All loudspeakers installed must be fully weatherproof. In addition, the prevailing background noise conditions will usually call for the use of high-directivity loudspeakers with sharply focused beam characteristics which ideally should address only the spectator areas while radiating a minimum of noise to the surrounding environment.

A straightforward and inexpensive type is the horn loudspeaker with pneumatic pressure chamber (Fig 5.4.5a). Such systems have a radiation angle of as little as 30° to 60° (related to 4000 Hz) and can therefore be easily focused on the areas to be covered. Another benefit of this loudspeaker type is its high efficiency, i.e. the ability to produce a high useful sound volume at a comparatively low amplifier

output. However, the reproduction frequency response of these units is very limited, comprising only the range between 300 and 6000 Hz. For this reason, horn loudspeakers are only suitable for speech announcements (e.g., lane allocation, competition results, crowd control information).
If the system is expected to transmit music as well as speech, it is necessary to use higher grade loudspeaker systems. These include line source units (Fig 5.4.5b) which, due to their linear sound emission characteristics, allow the designer to define the useful vertical sound aperture angle. The specific aperture angle depends on the individual model. At a length of approximately 1m, this angle will be approximately 15° (at 4000 Hz). By using shorter or longer dimensions, it is possible to provide an optimum sound aperture for the intended auditory reception area.

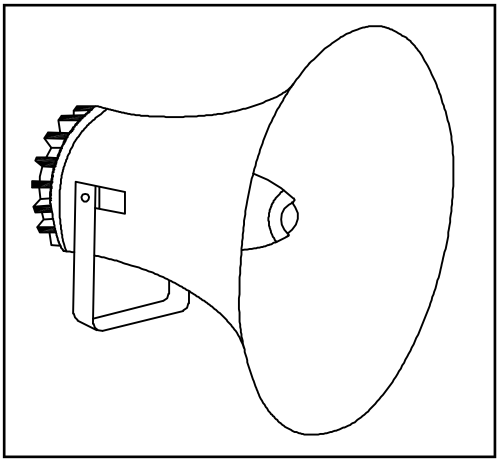


**Figure 5.4.5a - Reflecting horn loudspeaker characterized by high efficiency and good speech transmission properties**

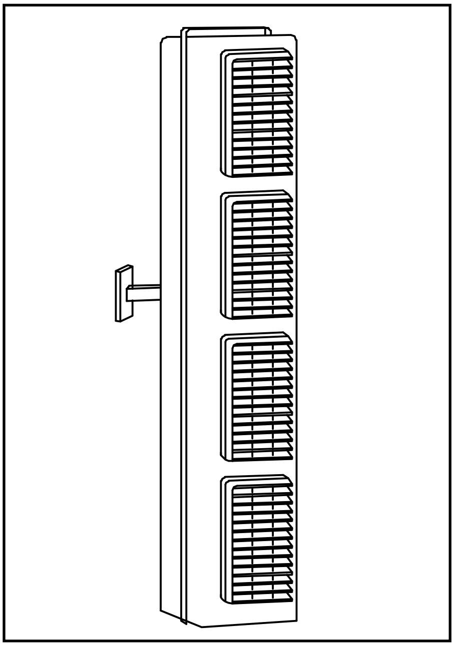


**Figure 5.4.5b**
**Line source speaker systems give ideal directionality and allow high-quality music transmission**

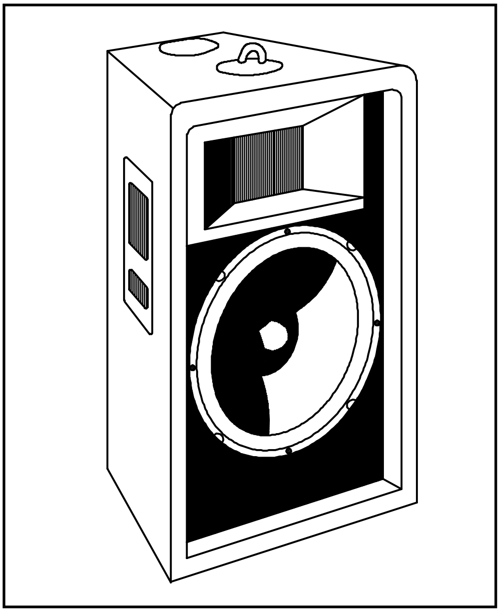


**Figure 5.4.5c**
**High-performance multipath speaker systems give optimum sound quality through separate woofers and tweeters**

The horizontal sound aperture angle lies between approximately 60° and 90°. The specific value will ultimately determine the distance between loud-speakers.

The frequency response of line source loudspeakers lies in the region of approximately 100 Hz to 12000 Hz. This makes them ideally suited for the transmission of speech and good quality entertainment music.

By arranging several loudspeakers into groups, it is possible to create almost any desired radiation characteristics, so that the system will probably be able to achieve a good compromise between a high useful signal volume inside the sports facility and a low external noise impact.

Where very high requirements are placed on the music transmission quality, it is necessary to use high-performance multipath speaker systems (Fig 5.4.5c). These combine several dedicated loudspeakers for separate frequency ranges in a common housing. Units designed for outdoor use will usually comprise woofer and tweeter systems. Such systems provide frequency response curves from approximately 50 Hz to 15000 Hz and deliver an optimum crisp and pure sound quality.

One disadvantage of these systems is that the bass frequencies are difficult to focus. "Stray bass" phenomena can contribute greatly to the emission of unpleasant noise. The use of such systems will therefore often be limited to covered spectator stand areas where the sound radiation is restricted by walls and roof structures, or to outdoor facilities located far away from residential areas.

### *5.4.6. AMPLIFIER OUTPUT REQUIREMENTS*

The necessary amplifier output is essentially dependent on the size of the facility and the useful signal volume to be achieved. As the human ear perceives sound on a basically logarithmic scale, a similar law applies to the selection of the desired amplifier power.

Doubling the amplifier output (and hence, the loudspeaker power handling capacity), for example from 100 watts to 200 watts, will increase the loudness by only 3 dB. The difference is barely perceivable, regardless of whether a speech or music signal is emitted. In order to double the loudness, for example from 80 dB(A) to 90 dB(A), it is necessary to increase the amplifier and loudspeaker output by a factor of 10. In the above example this would mean an increase from 100 watts to 1000 watts.

In a sports facility with covered spectator stands along both sides and a capacity of approximately 50,000 to 60,000 seats, a broadband multipath speaker system for speech and high quality music transmission would have to provide a loudness of approximately 100 dB(A). This requires an amplifier output of at least 10.000 watts.

### *5.4.7. CONTROL FACILITY, OPERATION AND SYSTEM AVAILABILITY*

The control facility must be installed in an appropriate location providing sufficient room. The announcer's position behind the microphone must afford good visibility of everything in the stadium.

Equipment required for a large stadium should include the following:

a) Announcers' room, with soundproofing against external noise (approximately 50 dB insulation value) to avoid acoustic feedback to the microphone.

b) Police announcer's position meeting similar requirements as the facility described in a),but with an additional absolute priority function to overrule the stadium announcer as well as a circuit design allowing individual spectator stand sections to be separately addressed (e.g., fan blocks, access and escape routes).

c) Sound control room meeting similar requirements as described in a), designed to accommodate a sound control desk, sound playback equipment, and an announcer's microphone.

d) Amplifier room for the central amplifier and system control unit (cabinet with chassis rack), including an appropriate ventilation system ensuring proper heat dissipation.

e) Microphone connections will likewise be found to be practical in the VIP box (for speeches) and near the track perimeter (for the victory ceremony, event management, etc). A wireless microphone installation (microport system) for interviews and similar uses may be provided.

The entire system is controlled from a sound control desk allowing the operator to select optimum tone and volume settings for each sound source. A pushbutton panel allowing a separate activation of individual sound system sections and/or spectator stand areas will also be found to be practical, as sound should only be directed to those parts of the stadium which are actually occupied by spectators.

The larger the sports facility, the more important is the proper availability and reliability of the public address system. Operating reliability can be achieved by selective automatic monitoring features, for example the continuous supervision of the power amplifiers by means of a pilot tone that is emitted at a frequency above the audibility threshold (approximately 20 kHz). If the pilot signal changes across an amplifier output due to a malfunction, this condition is immediately indicated and the system activates a standby unit. The spectators will not even become aware of the defect.

It is also possible to have the entire installation (including the wiring and loudspeakers) supervised by a digital system monitoring unit, which will offer a maximum degree of system reliability and availability.

A major item to be considered is the ability of the sound control technician. The availability of competent personnel is an issue to be clarified as early as at the system design stage. An anticipated lack of qualified control personnel can largely be compensated by increasing the use of automatic equipment, but the system flexibility will suffer as a result.

The main reason why an uninterrupted system availability is so important is the need for safety control announcements by the police. Such announcements must be possible by the touch of a single push button at the microphone announcing station and must overrule all other sound sources and controls fully automatically.

For specific emergency situations it is also helpful to provide a digital speech storage device in which all relevant announcements are recorded in advance. In a hazard situation, the suitable announcement is released at the touch of a button and will be transmitted, objectively, in optimum quality and at the right volume.

### *5.4.8. SUMMARY*

There are no all-purpose standard PA system designs. The builder, owner and architect must jointly discuss all relevant facts for each individual situation in order to create a system concept that will satisfy both engineering and financial requirements in the best possible manner.

## 5.5 Television Monitoring Systems (crowd control)

To monitor car parks, spectator access ways, ticketing facilities, control points and spectator seating/standing areas, installations are necessary for safety and security reasons.

Such television monitoring systems have until recently only been available in black and white because of the prohibitive cost. Another disadvantage was the required level of lighting for sufficient picture clarity. Today colour cameras are only slightly more expensive than black and white. Due to the change in the recording technology (from the camera tube to the semi-conductor image converter), colour cameras require no more light than conventional black and white ones. Since different colours can now be identified, objects can be distinguished with greater ease.

In areas monitored by colour cameras, it is easy to identify people and vehicles. In this way control can be effected quickly. Through continuous surveillance it is possible, even over relatively long distances, to identify individual persons when safety-related incidents occur. CCD recording technology now allows the cameras

to operate relatively maintenance-free.
For this reason, cameras can even be installed in poorly accessible places.

### *5.5.1 LIGHTING REQUIREMENTS*

CCD colour cameras supply distortion-free images in natural colours in almost all light conditions. In the case of artificial lighting, it is essential that the lamp contains all the colours of natural light. Halogen lamps, for example, meet this requirement. Colour cameras observe a scene just as the human eye would see it. The spectral sensitivity of the camera has been adapted to that of the eye. In this way, the quality of the colour rendition is maintained, even in fading light.

### *5.5.2 LAMP TYPES/COLOUR FIDELITY*

Table 5.5.2 indicates colour fidelity in relation to the type of lamp chosen.

| ***COLUMN*** | ***1*** | ***2*** |
|---|---|---|
| ***Line*** | | |
| ***1*** | ***Lamp Type*** | ***Colour Fidelity*** |
| ***2*** | LP sodium vapour discharge (SOX) | Poor, monochrome yellow |
| ***3*** | HP sodium vapour discharge (SON) | Moderate |
| ***4*** | HP mercury vapour discharge (HPL) | Moderate |
| ***5*** | Metal halide (HPI) | Good to excellent |
| ***6*** | Tubular fluorescent (TL) | Moderate to excellent |
| ***7*** | Halogen lamps | Excellent |
| ***8*** | Incandescent lamps | Excellent |

**Table 5.5.2 - Effects of lighting technology on colour rendition.**

Modern cameras can operate with as little as 5 lux. The latest colour cameras require a minimum of 0.9 lux of light reflected by the object, measured at the lens (f 1.0). With this illumination, the video signal has only about 50% of the normal amplitude but it is still capable of producing acceptable images.

### *5.5.3 IMAGE PROCESSING*

A high image resolution is also necessary at the monitor. Central units, such as video-matrix, quad units, multiplexers and video switches, enable the pictures to be available in the right place at the right time. Because monitoring staff find it difficult to study several pictures at the same time, surveillance is simplified by multiplexers. Four, eight or sixteen pictures are shown reduced in size on a grid on a single monitor. If the observer notices an incident, he can switch to a full screen picture on the same monitor. With a 2-fold zoom, he can study details of pictures. The installation of a multiplexer can often replace a bank of monitors or at least the manual switching gear.

The multiplexers operate with a video digitalization process and the camera signals are coded in such a way that it is always possible, when the pictures are played back, to ascertain which camera took the picture. For ease of identification, each camera picture is capable of displaying camera number, location, time and date. The standard functions of a multiplexer include such facilities as the automatically controlled sequential display of full-size pictures with individually specified hold times along with by-pass switches for periodically unimportant camera shots. The picture freeze function enables stills to be created for closer analysis.

### *5.5.4 TECHNICAL INSTALLATION CONCEPT*

To document and later reconstruct crowd violence or other incidents, it is desirable to have a complete record of all incidents from the beginning to the end of the sports event. Multi-camera systems would require a large number of video recorders with high investment and operating costs (tapes, recorder servicing). The use of a long-playing video recorder minimizes this outlay. Used in conjunction with a multiplexer, four, eight or sixteen pictures can be digitally recorded simultaneously. The picture can then be played back, similar to monitor surveillance, as a full screen picture.

More recent recorder models also offer important auxiliary functions: still picture, automatic search and slow-motion replay. During playback, the operator can then choose any of the pictures for full screen replay.

The choice of camera positions requires special consideration. It is usually possible to erect outside cameras on roofs, columns or walls. Suitable brackets, including those for remote controlled pivot/tilt heads, should be used. When choosing the locations, it is essential that they are not directed straight at the rising or setting sun (Fig 5.5.4). If the camera has an unobstructed view of the horizon, the low height of the midday sun from autumn through to spring should also be borne in mind.

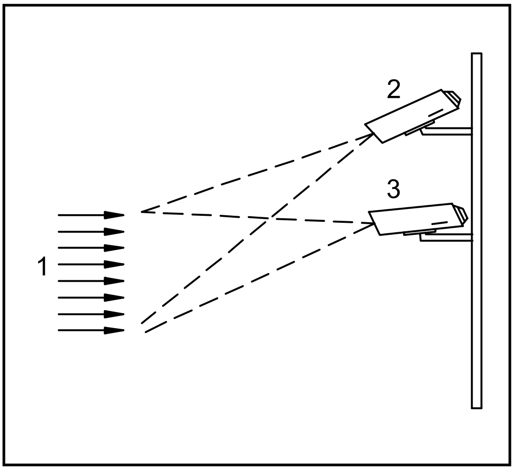



**Figure 5.5.4 - Elimination of glare caused by low-lying sun by choosing higher camera positions**
1 Light from rising or setting sun
2 right position
3 wrong position

# 5.6 Technical Services for the Media

***5.6.1 COMMUNICATIONS***

Electronic interface between key elements within the stadium has become a vital aspect of modern athletics. Technological advances have greatly enhanced the management of the sport. However, the proliferation and sophistication of available equipment requires a high level of cooperation and interface.

The parties required to submit to a working interface are

- Television
- Announcers
- Scoreboard
- Videoboard
- Timing Service
- Computer Service Telecommunications Agency
- Event Management
- Ceremonies Division
- Printing/Photocopying

The smooth conduct of an athletic competition requires well prepared, professional conduct by the officials. However, the complexity of athletics requires that for a major competition the event must be conducted so that the public can follow the significance of all that is happening at any one time. To this end the coordination between competition director, announcers and scoreboard operator is of vital importance. Communication between these three parties must be constant. Direct sight, telephone link or ideally open radio link are essential. Whilst the use of portable telephones has escalated in recent years, caution is advised in the stadium where prestressed concrete breaks the signal and limits the range.

The public address (PA) system used by the announcers should be given comprehensive testing and rehearsal, particularly in regard to its effect on planned television microphone positions (Fig 5.6.1) and the working areas of television, radio and journalists.

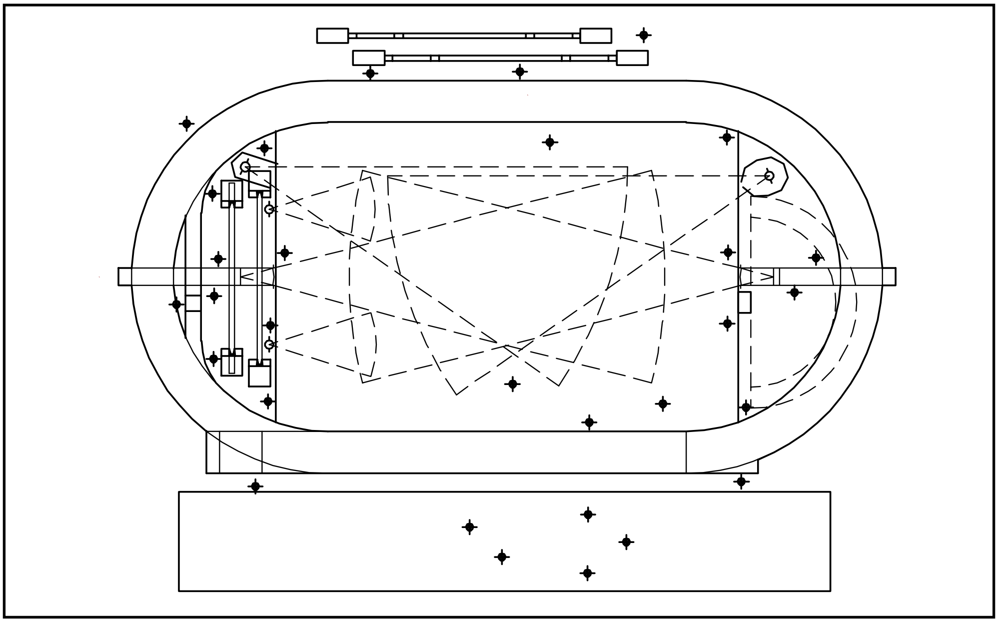


**Figure 5.6.1 - Television microphone positions for major track and field events**

The interface between the Official Data Processing Company and the Scoreboard is essential to avoid the need for data re-entry, thus keeping delivery time of key information to a minimum.

A protocol for the commencement of sessions, events, ceremonies must be established prior to the competition. The sequence, visual images and words must be clearly defined by all three parties. Care with languages, abbreviations and names is of great importance. Additional attention is necessary when North American/European equipment/software is to be employed in a venue where Asian/Arabic/Cyrillic lettering will predominate. The lines and space available on the scoreboard are critical when preparing the protocol.
Advance notice of required video formats for the videoboard must be provided to television, sponsors, etc.

A separate television edit for use on the video scoreboard can be created, but advance preparations are necessary to provide the equipment, staff and interface required.

Fast provision of hard copy is essential. Therefore full consideration must be given to printing capability and delivery to the desks. One high speed copier with sorter (80 copies per minute) for every 100 media representatives (excluding technicians) is recommended. 2/3 of these copiers to serve the media stands, 1/3 for the main press centre/international broadcast centre/working area within the stadium.

One “runner” can effectively serve 35 working positions. Back up services and replacements are essential.

At the World Championships in Athletics held in Athens in 1997, the following numbers of copiers were used: 8(80cpm) + 1(40cpm) in the main photocopy unit; 4(80cpm) in the main press centre; 3(55cpm) in the international broadcast centre, as well as additional machines in the sub-press centres located in media hotels.

### *5.6.2 PRESS*

#### 5.6.2.1 Work Area of Journalists

The working area allocated to each journalist should have dimensions of 0.75m in width and 1.60 in depth (compared to normal grandstand dimensions of 0.50m in width and 0.80m in depth for each seat). These measures provide sufficient space behind the seat for the comfortable movement of other journalists, and delivery of results by “runners”.

#### 5.6.2.2 TV Monitors

At a national/local event it is unlikely that TV monitors will be available for the media stand. At larger events, seats with desks require TV monitors (no larger that 35cm/14"), and a 110/250V power supply. One monitor per two journalists, recessed into the table, should be provided. Recommended are 150 for major regional, and 400 for major international, events.
Multi-channel facility is required. A full Electronic Results Service (ERS) either via the TV monitors or computer terminals must be provided.

#### 5.6.2.3 Telephones

Journalists may require provision of a dedicated direct telephone line at their working desk. These should be reserved in advance. The following numbers of telephones can be estimated: for national events 25/30, regional events 150 and for international events 300 to 500.

### *5.6.3 TELEVISION AND RADIO*

#### 5.6.3.1 Work Area of Commentators

An equipped commentary position caters for three persons and is usually furnished with the following.

- Commentary unit connected to the commentary control room at the venue, and 3 headsets for TV commentators.
- Colour TV monitor connected for reception of the international signal produced at the venue, as well as signals broadcast over the air, and data channels. An information terminal carrying the ERS must be provided to each commentary position. A 110/220V tension socket supply is required for the equipment.

Size: As the sport expands, so does the traditional commentary team.
There must be room for 3 persons, and the total width must be at least 1.60m (Fig 5.6.3.1). Broadcasters with larger teams can order further modules.
There must be 0.66m of leg height under the working table. There must be at least 1.00m between the edge of the working table and the start of the row behind, to allow clear passage for other workers and results distributors. The depth of the working surface should be 0.90m.

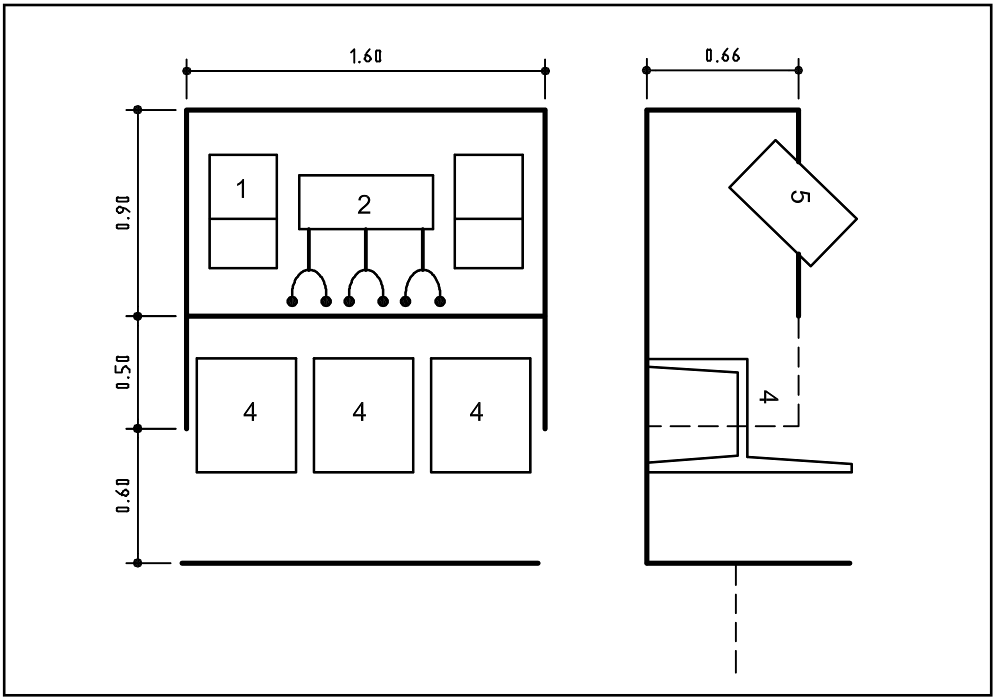



**Figure 5.6.3.1 - TV-commentary position top and side views**
1 Television monitor, 2 commentary unit, 3 information terminal, 4 chair, 5 recessed monitor

It should be noted that unlike journalists, commentators cannot move freely around the stadium. Consideration must be given to service access for information, catering (especially drinks), technicians, etc. The quality of seating is important, as is storage and security of papers. Protection of the commentators and equipment from the elements must be fully considered.

Telecommunication requirements (which are detailed in the following part of this Chapter) are TV monitors, commentary unit, telephones (telefax).

The cabling of telephones, TV monitors and commentary units at the commentators' seating needs considerable forward planning, in particular the path and size of ducts for cabling, and security of all cabling.

#### 5.6.3.2 International Broadcast Centre (IBC)

Creation of an IBC is only necessary for a major games or championships, and can be extensive, as at the Olympic Games (Barcelona - 45,000m$^2$). The IBC is the nucleus of television and radio operations. The IBC also houses numerous facilities for broadcasters' unilateral programme production. Facilities are made available on a bookable basis and include edit rooms and television studios equipped with cameras, vision mixers, etc.

Approximately 600 persons can be expected to be employed by the host broadcaster alone in the IBC at a major games. All participating broadcasters will require administrative office space of varying sizes.

The telecommunications (telco) room, commentary switching and distribution centres will be linked by a complex telecommunications network.

##### *5.6.3.2.1 The Telecommunication Room (Telco)*

At the IBC, the telco room is the point of entry for contribution network lines on their way to the distribution centre. Optic fibre and radiolink terminals will be located there. The telco room will also house the equipment for signal equalising, measuring and control for maintaining video and audio quality.

##### *5.6.3.2.2 Commentary Switching Centre*

The commentary switching centre is the control facility for the entire commentary system. All commentary circuits terminate there. The circuits are then distributed to broadcaster production facilities within the IBC. Numerous 4-wire circuits (up to 400 at the '92 Olympic Games) will carry the outgoing international programmes to destinations around the world.

##### *5.6.3.2.3 Distribution Centre*

The monitoring and equalising of incoming Vanda signals from the venue(s) takes place in the distribution centre before delivery to the world broadcasters' areas, transmission control and bookable facilities. The distribution centre will generate the master synchronisation signals, test signals and the master clock reference signal for the IBC and venues.

##### *5.6.3.2.4 Central Facilities*

Central Facilities will house a Video Tape Recording (VTR) room to record signals from venues at major competitions, editing rooms for summaries and a post-production suite.

##### *5.6.3.2.5 Transmission Control*

The main functions of transmission control are the switching, processing and insertion of Video International Transmission Signal ((VITS) and International Distribution (ID) signals and the equalisation, monitoring and transmission of outgoing signals (via both satellite and earth networks).

#### *5.6.3.2.6 Broadcasters' Coordination*

A terminal from the IBC general intercom matrix can be installed which permits coordination with the distribution and transmission centres for broadcasters who are receiving the host broadcaster international signal(s) and who dispose of unilateral distribution channels. It should not be possible however to have direct communication with other technical areas of the host broadcaster operation.

#### *5.6.3.3.7 Booking Office*

The booking office at the IBC will take bookings of occasional services and facilites made available by broadcasters. The following services and facilities should be available on a booking basis in the IBC:

- TV Studio
- Radio Studio
- Editing Rooms
- Off-Tube Booths
- Post-Production Suite
- Briefing Room

#### *5.6.3.2.8 Information Office*

The information office at the IBC is responsible for immediately compiling and distributing results and general information for broadcasters before and during the event. Hard copies of results are distributed through a pigeon hole system, a regular structure of openended shelving that permits the distribution into neat orderly files. The media representatives then take the information they require. Each individual shelf should be capable of comfortably containing up to 150/200 copies of an A4 document at any one time.

Other information of interest to broadcasters should be edited and distributed via a daily bulletin and bulletin boards.

#### *5.6.3.2.9 Audiovisual Archive*

There should be a documentation service in the IBC available for broadcasters' use. The service should process all audiovisual information produced by the host broadcaster. The service should give access to tapes of professional quality.

#### *5.6.3.2.10 Common Service Centre*

A common service area for all media representatives between the IBC and MPC should be provided for rest, recreation and additional services, e.g. restaurants, travel agency, car rental, bank, medical centre, pharmacy, news-stand, post office and courier service, customs agent, safe deposit, office materials shop, souvenirs, florist, cash-point, computer maintenance, etc.

#### *5.6.3.2.11 Telecommunications Network*

- *Vanda Contribution Network*

  The contribution network is designed to transport all international television and radio signals and unilateral Vandas from venue(s) to the IBC.
  Optic fibre with back up links in a ring configuration can be used for the transportation of signals within a confined city area. Signals emanating beyond such a city ring will require transportation to a telecommunications tower via radiolinks and on to the city ring and from there to the IBC.

- *Audio Contribution Network*
  The telecommunications agency will need to provide a system for the transportation of audio signals from the venue(s) to the IBC. A convergent network of 4-wire circuits is required. This may be achieved in three stages:
  - transport of the audio signal in low frequency from the venue(s) to the nearest telephone exchange
  - transport of the radio signal in high frequency (multiplexer channels transmitted by optic fibre) between the telephone exchange nearest the venue to the telephone exchange nearest to the IBC
  - transport of the audio signal in low frequency from the nearest telephone exchange to the IBC.

  The following types of 4-wire circuits are used: Type I (3.4 KHz), Type II (7 KHz) and Type III (15 KHz).

- *Outgoing Communications Network*
  The numerous television signals produced in the IBC by broadcasters and other international and unilateral signals are transmitted via optic fibre and radiolink earth network. Outbound signals are uplinked to communication satellites from earth station (s) within the host country.
  The international distribution of television signals is carried out by means of a ground network of national and international links provided by the telecommunications agency.
  The network will be made up of analogue and digital systems over radiolinks and fibre optic systems, with sufficient capacity for routing all expected traffic and with the possibility of restoring and diversifying routes to ensure the efficiency of the system.

#### *5.6.3.2.12 Outside Broadcast (OB) Van Compound*

The camera feeds of all unilateral cameras are channelled into the OB van compound. Interface with the organising committee data network is necessary if data and timing graphics are to be injected on to unilateral pictures, unless the broadcaster has its own character generator facility.

At major competitions adequate power sources must be provided for the large number of OB vans. For 20 to 25 OB vans an outlay of approximately 600KW is necessary.

# CONTENTS - CHAPTER 6
# COMPETITION EQUIPMENT SPECIFICATIONS

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## 6.1 Equipment for Track Disciplines

In competitions directly under IAAF control, all equipment and implements used must conform to IAAF requirements and must hold current IAAF certificates of approval.

These certificates do not, of course, preclude the need for regular and proper maintenance.

While other equipment may conform to IAAF rules it is preferable that equipment fully approved by IAAF is used at all levels of competition. The list of certified equipment is available for download from the IAAF website (www.iaaf.org).

### *6.1.1 STARTING BLOCK (RULE 161)*

Starting blocks must be used for all races up to and including 400m (including the first leg of the 4x200m and 4x400m) and must not be used for any other race. When in position on the track, no part of the starting block must overlap the starting line or extend into another lane.

Starting blocks must comply with the following general specifications:

- Starting blocks must be rigid in construction and must be totally inert.
- They must be fixed to the track by a number of pins or spikes, arranged to cause the minimum possible damage to the track. The arrangement must permit the starting blocks to be quickly and easily removed. The number, thickness and length of pins or spikes depends on the track construction. The anchorage must permit no movement during the actual start.
- They shall consist of two foot plates and be mounted on a rigid frame, which shall in no way obstruct the athlete’s feet as they leave the blocks.
- The foot plates shall be sloped to suit the starting position of the athlete, and may be flat or slightly concave. The surface of the foot plates shall be prepared to accommodate the spikes in the athlete’s shoes, either by using slots or recesses in the face of the foot plate, or by covering the surface of the foot plate with suitable material permitting the use of spiked shoes.
- The mounting of the foot plates on a rigid frame may be adjustable, but it must allow no movement during the actual start. In all cases, the foot plates shall be adjustable forward or backward in relation to each other.
  The adjustments must be secured by firm clamps or locking mechanism, which can be easily and quickly operated by the athlete.
- In competitions held under Rule 12.1 (a), (b) and (c), the starting blocks must be linked to a false start detection apparatus.

### *6.1.2 HURDLE (RULE 168)*

Each lane in a hurdles race will have ten flights of hurdles. The hurdles shall be positioned so that the side of the top bar nearest the athlete coincides with the edge of the line or mark indicating the position of the hurdle (Table 2.2.3.1, Chapter 2).

The hurdle shall consist of two feet and two uprights made of metal or other suitable material and a top bar of wood, PVC or other suitable material. The uprights shall be at the extreme end of each base which may be rounded to ensure, as far as possible, that, when toppled in competition, the hurdle remains in its own lane.

The hurdle shall be of such a design that a force exerted by a weight of at least equal to 3.6kg and not greater than 4kg applied to the centre of the top edge of the top bar is required to topple it. Where a hurdle is adjustable in height the counter weights must be similarly adjustable.

Hurdle Specifications

| | |
|---|---|
| Weight: | Minimum 10kg |
| Width: | 1.18-1.20m |
| Base Length: | Maximum 0.70m |

Top Bar:

| | |
|---|---|
| Height: | 0.07m |
| Length: | 1.18-1.20mm |
| Thickness: | Between 0.01m and 0.025m |

Competition Heights:

| | | |
|---|---|---|
| Women: | 400m | 0.762m (± 0.003m) |
| | 100m | 0.840m (± 0.003m) |
| Men: | 400m | 0.914m (± 0.003m) |
| | 110m | 1.067m (± 0.003m) |
| Girls: | 400m | 0.762m (± 0.003m) |
| | 100m | 0.762m (± 0.003m) |
| Boys: | 400m | 0.840m (± 0.003m) |
| | 110m | 0.914m (± 0.003m) |

The top edge of the top bar shall be rounded and the bar should be painted with white and black stripes or with other contrasting colours such that the lighter stripes are on the outside. The stripes shall be at least 0.225m wide.
The width of the top bar shall be 7cm. The thickness of this bar should be between 1cm and 2.5cm.

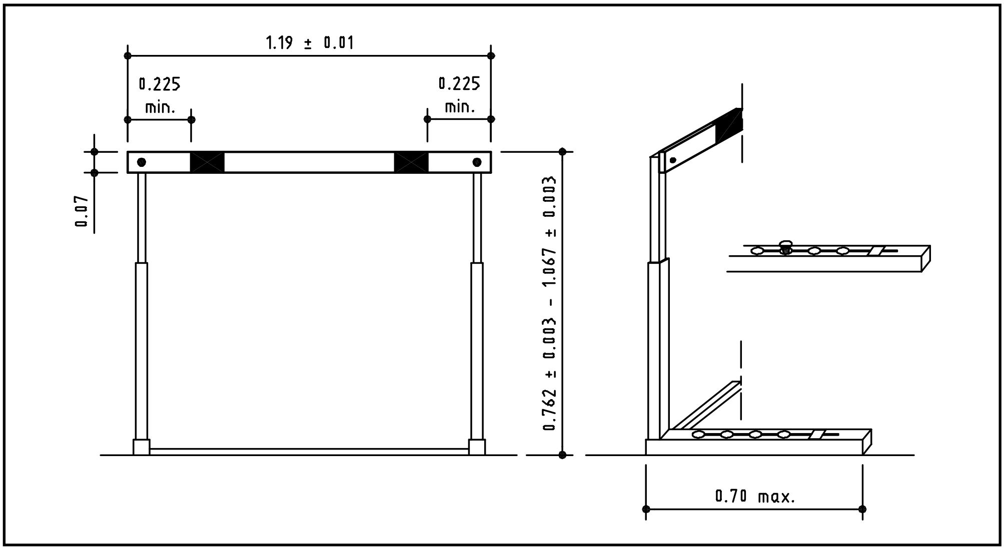



**Figure 6.1.2 - Hurdle, view from the direction of running and side view**
(Dimensions in m)

### *6.1.3 STEEPLECHASE WATER JUMP (RULE 169)*

The water jump, including the hurdle, shall be 3.66m (± 0.02m) in length and 3.66m (± 0.02m) in width (See 2.2.4).

At the hurdle end, the depth of the trough below the level of the surface shall be 0.70m and this depth shall be maintained for 0.30m. The level will then slope regularly upwards to the level of the track surface at the farther end of the jump.

The bottom of the water jump should be surfaced with the same synthetic material as the track of maximum thickness 0.025m. This material shall extend for at least 2.50m from the end of the jump in the direction of the hurdle.

For a non-synthetic track a heavy coir matting may be fixed to a concrete base. The sides of the trough shall have no rough or sharp edges which might be a hazard to athletes.

The hurdle may be fixed or removable but, when in position, must be firm and immovable.

The hurdle shall be 3.66m wide and for mens events 0.914m (± 0.003m) high and for womens events 0.762m (± 0.003m) high. The top bar shall be 0.127m square.

If adjustable steeplechase hurdles are used, they must be constructed so as to be perfectly stable at any height to which they may be set.

The top bar should be painted with white and black stripes or with other distinctive contrasting colours, so that the lighter stripes are on the outside, which should be at least 0.225m wide.

When not in use, the water jump may be covered by blanking boards.

### *6.1.4 STEEPLECHASE HURDLE (RULE 169)*

Each hurdle will be constructed of wood or other suitable material.

The top bar shall be of wood or other material which will allow an athlete wearing spiked shoes to step safely on the hurdle.

The section of the top bar shall be 0.127m square. The top bar shall be painted with black and white stripes, or with other distinctive contrasting colours, so that the lighter stripes are on the outside. The stripes shall be at least 0.225m wide.

Each hurdle for mens event shall be 0.914m (± 0.003m) high and for womens events 0.762m (± 0.003m) high with a minimum width of 3.96m and shall weigh between 80kg and 100kg. It shall have a base between 1.20m and 1.40m at each end.

Each hurdle shall be positioned so that the top bar extends 0.30m inside the inner edge of the track.

It is recommended that the first hurdle should be at least 5.00m wide.

Where adjustable hurdles are used, they must be constructed so as to be perfectly stable at any height to which they may be set.

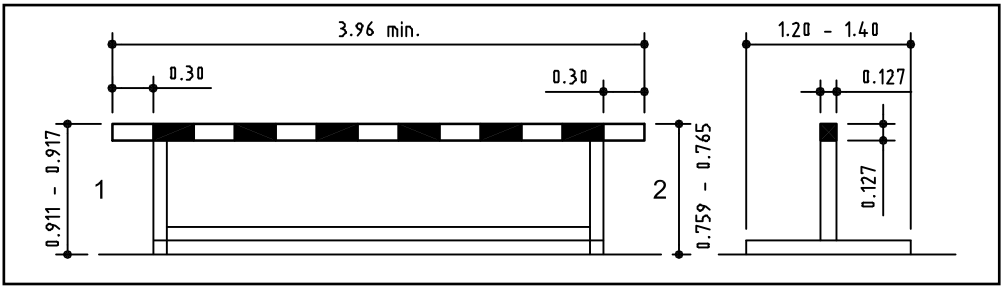



**Figure 6.1.4 - Steeplechase hurdle, front and side view**
(Dimensions in m)
1 Height for mens' races: 0.911m to 0.917m
2 Height for womens' races: 0.759m to 0.765m

# 6.2 Equipment for Jumping Disciplines

### *6.2.1 TAKE-OFF BOARD FOR LONG AND TRIPLE JUMP (RULES 185 AND 186)*

#### 6.2.1.1 Take-off Board with Indicator Board

In the long jump a take-off board shall be installed between 1.00m and 3.00m from the nearer edge of the landing area.

In the triple jump, provision shall be made for take-off boards at 13.00m (for Men) and 11.00m (for Women) from the nearer edge of the landing area. Additional positions appropriate to different levels of competition may also be provided.

Take-off-positions not in use shall be filled by solid, firmly fitting blanking boards covered with the same synthetic material as used on the runway.

The take-off board shall be installed so that its surface is level with the surface of the runway.
It shall be rectangular, made of wood or other suitable rigid material, 1.22m ± 0.01m long, 0.20m (± 0.002m) wide, not more than 0.10m deep and coloured white. The take-off board may be enlarged to incorporate the indicator board as shown in figure 6.2.1.1.
When in position, the take-off board shall be firm and unyielding.

The indicator board is 0.10m (± 0.002m) wide and 1.22m ± 0.01m long made of wood or other suitable rigid material.

The indicator board will rise from the level of the take-off board to a height of 0.07m (± 0.001m). The edges shall either slant at an angle of 45° or shall be cut away so that the recess, when filled with plasticine, shall slant at an angle of 45°.

When mounted in this recess, the whole assembly must be sufficiently rigid to accept the full force of the athlete’s foot. The surface of the board beneath the plasticine shall be of a material in which a spiked shoe will grip and not skid.

Constructions in which the take-off board incorporates an indicator board recess are recommended.

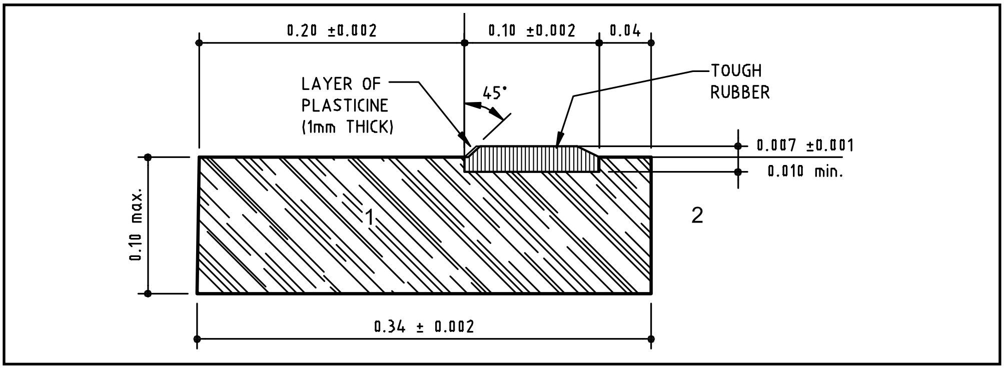



**Figure 6.2.1.1 - Example of a take-off board incorporating indicator board**
(Dimensions in m)

### 6.2.1.2 Blanking Board

The function of the blanking board is to cover a take-off board not in use.

It may be of metal or any other suitable material covered with synthetic material identical to the runway.

It should fit firmly in the foundation tray and may be fitted with adjustable legs to ensure that, when in position, the surface is level with the surrounding runway.

If constructed of metal the support legs or base of the tray should be coated with rubber, PVC or other sound absorbing material.

### *6.2.2 HIGH JUMP UPRIGHTS (RULE 182)*

Any style of uprights or posts may be used, provided they are rigid. They shall have supports firmly fixed to them and be constructed so as to exceed the maximum height to which the cross-bar can be raised by 0.10m.

They shall be positioned at least 4.00m and not more than 4.04m apart.

### *6.2.3 LANDING MATS FOR HIGH JUMP*

The landing mats shall be at least 6.00m x 4.00m and shall be positioned so that no part of either upright is nearer than 0.10m to the landing area, to avoid any risk of the cross-bar being dislodged by the landing area coming in contact with the uprights during the competition.

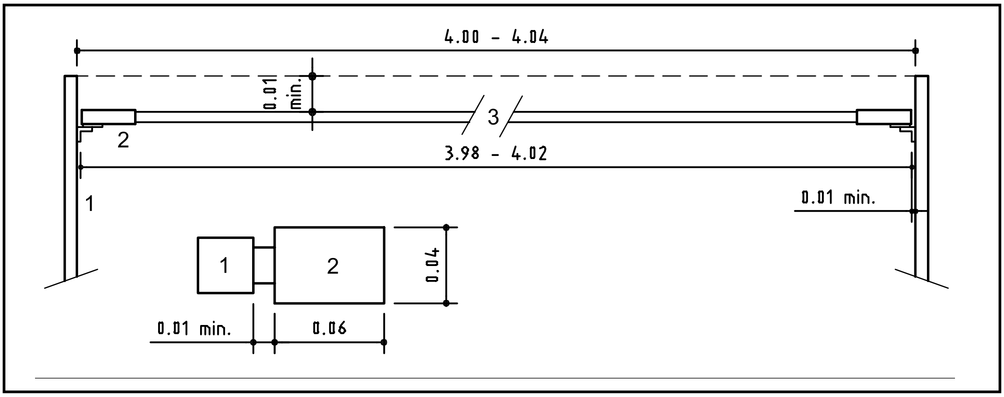



**Figure 6.2.2 - High jump crossbar support**
(Dimensions in m)
1 Upright, 2 support, 3 crossbar

The landing area shall be constructed of one or more pads of a honeycomb or similar construction designed to protect a jumper falling from a height of 2.50m. The pad(s) shall be covered and bound together in such manner as to prevent the athlete’s limbs or any part of the athlete’s body from catching between pads.

The entire landing area shall be covered by a single spike-proof top mat approximately 0.05m thick and should have a weatherproof covering.

The landing area may have ‘cut outs’ to allow the front of the landing area to be placed immediately under the crossbar. It should be not less than 0.70m high and may be placed on a base or pallets to increase ventilation.
The base should not be more than 0.10m high.

It should be stressed that the type of foam and the construction used is the major factor in the cushioning ability of the landing area.

### *6.2.4 BOX AND BLANKING BOARD FOR POLE VAULT (RULE 183)*

The take-off shall be from a box constructed from metal, wood or other suitable rigid material.

It shall be sunk level with the ground and shall be 1.00m in length measured along the bottom of the box, 0.60m in width at the front end and tapering to 0.15m wide at the bottom of the stop board. The angle between the bottom of the box and the stop board shall be 105° and the stop board shall be 0.224m long. The side walls of the box shall slope outwards to form an angle of approximately 120° to the base.

If the box is constructed of wood the bottom shall be lined with sheet metal for a distance of at least 0.80m from the front of the box.

The box may have one or more drainage holes in the corners of the base.

A blanking board, surfaced with the same material as the runway may be placed over the box when not in use.

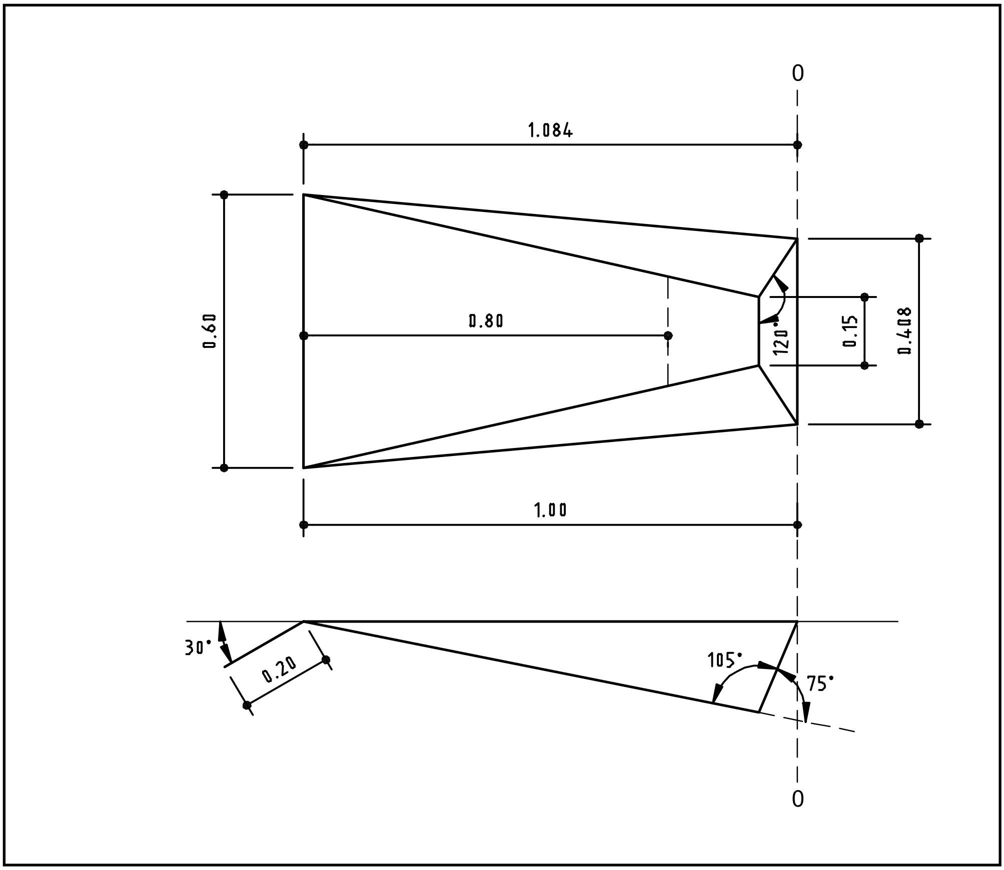



**Figure 6.2.4 - Pole vault box**
(Dimensions in m)
0 — 0: Zero line

### *6.2.5 POLE VAULT UPRIGHTS (RULE 183)*

Any style of uprights or posts may be used provided they are rigid.

Pegs mounted on the uprights or on extension arms shall be used to support the crossbar. The distance between these pegs shall be not less than 4.30m nor more than 4.37m.

The construction shall ensure that the crossbar may be moved 0.40m in the direction of the runway or 0.80m in the direction of the landing area from the vertical plane of the inside edge of the top of the pole vault box (the zero line). As this Rule may be reviewed, the current edition of the IAAF Handbook should be checked.

This may be done by moving the uprights on rails or by using fixed uprights with horizontally adjustable pegs on a vertically adjustable rail.

The base tracking should be covered with padding to protect the athletes.

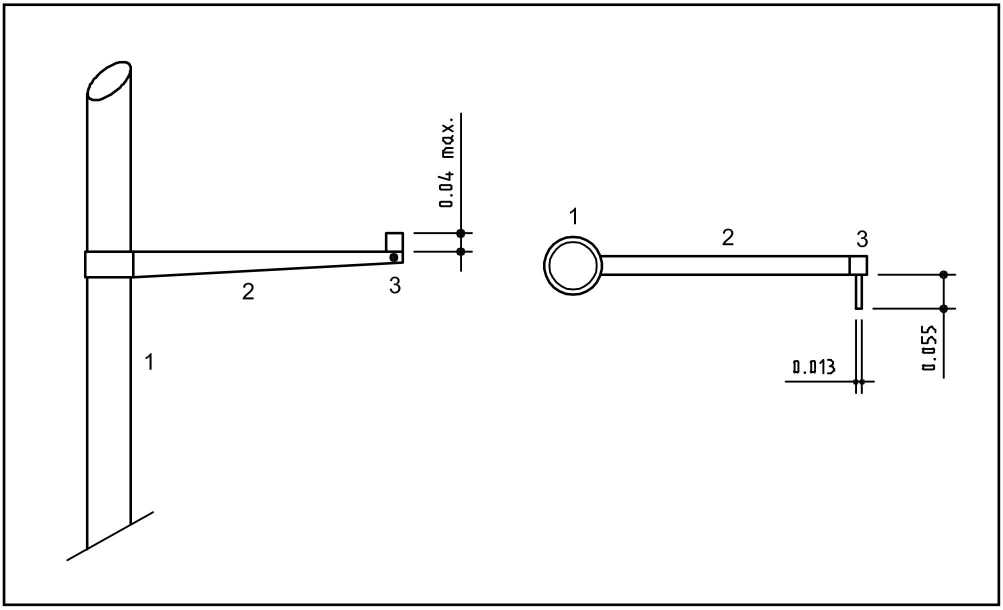



**Figure 6.2.5 - Pole vault crossbar support, view from the landing mat and top view**
(Dimensions in m)
1 Upright, 2 support, 3 peg

### *6.2.6 LANDING MATS FOR POLE VAULT*

The landing area shall be at least 5.70m x 6.00m positioned behind the zero line with sloped sections at either side of the pole vault box extending approximately 1.30m in the direction of the runway. The sides of the landing area nearest the box shall be placed 0.10m to 0.15m from the box and shall slope away from the box at an angle of 30° from the vertical plane. As this Rule may be reviewed, the current edition of the IAAF Handbook should be checked.

The landing area should be approximately 0.10m from the uprights to avoid any risk of the crossbar being dislodged by the landing area coming in contact with the uprights during competition.

The landing area shall be constructed of one or more pads of good quality PVC foam of a honeycomb or similar construction designed to protect a vaulter falling from a height of 6.50m. The pad(s) shall be covered and bound together in such manner as to prevent the athlete's limbs or any part of the athlete's body from catching between pads.

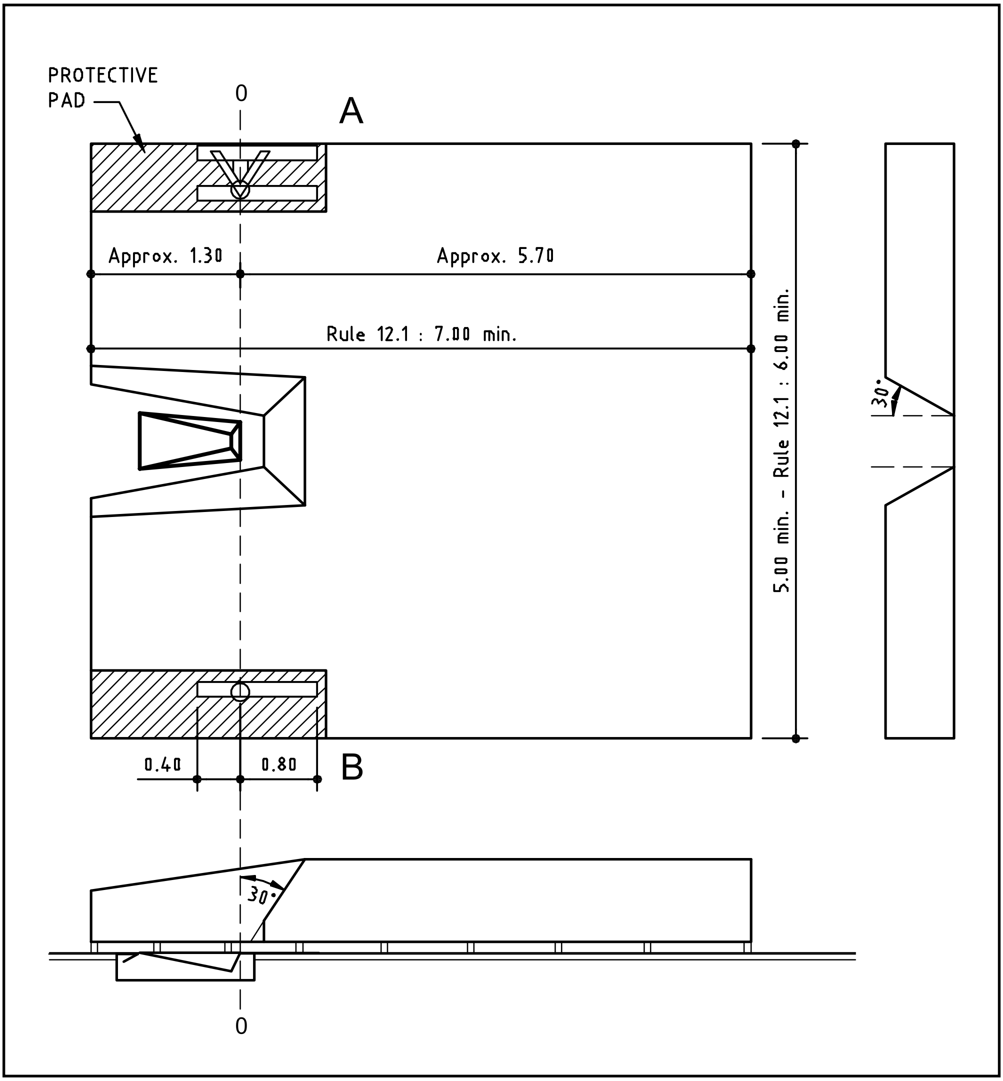



**Figure 6.2.6 - Landing area for pole vault, top view, cross section and longitudinal section**
(Dimensions in m)
0 — 0: Zero line
A Upright on rails
B Fixed upright

The entire landing area shall be covered by a single spike-proof top mat approximately 0.05m thick and should have a weatherproof covering.

The landing area should be not less than 0.80m high but may be placed on a base or pallets to increase ventilation. This base should not be more than 0.10m high. The section immediately behind the box should be closed.

It should be stressed that the type of foam and the construction used is the major factor in the cushioning ability of the landing area.

### *6.2.7 CROSSBAR*

The crossbar shall be made of fibre-glass, or other suitable material but not metal, circular in cross-section except for the end pieces. The overall length of the crossbar shall be 4.00m (±2cm) in the High Jump and 4.50m (±2cm) in Pole Vault. The maximum weight of the crossbar shall be 2kg in the High Jump and 2.25kg in Pole Vault. The diameter of the circular part of the crossbar shall be 30mm (± 1mm).

The crossbar shall consist of three parts - the circular bar and two end pieces, each 30-35mm wide and 15-20cm long for the purpose of resting on the supports of the uprights.

These end pieces shall be circular or semicircular with one clearly defined flat surface on which the bar rests on the crossbar supports. They shall be hard and smooth.

They may not be covered with rubber or any other material, which has the effect of increasing the friction between them and the supports.

The crossbar shall have no bias and, when in place, shall sag a maximum of 2cm in the High Jump and 3cm in Pole Vault.

Control of elasticity: Hang a 3kg weight in the middle of the crossbar when in position. It may sag a maximum of 7cm in the High Jump and 11cm in Pole Vault.

## 6.3 Equipment for Throwing Disciplines

### *6.3.1 SHOT PUT STOP BOARD (RULE 188)*

The stop board shall be white and made of wood or similar suitable material in the shape of an arc so that its inner edge coincides with the inner edge of the shot circle. It shall be placed midway between the landing sector lines and shall be firmly fixed to the ground.
The board shall be at least 0.112m wide and, when firmly in position 0.10m (± 0.002m) high in relation to the level inside the circle (Fig 2.4.4.2).

### *6.3.2 SAFETY CAGES*

Hammer and discus shall only be thrown from an enclosure or cage to ensure the safety of spectators, officials and competitors. (Figures 2.4.1.2 and 2.4.2.2)

Cages specified here are intended for use in major stadia in high class competition. Simpler and smaller cages may be adequate for competition of lower standard and for well regulated training facilities.

Hammer cages may also be used for discus competition either by installing 2.135m/2.50m concentric circles (Fig 6.3.2) or by using an enlarged hammer cage with a discus circle installed behind the hammer circle. This latter construction is not recommended because of the cost involved, the space requirements and the effect on viewing.

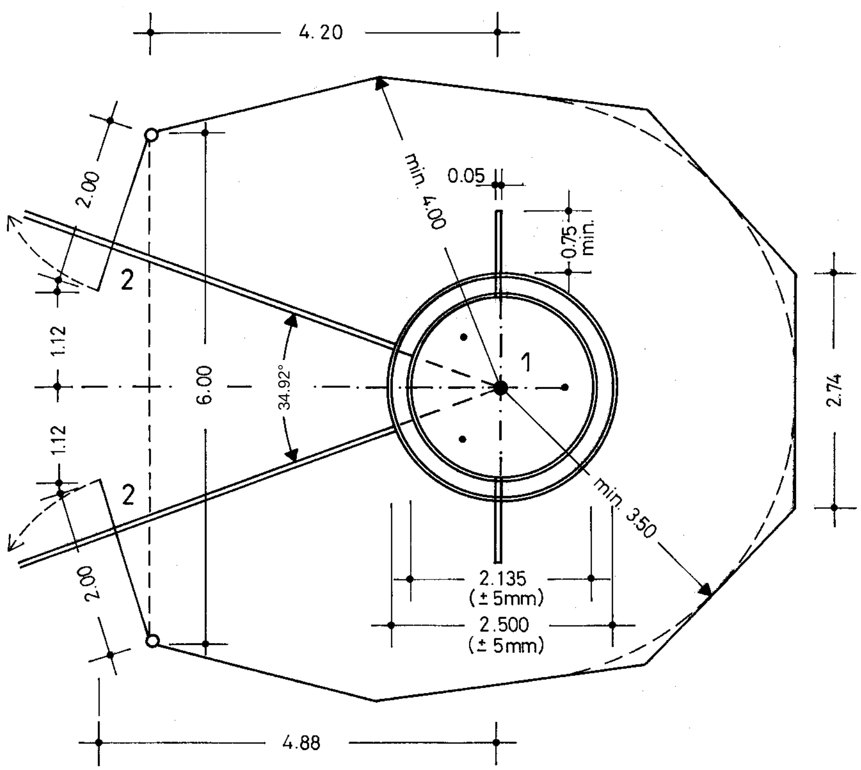



**Figure 6.3.2 - Combined discus and hammer throwing cage**
(Dimensions in m)

#### 6.3.2.1 Necessary Safety Precautions

National safety regulations may require tests in addition to those listed.

However, the following are considered to be the minimum safety tests and requirements:

- Careful and regular check of all materials, joints, bolts and supports before each competition season.

- Inspection of netting before each competition.

- Testing of netting materials at least once per year.

If fibre netting is used, several sample lengths, minimum 2 metres long, should be worked into the net by the manufacturer. Some of these cords should be removed and tested to ensure the continued strength of the netting.

The netting cord must be strong enough so that it does not break under the impact of the hammer, abrade where it is attached or deteriorate unduly under the effects of ultra violet ray exposure.

#### 6.3.2.2 Hammer Cage (Rule 192 and Fig. 2.4.2.2)

The hammer cage shall be designed, manufactured and maintained so as to be capable of stopping a 7.26kg hammer moving at up to speeds of 32m per second.

The netting which may be of suitable natural or synthetic fibre cord or of mild or high tensile steel wire should be arranged so that there is no danger of the hammer ricocheting, rebounding or forcing its way through joints in the netting or panelling. The minimum height of the netting shall be 7.00m.

There must be adequate attachment of the netting at ground level which maintains the net in correct relationship to the throwing circle.

The maximum mesh size for wire netting shall be 0.05m and, for cord netting, 0.044m and the minimum breaking strength shall be 300kg.

The netting may be in sections or in continuous form hung from a well supported and braced framework. It is desirable that the netting can be raised and lowered quickly. In any construction the minimum distance from the centre of the circle to any point on the cage shall be 3.50m. The netting shall be hung clear of the support posts so that it cannot be struck by a thrown implement.

The supporting structure shall be rigid enough so that it does not deflect out of position unduly under the weight of the netting or the force of the wind.

The width of the cage at the mouth should be 6.00m positioned 4.20m in front of the centre of the hammer circle.

Two movable netting panels 2.00m wide and at least 9.00m high shall be provided at the front of the cage. These panels shall be constructed and erected so as to allow the panels to be opened and closed to suit “right-handed” and “left-handed” throwers.

The posts supporting the front panels (gates) shall be easy to open and close manually and constructed so that they can be secured firmly in the fully open and closed positions.

As this Rule may be reviewed, the current edition of the IAAF Handbook should be checked.

**This cage is suitable for Discus Throwing.**

#### 6.3.2.3 Discus Cage (Rule 190 and Fig. 2.4.1.2)

The cage should be designed, manufactured and maintained so as to be capable of stopping a 2kg discus moving at speeds of up to 25.00m per second.

The netting which may be of suitable natural or synthetic fibre cord or of mild or high tensile steel wire should be arranged so that there is no danger of the discus ricocheting or rebounding. It shall be at least 4.00m high.

The maximum mesh size for wire netting shall be 0.05m, and, for cord netting, 0.044m.

The netting may be in sections or in continuous form hung from a well supported and braced framework. It is desirable that the netting can be raised and lowered quickly. In any construction the minimum distance from the centre of the circle to any point on the cage shall be 3.00m. The netting shall be hung clear of the support posts so that it cannot be struck by a thrown implement.

The supporting structure shall be rigid enough so that it does not deflect out of position unduly under the weight of the netting or the force of the wind.

The width of the cage at the mouth should be 6.00m positioned 5.00m in front of the centre of the discus circle.

As this Rule may be reviewed, the current edition of the IAAF Handbook should be checked.

**This cage is not suitable for Hammer Throwing.**

# CONTENTS - CHAPTER 7
# MAINTENANCE

# CHAPTER 7
# MAINTENANCE

## 7.1 General Aspects

The proper maintenance of the stadium is of paramount importance for the sport. The enjoyment of athletes and spectators is conditional upon such maintenance.
The benefit to the community of an attractive stadium cannot be over emphasised.
The lifetime of track and field facilities depends on regular maintenance.
Lack of maintenance leads to deterioration and is costly to rectify. It projects a bad image and can result in overspending of annual budgets.
Maximum use of track and field stadia requires the best conditions for athletes and spectators and for all maintenance personnel.
Authorities responsible for annual budgets must make adequate provision for the cost of necessary maintenance which should include cleaning, renovation and rebuilding works. Annual budgets must take into consideration all expenses including:

- capital charges
- running costs
- arena equipment
- maintenance equipment
- maintenance materials
- renovation of the sports surface

Failure to maintain and renovate regularly will result in expensive reconstruction costs often as much as 100% more.
Maintenance works must be carefully planned in good time and reviewed annually.
All maintenance personnel must be kept well informed of these plans.
The education of staff at all levels must be conducted regularly. Lectures on proper maintenance, new methods and materials should be part of their employment.

## 7.2 Maintenance of Competition and Training Surfaces

Important factors for a high standard of maintenance are:

- well designed and constructed track and field facilities
- competent management
- well qualified and trained groundsmen and other staff
- adequate annual budget and continuous financial control of all types of maintenance
- readily available and suitable equipment for maintenance
- sufficient quantity of necessary materials

- detailed planning (daily, weekly, seasonally and annually) of all maintenance including a “log-book” recording all maintenance operations
- all persons involved should be informed in good time
- technical supervision of the condition of the stadium and action on any resulting recommendations

### *7.2.1 SYNTHETIC SURFACED TRACKS*

#### 7.2.1.1 General Aspects

Synthetic surfaces for athletics facilities are not maintenance free. To obtain the required high standard, certain daily and seasonal procedures must be carried out. Consideration must be given to the right time for renovation by replacing a worn-out surface or retopping and adequate budgetary provision must be made for this.

#### 7.2.1.2 Suitable Equipment

For normal maintenance of a synthetic surface the following equipment is necessary:

- hand tools for manual cleaning (hose, brush)
- ride-on sweeper with rotary nylon (not metal) brushes
- high pressure (water) ride-on cleaner (tractor with equipment for high pressure and water tank)
- ice spray boxes
- repair kit for synthetic materials
- marking and spraying kits
- portable sprayer

#### 7.2.1.3 Necessary Materials

It is recommended that colours for marking, synthetic material and glue for smaller repairs be available in the stadium.

#### 7.2.1.4 Required Properties of the Surface

The most important factors are cleanliness of the running track, overall colour of the surface and white, accurate lines and standardised marks (correct form and colour).
Adequate maintenance will ensure these objectives.

#### 7.2.1.5 Regular Procedure

Regular maintenance - after daily general inspection for damage, loose spots, need for cleaning - consists of cleaning, manual or with ride-on sweeper, hosing down partly or totally, removal of debris and loose deposits such as litter, grasscuts, leaves and sand from the landing area.

#### 7.2.1.6 Basic Procedure

The basic maintenance programme for a synthetic surface should consist of:

- manual cleaning with hose/brush
- mechanical cleaning with a ride-on sweeper (large or small, as required)
- treatment of weeds, algae and moss with approved chemicals then removal using pressure washing
- freezing away chewing gum by means of ice spray

- checking the top of surface is securely fixed to the base loose spots are to be fixed immediately
- special controls of areas with heavy traffic of spiked shoes
- checking of all lines and marks, renewing when needed
- allocation of lanes available for training

#### 7.2.1.7 Seasonal Works

Seasonal maintenance, including major cleaning, is to be carried out twice a year. It is not recommended to hose down the total surface with water but to use high pressure water-cleaning, namely full rinsing using tractor with unit for high pressure treatment. No chemicals should be used on the synthetic surface.

Renewal of lines and marks should follow when needed.
When snow is to be removed, it must be swept off.

#### 7.2.1.8 Restrictions on Use

To ensure a high standard of maintenance, restrictions should be imposed on the use of the synthetic track. In general, no vehicles should be permitted to drive on the synthetic surface. Before heavy-duty vehicles are allowed onto the surface, it must be protected by boards.
The use by athletes of chemicals (eg for muscle treatment) within the arena should not be allowed.
Fireworks and cigarettes on the synthetic surface are always forbidden.
The inside lane should be closed for training using barriers.
Soiling of the track surface from football boots should be avoided by placing covers on transition areas.

#### 7.2.1.9 Renovation

The lifetime of a synthetic surface will depend upon its quality, its usage and its level of maintenance. In general, a normal synthetic surface used intensively will last 8 to 10 years before renovation is required.
Renovation should be periodically carried out to prevent the total damage of the surface which would necessitate complete renewal.

There are different procedures for the renovation of a surface:
- total renewal by replacing the worn-out synthetic surface with a new material
- section renewal by replacing the localised worn areas
- renewal by re-topping or sealing with adequate synthetic materials
- part re-topping in particular worn-out areas

Tracks must be re-marked and resurveyed after complete renovation. If the track has an IAAF certificate an IAAF Measurement Report must be forwarded to the IAAF. Where improvements have been made to only certain sections of the surface, it must be decided whether or not a complete re-marking is necessary.
It should be noted that, for synthetic surfaces which are permeable to water, renovation by means of sealing or spray coating may diminish the water permeability of the surface.

## *7.2.2 UNBOUND MINERAL SURFACED TRACKS*

### 7.2.2.1 General Aspects

Maintenance of unbound mineral surfaces is time consuming and continuous. It requires skilled groundsmen and a variety of modern equipment. The essential factor of maintenance is regularity. To maintain unbound mineral surfaces to the high standards demanded today, they should be completely reconditioned after each use.

### 7.2.2.2 Suitable Equipment

For normal maintenance, the following equipment is required:

- machinery:
  tractor or other suitable vehicle with hydraulic lift mechanism,
  grading frame or levelling boom
- accessories:
  trulute, scarifyer, rake, brush
- watering:
  hose, at least 200m long, with 25mm diameter, and suitable nozzle
- hand tools:
  drag brushes, rakes, shovels, trulutes, trolley for transport of equipment
- marking equipment:
  pressure jet markers, straight edges, steel tapes, portable sprayer

### 7.2.2.3 Necessary Materials

Sufficient surface material in correct gradients must always be available and stored under cover. Paint (powder) for the lines/marks must be available.

### 7.2.2.4 Required Properties of the Surface

For an unbound mineral surface the most important factors are: evenness, compactness, moisture and markings.

### 7.2.2.5 Regular Procedure

A general inspection is usually sufficient to ascertain the maintenance required. On a daily basis, the whole track surface should be mechanically truluted and brushed, usually with two passes in opposite directions.

### 7.2.2.6 Basic Procedure

The evenness of the surface will be restored by using levelling equipment (truluting). Local unevenness must be eliminated beforehand by manual filling and sealing.
It is essential that the top surface never dries out. When necessary, the surface must be uniformly watered. When necessary, it must be rolled with a two-piece static roller.
The position of the inner kerb should always be checked.
The track should be marked in accordance with accepted colour codes.
Special attention must be paid to the runways for high jump, long jump, triple jump, pole vault and javelin throw as well as the surface before and after the water jump. These areas must be levelled, be given a good bond with water and well rolled.

#### 7.2.2.7 Seasonal Works

Before the start of a season, the complete surface should be carefully treated. The whole area should be mechanically scarified, followed by truluting, brushing and rolling when needed.
Salt treatment is advised when dust problems occur or if the track is used in the winter. Weeds must be controlled and removed manually or chemically.
The inner kerb is often removed in the winter and must be reset before the season starts. Its position and rigidity should be checked regularly.
Defects must be repaired.
Top dressing with the appropriate materials and local repairs must be carried out whenever needed.

#### 7.2.2.8 Restrictions on Use

Generally, no vehicles should be parked on the surface. Heavy vehicles should not be driven on the surface.
The track should never be used under thaw conditions.

#### 7.2.2.9 Renovation

With high quality maintenance and weather resistent high quality material, an unbound mineral surface will give satisfactory performance for 25 to 40 years.
Renovation of a mineral surface entails the renewal of the top layer, or more, of the construction.
To improve the grain composition of the surface, it should be perforated and spread with silt-free material.It may also be necessary to restore the compactness and evenness of the layers.

### *7.2.3 NATURAL GRASS SURFACED TRACKS*

#### 7.2.3.1 General Aspects

Natural grass surfaces are mainly used for infield throwing events. However, they can be used for tracks. Turf requires specialist care. Since it is a living material, particular attention must be paid to the frequency of use.

#### 7.2.3.2 Suitable Equipment

For normal maintenance, the following equipment is required:

- tractor
- ride-on grass-cutter
- nutrient spreader
- sand spreader
- seed spreader
- hand tools
- renovation equipment

For renovation, the following equipment is recommended:

- top dresser
- airifyer/aerator with slices/pipes
- slotter
- verticutter
- vertidrain
- seeder

#### 7.2.3.3 Necessary Materials

The following materials must be available:

- substitute grass area
- seeds
- nutrients
- sand in specific gradients
- growth medium of standardised quality

#### 7.2.3.4 Required Properties of the Surface

The most important factors are: evenness, compactness, growth and height of grass.

#### 7.2.3.5 Regular Procedure

A natural grass surface should be inspected daily. The normal procedure consists of cutting and watering (frequency varies) and repair of the surface, when necessary.

#### 7.2.3.6 Basic Procedure

The following main tasks should be undertaken in a basic maintenance plan:
When mowing, the cutting height must take into consideration the sports activities for which the surface will be used. Prior to a track and field competition the grass should be cut to 1.5cm to 2cm in height.
All grass cuttings should be removed, ensuring they are not spilt onto a synthetic or unbound mineral surface.
A quantity, quality and time programme of nutrition must be established.
For watering, flush sprinklers are recommended.
Local damage must be repaired immediately. All thatches are to be removed.
When necessary, the surface must be loosened with special tools and sanded with 0.2mm to 0.4mm particles. Leaves, litter and other deposits are to be removed.
Plant protection must be observed in accordance with national law.

#### 7.2.3.7 Seasonal Works

The seasonal preparation of the grass surface is of great importance. Plans should be established for Spring works (general preparation), Autumn works and maintenance after each training session.

#### 7.2.3.8 Restrictions on Use

Natural grass must be protected. The frequency of use must be regulated and sufficient time allowed for growth and maintenance (repair of bad spots, general treatment, renovation). The surface should be protected from heavy vehicles.
For the hammer event, the surface should only be used for competition and not for training. The inside lane should be closed for training using barriers.

#### 7.2.3.9 Regeneration/Renewing

Even with well planned and practiced maintenance, a natural grass surface will require a carefully planned regeneration after 6 to 10 years. Based on analysis of the growth medium, compactness, porousness and the condition of the grass, there are different principles for regeneration or renewing.

- Simple surface renovation
  This method is recommended as a natural renovation for uneven surfaces of large areas of worn grass.
  The procedure consists of cutting the grass 1cm, verticutting for cleaning the surface and removal of dead grass and thereafter levelling with growth material. It is important that all compact areas are loosened. This is followed by a top dressing of sand and, finally, overseeding.

- Combined surface and depth renovation
  To be used in cases of greater compactions, bad drainage and poor grass cover. The surface should be cut, cleaned and levelled. In addition, it should be vertidrained to a depth of 15cm to 30cm before sanding and overseeding.

- Renewing
  This procedure is to be recommended in acute circumstances. The grass surface may be waterfilled due to compaction. The procedure for renewing is the removal of the top layer of approximately 5cm. The drainage must be inspected and, if necessary, renewed. The ground should be loosened and levelled with granular materials to the required standard consistency.
  New soil of a standardised sand-based composition should be laid to a depth of 8cm to 12cm. This soil should be levelled and seeded.

# 7.3 Maintenance of Technical Installations

All technical installations in an athletics stadium need proper and regular care and maintenance to prevent deterioration.

## *7.3.1 TECHNICAL SYSTEMS*

### 7.3.1.1 Drainage

General inspection of drainage channel (hosing down)
All drainage kerbs should be cleared by rodding or jetting
All gully pots and catch pits should be cleared

### 7.3.1.2 Water Hydrants

Control of water pressure
All joints to be checked
Water supply joint in the water jump to be checked

### 7.3.1.3 Irrigation Installation

Movable systems (control of tubes, hose, sprinkler and joints)
Automatic systems (control of tubes, joints, water pressure, pop-ups)

### 7.3.1.4 Cable Channels

Control of all channels

### 7.3.1.5 Ducts for TV and Electronic Equipment

All plug-in points to be controlled

## *7.3.2 COMPETITION EQUIPMENT*

### 7.3.2.1 Ground Equipment

#### *7.3.2.1.1 Kerb*

To be inspected and to be cleaned with liquid detergent

#### *7.3.2.1.2 Landing Area for Long and Triple Jump*

Sand should have a gradient 0.2mm to 2.0mm, with no sharp edges. Salt may be added. The landing area should be well turned over, levelled and moist.

#### *7.3.2.1.3 Take-off Board for Long and Triple Jump*

No irregular edges
Solid foundation
Painted white
Supply of extra boards
Plasticine indicator boards and supply of plasticine
Trays for removable boards including drainage holes to be regularly cleaned

#### *7.3.2.1.4 Throwing Circles*

Flat, with gentle stippled surface and no loose areas
Check of dimensions
Cleaning (hose, brush, cloth)
Drainage holes to be kept clear
Shoe cleaning apparatus
Shot put stop board must be firmly secured and checked for correct positioning.
It should be painted white.

#### *7.3.2.1.5 Throwing Cages*

Frequent examination of all uprights, panels, nets and nettings
Any repairs must be carried out without delay
Grounds sockets should be free from mud, etc
All nets to be pegged down firmly

#### *7.3.2.1.6 Uprights for Jumping/Vaulting*

To be adjusted and repaired, when needed
Rigidity to be checked

#### *7.3.2.1.7 Box for Pole Vault*

Drainage holes to be cleared
Rigidity to be checked

#### *7.3.2.1.8 Landing Mats for Jumping/Vaulting*

Must receive frequent attention
Misuse must be prevented
Must be mounted on open duckboards
Stored in a dry place
Protected by a removable cover
Repaired when necessary
Correct handling when moved

#### *7.3.2.1.9 Arc for Javelin*
Must be painted white

#### *7.3.2.1.10 Water Jump*
Outlet drain to be controlled
Hydrant for water filling to be checked
Water to be drained after the event
Landing area to be regularly checked to ensure that the synthetic surface is in good condition and safe
Firmness of hurdle to be checked
Hurdle well painted
Concrete retaining walls to be checked for damage
Removable kerb to be checked

### 7.3.2.2 Track Equipment
#### *7.3.2.2.1 Hurdles*
To be checked at regular intervals
To be kept clean with moving parts well lubricated
Repainted when necessary
Inspection of weights

#### *7.3.2.2.2 Starting Blocks*
To be kept clean with moving parts lubricated
To be stored in a dry place

#### *7.3.2.2.3 Hurdles for Steeplechase*
To be carefully stored and painted
Firmness and stability to be checked

### 7.3.2.3 Timing and Measuring Equipment
All equipment must be stored carefully, checked before use and be calibrated annually.

### 7.3.2.4 Fencing
Fences and gates have to be checked in respect of rigidity and wear.
Damage has to be repaired.

# CONTENTS - CHAPTER 8
# FACILITIES FOR INDOOR ATHLETICS

# CHAPTER 8
# FACILITIES FOR INDOOR ATHLETICS

## 8.1 Special Features of Indoor Athletics

The indoor stadium should include facilities adequate for the full range of events normally held indoors and should conform to IAAF Rules and Regulations.

### *8.1.1 IAAF RULES FOR INDOOR MEETINGS*

The indoor stadium shall be completely enclosed and covered. Lighting, heating and ventilation shall be provided to give satisfactory ambient conditions for competition. In hot climates full air-conditioning may be necessary.

#### 8.1.1.1 The Arena

The arena should include a 200m long oval track (Standard Distance Indoor Track) consisting of two horizontal straights and two bends which shall be banked; an infield straight track for sprints and hurdles; runways and landing areas for high jump, pole vault, long jump and triple jump and a circle and landing sector for shot put (Fig. 8.1.1.1).

The IAAF recommends the “200m Standard Indoor Track” as the optimum solution but having regards to the need to accommodate demountable tracks in multipurpose facilities, also accepts the “200m Standard Distance Indoor Track” for all competitions.

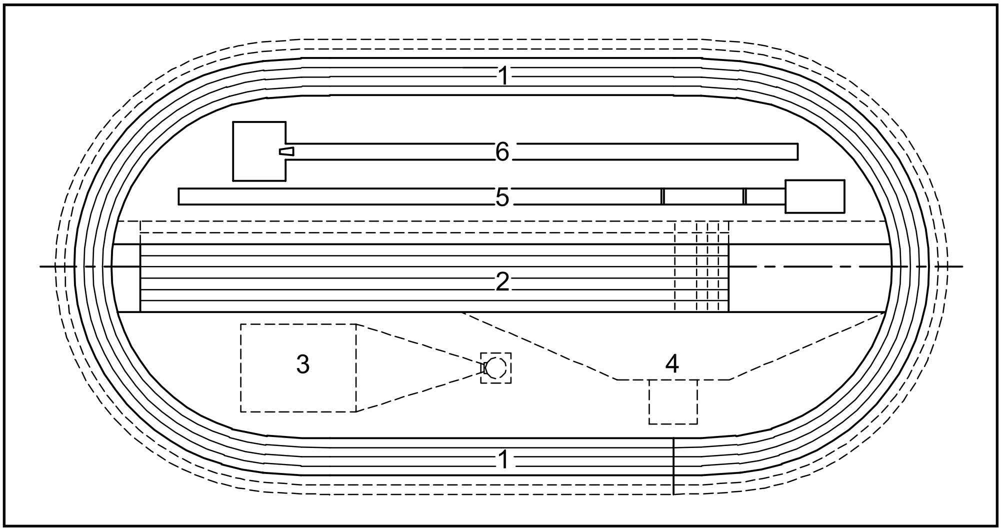



**Figure 8.1.1.1 - Layout plan of the 200m Standard Indoor Track**
1 Standard track, 2 infield track, 3 shot put, 4 high jump, 5 long and triple jump, 6 pole vault

### 8.1.1.2 Tracks and Lanes

The infield track should have a minimum of 6 and a maximum of 8 lanes, each 1.22m ± 0.01 wide.

The oval track should have a minimum of 4 and a maximum of 6 lanes. All lanes should have the same width with a minimum of 0.90m ± 0.01 and a maximum of 1.10m ± 0.01.

The tracks, runways or take-off surfaces shall be covered with the same synthetic material to specifications as outlined in Chapter 3. Preferably the surfaces should be able to accept 6mm spikes but stadium authorities may specify shorter spikes.

The thickness of the synthetic material on the oval track shall not be less than 9mm.

As far as is technically possible, each runway shall have a uniform resilience throughout. It is accepted that where there is suspended construction, there will be some variation in the "feel" of the runway between supporting joists even when the surfacing is of a reasonable thickness.

### 8.1.1.3 The Oval Track

The length of the Standard Distance Oval Track should not be less than 200m (+ 0.04m).

The oval track consists of two horizontal straights and two bends which shall be banked.

The inside of the track shall be bordered either with a kerb of suitable material, approximately 0.05m in height and width, or a white line 0.05m wide. The length of the inside lane shall be measured (measurement line) along the surface of the track 0.30m outward from the kerb. If there is no kerb, the measurement shall be taken 0.20m outward along the surface from the outer edge of the white line marking the inside of the track. A kerbed track is preferred.

The inside edge of the line or kerb shall be generally horizontal throughout the length of the track with a maximum longitudinal slope of 0.1%.

Recent experience has shown that the most suitable 200m oval tracks are constructed with bend radii of between 15m and 19m with an optimum of 17.204m. The IAAF recommends that where possible all future tracks are constructed to the latter specification and will be referred to as the “200m Standard Indoor Track”. It is accepted that building and other limitations may dictate that an indoor track be of a different radius and/or geometry. The designer shall ensure that the sprint track and field facilities can be fitted on the infield with satisfactory safety clearances.

The angle of banking of the bends should not exceed 15°. The suggested maximum angles of banking for a range of radii are given in Table 8.1.1.3.

| | | | | | | |
|---|---|---|---|---|---|---|
| Radius | 15.00 m | 15.50 m | 16.50 m | 17.50 m | 18.50 m | 19.00 m |
| Banking | 15° | 13° | 11.5° | 10° | 10° | 10° |

**Table 8.1.1.3** - Suggested maximum angles of banking
Source: Swedish Athletic Association

The angle of banking in all lanes should be the same at any radial cross-section of the track.

The vertical transition between flat straights and banked bends must be continuous and uniform. The maximum gradient of the vertical transitions, measured in the running direction along the outside edge of the outer lane, should not exceed 5%. The vertical transition between straights and bends may extend up to 5m into the straight. The connection between the horizontal area and ascending and descending areas should be smooth, with a minimum vertical radius of 5m.

To ease the athletes' smooth passage from the straights to the bends, clothoid-type radial transitions may be constructed between the straights and the bends. However, the length of the straight should not where possible be less than 35m.

Clothoid-type radial transitions are widely used in road, railway and roller coaster curve design since the curvature of a clothoid varies continuously along the curve. As a consequence the centrifugal force on a vehicle moving continuously along the curve also varies continuously and can be counterbalanced through a continuous increment of banking.

A clothoid is a curve where the radius at any point reduces as the arc length increases according to the clothoid parameter that determines the tightness of the curve.
The equations for a clothoid are somewhat complicated, but can be expressed in terms of the Fresnel integrals, which are used in physical optics and are well tabulated. Tables of standard offsets for a given curve radius and transition length are published.

Whilst the kerb or lane 1 marking can be set out with a true clothoid-type transition, all other lanes markings will not be true clothoids. Each lane has to be set out from the kerb or lane 1 marking so that the lane width is maintained on the banked track.

The radial transition between straights and bends may also be made with two or three sections of radii gradually decreasing from a very large radius to the bend radius. This is a very practical solution to the radial transition problem that has been successfully adopted by several manufacturers.

#### 8.1.1.4 Facility for High Jump

The same facility should be provided as for outdoors. The minimum length of runway shall be 15.00m except in competitions held under Rule 12.1(a), (b) and (c) where the minimum shall be 20m. However, IAAF Rules allow an athlete to start his approach on the banking of the oval track provided that the last 5m of his run-up is on the level runway. This should be borne in mind when designing the infield layout.

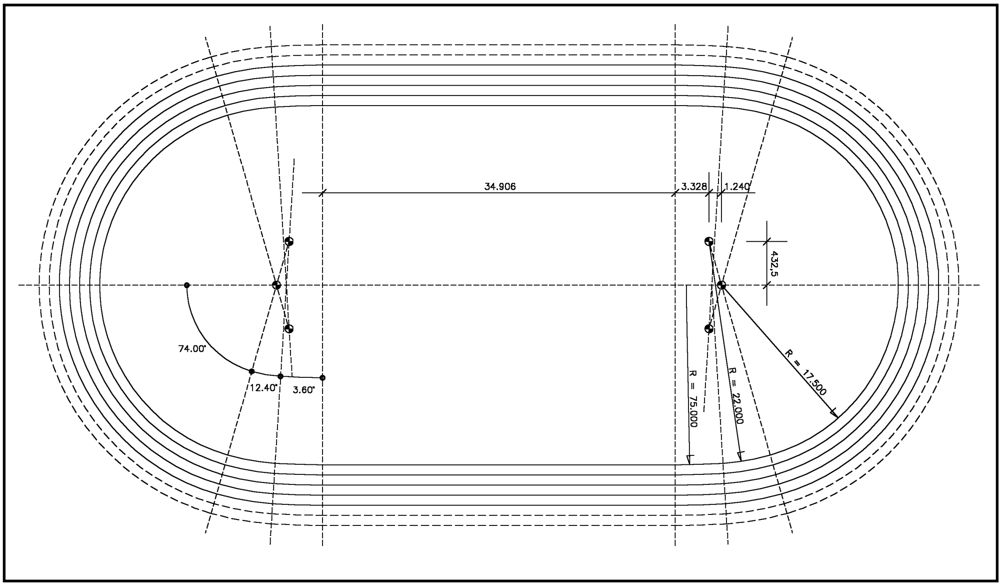



**Figure 8.1.1.3 - Alternative option for multi-radii transitions**

| | |
|---|---|
| 1/4 semi-circle | pi x 74 x 17.5/180 = 22.602m |
| | pi x 3.6 x 75/180 = 4.712m |
| | pi x 12.4 x 22/180 = 4.761m |
| 2 semi-cicles | 32.075m x 4 = 128.300m |
| 2 straights | 34.906m x 2= 69.812m |
| Kerb length | 198.112m |

#### 8.1.1.5 Facility for Pole Vault

The same facility should be provided as for outdoors. However, IAAF Rules allow an athlete to start his approach on the banking of the oval track provided that the last 40m of his run-up is on the level runway.

#### 8.1.1.6 Facility for Long Jump and Triple Jump

The same facility should be provided as for outdoors. However, IAAF Rules allow an athlete to start his approach on the banking of the oval track provided that the last 40m of his run-up is on the level runway.

#### 8.1.1.7 Facility for Shot Put

The landing sector shall be enclosed by a stop barrier and shall consist of some suitable material on which the shot will make an imprint, but which will minimize any bounce. The landing sector lines may either run radially from the centre of the shot put circle including a full 34.92° sector, or may be parallel to each other, the minimum distance between them being 9m. The stop barrier at the far end shall be at least 0.50m beyond the current world record for men or women.

### *8.1.2 MEETING VENUES, TYPE AND SIZE*

The facility should be adequate to cater for the various track and field disciplines mentioned in Section 8.1.1.1. The use of the competition area inside the oval track for other sports is possible. Dimensions including safety zones are listed in table 8.1.2.

| ***COLUMN*** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** |
|---|---|---|---|---|---|---|---|---|
| ***Line*** <br> ***1*** | ***Sport*** | ***Activity area Standard size*** | | ***Safety zone*** | | ***Total*** | | ***Height*** |
| | | Width m | Length m | Long side m | Short side m | Width m | Length m | m |
| ***2*** | Acrobatics | 12.00 | 12.00 | 1.00 | 1.00 | 14.00 | 14.00 | 5.50 |
| ***3*** | Badminton | 6.10 | 13.40 | 1.50 | 2.50 | 9.10 | 18.40 | 9.00 |
| ***4*** | Basketball | 15.00 | 28.00 | 1.00 | 1.00 | 17.00 | 30.00 | 7.00 |
| ***5*** | Boxing | 6.10 | 6.10 | 0.50 | 0.50 | 7.10 | 7.10 | 4.00 |
| ***6*** | Dance | 14.00 | 16.00 | - | - | 14.00 | 16.00 | 4.00 |
| ***7*** | Handball | 20.00 | 40.00 | 1.00 | 2.00 | 22.00 | 44.00 | 7.00 |
| ***8*** | Hockey | 20.00 | 40.00 | 0.50 | 2.00 | 21.00 | 44.00 | 5.50 |
| ***9*** | Ice hockey | 30.00 | 60.00 | - | - | 30.00 | 60.00 | 5.50 |
| ***10*** | Indoor soccer | 22.00 | 42.00 | 1.00 | 2.00 | 24.00 | 46.00 | 7.50 |
| ***11*** | Judo/Karate | 10.00 | 10.00 | 2.00 | 2.00 | 14.00 | 14.00 | 4.00 |
| ***12*** | Olympic gymnastics | 27.00 | 52.00 | - | - | 27.00 | 52.00 | 8.00 |
| ***13*** | Roller hockey | 20.00 | 40.00 | - | - | 20.00 | 40.00 | 4.00 |
| ***14*** | Rhythmic gymnastics | 13.00 | 13.00 | 1.00 | 1.00 | 15.00 | 15.00 | 8.00 |
| ***15*** | Tennis | 10.97 | 23.77 | 3.65 | 6.40 | 18.27 | 36.57 | 9.00 |
| ***16*** | Volleyball | 9.00 | 18.00 | 5.00 | 8.00 | 19.00 | 34.00 | 12.50 |
| ***17*** | Wrestling | 12.00 | 12.00 | 2.00 | 2.00 | 16.00 | 16.00 | 4.00 |

**Table 8.1.2 - Additional possibilities for use of the competition area inside the oval track**

# 8.2 Requirements, Design Principles and Guidelines

The building housing the indoor track will normally be fully integrated into urban development and will conform to local and national requirements for design, construction and safety.

The building will frequently be a multi-event venue designed to adapt to the needs of a variety of sports, cultural events, displays and exhibitions.

Indoor track designs are complex and should only be undertaken by design professionals with considerable experience otherwise costly mistakes can be made and the constructed facility may not meet IAAF and athlete expectations.

### *8.2.1 THE OVAL TRACK DESIGN*

The requirements of Sections 1.1.3 and 1.2.2 should, as far as possible, be met so as to ensure equality of opportunity for all athletes as well as a basis for comparability of performances.

To this end, a Standard Distance Indoor Track can be designed incorporating the requirements of the IAAF Rules for indoor competition and providing for:

- Track geometry based on an optimum radius of 17.204m but not less than 15.00m nor greater than 19.00m.
- A construction type related to the projected uses of the building housing the track.
- Use of the arena for other sports (ball games, ice hockey, cycling, etc. - Table 8.1.2).
- The possible installation of mechanically or hydraulically activated retraction equipment or use of a demountable removable track to allow additional space for exhibitions, concerts, etc.

Basically, there are two design alternatives for oval tracks:

- An oval track may be constructed within an existing sports hall the dimensions of which limit track design to an acceptable, but not ideal, standard.
- An oval track may be designed as a component of a new indoor stadium where the dimensions of the building allow for a Standard Distance Indoor Track to be constructed.

#### 8.2.1.1 200m Standard Indoor Track

For the reasons outlined in Section 8.2.1, it is recommended that, whenever possible, 200m Standard Indoor Tracks are constructed.

The 200m Standard Distance Indoor Track (Fig 8.2.1.1a) comprises two bends, each with kerb radius of 17.204m, joined by two 10.022m long clothoid-type transitions to two straights 35.00m long. (Table 8.2.1.1a). This will form an oval shape such that the competition area inside the track is large enough to accommodate an infield track for sprints, facilities for the jumping events and the shot put.

The inside of the 200m Standard Indoor Track is bordered with a kerb of suitable material, approximately 0.05m in height and width. Therefore the length of the inside lane shall be measured along the surface of the track 0.30m outward from the kerb.

The lanes of the 200m standard Indoor Track are 0.90m wide.

| ***COLUMN*** | ***1*** | ***2*** |
|---|---|---|
| ***Line*** 1 | ***Track components*** | ***200m Standard Indoor Oval Track*** |
| ***2*** | Length of the track at the kerb | 198.140m |
| ***3*** | Length of the track at the measurement line of the first lane | 200.000m |
| ***4*** | R = radius of the kerb | 17.204m |
| ***5*** | R1 = radius of the first lane | 17.500m |
| ***6*** | Clothoid length at the kerb | 10.022m |
| ***7*** | Clothoid length in the first lane | 10.108m |
| ***8*** | Straight length | 35.000m |
| ***9*** | Inclination angle of banking | 10.0925° |

**Table 8.2.1.1a - Dimensions of the 200m Standard Indoor Track**

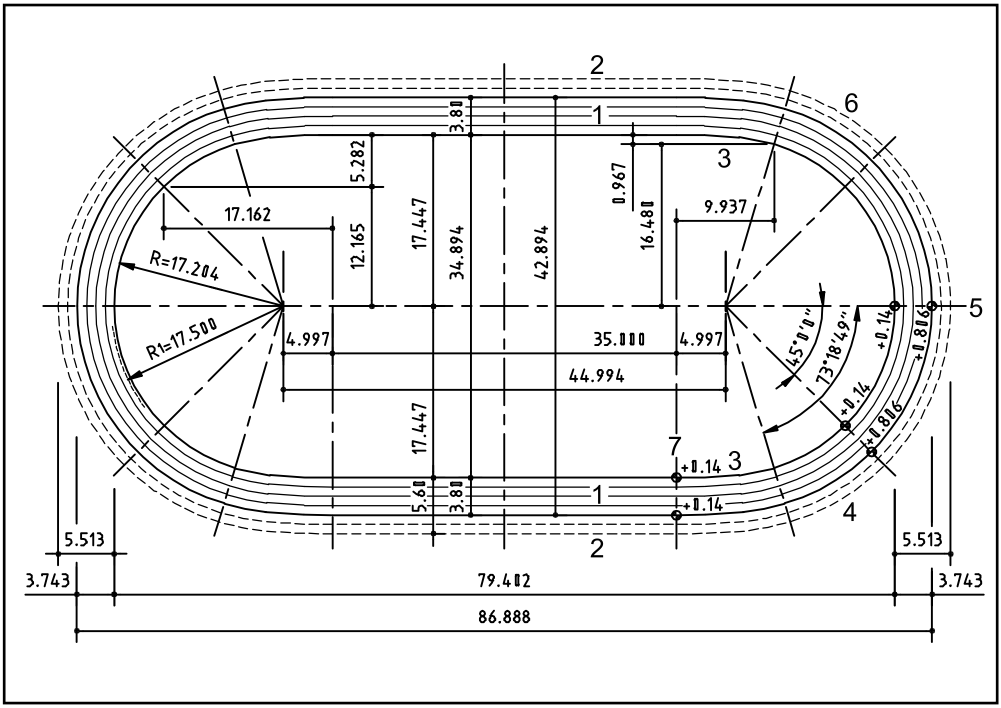



**Figure 8.2.1.1a - Setting out plan of the 200m Standard Indoor Track**
1 Straight, 2 flat stretch, 3 transition curve, 3-4 ascending track
5 bend with constant inclination, 6+3 descending track, 7 finish line

The bends of the 200m Standard Indoor Track must be banked. The maximum angle of banking is 10.00˚.

The vertical transition between flat straights and banked curves may extend up to 5m into the straights. The gradient of the vertical transition, measured in the running direction along the outside edge of the outer lane of the track, is of 5%. The connection between horizontal areas and ascending and descending areas are smooth, with a vertical radius of 5m (Figure 8.2.1.1.b).
The clothoid coordinates relative to the kerb, needed to set out the radial transitions, are given in Table 8.2.1.1.b (Figure 8.2.1.1c). Each lane has to be set out from the kerb so that the lane width is maintained on the banked track.

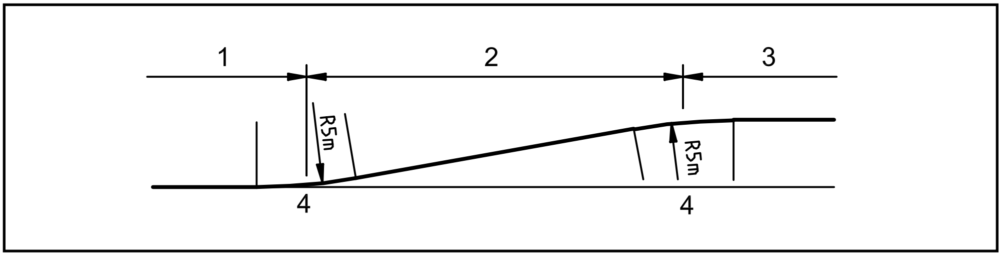



**Figure 8.2.1.1b - Ascending line of the outside edge of the track from the flat stretch to the highest level of banked track**
1 Flat stretch, 2 ascending track, 3 bend with constant inclination, 4 gradual transition with 5m radius

| ***COLUMN*** | ***1*** | ***2*** | ***3*** |
|---|---|---|---|
| ***Line*** | | | |
| ***1*** | ***L*** | ***X*** | ***Y*** |
| ***2*** | 0.0 | 0.000 | 0.000 |
| ***3*** | 0.5 | 0.500 | 0.000 |
| ***4*** | 1.0 | 1.000 | 0.001 |
| ***5*** | 1.5 | 1.500 | 0.003 |
| ***6*** | 2.0 | 2.000 | 0.008 |
| ***7*** | 2.5 | 2.500 | 0.015 |
| ***8*** | 3.0 | 3.000 | 0.026 |
| ***9*** | 3.5 | 3.500 | 0.041 |
| ***10*** | 4.0 | 3.999 | 0.062 |
| ***11*** | 4.5 | 4.498 | 0.088 |
| ***12*** | 5.0 | 4.997 | 0.121 |
| ***13*** | 5.5 | 5.496 | 0.161 |
| ***14*** | 6.0 | 5.993 | 0.209 |
| ***15*** | 6.5 | 6.490 | 0.265 |
| ***16*** | 7.0 | 6.986 | 0.331 |
| ***17*** | 7.5 | 7.480 | 0.407 |
| ***18*** | 8.0 | 7.972 | 0.494 |
| ***19*** | 8.5 | 8.463 | 0.592 |
| ***20*** | 9.0 | 8.950 | 0.702 |
| ***21*** | 9.5 | 9.435 | 0.825 |
| ***22*** | 10.0 | 9.916 | 0.961 |
| ***23*** | 10.022 | 9.937 | 0.967 |

**Table 8.2.1.1b - Clothoid coordinates, relative to the kerb**

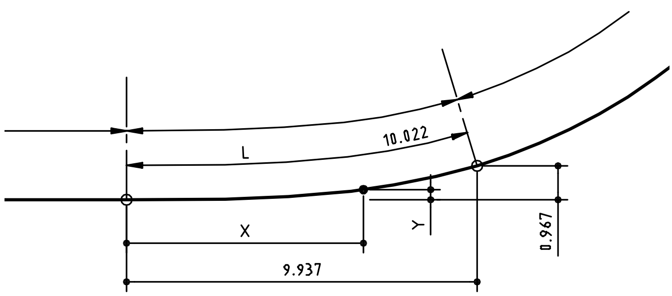



**Figure 8.2.1.1c - Coordinates of clothoid**
Coordinates, at 0.5m intervals along the clothoid, relative to the kerb at the end of the straight, are contained in Table 8.2.1.1b.

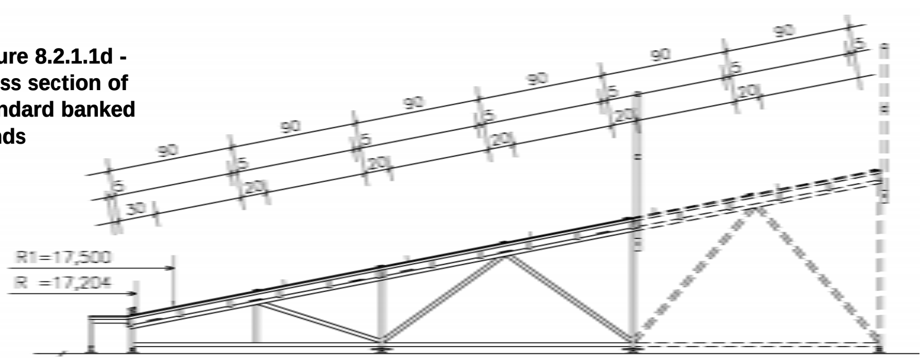



**Figure 8.2.1.1d - Cross section of standard banked bends**

### 8.2.1.2 Dimensional accuracy of 200m Standard Indoor Track

The dimensional accuracy required for all classes of competition is deemed fulfilled if the following set values are attained in the “29-Point-control-measurement”

(Figures 8.2.1.2a and b) on the outside edge of the inner track border: (New dimensions to be added)

- 44.994m ± 0.005m from the centres of the circular arches (1 reading)
- 34.894m ± 0.005m between the two straights, at each end of the straights (2 readings)
- 35.000m ± 0.005m for the length of the two straights each (2 readings)
- Alignment of the kerb in the area of two straights: no deviation greater than 0.01m (2 readings)
- 10.022m ± 0.005m for the four clothoid lengths each (4 readings)
- 17.204m ± 0.005m for 9 points on each of the two circle arches (18 readings). Each arch length must be 44.026m.
- The overall length of the 200m Standard Indoor Track along the outside edge of kerb: (2x35.000) + (2x44.026) + (4x10.022) = 198.140m.

The 29 point control measurement should be carried out and the readings recorded. The average of the deviations must not exceed + 0.04m nor be less that 0.00m (Figure 8.2.1.2a, Table 8.2.1.2).

For portable tracks the control measurement must be undertaken before the start of any competition.

For the dimensional accuracy of the 200m Standard Distance Indoor Track location of the main control points should be marked by permanent non corrodable drilled-in pegs or imbedded tubes flush with the hall flooring enabling the stadium staff to produce always the track of required dimensional accuracy.

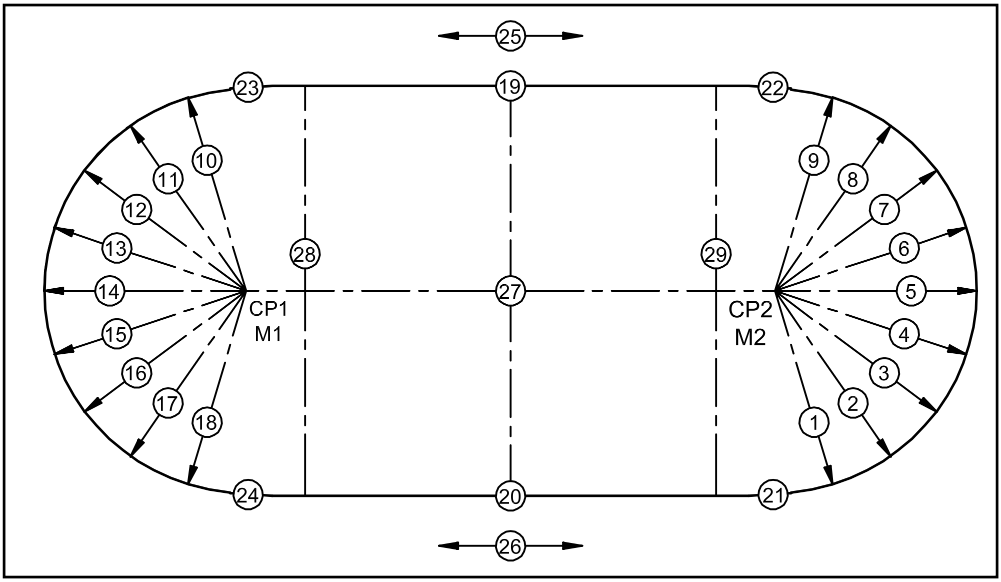



**Fig 8.2.1.2a : 29 Point control measurement of 200m Standard Indoor Track**
Measurement 1-9 and 10-18: 17,204 resp. (±0,005)
Measurement 19 and 20: 35,000 resp. (±0,005)
Measurement 21 to 24: clothoid length: 10,022 resp. (±0,005)
Measurement 25 and 26: alignment of the straights
Measurement 27: Distance from centres of circular arches (CP/M) = 44,994 (±0,005)
Measurement 28 and 29: Distance between the two straights: 34,894 resp (±0,005)
Example of readings see in table 8.2.1.2

| ***COLUMN*** | ***1*** | ***2*** | ***3*** | ***4*** |
|---|---|---|---|---|
| ***Line*** <br> ***1*** | ***Measurement in accordance with Fig 8.2.1.2a Number*** | ***Measuring result*** <br> ***m*** | ***Deviation from the desired value*** <br> ***± mm*** | ***Calculation of the running length based on average deviation*** <br> ***m*** |
| ***2*** | 1 | 17.206 | + 2 | |
| ***3*** | 2 | 17.204 | ± 0 | |
| ***4*** | 3 | 17.207 | + 3 | |
| ***5*** | 4 | 17.206 | + 2 | |
| ***6*** | 5 | 17.202 | - 2 | |
| ***7*** | 6 | 17.203 | - 1 | |
| ***8*** | 7 | 17.205 | + 1 | |
| ***9*** | 8 | 17.208 | + 4 | |
| ***10*** | 9 | 17.206 | + 2 | |
| ***11*** | Average of measurements 1 to 9 = | | +11:9 = +1.2 | 1. Curve (17.204+0.0012):17.204x44.026=44.0291 +0.0031 m |
| ***12*** | 10 | 17.205 | + 1 | |
| ***13*** | 11 | 17.202 | - 2 | |
| ***14*** | 12 | 17.203 | - 1 | |
| ***15*** | 13 | 17.200 | - 4 | |
| ***16*** | 14 | 17.202 | - 2 | |
| ***17*** | 15 | 17.205 | + 1 | |
| ***18*** | 16 | 17.206 | + 2 | |
| ***19*** | 17 | 17.208 | + 4 | |
| ***20*** | 18 | 17.207 | + 3 | |
| ***21*** | Average of measurements 10 to 18 = | | +3:9 = +0.3 | 2. Curve (17.204+0.0003):17.204x44.026=44.0268 + 0.0008 m |
| ***22*** | 19 | 35.003 | + 3 | |
| ***23*** | 20 | 34.998 | - 2 | |
| ***24*** | Average of measurements 19 to 20 = | | + 1 | 2 Straights + 0.001 |
| ***25*** | 21 | 10.020 | - 2 | |
| ***26*** | 22 | 10.024 | + 2 | |
| ***27*** | 23 | 10.020 | - 2 | |
| ***28*** | 24 | 10.021 | - 1 | |
| ***29*** | 25 | 0.005 | - | |
| ***30*** | 26 | 0.008 | - | |
| | Average of measurements 21 to 24 = | | - 3 | 4 Clothoids - 0.003 |

Deviation from the running length

| | | |
|---|---|---|
| 1. | Curve | + 0.0031 m |
| 2. | Curve | + 0.0008 m |
| | 2 Straights + 0.0010 m | |
| | 4 Clothoids - 0.0030 m | |
| Total: | | + 0.0019 m |
| Permitted max | | + 0.0400 m |

**Table 8.2.1.2: Record of 29-Point-control-measurement (Example with readings)**

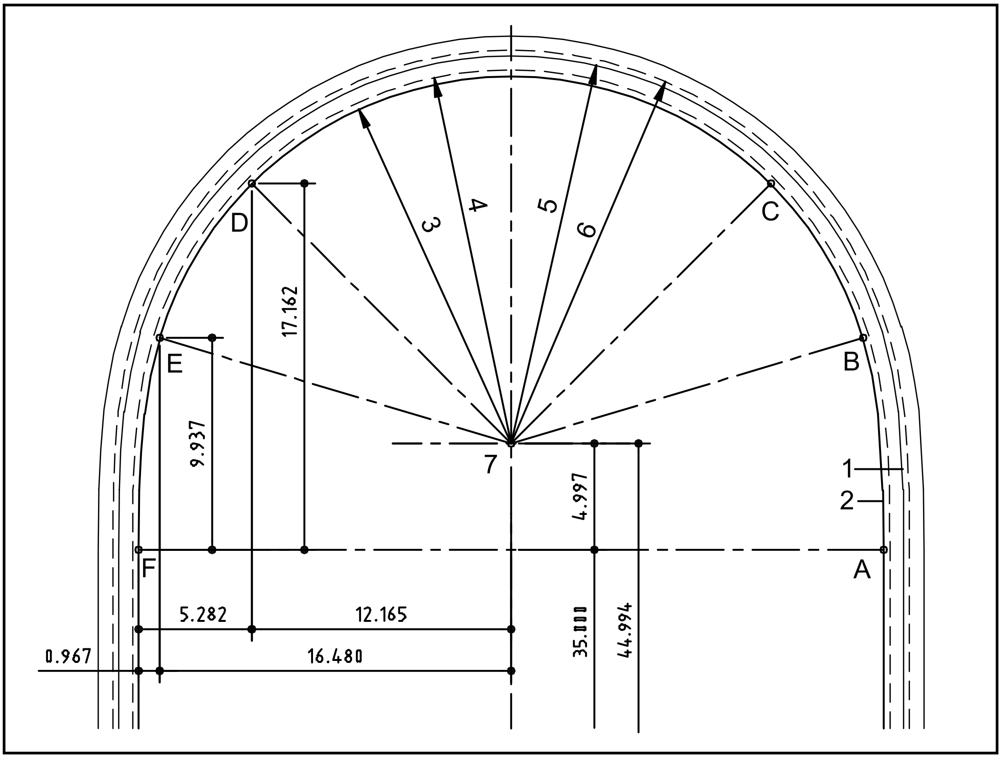



**Fig 8.2.1.2b - Calculation of track length of the 200m Standard Indoor Track**
(Dimensions in m)
1 Lane marking, 2 kerb, 3 outside edge of kerb, 4 running line of inside lane (R’ = 17.50m)
5 outside edge of track marking lane 2, 6 running line of lane 2, 7 centre point of semicircle

A-B Transition curve
A-C Ascending track
C-D Bend with constant inclination
D-F Descending track
E-F Transition curve

As a matter of course the control reading can be applied for all other indoor tracks having individual dimensions using the basic dimensions of the given track in a logical way.

### *8.2.2 DESIGN OF INFIELD INSTALLATIONS*

Infields in indoor tracks are more congested than for outdoors. Therefore, careful attention must be paid to the layout since it will affect the safety of competitors and officials, and the timetabling of events.

The infield track should be located along the longitudinal axis of the oval track. There should be 3.00m clearance before the startline and 10.00m to 15.00m after the finish line.

It is recommended that the pole vault, long jump and triple jump facilities be placed on one side of the infield track and the high jump and shot put facilities on the other.

#### 8.2.2.1 Facilities for Hurdle Races

The layout of hurdles for 50m and 60m races is shown in table 8.2.2.1.

| ***COLUMN*** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** |
|---|---|---|---|---|---|
| ***Line*** | | | | | |
| ***1*** | ***Denomination*** | ***Men*** | | ***Women*** | |
| ***2*** | Length of race | 50m | 60m | 50m | 60m |
| ***3*** | Height of hurdles | 1.067m | 1.067m | 0.838m | 0.838m |
| ***4*** | Number of hurdles | 4 | 5 | 4 | 5 |
| ***5*** | ***Distances*** | | | | |
| ***6*** | Starting line to first hurdle | 13.72m | 13.72m | 13.00m | 13.00m |
| ***7*** | Separation between hurdles | 9.14m | 9.14m | 8.50m | 8.50m |
| ***8*** | Last hurdle to finish-line | 8.86m | 9.72m | 11.50m | 13.00m |

**Table 8.2.2.1 - Layout of hurdles**

#### 8.2.2.2 Facilities for Jumping Disciplines

The best location for the long and triple jump runways is on one side of the infield straight track with the pole vault runway adjacent and parallel to it. The runways should be constructed in opposite directions to each other to allow both runways to be used simultaneously, if required.

The runways may be extended up to the banked bends.

The high jump facility should be placed with an equal run-up from both sides.

#### 8.2.2.3 Facility for Shot Put

The shot put facility should preferably be situated with putting direction outward from the infield centre and parallel to the straight track in order to best separate shot put from other events.

### *8.2.3 OTHER EQUIPMENT WITHIN THE OVAL TRACK*

In addition to the normal equipment necessary for competitions, provision must be made for infield scoreboards and victory ceremony podiums. Consideration should be given to locate podiums outside the competition area.

#### 8.2.3.1 Scoreboards and Podium for Victory Ceremonies

At least one movable scoreboard which displays the athlete’s name, trials and results should be provided for each field event. These scoreboards should be linked to the information system.

A podium for victory ceremonies should be placed such that it is clearly visible to the spectators and the announcer.

#### 8.2.3.2 Electrical Connections

The electrical cables supplying the measuring instruments and communication network should be run underfloor or in recessed ducting around the oval track with sockets for connection at appropriate points.

The connection points should be safely placed under a flat lid, flush with the track or floor.

# 8.3. Track Construction

### *8.3.1 CONSTRUCTION ALTERNATIVES FOR OVAL TRACKS*

The design of the track is dependent upon the uses to which the hall will be put. In a single-purpose athletic hall, the oval track may be permanently installed. For a multi-purpose hall which is used for other sports and non-sporting events see 8.3.1.2 and 8.3.1.3.

#### 8.3.1.1 Permanent Track

In single-purpose athletic hall, a permanent track should preferably be installed.

A permanent track has the advantage that it can be laid on a solid base such that there is uniform resilience throughout. The foundation is normally of concrete.

Whilst a permanent installation offers the best facilities for athletics competition and training, it can have economical disadvantage because of its lack of flexibility in usage. If flexibility of usage is required, a permanent track with height-adjustable bends or a portable track should be installed.

#### 8.3.1.2 Permanent Track with Height-adjustable Bends

The disadvantages of a permanent track can partly be overcome by a track which is a combination of fixed and movable track portions. This is a track the straights and bends of which are installed flush with the floor level or marked on the floor. However, when required for competition or training, the bends can be raised to the required height. If a system of mechanical or hydraulic jacks is installed this procedure will only take a few minutes. Another benefit of a hydraulic or mechanical system is that the whole bend can be raised as a single unit thus ensuring that the synthetic surface of the track is even. During installation, the units laying flat have joints between the panels changing from 0 to a few milliimetres outwards.

The rate of banking along the transition curve should be defined for each section and programmed for synchronized elevation by pushbuttons. The jacking into position of the banked bend is effected by using electronically controlled brakes.

The main advantages of a permanent track with height-adjustable bends are the flexibility of use for other events and the speed of assembly and disassembly.

#### 8.3.1.3 Portable Track

A portable track can be assembled from prefabricated units which, after disassembly, will be stored when not in use.

There are two different unit types: the floor units with synthetic top layer and the support elements of the banked bends.

The floor units are panels made of wooden joists with frames faced with plywood sheets or boarding as a supporting layer for the synthetic surface. The panel edges should be made in tongued and grooved design to facilitate joining.

The support structure framing can be made either of wood or metal, preferably in stackable design.

The assembly of the portable track is performed in the following stages:

- Pushing back the retractable stands (if any)
- Identification of the layout markings of the track
- Laying of a protective mat over the track area
- Installation of support frames for the banked bends
- Assembly of the 200m oval track
- Assembly of the 60m infield track
- Installation of runways and landing areas for jumping events
- Installation of the shot put facility
- Installation of a safety railing on the outside of the bends and a padded brake wall for sprinters.

The track must be carefully designed to produce uniform resilience throughout. Heavy duty and rigid panels must be used although some difficulty may be encountered with assembly and disassembly, which are time consuming and labour-intensive, transportation and storage.

With careful design, a high quality portable track which meets all of the requirements of top athletes can be produced.

### *8.3.2 STRUCTURAL DETAILS OF THE OVAL TRACK*

The performance specifications in Chapter 3 apply generally to the synthetic surface of the track with necessary adjustments where the thickness is different. The thickness of the synthetic material on portable oval tracks shall be not less than 9mm and on permanent oval tracks 13mm.

For safety reasons the banked bends' outer edges should be provided with a protective railing from the beginning of the transition curve throughout the bend up to the beginning of the next straight.

If the inside edge of the track has a vertical drop in excess of 0.10m a safety zone minimum 0.30m wide, flush with the inner edge of the track, should be supplied.

### *8.3.3 STRUCTURAL DETAILS OF THE INFIELD TRACK*

The synthetic surface of the infield track and the oval track should be the same product but may have a different thickness.

Where possible the synthetic surface on the infield track and the runways should meet the Outdoor Track Performance Specifications and be the thickness as indicated on the IAAF Product Certificate. The IAAF will provide a Performance Specification for Indoor Tracks in due course.

The overall dimensions of the infield track, with 3.00m clearance behind the start line and 10.00m to 15.00m clearance beyond the finish line will be 73.00m to 78.00m long and 7.32m (6 lanes at 1.22m) to 9.76m (8 lanes at 1.22m) wide.

The padded brake wall, where the athletes may come to a halt safely, should have a rigid frame and bracing enabling it to withstand horizontal impact stresses caused by 6 to 8 athletes arriving at the wall at speeds of up to 8m/sec.

The maximum lateral inclination of the infield track shall not exceed 1% and the inclination in the running direction shall not exceed 0.1% overall.

### *8.3.4 STRUCTURAL DETAILS OF THE JUMPING FACILITIES*

The Rules for jumping events require that the foundation on which the surface of the runway is laid must either be solid (for example concrete) or of suspended construction (such as wooden boards or plywood sheets, of adequate thickness so as not to spring unduly, mounted on joists) without any sprung sections.

The landing area for the long and triple jump should preferably be a permanent construction in the hall floor.

The depth of the pole vault box must be taken into consideration when deciding the panel thickness of a portable pole vault runway.

In all other respects, structural requirements are as for outdoors.

### *8.3.5 STRUCTURAL DETAILS OF THE SHOT PUT FACILITY*

The landing sector for shot put usually has a combined shape of a triangle (a portion of a 34.92° sector running radially from the centre of the shot put circle) and of a rectangle with sides minimum 9.00m apart and a base line at the far end at least 0.50m beyond the current world record for men or women (Fig 8.3.5). The surface of the shot landing area should be covered with a suitable material on which the shot will make an imprint, but which will minimize any bounce. The landing sector shall be surrounded at the far end and as close to the circle as may be necessary for safety of athletes and officials, with a stop barrier which will arrest a shot whether in flight or bouncing from the landing surface.

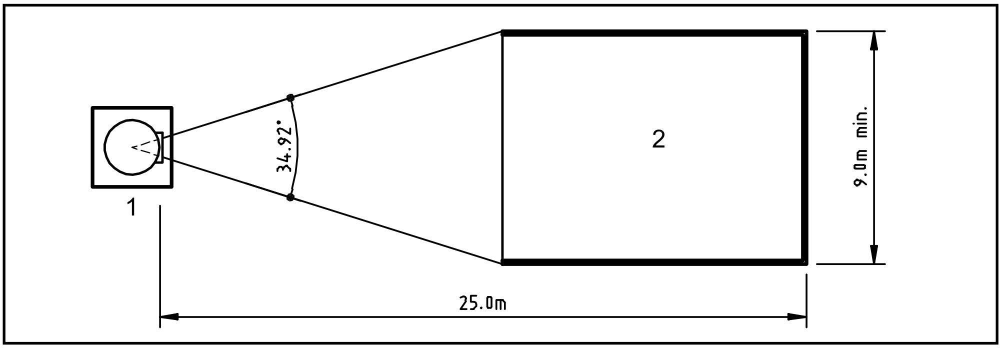



**Figure 8.3.5 - Shot put facility**
1 Shot put circle, 2 landing area with safety barriers

### *8.3.6 MEASUREMENT AND MARKINGS OF THE 200M INDOOR TRACK*

Detailed rules cannot be laid down for the marking of the start and finish for every track since the position will vary with the length of the track in lane 1. Instead, the basic principles to be adopted for any track are outlined together with details for marking a track of nominal length 200m.

The measurement of the track shall be made 0.30m outwards from the inside of the kerb or, where is no kerb, 0.20m from the white line marking the inside of the track. The other lanes shall be measured 0.20m outwards from the outer edge of each respective inside lane.

The start and finish of a race shall be denoted by white lines 0.05m wide, at right angles to the lane lines for straight parts of the track and along a radius line for curved parts of the track. All distances are measured in a clockwise direction from the edge of the finish line nearer to the start to the edge of the start line farther from the finish.

The requirements for the finish line are that, if at all possible, there should be only one for all lengths of race, that it must be on a straight part of the track and that as much of that straight as possible should be before the finish.

To assist alignment of the photo finish equipment and to facilitate the reading of the photo finish, the intersection of the lane lines and the finish line shall be painted black in a suitable design.

The essential requirement for all start lines, straight, staggered or curved, is that the distance for every athlete, when taking the shortest permitted route, shall be the same.

As far as possible, start lines (and take-over lines for relay races) should not be on the sharpest part of a bend nor the steepest part of the banking.

Races of up to, and including, 200m shall be run entirely in lanes. Races over 200m, and less than 800m shall start and continue in lanes until the end of the second bend. Races of 800m shall either start and continue in lanes until the end of the first bend or use a group start. The method of marking shall be similar to that outlined in 2.2.1.6.

There shall be 0.05m wide lines (break lines) distinctively marked across all the lanes to indicate when the athletes can break from their lanes. Races over 800m shall be run without lanes using a curved start line.

The start line in lane 1 should be on the principal straight. Its position shall be determined so that the most advanced staggered start line in the outside lane should be in a position where the height of the banking at the outside lane should not be more than 0.80m or one half of the maximum height of the banking at the peak of the bend (whichever is greater).

The finish line for all races on the oval track shall be an extension of the start line in lane 1, right across the track and at right angles to the lane lines.

The staggered start lines for 200m and races up to and including 800m should be measured and marked in the following manner:

*Staggered Start Line for 200m Race*

The position of the start line in lane 1 and the position of the finish line having been established, the position of the start lines in the remaining lanes should be determined by measurement in each lane back from the finish line. Measurement in each lane shall be carried out in exactly the same way as for lane 1 when measuring the length of the track.

Having established the position of the start line where it intersects the measurement line 0.20m outward from the inside of the lane, the line shall be extended right across the lane, at right angles to the lane lines if on a straight section of the track. If on a curved section of the track, along a radius line through the centre of the bend and if on one of the transition sections along a radius line through the theoretical centre of curvature at that point. The start line can then be marked on the side of the measured position nearer the finish.

*Staggered Start Lines for Races over 200m, up to and including 800m*

As the runners are permitted to leave their respective lanes on entering the straight after running one or two bends in lanes, the starting positions must take two factors into consideration: Firstly, the normal echelon allowance similar to that for a 200m race. Secondly, an adjustment to the starting point in each lane to compensate for the athletes in outside lanes having farther to run than those in the inside lanes to reach the inside position at the end of the straight, after the break line.

These adjustments can be determined when marking out the break line, where the athletes are allowed to leave their lanes (see below). Since start lines are 0.05m wide, it is impossible to mark two different start lines unless the difference in position is in excess of approximately 0.07m to allow a clear gap of 0.02m between the start lines. Where this problem arises, the solution is to use the rearmost start line. The problem does not arise in lane 1 since, by definition, there is no adjustment for the break line. It arises in the inner lanes (for example lanes 2 and 3) but not in the outer lanes (for example lanes 5 and 6) where the adjustment due to the break line is greater than 0.07m.

In those outer lanes where the separation is sufficient, a second start line can be measured in front of the first one by the required adjustment determined from the break line layout. The second start line can then be marked out in the same way as that for the 200m race.

Figure 8.3.6a shows the staggered start lines for 200m, 400m and 800m in accordance with Table 8.3.6.

It is the position of the start line in the outside lane which determines the position of all the start lines and the finish line on the track. In order to avoid exposing the athlete starting in the outside lane to the very severe disadvantage of starting on a steeply banked track, all the start lines and hence the finish line are moved sufficiently far back from the first bend so as to restrict the steepness of the banking to an acceptable level. It is, therefore, necessary first to fix the position of the 400m and

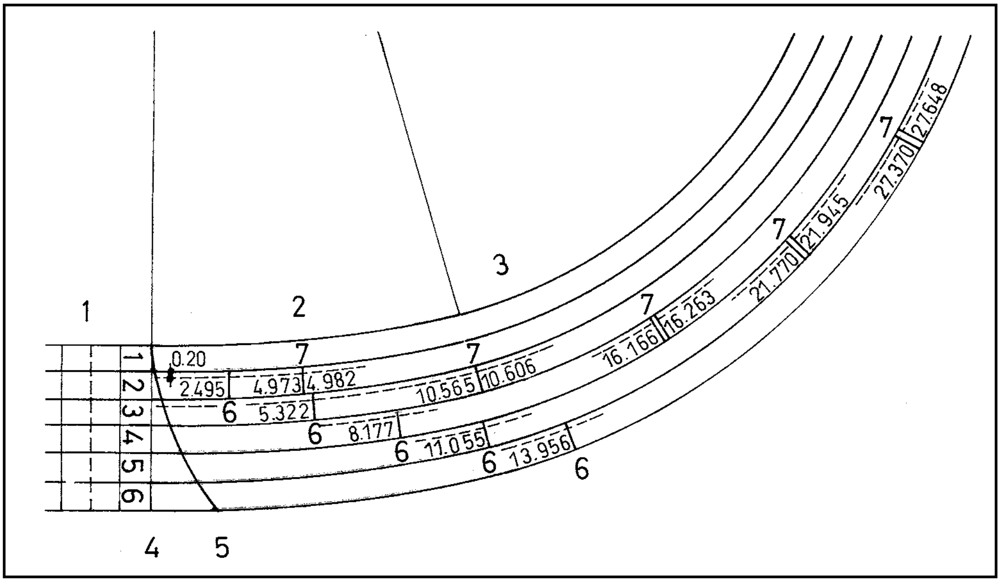



**Figure 8.3.6a - Marking of staggered start lines and 3000m start line for a Standard Indoor Track**
1 Straight, 2 transition curve, 3 curve, 4 finish line, 5 start line 3000m, 6 start lines 800m, lanes 2 to 6, 7 start lines 200m/400m, lanes 2 and 3 single line 4.973m and 10.565 respectively, lanes 4 to 6 double lines

800m start lines in the outside lane and then work back through all the other start lines, finally arriving at the finish line.

*The Break Lines for 400m and 800m Races:*
The break line where the athletes may leave their lanes at the end of a bend (or transition section of that bend) may be laid out as follows:

Mark out a temporary line right across the track, at right angles to the lane lines at the end of a bend.

Mark point X, on this line 0.30m (0.20m for a track without a kerb) outward from the inside of lane 1.

Similarly mark point $X^2$, $X^3$ etc for lanes 2, 3 etc. Lastly, mark point Y where the temporary line cuts the line marking the outside of the track.

Stretch a cord tightly from this point Y to form a tangent to the measurement line 0.30m (0.20m for a track without a kerb) outward from the inside of lane 1 beyond the far end of the straight. Mark the point of contact of the tangent Z.
With point Z as centre and with radius $ZX^1$, draw an arc right across the track from the inside of lane 1 to the outside lane. Mark the points where this arc crosses the measurement line in each lane $Y^2$, $Y^3$ etc. Measure the offset $X^2$ - $Y^2$, $X^3$ - $Y^3$ etc. in each of the lanes.

With this arc as the edge nearest to the start, mark a line 0.05m wide. This is the break line. The end of the line outside the running track should be marked with flags or cones.

For group starts in 800m the break mark is at the intersection of the break line and the inner line of the lane in which the outer group starts.

To assist competitors identify the breakline small cones or prisms (5cm x 5cm) and no more than 15cm high of the same colour as the breakline may be placed on the intersection of each lane and the breakline.

Figure 8.3.6b shows the break line for a Standard Indoor Track in accordance with Table 8.3.6.

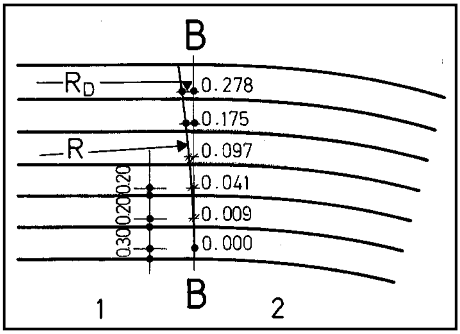



**Figure 8.3.6b**
**Break line marking for a Standard Indoor Track**
RDdeviation from B-line
R radius 35.00m
1 Straight
2 transition curve

| COLUMN | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| LINE 1 | ***Denomination (inside)*** | ***Kerb*** | ***Lane 1*** | ***Lane 2*** | ***Lane 3*** | ***Lane 4*** | ***Lane 5*** | ***Lane 6*** |
| 2 | Radius of measurement line in projection | 17.204 | 17.500 (17.4994) | 18.287 | 19.173 | 20.059 | 20.945 | 21.831 |
| 3 | Length of a quarter of bend in projection | 32.035 | 32.500 | 33.743 | 35.139 | 36.537 | 37.935 | 39.331 |
| 4 | Rising length | 18.523 | 18.756 | 19.380 | 20.081 | 20.783 | 21.485 | 22.185 |
| 5 | Length of unchanged banked bend | 13.512 | 13.744 | 14.363 | 15.058 | 15.754 | 16.450 | 17.146 |
| 6 | Length of track measurement line | 198.140 | 200.000 | 204.970 | 210.556 | 216.148 | 221.740 | 227.325 |
| 7 | Growth of rise for a quarter of bend | - | - | 0.001 | 0.003 | 0.006 | 0.010 | 0.015 |
| 8 | Position of break lines | - | - | 0.009 | 0.041 | 0.097 | 0.175 | 0.278 |
| 9 | Position of staggered start lines: for 200m | - | - | 4.973 | 10.565 | 16.166 | 21.770 | 27.370 |
| 10 | for 400m | - | - | 4.982 | 10.606 | 16.263 | 21.945 | 27.648 |
| 11 | for 800m | - | - | 2.495 | 5.322 | 8.177 | 11.055 | 13.956 |

**Table 8.3.6 - Data of measurement lines for kerb and lanes, position of break lines and staggered start lines for a Standard Indoor Track (dimensions in m)**

*Curved Start Lines for Races over 800m*

Races over 800m shall be started from a curved line.

The principles for the layout and marking of curved starting lines are very similar to those of the break line in races run partly in lanes.

The length of the race is first measured back from the finish line along the measurement line (0.30m or 0.20m outward from the inside of the track depending on whether it has kerb or not). Mark this point A on the measurement line.
This is the point where the rear edge of the start line will begin.

Securely fix pins along a 0.30m measurement line (0.20m for track without kerb) beyond the starting point in lane 1. The pins should be not more than 0.30m apart.

Secure the end of a length of cord to the surface of the track just beyond the last pin. This pin must be beyond the point where the cord forms a tangent to the measurement line when marking the outside of the start line.

Laying the cord along the surface of the track against the pins B, C, D, etc., pull tight and mark the position on the cord of point A. Using this position on the cord and keeping the cord tight, mark the rear of the start line.

The section from point A in lane 1 at either 0.30m to the kerb or 0.20m to the inside edge of the track, as appropriate, should be marked at right angles to the lane line, if the start coincides with the straight, and radially, if on a curve.

*Relay Races*

In the 4x200m relay race all the first stage, and the first bend of the second stage shall be run in lanes. There shall be a 0.05m wide line (break line) distinctively marked across all the lanes at those points to indicate where each athlete can break from his lane.

In the 4x400m relay race, the first two bends shall be run in lanes. Thus the same break line, scratch lines etc. will be used as for the individual 400m race.

In the 4x800m relay race, the first bend shall be run in lanes. Thus the same break line, scratch lines etc. will be used as for the individual 800m race.

# 8.4 Hall Finish and Installations

### *8.4.1 DESIGN OF THE FLOOR, WALLS AND CEILING*

*Floor*

The primary object in the design and construction of a suitable surface for indoor athletics is to provide a uniform competition surface conforming as far as possible to the IAAF Performance Specifications (Chapter 3).

The floor finish of the arena outside the oval track can be made of different, less expensive material. In multipurpose halls where the track is assembled in prefabricated units, the original hall floor should be suitably protected.

*Walls and ceiling*

In athletic halls, as in any other sports facility, the walls receive strong mechanical impacts. Consequently the wall linings should have appropriate material, construction and surface finish to withstand these stresses. Walls to a minimum height of 2.00m from the floor surface should have no projections nor indentations and be closed, non-splintering and smooth. Permissible construction joints of a wall lining is maximum 8mm and, for telescopic stands, 20mm. In both cases, however, edges must either be chamfered or rounded.

Doors, sports equipment, fixtures and installations of all kinds (hinges, door handles, switches, pipes, etc.) must be mounted flush with the wall in order to avoid injuries caused by protruding parts.

The impact resistance requirements for ceilings are the same as those for walls.

The colour scheme of the walls and ceiling should preferably be light.

Viewed from the hall, doors should open outwards.

In multipurpose halls, curtains or nets can be installed for the subdivision of the hall. These partitions should not constitute risk of injury. The same applies to practice facilities for discus and javelin.

Beyond the finish line of a straight track, after a clearance of 10m to 15m, a padded brake wall must be installed where the athletes can come to a halt without injury.

The same precaution should be taken in standard halls with the long jump and triple jump facility, where clearance is often needed when an athlete runs through.

## *8.4.2 MEASUREMENT AND DISPLAY INSTALLATIONS*

### 8.4.2.1 Timing

Indoor facilities used for high level competitions will need fully automatic timing.

### 8.4.2.2 Photo Finish

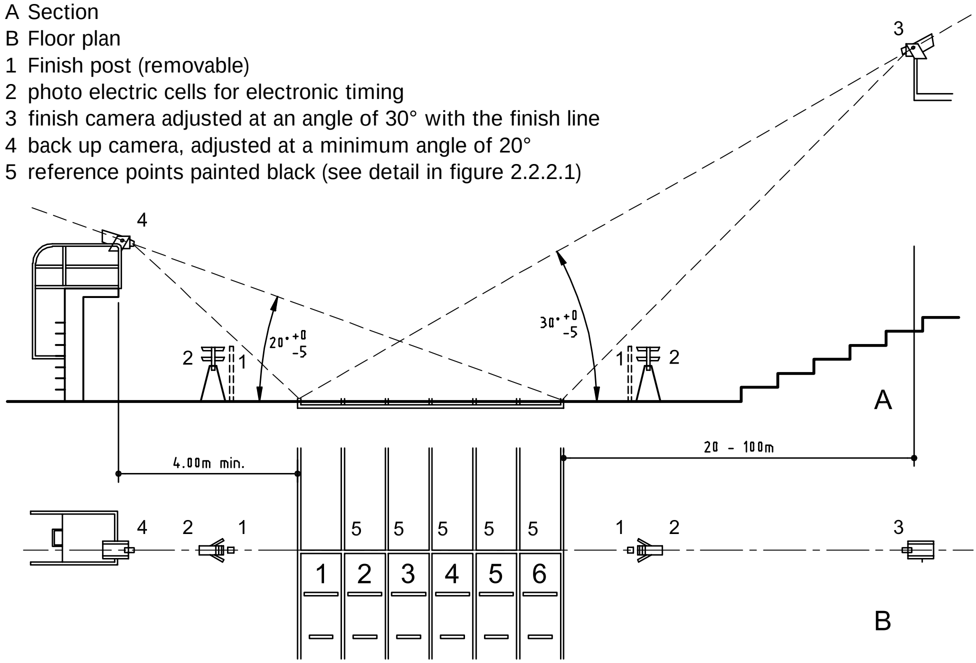
Times and finish placings in a race are determined by the photo finish camera or similar approved equipment.

The optical axis of the camera shall be adjusted in line with the finish line, and this axis shall be inclined at a 30° angle in relation to the farthest edge of the track. The distance of the camera from the closest edge of the track is minimum 20.00m (Fig 8.4.2.2).

For high level competitions, a second camera - the back up camera - shall be installed, opposite to the former one, the optical axis of which should be inclined at an angle of 20°, in relation to the farthest edge of the track. The minimum distance of the camera from the closest edge of the track is 4.00m.

Space requirements are included in table 8.4.2.

**Figure 8.4.2.2 - Timing installations in a track and field hall**
A Section
B Floor plan
1 Finish post (removable)
2 photo electric cells for electronic timing
3 finish camera adjusted at an angle of 30° with the finish line
4 back up camera, adjusted at a minimum angle of 20°
5 reference points painted black (see detail in figure 2.2.2.1)




| COLUMN | 1 | 2 |
|---|---|---|
| ***Line*** | | |
| ***1*** | ***Services*** | ***Area in m≈*** |
| ***2*** | 60m photo finish-line camera | 4 |
| ***3*** | 60m back up camera | 4 |
| ***4*** | 200m photo finish line camera | 10 |
| ***5*** | 200m back up camera | 4 |
| ***6*** | Photocells at four arena locations | 1 each |
| ***7*** | Timing and photo-finish evaluation | 12 |
| ***8*** | Scoreboard Operator | 15 |
| ***9*** | Competition Director | 15 |
| ***10*** | Announcers | 20 |
| ***11*** | Computer Centre/Data handling | 60 |
| ***12*** | Results print-out | 20 |
| ***13*** | Darkroom | 8 |
| ***14*** | Closed circuit TV | 12 |

**Table 8.4.2 - Space Requirements for Technical Services**

### 8.4.2.3 Video Network

In World and Continental Championships a continuous video recording should be made of all events for official use.

#### 8.4.2.4 Infield Scoreboards

For the information of both spectators and the athletes, a continuous display of results in all the events is necessary. This can be done manually in local and lower level meetings. In international meetings and championships the information should be displayed by electronic board units. Mechanical data transfer should be minimized as much as possible.

#### 8.4.2.5 Main Scoreboards

For an athletic hall designed for meetings of all levels and attended by spectators, a central score board system able to indicate events, competitors and results is essential.

Comprehensive details are shown in Section 5.3.

#### 8.4.2.6 Information Network System

The most important components of the information system are: the press centre, radio and TV commentators' places, workplaces of media in the stands, bureau of press chief, offices of competition director and technical manager, announcers' room, jury room, VIP and press areas. The data centre of the system can either be permanent or temporary. Connections for information monitors should be provided in all the listed locations.

#### 8.4.2.7 Telephone Network

All rooms of the building, all the event locations and all workplaces in the arena should be connected to the telephone network in an athletic hall.

#### 8.4.2.8 UHF Communication System

Referees, technical liaison personnel and key security staff should be given hand-held radios operated on preselected frequencies, enabling them to communicate.
The operational range of the radios and the problem of interference should be taken into consideration.

#### 8.4.2.9 Optical Distance and Height Measuring System

To ensure the required accuracy in measuring field events, instruments for an optical measuring system should be provided. Care should be taken that readings from the system are transferred directly to the data bank of the central computer.

#### 8.4.2.10 Cables

To connect up the timing, distance measurement and data processing equipment, permanently laid cables should be provided (figures 8.4.2.10a to 8.4.2.10c).

### *8.4.3 HALL TECHNICAL INSTALLATIONS*

#### 8.4.3.1 Heating, Ventilation, Air Conditioning, Cooling (HVAC) Systems

Athletic halls should be heated in moderate and cold climatic zones. Panel heating, infrared radiation and fan-coil systems (mechanical ventilation with heating or cooling operation) or a combination of these systems can be used.

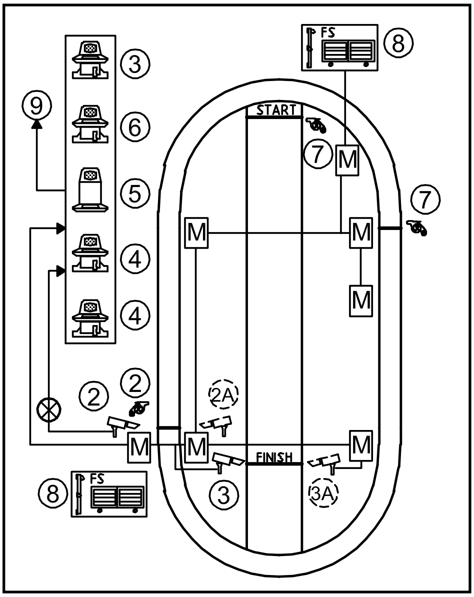



**Figure 8.4.2.10a - Timing installation**

1 Control room with feed to television, scoreboard and data processing
2 and 2A video finish cameras I and II
3 and 3A video finish cameras III and IV
4 camera I and II evaluation point
5 computer for processing the information
6 camera III and IV evaluation point
7 starter’s gun
8 false start system
9 exit to TV, connection to data processing and exit to scoreboard
M Manhole with connection points for permanent cables for track and field events

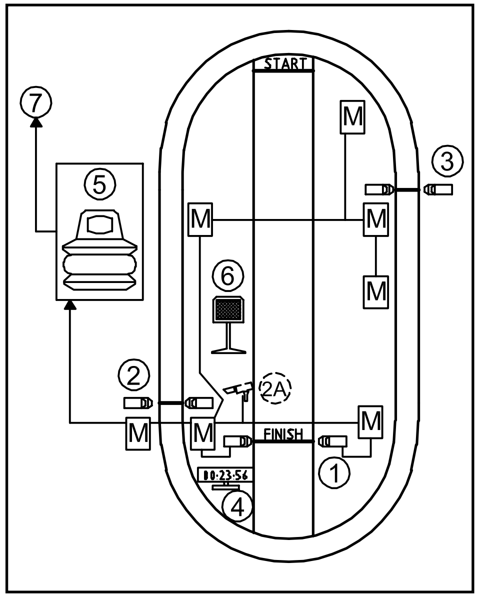



**Figure 8.4.2.10b - Cables and auxiliary equipment for timing**

1 Double photo electric cell at the 60m finish line
2 double photo electric cell at the 200m finish line
3 photo electric cells for intermediate times
4 numeric board for the running time
5 timing instrument for intermediate times
6 lap counter
7 exit to data processing station
M Manhole with connection points for permanent cables for track and field events

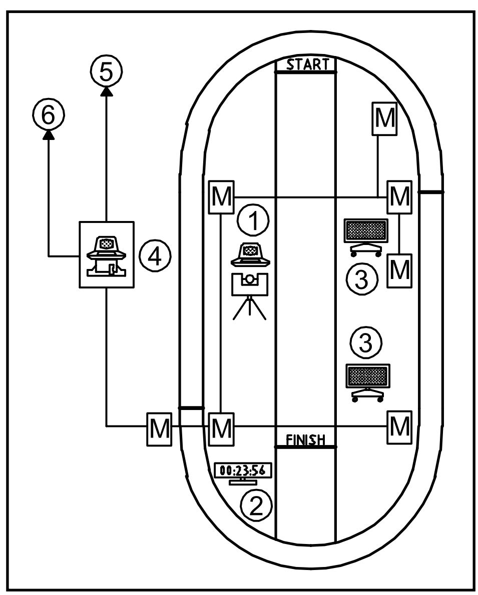



**Figure 8.4.2.10c - Cables and auxiliary equipment for field events**

1 Tachometer, for measuring distances and checking height for high jump and pole vault
2 time elapsed clock (concentration clock)
3 field board with computer
4 control room for data processing station
M Manhole with connection points for permanent cables for track and field events

The heating system should be adequate to ensure the room temperatures shown in table 8.4.3.1.

Natural ventilation is needed in all types of hall during long periods of non use and in case of possible break downs, especially in a fire emergency.

Halls which are larger than 1000m$^2$ and also have a spectator facility (with a minimum seating capacity of 500 persons) should be considered for mechanical ventilation.

| ***COLUMN*** | ***1*** | ***2*** |
|---|---|---|
| ***Line*** | | |
| ***1*** | ***Room*** | ***Temperature °C*** |
| ***2*** | Athletic Hall | 16 to 18 |
| ***3*** | Changing Room | 22 |
| ***4*** | Shower Room, Toilets | 24 |
| ***5*** | Massage Room | 24 |
| ***6*** | Medical and doping control room | 22 |
| ***7*** | Prevention of overcooling | 8 |
| ***8*** | Practice and Training Hall | 12 to 16 |

**Table 8.4.3.1 - Room temperatures, caloric calculation values**

In smaller sports and games halls, air inlets not less than 2.5m above the hall floor surface with air outlets installed beneath and directly above the hall floor surface are adequate.
The minimum fresh air requirements are 30m$^3$ fresh air/hour/athlete, assuming that minimum 35 athletes are present in the arena simultaneously and 20m$^3$ fresh air/hour/spectator.

Noise level of the ventilation system in the hall must be below 45dBA.

Care must be taken to ensure the supply of clean air to minimize the amount of dust in the hall.

The air stream velocity of mechanical ventilation should be controlled to avoid draughts.

In warm and hot climatic zones, air conditioning of the hall and possibly the service rooms may be considered. In moderate climatic zones on hot summer days a mechanical ventilation with cooling operation might be satisfactory, (fan-coil system).

#### 8.4.3.2 Lighting
The lighting must be adequate for TV and photo finish, for athletes and spectators. It should be free from glare.

*Daylight lighting*
Natural lighting of a hall can take the form of windows in the walls and/or skylights in the ceiling. The installation of these should be done according to safety requirements

of Section 8.4.1 for walls and ceiling. For athletics, uniform, non-dazzling daylight lighting can only be attained by skylights in the ceiling. Exclusion of direct sunlight can be made by sun-breaks and blinds, or by appropriate orientation of the windows.

The windows situated in the boundary walls of the hall should also be protected from direct sunlight by movable blinds, and the shadow-casting effect of masonry walls or pillars should be taken into account to ensure an even and uniform illumination.

*Artificial lighting*

Fixtures and switches for the artificial lighting should be arranged and their type selected taking into consideration the need for uniformity and density of lighting without causing dazzling. Lamps with a high luminosity factor and low radiant intensity (for example fluorescent lamps) in warm-white and neutral-white colours are particularly suitable.

The balanced visibility conditions depend to a great extent on the degrees of reflection of the space-enclosing surfaces. The values specified below are required:

- Ceiling 70 %
- Walls 30 to 60 %
- Floor 25 %

The degrees of reflection of various colours and materials are given in tables 8.4.3.2a and 8.4.3.2b.

| ***COLUMN*** | ***1*** | ***2*** |
|---|---|---|
| ***Line*** | | |
| ***1*** | ***Colour*** | ***Reflection*** |
| ***2*** | Yellow | 0.40 to 0.60 |
| ***3*** | Green | 0.15 to 0.55 |
| ***4*** | Blue | 0.10 to 0.50 |
| ***5*** | Red | 0.10 to 0.50 |
| ***6*** | Brown | 0.10 to 0.40 |
| ***7*** | Grey | 0.15 to 0.60 |
| ***8*** | Black | 0.05 to 0.10 |
| ***9*** | White | 0.70 to 0.75 |
| ***10*** | White broken | 0.60 to 0.65 |

**Table 8.4.3.2a - Degree of reflection of various colours**

| ***COLUMN*** | ***1*** | ***2*** |
|---|---|---|
| ***Line*** | | |
| ***1*** | ***Material*** | ***Reflection*** |
| ***2*** | Fair faced concrete (depending on design) | 0.25 to 0.45) |
| ***3*** | Brick wall of red brick | 0.15 to 0.45 |
| ***4*** | Brick wall of yellow brick | 0.30 to 0.45 |
| ***5*** | Lime sand brick | 0.20 to 0.50 |
| ***6*** | Wood surface: Dark | 0.10 to 0.40 |
| ***7*** | Wood surface: Medium | 0.15 to 0.40 |
| ***8*** | Wood surface: Light | 0.20 to 0.50 |
| ***9*** | Floor surface: Dark | 0.10 to 0.15 |
| ***10*** | Floor surface: Medium | 0.15 to 0.25 |
| ***11*** | Floor surface: Light | 0.25 to 0.40 |

**Table 8.4.3.2b - Degree of reflection of various materials**

In athletic halls, in multipurpose sports halls and in games halls used for track and field athletics practice and training, the average horizontal illumination, should not be less than

- 75 lux for recreation and training
- 200 lux for club competition
- 500 lux for national and international competition

For uniformity of horizontal illuminance, colour temperature and colour rendering see 5.1.3 (tables 5.1.3.1 and 5.1.3.2).

Photo finish equipment requires careful lighting of the actual finish lines to avoid problems caused by strobing.

Lighting requirements for colour film and television are quantitatively and qualitatively higher. Since cameras mainly record vertical surfaces, the vertical illumination value, measured 1.5m above the sports surface is significant. For international competition, this value should be 1400 lux and, for national competition, 1000 lux.

For average vertical illuminance, uniformity, colour temperature and colour rendering index see 5.1.3.

#### 8.4.3.3 Public Address and Additional Information Systems

The functions of the PA system include:

- informing the spectators
- informing the athletes in the arena
- transmitting music

The supplementary communication systems (walkie-talkie and other similar devices) are used to:

- transmit informations and instructions to the changing rooms, warm-up rooms and other ancillary rooms;
- establish contact between referees, umpires and judges;
- establish contact between the competition control centre and the judges.

For an effective sound system, installation of a sound centre is necessary. It usually consists of two rooms: one is the operators’ room containing control panels, record and CD players, tape recorders and the loudspeaker system and having an overall view of the arena and spectator stands. It should have a connection also to the competition control centre. This room has both high voltage and low voltage power supplies and telephone lines. The amplifiers are located in the other room, together with stand-by power generation equipment.

#### 8.4.3.4 Room Acoustics

The reverberation time for an athletic hall which is empty should not exceed 2.3 seconds. Generally this requires a sound absorbing ceiling and wall lining on a portion of the wall.

Due to the large span of an athletic hall possessing both an oval track and spectators, care should be taken to avoid echo phenomenon and measures should be applied to produce an appropriate reverberation time. Instead of sound absorbing lining, resonators or sound boxes operating like resonators may be more practical. In this latter case, dimensions, facing materials of the sound boxes and the thickness of the enclosed air cushion should be calculated by an acoustics specialist. A decision should be made also to define the frequency zone which must be damped. If the hall will be used only for athletics (or another sport) as a single-purpose facility the frequency zone forming the basis for reverberation calculations will be between 1,000Hz and 10,000Hz. In a concert of a symphonic orchestra lower and higher frequencies (up to 25,000Hz) can occur.

Aspects of room acoustics should be taken into consideration at an early stage in architectural design of the hall's shape. There are shapes developed by rotation which either have an axis or a centre where sound can be accumulated causing different sound volumes. Mistakes in selecting the architectural form can later be corrected only by additional, often expensive, measures.

#### 8.4.3.5 TV Network

In athletic halls, installation of cables and antennae is necessary for the purpose of transmitting live or edited TV programmes.

Outside broadcasting equipment and vehicles should have adequate reserved parking space close to the hall and with connecting points to the hall's coaxial cable network.

#### 8.4.3.6 Alarm System and Security

Adequate alarm systems for fire and security conforming to national standards must be installed.

Installation of a closed circuit TV network is sometimes advisable for security purposes.

### *8.4.4 STORAGE AND TRANSPORT OF TRACK AND HALL EQUIPMENT*

The size of the storage area depends on the type of track construction. A portable track consists of more than 1000 components and, with all the other items of equipment needed for a competition, represents a large stock to be stored.

The area required should be determined in the design development stage by preparing a storage scheme, based on an assembly sequence of both the track and other equipment used in the arena. Handling and transport of the stored and stacked material and track units should be managed with mechanical devices, elevators or lifting platforms depending on horizontal or vertical type of transport.

## 8.5 Additional Sports Rooms

Apart from those facilities immediately required for training and competition, additional sports rooms are desirable and often necessary.

### *8.5.1 WARM-UP AREAS*

It is very important that warm-up areas appropriate to the standard of competition are provided. This can be in a synthetic floored corridor or in an adjacent hall or building (Table 8.5.1).

| COLUMN | 1 | 2 | 3 |
|---|---|---|---|
| Line | | | |
| 1 | *Area* | *Size (m)* | *Installation* |
| 2 | Running corridor | 75.00x6.00x3.00 | Starting blocks Hurdles |
| 3 | "Standard" Sports Hall,<br>with or withoutadjoining rooms | 45.00x27.00x7.00 | Landing mats<br>Landing areas |

**Table 8.5.1 - Size of, and installations in, warm-up areas**

### *8.5.2 WEIGHT TRAINING ROOM*

As stated in Chapter 4 modern athletic training systems recommend the use of weight lifting and other body building devices.

A weight training facility can range from a relatively small (approximately 24m$^2$) to a fairly large room (approximately 240m$^2$).

Its equipment may range from a common weight lifting platform to specialized training machines and up to 12-station training machines. The machines can be placed on the floor or mounted onto the wall or ceiling. Their weight and forces applied to the building components should be taken into account together with ways and means of connection and fixing.

At drop points for dumbbells the tread and skidproof floor must be protected appropriately with an additional load distribution plate or mat. Ceiling, walls and lighting fixtures should be shockproof. A mechanically operated ventilation system should supply fresh air of minimum 100m$^3$/hour per apparatus station.

### *8.5.3 SAUNA/RELAXATION AREA*

See Chapter 4.1.1.1.7.

## 8.6 Alternatives for Competition and Training Facilities

Modern athletics has developed from a seasonal summer sport into a year-round programme of outdoor and indoor competitions.

Table 8.6 lists possible ways in which use of sports halls may be maximized.

### *8.6.1 MULTIPURPOSE SPORTS HALLS, WITH OVAL TRACK FOR COMPETITION, WITH SPECTATOR STANDS*

In some multipurpose sports halls, national, international and world championships are held, as part of a year-round schedule.

Since the majority of events in a multi-purpose hall require flat flooring, it is preferable that the track and the field event facilities be assembled from prefabricated units or at least that the bends of the 200m oval track be laid flush

| COLUMN | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Line<br><br>1 | ***Basic equipment and additional facilities Hall types and size in m***<br>**** Yes***<br>***(*) Possible***<br>***- No*** | ***Multipurpose sports hall, oval track for competition, spectator stands***<br><br>***(8.6.1)*** | ***Special athletic hall, oval track for competition and training, spectator stands***<br><br>***(8.6.2)*** | ***Special athletic hall, oval track for training, no spectator stands***<br><br>***(8.6.3)*** | ***Special athletic hall, no oval track, for training only 44x66x8.0 44x88x9.0***<br><br>***(8.6.4)*** | ***“Standard” sports hall, additional equipment for training only 27x45x7.0 22x44x7.0***<br><br>***(8.6.5)*** |
| ***2*** | ***Basic equipment:*** | | | | | |
| ***3*** | 200m standard track, 4 lanes | * | * | * | - | - |
| ***4*** | 60m straight, 8 lanes | * | - | - | - | - |
| ***5*** | 60m straight, 6 lanes | - | * | - | - | - |
| ***6*** | 60m straight, 4 lanes | - | - | * | * | - |
| ***7*** | 50m, 40m, 30m straight, 3 to 6 lanes | - | - | - | - | * |
| ***8*** | Facility for high jump | * | * | * | * | * |
| ***9*** | Facility for long jump | * | * | * | * | * |
| ***10*** | Facility for triple jump | * | * | * | - | - |
| ***11*** | Facility for shot put | * | * | * | * | (*) |
| ***12*** | ***Additional facilities:*** | | | | | |
| ***13*** | Sprint straight, 100m and 110m hurdles | - | * | * | (*) | - |
| ***14*** | Practice facility for shot put, discus, hammer, javelin | - | * | * | * | (*) |
| ***15*** | Spectator stands | * | * | - | - | - |

**Table 8.6 - Alternative training and competition facilities**

with the rest of the flooring and jacked up to the required position, hydraulically or mechanically when necessary.
Training and practice in these halls can only be conducted before and after competition days while the track is installed.

### *8.6.2 SPECIAL ATHLETIC HALL, WITH OVAL TRACK FOR COMPETITION AND TRAINING, WITH SPECTATOR STANDS*

A single purpose athletic hall should be equipped in conformity with IAAF Rules and specifications.
The 200m oval track can be a permanent installation. The requirements of the athletes, the spectators and the media should be met while observing IAAF Rules for indoor competitions.

Additional training and practice opportunities in such a hall are useful, especially when a longer straight track for 100m and 110m hurdles (also used as run-up for long and triple jump) is added, together with training facilities for shot put, discus, hammer and javelin.

Figures 8.6.2ato 8.6.2c are examples of different types of use of such a facility. While figure 8.6.2a shows the floor plan for a high level event with 4,000 seated and 1,400 standing spectators, the example in figure 8.6.2b shows the same facility with 2,800 seated and 1,400 standing spectators. The space of 1,200 seats on retractable stands is used for an additional training area for sprints, long jump, triple jump and pole vault. Figure 8.6.2c shows the division of the complete inner space of the hall into training areas for ball games, standard track events and sprint/jump disciplines.

### *8.6.3 SPECIAL ATHLETIC HALL, WITH OVAL TRACK FOR TRAINING AND COMPETITION, WITHOUT SPECTATOR STANDS*

The nature of this hall enables construction of a permanently installed oval track. The landing facility for long jump and triple jump can be a permanent construction. A removable cover for the long and triple jump landing area is necessary. A suitable construction is shown in figure 8.6.3.
The minimum clear height should be 9.00m.

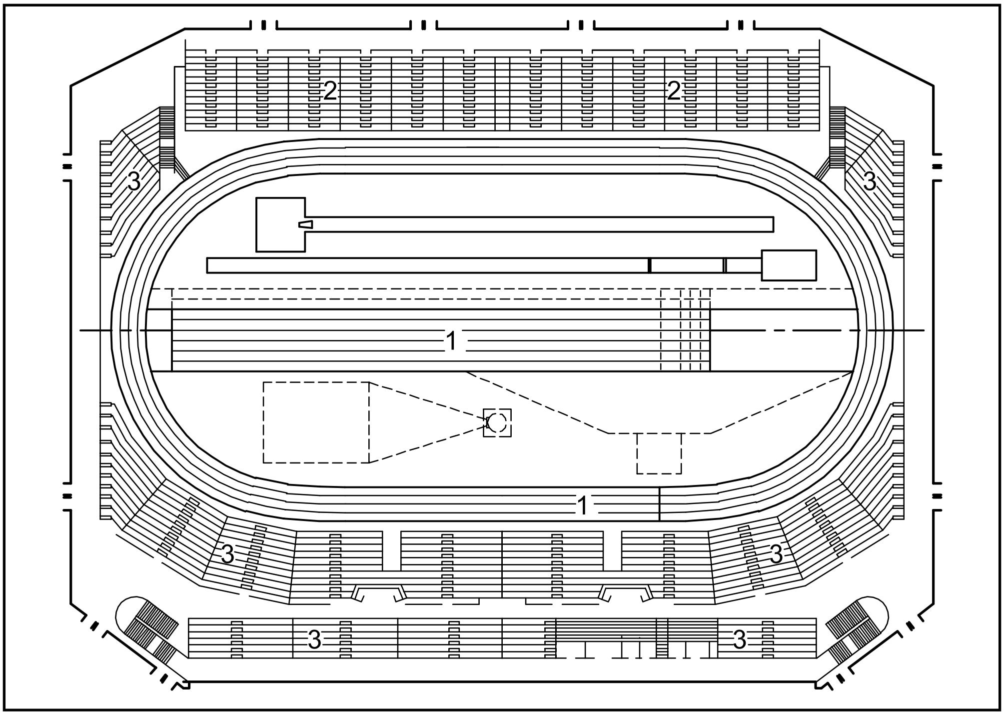



**Figure 8.6.2a - Floor plan of a facility for a high level event**
1 Competition area with Standard Track, 2 retractable grandstands with 1,200 seats,
3 grandstands with 2,800 seats

*Source: Hallen für Leichtathletik, P1/92, Federal Institute for Sports Science, Cologne*

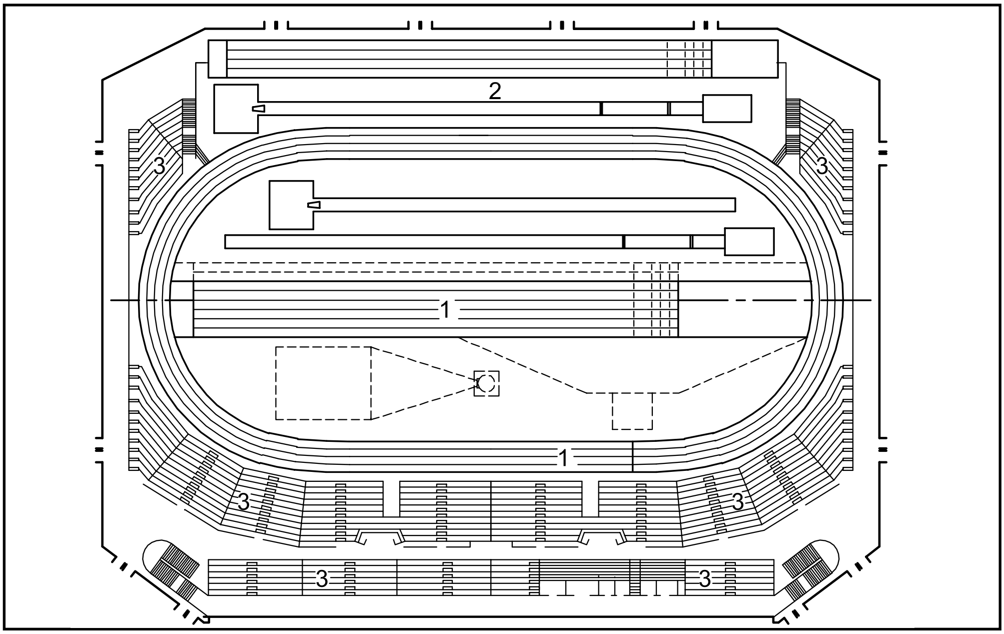



**Figure 8.6.2b - Floor plan of a facility for a less important event**
1 Competition area with Standard Track, 2 additional training area, 3 grandstand with 2,800 seats

*Source: Hallen für Leichtathletik, P1/92, Federal Institute for Sports Science, Cologne*

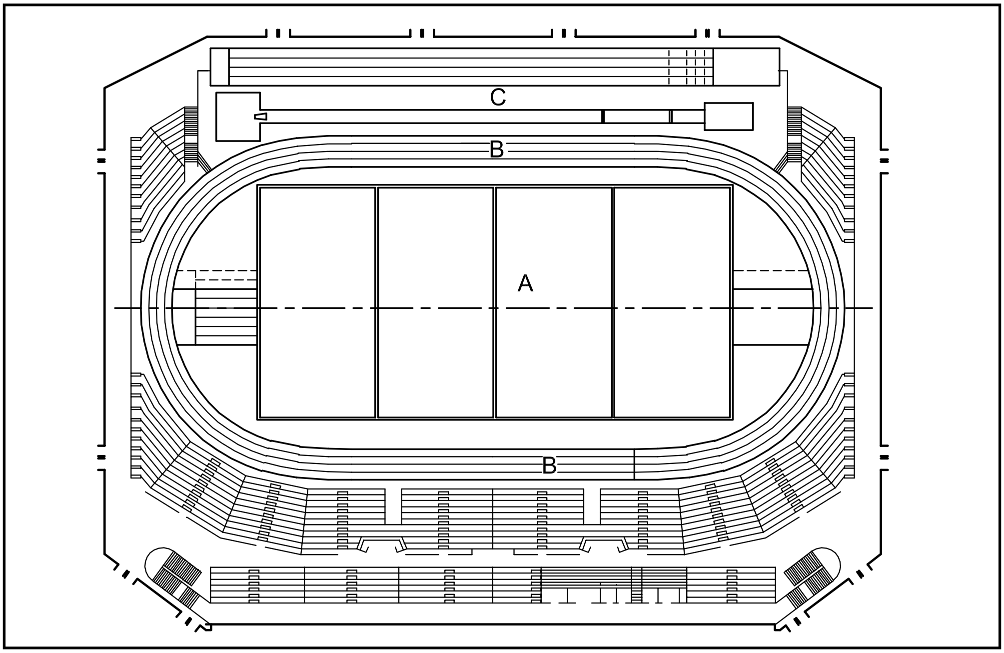



**Figure 8.6.2c**
**Division of the inner hall space of the facility under figures 8.6.2a and 8.6.2b for training purposes**
A Ball games area, B Standard running track disciplines, C Sprint/jump disciplines

*Source: Hallen für Leichtathletik, P1/92, Federal Institute for Sports Science, Cologne*

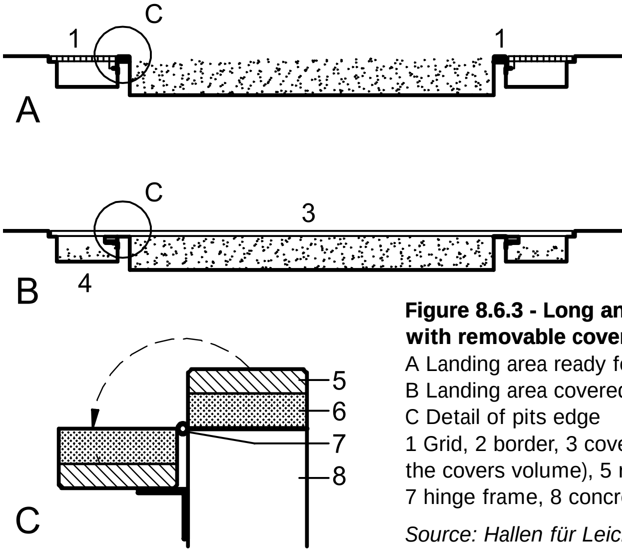



**Figure 8.6.3 - Long and triple jump landing area with removable cover**
A Landing area ready for use
B Landing area covered
C Detail of pits edge
1 Grid, 2 border, 3 cover,4 space for sand (equivalent to the covers volume), 5 rubber, 6 black board or similar, 7 hinge frame, 8 concrete

*Source: Hallen für Leichtathletik, P1/92*
*Federal Institute for Sports Science, Cologne*

Additional training and practice oppportunities in these halls are useful, especially if both longer straights and training and practice facilities as explained in Section 8.6.2 are provided.

### *8.6.4 SPECIAL ATHLETIC HALL, WITHOUT OVAL TRACK, FOR ATHLETIC TRAINING ONLY*

The basic function of this hall type is to provide specialized training opportunities for top athletes and coaches. Although these special athletic halls are mainly used for training, most of the equipment is also suitable for competition.

The minimum length of the straight shall be 60m, but a length of 110m is preferable. With no oval track, these halls are usually equipped with training facilities for shot put, discus, hammer and javelin and with runways and landing areas for all jumping events.

Figure 8.6.4 shows, as an example, the track and field hall of the German Sports University, Cologne.

### *8.6.5 "STANDARD" SPORTS HALL, WITH ADDITIONAL EQUIPMENT FOR ATHLETIC TRAINING*

The basic function of these halls is to meet the requirements of physical education in schools and "sport for all" in a community. Athletic training and competition can be performed in them only to a limited extent, even when they are equipped with additional installations.

When considering hall sizes it should be borne in mind that for straight tracks a clearance of at least 3.00m behind the start line should be provided and at least 10.00m, but preferably 13.00m to 15.00m is needed beyond the finishing line, free

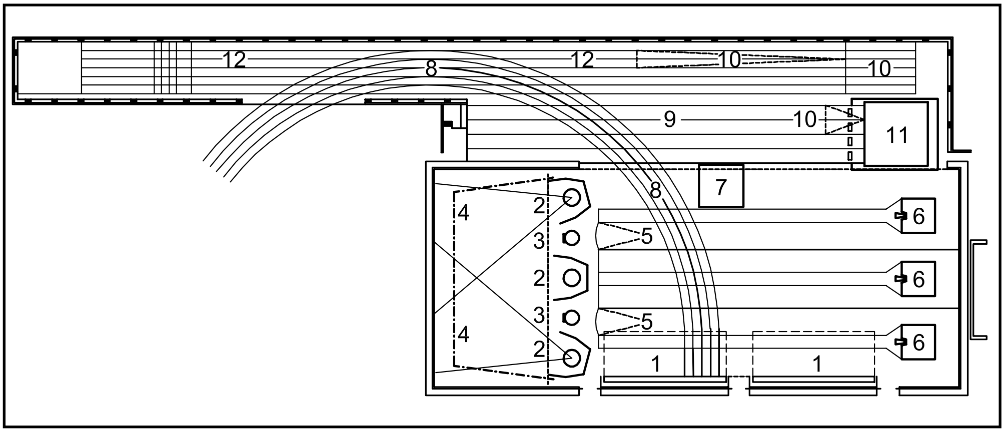



**Figure 8.6.4 - Training facility without oval track**
1 Telescope grandstands, 2 discus cage, 3 shot put circle, 4 stop curtain, 5 javelin runway, 6 pole vault landing area, 7 high jump landing area, 8 part of a 400m Standard Track bend for relay training, 9 long and triple jump runway, 10 ramp, 11 landing area, 12 straight

*Source: Hallen für Leichtathletik, P1/92, Federal Institute for Sports Science, Cologne*

of any obstruction with adequate provision of a padded brake wall beyond, for the athletes to come to a halt without injury.

### *8.6.6 TRAINING FACILITIES FOR DISCUS, HAMMER, JAVELIN AND SHOT PUT*

Due to the limited space available in most athletic halls, competition cannot be held in discus, hammer and javelin. For these disciplines, only training facilities can be provided. The primary considerations for these facilities are the safety of all people in the hall and the protection from damage to the floor, walls and ceiling.

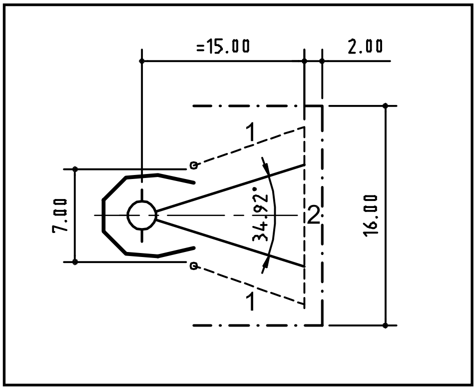



**Figure 8.6.6a - Training facility for discus**
1 Stop net or curtain
2 space for obstacle free moving of net or curtain

*Source: Hallen für Leichtathletik, P1/92, Federal Institute for Sports Science, Cologne*

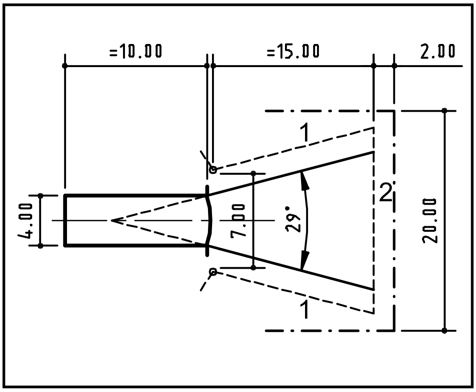



**Figure 8.6.6b - Training facility for javelin**
1 Stop net or curtain
2 space for obstacle free moving of net or curtain

*Source: Hallen für Leichtathletik, P1/92, Federal Institute for Sports Science, Cologne*

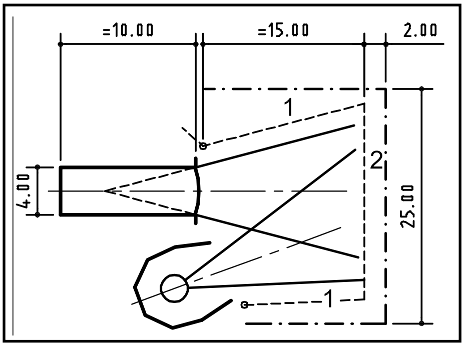



**Figure 8.6.6c - Combined training facility for javelin and discus**
1 Stop net or curtain
2 space for obstacle free moving of net or curtain

*Source: Hallen für Leichtathletik, P1/92, Federal Institute for Sports Science, Cologne*

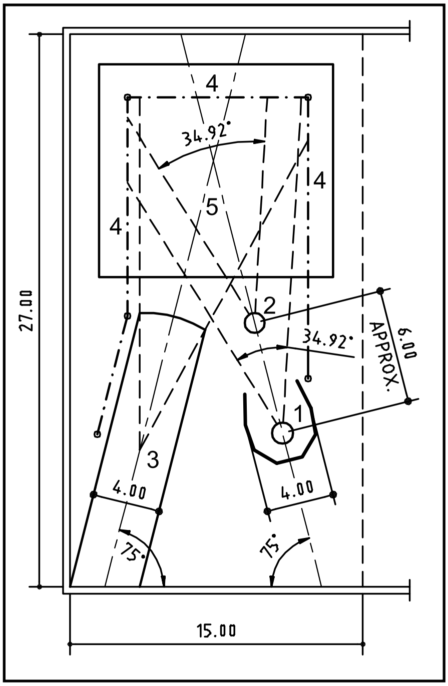



**Figure 8.6.6d - Combined training facility for discus, hammer, javelin and shot put**
1 Combined hammer and discus cage
2 shot put circle, 3 javelin runway
4 stop net or curtain, 5 floor protection

The best way to absorb the kinetic energy of flying objects is to throw them into curtains made of loose fabric or net with a weight at the bottom. The curtain will move with the impact of the flying object but at the same time it will stop the projectile. Measurable distances cannot be obtained, but training and practice can be performed indoors in winter months. Technical details of discus, hammer and javelin facilities for athletic halls shall be specific to each hall. For shot put facilities the same consideration should be borne in mind as explained in Section 8.3.5 but a stop barrier is not required if the shot put area is a portion of the separate practice area for other throwing disciplines.

# 8.7 Ancillary Rooms

Due to the limited space available, it is not always possible to provide the same number and size of rooms and areas as for outdoor stadia. Also, the number of participants - athletes, competition officials and auxiliary personnel - is, generally, less than for outdoors.

However, many of the requirements for outdoors, as described in Chapter 4, should be met. Therefore, in this Chapter, appropriate reference is made to Chapter 4.

Number of athletes, competition officials and auxiliary personnel at indoor meetings of different categories is shown in table 8.7a. Table 8.7b illustrates the number of participants in athletic meetings of different levels, including staff and media personnel.

| COLUMN | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Line | | | | | |
| 1 | ***Competition category*** | ***Approximate maximum number of participants at anyone time*** | | | ***Duration of competition*** |
| 2 | | ***Athletes*** | ***Competition officials*** | ***Personnel*** | ***Number of days*** |
| ***3*** | World Championships | 40-60 | 50 | 20 | 3 |
| ***4*** | Continental, Regional or Area Championships | 50-60 | 50 | 20 | 3 |
| ***5*** | Cups open to all IAAF Members in the Area or Region | 30-40 | 40 | 12 | 1-2 |
| ***6*** | Group Games | 30-40 | 40 | 12 | 1-2 |
| ***7*** | Matches between two or more Members | 20-30 | 30 | 12 | 1-2 |
| ***8*** | International Invitation Meetings specially sanctioned by IAAF | 30-40 | 40 | 12 | 1 |
| ***9*** | International Invitation Meetings specially sanctioned by an Area Group Association | 30-40 | 40 | 12 | 1 |
| ***10*** | Other Meetings specially sanctioned by a Member so that foreign athletes may take part | 30-40 | 40 | 12 | 1-2 |
| ***11*** | Combined events | 20-30 | 30 | 10 | 2 |
| ***12*** | Non-classified domestic events | 40-60 | 40 | 16 | 1-2 |

*Note: Technical control for all events as per IAAF Rule 12.*

**Table 8.7a - Number of athletes, competition officials and auxiliary personnel at indoor meetings of different categories**

## *8.7.1 CHANGING ROOMS, SHOWERS AND TOILETS*

### 8.7.1.1 Changing Rooms for Athletes with Showers and Toilets

See 4.1.1.1.1 and 4.1.1.1.2

### 8.7.1.2 Rooms for Coaches and Officials

See 4.1.1.1.3 and 4.1.1.2

### 8.7.1.3 Changing Rooms for Ancillary Staff

Spare hall rooms with an area large enough for about 60 persons should be temporarily converted into changing rooms for the ancillary staff, separated by sex and equipped with washing and toilet facilities.

## *8.7.2 FIRST AID ROOM, MEDICAL ROOM AND DOPING CONTROL ROOMS*

See 4.1.1.3 and 4.1.1.4.

## *8.7.3 COMPETITION OFFICE*

See 4.3.

| ***COLUMN*** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** |
|---|---|---|---|---|---|
| ***Line*** ***1*** | ***Event*** | ***Club, national and association meetings*** | ***International meetings*** | ***Meetings between countries*** | ***Continental and world championships*** |
| ***2*** | Number of disciplines | 6-25 | 15-25 | 25-30 | 26 |
| ***3*** | Athletes - male | 30-150 | 100-150 | 30-85 | 350 |
| ***4*** | Athletes - female | 20-140 | 80-120 | 30-80 | 300 |
| ***5*** | Judges in the arena | 20-40 | 40 | 40 | 50 |
| ***6*** | Competition management including ancillary staff | 10-20 | 30 | 30 | 40 |
| ***7*** | Victory ceremony staff | 4 | 6 | 6 | 10 |
| ***8*** | Stadium staff | 6 | 10 | 10 | 12 |
| ***9*** | Call room staff | 3 | 6 | 3 | 15 |
| ***10*** | Jury of Appeal | - | 3 | 3 | 5 |
| ***11*** | Technical staff (lighting, sound, scoreboard, photo finish) | 3 | 3 | 6 | 6 |
| ***12*** | Additional technical personnel | 8 | 8 | 16 | 16 |
| ***13*** | Authorities on duty (police, fire, ambulance) | 3 | 8 | 8 | 12 |
| ***14*** | Journalists | 2-5 | 30-40 | 30-40 | 300-500 |
| ***15*** | Radio and TV | - | 8-10 | 8-10 | 40-50 |
| ***16*** | Security staff | - | 5 | 5 | 30 |

**Table 8.7b - Number of participants in various athletic meetings**

### *8.7.4 OFFICIALS' ROOM*

See 4.1.1.2.

### *8.7.5 ROOM FOR VICTORY CEREMONY PREPARATION*

See 4.1.1.1.5

### *8.7.6 COMPETITION CONTROL CENTRE*

See 4.3.1.1.

### *8.7.7 RESULTS DISPLAY*

See 4.3.1.3.

### *8.7.8 ADMINISTRATION ROOMS*

As the size of a facility varies from a gymnasium to a multipurpose indoor stadium number and size of offices needed for management vary, depending on the daily tasks of administration and the particular needs of each indoor meeting, according to the design brief.

#### *8.7.9 DUTY STATIONS*

The requirements for duty stations for fire brigade, police, ambulance/first aid and security staff must conform to national and local regulations and bylaws.

#### *8.7.10 ROOMS FOR CLEANING EQUIPMENT AND WASTE DISPOSAL*

Spectators in an athletic hall produce substantial waste, thus requiring a well-planned, well-organized cleaning operation.

Cleaning of circulation routes, toilets, consumption areas of kiosks, refreshment rooms and cafeterias needs particular attention. The cleaning of the stands and arena is an entirely different operation. Both need a stock of cleaning machines with abundant supply of detergents and chemical agents.

Waste should be collected in disposal bags and deposited in sealed containers, preferably in compressed state in a closed, ventilated room until final disposal.

For storage of cleaning machines, equipment and detergents, a well-ventilated storage room is needed.

An access route for heavy vehicles should be provided.

#### *8.7.11 WORKSHOP ROOMS AND PLANT ROOMS*

See 4.4.1.2.4 and 4.4.1.2.5.

## 8.8 Facilities and Technical Services for the Media

The facilities and services provided to the media (journalists, photographers, television and radio) at indoor competitions should be in conformity with the principles detailed in Chapter 4, Chapter 5 and in table 8.8.

### *8.8.1 PRESS*

#### 8.8.1.1 Seating/Tables and Seats

The limited amount of seating available allows for far fewer media personnel to be seated on the extension of the finish line(s). As for the outdoor stadium, priority should be given to television and radio personnel conducting live transmission.

The working area allocated to each journalist should conform as closely as possible to that defined for the outdoor stadium. Access to, and from, the seating area should be carefully considered, particularly when steep steps have to be encountered. Wherever possible the widest access points should be used, and well marshalled to avoid congestion from loitering.

#### 8.8.1.2 Working Area within the Arena

The work room will mainly be used prior to, and at the conclusion of the meeting or session. The working room should be as close to the journalists' seats as possible. The mixed zone and formal interview room should also be in close proximity. It must be well lit, well ventilated and easily accessible. It should have sufficient space to

| ***COLUMN*** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** |
|---|---|---|---|---|---|
| ***Line*** 1 | ***Function*** | ***Equipment*** | ***National Competitions*** | ***Regional Competitions*** | ***World Competitions*** |
| ***2*** | Press seating | Seat (with desk) | 40 | 200 | 250-280 |
| ***3*** | | Seat (only) | 20 | 50 | 50-70 |
| ***4*** | | TV monitors (written press) | - | 75-100 | 120-140 |
| ***5*** | | Phones (dedicated lines) | 15 | 50 | 75 |
| ***6*** | Press Centre | Desks in working area | 30-40 | 100-125 | 180-200 |
| ***7*** | | TV monitors | - | 6 | 10 |
| ***8*** | | Typewriters | 3 | 5 | 8-10 |
| ***9*** | | Phones (card) | 5 | 15 | 20-25 |
| ***10*** | | Telefax | 2-3 | 3-4 | 4-6 |
| ***11*** | | Pigeon Holes | 50-80 | 80-100 | 150-200 |
| ***12*** | Formal Interview Room | Seat capacity | 20-30 | 30-40 | 60-80 |
| ***13*** | Commentary Positions | Units with three seats each | 3 | 30 | 50 |
| ***14*** | Camera Positions | Fixed cameras | 4 | 6 | 8 |
| ***15*** | | Hand-held cameras | 1 | 2 | 4 |
| ***16*** | OB Vans Compound | 16.00x2.50x4.50m | 1-2 | 6-8 | 12-15 |
| ***17*** | | | 600m$^2$ | 1200m$^2$ | 2000m$^2$ |

**Table 8.8 - Seating and equipment in journalists' working area**

accommodate 50% of the accredited media representatives at any one time, for example in national events 30 - 40 persons, in regional events 100 - 125 persons and in world events 200 persons.

Full telecommunication services are required in the work room, or immediately adjacent to it. If the event is of major importance - world/regional championships - these facilities would be contained within the main press centre.

#### 8.8.1.3 Formal Interview Room
See 4.2.1.2.3 and 4.2.1.3.3.

#### 8.8.1.4 Results Preparation and Delivery
See 4.2.1.2.5.

#### 8.8.1.5 Mixed Zone
See 4.2.2.2.3.

#### 8.8.1.6 Press Agencies

See 4.2.1.2.9.

### *8.8.2 PHOTOGRAPHERS*

Due to the complexity of the problems with which photographers are faced - limited infield space, difficulty in gaining access to the infield (because of the bends), limited space outside the track, and usually difficulties regarding circulation - it is important to take the following aspects into consideration.

#### 8.8.2.1 Photographers' Positions/Access and Movement

For indoor athletics, the key photographers' positions within the stadium are as follows:

- infield including finish line / pool - maximum 10 persons (A)
- head-on finish line - lap (B)
- head-on finish line - sprint (C)
- finish infield/ceremonies (D)
- back infield/field events (E)
- sprint start, raised (F)

The angles of these positions in relation to the track are similar to those outdoors but particular attention must be paid to the height of the banked bends and the advertising boards.

"No go" zones must be established, and respected, in keeping with those adopted for outdoor. (See Fig 8.8.2.1a & b)

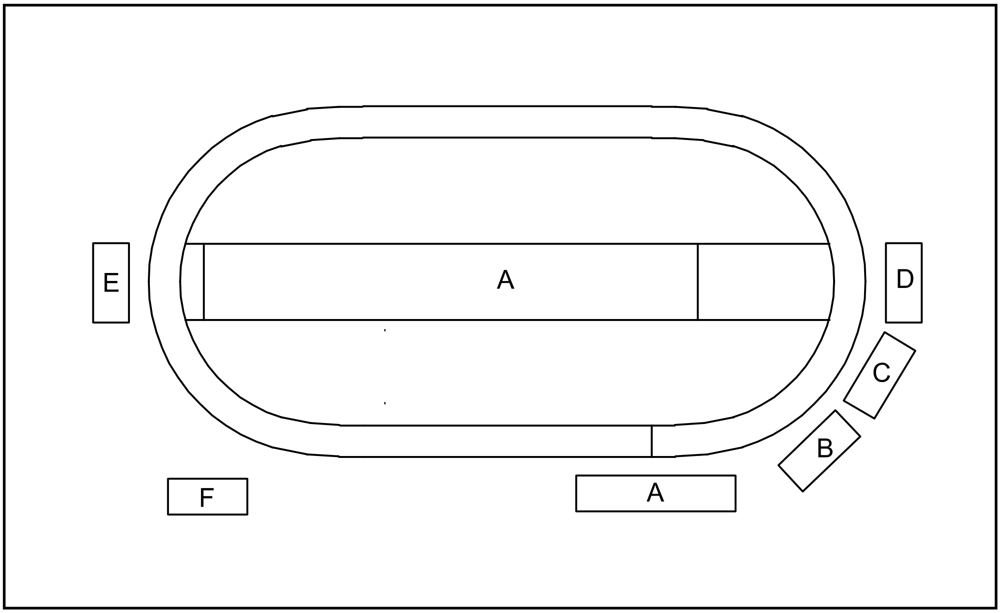



**Figure 8.8.2.1a - Key photographers' positions**
A Infield/finish line, B finish line, lap, C finish line, sprint
D finish line, straight/ceremonies, E back-straight/field events, F start, straight

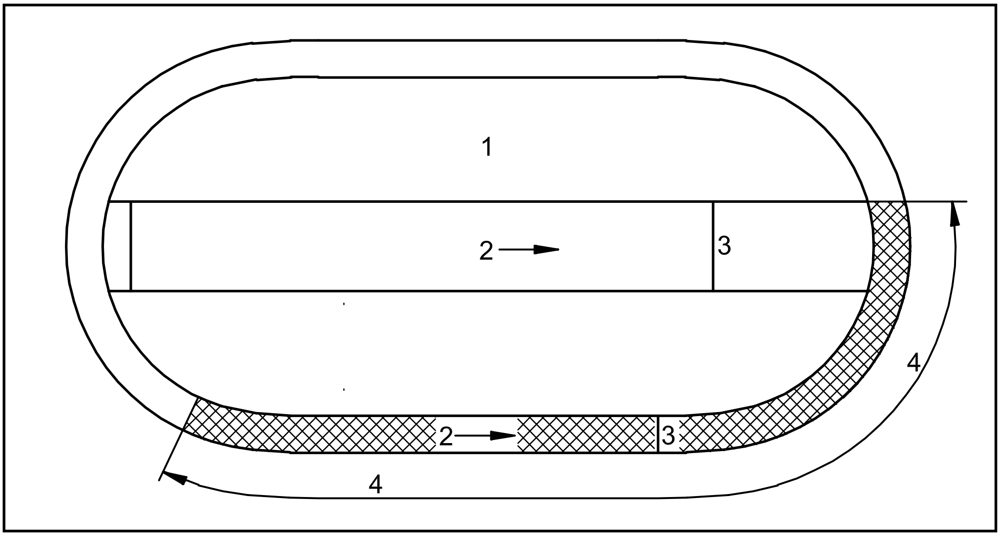



**Figure 8.8.2.1b - "No go"-zone**
1 Infield, 2 direction of running, 3 finish line, 4 "no-go"-zone

#### 8.8.2.2 Film Development/Replacement
See 4.2.1.2.6.

#### 8.8.2.3 Camera Repair
See 4.2.1.2.7.

#### 8.8.2.4 Equipment Storage
See 4.2.1.2.8.

### *8.8.3 TELEVISION AND RADIO*
**8.8.3.1 Commentary Positions -** Greater attention must be paid indoors to acoustics since all sound will be contained more easily than outdoors (See 8.8.5).

Within an indoor stadium, commentators have even less room than for outdoors. Therefore, consideration must be given to service access for information, catering technical services etc. One advantage of an indoor stadium is the absence of wind which might scatter papers. However, it is still necessary to provide filing facilities.

#### 8.8.3.2 Camera Positions
The reduced space and competition programme enables coverage of indoor athletics to be carried out with fewer cameras than for outdoors. Certain key camera positions however must be guaranteed no matter how small the event or corresponding TV production. Platforms for such cameras should be part of the permanent construction of the stadium.

Cabling ducts to these positions should be provided for in the stadium construction. There must be at least four cameras, one for running events located at the finish, one for the high jump and pole vault, one for the long and triple jump and one for the shot put.

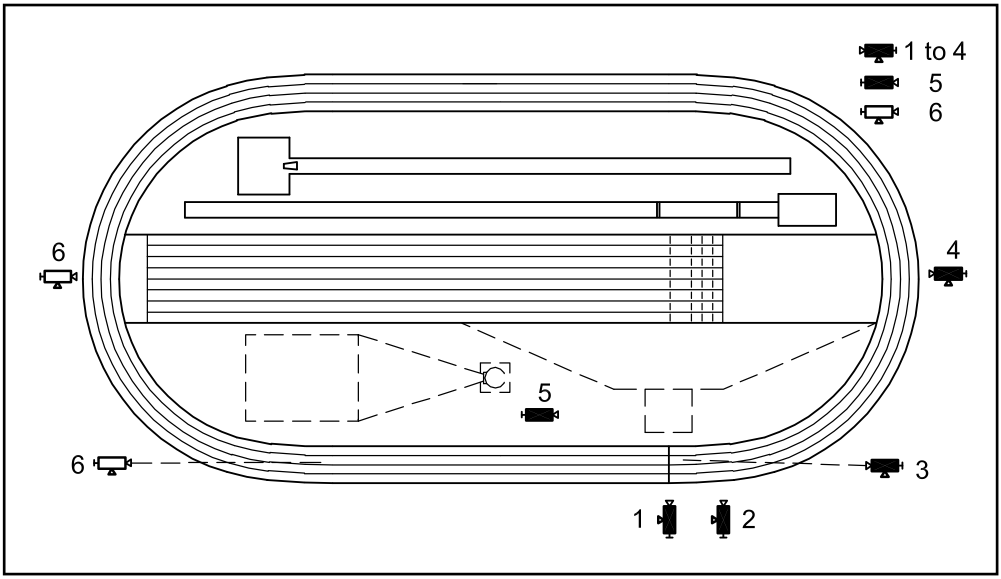



**Figure 8.8.3.2 - Camera positions for major indoor competitions**
1 Camera on finish line of the oval races, 2 camera on finish line of the sprint races
3 camera head on to the finishing straight, 4 camera head on to the sprint straight
5 hand-held camera, 6 camera on the back of the oval straight or the sprint straight

The ideal camera positions for a major indoor competition are shown in Fig 8.8.3.2.

Camera 1 is situated on the finish line of the oval races. This camera provides the master shot of the longer races.

Camera 2 is situated on the finish line of the sprint races. If the two lines are contiguous but the sprint lanes are in the middle of the arena, this camera should be higher than camera 1, to maintain the desired angle.

*Note*

Cameras 1 and 2 complement each other. On the longer races camera 1 is the master shot, while camera 2 provides the tighter coverage. This is reversed during the sprints.

Camera 3 is situated head on to the finishing straight. This camera provides coverage of the runners as they enter the first turn and the runout, and can serve as a good position for unilateral interviews. It should not be obstructed by photographers or barriers.

Camera 4 is head on to the sprint straight, and should be able to be aligned with the middle lanes.

Camera 5 is a hand-held camera, ideally on radio-frequency to allow it to be used in the congested environment unhampered by cables. It is used for the lane introductions of the runners and different shots such as the lap bell and the low perspective of the runners as they pass by on the back straight.

#### 8.8.3.3 Unilateral Facilities
See 4.2.2.3.3.

#### 8.8.3.4 Finish Line Positions
Despite the cramped facilities the unilateral TV network will seek space on the finish line for a camera which will concentrate on individual athletes of national interest. The same camera will be used for post-event interviews. Access (See 4.2.2.3.4) is therefore required for cameramen, sound recorders, interviewers, technicians/engineers. This space - the post-event interview area/mixed zone - is the most pressured zone in the stadium.

#### 8.8.3.5 Infield Positions
In providing television coverage for participating broadcasters, the host broadcaster must have presence on the infield. This is particularly relevant for field events. Maximum use of hand-held cameras can be made to great effect.

#### 8.8.3.6 Formal Interview Room
See 4.2.1.3.3.

#### 8.8.3.7 Outside Broadcast (OB) Vans Compound
The host broadcaster and those TV companies who have undertaken unilateral coverage will require space adjacent to the stadium for parking their outside broadcast (OB) vans. Where the location of the stadium limits available space adjacent to the venue, thought should be given to the use of an adjacent street which can be closed off for the duration of preparations and the competition itself. Maximum cooperation will be required from city authorities such as police and fire department to secure such a solution.

The size of the compound will depend on the scale of the event. A national event will require space for 1 to 2 vans, which require 600m$^2$ (maximum) including administration and services. A major regional/continental event must cater for 6 to 8 vans within an area of 1200m$^2$, whilst an event on the scale of the world championships must provide for 12 to 15 vans and will require 2000m$^2$.

The average size of a single OB van is 16m in length, 2.50m in width, 4.50m in height. The overall weight is approximately 30 metric tons.

Independent power units should be provided, with back up generator(s). 24 hours security and very limited, strict access is absolutely essential.

#### 8.8.3.8 International Broadcast Centre
An international broadcast centre will only be required for a major world/regional event. It is a separate entity from the press centre and functions solely for television and radio.

Size is in proportion to the magnitude of the event. See 5.6.3.2.

The telecommunication requirements of the IBC can be extensive for major games and championships. In general see 4.2.1.3.4 and 5.6.3.2.

### *8.8.4 ACOUSTICS AND LIGHTING*

The acoustics of an indoor stadium must be carefully considered for the media. For journalists working at desks in the stadium, it is very difficult to communicate by telephone if the volume of sound from the spectators is increased by a constant stream of sound from the PA system. Whenever possible, the latter should be directed away from the media working areas. Since the host broadcaster will wish to place directional microphones in, and around, the arena, detailed pre-planning is necessary to avoid problems with competition officials and/or equipment.

Strength, direction and quality of lighting must be considered for both television and photographers. The required lux levels across the arena must be maintained throughout a competition.

Coordination is required with the official timing company which will require increased lighting over finish line to guarantee accuracy of results and to prevent strobing.

## 8.9 Competition Equipment Specifications

The requirements for pole vault, high jump, triple jump and long jump, indoors and outdoors are identical.

The shot put indoors is normally from a portable circle made of plywood or reconstituted wood with a rim of similar material (See Fig 8.9).

The landing sector for shot put shall be of a suitable material on which the shot will make an imprint and which will minimise any bounce or damage to the flooring. The sector will be surrounded at the far end and on both sides as close to the circle as may be necessary for safety by a stop barrier which should be adequate to stop a shot whether in flight or bouncing.

The height of the protective barrier should not be less than 2.50m.

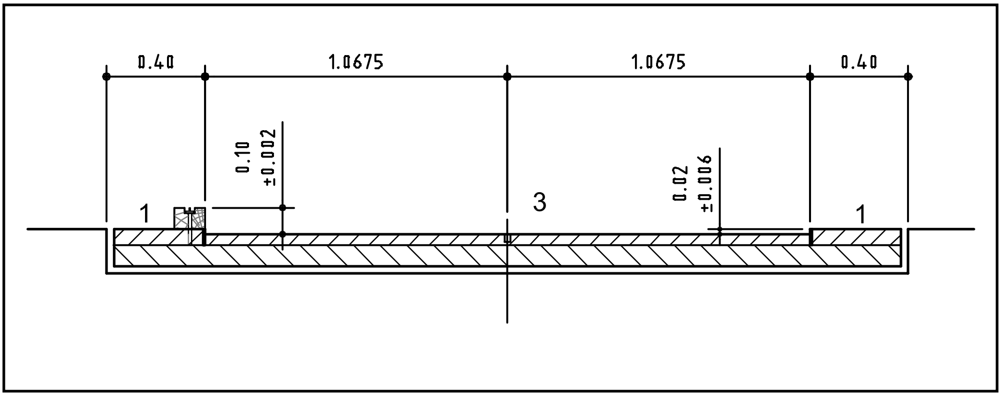
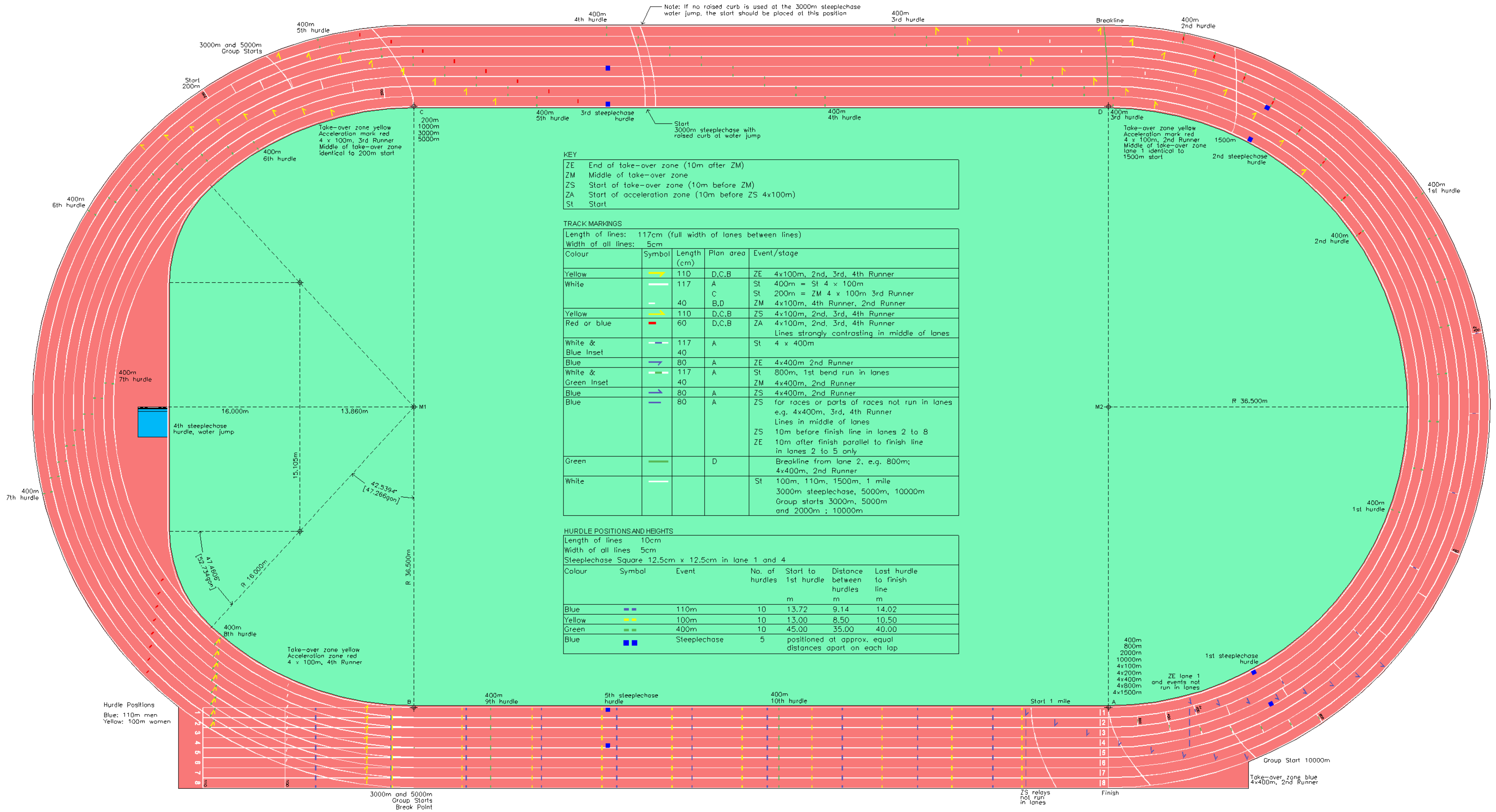



**Figure 8.9 - Shot put indoors**
1 Portable shot put circle, 2 stop board, 3 centre point

# IAAF 400 METRE STANDARD TRACK, MARKING PLAN

SCALE - 1:300




KEY

| | |
|---|---|
| ZE | End of take-over zone (10m after ZM) |
| ZM | Middle of take-over zone |
| ZS | Start of take-over zone (10m before ZM) |
| ZA | Start of acceleration zone (10m before ZS 4x100m) |
| St | Start |

TRACK MARKINGS

Length of lines: 117cm (full width of lanes between lines)
Width of all lines: 5cm

| Colour | Symbol | Length (cm) | Plan area | Event/stage |
|---|---|---|---|---|
| Yellow | | 110 | D,C,B | ZE 4x100m, 2nd, 3rd, 4th Runner |
| White | | 117 | A | St 400m = St 4 x 100m |
| | | | C | St 200m = ZM 4 x 100m 3rd Runner |
| | | 40 | B,D | ZM 4x100m, 4th Runner, 2nd Runner |
| Yellow | | 110 | D,C,B | ZS 4x100m, 2nd, 3rd, 4th Runner |
| Red or blue | | 60 | D,C,B | ZA 4x100m, 2nd, 3rd, 4th Runner<br>Lines strongly contrasting in middle of lanes |
| White & Blue Inset | | 117<br>40 | A | St 4 x 400m |
| Blue | | 80 | A | ZE 4x400m 2nd Runner |
| White & Green Inset | | 117<br>40 | A | St 800m, 1st bend run in lanes<br>ZM 4x400m, 2nd Runner |
| Blue | | 80 | A | ZS 4x400m, 2nd Runner |
| Blue | | 80 | A | ZS for races or parts of races not run in lanes e.g. 4x400m, 3rd, 4th Runner<br>Lines in middle of lanes<br>ZS 10m before finish line in lanes 2 to 8<br>ZE 10m after finish parallel to finish line in lanes 2 to 5 only |
| Green | | | D | Breakline from lane 2, e.g. 800m; 4x400m, 2nd Runner |
| White | | | | St 100m, 110m, 1500m, 1 mile<br>3000m steeplechase, 5000m, 10000m<br>Group starts 3000m, 5000m and 2000m ; 10000m |

HURDLE POSITIONS AND HEIGHTS

Length of lines 10cm
Width of all lines 5cm
Steeplechase Square 12.5cm x 12.5cm in lane 1 and 4

| Colour | Symbol | Event | No. of hurdles | Start to 1st hurdle (m) | Distance between hurdles (m) | Last hurdle to finish line (m) |
|---|---|---|---|---|---|---|
| Blue | | 110m | 10 | 13.72 | 9.14 | 14.02 |
| Yellow | | 100m | 10 | 13.00 | 8.50 | 10.50 |
| Green | | 400m | 10 | 45.00 | 35.00 | 40.00 |
| Blue | | Steeplechase | 5 | positioned at approx. equal distances apart on each lap | | |

CONSTRUCTION MEASUREMENTS

| | |
|---|---|
| Length of each straight section | 84.390m |
| Construction radius of curve (including the raised kerb on inside of track) | 36.500m |
| Construction length of curve (semi-circle) | 114.668m |
| Radius of measurement line in lane 1 (30cm outside raised kerb) | 36.800m |
| Length of curve along measurement line | 115.610m |
| Length of track along measurement line | 400.000m |
| Length of track on construction line (kerb) | 398.120m |
| Lane width (including 5cm on outside) | 1.220m |
| Steeplechase lap where the water jump is inside the 400m track without raised curb | 396.084m |
| Steeplechase lap where the water jump is inside the 400m track with raised curb | 396.248m |

With the exception of lane 1, all lanes are measured 20cm out from the outer edge of the inner line.
Marking of start, relay and hurdle positions
With measuring tape on straights only; with theodolite on the bends according to the centre angles of the nominal arc segments.
Marking with measuring tape on bends only as a backup method,
e.g. checking, correcting and supplementing.
In each lane, always measure from the start (A,C) or end (B,D) of the arc.

Lane staggers in m, measurement line distance 0.20m

| Distance/ plan area | | Bend | Lane 2 | Lane 3 | Lane 4 | Lane 5 | Lane 6 | Lane 7 | Lane 8 |
|---|---|---|---|---|---|---|---|---|---|
| 200 | C | 1 | 3.519 | 7.352 | 11.185 | 15.017 | 18.850 | 22.683 | 26.516 |
| 400 | A | 2 | 7.038 | 14.704 | 22.370 | 30.034 | 37.700 | 45.366 | 53.032 |
| 800 | A | 1 | 3.526 | 7.384 | 11.260 | 15.151 | 19.061 | 22.989 | 26.933 |
| 4 x 400 | A | 3 | 10.564 | 22.088 | 33.630 | 45.185 | 56.761 | 68.355 | 79.965 |

All distances are measured in a clockwise direction from the edge of the finish line nearer to the start to the edge of the appropriate line farther from the finish.