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ABSTRACT

Guidelines are presented on tennis court and track and field construction that reflect the latest developments in construction technology, methodology, and practice. Based on contributions from experienced certified tennis court and track builders, material suppliers and design professionals, this manual examines each of the critical areas of court and field design and construction issues to consider when building these facilities. Section 1 provides guidelines in the areas of general conditions for construction, site investigation and preparation, vegetation control, and drainage for recreational areas. Section 2 focuses on tennis court guidelines that include court orientation and dimensions, court surfaces, lighting, surface painting, maintenance and repair of asphalt courts, conversion of hard to fast dry courts, and indoor tennis air structure construction. The third and final section addresses track guidelines and includes basic dimensions and site considerations, concrete construction, fencing, six types of track surfaces, field event construction, and layout and striping of running tracks. (GR)

# USTC & TBA GUIDELINES FOR TENNIS COURT & RUNNING TRACK CONSTRUCTION

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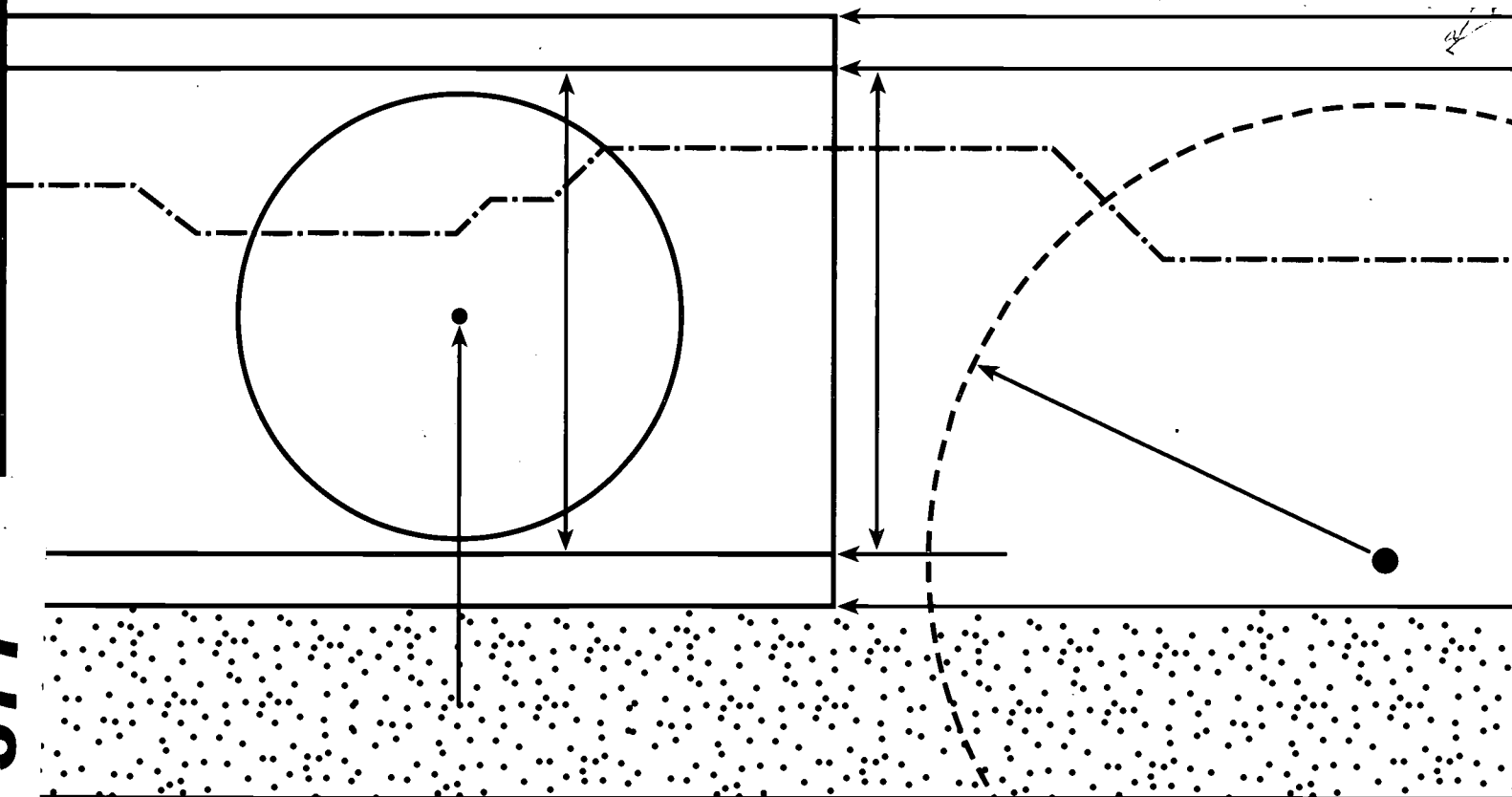
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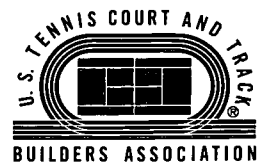
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# U.S. TENNIS COURT AND TRACK BUILDERS ASSOCIATION GUIDELINES FOR TENNIS COURT AND RUNNING TRACK CONSTRUCTION

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# FOREWORD

The United States Tennis Court and Track Builders Association is proud to present the 1998 revision of its Guidelines for Tennis Court and Running Track Construction. It is believed that these Guidelines will prove to be a useful reference for those having an interest in tennis court and running track construction, and that knowledge of the construction practices and methods set forth will further enhance the quality of such construction in the United States.

The former Guideline Specifications have been completely reviewed, revised and updated. A committee of experienced contractors, including Certified Tennis Court Builders and Certified Track Builders, materials suppliers and design professionals contributed to this project.

Tennis courts and running tracks often rest on dynamic soils, and varying climate, soil and topographic conditions make it impossible to specify construction practices and methods which can be safely followed in all parts of the United States. The revision has been retitled from "Guideline Specifications" to "Guidelines" to emphasize this fact. Users are cautioned that site specific conditions may require materials or methods different from those described herein, and those not experienced in tennis court or running track construction are advised to seek the advice of a qualified contractor and/or design professional.

Changing technology and new developments in construction methods will certainly necessitate further revisions to these Guidelines. It can be expected that individual sections of these Guidelines will be revised from time to time prior to the next general revision. Users should ensure that they are using the most recent version of the Guidelines, and should take appropriate steps to inform themselves of new developments that may not yet be reflected even in the most current version.

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**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors, tennis court and running track owners. Parties not experienced in tennis court or running track construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

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<b>SECTION</b>	<b>I.A.</b>	<b>PAGE</b>	<b>1</b>
<b>TITLE</b> <b>GENERAL CONDITIONS FOR CONSTRUCTION – TENNIS AND TRACK</b>		<b>REVISION DATE</b> <b>1998</b>  <b>COPYRIGHT © 1998 BY U.S. TENNIS COURT &amp; TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.</b>	
<b>1.0 Definitions</b>  <b>A. Contract Documents</b> The "contract documents" should consist of the construction contract, conditions of the contract, drawings (if required) and specifications defining the scope of work. These should be issued prior to signing the construction contract.  <b>B. Scope of Work</b> The term "scope of work" includes all labor, materials, equipment and transportation to complete the work as defined in the contract documents.  <b>C. Project</b> The "project" is that total construction defined in the contract documents of which the work may be the whole or only a part.  <b>D. Owner</b> The "owner" is the person or organization identified as such in the contract documents. The term "owner" means that person or his authorized representative.  <b>E. Contractor</b> The "contractor" is the person or organization identified as such in the construction contract. The term "contractor" means that person or his authorized representative.			
<b>2.0 Construction Contract</b>  <b>A. Execution</b> The construction contract should be signed by both the owner and contractor.  <b>B. Contractor's Familiarity with Site and Work</b> By executing the construction contract, the contractor acknowledges that he has visited the site, has familiarized himself with the local conditions under which the work is to be performed, and understands the scope of work as defined in the contract documents.  <b>C. Payment Terms and Insurance</b> The contract documents should set forth requirements for payments and insurance.			
<b>3.0 Owner's Responsibilities</b>  <b>A. Electrical Power and Water</b> The owner should furnish adequate electrical power and water at the construction site for the performance of the work. The contractor should furnish, install, maintain, and remove any temporary wiring or piping that may be additionally required.  <b>B. Permits and Taxes</b> Unless otherwise provided, the owner should obtain and pay for all construction permits, fees, licenses, etc. as may be required by law. The contractor's contract sum should include such federal, state and local taxes as may be applicable to the performance of the contract.			

**4.0 Contractor's Responsibilities****A. Review of Contract Documents**

The contractor should carefully review the contract documents and should promptly report any errors, inconsistencies or omissions he may discover.

**B. Layout of Work**

The work should be laid out to true lines and grades in full accord with the drawings. Surveying of lines and grades, from a base line and benchmark established by the owner at the construction site, and staking thereof, should be accomplished by the contractor. Monuments should be substantially established, protected and maintained in place by the contractor for the duration of the contract or until such other time as their removal may be authorized by the owner or his representative.

**C. Errors in the Contract Documents**

The contractor should not be liable to the owner for errors, inconsistencies or omissions in the contract documents.

**D. Corrective Work**

The contractor should secure proper written authorization for any corrective work which becomes the responsibility of the owner.

**E. Schedule**

The contractor should submit a schedule indicating the intended starting date of the work, the different phases and timetable if possible, and the intended date of completion.

**F. Delays**

The contractor should inform the owner of any delays, and causes of such, that affect the completion of the work.

**G. Supervision and Direction**

The contractor should be responsible for the supervision and direction of the work. He should direct his authorized staff and/or subcontractors as deemed necessary and consistent with good construction practices.

**H. Contractor's Responsibility**

The contractor should be solely responsible for all construction means, methods, techniques, sequences and procedures, and for coordinating all portions of the work. Unless specifically noted otherwise, the contractor should provide and pay for all labor, materials, equipment, tools, construction machinery and transportation necessary for proper execution and completion of the work.

**I. Protection of the Public**

The contractor should erect and maintain barricades, canopies, guards, lights, and warning signs to the extent required by law or reasonably necessary for protection of the public.

**J. Premises**

The contractor should at all times keep the premises clean and free of accumulated waste materials and rubbish caused by the operations. At the final completion of the job, the contractor should restore all areas damaged in the course of the work.

SECTION	I.A.	PAGE
<p><b>K. Communications</b> The contractor should direct all communications regarding the work to the owner.</p> <p><b>L. Guarantee</b> The contractor performing any part of the work and any subcontractors under the contract should guarantee their respective work against defective materials or workmanship for a specific number of month(s) from the date of filing notice of completion by the contractor and acceptance of such by the owner.</p>		3
<p>NOTICE: These Construction Guidelines are for use by architects, engineers, contractors, tennis court and running track owners. Parties not experienced in tennis court or running track construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.</p> <p>Copyright © 1998 by U.S. Tennis Court and Track Builders Association. All Rights Reserved.</p>		

SECTION	I.B.	PAGE	1
TITLE SITE INVESTIGATION	REVISION DATE		1998
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1.0 Scope			
<p>The ultimate performance of any tennis court or running track depends to an important degree on subsoil and drainage conditions. The stability of the subsoil also has a direct influence on the ability of the contractor to properly construct the court or track and to maintain design grades under the deformations generated by the construction equipment itself.</p> <p>Expansive soils or plastic soils and use of base course materials consisting of these types of soils can create further problems.</p> <p>Frost action is exaggerated where frost susceptible materials exist with moisture available to generate frost heave.</p> <p>It is, therefore, necessary for the owner, or the contractor, or a consultant retained by either the owner or the contractor; to identify soil conditions existing at the site and to take these conditions into account in designing the court or track. Site preparation, including stripping, placement of backfill and base construction must be properly performed to minimize the risk of problems due to subsoil and subgrade conditions. (See Site Preparation Guidelines, Section 1.C.)</p>			
2.0 Site Investigation			
<p>The following Guidelines for site investigation should be applied with considerable flexibility depending on the nature of the conditions that exist at a particular site, and the degree of risk that the owner is willing to take regarding adverse effects of subsoil conditions.</p> <p>Obviously, the more serious conditions that require an adequate study include:</p> <ol style="list-style-type: none"><li>1. The existence of peat or other organic soils at the site;</li><li>2. Uncontrolled fill materials or waste materials at the site;</li><li>3. Expansive soils at the site;</li><li>4. High ground water conditions or surface water retention areas (low area flooding);</li><li>5. Special usage of the facility (i.e. using tennis court as ice skating rink).</li></ol> <p>These risks have been identified in subsequent paragraphs, with Guidelines for investigation under different circumstances. Such risks require the owner and the contractor to make a joint decision as to which level of investigation to make before the project is constructed. This is done so that an adequate study can be made, and in the event of any problems developing because of subgrade conditions, the responsibility can be clearly allocated between the owner and the contractor.</p>			
3.0 Soil and Site Conditions			
A. Sites with No Anticipated Problems			
It is expected that most sites will not require extensive investigation, but			



it is recommended that every site be investigated to the extent that shallow hand dug test pits, hand auger borings, or backhoe excavations be performed to identify conditions that might create problems later and require a more thorough study, as well as to serve as a basis for determining topsoil removal and placement of fill and drainage.

It should be noted that if test pits are dug, the backfill must be adequately compacted or the test pit itself will become a source of depression in the surface. Thus, such test pits should be located between courts or outside the limits of the tennis or track surface to be constructed.

Soils should be classified, in general, in accordance with the visual manual method of identification of soils, utilizing the Unified Soil Classification System (ASTM Methods D 2488 "Description of Soil Visual Manual Procedure", and D 2487 "Classification of Soils for Engineering Purposes"). It is not intended, however, that a rigorous use of these methods be required, but only use of terminology that will describe the soil conditions in terms of soil types using the Unified Soil Classification symbols, such as CL, CH, etc.

Data obtained from this investigation should be prepared for later reference, if necessary, or for review by a qualified engineer if an evaluation is decided upon by the owner and/or the contractor.

**B. Intermediate Classification of Site Problems**

Where the owner wishes to have additional information to provide a sounder basis for design, an auger investigation is recommended, with auger borings performed in each quadrant of the track or at the four corners of the tennis court, plus intermediate borings between courts as required to secure adequate site information.

ASTM Method D 1452 is recommended for performing these borings, which should be carried to a depth of 5 ft. minimum, or to firm materials, if unsuitable materials are encountered. These borings may be made by the owner or contractor, or by a qualified engineer or architect.

If borings are made by the owner or contractor, soils should be reclassified, again in accordance with D 2488 and D 2487, by a geotechnical engineer selected or approved by the owner. In addition, a letter report commenting on soil conditions and recommending design and construction procedures should be prepared by the geotechnical engineer or architect.

**C. Difficult Site or Soil Conditions**

Where any of the problem soils previously referred to, such as existence of fill material, organic material or expansive soils, are known or believed to exist at a site, then it is recommended that the owner retain a geotechnical consultant to obtain samples in accordance with ASTM Method D 1587 in cohesive soils, and D 1586 in granular soils, with borings to a depth of at least 10 ft. or into firm materials. This should be followed by appropriate unconfined compressions tests, water content and density determinations on cohesive soils, and penetration resistances and blows per foot for granular soils, plus water level determinations, again with borings at each corner of the tennis

court or at each quadrant of the track and intermediate borings not greater than 200 ft. apart outside the pavement area.

This information should be prepared on boring log forms that are utilized by the geotechnical consultant, and accompanied by a report summarizing conditions encountered, the test data, and recommendations for site preparation and design of the court or track, including compaction specifications for the backfill material.

Where expansive soils are indicated, whether due to natural or fill materials, appropriate expansion tests should be performed to determine the degree of expansion that can be expected.

The geotechnical consultant should provide recommendations for drainage and any other recommendations considered appropriate to minimize the risk of ultimate damage to the surface due to settlement or heave, or due to instability during construction under the weight of the construction equipment.

ASTM specifications are available from American Society of Testing Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428, 610-832-9500.

**See also Guidelines for:**

- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**

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SECTION	I.C.	PAGE	1
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1.0 Scope			
<p>This document is intended to be used in conjunction with Guideline I.B., Site Investigation, and with the various other Guidelines for construction of the particular type of facility. Where more specific requirements are recommended, based on the site investigation, such requirements should prevail over those stated herein.</p> <p>Site grades, to minimize problems with surface water, including surface drainage, are beyond the scope of this Guideline.</p>			
2.0 Site Stripping and Excavation			
<p>Unless otherwise specified, topsoil and other unsuitable materials at the site, and to a minimum distance of 5' beyond the surfaced area, should be removed in such a manner as to minimize disturbance of the remaining subgrade soils, and to facilitate placement of embankment materials and/or base course materials. Topsoil should be stored at the site and reused for landscaping at the completion of construction.</p>			
3.0 Subsurface Drainage			
<p>Where surface inlets are provided on or near the courts or track, drain lines to carry the water to appropriate discharge channels should be in accordance with local building codes and regulations.</p> <p>Where it is necessary or otherwise decided to lower the water table at the site, French drains (permeable, properly graded gravel-filled trenches), geocomposites or perforated drain lines surrounded with a stone material, should be utilized, discharging to appropriate channels. Non-woven geotextile fabric may be used, depending on the stone materials available.</p> <p>Backfill of all trenches should be granular material, placed in layers not to exceed 6" in thickness, compacted with appropriate compaction equipment to 95% of the maximum density determined by ASTM Method D 1557. This compaction is necessary to minimize the risk of subsequent settlement of the surface over the trench.</p> <p>When trenching or draitile is used under existing permanent pavement, it is required that this area be compacted to 100% of the maximum density determined by ASTM Method D 1557. This method will reduce the amount of settlement that may occur in these trenches which will reflect on the final surface.</p>			
4.0 Subbase Embankment			
<p>Embankment is fill material necessary to raise the grade at the site, after removal of unsuitable materials noted in Section 2.0, to provide the surface on which to place the base course for the tennis court or running track.</p> <p>While well-graded granular soil is preferred for embankment fill, normally locally</p>			

available soil is used for economic reasons. The material should be free of organic or expansive material, and of particles greater than 1 1/2" in dimension. It should be placed in lifts not to exceed 6" in thickness and compacted to a minimum density of 95% of D 1557 density. The water content of the fill should be reduced by aeration or increased by adding water, as necessary to achieve the required compaction.

Where the natural soil at the bottom of the subbase course is stable, as evidenced by stability under construction equipment, hand auger or other exploration, base course materials can be placed on this soil. Soft clay and plastic soils should be appropriately stabilized.

## **5.0 Inspection and Testing**

Compliance with these Guidelines can best be determined by inspection and testing. Tests should be performed according to applicable ASTM specifications by a certified engineer or testing laboratory. Use of nuclear moisture and density equipment would permit rapid determination of *in situ* density and moisture content. Responsibility for the cost of such inspection should be agreed upon in advance between the owner and the contractor.

For most court or track construction, the required inspection and testing could be performed by a properly equipped and qualified contractor.

For difficult sites, as described in Guidelines for Site Investigation, inspection at various critical stages by a geotechnical engineer, is recommended.

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### **See also Guidelines for:**

- I.B. Site Investigation**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**

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SECTION	I.D.	PAGE	1
TITLE VEGETATION CONTROL OR VEGETATION REGROWTH PREVENTION	REVISION DATE		1998
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1.0	Purpose		
	Soil conditions vary from area to area. Where problems exist, it may be necessary to sterilize the soil. If so, the owner and/or contractor should recognize the problem and proceed with corrective treatment. These Guidelines will serve to aid in determining when soil sterilization is necessary and offer methods for rectifying problems caused by vegetation.		
2.0	Scope		
	These Guidelines cover causes of vegetation growth, methods of control including the use of herbicides, possible side effects resulting from the use of herbicides, degree of need, and the economic factors in any soil sterilization program. For further information on soil investigation, see Guideline I.B., Site Investigation.		
3.0	Soil Conditions		
	The owner or contractor should always determine whether soil conditions make sterilization necessary or desirable. Adjacent pavements, whether sealed or not, provide good indications of possible need for treatment. Tennis courts and running tracks that are two or more years old also attest to the problem if it exists. Where necessary, take soil samples at various levels from the surface down to a point below the subgrade of the proposed track or court and down to the depth of the root zone. These samples should be sent to a soil laboratory to determine whether the potential for weed growth warrants sterilization.		
4.0	Possible Conditions of Growth		
	There are three main causes for vegetation growth under and through a surface:		
	1. Excavation cuts existing vegetation growth but does not entirely eliminate it. Tree roots extending under the court or track area must be neutralized or removed prior to construction. (There are commercially available products which inhibit root growth).		
	2. Excavation uncovers ungerminated seeds but does not remove all of them. After construction is complete, these dormant seeds are more apt to germinate due to the likelihood of increased moisture in the soil and warmer soil temperatures. This is particularly true with asphaltic-concrete construction. Note: When a coating is applied to these pavements, it serves as a barrier to filtration of surface water. Also, it reflects rather than absorbs more of the sun's heat, thus reducing the incidence of germination.		
	3. Fill materials brought in to raise the subgrade or backfill excavations and trenches may contain ungerminated seeds and/or the live root sections of weeds.		

**5.0 Use of Herbicides****A. General**

Herbicides suitable for vegetation regrowth prevention come in liquid, pellet and powder form. Liquid herbicides are mixed with water to facilitate application. A water mixture is designed to permit root systems to absorb the herbicide. Herbicides in pellet form are useful where rainfall is sufficient to carry them to root systems. Herbicide manufacturers publish dosage rates for effective weed control. Heavier applications usually provide longer residual effects; however, strict adherence to manufacturers' recommendations is advised.

**B. Under Pavement**

If vegetation control is required, the owner, contractor or a designated subcontractor can apply liquid, powdered, or pelletized herbicide to the subgrade before installing the concrete or asphaltic-concrete pavement.

**C. Cautions**

1. Apply herbicides, in any form, in strict accordance with the label instructions. The label provides complete specifications regarding the chemical content and directions for use of the herbicide. It is important to read the label carefully and then precisely follow instructions to assure the effectiveness and safety of the process.
2. After treatment is complete, it is important to pave the subgrade as soon as possible. If rain or surface water washes into the excavation, or enters it through a porous stratum such as an uncovered stone base or an unsealed asphaltic-concrete surface, there is a strong possibility that the herbicide will leach or wash into the surrounding ground, causing possible harm to desirable plant growth.
3. It is advisable to plant new vegetation, such as trees, shrubs, and flowers, sufficiently far from the sterilized area to protect their root systems from becoming contaminated by the herbicide.
4. Liquid herbicides can be carried by the wind during application. Should this occur, it could severely damage vegetation adjacent to the construction site. Never attempt to apply liquid herbicides when there are strong breezes or when rain is imminent.
5. Do not apply liquid herbicides to water-saturated soils such as may exist after a rainfall.

**6.0 Track and Tennis Court Maintenance****A. Crack Treatment of Existing Tennis Courts and Tracks**

The same herbicides that are used in new construction can be utilized in the patching and/or sealing process for existing hard-surfaced tennis courts and tracks. Since cracks are sites for possible weed growth, they should not be repaired until the potential for such growth is eliminated. If there are weeds in the cracks, apply liquid herbicides before removing them. This allows the herbicide to enter the weeds through both the foliage and the root system. After an appropriate time, which depends on the herbicide used, remove the weeds, all dirt, and other foreign material from the cracks. Apply a second dose of herbicide to the crack areas just before patching or sealing them. It is

essential, however, to determine beforehand whether application of the herbicide will prevent such patches from adhering properly to the treated areas.

**B. Surface Patching**

Low areas, such as birdbaths, are possible sites for growth of weeds, algae or fungus. For weeds, it may well be advisable to apply liquid herbicide to these areas before surface patching. For algae or fungus growth, apply a diluted solution of liquid bleach (1 part bleach to 5-7 parts water); then, scrub the surface to remove algae or fungus. It is essential in either case to determine beforehand whether application of the herbicide or bleach will prevent patches from adhering properly to the treated areas.

**See also Guidelines for:**

**I.B. Site Investigation**

**I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**

**I.E. Subsurface and Surface Drainage for Recreational Areas**

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1.0 Introduction			
<p>The greatest single factor in the deterioration of recreational surfaces is the presence of standing water on or free water beneath the surface.</p> <p>Surface drainage (above ground) and subsurface drainage (below ground) are both essential components of properly constructed recreational surfaces. There are three basic tasks of water drainage:</p> <ol style="list-style-type: none"><li>1. Collect;</li><li>2. Conduct; and</li><li>3. Dispose of excess water.</li></ol>			
2.0 Purpose			
<p>The intention of this Guideline is to equip the reader with a basic understanding of systems in order to plan properly for new construction or to recognize and correct existing problems.</p>			
3.0 General Requirements			
A. Subsurface Drainage			
<p>A peripheral subsurface drainage system is installed where needed to intercept and redirect the flow of subsurface water that might otherwise accumulate beneath recreational areas.</p> <p>Where it is necessary to lower the water table at a given site, a subsurface lateral or parallel drainage system may be required to direct free water from the subsurface to other areas.</p>			
B. Surface Drainage			
<p>Surface drainage usually consists of a series of swales or a fabricated system designed to redirect surface water that might otherwise flow over the recreational surface, and to prevent seepage of water beneath the surface.</p>			
4.0 Procedures			
A. Subsurface Drainage			
<p>There are three types of subsurface drainage systems used to redirect subsurface water:</p> <p><u>Conventional Vertical Stone Drains</u></p> <ol style="list-style-type: none"><li>1. This type of drain is classified as an interceptor drain. It intercepts subsurface water in a stone "wall" and causes it to drain downward into a perforated pipe which carries the water to an outlet.</li><li>2. A trench is dug 1'-2' wide on the full or partial perimeter of the facility as directed by local conditions. The depth of the trench will depend on the predetermined water level, but should have a minimum depth of 18".</li></ol>			



Since the trench must be sloped a minimum of 0.28% (1:360), the depth of the trench will also be determined by the length of the trench before the water outlet. Multiple water outlets or catch basins may be necessary to minimize trench depths. Place 2" to 4" of permeable aggregate in the base of the trench.

Note: Non-woven geotextiles are usually used as a filter fabric to protect either the entire stone trench or the pipe only. Corrugated, perforated pipe is available with a "sock" over it. In either case, filter fabrics tend to clog when used in clay or silty soils.

3. A porous or perforated pipe with a minimum diameter of 4" should be placed on the aggregate in such a way as to have not less than 0.28% (1:360) of pitch and not more than 0.83% (1:120) of pitch. A larger pipe may be required as dictated by the amount of free water to be conveyed, the surface area to be drained, or available pitch on the pipe.
4. Back fill of the trenches should be of permeable aggregate of no larger than 1 1/2" placed in 6" lifts, each of which should be compacted to minimize the risk of subsequent settlement.

Note: It is generally recommended when using a filter fabric around the stone to use 1 1/2" stone size and when not using a filter fabric, to use smaller aggregate to act as a natural filter.

5. The trench is then filled to the surface with smaller washed stone where an open drain is desirable.
6. Where a closed drain is desired, the trench is filled to 8" below the surface, after which a porous type membrane is placed over the stone, and a sod or an impervious type swale formed over this.

#### Subsurface Horizontal Stone Drain Layer

This drainage layer is a "capillary breaker" used in areas with ground water problems or heavy clay soils. When installed properly, it prevents vertical movement of ground water under a surfaced area. It is highly recommended that this system be used in conjunction with a perimeter interceptor drain system.

1. Installation includes excavation of all vegetation and topsoils under the surfaced area and to a minimum of 5' beyond. The soil subgrade must be sloped. The slope of the stone drainage layer is then graded to match the proposed finish slope requirements of the surfaced area. Installation includes a 6" to 12" stone layer of two inch (2") minimum washed aggregate installed and compacted in 6" lifts. Compaction should be 95% of the maximum density determined by ASTM Method D1557.
2. On the low end of the drainage layer, a perforated pipe should be installed with a proper slope to collect and dispose of water at the outlet area.
3. The horizontal drain layer does not necessarily take the place of subgrade gravel materials.
4. Design of this system should be done by a geotechnical engineer.

**"Prefabricated Rockless" or "Geocomposite Drain"**

This system is also classified as an interceptor or curtain drain.

1. The system consists of a plastic dimpled or waffle sheet that forms a channel to permit the vertical and horizontal flow of water on each side covered by a non-woven geotextile fabric. Curtain drains usually have a corrugated pipe inserted along the bottom to carry the accumulated ground water to the outlet area.
2. Geocomposites are available in various heights ranging, depending on the manufacturer, from 2" to 60'. The installation requirements may differ from manufacturer to manufacturer but, in general, the installation requires excavation of a trench wide enough to install the geocomposite (usually 4" to 8"). The trench is backfilled with the excavated material. Some clay type soils may require backfilling with a coarse sand. Consult with your local contractor, geotechnical engineer or architect for design and installation specifications.

**B. Surface Drainage – Tennis Courts**

There are several types of systems.

**Open Drain System**

Open drains are shallow swales using gravity to move water around the recreational area. Swales used to collect and conduct surface water should be a minimum of 5' wide and 6" to 8" deep in the center. Slope requirement should be a minimum of 2% (1:50) on grass and 0.56% (1:180) on pavement. Swales can be located on the ends or sides of a facility and carry water to the outlet area.

**Closed Drain System**

A closed drain system utilizes the swale design to collect and conduct water to inlets located (at a minimum of every 200') in the center of the swales. The water inlets are connected below ground to pipe (size is determined by volume of water being collected) which carries water to catch basins or other outlet areas.

**Combination Systems**

Combination systems utilize swales and/or conventional open or closed vertical stone drains or "prefabricated rockless" geocomposite drains as discussed in the above section on subsurface drainage.

**Prefabricated Channel Drain Systems**

Another functional system being used for surface drainage is the prefabricated channel drain. These vertical lineal drains have been used for years in the track industry to drain both the field and the track surface. Their application with tennis courts and other related surfaces are also being used successfully. They require shallow excavation and some manufacturers offer sections with "built in slopes". Channel drains are available in radius, angles and straight lengths. They also have removable grates to allow for easy cleaning.

To obtain the correct system for your facility, you should consult with an experienced contractor, qualified architect and/or engineer.

**C. Surface Drainage – Tracks**

Calculations should be done to determine the amount of subsurface and surface drainage that must be handled. Following are several systems that have worked effectively for running track construction.

1. A perimeter drain tile system is an effective way of intercepting and redirecting the flow of surface and subsurface water that would otherwise accumulate beneath the track surface. Such a system normally terminates either in a storm sewer connection or through an end wall to direct water to an area of the site that is lower in elevation. It has proven to be an effective and economical system for providing subsurface drainage and also providing some residual surface drainage. Normally this would form a perimeter drain around the inside of the running track.
2. Four to eight catch basins can be located around the inside of the track to intercept surface water and direct it into a storm sewer, drain pit, or end wall outlet. The swale in this area should be graded to allow track and infield water to flow to the catch basins.
3. Curb and gutter drainage consists typically of a 6" x 18" interior curb with a 12" wide gutter pan. In most applications, the track is sloped 6" (maximum of 8") toward the lower end of the existing exterior terrain. Water from the track surface, as well as the infield, flows on the gutter pan to the low end, where it enters multiple catch basins located in the gutter pan. Catch basins are connected to a concrete or PVC pipe installed under the radius of the track.
4. A permeable system allows surface water to flow through the track surface, asphalt, and aggregate base to a collector system that directs it to a storm drainage outlet.
5. Continuous trench drains can be used around the inside edge of the track surface. This system allows for rapid movement of water. It typically has several outlets to a storm drainage system. This drain can also serve as a termination point for artificial turf on the infield.

**D. Storm Water Detention**

The free water "spill off" from the drainage system should be directed to avoid complications to surrounding areas. Local building and/or zoning codes may require detention basins or dry wells large enough to retain approximately 1/2" to 1" of rain water falling on the surface area in one hour. Consult with local authorities having jurisdiction. A pipe having an open discharge should be protected with a head wall for easy identification, and covered with screening to prevent small animals from entering and clogging the drainage system.

**5.0 Conclusion**

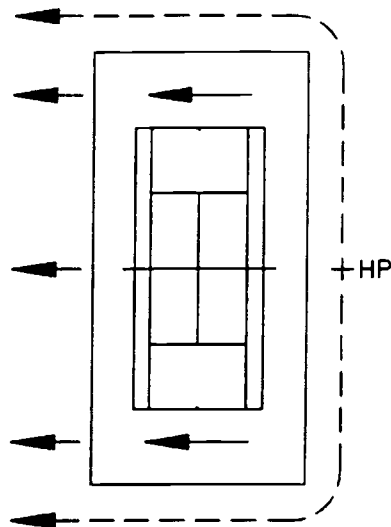
- A. The greatest single factor in the deterioration of recreational surfaces is the presence of standing water on or free water beneath the surface.
- B. Addition of more base or placement of overlays does not eliminate the basic problems of surface failures due to poorly designed facilities or improper drainage systems.
- C. Proper pitch and consistency of grade in the subsurface drainage system are essential.
- D. Proper and consistent pitch to the subgrade and in the subbase are frequently underestimated. Correct pitch is essential to avoid "pockets" that might hold free water, thereby negating an otherwise functional drainage system.

**See also Guidelines for:**

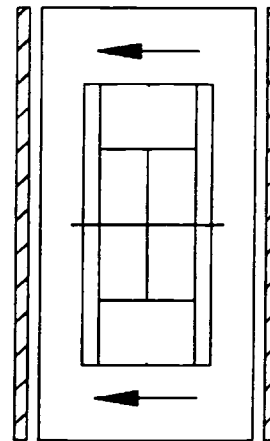
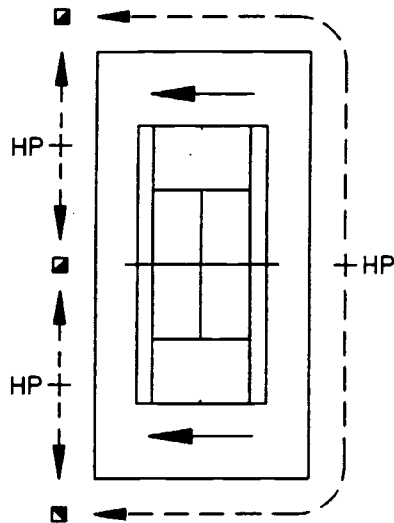
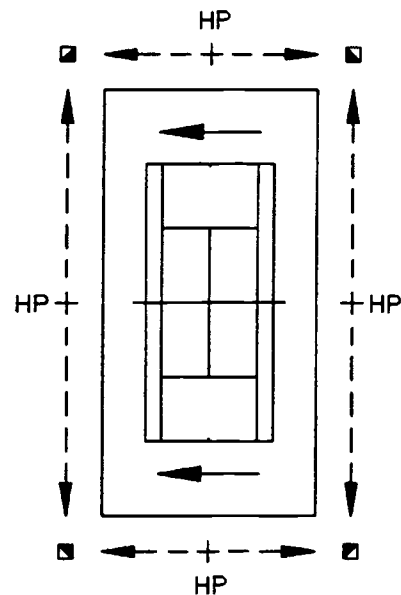
- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors, tennis court and running track owners. Parties not experienced in tennis court or running track construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

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LAWN SWALES

TRENCH OR  
INTERCEPTOR DRAINSLAWN SWALES AND  
CATCH BASINSLAWN SWALES AND  
CATCH BASINS

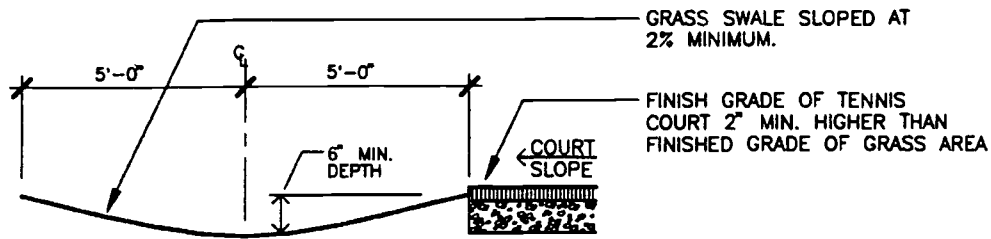
## TYPICAL DRAINAGE PATTERNS FOR ONE TENNIS COURT

NOT TO SCALE

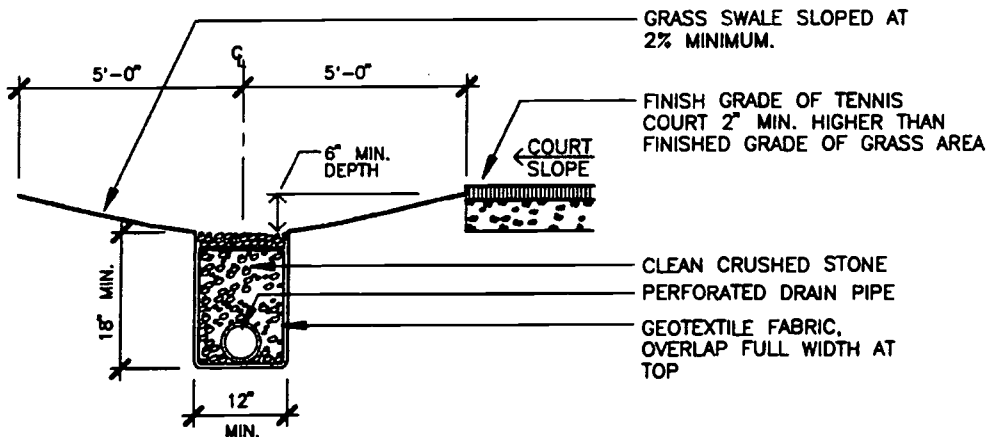


DRAIN—1

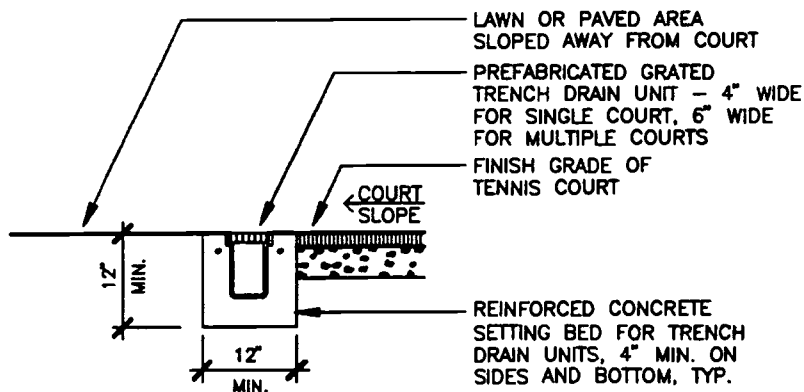
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SECTION GRASS DRAINAGE SWALE  
AT EDGE OF TENNIS COURT  
(OPEN TYPE DRAIN SYSTEM)



SECTION GRAVEL TRENCH DRAIN  
AT EDGE OF TENNIS COURT  
(COMBINATION TYPE DRAIN SYSTEM)



SECTION GRATED TRENCH DRAIN  
AT EDGE OF TENNIS COURT  
(CLOSED TYPE DRAIN SYSTEM)

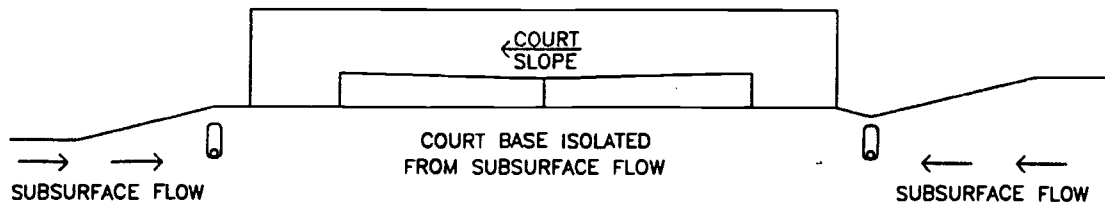
## SURFACE DRAINAGE AT COURT EDGES

NOT TO SCALE

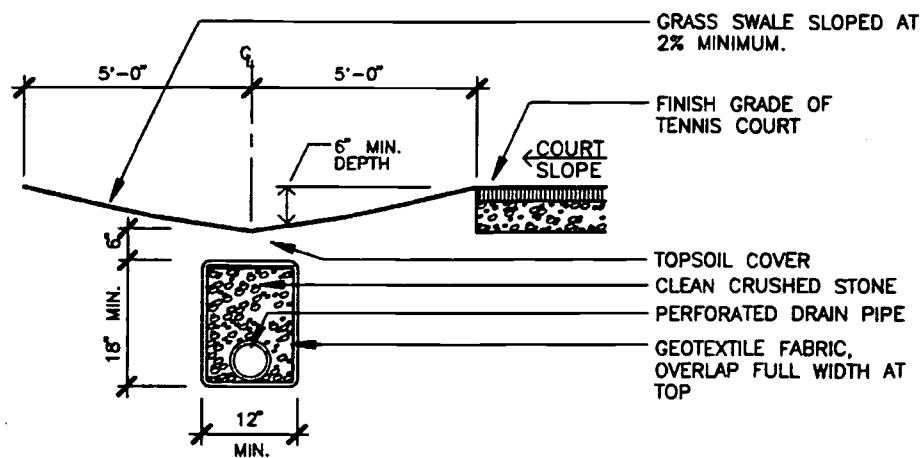


DRAIN—3

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TYPICAL SUBSURFACE DRAIN LOCATION

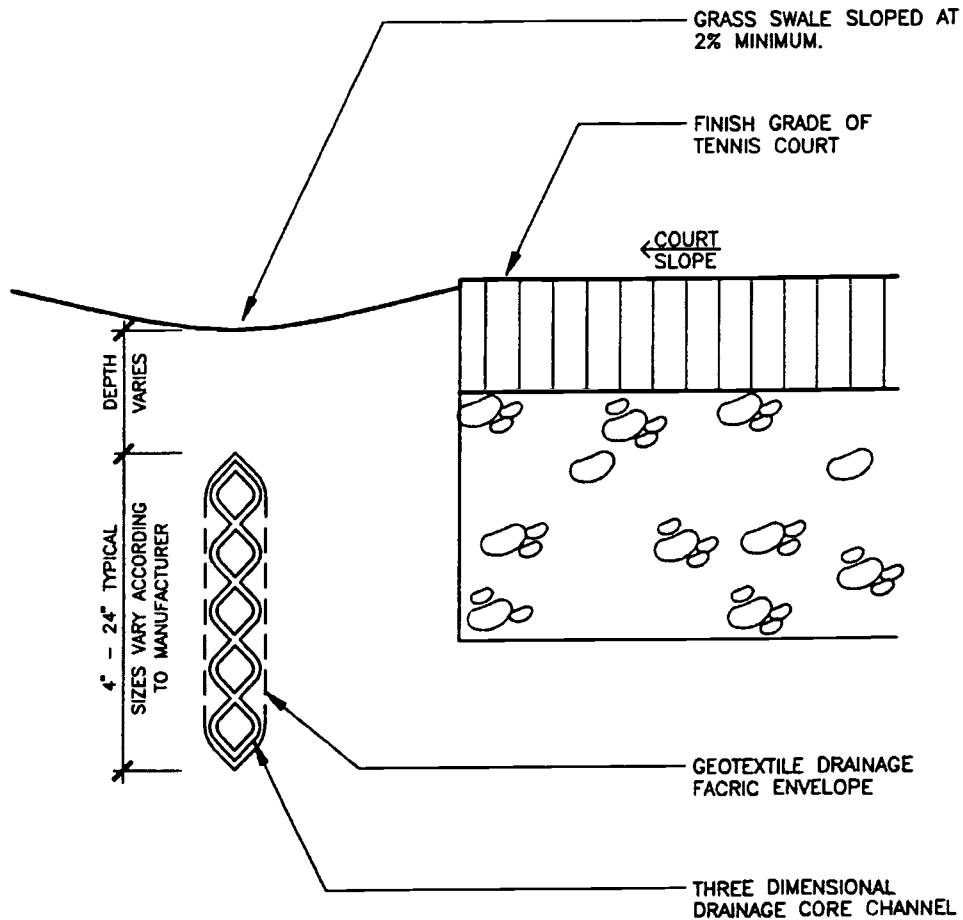
SECTION GRAVEL TRENCH DRAIN  
AT EDGE OF TENNIS COURTSUBSURFACE DRAINAGE AT COURT EDGES

NOT TO SCALE



DRAIN—4

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## ROCKLESS OR GEOCOMPOSITE DRAIN AT COURT EDGE

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DRAIN—5

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SECTION	II.A.	PAGE	1
TITLE TENNIS COURT ORIENTATION	REVISION DATE		1998
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1.0      Orientation Relative to Sun Angle			
<p>A tennis court should be laid out to minimize players looking into the sun when serving or when following the flight of a ball. A tennis court also should be laid out to avoid distracting shadow lines and patterns on the court surface.</p> <p>Theoretically, the best possible layout would be to orient the longitudinal axis of the court perpendicular to the azimuth of the sun -- the angular measurement of the horizontal location of the sun in relation to true north. Since the azimuth of the sun constantly shifts according to the time of day, the season of the year and the latitude in which it is observed, it is difficult to generalize about an ideal orientation.</p> <p>It is not unusual to orient a tennis court to match a specific season. Courts in the northern United States, for example, are generally used from late April to October. Therefore, northern courts usually are oriented according to the summer solstice which is approximately mid-season and, therefore, an average of the varying solar angles during this period. In the southern United States, the milder climate allows for play year round. For this reason, southern courts often are oriented according to either the spring or fall equinox, again an average of varying solar angles.</p> <p>Orientation can be more specific. If a court is to be used most often in the afternoon hours during the spring, as is the case with many collegiate facilities, the court should be oriented west of north for the months of April and May to minimize conflict with the afternoon sun. If the court is to be used for a specific tournament held at the same time each year, the court can be oriented properly for the actual hours of play of the final match.</p> <p><b>NOTE: It is important to remember that the orientation of the court should be in relation to true north, not to magnetic north. The angular difference between true north and magnetic north is referred to as the "deviation of magnetic north." This deviation changes according to the geographic location. Information relating to the deviation of magnetic north from true north can be easily obtained from a local surveyor or airport facility.</b></p>			
2.0      Orientation Relative to Other Factors			
<p>Orientation also should take into consideration other structures and features on the site, neighboring property, vehicle and pedestrian traffic and prevailing winds. Property lines, zoning requirements, topography of the site and efficient site utilization should be considered as well.</p>			
See also Guidelines for:			
II.B.      Tennis Court Dimensions and Related Measurements			
<p>NOTICE: These Construction Guidelines are for use by architects, engineers, contractors, and tennis court owners. Parties not experienced in tennis court construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.</p> <p>Copyright © 1998 by U.S. Tennis Court and Track Builders Association. All Rights Reserved.</p>			

APPROXIMATE LATITUDE

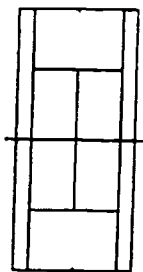
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NOON

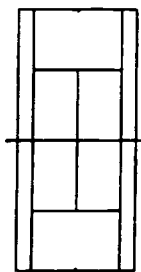
4:00 PM

BOSTON, MA  
CHICAGO, IL  
GRANT'S PASS, OR

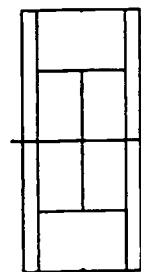
(42.5° LATITUDE)



**1° ROTATION**  
EAST OF TRUE NORTH



**TRUE**  
NORTH/SOUTH

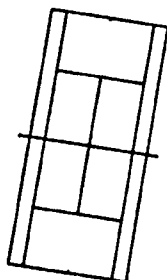


**1° ROTATION**  
WEST OF TRUE NORTH

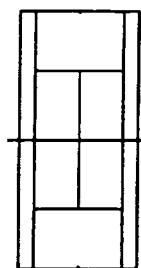
NORTHERN UNITED STATES LOCATIONS

RICHMOND, VA  
SPRINGFIELD, MO  
SAN FRANCISCO, CA

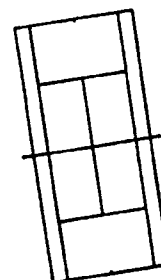
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**9° ROTATION**  
EAST OF TRUE NORTH



**TRUE**  
NORTH/SOUTH

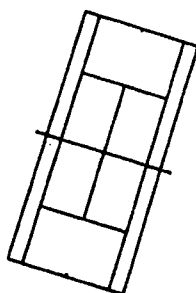


**9° ROTATION**  
WEST OF TRUE NORTH

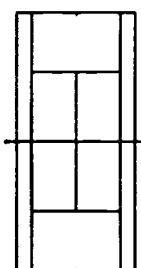
CENTRAL UNITED STATES LOCATIONS

CHARLESTON, SC  
DALLAS, TX  
SAN DIEGO, CA

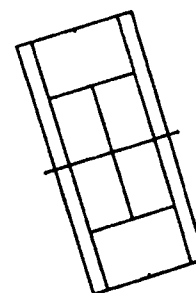
(32.75° LATITUDE)



**17.25° ROTATION**  
EAST OF TRUE NORTH



**TRUE**  
NORTH/SOUTH



**17.25° ROTATION**  
WEST OF TRUE NORTH

SOUTHERN UNITED STATES LOCATIONS

## TENNIS COURT ORIENTATION

NOT TO SCALE



ORIENT

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SECTION	II.B.	PAGE	1
TITLE TENNIS COURT DIMENSIONS AND RELATED MEASUREMENTS	REVISION DATE		1998
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1.0     Playing Lines			
<p>The outside dimensions of the playing lines should be as follows: Doubles 36' x 78' (10.97m x 23.77m) Singles 27' x 78' (8.23m x 23.77m)</p> <p>Metric equivalents for specific items such as tennis court playing lines, layouts and net heights must be converted as accurately as possible to conform to the rules of tennis. These are called hard conversions. In practice, however, other conversions are routinely adapted. For example, these Guidelines recommend a 24' separation between courts in a common enclosure, which is converted by the formula to 7.315m. For ease of construction, that dimension might be rounded to 7.5m or 8m or even 7m (which, of course, is slightly less than the recommended dimension). In other words, the nearest appropriate metric dimension is chosen—appropriate in terms of feasibility of construction, design intention, etc. These are called soft conversions. In the case of materials, the equivalent standard dimension material may be substituted.</p> <p>All lines should be not less than 1" (2.54 cm) nor more than 2" (5 cm) in width, except the base line which may be up to 4" (10 cm) in width and the center line which should be 2" (5 cm) in width.</p> <p>This allowable variation in line width results in non-uniformity and confusion and, therefore, the U.S. Tennis Court and Track Builders Association recommends that all lines be 2" (5 cm) in width, except the base line which may be up to 4" (10 cm) in width.</p> <p>All measurements should be to the outer edge of the lines except the center line and the center mark which should be on the center line of the court.</p>			
2.0     Tolerance			
<p>The lines should be laid out and applied as close to the exact measurements as is possible within the limitations of the surface on which they are being applied. At no time should the playing lines or the line dimensions vary more than 1/4" from the exact measurements, unless the court surface won't allow (natural grass moves, artificial grass stretches, etc).</p>			
3.0     Back Space			
<p>Tournament play requires a minimum 21' (6.401 m) from base line to fixed obstruction (i.e. backstop, wall, etc.). In non-tournament play, this distance may be reduced to 18' (5.486m).</p>			
4.0     Side Space			
<p>Not less than 12' (3.658 m) is required from the side line to a fixed obstruction (i.e. side-stop, light pole, wall, etc.). Where courts are in battery and where netting is used between courts, the netting is considered to be a movable obstruction, in which case 9' (2.743m) is considered a minimum between sideline and netting. (Only where space limitations become a factor and the 12' [3.658 m] minimum cannot be provided may the side space from side line to a fixed obstruction be reduced to a minimum of 10' [3.048m].) This dimension does not restrict obstructions at the net line; for example, the net post of the adjacent court or light standards.</p>			

**5.0 Clearance Between Courts**

Where courts are constructed within the confines of a common enclosure, the distance between side lines should be not less than 12' (3.658m). Where space permits, it is desirable to provide additional space between side lines to enhance play; 24' (7.315m) is recommended.

**6.0 Overhead Clearance**

The space directly above the area within the playing lines should be free from any overhead obstructions for outside play, and should be not less than 21' over the baseline and 35' minimum, 38' recommended over the net line.

**7.0 Fencing**

The purpose of fencing around a tennis court is to keep most of the balls within the court during play. Chain link fencing is most commonly used for this purpose, but wooden fencing, walls, hedges and netting also are used.

Fencing, or an acceptable alternative, is required across the back of the court (backstop) and along each sideline from the corner 20'–40' up the sidelines (sidestop). The area up to 40' on either side of the net can be left open or shorter fencing may be used.

The backstops should be 10' (or 3m) in height above the court surface for most normal installations. Where local conditions dictate additional security or ball retention, a higher backstop may be required. For residential courts, 8' (2.438m) in height is adequate when the adjacent area is such that a ball going over the backstop or sidestop can be retrieved without personal hazard or hardship and without undue intrusion on adjoining property.

The sidestops should be the same height as the backstops for the minimum distance of approximately 20' (6.096m) from the backstop. The height of the sidestop in the remaining area, if used, may vary to suit local conditions. In no instance should the sidestop, where used, be less than 3' (or 1m) in height.

Backstop and sidestop material, when manufactured to metric standards, varies slightly from the dimensions set forth above. The equivalent standard dimension material may be substituted and has been indicated above.

**8.0 Stadium-Tournament Court**

For tournament play where judges are required, a clear area a minimum of 70' x 130' (21.33m x 39.62m) should be provided. This allows a minimum clear playing area of 60' x 120' (18.28m x 36.57m) with an additional perimeter area for judges as well as a safe overrun area for the players.

**9.0 Net Posts**

Net posts should be set 3' (.91m) outside the side line, which is 42' (12.802m) apart, center to center for doubles play, and 33' (10.058m) apart, center to center for singles play. (Please refer to the diagram.) The top of the net at the inside face of the posts or supports when used to support a net for singles play on a doubles court should be exactly 42" (1.067m) above the court surface. There should be no obstruction above the top of the net at any point, including at the post.

**10.0 Playing Lines**

Playing lines should be painted on an asphalt or concrete court using line paint approved by the manufacturer of the coating material used on the court. For clay or fast dry courts, lines should be woven coated webbing, firmly held in place by rust-resistant nails. Use copper nails if the base course contains slag or cinders.

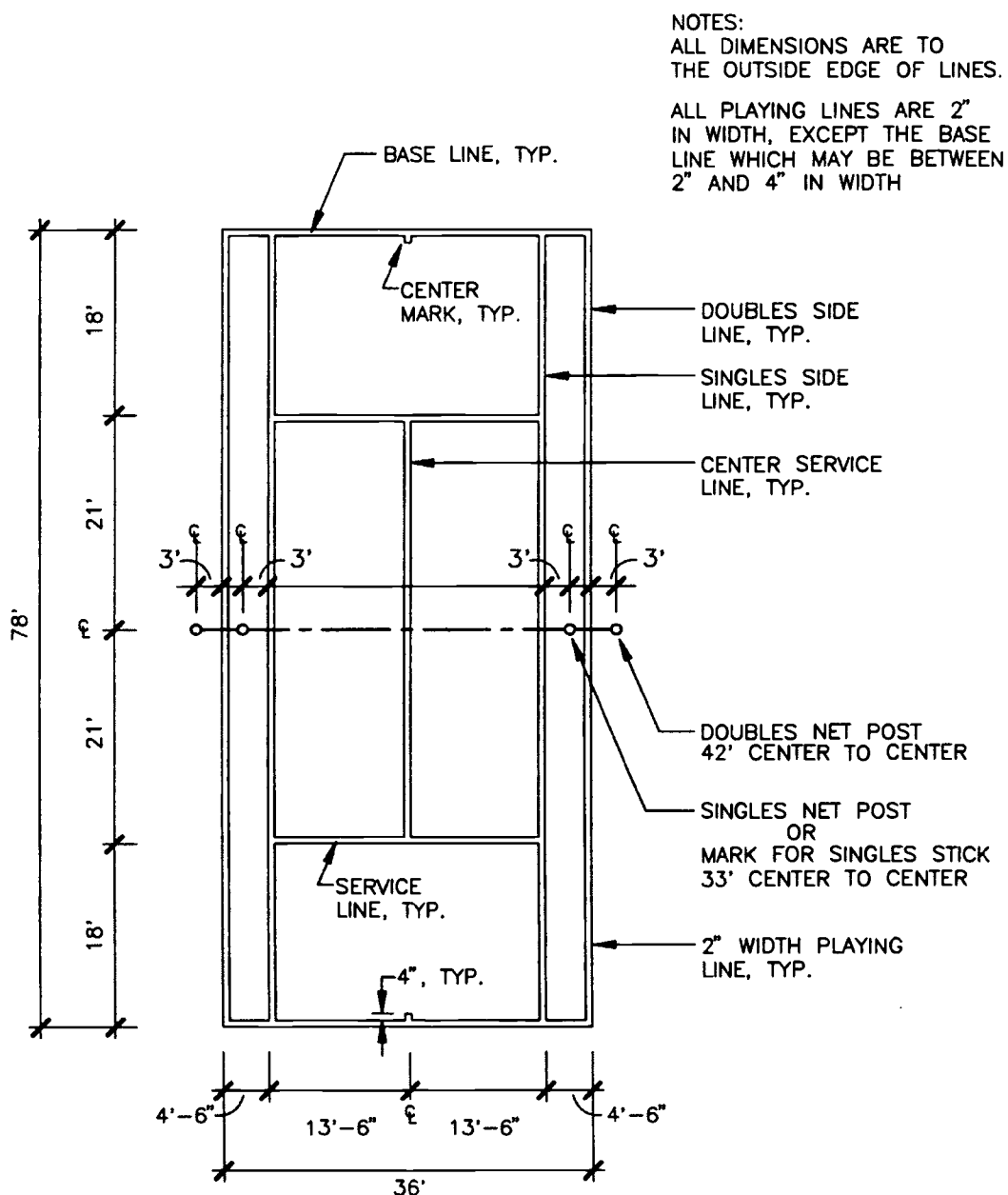
Base lines should be not more than four inches (4") wide and playing lines not more than two inches (2") wide, accurately positioned in accordance with regulations of the United States Tennis Association.

**See also Guidelines for:**

**II.A. Tennis Court Orientation**

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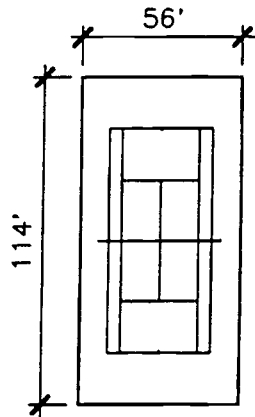
## TENNIS COURT PLAYING LINE LAYOUT PLAN

NOT TO SCALE



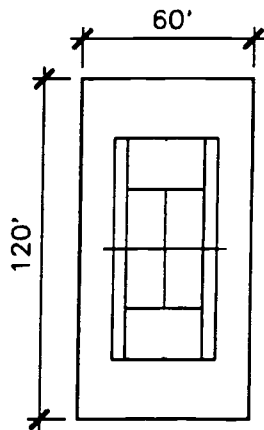
PLINES

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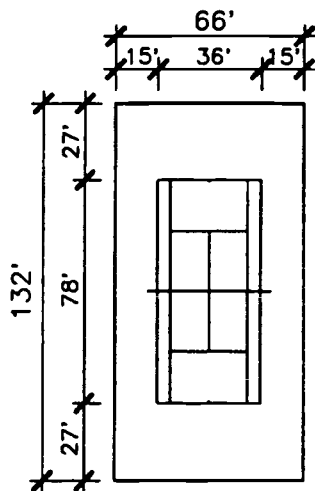


MINIMUM COURT SIZE

(IN ACCORDANCE WITH I.T.F.  
REGULATIONS—NOT RECOMMENDED)



RECOMMENDED  
MINIMUM COURT SIZE



STADIUM COURT

(AS RECOMMENDED FOR DAVIS CUP  
WORLD GROUP AND FEDERATION CUP  
MAIN DRAW EVENTS)

## TYPICAL SINGLE COURT LAYOUT PLANS

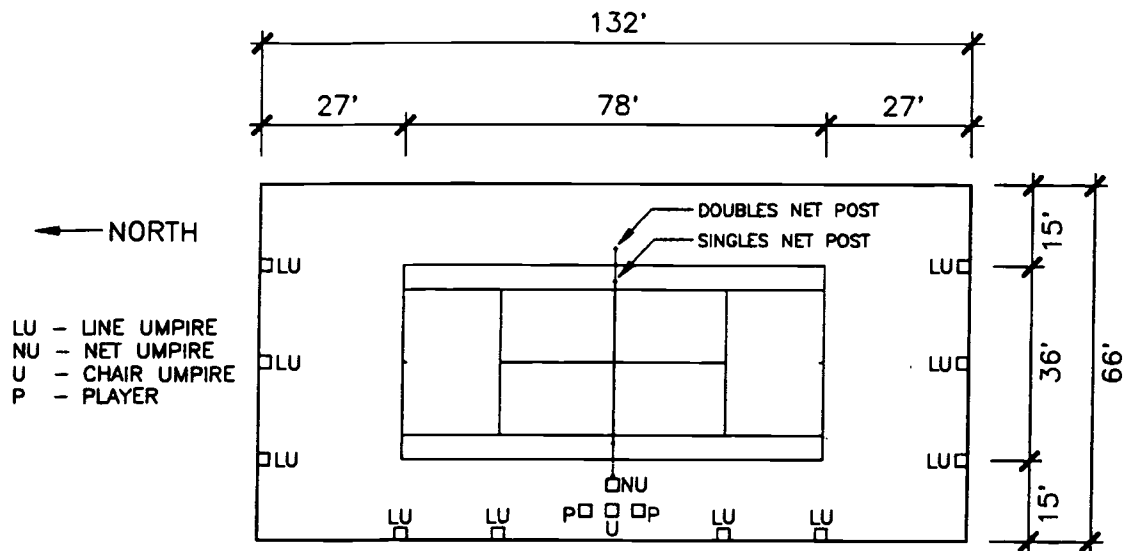
NOT TO SCALE



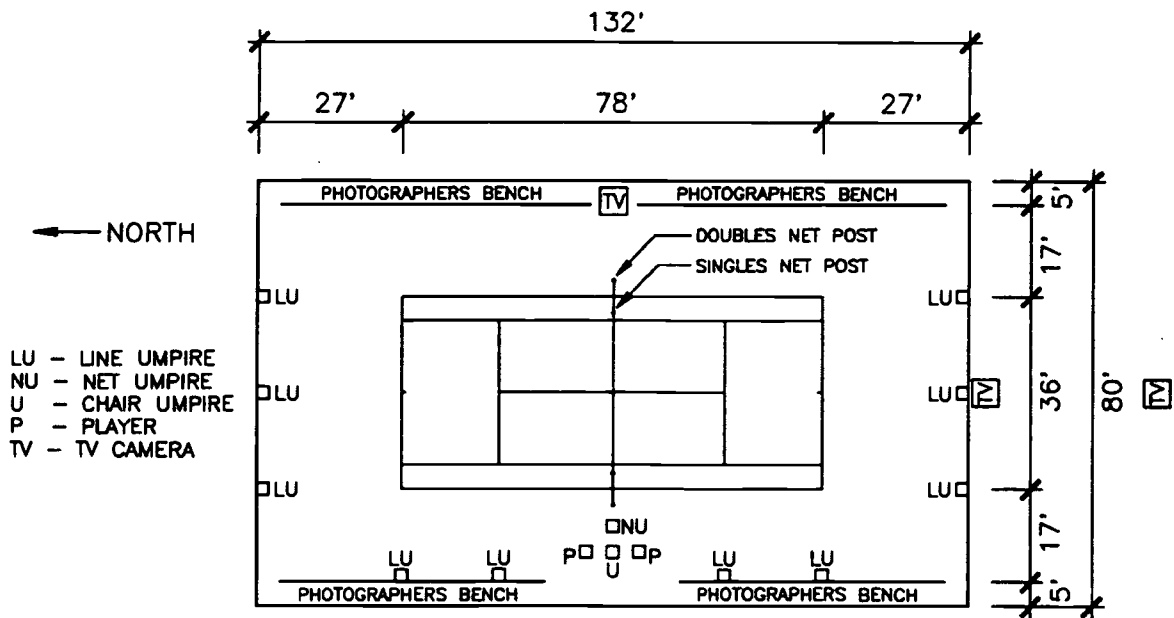
LAYOUT—1

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LAYOUT RECOMMENDED FOR  
DAVIS CUP WORLD GROUP AND FEDERATION  
CUP MAIN DRAW EVENTS



TYPICAL LAYOUT FOR  
TELEVISED INTERNATIONAL COMPETITION

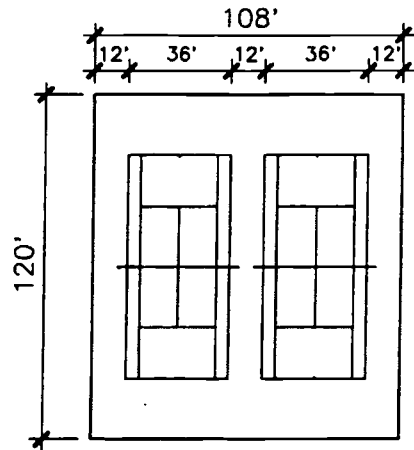
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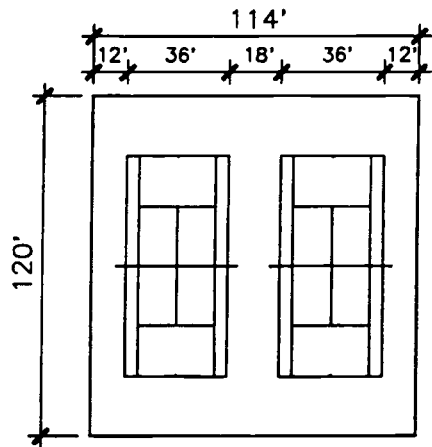


STADIUM

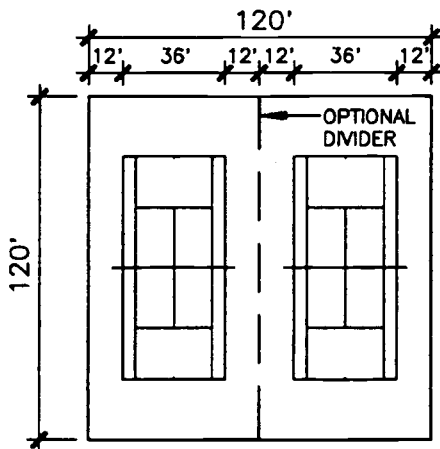
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MINIMUM SIZE



PREFERRED MINIMUM SIZE



FULL SIZE (RECOMMENDED)

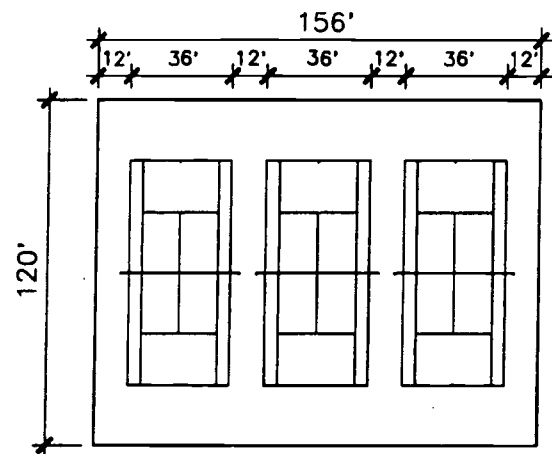
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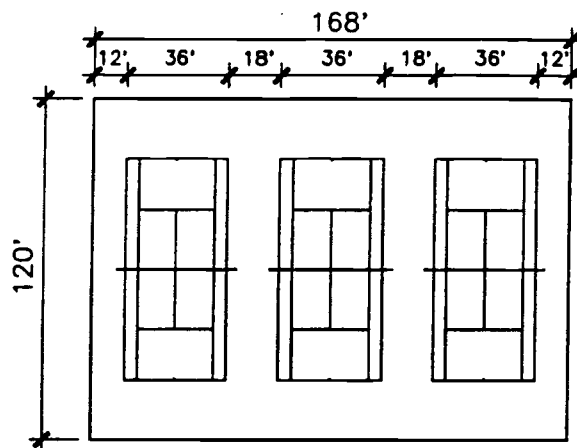


LAYOUT—2

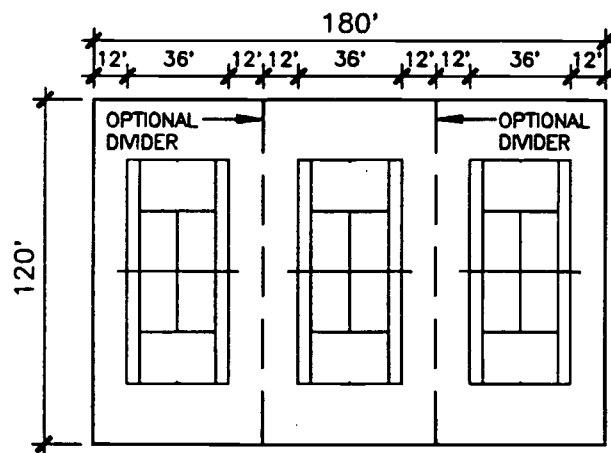
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MINIMUM SIZE



PREFERRED MINIMUM SIZE



FULL SIZE (RECOMMENDED)

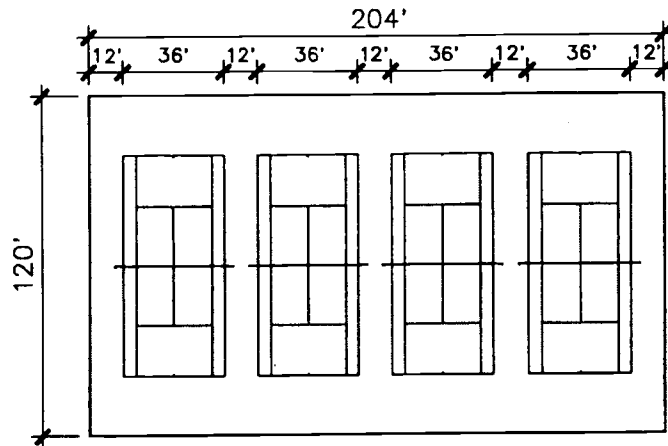
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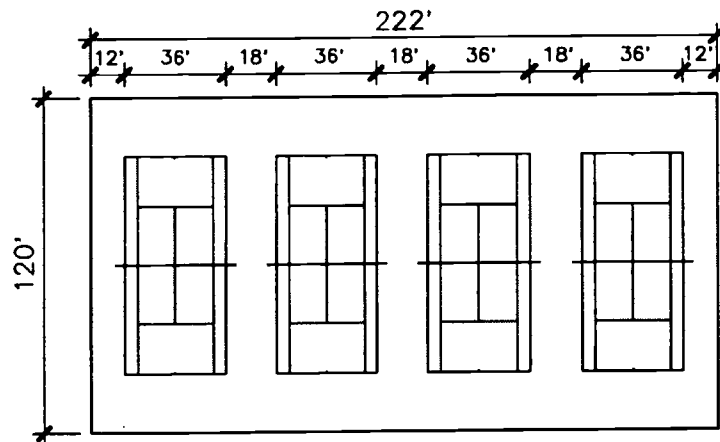


LAYOUT—3

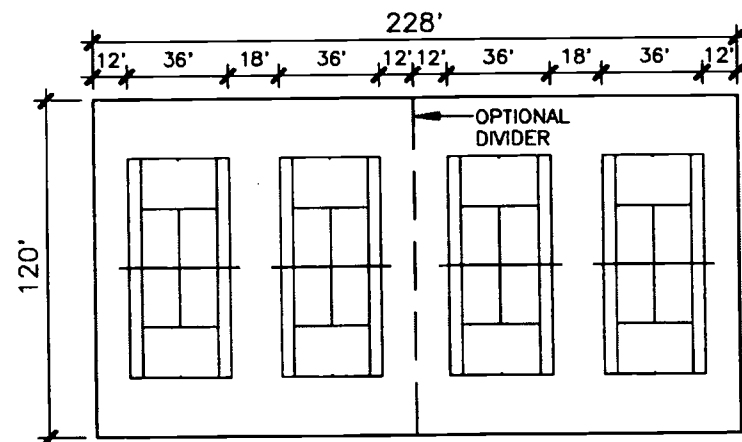
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MINIMUM SIZE



PREFERRED MINIMUM SIZE



PAIRED TWO COURT BATTERY (RECOMMENDED SIZE)

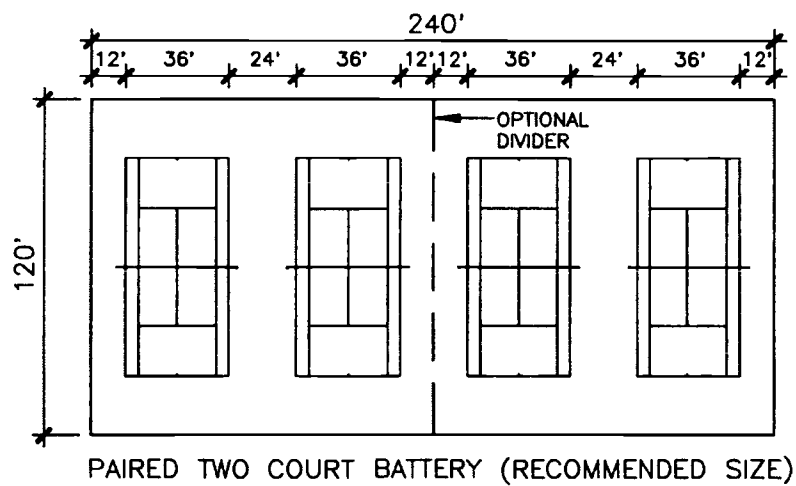
## TYPICAL 4 COURT BATTERY LAYOUTS

NOT TO SCALE



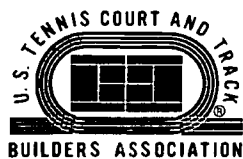
LAYOUT—4

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## TYPICAL 4 COURT BATTERY LAYOUT

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LAYOUT—5

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SECTION	II.C.	PAGE	1
TITLE STANDARD CLASSIFICATION FOR TENNIS COURT SURFACING SYSTEMS		REVISION DATE	1998
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1. Scope			
This Guideline establishes a classification of materials used in the construction of the subbase and the surface systems.			
2. Terminology			
A. Non-porous - a system which does not permit water to permeate through the surface. Drainage is achieved by surface run off.			
B. Porous - a system which permits some water to permeate through the surface.			
3. Classification Listing			
A. Porous Construction			
1. Fast Dry			
2. Clay			
3. Natural Grass			
4. Sand-filled Synthetic Turf			
5. Porous Asphalt			
6. Porous Concrete			
7. Modular			
B. Non-Porous Construction			
1. Non-Cushioned			
a. Reinforced Concrete and Post-Tensioned Concrete			
b. Hot Plant Mix Asphalt			
c. Asphalt Penetration Macadam			
2. Cushioned			
a. Acrylic Bound Systems			
b. Textiles			
c. Sand-Filled Synthetic Turf (over non-porous base)			
d. Portable			
NOTICE: These Construction Guidelines are for use by architects, engineers, contractors and tennis court owners. Parties not experienced in tennis court construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.			
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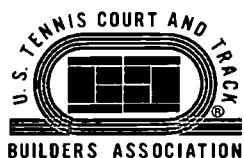
### STANDARD CLASSIFICATION FOR TENNIS COURT SURFACE SYSTEMS

1. Scope: This system establishes a classification of materials used in the construction of the subbase, pavement, and surface systems of tennis courts.
2. Terminology:
  - Porous - a system which permits water to permeate the surface.
  - Non-porous - a system which inhibits water from permeating the surface (drainage is achieved through surface runoff).
  - Cushioned - having a resilient or soft feel during play.
  - Non-cushioned - having a rigid or hard feel during play.
3. Classification Listing:

Subbase, Pavement, and Surface Type	Maintenance	Colors	Ball Skid	Portability	Foot Slide	Drying Time
<b>Porous Construction:</b>						
Non-cushioned:						
Porous Asphalt	Yearly	Varies	Adjustable	No	None	Rapid
Porous Concrete	Yearly	Varies	Adjustable	No	None	Rapid
Modular (such as interlocking tiles)	Yearly	Varies	Short	Yes	None	Rapid
Cushioned:						
Fast Dry	Daily	Red, Green	Short	No	Good	Moderate
Clay (natural clay)	Daily	Red	Short	No	Good	Slow
Natural Grass	Daily	Green	Long	No	Good	Slow
Sand-filled synthetic turf	Daily	Green	Medium	No	Good	Moderate
<b>Non-porous Construction:</b>						
Non-cushioned:						
Concrete - Standard and post tensioned	Yearly	Varies	Adjustable	No	None	Rapid
Asphalt - Hot plant mix	Yearly	Varies	Adjustable	No	None	Rapid
Macadam - Asphalt penetration	Yearly	Varies	Adjustable	No	None	Rapid
Cushioned:						
Acrylic bound surface systems	Yearly	Varies	Adjustable	No	None	Rapid
Textiles (carpetlike, manufactured from synthetic fibers)	Yearly	Green	Short	Yes	Some	(Indoor)
Synthetic granular (such as polyurethane bound rubber granules)	Yearly	Varies	Adjustable	No	None	Rapid
Resilient membrane (seamed together roll goods)	Yearly	Varies	Adjustable	No	None	Rapid

TENNIS COURT SURFACE COMPARISON							
Surface Type	Surface Hardness	Cushioned Surface	Surface Slide	Ball Skid Length	Adjustable Court Speed	Color Availability	Drying Time After Rain
<b>Porous</b>							
Fast Dry (Above Ground Irrigation)	Soft	No	Yes	Short	Yes	Green, Red	Medium
Fast Dry (Subsurface Irrigation)	Soft	No	Yes	Short	Yes	Green, Red	Fast
Natural Clay	Soft	No	Yes	Short	Yes	Varies	Slow
Grass	Soft	No	Yes	Long	No	Green	Slow
Sand-Filled Turf	Soft	Yes	Yes	Medium-Short	Yes	Variety	Fast
Porous Concrete	Hard	Yes	No	Short	Yes	Variety	Fast
<b>Non-Porous Non-Cushioned</b>							
Concrete	Hard	No	No	Controllable	Yes	Variety	Fast
Asphalt	Hard	No	No	Controllable	Yes	Variety	Fast
<b>Non-Porous Cushioned</b>							
Concrete	Medium	Yes	No	Controllable	Yes	Variety	Fast
Asphalt	Medium	Yes	No	Controllable	Yes	Variety	Fast
Modular	Medium	Yes	No	Medium-Short	No	Variety	Fast
Roll-Goods	Medium	Yes	No	Medium-Short	Yes	Variety	Fast
Textile (Indoor Only)	Medium	Yes	No	Short	No	Variety	NA

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SECTION	I.D.1.	PAGE	1																
TITLE FAST DRY TENNIS COURTS FOR USE WITH ABOVE SURFACE IRRIGATION	REVISION DATE		1998																
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1.0 Definition																			
Fast dry is a porous tennis court surface material consisting of natural crushed stone, brick, or tile, that is ground, screened, well graded, and may or may not be mixed with a chemical binder to form a stable homogeneous mixture having an affinity for water.																			
2.0 Slope and Elevation Requirements																			
All excavating, filling, and grading requirements and compacting work of the subbase should be performed so that the finished subgrade should be above the surrounding ground, i.e. 4"-6", and should slope not less than 0.28% (1:360) and not more than 0.35% (1:288). Each court must slope on a true plane, preferably from side to side (but from end to end or from corner to corner also are acceptable), or in the shortest direction for good drainage/water run-off. The court should never be sloped from the net line to the baseline, from the baseline to the netline, from the sides to the centerline or from the centerline to the sides.																			
3.0 Perimeter Edging																			
An edging of brick or block set in cement mortar, treated wood timber or concrete should be installed around the entire perimeter of the court area. The finished curb elevation should be 1/2" below the finished court surface, after compaction, and the court surface should be tapered from approximately 2' out to meet the top of the edging.																			
4.0 Standard Base Construction																			
A base course of crushed stone or gravel should be installed over the subbase. The crushed stone or gravel should conform to gradations as approved by the surface material manufacturer, for example:																			
<table><tr><td colspan="2">U.S. Standard</td></tr><tr><td>Sieve Size</td><td>% Passing</td></tr><tr><td>1"</td><td>100%</td></tr><tr><td>3/4"</td><td>95-100%</td></tr><tr><td>3/8"</td><td>60- 80%</td></tr><tr><td>No. 4</td><td>16- 60%</td></tr><tr><td>No. 40</td><td>10- 35%</td></tr><tr><td>No. 200</td><td>Less than 10%</td></tr></table>				U.S. Standard		Sieve Size	% Passing	1"	100%	3/4"	95-100%	3/8"	60- 80%	No. 4	16- 60%	No. 40	10- 35%	No. 200	Less than 10%
U.S. Standard																			
Sieve Size	% Passing																		
1"	100%																		
3/4"	95-100%																		
3/8"	60- 80%																		
No. 4	16- 60%																		
No. 40	10- 35%																		
No. 200	Less than 10%																		
The thickness of the base course may vary to meet local soil and climatic conditions, but in no case should it be less than 3" after compaction. The surface of the base course after compaction should be smooth, even, and should not vary more than 3/8" in 10' when measured in any direction.																			

### 5.0 Standard Base Leveling Course

A leveling course of crushed stone or gravel screenings should be installed over the standard base course. Screenings should conform to the following gradation:

#### U.S. Standard

<u>Sieve Size</u>	<u>% Passing</u>
3/8"	100%
No. 4	80-100%
No. 100	10- 30%
No. 200	Less than 10%

Screenings should be spread and thoroughly compacted to a thickness of not less than 1". The finished surface of the leveling course should not vary more than 1/4" in 10', when measured in any direction.

### 6.0 Modified Base Construction

Other materials such as slag, washed limerock screenings, washed shell, cinders, crushed concrete or other suitable material may be substituted for the Standard Base and Leveling Material (Section 4.0 & 5.0).

A modified base course is sometimes used, particularly in areas not subject to freeze/thaw action. The modified base may consist of one course of suitable material as described above and may be installed to a uniform thickness of 2 1/2" to 4". The modified base should be compacted to provide a smooth, true plane surface, and should not vary more than 1/4" in ten feet 10', when measured in any direction.

When selecting a base material, the following Guidelines should be considered:

- a. The material should be porous enough to allow water to penetrate after compaction but not so porous that water drains entirely through the base material. Water should drain through the court surface and should be retained in the base as moisture until the court surface begins to dry and "pulls" (capillary action) this moisture from the base back to the court surface.
- b. The base should be stable so as not to shift under the weight of a roller.
- c. Based on (a) and (b) above, precaution should be exercised to avoid some limestone type materials which may solidify and become non-porous when in contact with water for prolonged periods of time. Some sandy materials may shift and become unstable.
- d. It should also be noted that while making an excellent base, cinders, slag, and other lightweight materials may heave through the surface in frost areas and should be avoided.
- e. When in doubt, the base material should be approved by the manufacturer of the fast dry surface material.

### 7.0 Court Surfacing/Tennis Court Material (TCM)

A surface course of fast dry tennis court surface material as defined above, should be installed over the leveling course (or modified base course) to a uniform thickness of approximately 1 1/4". The surface course material should then be watered to its full depth and compacted with a roller to a thickness of 1".

The fast dry material gradation may vary with materials of varying physical characteristics and with manufacturers' formulae. In general the material should pass a 1/8" screen and be uniformly graded down through a 200 mesh screen.

The finished surface course should not vary more than 1/8" in 10' when measured in any direction.

#### **8.0 Compaction**

Compaction of base and surface courses should be obtained with a roller weighing approximately 600 lbs. per roller drum.

**Note:**

**Refer to Guide Specifications:**

- I.A. General Conditions for Construction**
- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurements**
- II.F.1. Above Surface Watering Systems for Clay and Fast Dry Tennis Courts**
- II.L. Net and Net Post Equipment**

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and tennis court owners. Parties not experienced in tennis court construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

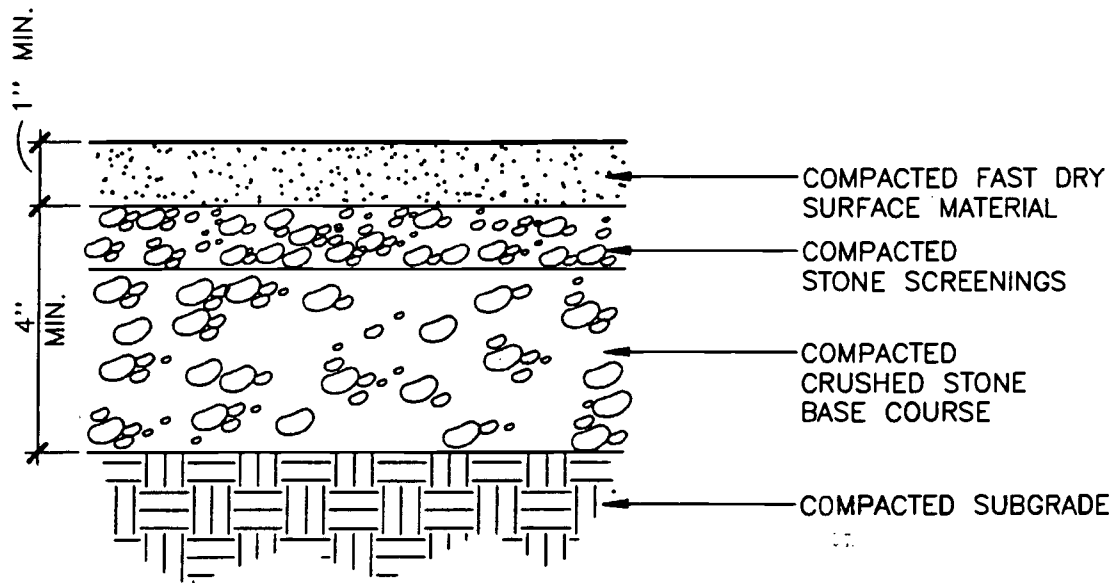
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## NOTE:

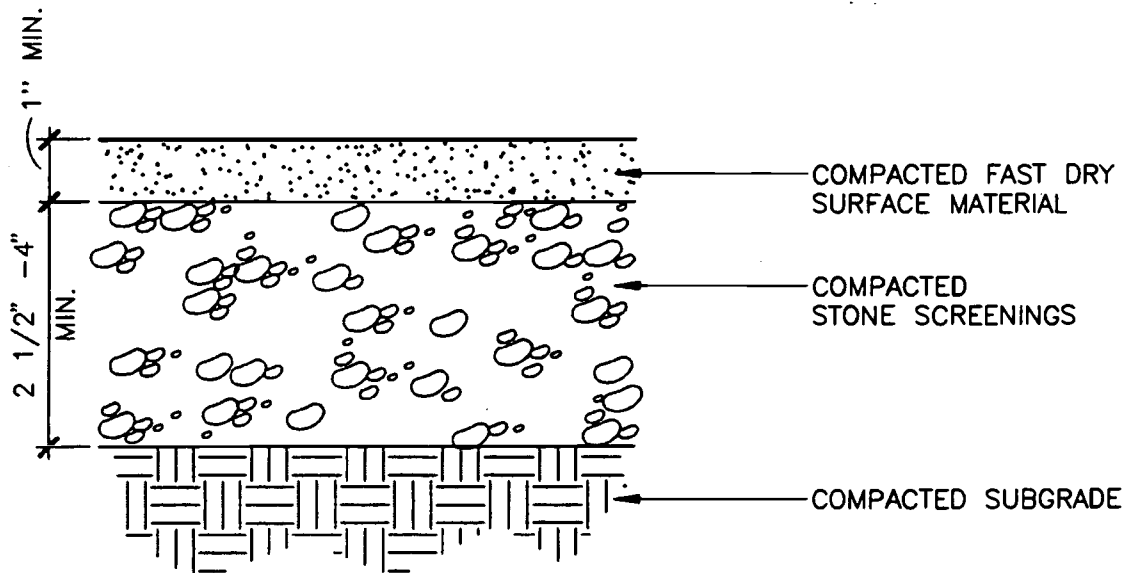
RECOMMENDED COURT SLOPE:

MINIMUM - 1" IN 30'

MAXIMUM - 1" IN 24'



STANDARD BASE



MODIFIED BASE

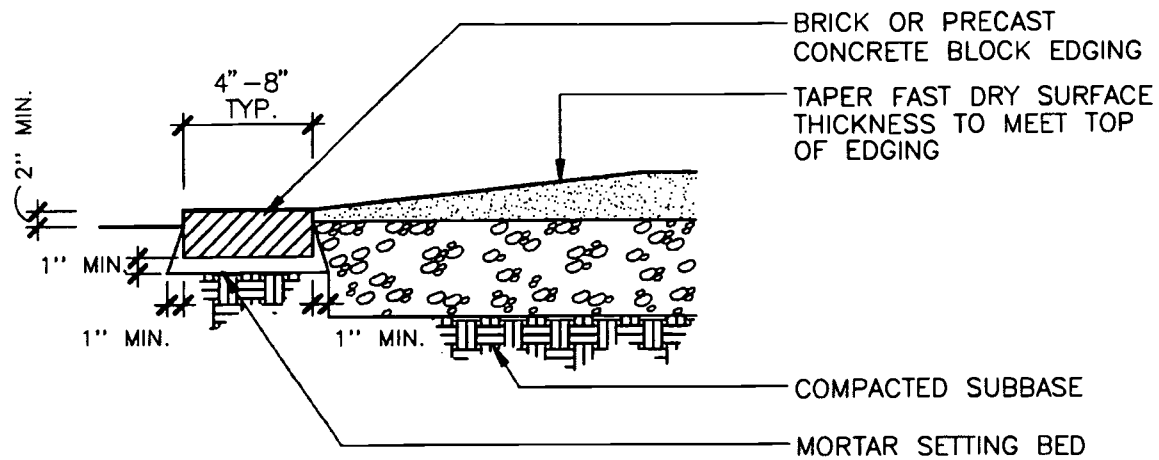
## TYPICAL FAST DRY COURT SECTION

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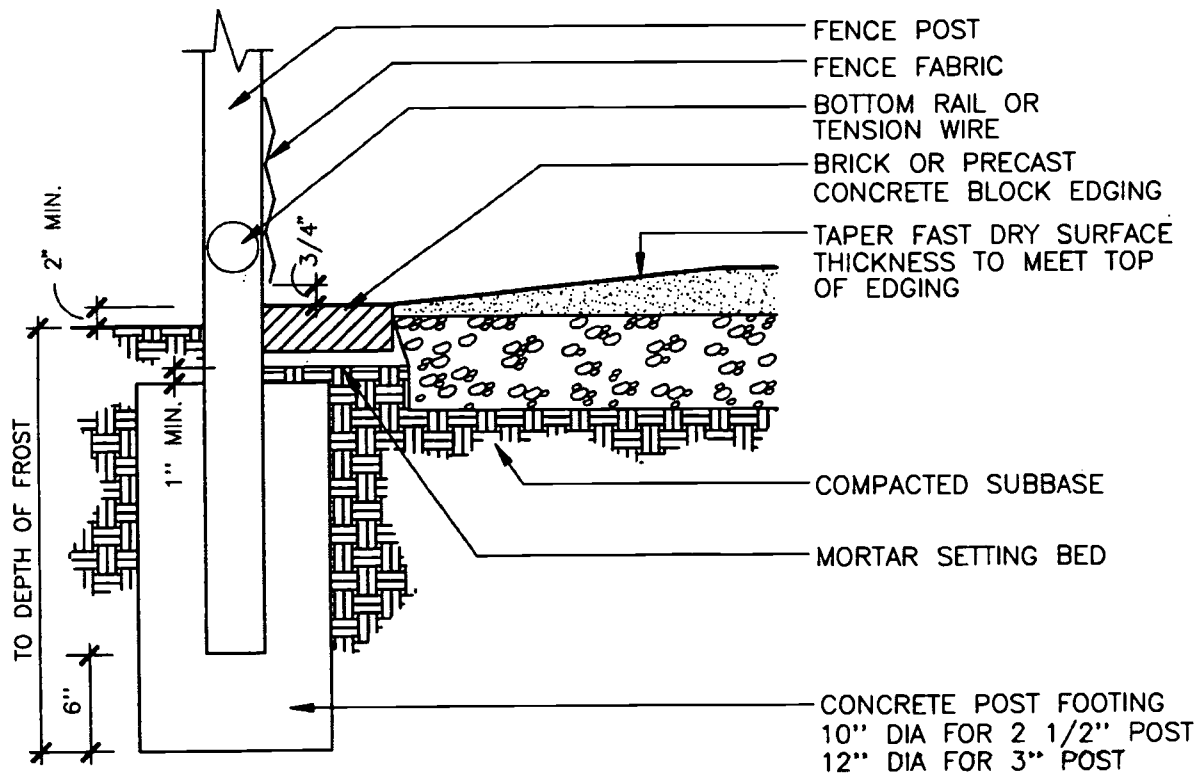


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SECTION AT COURT EDGING



SECTION AT FENCE POST

## TYPICAL FAST DRY COURT EDGING

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EDGE—3

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SECTION	II.D.2.	PAGE	1
TITLE FAST DRY TENNIS COURTS FOR USE WITH SUBSURFACE IRRIGATION	REVISION DATE		1998
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1.0 Definition			
Fast dry is a porous tennis court surface material consisting of natural crushed stone, brick, or tile, that is ground, screened, well graded, and may or may not be mixed with a chemical binder to form a stable homogeneous mixture having an affinity for water.			
2.0 Purpose			
The objectives for using a subsurface irrigation system for fast dry courts are to conserve water, to maintain a more uniformly moist surface, to provide a more consistent playing surface, to reduce maintenance, and to reduce the quantity of replacement tennis court material. These features allow fast dry courts to be considered in areas where water consumption is restricted and where maintenance considerations are a factor.			
3.0 Slope and Elevation			
All excavating, filling, grading requirements and compacting work of the sub-base should be performed so that the finished sub-grade is above the surrounding ground, i.e. 4"-6". The finished court surface should slope not less than 0.14% (1:720) and not more than 0.28% (1:360). Each court must slope on a true plane, preferably from side to side (but can slope from end to end or corner to corner), or in the shortest direction for good drainage/water run-off. The court should never be sloped from the net line to the baseline, from the baseline to the net line, from the sides to the centerline or from the centerline to the sides.			
All subgrade preparation should be in accordance with the system manufacturer's specifications. See Section I.C., Site Preparation, Earthwork, Drainage and Subbase Construction.			
4.0 Perimeter Edging			
An edging of brick or block set in cement mortar, treated wood timber or concrete should be installed around the entire perimeter of the court area. The finished curb elevation should be 1/2" below the finished court surface, after compaction, and the court surface should be tapered from approximately 2' out to meet the top of the edging.			
5.0 Subbase Liner or Moisture Barrier			
For water conservation in subsurface irrigated tennis courts, a non-permeable, non-biodegradable moisture barrier should be installed to retain moisture and should cover the subgrade of the court; refer to individual system manufacturer's specifications.			
6.0 Irrigation and Drainage			
A moisture control system, which may be manually, electrically, or hydraulically operated, should be included in the system to allow for the regulation of water in the court as dictated by atmospheric conditions.			
Irrigation and drainage pipes should be fitted with appropriate fittings which pass through the liner and edging. The system should be equipped with an active and/or			

passive drainage system. Various systems differ in how the water is distributed throughout the court; refer to individual system manufacturer's specifications.

### 7.0 Geotextile Filter Fabric

A geotextile filter fabric may be used to prevent screenings from entering the subsurface irrigation system. Individual systems incorporate varying applications of a geotextile filter fabric; refer to individual system manufacturer's specifications.

### 8.0 Screenings

Because water must be retained in the court and conversely, water must be allowed to move upwards to the court surface by capillary action, as well as laterally, the gradation of screenings with a low percentage of fines is of utmost importance. The screenings should be hard and not water soluble. The recommended gradations for the screenings are as follows:

#### U.S. Standard

<u>Sieve Size</u>	<u>% Passing</u>
3/8"	100%
No. 4	80 - 100%
No. 100	4 - 18%
No. 200	0 - 10%

Refer to individual systems manufacturer's specifications.

An average of 2" to 6" of screenings per court should be spread and compacted. The finished surface of screenings course should not vary more than 1/4" in 10' when measured in any direction.

### 9.0 Court Surfacing/Tennis Court Material (TCM)

A surface course of fast dry tennis court surface material as defined above, should be installed over the leveling course to a uniform thickness of approximately 1 1/4". The surface course material should then be watered to its full depth and compacted with a roller to a thickness of 1".

The fast dry material gradation may vary with materials of varying physical characteristics and with manufacturers' formulae. In general, the material should pass a 1/8" screen and be uniformly graded down through a 200 mesh screen.

The finished surface course should not vary more than 1/8" in 10' when measured in any direction.

### 10.0 Compaction

Compaction of base and surface courses should be obtained with a roller weighing approximately 600 lbs. per roller drum.

### 11.0 Water

Some systems or installations may require potable water. Contact a qualified tennis court contractor or system or surface manufacturer.

### 12.0 Disclaimer

Portions of the technology described above are protected under U.S. Patents.

**Note:**

**Refer to the Guideline Specifications for:**

- I.A. General Conditions for Construction**
- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurements**
- II.L. Net and Net Post Equipment**

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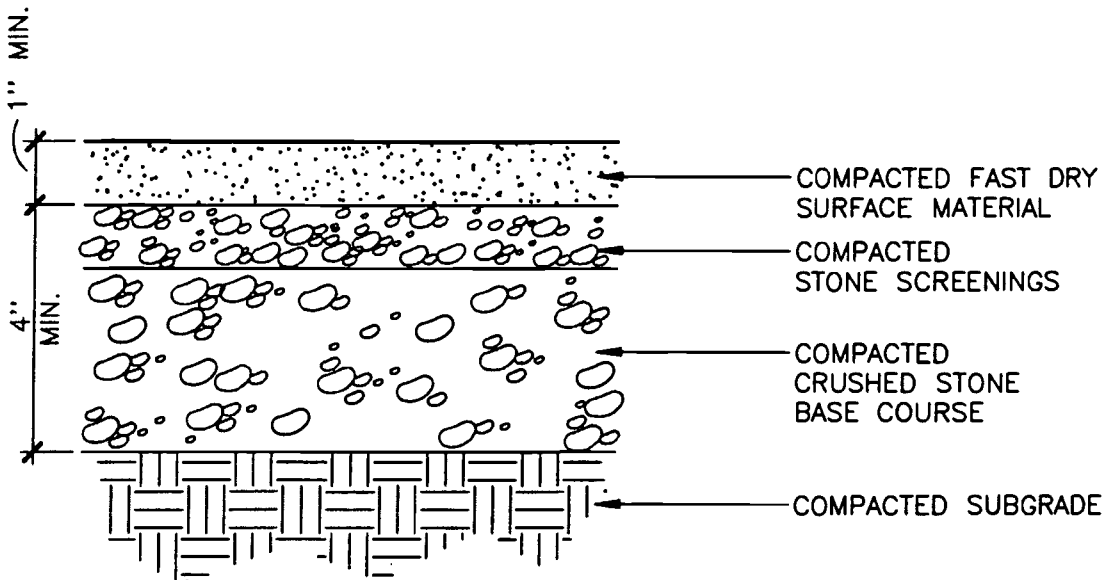


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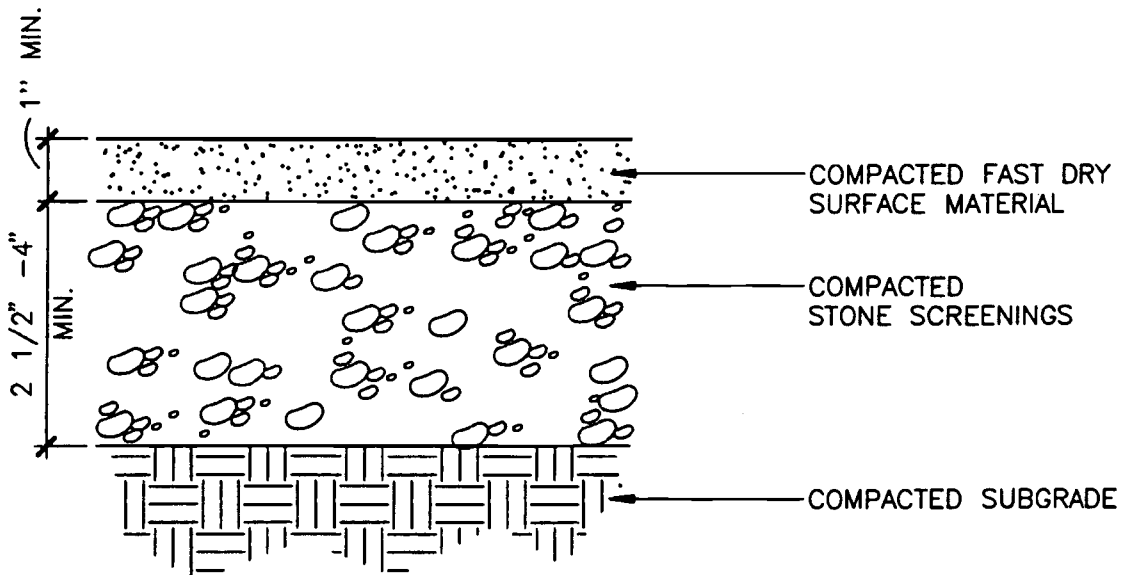
RECOMMENDED COURT SLOPE:

MINIMUM - 1" IN 30'

MAXIMUM - 1" IN 24'



STANDARD BASE



MODIFIED BASE

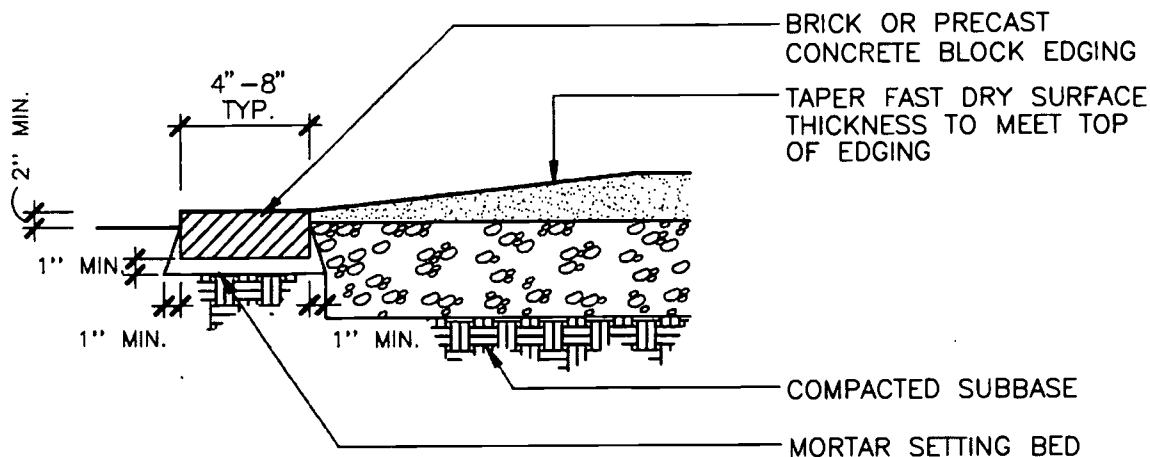
## TYPICAL FAST DRY COURT SECTION

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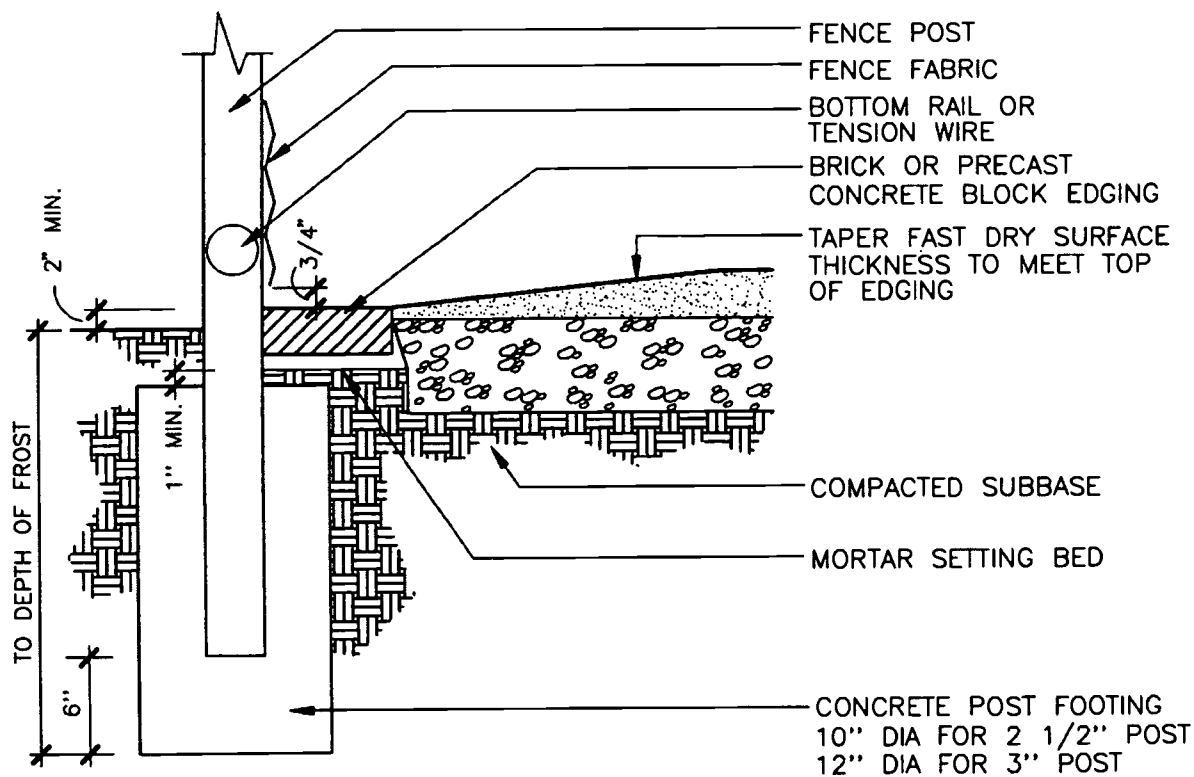


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SECTION AT COURT EDGING



SECTION AT FENCE POST

## TYPICAL FAST DRY COURT EDGING

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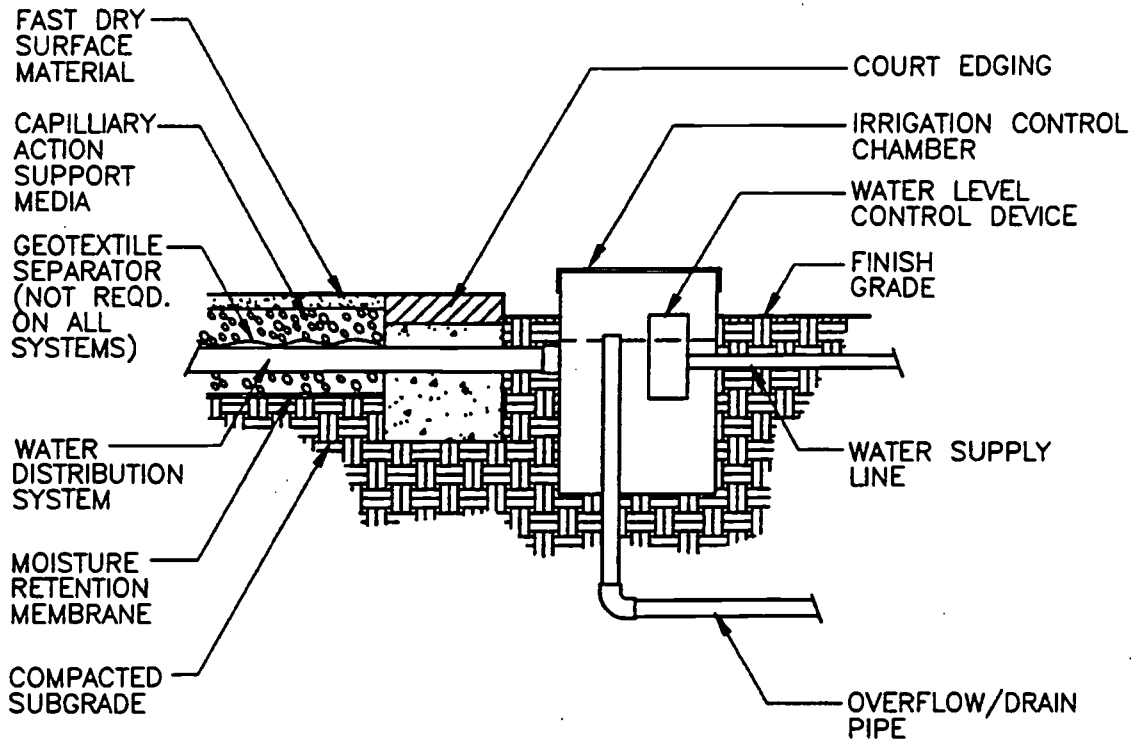
EDGE—3

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## NOTES:

PORTIONS OF THE TECHNOLOGY ILLUSTRATED  
IN THIS DRAWING ARE PROTECTED UNDER  
U.S. PATENTS.

CONTACT A SUBSURFACE IRRIGATION SYSTEM  
MANUFACTURER FOR SPECIFIC DESIGN AND  
CONSTRUCTION REQUIREMENTS.



## SCHEMATIC DIAGRAM OF FAST DRY COURT SUBSURFACE IRRIGATION SYSTEM

NOT TO SCALE



IRRIG2

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SECTION	I.E.	PAGE	1														
TITLE CLAY TENNIS COURTS	REVISION DATE		1998														
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1.0 Definition																	
Clay is a porous tennis court surface material consisting of natural clay or processed clay which has been mixed, crushed, screened and blended with sand and silt, resulting in a plasticity index between 12% and 20% as per ASTM No. D 4318, Atterberg Limits.																	
2.0 Slope and Elevation Requirements																	
All excavating, filling, and grading requirements and compacting work of the subbase should be performed so that the finished subgrade should be 4" – 6" above the surrounding ground, and should slope not less than 0.28% (1:360) and not more than 0.35% (1:288). Each court must slope on a true plane, preferably from side to side (but can slope from end to end or corner to corner), or in the shortest direction for good drainage/water run-off. The court should never be sloped from the net line to the baseline, from the baseline to the net line, from the sides to the centerline or from the centerline to the sides.																	
3.0 Perimeter Edging																	
An edging of brick or block set in cement mortar, treated wood timber or concrete should be installed around the entire perimeter of the court area. The finished curb elevation should be 1/2" below the finished court surface, after compaction, and the court surface should be tapered from approximately 2' out to meet the top of the edging.																	
4.0 Standard Base Construction																	
A base course of crushed stone or gravel should be installed over the subbase. The crushed stone or gravel should conform to gradations as approved by the surface material manufacturer, for example:																	
<table><tr><td>Sieve Size</td><td>% Passing</td></tr><tr><td>1"</td><td>100%</td></tr><tr><td>3/4"</td><td>95 - 100%</td></tr><tr><td>3/8"</td><td>60 - 80%</td></tr><tr><td>No. 4</td><td>16 - 60%</td></tr><tr><td>No. 40</td><td>10 - 35%</td></tr><tr><td>No. 200</td><td>Less than 10%</td></tr></table>				Sieve Size	% Passing	1"	100%	3/4"	95 - 100%	3/8"	60 - 80%	No. 4	16 - 60%	No. 40	10 - 35%	No. 200	Less than 10%
Sieve Size	% Passing																
1"	100%																
3/4"	95 - 100%																
3/8"	60 - 80%																
No. 4	16 - 60%																
No. 40	10 - 35%																
No. 200	Less than 10%																
The thickness of the base course may vary to meet local soil and climatic conditions, but in no case should it be less than 3" after compaction. The surface of the base course after compaction should be smooth, even, and should not vary more than 3/8" in 10' when measured in any direction.																	
5.0 Standard Base Leveling Course																	
(Optional, dependent upon thickness of clay surface course). A leveling course of crushed stone or gravel screenings should be installed over the standard base course. Screenings should conform to the following gradation:																	

<u>Sieve Size</u>	<u>% Passing</u>
3/8"	100%
No. 4	80-100%
No. 100	10-30%
No. 200	Less than 10%

Screenings should be spread and thoroughly compacted to a thickness of not less than 1". The finished surface of the leveling course should not vary more than 1/4" in 10', when measured in any direction.

#### **6.0 Modified Base Construction**

Other materials such as slag, washed limerock screenings, washed shell, cinders, crushed concrete or other suitable material may be substituted for the Standard Base and Leveling Material (Section 4.0 & 5.0).

A modified base course is sometimes used, particularly in areas not subject to freeze/thaw action. The modified base may consist of one course of suitable material as described above and may be installed to a uniform thickness of 2 1/2" to 4". The modified base should be compacted to provide a smooth, true plane surface, and should not vary more than 1/4" in ten feet 10', when measured in any direction.

When selecting a base material, the following Guidelines should be considered:

- a. The material should be porous enough to allow water to penetrate after compaction but not so porous that water drains entirely through the base material. Water should drain through the court surface and should be retained in the base as moisture until the court surface begins to dry and "pulls" (capillary action) this moisture from the base back to the court surface.
- b. The base should be stable so as not to shift under the weight of a roller.
- c. Based on (a) and (b) above, precaution should be exercised to avoid some limestone type materials which may solidify and become non-porous when in contact with water for prolonged periods of time. Some sandy materials may shift and become unstable.
- d. It should also be noted that while making an excellent base, cinders, slag, and other lightweight materials may heave through the surface in frost areas and should be avoided.

#### **7.0 Court Surfacing/Tennis Court Material (TCM)**

A surface course of natural clay or processed clay, as described in Section 1.0, should be constructed over the finished base course/leveling base course to a compacted thickness of no less than 3" for natural clay or 2" for blended material. These materials must meet the following requirements:

- A. Clay content should be not less than 25% nor more than 40% and the remaining percentage should be divided equally between sand and silt.
- B. Clay material on the surface should have a plasticity index of not less than 12% nor more than 20% as per ASTM No. D 4318, Atterberg Limits.
- C. Finished surface should not vary from the specified finished grade more than 1/8" in 10' when measured in any direction.

**8.0 Compaction**

All compaction of base and surface courses should be obtained with a roller weighing approximately 600 lbs. per roller drum.

**9.0 Top Dressing (Optional)**

A clay court may be top dressed with a fast dry or other granular material.

**Note:**

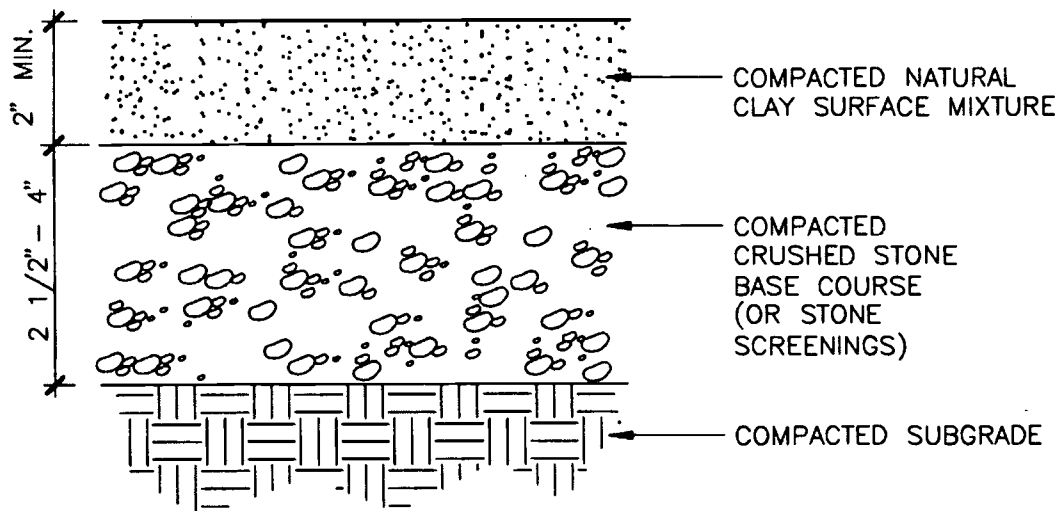
Refer to the Guideline Specifications for:

- I.A. General Conditions for Construction**
- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurements**
- II.F.1. Above Surface Watering Systems for Clay and Fast Dry Tennis Courts**
- II.L. Net and Net Post Equipment**

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and tennis court owners. Parties not experienced in tennis court construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

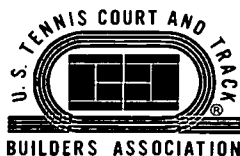
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NOTE:  
RECOMMENDED COURT SLOPE:  
MINIMUM - 1" IN 30'  
MAXIMUM - 1" IN 24'



## TYPICAL NATURAL CLAY COURT SECTIONS

NOT TO SCALE



CLAY—1

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SECTION	II.F.1.	PAGE	1
TITLE ABOVE SURFACE IRRIGATION SYSTEMS FOR CLAY AND FAST DRY TENNIS COURTS	REVISION DATE		1998
	COPYRIGHT © 1998 BY U.S. TENNIS COURT & TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.		
<div>1.0Definitions</div> <p>Fast dry is a porous tennis court surface material consisting of natural crushed stone, brick, or tile, that is ground, screened, well graded, and may or may not be mixed with a chemical binder to form a stable homogeneous mixture having an affinity for water.</p> <p>Clay is a porous tennis court surface material consisting of natural or processed clay which has been mixed, crushed, screened and blended with sand and silt, resulting in a plasticity index between 12% and 20%.</p> <div>2.0Purpose</div> <p>The following is not intended as a specification for tennis court sprinkler systems, but merely as a guideline to be considered in selecting the best system under given conditions.</p> <div>3.0Objective</div> <p>The main objective of an irrigation system is to provide an adequate amount of water to the court to totally saturate the court surface and base. The water should be distributed as evenly as possible over the entire court and should cascade to the surface as gently as possible to prevent washout and erosion.</p> <div>4.0Sprinkler System Layout</div> <p>There are several brands and models of sprinkler heads available that will give adequate coverage if properly installed. In selecting a suitable layout, several variables should be considered, such as water pressure, volume, radius of coverage, friction loss, prevailing wind, and any surrounding conditions which would affect or be affected by the system. The following layouts are based on minimum throw patterns that must be achieved at each sprinkler head. Once a layout is selected and minimum throw radius becomes fixed, a head can be selected depending on volume and pressure available. NOTE: To maintain the minimum radius, a system must be able to supply the constant minimum pressure at each head and adequate volume for the total number of heads in operation at any one time. In some cases, a lack of sufficient volume and pressure may dictate selecting a smaller head or nozzle or operating only a few heads at one time to maintain the minimum required radius. Either alternative, however, will require longer irrigation time.</p> <div>5.0Site Selection</div> <p>After a suitable layout has been chosen and heads selected, the system must be designed with adequately sized lines to supply sufficient volume to each head, with a minimum loss in pressure. A main line must be able to supply a volume equal to the total volume of all the heads operating at one time. If necessary, individual lines may be sized downward after each head depending on the number of heads each line supplies. Pipes should be selected using friction loss tables which apply to the type of pipe being installed. These tables are usually available from a local irrigation supplier or from the sprinkler head manufacturer.</p>			



**6.0 Type of Pipe**

Galvanized steel, copper, or P.V.C. pipe are all acceptable for tennis court systems, with P.V.C. being the most popular because of its cost and ease of installation. When using P.V.C., the pipe should be set in stone screenings to protect it from damage by large rocks.

**7.0 Frost Prevention**

In areas where freezing occurs, the pipe should either be buried below the frost line or installed with adequate slope and drain valves to allow drainage when frost is anticipated. Where a compressor is available, pipe fittings may be installed and used to blow all remaining water from the lines at the end of the playing season.

**8.0 Irrigation Cycles and Zoning**

Multiple irrigation cycles may provide more efficient use of water. Shorter, more frequent irrigation cycles will allow gradual absorption of water into the surface and base. Irrigation cycles of longer duration may result in excess water run-off rather than absorption. Automatic timers are available to provide desired watering cycles.

Zoning certain areas of the court may also result in more uniform coverage. For example, shaded areas or areas along the low side may require less irrigation than sunny ones or areas on the high side of the court. These areas could be controlled by a separate zone allowing for shorter irrigation cycles.

Irrigation cycles and zoning should be considered in the design of a new irrigation system.

**9.0 Alternative Methods**

Refer to II.D.2., Fast Dry Tennis Courts for Use With Subsurface Irrigation.

**10.0 Disclaimer**

In designing any above surface irrigation system, caution should be exercised in determining the location, elevation and type of sprinkler heads to minimize any potential hazard to players.

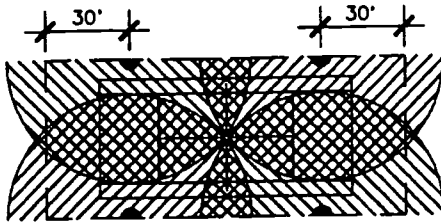
**Note:**

Refer to the Guideline Specifications for:

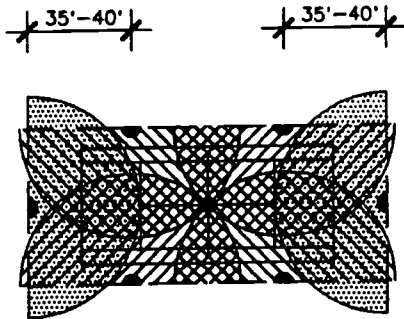
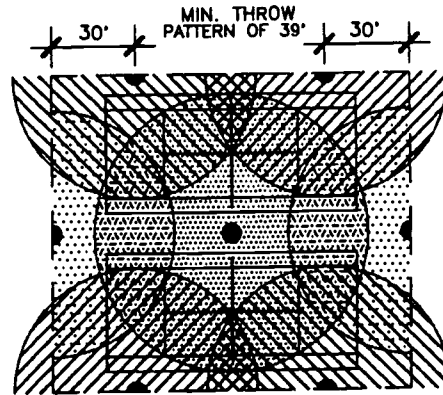
- I.A. General Conditions for Construction**
- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurements**
- II.D. Fast Dry Type Tennis Court for Use with Above Surface Irrigation**
- II.L. Net and Net Post Equipment**

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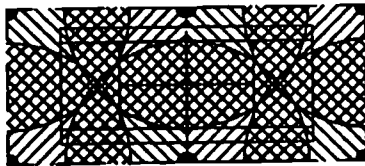
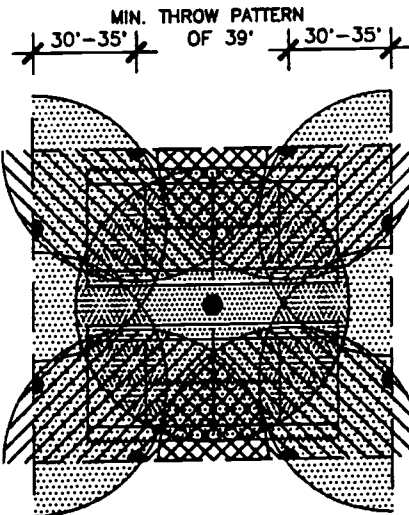
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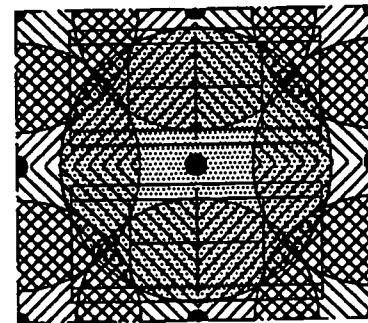
IDEAL WHERE NO WIND PROBLEMS EXIST AND ADEQUATE PRESSURE AND VOLUME CAN ACHIEVE A MINIMUM THROW PATTERN OF 43'



GOOD WHEN CONDITIONS ARE LESS THAN PERFECT. WORKS WHEN ADEQUATE PRESSURE AND VOLUME CAN ACHIEVE A MINIMUM THROW PATTERN OF 39' (36' AT 40') CAUTION: REAR SPRINKLER BEHIND BASE LINE COULD BE A SAFETY HAZARD.



CONFIGURATION PROVIDES EXCELLENT COVERAGE BUT USUALLY REQUIRES A HIGHER VOLUME SOURCE UNLESS THE SYSTEM IS ZONED. REQUIRES ADEQUATE PRESSURE AND VOLUME TO ACHIEVE A MINIMUM THROW PATTERN OF 43'



MINIMUM THROW PATTERN OF 43'

SINGLE COURT

MULTIPLE COURTS

## TYPICAL SURFACE IRRIGATION SYSTEM LAYOUT PLANS

NOT TO SCALE



IRRIG

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SECTION	II.F.2.	PAGE	1
TITLE RETROFIT SUBSURFACE IRRIGATION SYSTEMS FOR FAST DRY TENNIS COURTS	REVISION DATE		1998
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1.0 Definition			
Fast dry is a porous tennis court surface material consisting of natural crushed stone, brick, or tile, that is ground, screened, well graded, and may or may not be mixed with a chemical binder to form a stable homogeneous mixture having an affinity for water.			
2.0 Purpose			
This guideline will address installing subsurface irrigation in an existing fast dry tennis court. It will not address reconstruction.			
The objectives for installing a subsurface irrigation system in existing fast dry courts are to maintain a more uniformly moist surface, to provide a consistent playing surface, to reduce maintenance, to reduce the quantity of replacement tennis court material, and under certain conditions, to conserve water.			
3.0 Base Requirements			
Prior to retrofitting existing fast dry tennis courts, the base layer should be cored and tested to insure its ability to perform adequately with a retrofit system. The existing base should exhibit proper wicking capability, as well as other required performance capabilities. A qualified tennis facility consultant, contractor, and/or subsurface irrigation manufacturer should be consulted.			
4.0 System Requirements			
The subsurface retrofit irrigation system should provide a consistent uniform moist playing surface assuming the base conditions are suitable. The extent of its performance is controlled both by the retrofit system and by the condition and consistency of the base material. The optimum retrofit system should achieve the above while also conserving water usage.			
Most subsurface retrofit irrigation systems are installed into the base layer of existing fast dry tennis courts. These systems consist of installed troughs or piping which allow water to be fed into the base layer under controlled conditions. The system is usually trenched into the existing court on 3' to 5' centers depending on the base and subbase conditions. The system should be such that uniform surface moisture is achieved with minimal piping.			
The subsurface irrigation system can be controlled by water level floats and/or timers and solenoid valves. The objective of the controlled system is to restrict the quantity and/or length of watering time to achieve optimum moisture content in the base layer. This moisture will then be transferred to the surface by capillary action.			
5.0 Surface Requirements			
Adequate new fast dry should be applied so as to result in a consistent uniform playing			

surface. The amount of new surfacing will vary depending on the extent of disturbance created by the retrofit installation. It may be necessary to patch trenches several times with new surfacing to achieve the final surface planarity.

It is recommended that a qualified tennis court contractor and/or subsurface irrigation system manufacturer be consulted.

#### **7.0 Disclaimer**

Portions of the technology described above are protected under U.S. Patents.

**Note:**

**Refer to the Guideline Specifications for :**

- I.A. General Conditions for Construction**
- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurements**
- II.D.2. Fast Dry Tennis Courts for Use with Subsurface Irrigation**
- II.L. Net and Net Post Equipment**

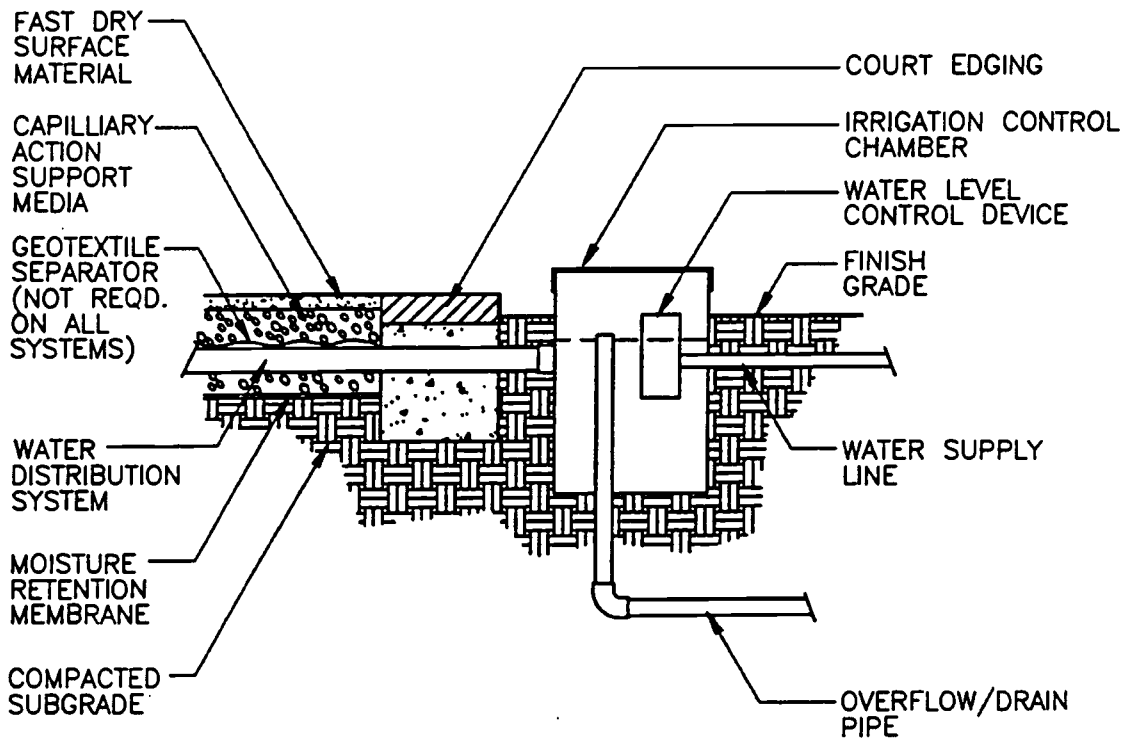
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## NOTES:

PORTIONS OF THE TECHNOLOGY ILLUSTRATED  
IN THIS DRAWING ARE PROTECTED UNDER  
U.S. PATENTS.

CONTACT A SUBSURFACE IRRIGATION SYSTEM  
MANUFACTURER FOR SPECIFIC DESIGN AND  
CONSTRUCTION REQUIREMENTS.



## SCHEMATIC DIAGRAM OF FAST DRY COURT SUBSURFACE IRRIGATION SYSTEM

NOT TO SCALE



IRRIG2

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<b>SECTION</b>	<b>I.I.G.</b>	<b>PAGE</b>	<b>1</b>
<b>TITLE</b> <b>REINFORCED CONCRETE</b> <b>TENNIS COURTS</b>		<b>REVISION DATE</b>	<b>1998</b>
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### **1.0 Slope and Elevation Requirements**

All excavating, filling and grading requirements and compacting work of the subbase should be performed so that the finished subgrade is 4"-6" above the surrounding ground and slopes not less than 0.83% (1:120) and not more than 1% (1:100). Each court must slope in a true plane, preferably from side to side (but from end to end or from corner to corner are also acceptable), or in the shortest direction for good drainage and water runoff. The court should never be sloped from the net line to the baseline, from the baseline to the net line, from the sides to the centerline or from the centerline to the sides.

### **2.0 Base Preparation**

Refer to section I.C., Site Preparation, Earthwork, Drainage and Subbase Construction.

### **3.0 Concrete Construction**

#### **A. Apron**

The overall dimension of an individual court should be 61' x 121' to provide a 6" apron around the court or 62' x 122' to provide a 1' apron around the court. This additional footage helps prevent vegetation intrusion, facilitates landscape maintenance and adds to the overall cosmetics. Fencing should remain at 60' x 120'. Fence posts, net posts, sleeves and center anchor should be installed prior to or during concrete placement. Fencing should be completed prior to surfacing.

#### **B. Moisture/Vapor Barrier**

As with all concrete construction, a moisture/vapor barrier, consisting of polyethylene (6 mil. minimum thickness) should be installed prior to installation of any steel and/or cables. Overlap polyethylene sheets at least 6" and tape joints. Once in place no vehicular traffic should be allowed on the moisture/vapor barrier nor any other object which could puncture the barrier or otherwise compromise the integrity of the surface. All concrete should be pumped, not driven onto the court. Excessive loads at any time are unacceptable.

#### **C. Cement**

Cement (Type 1 or 1A) should conform to one of the Standard Specifications for Portland Cement, ASTM C 150 or Specifications for Blending Hydraulic Cements, ASTM C 595, excluding slag cements Types S and SA. Do not use curing compounds.

#### **D. Air Entrainment**

Air entrainment by total volume of concrete should be:

4 to 6% for 1 1/2" maximum size coarse aggregate,  
5 to 7% for 3/4" or 1" maximum size coarse aggregate,  
6 1/2 to 8 1/2% for 3/8" or 1/2" maximum size coarse aggregate.

#### **E. Aggregate**

Aggregate should conform to Standard Specifications for Concrete Aggregates ASTM C 33. For concrete work that is 5" thick, the nominal size of the coarse



aggregate should not exceed 1 1/2" and for concrete work that is 4" thick, the nominal size of the coarse aggregate should not be greater than 1". Fly ash or other additives are not acceptable.

**F. Thickness of Concrete**

Concrete work should be 5" thick if the location of the tennis court is such that it will be subject to more than three freeze/thaw cycles annually. If the location is such that not more than three freeze/thaw cycles occur annually, concrete may be 4" thick.

**G. Reinforcement**

Steel reinforcement bars should conform to Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement ASTM A 615, Grade 60 or 40. For concrete that is 5" thick, the bars should be No. 5 in both directions at 12" on center. For concrete that is 4" thick, the bars should be No. 5 size in both directions at 15" on center. Bars should be accurately positioned at mid-depth, terminating 2" away from edges and joints, and should be adequately supported by chairs with sand plates provided to prevent bar supports from sinking into the subbase. Bars should be lapped at 18" and should also be securely tied or otherwise secured so that there is no possibility of displacement when concrete is placed. At the time of concrete placement, reinforcement should be free of loose, flaky rust and other coatings or films that could interfere with bonding to the concrete.

**H. Forms and Screeds**

Forms and screeds should be set accurately and secured to prevent settlement or movement during placing of concrete. Forms should remain in place until the concrete has taken its final set.

**I. Joints**

A non-extruded expansion joint filler material 3/4" thick should be installed at the net line if the two halves of the court are cast separately, and between courts if there is more than one court. The bottom edge of the filler material should extend to or slightly below the bottom of the slab; the top edge should be held 7/8" below the surface of the slab by a tack strip of wood, its top flush with the finished slab surface. Edges of joints should be tooled with an edging tool having a radius of 1/4". After the concrete has cured, the tack strips should be removed and the joints sealed with an elastomeric sealing compound to within 1/8" of the surface. If the two halves of the court are cast separately, a concrete beam 6" thick and 18" wide should be cast in a trench across the center of the court. This beam is for support of the two slabs at the expansion joint under the net. The top of the beam should be at the elevation of the bottom of the court slab. The beam should be cast a day or two in advance of the court concrete. Bonding between the beam and the court concrete should be prevented by painting the top of the beam with an asphaltic or other bond preventing material. This beam is thickened to 12" at the net posts to provide additional stability for the posts.

**CAUTION: All working joints may close and reopen.**

**J. Concrete Proportioning and Mixing**

The concrete should have a compression strength of not less than 3,000 psi at the 28th day after casting. The minimum cement content for finish-ability should be not less than 470 lbs. per cubic yard for 1 1/2" maximum size coarse aggregate, 520 lbs. for 3/4", 590 lbs. for 1/2" and 610 lbs. for 3/8" maximum size coarse aggregate. In freeze/thaw environments, the minimum cement con-

tent should not be less than 560 lbs. per cubic yard. The slump should not be more than 4". Ready-mixed concrete should be mixed and delivered in accordance with ASTM C 94, Specification for Ready-Mixed Concrete.

**K. Placing and Finishing**

At least a full half court should be placed in one continuous operation without intervening joints of any kind. Uninterrupted concrete placing operations without intervening joints should be limited to one full court with continuous reinforcement. Concrete should be spread, consolidated, screeded, bull-floated and finished in accordance with Section 7.2 of ACI (American Concrete Institute) Standard 302, Recommended Practice for Concrete Floor and Slab Construction. When concrete is sufficiently set to withstand foot pressure with only about 1/4" indentation and the water sheen has left the surface, the slab should be uniformly finished by power floating and troweling. The final finish texture should be a medium broom finish unless otherwise specified by the surface manufacturer.

**L. Surface Tolerances**

The finished surface of the court should not vary more than 1/8" in 10' when measured in any direction.

**M. Curing**

Immediately after finishing, the concrete should be kept continuously moist for 7 days by covering with polyethylene film, waterproof curing paper, sprinkling, ponding or other acceptable coverings. Curing time should be in accordance with surfacing system manufacturer's recommendations. No curing compounds should be used.

**4.0 Disclaimer**

The preferred method of concrete court construction is the post-tensioned concrete slab (Section II.H.) This system allows for a much larger single monolithic pour, eliminates the need for expansion joints and minimizes reflective and surface cracking.

ASTM specifications are available from American Society of Testing Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428, 610-832-9500.

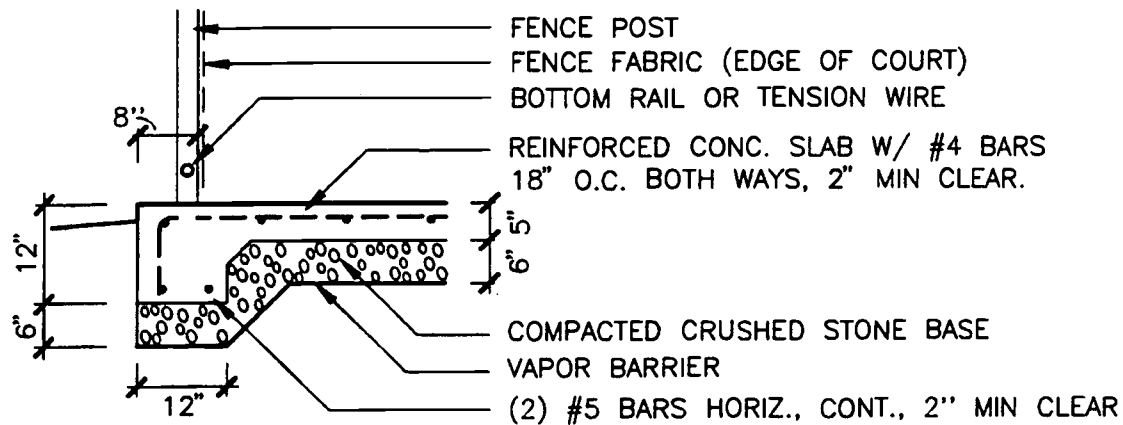
**Note: Refer to Guideline Specifications for:**

- I.A. General Conditions for Construction**
- I.B. Site Investigations**
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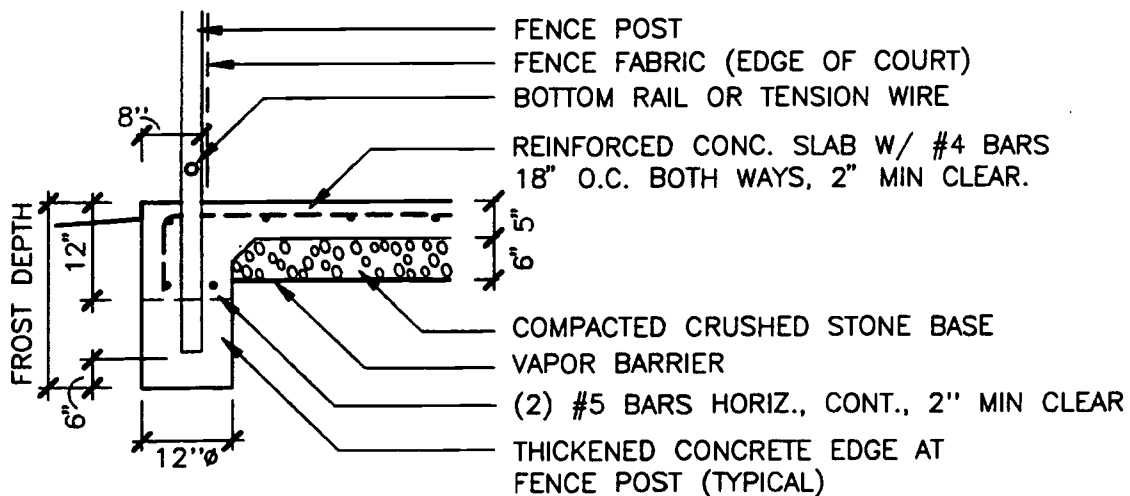
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SECTION THICKENED COURT EDGE



SECTION COURT EDGE AT FENCE POST

## TYPICAL SECTIONS REINFORCED CONCRETE COURT PAVEMENT

NOT TO SCALE



CONC—1

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<b>SECTION</b>	<b>II.H.</b>	<b>PAGE</b>	<b>1</b>
<b>TITLE</b> <b>POST-TENSIONED CONCRETE</b> <b>SLAB TENNIS COURTS</b>		<b>REVISION DATE</b>	<b>1998</b>
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### **1.0 Purpose**

The preferred method of concrete court construction is the post-tensioned concrete slab. This system allows for a much larger single monolithic pour, eliminates the need for expansion joints and minimizes reflective and surface cracking.

### **2.0 Slope and Elevation Requirements**

All excavating, filling and grading requirements and compacting work of the subbase should be performed so that the finished subgrade is 4"-6" above the surrounding ground and slopes not less than 0.83% (1:120) and not more than 0.1% (1:100). Each court must slope in a true plane, preferably from side to side (but from end to end or from corner to corner also are acceptable), or in the shortest direction for good drainage and water runoff. The court should never be sloped from the net line to the baseline, from the baseline to the netline, from the sides to the centerline or from the centerline to the sides.

### **3.0 Base Preparation**

Refer to Section I.C., Site Preparation, Earthwork, Drainage and Subbase Construction.

### **4.0 Concrete Construction**

#### **A. Apron**

The overall dimension of an individual court should be 61' x 121' to provide a 6" apron around the court or 62' x 122' to provide a 1' apron around the court. This additional footage helps prevent vegetation intrusion, facilitates landscape maintenance and adds to the overall cosmetics. Fencing should remain at 60' x 120'. Fence posts, net posts, sleeves and center anchor should be installed prior to or during concrete placement. Fencing should be completed prior to surfacing.

#### **B. Moisture/Vapor Barrier**

As with all concrete construction, a moisture/vapor barrier, consisting of polyethylene (6 mil. minimum thickness) should be installed prior to installation of any steel and or cables. Overlap polyethylene sheets at least 6" and tape joints. Once in place, no vehicular traffic should be allowed on the moisture/vapor barrier nor any other object which could puncture the barrier or otherwise compromise the integrity of the surface. All concrete should be pumped, not driven on the court. Excessive loads at any time are unacceptable.

#### **C. Cement**

Cement (Type 1 or 1A) should conform to one of the Standard Specifications for Portland Cement, ASTM C 150 or Specification for Blending Hydraulic Cements, ASTM C 595, excluding slag cements Types S and SA. Do not use curing compounds.

#### **D. Air Entrainment**

Air entrainment by total volume of concrete should be:

- 4 to 6% for 1 1/2" maximum size coarse aggregate,
- 5 to 7% for 3/4" or 1" maximum size coarse aggregate,
- 6 1/2 to 8 1/2% for 3/8" or 1/2" maximum size coarse aggregate.

**E. Aggregate**

Aggregate should conform to Standard Specifications for Concrete Aggregates ASTM C 33. For concrete work that is 5" thick, the nominal size of the coarse aggregate should not exceed 1 1/2" and for concrete work that is 4" thick, the nominal size of the coarse aggregate should not be greater than 1". Fly ash or other additives are not acceptable.

**F. Thickness of Concrete**

Concrete work should be 5" thick if the location of the tennis court is such that it will be subject to more than three freeze/thaw cycles annually. If location is such that not more than three freeze/thaw cycles occur annually, concrete may be 4" thick.

**G. Post-Tensioning**

Post-tensioning material should consist of seven wire stress-relieved strands, conforming to ASTM A 416, with an ultimate strength of 270 KSI. Strands should be coated with a permanent rust preventative lubricant and wrapped with plastic sheathing. If strand sheathing is damaged or removed, it is to be repaired by taping. A maximum of 6" exposed strand is permitted at the anchor. End anchorage devices will conform to Post-Tensioning Institute (PTI) specifications. All dead end anchorages must be power seated. All strands are to be supported on chairs and tied at all intersections or securely supported in beams to prevent vertical and horizontal movement during concrete placement. Cables should be laid out in grids no greater than 4' on center. Concrete must be well consolidated, especially in the vicinity of strand anchorages. Strands should be anchored at 28.9 KIPS, but may be initially stressed at 33 KIPS. A 9" diameter centered on the strand axis by a 36" length should be allowed for stressing equipment clearance. The stressing process generates tremendous pressures and extreme care should be taken to prevent injury from operator error or failure of equipment or materials.

Slabs should be designed using acceptable engineering practices in accordance with the American Concrete Institute Building Code Requirements for reinforced concrete and the Post-Tensioning Institute's tentative specifications for post-tensioning materials. The soil condition and plasticity index of the court site should be considered in determining strand spacings and beam requirements.

**H. Forms**

Forms should be set accurately to the lines and grades indicated on drawings and secured to prevent settlement or movement during placing of concrete. Forms should remain in place until concrete has taken its final set.

**I. Joints**

1. Single courts should be poured as a monolithic slab.
2. Double courts may have an elastomeric metal construction joint between courts. This joint may also be placed on the net line if needed. Joints should never be installed in the play areas.
3. Multiple court banks may have an expansion joint between every two courts. Where this occurs, the cables will be "dead ended" on both sides.
4. For multi-court banks, an accepted alternative expansion joint method would be to construct a common expansion joint between every two courts with a T-joint method. The cabling system can be continued through the system to allow for tension to be applied at the end of the total slab distance.

**J. Concrete Proportioning and Mixing**

The concrete should have a compressive strength of not less than 3,000 psi at 28th day after casting. Ready-mixed concrete should be mixed and delivered in accordance with ASTM C 94, Specification for Ready-Mixed Concrete with a 4" maximum slump.

**K. Placing and Finishing**

Concrete should be placed by pumping method. At least a full court should be placed in one continuous operation without intervening joints of any kind. Concrete should be spread, consolidated, screeded, bull-floated and finished in accordance with Section 7.2 of ACI (American Concrete Institute) Standard 302, Recommended Practice for Concrete Floor and Slab Construction. When concrete is sufficiently set to withstand foot pressure with only about 1/4" indentation and the water sheen has left the surface, the slab should be uniformly finished by power floating and troweling. The final finish texture should be a medium broom finish unless otherwise specified by the surface manufacturer. No curing compounds should be used at any time.

**L. Surface Tolerances**

The finished surface of the court should not vary more than 1/8" in 10' when measured in any direction.

**M. Curing**

Immediately after finishing, the concrete should be kept continuously moist for 7 days by covering with polyethylene film or waterproof curing paper, or by sprinkling or ponding or other acceptable coverings. No curing compounds should be used at any time. Curing time should be in accordance with surfacing system manufacturer's recommendations. Timing is critical on all of the above due to the possibility of disturbing the finished surface.

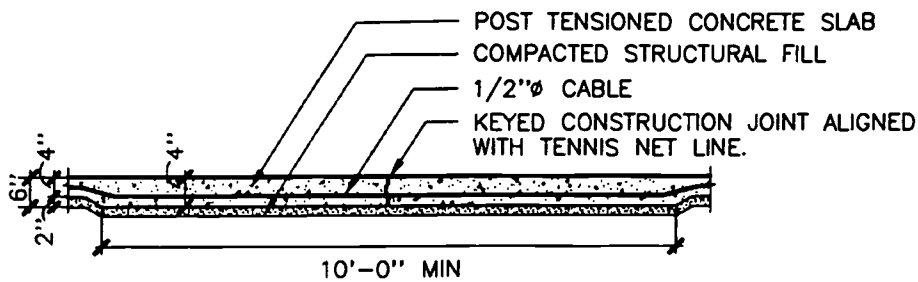
ASTM specifications are available from American Society of Testing Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428, 610-832-9500.

**Note: Refer to Guidelines for:**

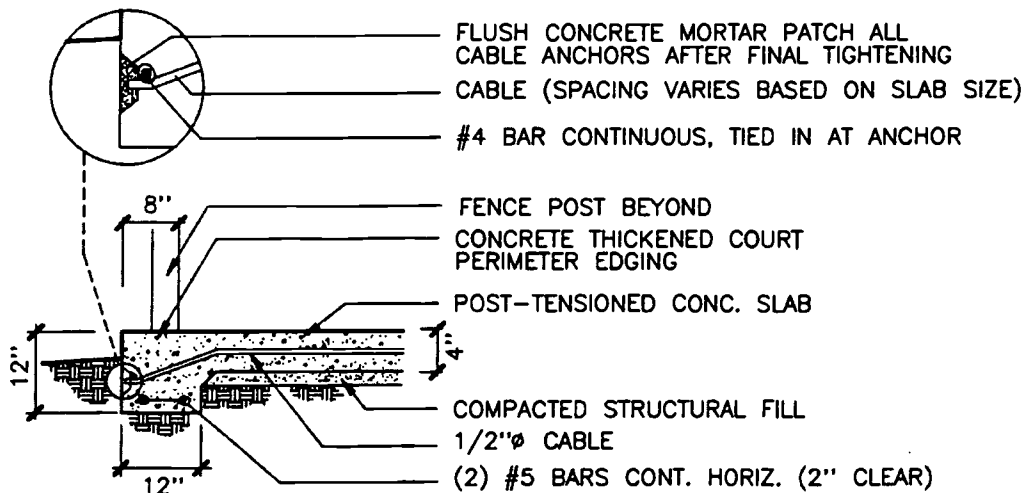
- I.A. General Conditions for Construction**
- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreation Areas**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurement**

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and tennis court owners. Parties not experienced in tennis court construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

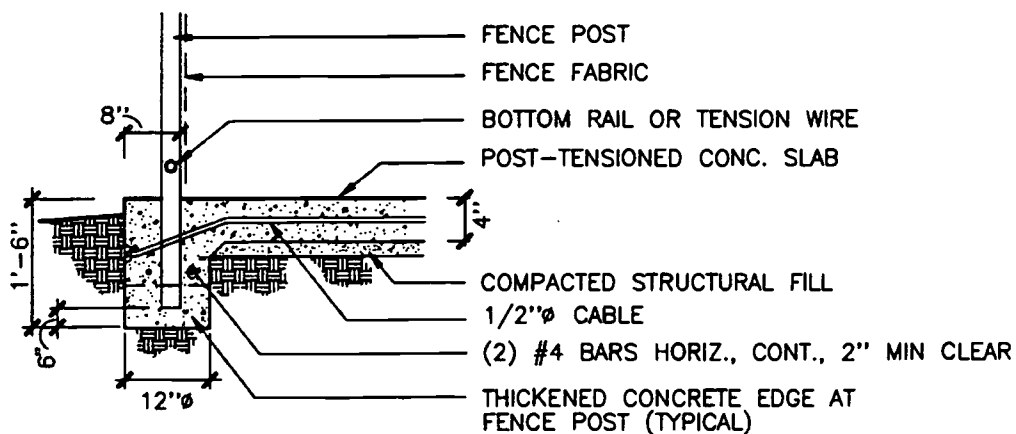
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SECTION KEY JOINT AT NET LINE



SECTION THICKENED COURT EDGE



SECTION THICKENED COURT EDGE AT FENCE POST

## TYPICAL SECTIONS POST-TENSIONED CONCRETE COURT PAVEMENT

NOT TO SCALE



PTCONC

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SECTION	II.I.	PAGE	1
TITLE  HOT MIX ASPHALT TENNIS COURTS	REVISION DATE		1998
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1.0 Slope Requirement			
All excavating, filling and grading requirements and compacting work of the subbase should be performed so that the finished subgrade is 4"-6" above the surrounding ground and slopes not less than 0.83% (1:120) and not more than 1% (1:100). Each court must slope on a true plane, preferably from side to side (but from end to end or from corner to corner are also acceptable), or in the shortest direction for good drainage and water runoff. The court should never be sloped from the net line to the baseline, from the baseline to the netline, from the sides to the centerline or from the centerline to the sides.			
2.0 Perimeter Edging			
A. Curbing (for decorative purposes) An optional edging of brick, concrete, steel or treated wood may be installed around the entire perimeter of the court area. Sections may be left open to allow trucks and other equipment to enter and leave the court area, until other work specified herein has been completed. Top elevation of the edging should be approximately 1/2" below the finished grade level and the court's surface should be tapered out to meet it.			
B. Apron The overall dimensions of an individual court should be 61' x 121' to provide a 6" apron around the court or 62' by 122' to provide a 1' apron around the court. This additional footage helps prevent vegetation intrusion from the perimeter, facilitates landscape maintenance and adds to the overall cosmetics. Fencing should remain 60' by 120' and should be installed after paving and prior to surfacing.			
3.0 Aggregate Base Course			
A. Material A base course of bituminous concrete mixture; crushed aggregate; processed/ recycled asphalt or processed/recycled concrete should be installed over the subgrade. The specified material should meet applicable ASTM specifications. Compacted thickness will depend on local soil and climatic conditions, but in no case should the thickness be less than the equivalent of 4" of thoroughly compacted crushed stone.			
B. Spreading and Compacting The material should be spread by methods and in a manner that produces a uniform density and thickness. The material thus spread should be compacted to 95% minimum Proctor Test with equipment that provides uniform density.			
C. Tolerances Surface of the base course as compacted should not vary more than 1/2" from the true plane of the court.			
4.0 Intermediate Pavement Course			
A leveling course of a hot plant mix having a maximum aggregate size of 3/8" to 3/4" in accordance with specifications of the state's Department of Transportation and/or the			

Asphalt Institute should be constructed over the base course to a compacted thickness of not less than 1 1/2".

This hot plant mix should be spread and compacted by methods and in a manner that produces a uniform density and thickness. The finished intermediate course should not vary more than 1/4" in 10', when measured in any direction.

#### 5.0 Modified Base Construction

A modified base course is sometimes used, particularly in areas not subject to freeze/thaw action. The modified base may consist of one course of suitable material as described above and may be installed to a uniform thickness of 2 1/2" to 4". The modified base should be compacted to provide a smooth, true plane surface, and should not vary more than 1/4" in 10', when measured in any direction.

#### 6.0 Asphaltic Surface Course

##### A. General Description

A surface course of a hot plant mix having a maximum aggregate size of 3/8" and a minimum aggregate size of 1/4" should be constructed over the hot mix intermediate course to a compacted thickness of not less than 1".\*

##### Suggested Mix Design:

<u>Screen</u>	<u>% Passing</u>
1/2	100
3/8	90-100
#4	55-85
#8	32-67
#50	7-23
#200	2-10

\*The proper type asphalt used for the surface course will vary from state to state if using the standard norm of the Department of Transportation (DOT) or State Highway Department standards. Local soil and climatic conditions also may impact the type of asphalt used.

Thickness: Not less than 1".

Liquid Asphalt Bitumen: Minimum 5.5% by weight.

Aggregate Type: Crushed stone, gravel, shale, limestone, etc. Foreign materials, i.e., pyrite, clay, ferrous compounds, dirt and organic material are not acceptable.

Cure Time: Minimum 14 days before application of playing surface.

Voids Content: Minimum as specified by the Department of Transportation or State Highways Department, but in no case should void content exceed 7%.

##### B. Spreading and Compacting

This hot plant mix should be spread and compacted by methods and in a manner that produces a uniform density and thickness.

##### C. Surface Tolerance

The finished surface of the court should not vary more than 1/8" in 10' when measured in any direction.



ASTM specifications are available from American Society of Testing Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428, 610-832-9500.

**Note: Refer to Guidelines for:**

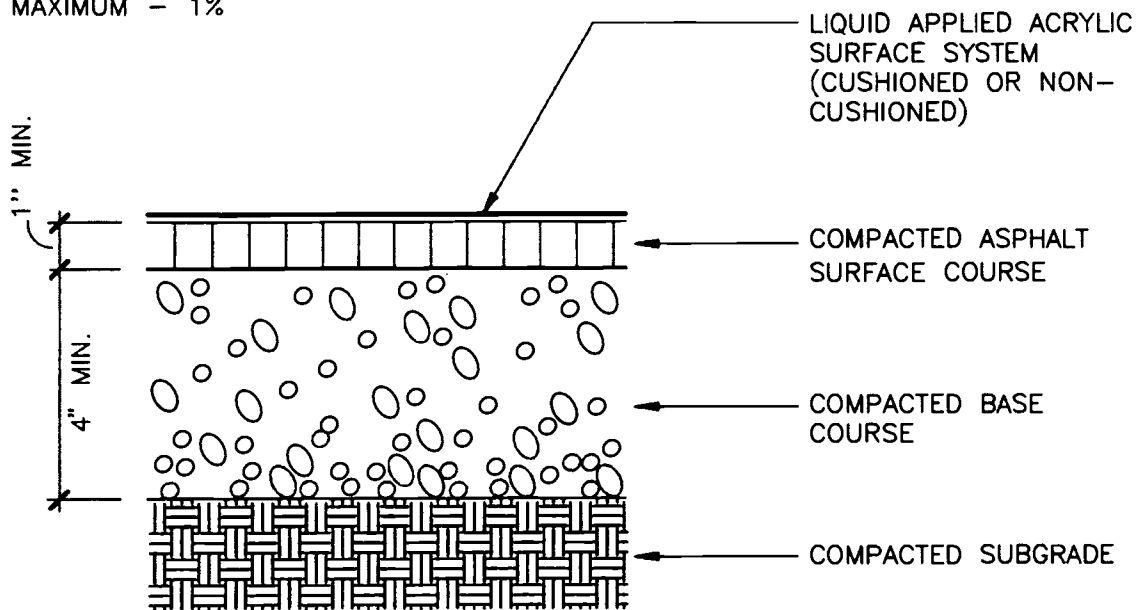
- I.A. General Conditions for Construction**
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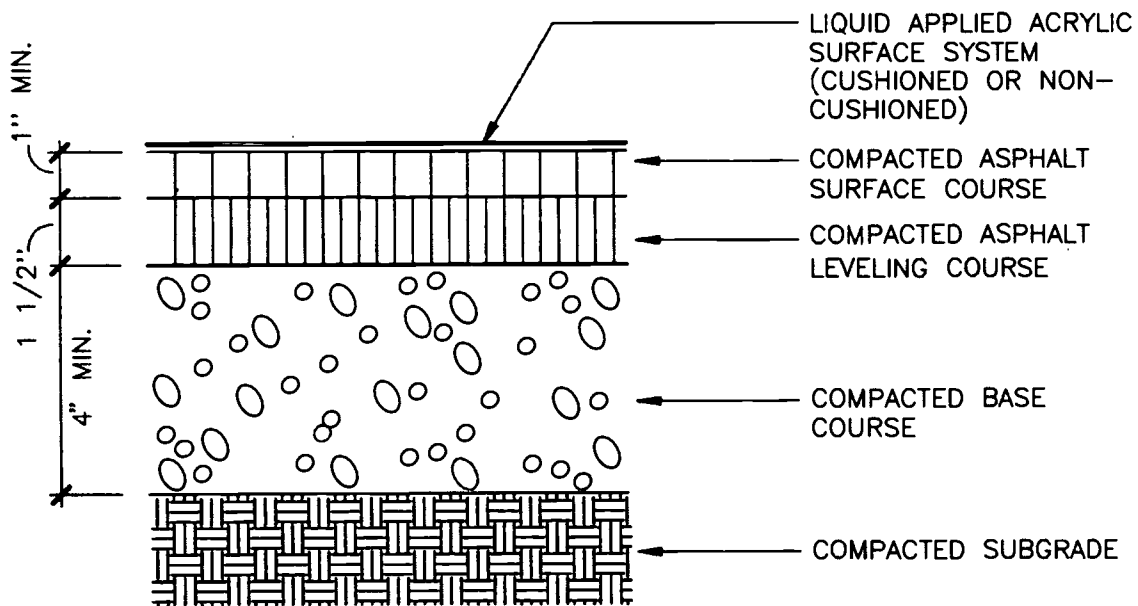
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NOTE:  
RECOMMENDED COURT SLOPE:  
MINIMUM - 0.833 %  
MAXIMUM - 1%



ASPHALT COURT FOR NON FREEZE/THAW CLIMATE



ASPHALT COURT FOR FREEZE/THAW CLIMATE

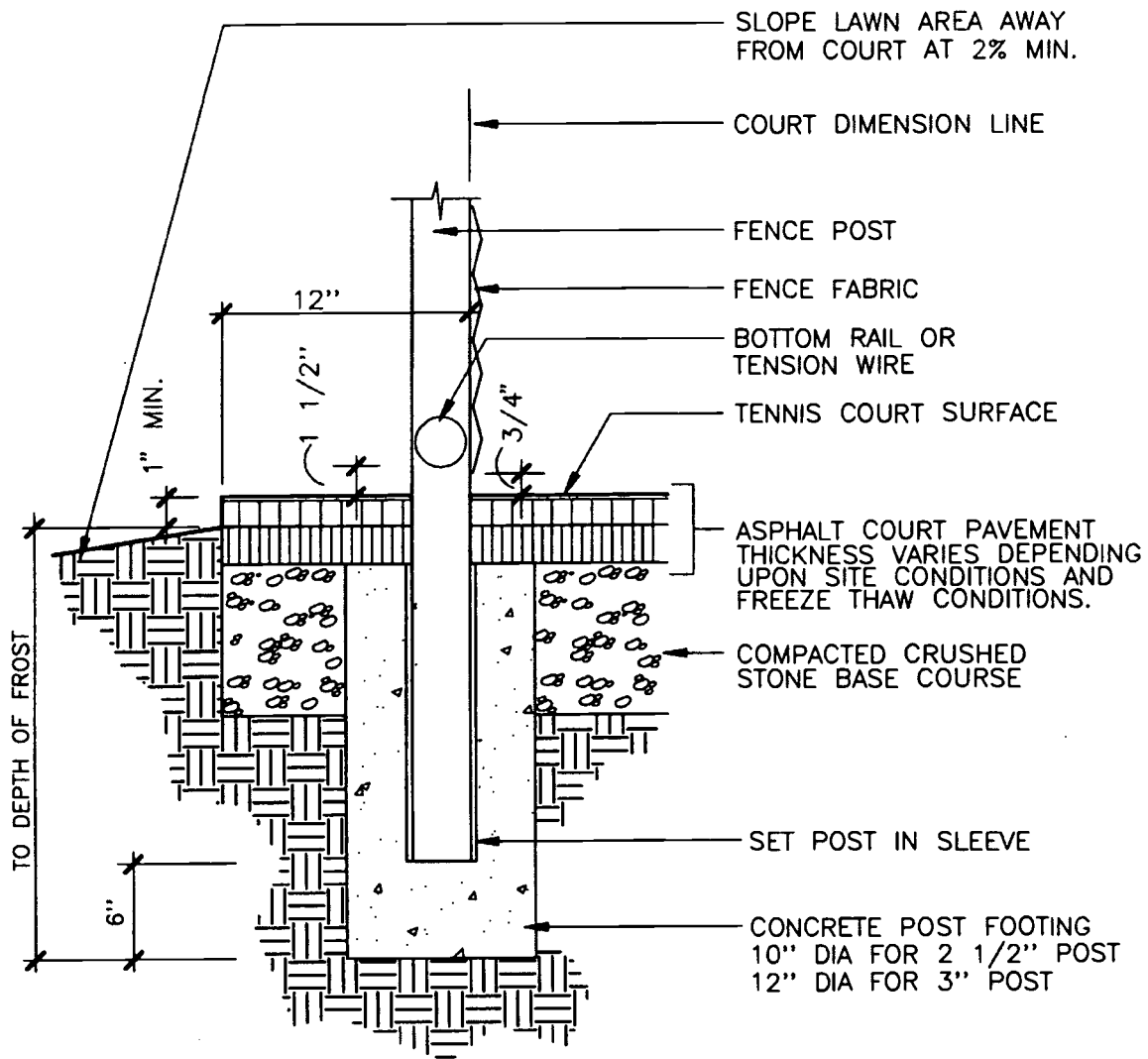
## TYPICAL ASPHALT COURT SECTIONS

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ASPH—1

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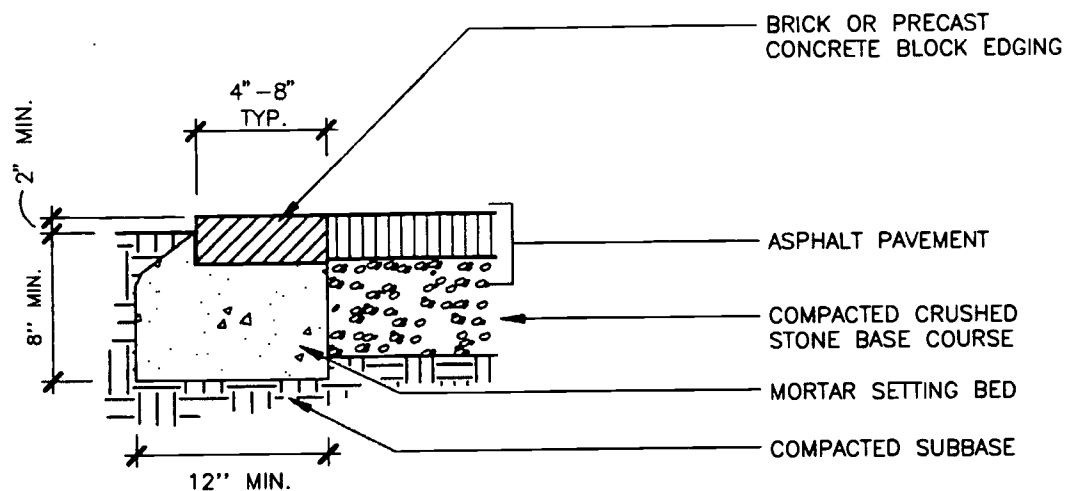
## SECTION EXTENDED APRON AT ASPHALT COURT EDGE

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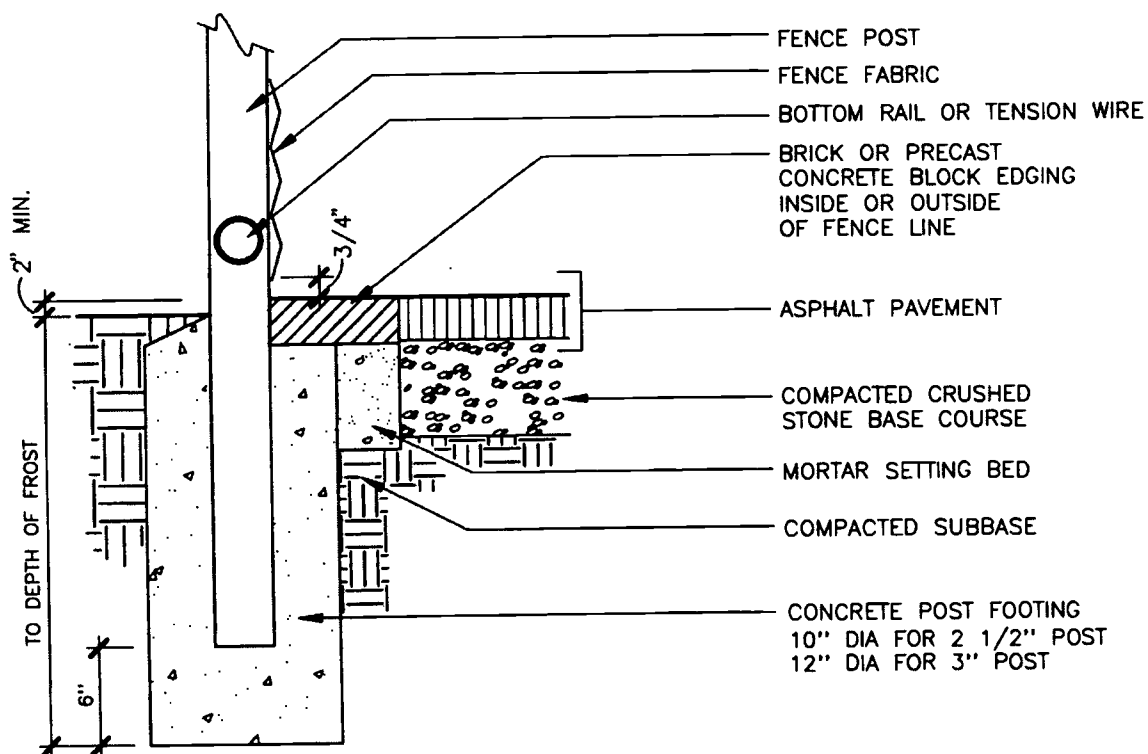


EDGE—2

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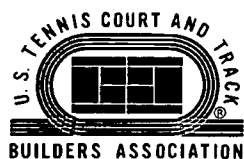
SECTION ASPHALT COURT EDGING



SECTION ASPHALT COURT EDGING AT FENCE POST

## TYPICAL ASPHALT COURT EDGING WITH BRICK OR CONCRETE BLOCK

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EDGE—1

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SECTION	II.J.1.	PAGE	1
TITLE PVC-COATED, ALUMINIZED OR GALVANIZED CHAIN LINK FENCING AND ACCESSORIES	REVISION DATE		1998
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1.0	Purpose		
<p>The primary reason for fencing around the perimeter of a tennis court is to contain most tennis balls within the court area during play. Therefore, any fence materials or design which accomplishes this objective in a safe and consistent manner may prove acceptable.</p> <p>Unless additional fencing is required for security and/or because of adjacent hazards such as parking lots, roads or water, a high fence around the perimeter of a tennis court is not necessary. Therefore, consideration may be given to providing lower fences at the sides of the court, or even eliminating fencing at the sides between the service lines. A fence configuration incorporating this type of design will provide adequate ball containment while offering economic and aesthetic advantages.</p>			
2.0	Scope		
<p>This guideline covers material and construction requirements for PVC (vinyl) coated, aluminized or galvanized fence fabric with PVC coated, polyester powder coated or galvanized steel framework.</p>			
3.0	Chain Link Fence Fabric		
A.	PVC Coated (Fused) Coated over galvanized wire: ASTM F 668, class 2B, 7 mil (0.18 mm) thermally fused polyvinyl chloride in a color to be selected from the manufacturer's choices. Galvanized steel core wire should meet ASTM A 641, tensile strength 75,000 psi (571 Mpa), 11 gauge (0.120" [3.05 mm]).		
B.	PVC Coated (Extruded) Coated over galvanized wire: ASTM F 668, class 1, 15 mil (0.38 mm) extruded polyvinyl chloride in a color to be selected from the manufacturer's choice. Galvanized steel core wire should meet ASTM A 641, tensile strength 75,000 psi (571 Mpa), 11 gauge (0.120" [3.05 mm]).		
C.	Aluminum Coated Wire ASTM A 491, 11 gauge, 0.35 oz./s.f. coating.		
D.	Zinc Coated Wire ASTM A 392 - 1.2 oz./s.f. coating.		
E.	Size Helically wound and woven to a chosen height of 8.'0" (2.438 m), 10.'0" (3.048 m) or 12.'0" (3.658 m). Fabric should be 1 3/4" (44 mm) diamond mesh of 11 gauge (0.120" [3.05 mm]) core wire and a break load of 850 pounds. Other height fabric (3.'0", 4.'0", 6.'0") may be used depending on design requirements; however, it may only be available in 2" mesh.		
<p>Note: For greater strength and durability, 1 3/4" (44 mm) mesh is available in 9 gauge (0.148" [3.76 mm]).</p>			

**F. Salvage**

Fabric should be knuckled at the top and at the bottom.

**4.0 Steel Fence Framing****A. Framing Types****1. Type 1**

ASTM F 1083, standard weight schedule 40; minimum yield strength of 25,000 psi (170 Mpa); sizes as indicated. Hot-dipped galvanized with minimum average 1.8 oz/sf (550 g/m<sup>2</sup>) of coated surface area.

**2. Type 2**

Cold formed and welded steel pipe complying with ASTM F 1043, Group IC, with minimum yield strength of 50,000 psi (344 Mpa), sizes as indicated. Protective coating per ASTM F 1043, external coating Type B, zinc with organic overcoat, 0.9 oz/sf (275 g/m<sup>2</sup>) minimum zinc coating with chromate conversion coating and verifiable polymer film. Internal coating Type B, minimum 0.9 oz/sf (275 g/m<sup>2</sup>) zinc or Type D, zinc pigmented, 81% nominal coating, minimum 3 mils (0.08 mm) thick.

**3. Formed Steel "C" Sections**

Roll formed steel shapes complying with ASTM F 1043, Group II, produced from 45,000 psi (310 Mpa) yield strength steel; sizes as indicated. External coating per ASTM F 1043, Type A, minimum average 2.0 oz/sf (510 g/m<sup>2</sup>) of zinc per ASTM A 123, or 4.0 oz/sf (1220 g/m<sup>2</sup>) per ASTM A 525. "C" section post may have ASTM F 1043, Type C external coating consisting of 0.9 oz/sf (275 g/m<sup>2</sup>) zinc 5% aluminum-mischmetal alloy.

**4. Steel Square Sections**

[ASTM A 500, Grade B.] Steel having minimum yield strength of 40,000 psi (275 Mpa); sizes as indicated. Hot dipped galvanized with minimum 1.8 oz/sf (550 g/m<sup>2</sup>) of coated surface area.

**5. PVC Coated Finish**

In accordance with ASTM F 1043, apply supplemental color coating of 10-15 mils (0.254 - 0.38 mm) of thermally fused PVC in a color selected from the manufacturer's choices, to match the fabric.

**6. Polyester Powder Coated**

In accordance with ASTM coating specification F 1234 - 90A, electrostatically apply and thermally bond at 450 degrees F a thermosetting polyester powder of 3 mils (.076 mm) minimum in color to match the fabric. Color should be selected from among the manufacturer's choices.

**B. Framing Specifications**

<u>Structure</u>	<u>10' or 12' Height</u>	<u>8' Height</u>
End, Corner and Gate Post	2.875" OD (76 mm)	2.375" OD (54 mm)
	5.79 lbs/ft (8.6 kg/m)	2.72 lbs/ft (4.0 kg/m)
	or	
	2.5" sq. (54 mm)	2.5" square (64mm)
	5.1 lbs/ft (7.59 kg/m)	5.1 lbs/ft (7.59 kg/m)

Line (Intermediate) Post	2.375" OD (54 mm)	2.375" OD (64)
	2.72 lbs/ft (4.0 kg/m)	2.72 lbs/ft (4.0 kg/m)
	or	
	2.25" x 1.7" "C"	2.25" x 1.7" "C"
	(57.15 x 43.18)	(57.15x43.182.7 mm)
	2.7 lbs/ft (4.02 kg/m)	2.7 lbs/ft (4.02 kg/m)
Rails & Braces	1.580" OD (42.2 mm)	1.580" OD (42.2 mm)
	2.27 lbs/ft (3.4 kg/m)	2.27 lbs/ft (3.4 kg/m)
	or	
	1.660" OD (42.2 mm)	1.660" OD (42.2 mm)
	2.27 lbs/ft(3.4 kg/m)	1.83 lbs/ft (2.72 kg/m)

### C. Gates

1. Chain link swing gates as specified in ASTM Section 02831C.
2. Chain link cantilever slide gates as specified in ASTM Section 02831D.
3. Chain link vertical lift gates as specified in Section 02831E.
4. Chain link overhead slide gates as specified in ASTM Section 02831F.

## 5.0 PVC Coated Accessories

### A. Chain Link Fence Accessories

1. **ASTM F 626**  
Provide items required to complete fence system. Galvanize each ferrous metal item and finish to match framing.
2. **Post Caps**  
Formed steel, malleable cast iron, or aluminum alloy weathertight closure cap for tubular posts. For each line post, provide tops to permit passage of top rail.
3. **Top Rail and Brace Ends**  
Formed steel or malleable cast iron for connection of rail and brace to terminal posts.
4. **Top Rail Sleeves**  
5" (150 mm) sleeve allowing for expansion and contraction of top rail.
5. **Wire Ties and Clops**  
10 gauge (0.135" [3.43 mm]) galvanized steel wire for attachment of fabric to line posts. Double wrap 13 gauge (0.092" [2.324 mm]) for rails, and braces. Hog ring ties of 12-1/2 gauge (0.0985" [2.502 mm]) for attachment of fabric to tension wire.
6. **Brace and Tension (Stretcher bar)**
  - a. **Bands**  
Pressed steel. At square post provide tension bar clips.

**b. Tension (Stretcher) Bars**

One-piece lengths, equal to 2" (50 mm) less than full height of fabric with a minimum cross-section of 3/16" x 3/4" (4.76 mm x 19 mm) or equivalent, fiberglass rod. Provide tension (stretcher) bars where chain link fabric meets terminal posts.

**7. Bottom Tension Wire**

Bottom tension wire should be used except where continuous bottom rail is specified. Bottom tension wire should be in accordance with ASTM A 824, with coating to match that selected for the fabric.

**8. Truss Rods**

Steel rods with minimum diameter of 5/16" (7.9 mm).

**9. Nuts and Bolts**

Nuts and bolts are galvanized but not vinyl coated. Cans of PVC touch up paint are available to color coat nuts and bolts if desired.

**6.0 Setting Materials**

Concrete, with a minimum 28-day compressive strength of 3,000 psi (20 Mpa).

**7.0 Execution****A. Examination**

1. Verify areas to receive fencing are completed to final grades and elevations.
2. Ensure property lines and legal boundaries of work are clearly established.

**B. Chain Link Fence Framing Installation**

1. Install chain link fence in accordance with ASTM F 969 and manufacturers' instructions.
2. Locate a terminal post at each fence termination, at each change in horizontal direction of 30° or more, and at each change in height.
3. Space line posts uniformly at a maximum of 10' (3.04 m) on center. Posts may be spaced uniformly at a closer distance (for example, 8' [2.44 m]) for greater strength.
4. Concrete set posts: Drill holes in firm, undisturbed or compacted soil. Holes should have diameter 4 times greater than outside dimension of post, and depths approximately 6" (150 mm) deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 36" (900 mm) below surface when in firm, undisturbed soil. Place concrete around posts in a continuous pour. Trowel finish around post. Slope to direct water away from posts.

**C. Gate hardware**

Set keepers, stops, sleeves, and other accessories into concrete.

**D. Alignment**

Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.

**E. Bracing**

Install horizontal pipe brace at mid-height for fences 6' (1830 mm) and over, on each side of terminal posts. Firmly attach with fittings.

**F. Tension wire**

Provide tension wire at bottom of fabric (and at top, if top rail is not specified). Install tension wire before stretching fabric and attach to each post with ties or clips. Secure tension wire to fabric with 12-1/2 gauge (.0985" [2.502 mm]) hog rings 24" (609.6 mm) on center.

**G. Top rail**

Install full 21' (640 m) lengths whenever possible. Connect lengths with sleeves for rigid connections under expansion/contraction conditions. Top rail with swaged ends may be joined directly.

**H. Central Rails for fabric height 12' (3660 mm) and over**

Install mid rails between posts with fittings and accessories.

**I. Bottom Rails**

Install bottom rails, where specified, between posts with fittings and accessories.

**8.0 Chain Link Fabric Installation****A. Fabric**

Install fabric on the inside toward the playing area, and attach so that fabric remains in tension after pulling force is released. Leave approximately 1" (25 mm) between finish grade and bottom selvage. Attach fabric with wire ties to line posts at 15" (380 mm) on center and to rails, braces, and tension wire at 24" (600 mm) on center.

**B. Tension (Stretcher) Bars**

Pull fabric taut; thread tension bar through fabric and attach to terminal posts with bands or clips spaced maximum of 15" (350 mm) on center.

**9.0 Gate Installation**

**A.** Install gates plumb, level and secure for full opening without interference.

**B.** Attach hardware by a means which will prevent unauthorized removal.

**C.** Adjust hardware for smooth operation.

**10.0 Accessories****A. Tie Wires**

Bend ends of wire to minimize hazard to persons and clothing.

**B. Fasteners**

Install nuts on side of fence opposite fabric side for added security.

**11.0 Caution Regarding Windscreens**

If windscreens are to be installed at the time of fence erection or at a later time, it is advisable to use stronger framework and parts, and closer spacing of posts, or back



bracing, depending upon the type of screening material to be used, area of fence to be covered, and local wind characteristics. For additional information refer to Section II.K.1, Outdoor Windscreens for Tennis Courts.

**Note Regarding Related ASTM Specifications:**

ASTM specifications are available from the American Society of Testing Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428, 610-832-9500. For more information on materials pertaining to or related to those covered in this specification, please see the following ASTM specifications:

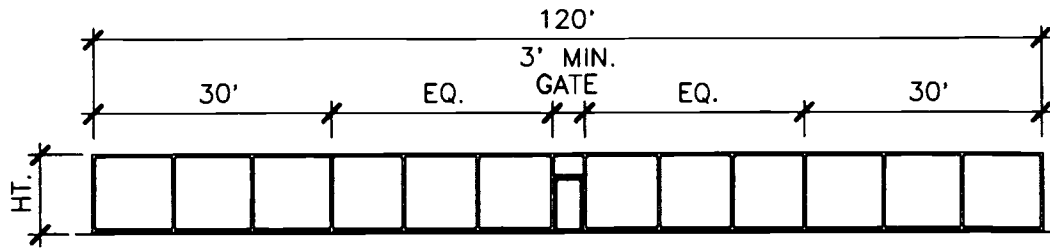
- A. Section 02500 - Paving and Surfacing
- B. Section 03300 - Cast-In-Place Concrete
- C. Section 04200 - Unit Masonry

**Note: Refer to Guidelines for:**

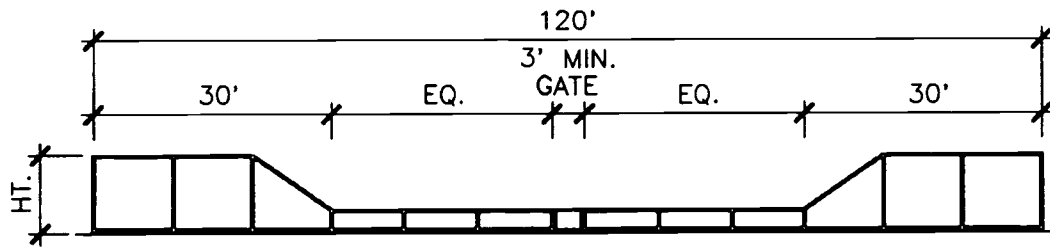
- I.A General Conditions for Construction
- II.A Tennis Court Orientation; Court Orientation Illustration
- II.B Tennis Court Dimensions and Related Measurements; Tennis Court Layout Illustration

NOTICE: These Construction Guidelines are for use by architects, engineers, contractors and tennis court owners. Parties not experienced in tennis court construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

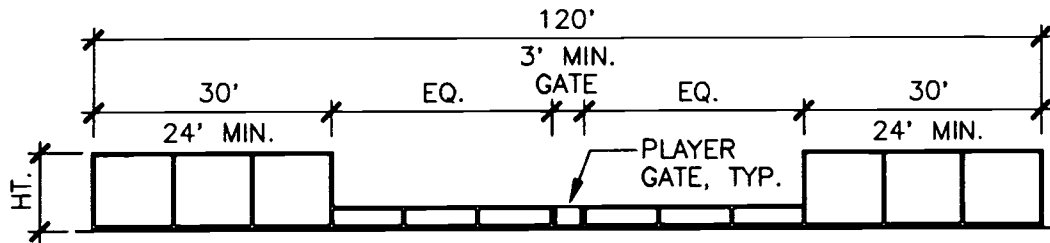
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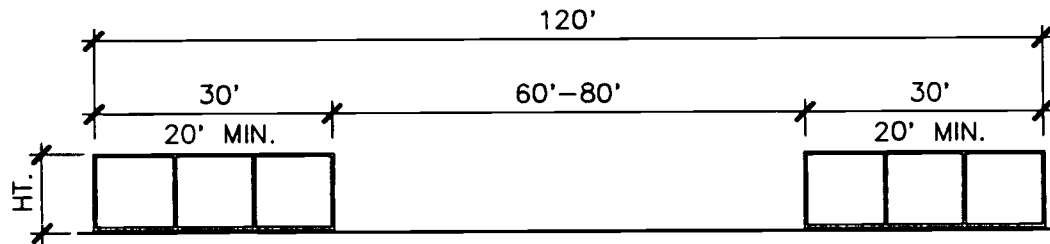
FULL HEIGHT SIDE FENCE



SIDE FENCE W/TAPERED DROP MIDDLE



SIDE FENCE W/DROPPED MIDDLE



SIDE FENCE W/OPEN MIDDLE

NOTE: FENCE HEIGHT VARIES BY SURFACE TYPE.

- 10' MIN. ASPHALT AND CONCRETE
- 8' MIN. CLAY, FAST DRY, & SAND-FILLED TURF
- 5' MIN. NATURAL GRASS
- 3' MIN. PREFERRED HEIGHT FOR VIEWING INTO COURT

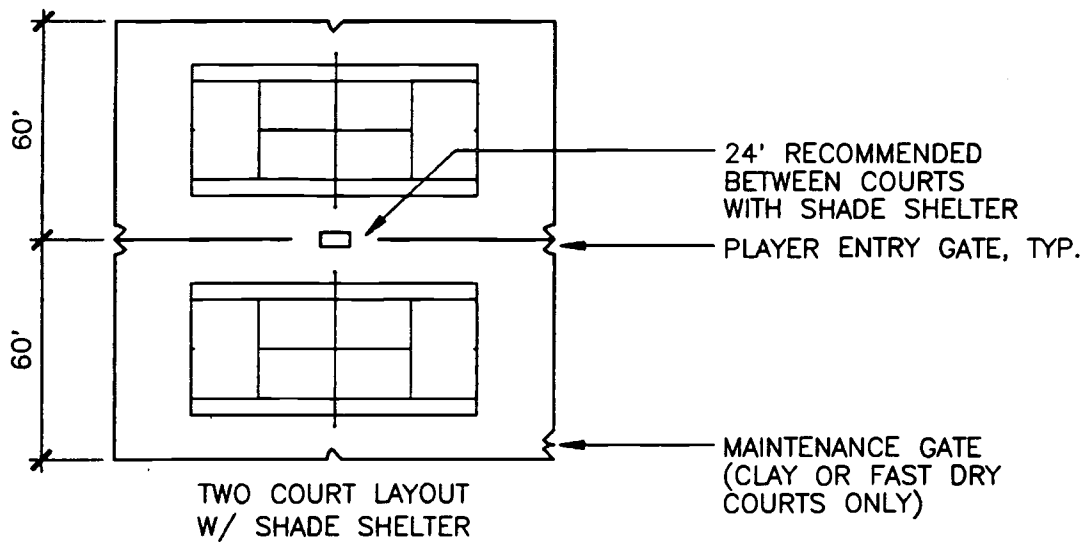
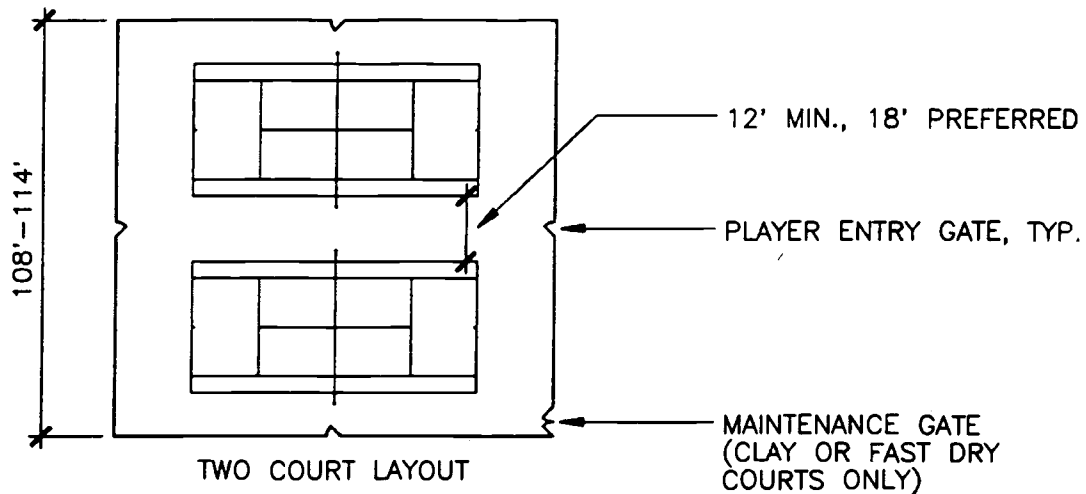
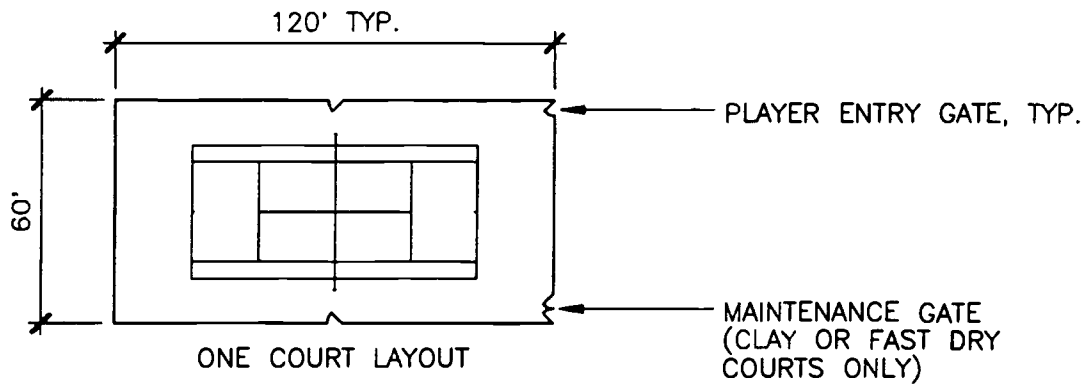
## TYPICAL SIDE FENCE ELEVATIONS

NOT TO SCALE



FENC—ELV

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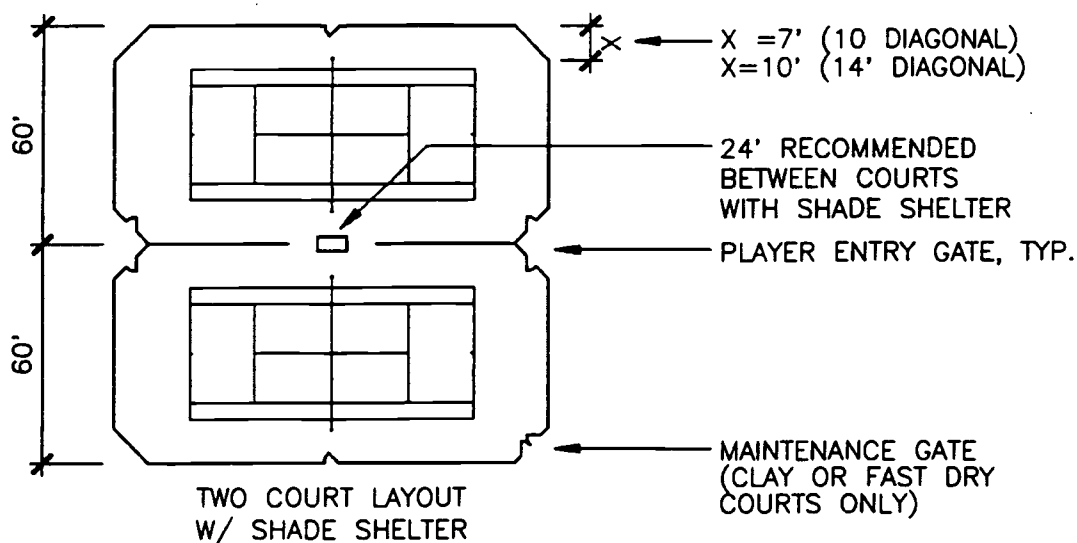
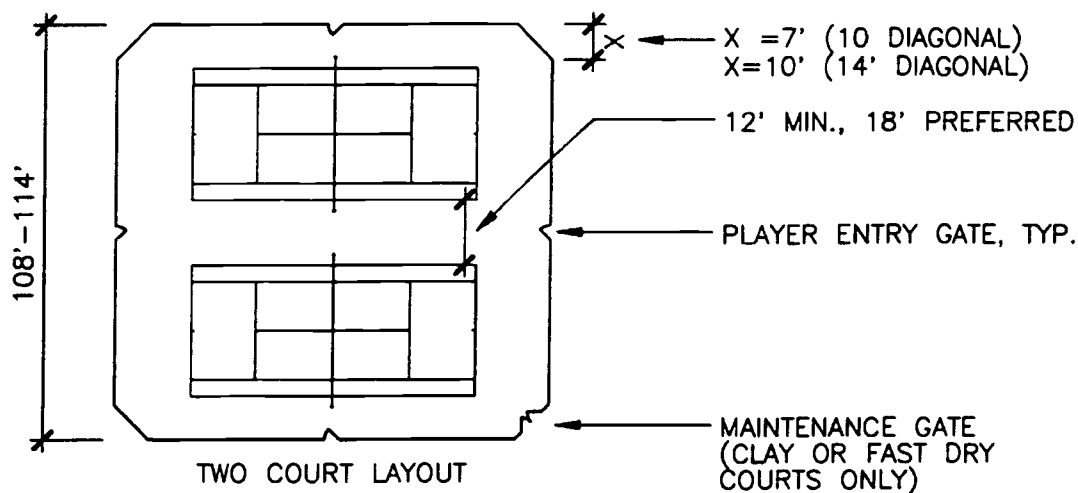
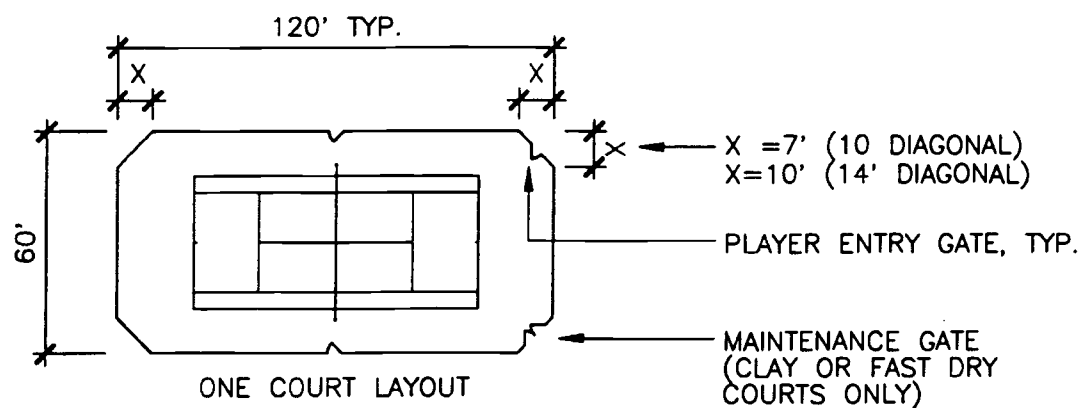
## TYPICAL FENCE PLANS—SQUARE CORNER

NOT TO SCALE



FENC—SQ

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## TYPICAL FENCE PLANS—CUT CORNER

NOT TO SCALE



FENC—CUT

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SECTION	II.J.2.	PAGE	1
TITLE WOODEN FENCE FRAMEWORK TO BE USED IN CONJUNCTION WITH METAL OR SYNTHETIC FABRICS	REVISION DATE		1998
	COPYRIGHT © 1998 BY U.S. TENNIS COURT & TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.		
<div>1.0 Purpose</div> <p>The primary reason for fencing around the perimeter of a tennis court is to contain most tennis balls within the court area during play. Therefore, any fence materials or design which accomplishes this objective in a safe and consistent manner may prove acceptable.</p> <p>Unless additional fencing is required for security and/or because of adjacent hazards such as parking lots, roads or water, a high fence around the perimeter of a tennis court is not necessary. Therefore, consideration may be given to providing lower fences at the sides of the court, or even eliminating fencing at the sides between the service lines. A fence configuration incorporating this type of design will provide adequate ball containment while offering economic and aesthetic advantages.</p> <div>2.0 Height</div> <p>Overall height of the fence when erected should be in accordance with the design. When used with standard size courts (60' x 120'), a minimum height of 8' is recommended across the back, including minimum wings of at least 20' long extending from the ends toward the net line. The area in between the wings could continue with 8' high fencing or be reduced to a lesser height or eliminated altogether. If lower fences are used on the sides of courts, they should be not less than 3'. Fences using wooden frames are usually limited to a 10' maximum height due to wood post length availability.</p> <div>3.0 Wood Types</div> <p>Wood used in fencing can be divided into two categories; naturally decay-resistant woods and chemically induced decay-resistant woods; i.e., untreated and treated,</p> <p>"Untreated fence posts containing a large portion of the very resistant heartwood may last 20 or more years, while those with non-resistant heartwood might only last five years or less".<sup>(1)</sup> Species of wood which are naturally decay resistant vary regionally; it would be advisable to consult local suppliers for the types available in the area.</p> <p>Pressure treating wood is a process in which preservative chemicals are pressure-impregnated and chemically fixed in the wood cells. The specific chemical(s) used in the treatment process varies with different manufacturers. The use of pressure treated wood in ground may cause some environmental concern; however, its manufacturers insist that when properly used, it shows no harmful effects to the environment. Major manufacturers will have information regarding safety, application and warranty.</p> <div>4.0 Framework Shapes</div> <p>Wood is available in square, rectangular or round stock. The rectangular or square stock can be smooth or rough sawn and may have traces of bark. The round stock also varies in degree of roundness and includes stock which is uniform in diameter from one end to the other and tapered stock.</p>			

**5.0 Fastening**

When using round stock, rails must be fastened to posts by doweling or lapping or by some similar method. Angular stock (square or rectangular) may be fastened by numerous methods including, but not limited to doweling, notching, mortising, ship lapping and butt ending with a support member.

If the system used to fasten the post and rail together requires nailing or screwing, a galvanized aluminum, brass, bronze or stainless steel fastener should be used.

**6.0 Checking/Warping**

All wood is prone to some degree of drying out after it is processed. If it is a naturally decay-resistant wood, the bark is usually removed and the stock is either sawn, planed, stripped or sanded. During and after this processing, the wood begins to dry out and season. Often splits or cracks, more accurately known as "checks," develop. Since this is a natural seasoning process, it does not harm the durability of the wood.

In the case of pressure treated wood, the liquid preservative saturates the timber and it must be either baked out, as some manufacturers do, or it must dry out naturally.

If the wood is "bake dried," any additional seasoning will be minimal; however, if it is not previously dried, expect severe drying or seasoning. It is impossible to tell whether this will cause warping or twisting in a particular piece of wood until it is fully sun dried. It is advisable to have the wood kiln dried or naturally dried prior to including it in a fence framework.

**7.0 Post Dimensions**

All posts, including terminal and corner posts, are typically of the same dimension. Whether round or square, it is generally agreed that 4" is the minimum cross-sectional dimension of any post. (There is, incidentally, some relation to the size of the wood versus the degree of warping or twisting. The larger the wood size, the less warping and the smaller the wood, the greater the degree of potential warping.) 5" x 5", 4" x 6" and 6" x 6" square and rectangular posts are available. In round posts, anywhere from 4" to 6" is common. Consideration of the stresses the fence posts are expected to encounter should be given when choosing the post size. Framework which will support chainlink fabric and wind-screens should be larger in dimension than those frames which will support a lighter weight fabric or netting. Over building is acceptable, but under building will cause problems.

**8.0 Post Foundations**

Posts should be set a minimum of 36" in the ground, especially in high stress installations. Wood length availability may dictate buriable lengths, but foundations less than 36" on 10' high fencing are not recommended.

The diameter of the foundation should be large enough to allow recompaction of gravel around the post with a suitable metal tamp. A rough gauge is that the foundation diameter should be two times the post diameter.

Posts must be set in gravel foundations only. If the soil removed from a potential post hole is compactible gravel, then set the post and add gravel in 6" lifts, compacting in between lifts with a solid metal tamp. If the material which is removed is unsuitable for recompaction; i.e, plastic or expansive soils, it is recommended that the unsuitable material be replaced with a suitable gravel and compacted as suggested above.

**9.0 Pressure Treated Wood**

Pressure treated wood must meet stringent building codes and other regulatory requirements regarding the percentage of chemical retention. This retention is measured in pounds per cubic foot. Example:

*	above ground applications	0.25 p.c.f.
*	soil and fresh water	0.40 p.c.f.
*	salt water splash	0.40 p.c.f.
*	wood foundation	0.60 p.c.f.
*	salt water	2.50 p.c.f.

\* Wolmanized Pressure Treated Lumber Specification Data Sheet, c 1989, Hickson Corporation.

All fence posts (in ground applications) should be minimum of 0.40 p.c.f. A product with 0.60 p.c.f. of retention is also available. A discussion of the specific application with the supplier is recommended. Always stay within specifications in order to be covered by the manufacturer's warranties.

**10.0 Rails**

Top rails, mid rails and bottom rails are sometimes used, but not all are necessary. A top rail around the entire perimeter with midrail bracing installed at each corner, terminal and end posts extending to first adjacent line post is a minimum suggestion. A continuous mid rail does provide additional bracing for chainlink and other fencing materials. Bottom rails can often create a barrier inside the court making it difficult to remove leaves, etc. from court surfaces. (A tension wire can be used in place of a bottom rail.) If a bottom rail is used, the bottom of the rail should be several inches above the court surface.

Rail diameter or dimension need not be the same size as that of the vertical posts. Depending on application, a rail 2" x 4" may be adequate; however, a rail this size has the potential to sag between posts. A minimum rail size of 4" diameter or 4" square will provide necessary support in most applications.

If using a substantially different size rail than the vertical post, consideration should be given to the dimension of the inside edge of the rail versus the inside edge of the post, especially when installing a heavy gauge chainlink.

**11.0 Post Spacing**

1. Locate a terminal post at each fence termination, at each change in horizontal direction of 30° or more, and at each change in height.
2. Space line posts uniformly at a maximum of 10' (3.04 m) on center. Posts may be spaced uniformly at a closer distance (for example, 8' [2.44 m]) for greater strength.

**12.0 Post Tops**

Top posts can be routed prior to installation to provide an attractive appearance.

Decorative prefabricated post caps are also available and can add a finishing touch to the fence frame installation.

**13.0 Gates**

Gate openings should not be less at 4' wide. When building a 4' x 7' high gate, the frame should have two vertical posts and three rails, top, mid and bottom. A 4' x 4' gate should have both a top and bottom rail.

Additional bracing is essential to insure a square and sturdy gate. Bracing can be a diagonal member, cut to fit corner to corner, or small shorter braces to secure each 90 degree corner.

In gates, the vertical and horizontal wood pieces should be at least the same size as the rails used in the fence framing.

Gate and gate post hinges should be furnished of adequate strength for the gate size and weight and to allow 180 degree swing. Latches and catches should also be of adequate strength to hold the gate in a closed position. A plunger rod, catch and semi-automatic outer catch should be installed on drive gates so as to secure gates in an open or closed position.

**14.0 Bottom Tension Wire**

Bottom tension wire should be used except where continuous bottom rail is specified. It should be 6 (0.192) gauge vinyl coated or 7 gauge galvanized steel marcelled wire or other suitable wire depending on the type of enclosure material.

Wire should be adequately secured to terminal corners and/or end posts and attached to each line post. Enclosure material can be secured to the tension wire at intervals of 24" with 11 gauge galvanized or 9 gauge vinyl covered galvanized steel hog rings.

**15.0 Fence Fabrics**

Wooden fence frames should be built to accommodate the proposed fence fabric. Fence fabrics available for use with wooden frames include chainlink, wire mesh, fabric netting and windscreen materials. Windscreens generally are not recommended for permanent installations.

**16.0 Mesh Size**

Recommended mesh size for tennis court installations is 1 3/4" or less.

**A. Chainlink Fabrics**

Chainlink fabrics as specified in Sections II.J.1., Vinyl Coated Chain Link Fencing, can be installed using 9 gauge, 1 1/2" or 1 3/4" galvanized staples.

**B. Other Wire Meshes**

A variety of industrial grade galvanized and vinyl wire meshes are suitable for ball retainage. As a rule, most of these meshes are available in 3', 4', 5' and 6' heights. When enclosing a 10' high section, two 5' rolls or one 5' and one 6' roll (if roll heights are less than exact) are secured together with galvanized or vinyl hog rings. A mid rail to secure this joint, where necessary, is recommended. Mesh can be fastened to a wood frame using galvanized 9 gauge staples at intervals of 24".

**C. Fabric Netting**

Fabric netting is a viable alternative to metal mesh fabric. It should be 1 3/4" mesh and should be reinforced at top, bottom and sides if it is to be permanently fastened to posts and rails.



Netting can be installed on a light duty fence, which has vertical posts only, by securing a cable at the top and bottom. To secure netting to the cable, use hog rings or lacing twine, and lace on every grommet.

For best results, manufacturers of netting suggest not pulling fabric netting taut, but rather allowing it to have some slack.

#### **17.0 Caution Regarding Windscreens**

If windscreens are to be installed at the time of fence erection or at a later time, it is advisable to use stronger framework and parts, and closer spacing of posts, or back bracing, depending upon the type of screening material to be used, area of fence to be covered, and local wind characteristics. For additional information, refer to Section II.K.1. Outdoor Windscreens for Tennis Courts.

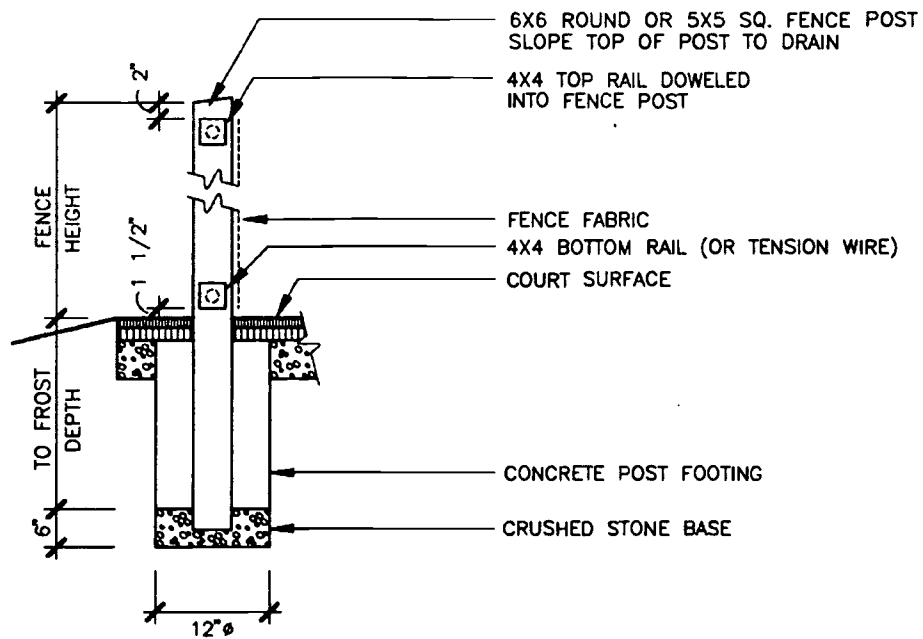
<sup>(1)</sup>U.S. Forest Service Research Note FPL 0153 1/1967

**Note: Refer to guideline for:**

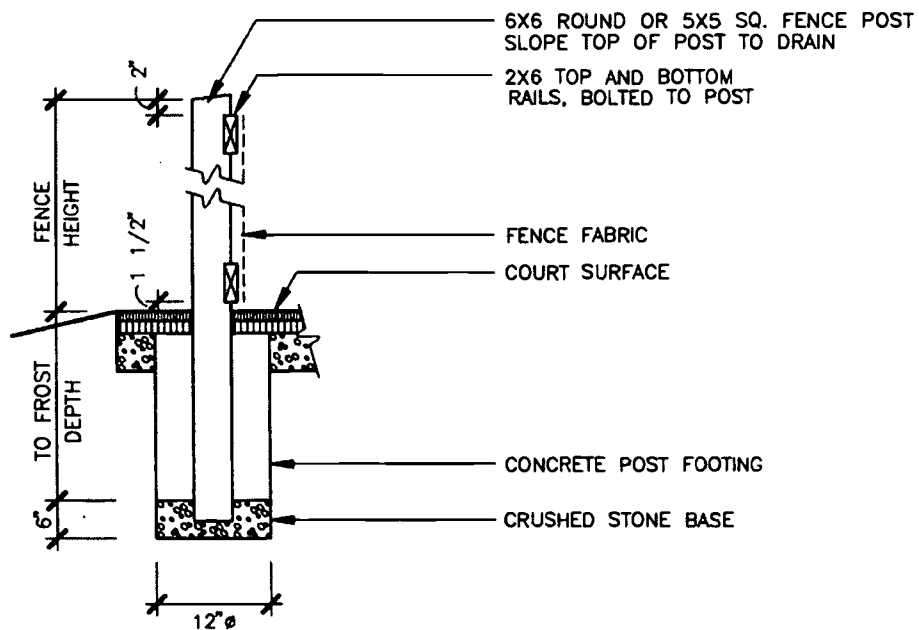
- I.A. General Conditions for Construction**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurement**
- II.J.1. PVC Coated, Aluminized or Galvanized Chain Link Fencing and Accessories**

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WOOD FENCE W/4X4 RAILS



WOOD FENCE W/2X6 RAILS

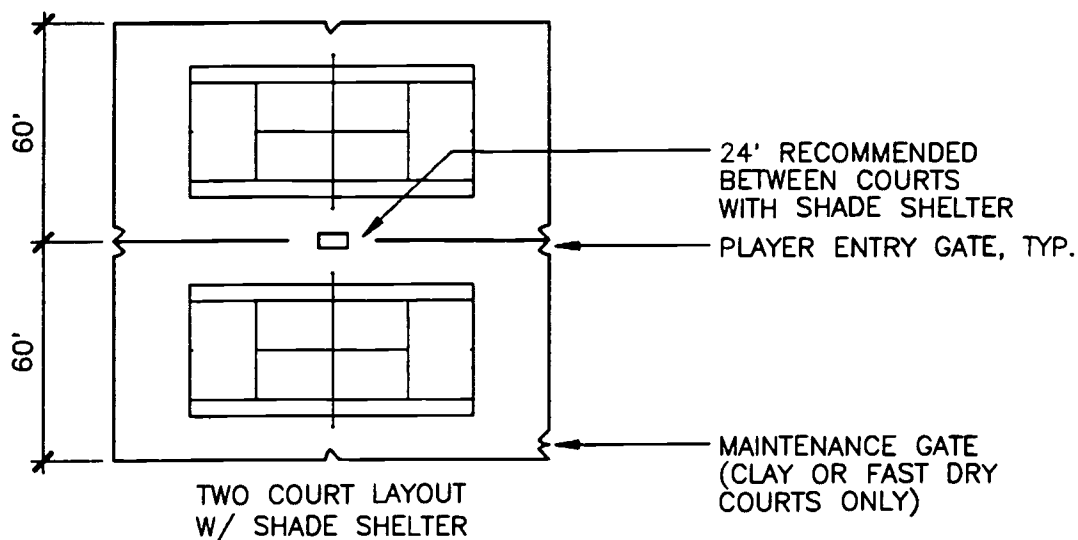
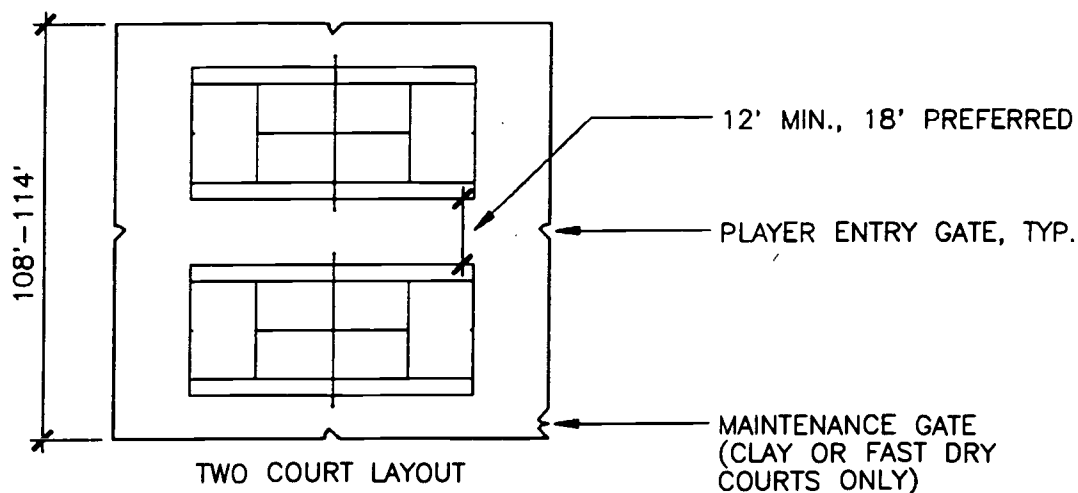
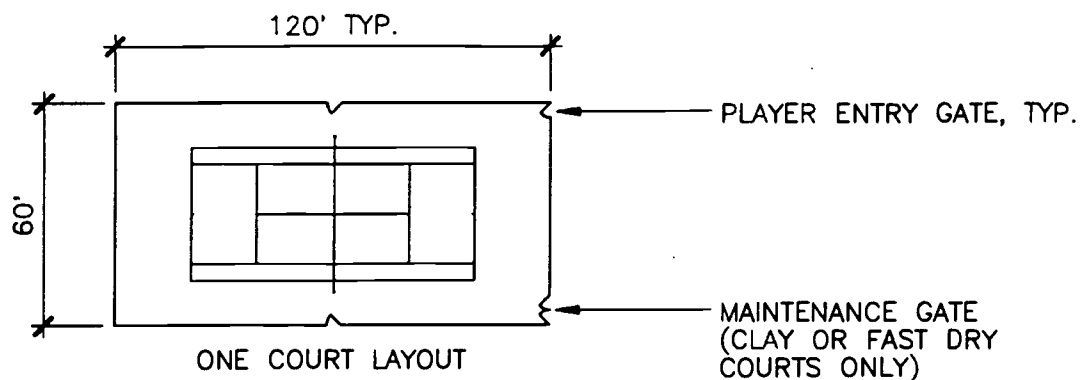
## TYPICAL SECTIONS TREATED WOOD FENCE POSTS

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FPOST—1

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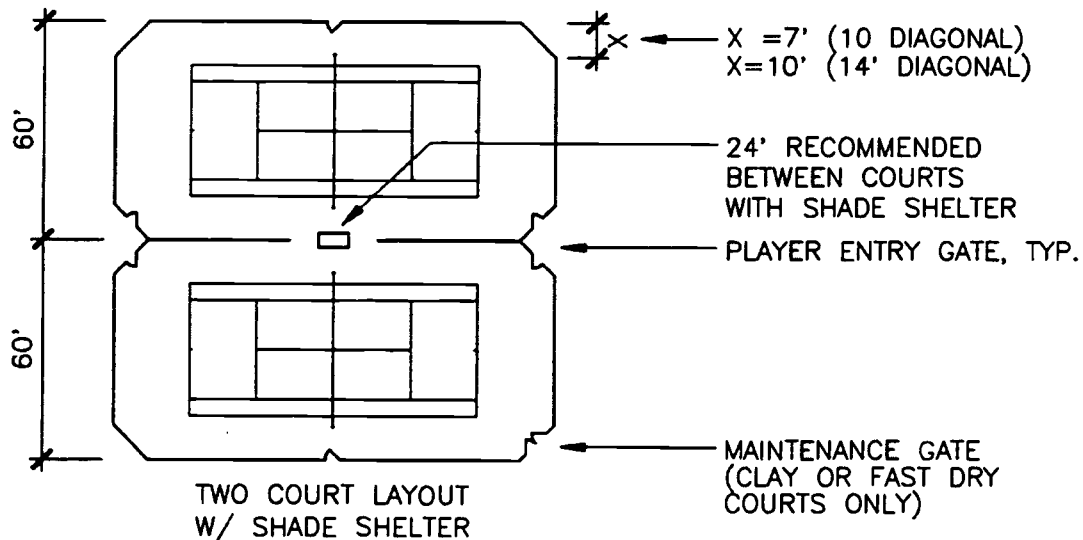
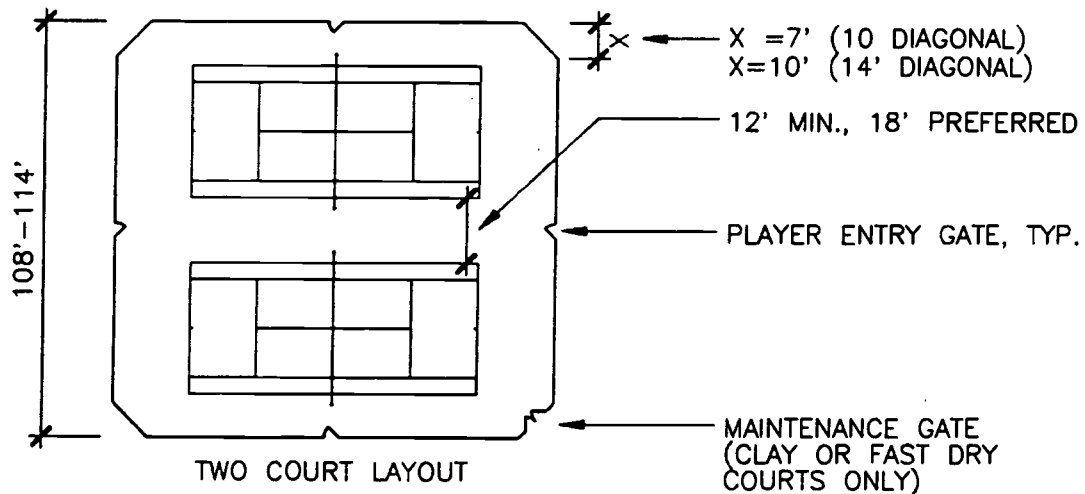
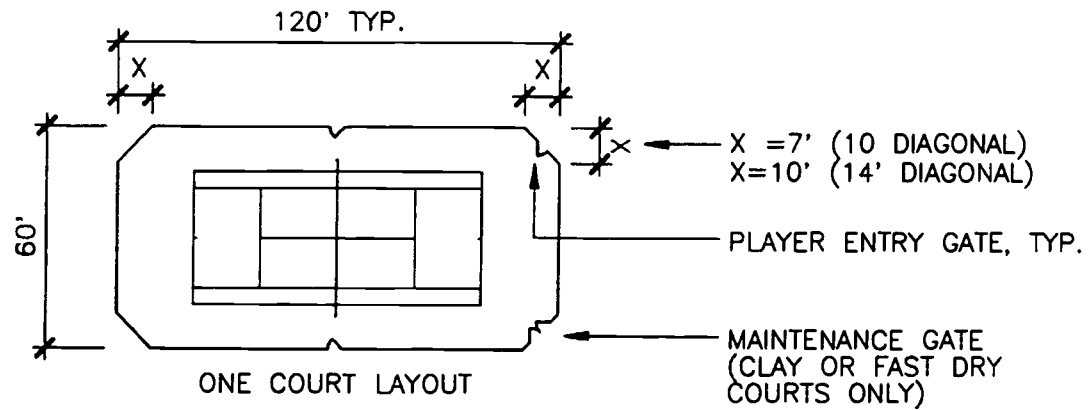
## TYPICAL FENCE PLANS—SQUARE CORNER

NOT TO SCALE



FENC—SQ

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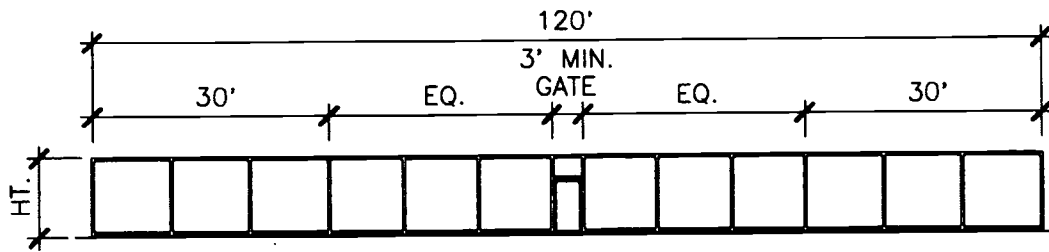
## TYPICAL FENCE PLANS—CUT CORNER

NOT TO SCALE

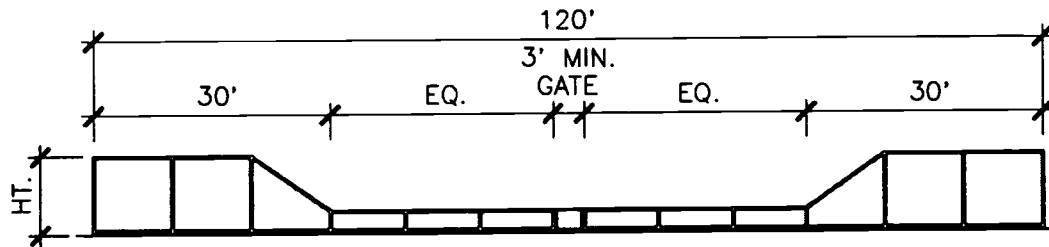


FENC—CUT

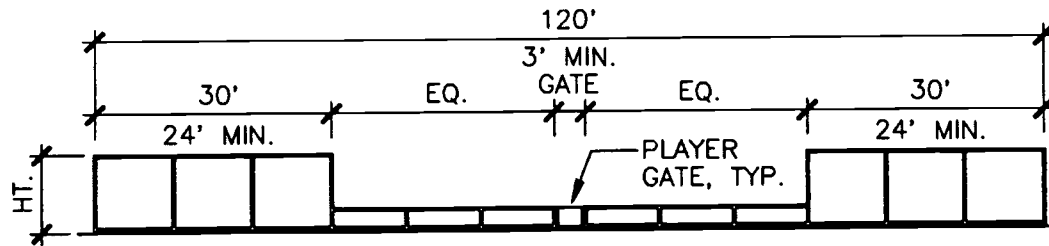
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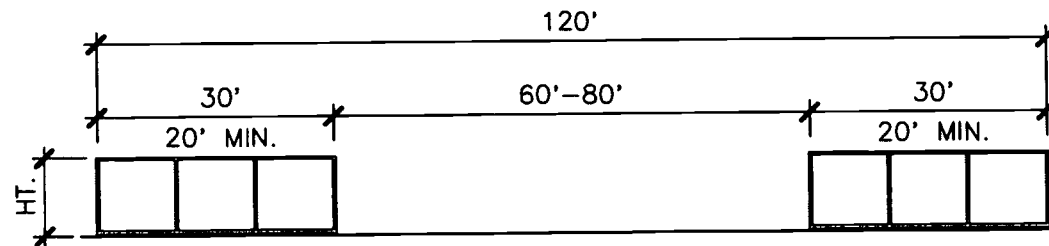
FULL HEIGHT SIDE FENCE



SIDE FENCE W/TAPERED DROP MIDDLE



SIDE FENCE W/DROPPED MIDDLE



SIDE FENCE W/OPEN MIDDLE

NOTE: FENCE HEIGHT VARIES BY SURFACE TYPE.

- 10' MIN. ASPHALT AND CONCRETE
- 8' MIN. CLAY, FAST DRY, & SAND-FILLED TURF
- 5' MIN. NATURAL GRASS
- 3' MIN. PREFERRED HEIGHT FOR VIEWING INTO COURT

## TYPICAL SIDE FENCE ELEVATIONS

NOT TO SCALE



FENC—ELV

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SECTION	II.K.1.	PAGE	1
TITLE <b>OUTDOOR WINDSCREENS FOR TENNIS COURTS</b>	REVISION DATE	1998	
	COPYRIGHT © 1998 BY U.S. TENNIS COURT & TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.		
<b>1.0 Scope</b>			
Windscreens (sometimes called background curtains) serve many purposes. There are several methods of accomplishing the desired results depending upon specific needs and budget. This guideline describes those issues which should be considered in selecting windscreens.			
<b>2.0 Purpose</b>			
The purposes of windscreens are:			
<b>A.</b> To provide a background to allow player to see the ball. The darker the back-ground, the better the ball definition.			
<b>B.</b> To aid the court in blending into its surroundings.			
<b>C.</b> To reduce the reflection of the sun's glare off chain link fencing and posts.			
<b>D.</b> To provide a shield for the player from the wind. A windscreen should either block or distort strong winds so that the game can be played under the best conditions, while allowing gentle breezes for ventilation and cooling.			
<b>E.</b> To provide privacy to players and to screen out annoying distractions, such as passersby, parking lots, swimming pools and highways.			
<b>F.</b> To contain artificial light at night.			
<b>3.0 Selecting the Right Type of Windscreen</b>			
<b>A. Background for Ball Visibility</b>			
The more background provided on the fence, the better. Therefore, a 9' wind screen is the most desirable height for the average 10' fence.			
<b>B. Wind Factor</b>			
All windscreens create wind resistance, some less than others. Careful consideration must be given to the structure of the fencing. If it is weak, an open mesh windscreen should be used. If it is strong and well supported, a less open mesh or a closed mesh could be used.			
Open mesh windscreens allow more wind to pass through than closed mesh. Therefore, open mesh should be used in most circumstances.			
For windscreens 9' and over, air vents should be placed a minimum of 10' on center and the screens should be tied, roped or otherwise fastened at the mid-point.			
<b>C. Courts with Outside Distractions</b>			
The easy answer to outside distractions is to use a closed mesh windscreen. However, if a fence is not well supported or if strong winds are possible, this alternative is not suggested.			

**D. Weak Fences**

In this case, the most desirable option is no windscreen at all. If, however, windscreen is desired, consideration should be given to a 6' open mesh windscreen. This, of course, would not accomplish all of the windscreen objectives, but would certainly achieve some of them.

**4.0 Materials and Fabrication**

The three materials most commonly used for windscreens are vinyl coated polyester, polypropylene and polyethylene. The vinyl coated polyester and polypropylene materials are woven fabrics and almost always come in custom fabricated panels. The polyethylene is generally a knitted product that is available by the roll in an unfabricated form.

It is well to bear in mind that there are many different grades of each type of material.

**A. Vinyl Coated Polyester****1. Fabric**

Vinyl coated polyester is a fabric made from polyester material weighing at least 3.0 oz. per square yard and coated after weaving with a 4.0 oz. per square yard dark color vinyl. The vinyl should consist of high quality PVC ingredients for the highest possible ultraviolet light, abrasion and mildew resistance.

**2. Hems**

All hems should be reinforced and should have two rows of stitching.

**3. Reinforcing Tape**

Windscreens 9' high should have a 1 1/4" or larger black polypropylene tape or its equivalent grommited 12" to 18" on center and sewn with two rows of stitching.

**4. Thread**

All hems and seams should be sewn with a heavy duty weather and ultraviolet light resistant polyester thread or its equivalent.

**5. Grommets**

No. 2 or No. 3 solid brass with plain washers, 12" to 18" on center.

**6. Air Vents**

Open or flap type, finished or unfinished, with a maximum spacing of 10'.

**B. Polypropylene****1. Fabric**

Polypropylene windscreens are made of a fabric woven from polypropylene yarns weighing 4.75 oz. or more per square yard. The yarns should be of a dark color and should have high ultraviolet light resistance.

**2. Hems**

All hems should be reinforced and should have two rows of stitching.

**3. Reinforcing Tape**

Windscreens 9' high should have a 1 1/4" or larger black polypropylene tape or its equivalent grommited 12" to 18" on center and sewn with two rows of stitching.

**4. Thread**

All hems and seams should be sewn with a heavy duty weather and ultraviolet light resistant polyester thread or its equivalent.

**5. Grommets**

No. 2 or No. 3 solid brass with plain washers, 12" to 18" on center.

**6. Air Vents**

Open or flap type, finished or unfinished, with a maximum spacing of 10'.

**C. Polyethylene**

Polyethylene windscreens are a knitted fabric made from high density monofilament polyethylene yarn weighing 6.5 oz. per square yard. The fabric should be of a dark color and should have high ultraviolet light resistance.

Polyethylene windscreens are generally not custom fabricated as are the ones made from vinyl coated polyester and/or polypropylene. The material is usually available by the roll and can be cut to size on the jobsite.

It is important with this fabric to make sure the manufacturer has specially designed reinforced edges for use without hems or grommets.

**5.0 Size of Windscreens**

Manufacturers will make windscreens in most lengths, but for ease of installation, it is recommended that installed lengths not exceed 66'. Standard heights are 6' and 9'.

**6.0 Fastening Windscreens to Fences**

It is important that all grommets be used when fastening a windscreen to the fence. This distributes the strain evenly. If some grommets are not used, the remaining ones have undue stress placed on them and could pull out of the hems. Also, wind whip can result if all grommets are not used and can destroy any windscreen. Installations using all grommets are neater and have a more "finished" appearance.

**7.0 Types of Fasteners****A. "S" Hooks**

1 3/4" zinc coated 3/16" diameter thickness. Advantages: Strength and durability. Disadvantages: They "pop" off, are hard to use, and cause wear on chain link fences.

**B. Lacing Cord**

3/16" nylon, polyester or polypropylene. Advantages: Gives windscreen a neat appearance, will not come undone like hooks, are easier on vinyl fence, and will give. In emergencies, the windscreen can be removed quickly. Disadvantages: Take longer to install than other devices.

**C. Springs**

Standard steel with 50 - 70 lb. strength. Advantages: If properly used, they will break away in a strong wind, thus saving fence and windscreens. Give windscreens a neat appearance. Disadvantages: Wear on chain link fences; relatively high priced. Some tend to stretch irregularly.



**D. Self-Releasing Tie-Wraps**

Vinyl serrated one-piece ties. Advantages: Inexpensive and will break when the wind pressure on a windscreen reaches a given threshold. Generally available in white or black. Disadvantages: Once installed, they must be cut or broken to remove, and therefore, they generally last only one season.

**8.0 Measuring for Windscreens**

The as built dimensions of chainlink fences are not always the same as the plans. To establish the length, it is necessary to physically measure the fence and determine the actual length from tension bar to tension bar.

**Note: Refer to Guidelines for:**

**I.A. General Conditions for Construction**

**II.A. Tennis Court Orientation**

**II.B. Tennis Court Dimensions and Related Measurement**

**II.J.1. PVC -Coated Aluminized or Galvanized Chain Link Fencing and Accessories**

**II.J.2. Wooden Fence Framework to be Used in Conjunction with Metal or Synthetic Fabrics**

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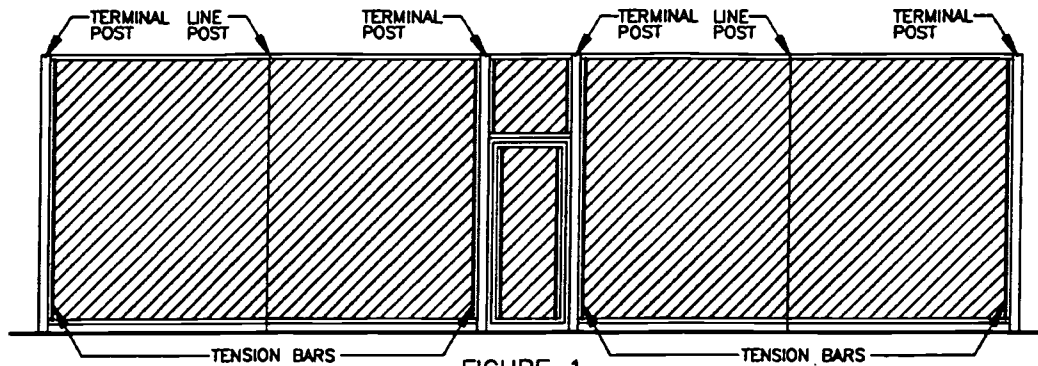


FIGURE 1

1. MAKE SURE THAT YOU BEGIN MEASUREMENT AT A TERMINAL (CORNER) POST AND CONTINUE TO THE NEXT TERMINAL POST. (SEE FIGURE 1) DO NOT HOLD THE MEASURING TAPE UP TO THE FENCE. THIS WILL CREATE SLACK WHICH COULD CAUSE MEASUREMENTS TO BE TOO LONG.
2. MEASURE WINDSCREEN LENGTH FROM INSIDE TENSION BAR TO INSIDE TENSION BAR. YOU MAY DISREGARD LINE POSTS UNLESS THEY ARE ON THE COURT SIDE OF THE FENCE. FOR EASE OF HANDLING, WINDSCREENS SHOULD NOT EXCEED 60'-70' LENGTH.
3. MEASURE WINDSCREEN HEIGHT FROM BOTTOM OF THE TOP RAIL TO THE TOP OF BOTTOM RAIL. YOU MAY WANT TO TAKE INTO CONSIDERATION THAT WINDSCREEN IS GENERALLY INSTALLED ONE OR MORE FEET FROM THE TOP AND BOTTOM OF THE FENCE.
4. MARK EACH MEASUREMENT ON A DIAGRAM OF EACH COURT. SEND A COPY OF THIS DIAGRAM TO THE WINDSCREEN MANUFACTURER WHEN YOU PLACE YOUR ORDER SO THAT EACH WINDSCREEN WILL BE PROPERLY LABELED WHEN IT IS SHIPPED TO YOU. ALSO BE SURE TO TAG EACH PANEL BEFORE YOU REMOVE YOUR WINDSCREEN FOR STORAGE EACH YEAR.
5. EXACT MEASUREMENTS ARE NECESSARY (INCLUDING FEET AND INCHES). DO NOT GUESS OR ROUND OFF DIMENSIONS. NO TWO FENCES ARE IDENTICAL.

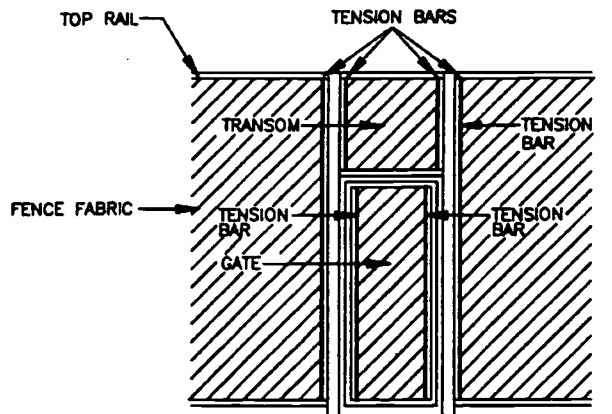


FIGURE 2

1. THE WIDTH OF THE GATE (SEE FIGURE 2) SHOULD BE MEASURED FROM INSIDE TENSION BAR TO INSIDE TENSION BAR. THE HEIGHT OF THE GATE SHOULD BE MEASURED FROM THE BOTTOM OF THE TOP RAIL TO THE TOP OF THE BOTTOM RAIL. YOU MAY WANT TO TAKE INTO CONSIDERATION THAT WINDSCREEN IS GENERALLY INSTALLED ONE OR MORE FEET FROM THE BOTTOM OF THE FENCE.
2. THE WIDTH OF THE TRANSOM (SEE FIGURE 2) SHOULD BE MEASURED FROM INSIDE TENSION BAR TO INSIDE TENSION BAR. THE HEIGHT SHOULD BE MEASURED FROM THE BOTTOM OF THE TOP RAIL TO THE TOP OF THE RAIL OVER THE GATE OPENING.

## WINDSCREEN MEASUREMENT DIAGRAM

NOT TO SCALE



WSCRN—1

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SECTION	II.K.2.	PAGE	1
TITLE INDOOR TENNIS CURTAINS, DIVIDERS AND PADS	REVISION DATE		1998
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1.0 Scope			
This guideline will provide suggestions for the proper placement, materials, and installation of backdrop curtains, dividers and column pads.			
2.0 Purpose			
A well-designed indoor facility utilizes backdrop curtains as a visual background for players and for ball control. Background curtains also define the playing area and may or may not guide traffic patterns to and from the courts. Additionally, they screen out distractions to the player.			
3.0 Perimeter Curtains			
A. Curtains for the perimeter of the tennis court playing area should be provided and installed.			
B. Curtains should be a minimum of 12' tall to a height as tall as the building allows (12' -14' is recommended), and should be designed to overlap from 12" - 24" and/or be laced together in order to prevent access between them. Colors may vary, but dark colors provide better contrast to allow players to see the ball.			
C. Perimeter curtain fabrics may be a minimum of ten ounces per square yard to a maximum suitable to the facility (18 ounces is recommended). Generally, heavier curtains offer greater life expectancy and durability. Perimeter curtains may be of a laminate style or spread-coated style. All curtains should meet the following flame retardant codes:			
Federal Standard 5903 NFPA 701 UL 214			
D. 1. Curtains should be constructed with dielectrically welded seams.			
2. Two-ply, three-ply or web strap top hems may be appropriate depending on use.			
3. Brass grommets should be spaced a minimum of 6" to a maximum of 24" on center.			
4. Hardware appropriate to the suspension system should be installed.			
5. Side and bottom hems should be a minimum of two-ply to a maximum of three-ply.			
6. Rod pockets/weighted bottom hems may be appropriate in certain instances and are generally recommended with lighter weight curtains.			
E. The location of curtains, whether installed on guy strand cable, airplane cable or on a track system, should be:			
1. 1" to 2" off the ground to provide good ball control, to optimize appearance and to minimize wear.			

2. Perimeter curtains should be located not less than 12" inside fixed obstructions.
3. Walkway curtains should be located approximately 36" inside fixed obstructions.

#### 4.0 High-Line Curtains

- A. White backdrop curtains above the perimeter curtains, called high-line curtains, may be provided and installed. Other colors may be appropriate as deemed necessary by the architect and/or owner. Light colored high-line curtains reflect light onto the court surface, aid in ball containment, compliment insulation and/or protect the walls.
- B. High-line curtains should extend from a minimum of 12" to a maximum of 24" below the perimeter curtains to a height appropriate for insulation and/or wall protection.
- C.
  1. Fabric should be minimum of 10 ounces per square yard (12-14 ounces is recommended) vinyl, laminate or spread-coated material, flame retardant to the following specifications:  
Federal Standard 5903  
NFPA 701  
UL 214
  2. Curtains should be constructed with dielectrically welded seams, two-ply or three-ply top hems with grommets a minimum of 18" to a maximum of 24" on center.
  3. Hardware as appropriate to installation should be included.
  4. Side and bottom hems should be two- or three-ply, as appropriate.

#### 5.0 Court Dividers

- A. Court dividers should be provided and installed between courts.
- B. Court dividers should be one or more of the following:
  1. Dividers should be a combination curtain with the bottom portion made of solid vinyl and the top portion a vinyl coated mesh and/or netting.
  2. Dividers should be a vinyl coated polyester mesh, flame retardant to the following spec:  
Federal Standard 5903  
NFPA 701  
UL 214
  3. Netting may be used as a divider and should be a minimum of #252 7/8" knotless nylon netting to a maximum of 1 3/4" knotted nylon, vinyl bound all around with grommets spaced a minimum of 18" to 24" top and sides, if required. Hardware may be installed appropriate to the suspension system.
  4. To avoid wear and tear along the bottom, the following options may be available:
    - a. A solid vinyl skirt similar to that specified for perimeter curtains.
    - b. A detachable net bottom (appropriate for netting only).
  5. Netting should be in two pieces that may be drawn to the ends for court maintenance.
  6. Netting should be dark green or black in color to minimize the visual impact.

SECTION	II.K.2.	PAGE	3
<p><b>6.0 Court Access</b></p> <ul style="list-style-type: none"> <li>A. Access may be as simple as entering/exiting through overlaps between curtains.</li> <li>B. Access may be facilitated by doorway entry flaps either cut into the perimeter curtains or suspended independently from the cable. A separate doorway curtain with viewing mesh window is recommended.</li> <li>C. Access and ball control may be enhanced with split wing entries which are part of the divider net and/or backwall curtains.</li> </ul> <p><b>7.0 Suspension System</b></p> <p>Perimeter curtains, high-line curtains and dividers can be supported by cable and turn-buckle, high-tension wire or a track system. High tension wire (3,000-4,000 lb. tension) is recommended because it is maintenance free and provides the best appearance.</p> <p><b>8.0 Column Pads</b></p> <ul style="list-style-type: none"> <li>A. Each frame or column behind the perimeter curtains should be covered with bonded foam pads.</li> <li>B. Pads should be a minimum of 3" thick.</li> <li>C. Pads should be constructed to extend 2" wider than the frame or column to be covered.</li> <li>D. Pads should extend to a minimum of 8' above the finished floor.</li> <li>E. Pads should be attached to columns or frames by gluing, lacing, wrapping around or other suitable method.</li> <li>F. Vinyl covers should be placed over exposed surfaces of pads to improve appearance and durability.</li> <li>G. Any fixed obstruction within 12" of an opaque curtain should be padded.</li> </ul> <p><b>9.0 Disclaimer</b></p> <p>It is important to note that some of the issues addressed in this guideline can affect safety and potential liability. A professional with experience in this type of construction should be consulted prior to finalization of design and construction.</p> <p><b>Note: Refer to Guidelines for:</b></p> <ul style="list-style-type: none"> <li>I.A. General Conditions for Construction</li> <li>II.A. Tennis Court Orientation</li> <li>II.B. Tennis Court Dimensions and Related Measurement</li> </ul>			
<p><b>NOTICE:</b> These Construction Guidelines are for use by architects, engineers, contractors and tennis court owners. Parties not experienced in tennis court construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.</p> <p>Copyright © 1998 by U.S. Tennis Court and Track Builders Association. All Rights Reserved.</p>			



# LONG BAY STRUCTURE COURT BUILDING SECTION



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Full Text Provided by ERIC

SECTION	ILL.	PAGE	1
TITLE  NET AND NET POST EQUIPMENT	REVISION DATE		1998
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1.0 Post Foundations			
<p>Post foundations should be not less than 18" in diameter at the top, not less than 30" at the bottom, and not less than 36" in depth, with side walls formed flat and square to each other. An extended concrete base at the bottom of the foundation, shaped like a foot pointing in the direction of the opposing net post, will increase the foundation's resistance to stress and strain of torque in the direction of force. Foundations should be so constructed as to provide a distance of 33' on a singles court and 42' on a doubles court, measured from center of post to center of post. Concrete for foundations should use well-graded rock, gravel or stone mixed in ratios attaining a compressive strength of not less than 3,500 lbs. per square inch at the 28th day after pouring. For asphalt courts, the top of the concrete foundation should be round to prevent radial cracking.</p>			
2.0 Net Posts and Sleeves			
<p>Net posts may be galvanized steel or aluminum. They may be installed in sleeves or installed permanently in foundations. Tennis post ground sleeves may be steel, aluminum or PVC. Circular posts should have an outside diameter of not less than 2 7/8", while square posts should not be less than 3" across. Minimum yield strength is 1,100 lbs., with a minimum of 1,500 lbs. tensile strength. Mechanical tensioning devices (worm gear, ratchet reel, or screw-type) are to be limited in the amount of force applied to the net post, not to exceed 1/2 post yield strength. Posts and post sleeves should be set 42' apart for a doubles court, measured from the center of one post to the center of the other. For tournament use, it is recommended that a second set of net post sleeves be supplied 33' (center to center) apart for singles play. Posts should be set plumb and true so as to support the net at a height of 42" above the court surface.</p>			
3.0 Center Strap Anchor			
<p>The ground anchor should be made from a strong, non-corrosive metal pipe not less than 10" in length, 1 5/8" o.d. minimum.</p> <p>A non-corrosive 1/4" o.d. pin is centered through the pipe 1/4" to 3/8" below the opening for the purposes of attaching a center strap hook.</p> <p>A center strap anchor should be set in concrete footings measuring 12" x 12" x 12". The base of the footing should be slightly larger (15" x 15") to avoid the possibility of heaving due to freeze/thaw action. The top of a concrete footing set in an asphalt court should be round to minimize radical cracking. The cross pin in the ground anchor should be flush with the court and parallel to the net.</p>			
4.0 Net			
<p>A regulation doubles tennis net is 42' (12.802m) long and 3'3" (991mm) high. A regulation singles net is the same height, but is only 33' (10.058m) long. Since according to the rules of tennis, net posts are set 42' (12.802m) apart for doubles and 33' (10.058m) apart for singles, measured from center to center, this creates an obvious problem—</p>			



how to install a 42' (12.802m) or 33' (10.058m) net, pulled taut with tension bars and cording, on the posts. To solve this problem, many net manufacturers actually offer nets slightly shorter than the regulation dimension (i.e. 41' 9" [12.725m] for a doubles net).

The net is composed of eight distinct parts referred to by various names. For the purpose of this Guideline, components are called the body, headband, cable, side bindings, bottom bindings, dowels, tie strings, and lacing twine.

**A. Body**

The net body should be weather resistant synthetic netting 1 3/4" square mesh and the tensile strength of the twine should not be less than 275 lbs.

**B. Headband (top binding)**

The headband should be made of two pieces or plies. The outer piece should be manufactured from a white synthetic material or white canvas, treated for resistance to sunlight and mildew. Inner and outer headbands should be folded over the cable and lock stitched with four separate rows of stitching the length of the net.

**C. Cable**

The cable should be fabricated from multi-stranded galvanized steel wire rope. It should have a minimum core diameter of 5/32" (excluding coating) and be 47' in length. Its tensile strength should be not less than 2,600 lbs. The cable may be vinyl coated.

**D. Side Bindings (tapes)**

Side bindings should be fabricated of black synthetic material, treated to prevent deterioration from sunlight. Five nickel or brass grommets should be placed equidistantly from top to bottom at each side of the net to accommodate the lacing twine after forming a pocket to accept dowels.

**E. Bottom Bindings (tapes)**

Bottom bindings should be made of black abrasion-resistant synthetic material, treated to prevent deterioration from sunlight.

**F. Dowels**

Dowels should be 3/8" - 5/8" round and a maximum of 40" in length and should be made of wood, metal or fiberglass.

**G. Tie Strings**

Tie strings should be made from black u.v. stabilized, synthetic cord, not less than 60" long, and having a breaking strain of not less than 275 lbs. One piece is required for each end of the net headband.

**H. Lacing Twine**

Lacing twine should be made from the same material as tie strings, but should be not less than 96" inches long. There should be one such piece for each side binding.

**5.0 Tautness and Center Height**

Check net tautness by suspending a 24 lb. (10.9kg) weight from the center of a singles net or a 14 lb. (6.36kg) weight from the center of a doubles net and wind the net slowly to a center height of 36" (914mm). Install the center strap and adjust it to maintain the



height of 36" (914mm). Remove the weight. This method produces a net cable tautness of approximately 500 - 550 lbs. (227 - 250kg).

When a weight is not available, net height is commonly adjusted by winding the net to a height of about 3' 4" (1.016m) at the center and using the center strap to pull the net down to 36" (914mm). This method is not recommended, however, since it may result in significant tautness variations from court to court.

For proper maintenance of court equipment and consistent ball response off the net, a net tensioning device is recommended.

#### **6.0 Center Strap**

A center strap is used to hold the net at the proper height of 36" at its center. A white strap 2" wide, made from canvas or synthetic material treated for resistance to sunlight and mildew, is used. A height adjusting non-corrosive buckle or buckles must prevent slippage when fully stressed. At the bottom of the strap, a non-corrosive spring loaded hook is used to attach the center strap to the ground anchor pin.

**Note: Refer to Guidelines for:**

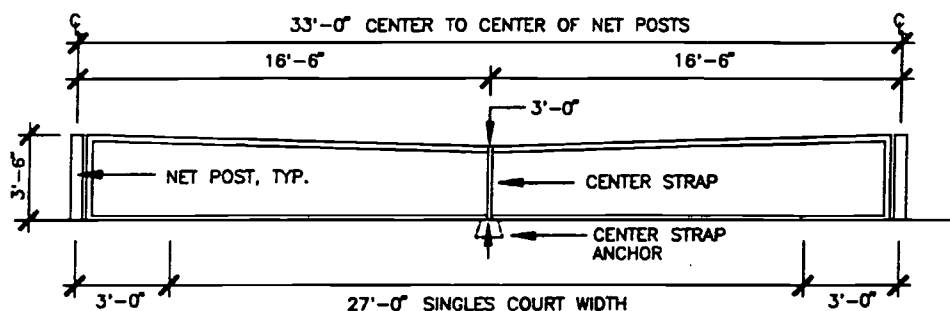
- I.A. General Conditions for Construction**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurement**

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and potential tennis court owners. Parties not experienced in tennis court construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

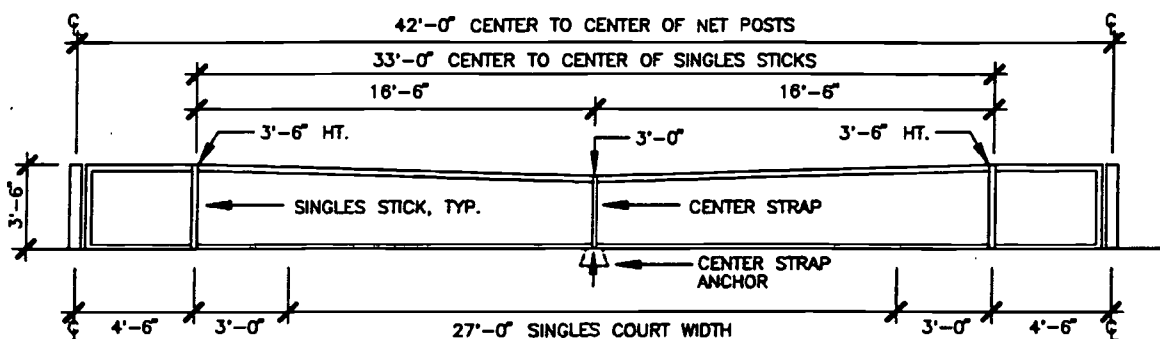
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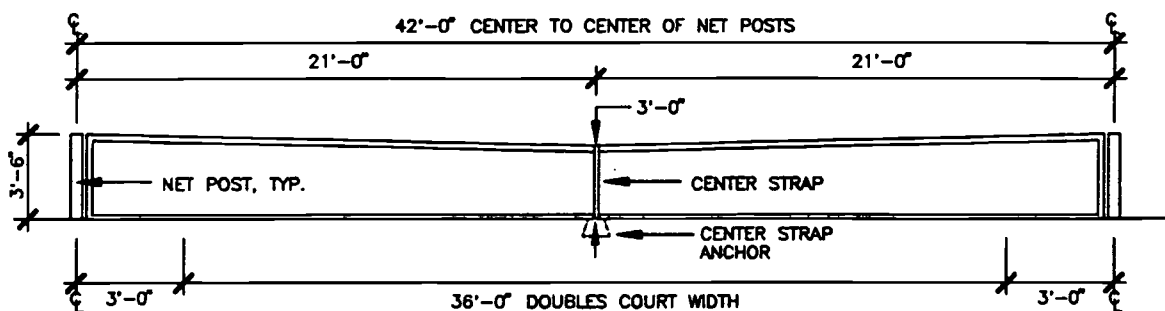
NOTE:  
THE NET SHOULD BE INSTALLED  
WITH A RECOMMENDED TENSION  
OF 500 TO 550 LBS.



SINGLES NET



DOUBLES NET W/SINGLES STICKS



DOUBLES NET

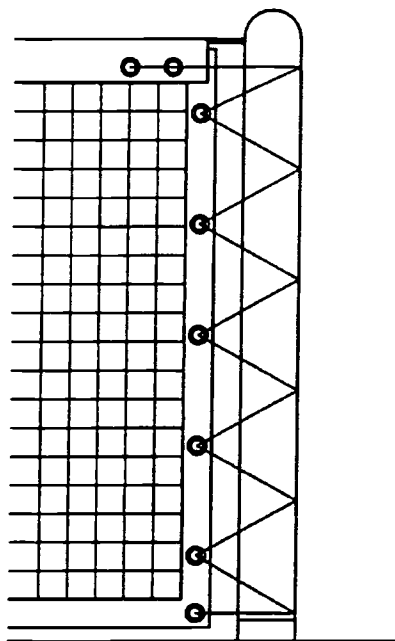
## TYPICAL TENNIS NET ELEVATIONS

NOT TO SCALE

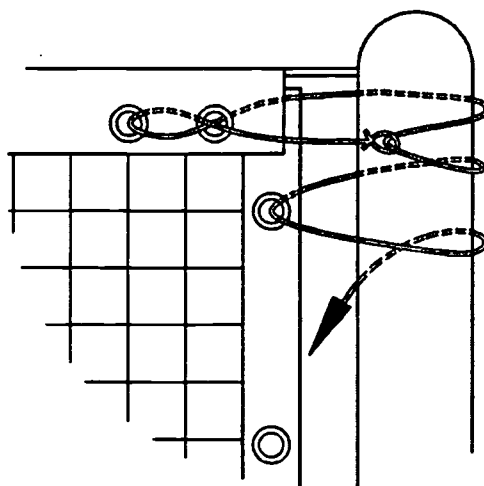


NET—ELEV

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TYPICAL ELEVATION OF A PROPERLY LACED NET



NET LACING DIAGRAM

## TYPICAL NET LACING DIAGRAM

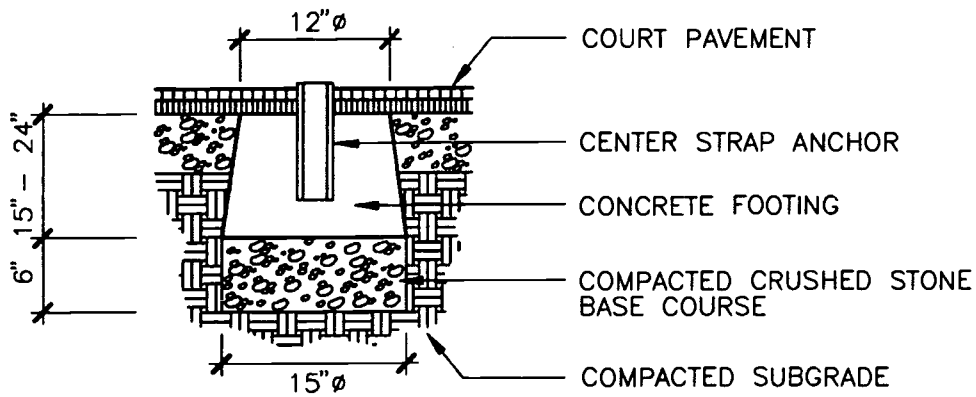
NOT TO SCALE



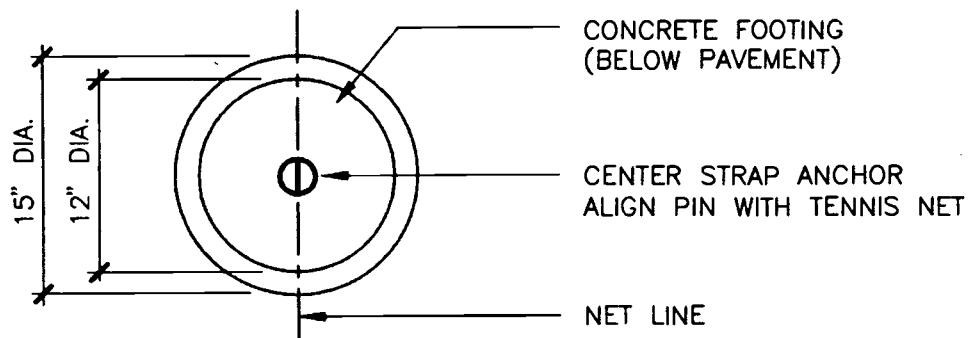
NET—ELV2

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NOTE:  
IN AREAS SUSCEPTIBLE TO  
FROST HEAVING, INCREASE  
FOOTING DEPTH TO 24".



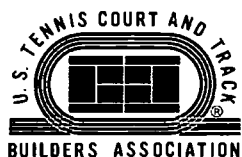
SECTION



PLAN

## TENNIS NET CENTER STRAP ANCHOR

NOT TO SCALE



CSTRAP

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<b>SECTION</b>	<b>IL.M.1.</b>	<b>PAGE</b>	<b>1</b>
<b>TITLE</b> <b>LIGHTING OUTDOOR</b> <b>TENNIS COURTS</b>		<b>REVISION DATE</b>	<b>1998</b>
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### **1.0 Introduction**

An effective way of creating more prime time hours of tennis play is to include lighting in plans for new courts or to light existing ones. Lighted outdoor courts can provide additional hours of play for working people who, because of limited daylight free time, have no other choice than to play at night. In some areas, daytime conditions (heat, glare, wind) can be uncomfortable, making play in the evening desirable.

There are several ways to illuminate tennis courts using various types and configurations of lighting systems. The purpose of this guideline is to set forth some of the factors that should be considered and some of the system components available to provide a lighting system to satisfy the requirements of a particular tennis facility.

### **2.0 Objectives of Proper Lighting**

- A. To make it easy to see and follow a ball at the time it is tossed in the air by the server, and while it is repeatedly hit and projected at every path it follows as long as it is in play.
- B. To minimize the glare from the lighting equipment.
- C. To design a system that is economical to install, clean, maintain and operate.

Be sure to note that it is not necessary to produce illumination simulating daylight, since the quality of the light is more important.

### **3.0 Quality of Light**

Quality of light is determined by a number of factors including uniformity of distribution, background colors and a non-glare light source.

Lighting levels should be as nearly uniform as possible within the entire playing space, including approximately 6' outside the sidelines and behind the base lines approximately 10' and/or within 10' of the back walls.

High Intensity Discharge (H.I.D.) fixtures are commonly used. Whatever the style of fixture employed, it is very important to avoid a source of high intensity concentrated in a small area visible to the player. An after-image of the light source in the player's eye causes him momentary blindness and he cannot see the ball during that time.

### **4.0 Quantity of Light**

The quantity of light is important, but must be considered along with other factors. In general, 60-75 footcandles average maintained is minimum while at least 75-100 footcandles average maintained is recommended for most facilities and 125 footcandles average maintained is minimum for professional, international, national and collegiate facilities. Televised events normally require 125 maintained foot-candles, however, recent developments in camera equipment do not require this high of illumination. Television networks should be contacted to determine the required lighting levels and locations for the event in question.

Light meter readings should be taken from a point 36" above the court surface with the light sensitized cell facing upward. The reading should include a location 6' outside the alley line of the court, and 10' behind the baseline. The variance from the average to the minimum or the maximum should be no more than 25%, preferably as low as 15%.

- A. Maintained illumination is determined by applying a light loss factor (LLF) to the initial calculated or measured foot-candle illumination. LLF depends on lamp characteristics, luminaire design, voltage variations, atmospheric conditions, and dirt accumulation. It can vary from 0.6 to 0.8. Consult manufacturer's publications for proper LLF values.
- B. Average maintained horizontal and minimum maintained horizontal illumination should be the calculated or measured and the values multiplied by the appropriate LLF.
- C. Uniformity ratio is defined as the ratio of maximum illumination divided by the minimum illumination.
- D. Primary Playing Area (PPA) is defined as an area measuring 48' by 98' or 6' outside the sidelines and 10' beyond the baselines.

#### **5.0 Location of Fixtures**

Lighting fixtures should be located outside playing lines, preferably parallel to the alley lines and outside the fence. On fast dry courts, location and selection of fixtures is particularly important since rain dripping off fixtures can damage the fast dry surface. Fixtures should be aimed to project light across the court to eliminate glare. When lighting a multiple court facility, no light poles should be placed between courts except at the net line unless there is at least 24' (7.315m) between courts. Any free standing lighting fixtures located inside the fence and more than 1' (305mm) from the fence should be heavily padded to reduce player injuries. Since players often stand at or behind the baseline during play, at least one fixture per side behind the baseline is recommended. Special caution should be exercised, however, to insure that fixtures are placed in such a way that players do not have to look directly toward a light behind the opposite baseline when serving or during normal play. For this reason, no lighting fixtures should be placed at the back of the court behind the principal playing area and lighting fixtures located at the corners should be on poles no less than 35' (10.668m) high and should be carefully aimed.

#### **6.0 Fixture Mounting**

New designs in HID sharp cut-off luminaires have reduced the required mounting heights to approximately 20' with good uniformity, low glare, reduced amounts of spill light onto the surrounding area, and easier maintenance than on higher poles. For floodlight type fixtures, 35' to 40' poles are frequently used.

All poles should be designed to withstand wind velocities as required by local codes. Mountain and coastal areas will typically require higher strength poles because of higher wind conditions. Unless specifically designed as such, light poles should not be used to support the tennis court fence in addition to the light fixtures. Attaching the fence to the light pole adds additional loading to the pole, which could cause it to fail, and electrical codes may prohibit it.

Spill light, or light pollution, has become a major issue in regard to tennis court lighting. Some tennis court lighting locations, generally those located close to residential areas, require special consideration in regard to the amount of impact the lighting system has

on the surrounding area. Low profile, sharp cutoff luminaires will generally have the least amount of impact in these locations, due to the low mounting height, reduced glare, and light control characteristics of this type of system. Lighting manufacturers can provide computer generated printouts showing the amount of light that will be projected outside of the court area.

## **7.0 Wiring**

Underground wiring is recommended for tennis court lighting, using direct burial cables or conductors in conduit. In general, the supply voltage selected should be the highest available. This usually results in 277/480 volt, three phase systems for large facilities, and 120/208 volt, single phase systems for smaller applications. Voltage drop can significantly affect the lumen output of the lamp. Conductors should be sized to limit the voltage drop to 5% or less from the source of the luminaire. All wiring must comply with the National Electrical Code and applicable local electrical and building codes. Consult these codes or a local electrical engineer for wire requirements and wire sizes.

Fluorescent, mercury, and high pressure sodium lighting are stroboscopic (flickering) in nature. This can be eliminated by using three phase wiring, with each alternate fixture on a different phase.

When cost considerations prevent the initial purchase of a lighting system, consider electrical capacity and the placement of conduit for future expansion at a slight increase in cost.

## **8.0 Control Devices**

Many types of control devices are available for tennis court lighting. A time clock device in conjunction with a photocell provides a good basic control system. Centralized switching, remote, or courtside time meters, and coin, token, or ID operated devices are available for different light sources. These options may be investigated for more convenient and efficient control to satisfy project requirements.

## **9.0 Costs**

Maintenance, operating, and initial costs should be considered. Initial costs include fixtures, poles, wiring, installation and control equipment. Operating and maintenance costs include electrical operating expenses, lamp and lens replacement, fixture cleaning and labor costs associated therewith.

## **10.0 Maintenance**

All luminaires should be periodically cleaned as recommended by the manufacturer to maintain maximum light output. As much as 30% of the light output can be lost over a period of time if the luminaires are not cleaned on a regular basis. Wipe lenses with a damp cloth since a dry cloth creates static electricity which causes dust to collect more rapidly. Louvres should be dipped in a cleaning solution, then in clear water. Both should be allowed to dry without wiping. Wear gloves when handling lamps since skin oils can reduce their efficiency and life.

Clean the fixtures at the same time relamping takes place. Relamping should occur at 75% of the rated life of the lamp. For economic reasons, it is recommended that all of the fixtures be relamped at the same time, rather than replacing one at a time. Consult luminaire manufacturer for maintenance instructions.



**11.0 Special Note**

Because of the numerous variables in designing a tennis court lighting system, it is recommended that an owner consult an engineer, architect or qualified tennis consultant or contractor who is completely familiar with tennis court lighting.

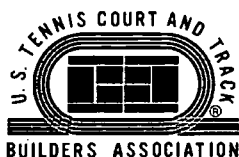
**Note: Refer to Guidelines for:**

- I.A. General Conditions for Construction**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurements**

RECOMMENDED ILLUMINATION FOR OUTDOOR TENNIS FACILITIES				
PERFORMANCE CRITERIA	RECOMMENDED			MINIMAL
	EXCELLENT	VERY GOOD	GOOD	FAIR
Average Maintained Horizontal Footcandles within PPA	125	100-75	75-50	50-30
Minimum Maintained Horizontal Footcandles within PPA	100	100-60	60-40	40
Maximum Uniformity Ratio	1.50	1.70	2.00	2.50

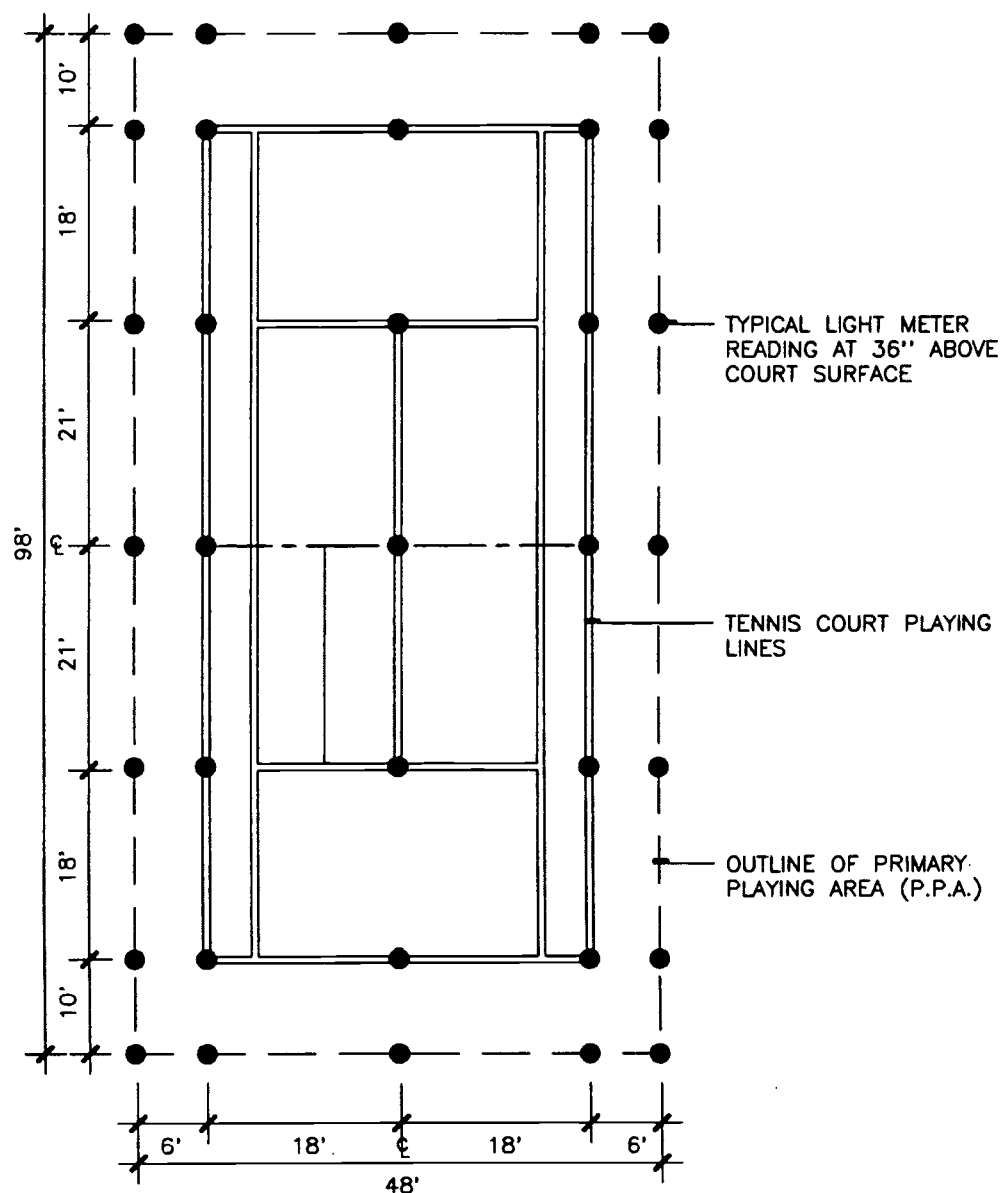
## NOTES:

1. Maintained horizontal foot candles is determined by applying a light loss factor (LLF) to the initial calculated or measured foot candles. LLF is dependent upon lamp characteristics, fixture design, fixture maintenance, voltage variations and atmospheric conditions. It normally varies between .6 – .85. Consult the *Illuminating Engineering Society Handbook* and fixture manufacturer's publications for proper LLF values.
2. Average maintained and minimum maintained horizontal foot candles should be calculated within the playing lines and/or within the Primary Playing Area (PPA) determined by the specifications of the project with foot candle values multiplied by the appropriate LLF.
3. Uniformity ratio is defined as the ratio of maximum foot candles divided by the minimum foot candles.
4. Primary Playing Area (PPA) is defined as the area that includes 6' beyond the sidelines and 10' behind the baseline.



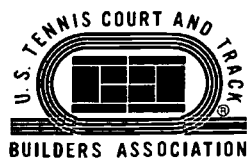
LIGHTING

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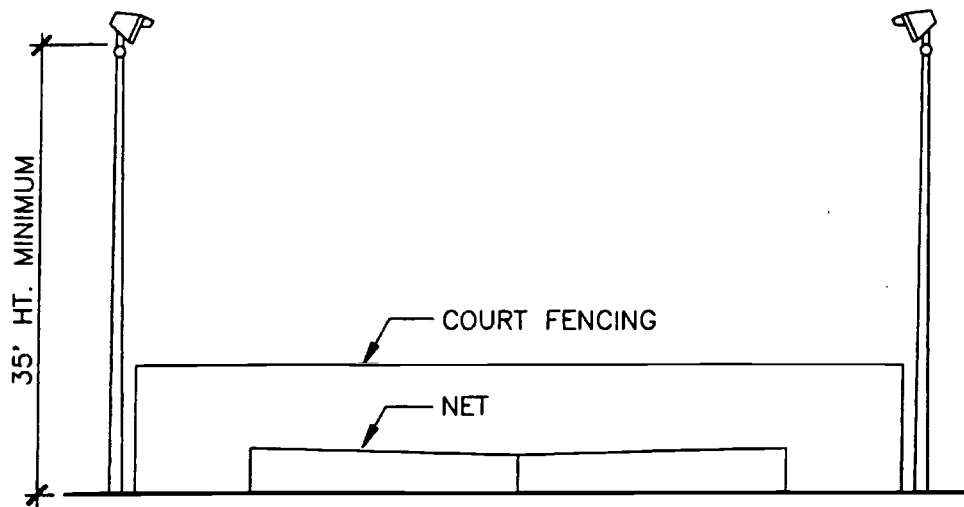
## LIGHT METER READING LOCATION DIAGRAM

NOT TO SCALE

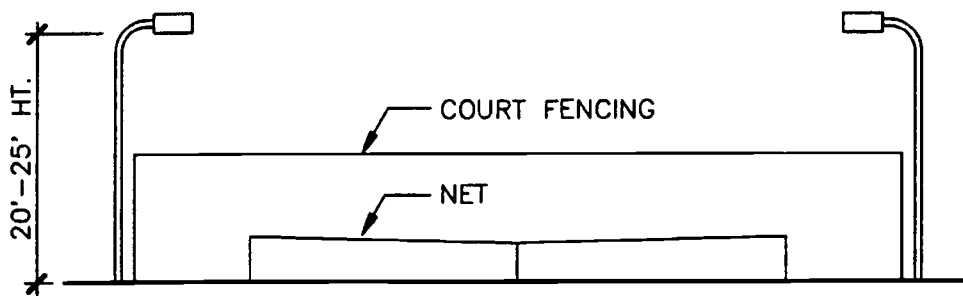


L—METER

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HIGH-MAST LIGHTNIG



LOW-MAST LIGHTING

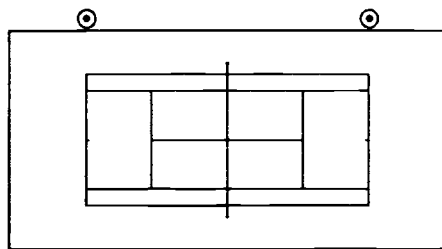
## TYPICAL COURT LIGHTING SECTIONS

NOT TO SCALE

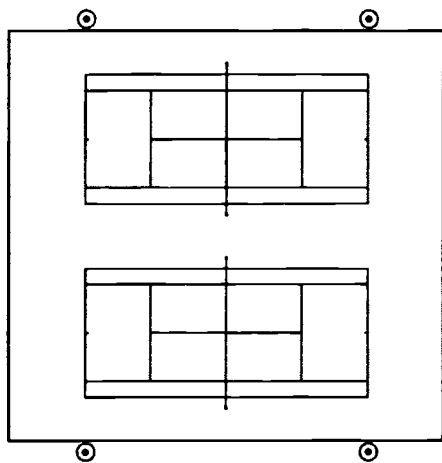


LIGHT—1

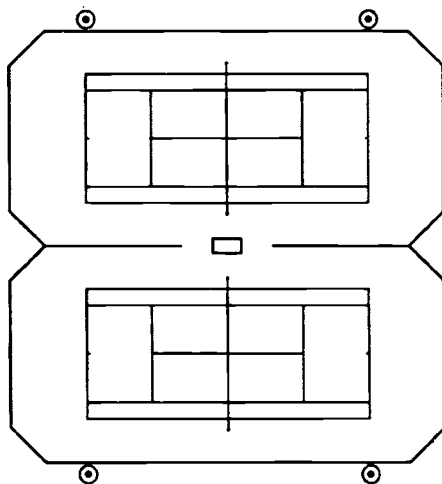
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ONE COURT LAYOUT



TWO COURT LAYOUT

TWO COURT LAYOUT  
W/ CUT CORNERS

## NOTES:

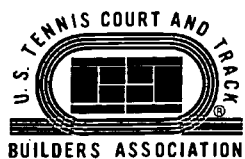
LIGHT FIXTURE HEIGHTS  
SHOULD BE 35' MIN.  
TO MINIMIZE GLARE IN  
PLAYERS' EYES.

RECOMMENDED LIGHT  
LEVELS:

1. EXCELLENT	125 FC
2. VERY GOOD	75 FC
3. GOOD	50 FC
4. MINIMUM	40 FC

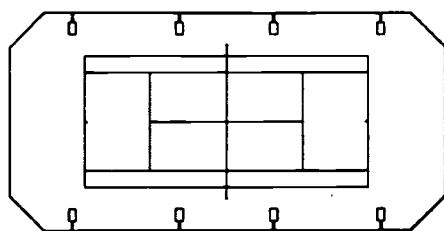
TYPICAL COURT LIGHTING—HIGH MAST

NOT TO SCALE

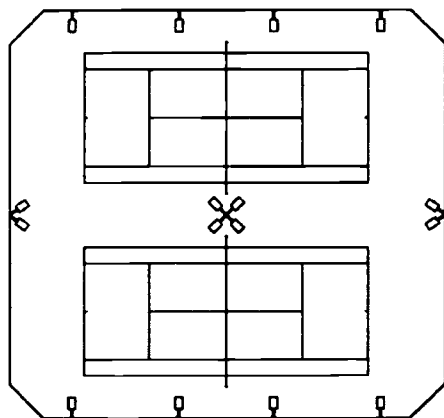


LIGHT—HM

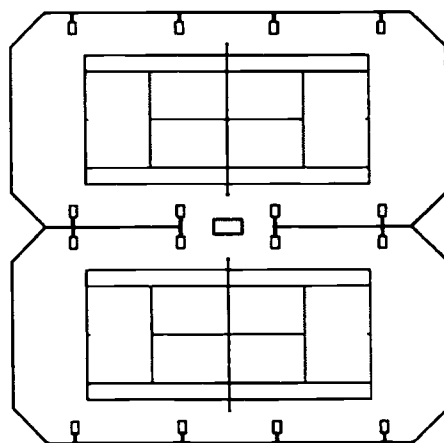
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ONE COURT LAYOUT



TWO COURT LAYOUT

TWO COURT LAYOUT  
W/ SHADE SHELTER

## NOTES:

NUMBERS OF LIGHT  
POLES, HEIGHTS, AND  
SPACING VARIES  
BY MANUFACTURER

RECOMMENDED LIGHT  
LEVELS:

1. EXCELLENT	125 FC
2. VERY GOOD	75 FC
3. GOOD	50 FC
4. MINIMUM	40 FC

← OFFSET GATE  
FOR LIGHT  
POLE, TYP.

TYPICAL COURT LIGHTING—LOW MAST

NOT TO SCALE



LIGHT—LM

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SECTION	I.I.M.2.	PAGE	1
TITLE  LIGHTING INDOOR TENNIS COURTS	REVISION DATE	1998	
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1.0 Introduction			
The following is not a specification for the lighting of indoor courts, because there are several ways of accomplishing desirable results in a wide variety of buildings. What is attempted is to provide Guidelines that should be considered in designing and specifying proper lighting for tennis courts.			
2.0 Objectives of Proper Lighting			
A. To make it easy to see and follow a ball at the time it is tossed in the air by the server, and while it is repeatedly hit and projected at every path it follows as long as it is in play.			
B. To minimize the glare from the lighting equipment.			
C. To design a system that is economical to install, clean, maintain and operate.			
Be sure to note that it is not necessary to produce illumination simulating daylight, since the quality of the light is more important.			
3.0 Quality of Light			
Quality of light is determined by a number of factors including uniformity of distribution, background colors and a non-glare light source.			
Lighting levels should be as nearly uniform as possible within the entire playing space, including approximately 6' outside the sidelines and behind the base lines approximately 10' and/or within 10' of the back walls.			
It is important to use colors that contrast with the tennis ball to a height of approximately 12' - 14' directly behind the court, high enough so that the background color is behind the ball on the service toss. Above these levels it is highly desirable to have a very light matte finish of uniform color including all structural members. On the walls adjacent to the length of the court (at the ends of the building), the contrasting colors should continue to at least the baseline of the court.			
High Intensity Discharge (H.I.D.) fixtures are commonly used. Whatever the style of fixture employed, it is very important to avoid a source of high intensity concentrated in a small area visible to the player. An after-image of the light source in the player's eye causes him momentary blindness and he cannot see the ball during that time. It is important to note that some H.I.D. fixtures cause "hot spots" from components of the fixture itself and/or from being located too close to the ceiling system. When H.I.D. fixtures are pointed towards the ceiling, it is very important to incorporate a reflective ceiling system to maximize lighting performance.			
If fluorescent fixtures are selected, lenses and louvers on the lighting fixtures will generally protect the eyes from excessive brightness provided that the diffusing lens is sufficiently far from the light source or the louvers are sufficiently close together. Louvers should provide a cutoff of approximately 45 degrees when looking parallel to the length of the court and 35 degrees at right angles to the length. If lenses are used, they should reduce glare. Florescent lighting is rarely used today.			

Lighting can be direct, indirect or direct/indirect. Up-lighting is very important in order to see the balls that go above the light source and to reduce the contrast between the lighting above and below the lighting fixtures. In general, it is advisable to have at least 40 percent of the light go upward.

#### 4.0 Quantity of Light

The quantity of light is important, but must be considered along with other factors. In general, 60-75 footcandles average maintained is minimum, 75-100 footcandles average maintained is recommended for most facilities and 125 footcandles average maintained is minimum for professional, international, national and collegiate facilities. Televised events normally require 125 maintained foot-candles, however, recent developments in camera equipment do not require this high of illumination. Television networks should be contacted to determine the required lighting levels and locations for the event in question.

Light meter readings should be taken from a point 36" above the court surface with the light sensitized cell facing upward. The reading should include a location 6' outside the alley line of the court, and 10' behind the baseline. The variance from the average to the minimum or the maximum should be no more than 25%, preferably as low as 15%.

- A. Maintained illumination is determined by applying a light loss factor (LLF) to the initial calculated or measured foot-candle illumination. LLF depends on lamp characteristics, luminaire design, voltage variations, atmospheric conditions, and dirt accumulation. It can vary from 0.6 to 0.8. Consult manufacturer's publications for proper LLF values.
- B. Average maintained horizontal and minimum maintained horizontal illumination should be the calculated or measured and the values multiplied by the appropriate LLF.
- C. Uniformity ratio is defined as the ratio of maximum illumination divided by the minimum illumination.
- D. Primary Playing Area (PPA) is defined as an area measuring 48' by 98' or 6' outside the sidelines and 10' beyond the baselines.

#### 5.0 Lighting Fixtures and Lamps

Lighting fixtures of nearly any type can be employed if they conform to the requirements of quantity, even distribution, low intensity of surface brightness and minimized contrast between the light source and the ceiling above. Lamps such as high-intensity discharge, fluorescent, mercury or incandescent can be used.

H.O. fluorescent lamps usually produce approximately 75 lumens per watt, have a life of approximately 18,000 hours based on 12 hours per start, and have good color rendition; the light efficiency remains high, and the lamps reach full brightness immediately. If lenses are used, they must be either non-breakable or protected against a direct hit by a tennis ball. Louvres must also be resistant to bending from a direct ball hit by means of close spacing of reinforcement or by means of sufficiently thick metal.

To avoid losing efficiency, four lamp fluorescent fixtures should be at least 24" wide. Six or eight lamp fixtures should be at least 30" wide.

Metal halide lamps produce approximately 110-125 lumens per watt, have a life of approximately 10,000 - 12,000 hours based on 10 hours per start, and have a good color rendition. Light efficiency drops approximately 10% in the first 5,000 hours and another 10% in the second 5,000 hours. Such lamps reach full brightness in about five minutes, but require about 15 minutes to cool down and come to full brightness again after being turned off.



NOTE: More frequent starting and stopping will reduce lamp life. Lamps must be protected from the ball coming down from the top.

Lamps must be easily changed.

Fixtures and lamps must be easily cleaned. Every fixture should be cleaned at least twice a year.

Daylighting by means of windows in the wall or skylights in the roof is not desirable. Outside lighting is much more intense than indoor lighting, causing an undesirable contrast. Outside lighting varies in intensity, and is, therefore, undependable; it may also cause glare, condensation and maintenance problems.

#### **6.0 Placement of Fixtures**

Placing of visible light sources directly over the playing area should be avoided. It is better to keep any visible light sources over or outside of the court alleys.

#### **7.0 Direct or Direct/Indirect Systems**

If fluorescent lighting fixtures are placed 16' to 22' over or outside the alleys parallel with the length of the court, they can be tilted inward to give more light to the center of the court and less to the outside. They should be placed parallel to the court surface, not sloped with the roof since this makes the light source more visible and objectionable to the player on the opposite side of the court.

Down-lighting very close to the ceiling generally creates strong contrasts with the darker ceiling, making it difficult for the player to follow a lob.

#### **8.0 Indirect Lighting Systems**

Lamps in fixtures aimed at a ceiling that is white bounce the light back to the playing area.

The number of lighting fixtures depends upon the efficiency of the fixture, the height and reflectivity of the ceiling and the level of lighting desired. These fixtures are usually mounted on a pendant and individually hung from the structure. They can also be mounted on a channel parallel to, but outside of, the sidelines. There are also two or three lights per court mounted parallel to and behind the base lines.

These high intensity lights should not be mounted any closer to the roof or structural members than about 6' or a "hot spot" will occur.

Some fixtures will require greater distances, depending upon their light distribution. It is important to note that the ceiling must have a reflective finish.

The open tops of the fixtures must have wire guards on them to prevent balls from falling on the lamps inside the fixtures.

#### **9.0 Wiring**

Underground wiring is recommended for tennis court lighting, using direct burial cables or conductors in conduit. In general, the supply voltage selected should be the highest available. This usually results in 277/480 volt, three phase systems for large facilities, and 120/208 volt, single phase systems for smaller applications. Voltage drop can significantly affect the lumen output of the lamp. Conductors should be sized to limit the voltage drop to 5% or less from the source of the luminaire. All wiring must comply with the National Electrical Code and applicable local electrical and building codes. Consult these codes or a local electrical engineer for wire requirements and wire sizes.

Fluorescent, mercury, and high pressure sodium lighting are stroboscopic (flickering) in nature. This can be eliminated by using three phase wiring, with each alternate fixture on a different phase.

#### **10.0 Control Devices**

Many types of control devices are available for tennis court lighting. A time clock device in conjunction with a photocell provides a good basic control system. Centralized switching, remote, or courtside time meters, and coin, token, or ID operated devices are available for different light sources. These options may be investigated for more convenient and efficient control to satisfy project requirements. Switching lights on and off at the counter is desirable.

#### **11.0 Costs**

Maintenance, operating, and initial costs should be considered. Initial costs include fixtures, poles, wiring, installation and control equipment. Operating and maintenance costs include electrical operating expenses, lamp and lens replacement, fixture cleaning and labor costs associated therewith.

#### **12.0 Maintenance**

All luminaires should be periodically cleaned as recommended by the manufacturer to maintain maximum light output. As much as 30% of the light output can be lost over a period of time if the luminaires are not cleaned on a regular basis. Wipe lenses with a damp cloth since a dry cloth creates static electricity which causes dust to collect more rapidly. Louvres should be dipped in a cleaning solution, then in clear water. Both should be allowed to dry without wiping. Wear gloves when handling lamps since skin oils can reduce their efficiency and life.

Clean the fixtures at the same time relamping takes place. Relamping should occur at 75% of the rated life of the lamp. For economic reasons, it is recommended that all of the fixtures be relamped at the same time, rather than replacing one at a time. Consult luminaire manufacturer for maintenance instructions.

#### **13.0 Special Note**

Because of the numerous variables in designing a tennis court lighting system, it is recommended that an owner consult an engineer, architect or qualified tennis consultant or contractor who is completely familiar with tennis court lighting.

**Note: Refer to Guidelines for:**

- I.A. General Conditions for Construction**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurement**
- II.K.2. Indoor Tennis Curtains, Dividers and Pads**
- II.M.1. Lighting Outdoor Tennis Courts**
- II.T. Indoor Tennis Air Structure Construction**

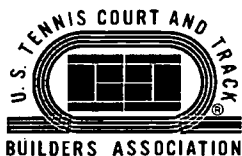
**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and tennis court owners. Parties not experienced in tennis court construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

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RECOMMENDED ILLUMINATION FOR INDOOR TENNIS FACILITIES				
PERFORMANCE CRITERIA	RECOMMENDED			MINIMAL
	EXCELLENT	VERY GOOD	GOOD	FAIR
Average Maintained Horizontal Footcandles within PPA	125	100-75	75-60	50
Minimum Maintained Horizontal Footcandles within PPA	100	100-60	60-50	40
Maximum Uniformity Ratio	1.50	1.50	1.70	2.00

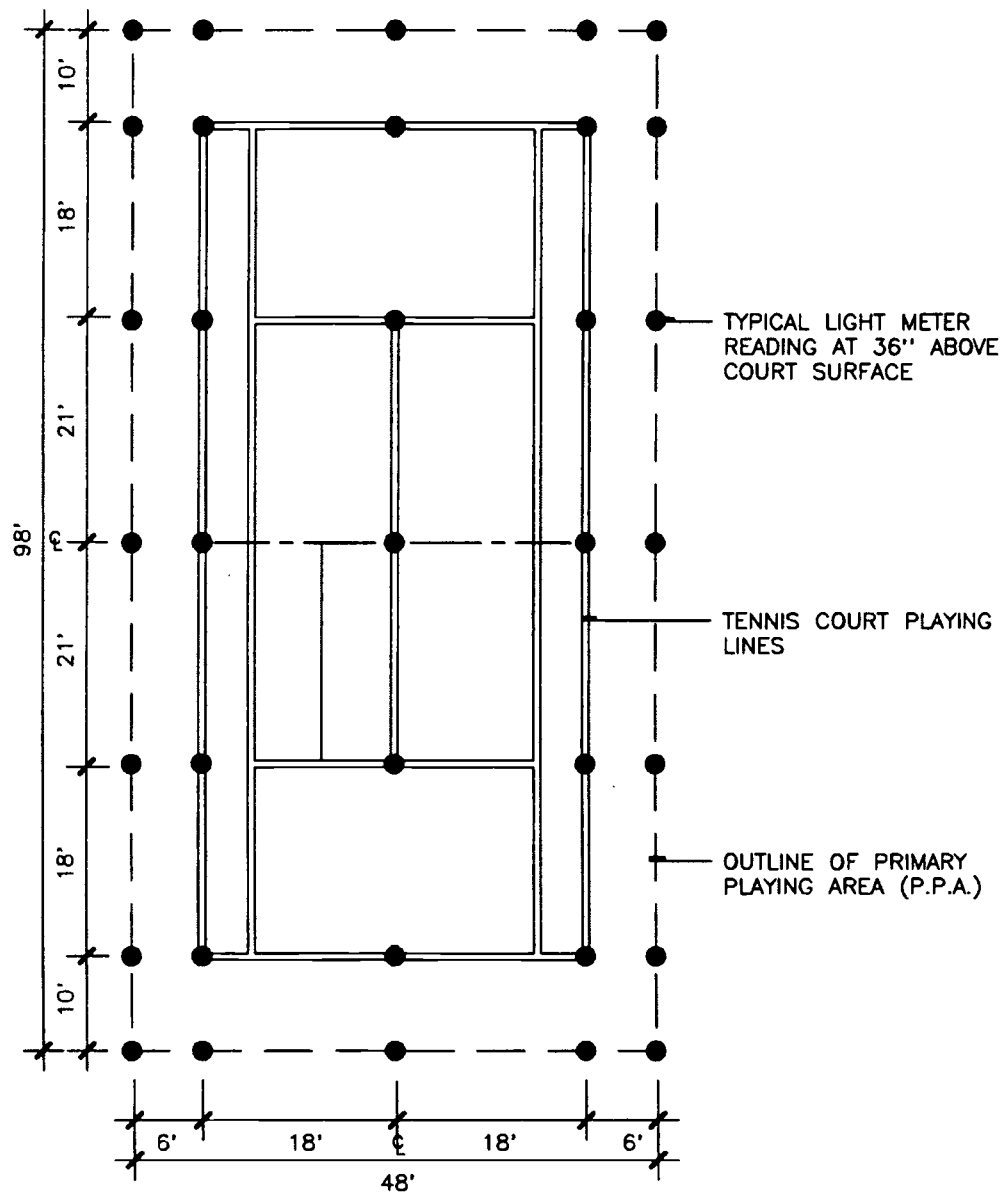
## NOTES:

1. Maintained horizontal foot candles is determined by applying a light loss factor (LLF) to the initial calculated or measured foot candles. LLF is dependent upon lamp characteristics, fixture design, fixture maintenance, voltage variations and atmospheric conditions. It normally varies between .6 – .85. Consult the *Illuminating Engineering Society Handbook* and fixture manufacturer's publications for proper LLF values.
2. Average maintained and minimum maintained horizontal foot candles should be calculated within the playing lines and/or within the Primary Playing Area (PPA) determined by the specifications of the project with foot candle values multiplied by the appropriate LLF.
3. Uniformity ratio is defined as the ratio of maximum foot candles divided by the minimum foot candles.
4. Primary Playing Area (PPA) is defined as the area that includes 6' beyond the sidelines and 10' behind the baseline.



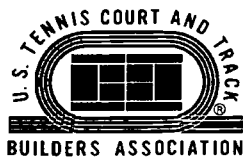
## LIGHTING

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## LIGHT METER READING LOCATION DIAGRAM

NOT TO SCALE



L—METER

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SECTION	II.N.	PAGE	1
TITLE RECONDITIONING FAST DRY TENNIS COURTS	REVISION DATE		1998
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1.0	Definition		
	Fast dry is a porous tennis court surface material consisting of natural crushed stone, brick, or tile, that is ground, screened, well graded, and may or may not be mixed with a chemical binder to form a stable homogeneous mixture having an affinity for water.		
2.0	Introduction		
	Periodic reconditioning is important to both the performance and life of a fast dry tennis court. Proper maintenance, both daily and yearly, will maintain a tennis court in good playing condition and extend the useful life of the court.		
	Reconditioning is the seasonal replacement of surfacing material lost due to play, wind and water erosion.		
3.0	General Requirements		
	An annual application of approximately 5 lbs./sq. yd. (2.8 kilos/sq. m.) of fast dry surface material should be applied, depending on type of irrigation system, intensity of play, and local climatic conditions. 5 lbs./sq. yd. (2.8 kilos/sq. m.) represents 2 tons (1814.4 kilos) per court.		
4.0	Procedure		
A.	Preparation		
	In preparation for reconditioning, the fast dry court should be cleaned of debris, groomed by brushing, and then rolled. The rolling insures the bonding of all usable material. After rolling, the excess loose ("dead") granules should be gathered into piles and removed from the court. Extra care should be exercised not to remove more material than necessary. If blowers are used, caution should be exercised so as not to remove usable surface material.		
	The loose ("dead") granules may be used at a later time as top dressing material on bald, slick and wet areas and on subsurface irrigated fast dry courts.		
B.	Location of Depressions		
	Depressions are generally located in the base line and in the service court areas. Exact locations may be determined by circling areas retaining water after a rain, as well as by stretching a string line in several directions and marking low areas.		
C.	Correction of Minor Depressions		
	The correction of a depression may necessitate the removal of portions of the line tapes.		
	Ideally, the court should be relatively dry before applying new surfacing.		
	The depression should be scarified to a depth of 1/8" (3mm) to 1/4" (6mm) and filled with new fast dry surface material. The new surface material should be spread and compacted in a dry state, then leveled to surface grade with a		

straightedge, scraping off any excess materials. The area should be watered to its full depth and compacted. After watering, light play may resume.

Occasionally, the new surface material may have a tendency to shift and adhere to the roller. In cases where shifting persists, the area should be cut out to a depth of 1" (25 mm) below the grade and filled with new fast dry surface material. The new surface material should be compacted by hand and leveled. After watering and rolling, play may resume when the patch is firm. After play, additional maintenance may be required to these repaired areas for several days.

**D. Correction of Major Depressions**

In the event that a depression is too broad for a straightedge, a "screed strip" should be placed in the center of the depression with the top edge set at surface grade. This strip should be set with an instrument or by stretching a string line to points at proper surface grade outside the depression.

In leveling the newly applied fast dry surface material, one end of a straight-edge should rest on the screed strip with the other end on the court area outside the depression. The screed strip acts as a guide for leveling each half of the depression. After the surface material is installed, the screed strip is removed and the remaining void patched with surface material.

For correction of major depressions, it is advisable to contact a qualified tennis court contractor or surface manufacturer.

**E. Correction of High Spots in the Aggregate Base**

In areas where the base is high, to the extent that aggregate is exposed in localized areas, the surface and aggregate should be removed to 1" (25 mm) below surface grade and filled with new fast dry surface material. After the surface material is compacted and leveled, the area should be watered and rolled. Play may resume when the patch is firm.

**F. Top Dressing**

After the loose "dead" material has been removed and the depressions filled and compacted, appropriate top dressing material should be applied. Above ground irrigated courts and subsurface irrigated courts may require different top dressing materials. It may be advisable to contact a qualified tennis court contractor or surface manufacturer to determine the appropriate material. A fertilizer-type spreader may be used to apply the top dressing material in several directions, brushing afterwards. If a spreader is not available, the fast dry top-dressing material should be applied by spacing the bags evenly and spreading the material as uniformly as possible. The newly applied surfacing should then be brushed in several directions to insure a uniform distribution of the material. The top-dressing material should be hand-watered with a fine spray and rolled. All line tapes which have been removed should be reinstalled.

It may be necessary to brush, water and roll successively over several days to insure a bonding of the top-dressing to the existing fast dry surface before resuming play.

The same procedure should be repeated if additional applications are required.

Subsurface irrigated courts may require special procedures.

**5.0 Courts Requiring Additional Conditioning**

Courts which are badly worn may necessitate the use of more than the normal 5 lb./sq.

yd (2.8 kilos/sq. m.) (2 tons). The additional fast dry should be applied according to the procedure above in applications not to exceed 5 lb/sq yd (2.8 kilos/sq. m.). It is not recommended that more than 10 lbs/sq yd (5.7 kilos/sq. m.) (4 tons) be used as a top dressing. Courts worn to a greater extent should be resurfaced with no less than 80 lbs/sq yd (45.6 kilos/sq. m.) (32 tons) using screed strips and a proper straightedge or laser controlled techniques as discussed in Section 6.0.

For courts requiring extra conditioning, it may be advisable to contact an experienced contractor or manufacturer.

#### **6.0 Laser Controlled Resurfacing**

Fast dry courts that have lost their original slope and planarity may be regraded using laser controlled equipment, returning the court's proper slope and planarity. Prior to determining the amount of new fast dry surfacing required, the court or courts should be surveyed on a 20' grid, recording the surface elevations and the depth of surface material. After regrading, a minimum of 1" of compacted fast dry surface should be maintained throughout.

Again for courts requiring this type of resurfacing, a qualified tennis court contractor and/or surface manufacturer should be consulted.

**Note: Refer to Guidelines for:**

- I.A. General Conditions for Construction**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurement**
- II.D.1. Fast Dry Tennis Courts for Use with Above Surface Irrigation**
- II.D.2. Fast Dry Tennis Courts for Use with Subsurface Irrigation**
- II.F.1. Above Surface Irrigation Systems for Clay and Fast Dry Tennis Courts**
- II.F.2. Retrofit Subsurface Irrigation Systems for Fast Dry Tennis Courts**

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and tennis court owners. Parties not experienced in tennis court construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

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SECTION	II.O.	PAGE	1
TITLE ACRYLIC COLOR FINISH SYSTEMS FOR TENNIS COURTS	REVISION DATE		1998
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1.0 Introduction			
The following is not intended to be a specification for color finish materials. These Guidelines provide minimum standards for the preparation and application of color finish surfaces to impervious tennis courts. There are several basic methods and/or types of materials that will accomplish the desired results.			
2.0 Objectives			
A. To provide a surface properly drained, without depressions exceeding acceptable tolerance.			
B. To provide a surface of uniform texture, speed of play and desired playing quality.			
C. To provide a weather-resistant and ultra-violet-resistant, durable, non-glare, protective finish.			
D. To provide color, contrast and other aesthetic values.			
3.0 Surface Inspection			
Prior to application of a color finish system, the court surface should be flooded with water and allowed to drain for one hour at 70 degrees Fahrenheit. If there is any remaining water that covers a 5 cent piece (American coin), that area, commonly called a "birdbath", should be patched and leveled in accordance with recommendations of the manufacturer of the color finish system specified. (Note: If the standing water does not cover a 5 cent piece, it is considered within tolerance and will evaporate within a reasonable time.) Reflooding and patching may be necessary until "birdbaths" are properly minimized.			
4.0 Preparation			
Surface course and subsurface materials must have been installed to proper slope requirements (.833% - 1.0%) in accordance with the U.S. Tennis Court and Track Builders Association Construction Guidelines and must be thoroughly cured (a minimum of 14 days for asphalt and 28 days for concrete), before application of any filler or color finish materials.			
A. Asphalt - Based on pavement conditions, porosity and texture, and upon completion of patching, it may be necessary to install an acrylic and/or asphalt emulsion resurfacer to provide a smooth, dense, uniform texture for subsequent acrylic color coatings. Asphalt emulsion products may be used only if approved by the color system manufacturer. Follow the instructions of the surfacing material manufacturer in the application of any resurfacer.			
B. Concrete - Surface preparation should include phosphoric acid etching with a thorough rinsing. Priming and patching should be as recommended by the acrylic surface manufacturer. Based on pavement conditions, porosity and texture, it may be necessary to install an acrylic resurfacer to provide a smooth, dense, uniform texture for subsequent acrylic color coatings.			



**5.0 Coating Materials**

Coating materials should be 100% acrylic emulsions, formulated with acrylic resins, mineral fillers, color fast pigments and approved silica sand. Both filler and finish coats should be fully pigmented, assuring the owner a uniform finish and consistent color throughout. Consult a qualified tennis court contractor, engineer or architect for assistance.

**A. Colored Texture Coats**

Once the surface has been properly prepared and has cured, the next step is the application of the texture materials as recommended by the manufacturer of the color finish system to achieve a uniform texture on the court. Application rates should be expressed in undiluted gallons per square yard.

**B. Color Finish**

The final coat may or may not contain aggregate, depending upon the finish desired. It is recommended that, wherever feasible, the finish coat be applied parallel to the net in the inbounds area. Application rate should be expressed in undiluted gallons per square yard.

**C. Cushion Coat**

Color finish systems may, at the owner's option, include resilient layers. Proper installation in accordance with the manufacturer's recommendations is of prime importance.

Each layer of cushion will improve the final performance and comfort of the court surface. Consult a qualified contractor, engineer or architect to assist in selecting the most appropriate system and the most effective method of application. This will assure the owner of the desired resilience and playing quality.

**6.0 Color Selection**

The available selection of colors enables the owner to select different combinations of multi-tone or single colors. While custom colors are available, the use of standard colors is recommended. Some custom colors may not be colorfast in exterior exposures.

**7.0 Application of the Color Materials**

The coating materials should be installed in multiple applications in the selected and approved colors, so as to form a true, uniform texture and color. Minor aesthetic differences may be seen when viewing the court from different angles and under different light conditions. Application work should be performed by skilled mechanics in a workman-like manner and in accordance with the manufacturer's standard printed instructions. No work should be performed when rain is imminent. Temperature must be 50 degrees Fahrenheit and rising for application. Surface temperatures in excess of 140 degrees Fahrenheit may not allow proper film formation.

**8.0 Playing Lines**

Base lines should not be more than 4" wide and playing lines not more than 2" wide, accurately located and marked in accordance with rules of the United States Tennis Association and painted with a paint recommended or approved by the manufacturer of the color finish material. Use of traffic, oil, alkyd, or solvent-vehicle type paint is prohibited. The painting should be done by skilled mechanics in a workman like manner in accordance with the manufacturer's standard printed instructions. At no time should the playing lines or the line dimensions vary more than 1/4" from the exact measurement.

**Note: Refer to Guidelines for:**

- I.A. General Conditions for Construction**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurement**
- II.G. Reinforced Concrete Tennis Courts**
- II.H. Post-Tensioned Concrete Slab Tennis Courts**
- II.I. Hot Mix Asphalt Tennis Courts**

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<b>SECTION</b>	<b>I.I.P.</b>	<b>PAGE</b>	<b>1</b>
<b>TITLE</b> <b>RESURFACING ASPHALT</b> <b>TENNIS COURTS</b>	<b>REVISION DATE</b>		<b>1998</b>
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## 1.0 Introduction

Asphalt-bound tennis surfaces, by far the most prevalent type of construction, require resurfacing periodically. This resurfacing can range from a simple new color finish system to full asphalt overlay(s). It is recommended that the owner consult a qualified tennis court contractor, professional engineer or architect.

Prior to installation of the new surface, special attention should be given to defects in the existing surface resulting from improper original construction or from other causes. Some of these defects and their causes are listed below.

### A. Drainage - Subsurface

Improper perimeter drainage can cause excessive subsoil expansion that results in greater damage to the surface from freeze/thaw action and can, in turn, cause the surface to heave and create "birdbaths." Also, this condition can cause loss of color and permit dirt and silt to wash onto the surface. By lowering the elevation of perimeter drainage swales, and consequently lowering the water table, this condition is improved or corrected. If wet conditions are encountered, a subsurface perimeter drainage system such as a perforated pipe in stone aggregate is advisable.

### B. Drainage - Surface

Puddling or "birdbaths" can be corrected or greatly improved by patching or overlay but only if the original surface was installed to essentially the correct recommended slope of .833% to 1% on a true plane from side to side, end to end or corner to corner. (Side to side is recommended if site conditions allow.) If the existing asphalt has lost its life and a complete asphalt overlay is dictated, depressed areas of 3/8" or less are generally corrected by the overlay. Depressed areas in excess of 3/8" should be patched prior to the overlay. On the other hand, if the existing surface is essentially sound and relatively free of expansive cracking, simple filling and leveling of depressed areas would correct or greatly improve major "birdbaths."

### C. Expansive Cracking

Expansive cracking is a fairly common condition encountered in older tennis surfaces and is directly related to the expansive nature of the subsoil, degree of oxidation, atmospheric temperature variations, improper original construction and/or other causes including substrate movement or other acts of nature.

The use of various geotextile mats or membranes in conjunction with a hot plant mix asphalt overlay has been the successful method employed to bridge expansive cracking, but it should be stressed that this method is NOT consistently successful. Specifically, it should be stressed that NO method employed to bridge expansive cracking is consistently successful short of removing the existing surface and correcting the cause of the problem before installing a new one.

**2.0 Range of Resurfacing Procedures****A. Color Finish System**

The application of a new multiple coat acrylic color finish system in accordance with manufacturer's directions is dictated over a surface essentially sound but showing loss of color and texture. Prior to application of the color system, "bird-baths" should be corrected by patching with an appropriate patching product, and possibly finished with one or more applications of acrylic resurfacer. This acrylic resurfacer is generally applied by squeegee and is intended to blend the patching with surrounding areas to a uniform texture.

**B. Complete Overlay**

The application of a complete in-depth hot mix overlay is dictated over surfaces that are badly oxidized or aged. In addition, an in-depth overlay is recommended to improve poor planarity and/or surface drainage. A poorly constructed base or drastic variations from a true plane are factors that should be considered in determining the depth of the overlay.

**C. Methods of Repair****1. Hot Asphalt Overlay Method**

Prior to the 1" overlay, a leveling course of dense asphalt may be necessary for correcting the planarity of the court surface. This is a method of placing 1" (compacted) or more of hot plant mix asphalt over an existing asphalt tennis court. The overlay system can be successfully done over a court that has minor faults; however, it may not prevent the reappearance of cracks from the slab beneath. To improve adhesion of the overlay to the existing slab or levelling course, a tack coat or a bond coat of emulsified asphalt should be used.

**2. Full Depth Repair**

In any patching, the area requiring a patch should be cleared of all loose material, dust and dirt. Any defective materials should be removed to the full depth of the defect. If the defect is in the asphaltic courses but is caused by a failure of the underlying base course, the defective base material should also be removed. If it is necessary to replace base course material, it should be ascertained that the subgrade condition is as it should be prior to replacing any base course. If the subgrade requires attention, it should be brought up to specification requirements prior to patching any of the asphaltic courses which the base course supports.

A tack coat, in accordance with the manufacturer's specification, must be applied to the bottom and sides of the patch, and allowed to cure thoroughly.

If the defective material is old asphalt pavement, and the depth of the defective material and the subsequent repair will exceed 3/8", hot plant mix asphalt may be used. The compacted lift should be brought to the elevation of the surrounding sound surface.

**3. Geotextile Membranes****a. Subgrade Use**

In major repairs, it may be necessary to spread the load of the tennis court more evenly over a larger area of the subbase. By

using such materials as geotextile membranes beneath the base course of the stone or aggregate, the load will be spread, reducing the possibility of settlement or reflection of the subgrade problem. This method can be used to localize the reconstruction or possibly to avoid major reconstruction.

**b. In Combination with Asphalt Overlay**

Use of geotextile membranes in overlays has become popular in road resurfacing. This method can reduce the need for reconstruction and minimize the cost of repairs. Consult geotextile manufacturers for appropriate construction methods.

**4. Stone Slip-Sheet**

This construction consists of a layer of crushed stone or aggregate overlaid with hot mix asphalt. The thickness of the aggregate layer will vary depending on the site condition. Once fine graded, the court is overlaid with hot mix asphalt, in two lifts, a 2" compacted lift of base asphalt and a 1" compacted lift of surface asphalt. Under certain conditions, one compacted lift of surface asphalt may be used over stone base.

This method can be used to repair tennis courts with a crown at the net without major reconstruction. It is also used to increase pitch on a level court without drainage and to overlay major surface failures and minimize the reflection of the problem.

**5. Asphalt Surface Course**

The final course of the asphalt should consist of a minimum compacted 1" thick mixture of asphalt and aggregate not to exceed 3/8" in size.

The proper type of asphalt used for the surface course will vary from state to state if using the standard norm of the Department of Transportation (DOT) or State Highway Department standards.

**Thickness:** Not less than 1 1/2" prior to compaction.

**Liquid Asphalt or Bitumen:** Not less than 5.5% by weight.

**Asphalt Penetration or Type:** 85-100 penetration.

**Aggregate Type:** Crushed stone, gravel, shale, limestone, etc. No foreign materials; i.e., pyrite, clay, ferrous compounds, dirt or organic material should be acceptable.

**Voids Content:** Minimum as specified by the Department of Transportation or State Highway Department, but in no case should voids content exceed 7%.

**Spreading and Compacting:** Hot plant mix should be spread and compacted by methods and in a manner that produces uniform density and thickness.

**Installation Equipment:** Self-propelled paving machine with heated vibratory screed.

**Rolling:** Not less than 3 to 5 ton tandem steel wheel finish roller.

**Finish Rolling:** Not less than 1 ton tandem steel wheel finish roller.

**Flood Check:** Any ponding or "birdbaths" remaining after 1 hour at 70 degrees F in sunlight which cover a five cent piece (American coin) should be filled prior to any further applications.

The finished surface should slope not less than 0.83% (1:120) but no more than 1% (1:100). Each court must slope on a true plane, preferably from side to side (but from end to end or from corner to corner are also acceptable), or in the shortest direction for good drainage and water runoff. The court should never be sloped from the net line to the baseline, from the baseline to the net line, from the sides to the centerline or from the centerline to the sides.

The finished surface of the court should not vary more than 1/8" in 10" when measured in any direction.

**6. Post-Tension Concrete Slab**

This method can reduce the need to remove or reconstruct the tennis court, serving as a feasible means for correction when site access is limited or conditions are confining. It is important to consult with a qualified contractor, architect or engineer to determine the feasibility of this method.

**7. Pre-manufactured and Modular Surface Systems**

This method can be considered if you find no evidence of base or sub-base failure or vertical deflection. These systems serve to retrofit existing courts without major disruption to site conditions such as fencing, net posts, landscape and drainage.

**8. Surface Repair**

**a. Birdbaths**

Any areas holding enough water to cover a five cent piece (American coin) after draining a minimum of one hour at a minimum of 70 degrees Fahrenheit in sunlight, should be outlined with chalk and the water swept out. After the area is cleaned and dried, a tack coat of suitable material must be applied to the entire area within the chalk-line.

Estimate the required quantity of the thin patching mixture to fill such "birdbaths." Apply it to the area, and strike it off with a straight-edge the length of which is in excess of the dimensions of the "birdbath." A proper strike-off will level such a birdbath to the same elevation as the surrounding surface. After the leveling operation, the patch should be allowed to cure properly.

There are various emulsified asphalt and acrylic materials to accomplish the above patching methods. The patch material should be compatible with the surfacing material and should be used in accordance with the surfacing manufacturer's directions.

**b. Fiberglass Membrane Systems**

This method is designed to restore the surface of courts with

extensive hairline surface cracking. There are several products on the market and they should be used as per manufacturer's specifications. These treatments are not intended to restore badly cracked or broken surfaces, nor to permanently seal cracks subject to base movement.

**c. Color Finish Course Re-Coating**

Re-coating of the color finish course should proceed after all repairs have been completed and all appurtenances such as net post sleeves and anchors, fences, and gates have been checked and all maintenance has been performed where needed. On tennis courts not requiring repairs, only re-coating, the following procedures will be the guide:

Over the suitably prepared surface of the tennis court, apply two or more coats of material in accordance with the coating manufacturer's recommendations. Resurfacing materials are suitable as a base coat, but the final applications should be acrylic color coatings made for tennis courts. When recoating existing acrylic surfaces, only compatible acrylic bound materials are acceptable.

It should be noted that excessive layers of color finish material may cause or magnify problems with the asphalt. Consult a qualified contractor, engineer, or architect to best evaluate your situation.

**Note: Refer to Guidelines for:**

- I.A. General Conditions for Construction**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurement**
- II.I. Hot Plant Mix Asphalt Tennis Courts**
- II.O. Acrylic Color Finish Systems for Tennis Courts**

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SECTION	II.Q.	PAGE	1
TITLE MAINTENANCE AND REPAIR OF ASPHALT TENNIS COURTS	REVISION DATE		1998
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1.0 Introduction			
<p>This guide for the repair and maintenance of asphalt tennis courts has been prepared to provide the tennis court owner with information on court conditions that may develop and with recommended procedures for periodic maintenance and repair of asphalt courts.</p> <p>The actual conditions on a court that require repair may vary somewhat from the illustrations provided here, so it is important to use this only as a general guide, and consult with a tennis court builder, engineer or materials manufacturer for their recommendation on repair of your particular court.</p>			
2.0 General Requirements			
A. Scope of Work to be Done			
<p>The repair work to be performed should include furnishing all the required labor, materials, equipment, implements, parts and supplies necessary for and pertinent to the work to be done. The products and procedures should be as recommended by the tennis court contractor and the manufacturer of the material used in the repair work. Prior to starting the work, the court owner and the contractor should have a written description of the present condition of the court, as well as the end result of the repair work expected by the owner.</p> <p>Regular housekeeping maintenance performed by the owner should follow the suggestions outlined in Section 5.0.</p>			
B. Standards			
<p>The repair work should be done in a thorough and workmanlike manner and should conform to the standards for tennis court construction as prescribed by the U.S. Tennis Court and Track Builders Association.</p>			
3.0 Repair Conditions			
A. Drainage - Subsurface			
<p>Improper perimeter drainage can cause excessive subsoil expansion that results in greater damage to the surface from freeze/thaw action and can, in turn, cause the surface to heave and create "birdbaths". Also, this condition can cause loss of color and permit dirt and silt to wash onto the surface. By lowering the elevation of perimeter drainage swales, and consequently lowering the water table, this condition is improved or corrected. If a wet-weather spring is encountered, a subsurface perimeter drainage system, such as a perforated pipe in stone aggregate, is advisable. Consult with a local civil or soils engineer for specific advice.</p>			
B. Cracking			
<p>Cracking conditions may occur either in the base or on the surface of an asphalt tennis court. Cracking may stem from construction or job-site conditions such as improper slope of the courts, inadequate drainage of the site, base movement or poor compaction of the subbase.</p>			



Where any of these situations are present, major reconstruction of the courts may be required instead of repair.

1. **Alligatoring**

Alligator cracking most often occurs in the surface treatment applied over asphalt pavement. It is a readily identified pattern of interconnected cracks will vary from a faint surface pattern to full depth cracks and loose particles of the surfacing material.

Possible Method of Repair: Repairs may be made to this type of cracking with surface treatment coatings or with a combination of fiberglass membrane and surface treatment coatings. Depending upon the severity of the cracking, it may be necessary to resurface the court incorporating various methods such as geotextile membranes, stone slip-sheet, or installation of a modular or premanufactured surface system. Consulting a qualified contractor may help refine your direction or need.

2. **Ravelling**

Ravelling or spalling is the progressive loss of material in the surface of the asphalt or concrete slab, usually caused by weathering or traffic abrasion on courts with no surface treatment.

Possible Method of Repair: This condition may be corrected with the use of surface treatment coatings or an overlay of asphalt mix, followed by surface treatment coatings, depending on the severity of the condition. It may be necessary to resurface the court incorporating various methods such as geotextile membranes, stone slip-sheet, or installation of a modular or pre-manufactured surface system.

3. **Reflection Cracks**

Reflection cracks occur in asphalt, asphalt emulsion, or surface overlays. These cracks reflect a crack pattern in the pavement structure underneath. Reflection cracks are caused by vertical or horizontal movements in the pavement beneath the overlay resulting from temperature fluctuations and/or earth movements.

If reflection cracks occur in an asphalt overlay on a concrete slab, the cracks frequently follow the construction joints of the original slab.

Possible Method of Repair: Depending upon the severity of the cracking, it may be necessary to resurface the court incorporating various methods such as geotextile membranes, stone slip-sheet, or installation of a modular or premanufactured surface systems. Consulting a qualified contractor may help refine your direction or need.

4. **Shrinkage Cracks**

Shrinkage cracks are a random pattern of interconnected cracks, usually forming irregular angles and sharp corners. Often it is difficult to determine whether shrinkage cracks are caused by volume change in the asphalt mix or in the base or in the subgrade. This volume change can be better controlled by use of proper materials. Asphalt materials will be placed under stress with the addition of surface coatings. As the asphalt ages, it will shrink, causing additional stress. It is important to follow the Guidelines for the surface course of asphalt to minimize a future problem with shrinkage.

Possible Method of Repair: Depending upon the severity of the cracking, it may be necessary to resurface the court incorporating various methods such as geotextile membranes, stone slip-sheet, or installation of a modular or premanufactured surface system. Consulting a qualified contractor may help refine your direction or need.

**5. Structural Cracks**

This condition is usually due to failure of the subbase or improper mix design of the asphalt.

Possible Method of Repair: Depending on the severity of the cracks and a review of the site conditions, the remedy may incorporate various methods such as geotextile membranes, stone slip-sheet, or reconstruction of the court subbase. Consulting a qualified contractor may help refine your direction and minimize your cost.

**6. Upheaval or Depression (Movement of Subbase)**

Upheavals or depressions are the localized displacements of pavement due to changes in the subgrade or some portion of the pavement structure. Upheavals are most commonly caused by frost expansion in the granular courses beneath the pavement or in the subgrade. Upheavals may also be caused by the effect of moisture on expansive soils. This type failure is usually due to improper drainage below and/or around the court area.

Major depressions are often caused by decaying organic matter below the subbase or improper compaction of the subbase.

Possible Method of Repair: Reconstruction of the court is usually required to remedy this condition. Consulting an engineer or qualified contractor may help refine your approach and minimize your costs.

**7. Hair-line Cracks**

Hair-line cracks are of variable lengths, usually prevalent over entire areas, and may be caused by a variety of factors such as foreign matter (leaves, worms, clay) improper mix design, solvent type coatings and improper seal coats. They may develop into more significant types of cracks, i.e., alligator or structural, requiring more extensive maintenance.

Possible Method of Repair: Early repair with surface treatment coatings may remedy this condition. Consulting an engineer or qualified contractor may help refine your approach and minimize your cost.

**8. Miscellaneous**

**a. Birdbaths**

A "birdbath" is a minor depression in which water settles on a non-porous court surface after a rain or flooding. An accepted industry method of determining a birdbath is the flooding of courts, and waiting one (1) hour in minimum 70-degree Fahrenheit in sunlight. Then, if remaining water covers the thickness of a five cent piece (American coin), it can be considered a reparable birdbath. If the standing water does not cover a five cent piece, it is considered within tolerance and will evaporate within a reasonable amount of time.

Possible Method of Repair: Multiple applications of surface treatment coating may minimize or eliminate ponding.

**b. Net Posts**

Court repair problems as outlined in this Guideline often involve net posts and net post footing failure. Because the problems of net post failure vary significantly in degree, you should consult an engineer or qualified contractor to determine the proper course of action for repair.

**4.0 Methods of Repair**

**A. Hot Asphalt Overlay Method**

This is a method of placing 1" or more of hot plant mix asphalt over an existing asphalt tennis court. Recommendations of the U.S. Tennis Court and Track Builders Association Section II.I., Hot Plant Mix Asphalt Tennis Courts, should be followed for gradation of the mix.

The overlay system can be successfully done over a court that has minor faults. The overlay system may not prevent the reappearance of major cracks in the slab beneath.

To improve adhesion of the overlay to the existing slab, a tack coat or bond coat of emulsified asphalt should be used prior to the overlayment.

**B. Full Depth Repair**

In any patching, the area requiring a patch should be cleared of all loose material, dust and dirt. Any defective materials should be removed to the full depth of the defect. If the defect is in the asphaltic courses but is caused by a failure of the underlying base course, the defective base course material should also be removed. If it is necessary to replace base course material, it should be ascertained that the subgrade condition is as it should be prior to replacing any base course. If the subgrade requires attention, it should be brought up to specification requirements prior to patching any of the asphaltic courses which the base course supports.

A tack coat must be applied to the bottom and sides of the patch and allowed to cure thoroughly.

If the defective material is old asphalt pavement, and the depth of the defective material and the subsequent repair will exceed 3/8", hot plant mix asphalt may be used. The compacted lift should be brought to the elevation of the surrounding sound surface.

**C. Asphalt Overlay**

The overlay of asphalt should consist of a 1" thick mixture of asphalt after compaction. Aggregate should not exceed 3/8" in size.

The proper type asphalt used for the overlayment will vary from state to state if using the standard norm of the Department of Transportation (DOT) or State Highway Department standards.

**Thickness:** Not less than 1 1/2" prior to compaction.

**Liquid Asphalt or Bitumen:** 5.5% by weight (+/- 0.5%)

**Asphalt Penetration or Type:** (85 - 100 penetration)

**Aggregate Type:** Crushed stone, gravel, shale, limestone, etc. Slag is unacceptable. Foreign materials, i.e., pyrite clay, ferrous compounds, dirt and organic compounds, should not exceed 3% of the total volume of aggregate.

**Installation Equipment:** Self-propelled paving machine with vibratory screed.

**Rolling:** Not less than 3 to 5 ton tandem steel wheel roller with working watering system.

**Finish Rolling:** Not less than 1 ton tandem steel wheel finish roller.

**Flood Check:** Any ponding or "birdbaths" remaining after one hour in minimum 70 degree Fahrenheit in sunlight and which cover a five cent piece (American coin) should be filled prior to any further applications.

**Voids Content:** Minimum as specified by the Department of Transportation or State Highway Department, but in no case should void content exceed 7%.

**D. Surface Repair**

**1. Birdbaths**

Any areas holding enough water to cover a five-cent piece after one (1) hour in minimum 70 degree Fahrenheit in sunlight, should be outlined with chalk, and the water swept out. After the area is surface-dry, a tack coat of suitable material must be applied to the entire area within the chalk-line.

Estimate the required quantity of the thin patching mixture required to fill such "birdbaths". Apply it to the area, and strike off with a straight-edge the length of which is in excess of the dimensions of the "bird-bath" to the same elevation as the surrounding surface. After the leveling operation, the patch should be allowed to cure properly.

There are various materials to accomplish the above patching methods. They should be used in accordance with the material manufacturer's specifications.

**2. Fiberglass Membrane System**

This method is designed to restore the surface of certain types of cracked courts, and provide a smooth, dense, water-tight playing surface. There are several products on the market that should be installed as per manufacturer's specifications. These treatments are not intended to restore a badly cracked or broken surface, nor to permanently seal cracks subject to base movement.

**3. Color Finish Course Re-Coating**

Re-coating of the color finish course should proceed after all repairs have been completed and all appurtenances such as net post sleeves and anchors, fences and gates have been checked and maintenance performed where needed. On tennis courts not requiring repairs, only re-coating, the following procedures will be the guide. Over the suitably prepared surface of the tennis court, apply one or more coats of material in accordance with the coating manufacturer's recommendations. Acrylic resurfacing materials are suitable as a base coat, but the final applications should be acrylic color coatings made for tennis courts.

**5.0 Regular Housekeeping Maintenance****A. Outdoor Acrylic Surfaces**

Outdoor acrylic surfaces are relatively easy to maintain due to natural cleansing by rains. Problems may develop due to lack of proper drainage or soil erosion. Surfaces may become coated with mud and dirt, pine needles and leaves, and other foreign matter which should be removed as required.

Suggested maintenance for outdoor acrylic surfaces is to keep the court clean at all times by occasional sweeping in order that dirt and foreign particles do not get ground into the surface by foot traffic. During the tennis season the courts should be hosed off with water periodically (once a month) and allowed to dry. Do not use a stiff bristle broom but soft nylon or hair types for sweeping. Use normal water pressure for hosing (approx. 70 lbs. per square inch or less). Should there be any stains on the court, they may be removed by application of a mild cold-water detergent and scrubbing with a hair-type scrub brush. Should mold or mildew form on the courts in shady areas, an application of diluted strength household bleach (minimum 2 parts water, 1 part bleach) may be used to remove the fungus and retard its further growth. Where areas are treated, they should be rinsed off after a few minutes to remove the surface contamination. (NOTE: Fungus grows on surfaces contaminated by foodstuffs, soft drinks, and decaying matter. Acrylic coatings do not support fungus growth.)

**B. Indoor Acrylic Surfaces**

Indoor acrylic surfaces become significantly more dirty than do outdoor surfaces and, because of dust, tracking in of dirt, ball fuzz, and other extraneous materials, the courts can become rather unsightly in a short period of time.

Indoor clubs generally have a regular schedule of cleaning maintenance in which the courts are swept by vacuum or by rotary sweeper once a day and cleaned either by water vacuum or self-contained water brush units approximately once a month. If they are not water cleaned approximately once each month, dirty indoor courts may show the formation of mold or other fungus growths due to a combination of humidity and temperature, along with contamination from perspiration, foodstuffs, soft drink spills and dirt tracking. Again, this fungus may be removed by the use of a bleach solution such as mentioned above.

In using the water brush unit, detergent should not be mixed with the water, and the water should be clear, cool, and free from contaminants. During the cleaning process, the water should be changed frequently. Again, as in the case of outdoor courts, if the indoor courts are stained by foreign matter, such as soft drinks, food, grease or other materials, then a mild cold-water detergent should be applied to the stained area and lightly scrubbed with a soft bristle brush.

The majority of color surfacings are acrylic synthetic polymers. For synthetic surfaces other than acrylics, contact the manufacturer for specific maintenance instructions.

**Note: Refer to Guidelines for:**

- I.A. General Conditions for Construction**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurement**
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SECTION	II.R.	PAGE	1
TITLE <b>CONVERSION OF HARD SURFACE COURTS TO FAST DRY TENNIS COURTS</b>	REVISION DATE		1998
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II.P. 1.0	<b>Resurfacing Asphalt Tennis Courts Definition</b>  Fast dry is a porous tennis court surface material consisting of natural crushed stone, brick, or tile, that is ground, screened, well graded, and may or may not be mixed with a chemical binder to form a stable homogeneous mixture having an affinity for water.		
2.0	<b>Introduction</b>  The following guideline is intended to provide viable alternatives for the conversion of hard surface courts to fast dry type courts, and to be used in conjunction with the Guidelines for construction of fast dry tennis courts (above surface irrigation or subsurface irrigation).		
3.0	<b>Objective</b>  The main objective is to provide the optimum project conditions for the conversion of a tennis court from a hard surface to a soft surface.		
4.0	<b>Slope Requirements</b>  The finished fast dry court surface slope should adhere to the recommendation for the fast dry court system selected for the project. Refer to the appropriate specification for fast dry tennis courts (above surface irrigation or subsurface irrigation).		
5.0	<b>Perimeter Edging</b>  The perimeter edging should adhere to the recommendation for the fast dry court system selected for the project. Refer to the appropriate specification for fast dry type tennis courts (above surface irrigation or subsurface irrigation).		
6.0	<b>Court Construction Above Surface Irrigation System</b>  Four alternatives are all generally acceptable. However, some may be eliminated due to local conditions; for example, it may be difficult to dispose of the existing hard surface. Cost of local materials may make one alternative more attractive than another.  In most cases, the finished surface elevation will be significantly higher than the original surface.  <b>Alternative A:</b> Overlay the hard surface with a standard base construction as per the guide specification for construction of fast dry tennis courts with the exception of thickness. A minimum thickness totaling 2" should be maintained at the high side with the low side thickness determined by the requirement for the new slope.  <b>Advantages:</b> The hard surface material does not have to be hauled away and disposed of in accordance with applicable laws. Provides a stable area to work on with fewer weather delays.		



**Disadvantages:** A greater quantity of stone base material is required to change the slope. A higher perimeter edging is required to retain the additional stone. Because of the extra depth of stone on the high side of the court, more water may be required to maintain the court in optimum playing condition.

**Alternative B:** Overlay the hard surface with an acceptable fill material maintaining a minimum thickness of 1" at the high side and a low side thickness as required for the new slope. Construct the new fast dry court over the fill as per the guide specification for construction of fast dry tennis courts.

**Advantages:** The hard surface material does not have to be hauled away. In addition, the fill material is usually less expensive than stone. The uniform thickness of the stone layer may also help the surface to maintain moisture uniformly.

**Disadvantage:** The overlay of the fill requires an additional step during construction. The fill material may be susceptible to weather delays.

**Alternative C:** Remove the existing hard court surface and regrade the remaining base, establishing a new slope as required by the guide specification for construction of fast dry tennis courts. Install a minimum of 2" of new base material as detailed in the specification. Install the fast dry surface in accordance with the appropriate fast dry specification.

**Advantages:** A smaller quantity of new stone may be required depending on the quantity of existing base remaining under the hard surface. The new perimeter edging would be lower in height.

**Disadvantage:** The hard surface material would require disposal in accordance with applicable laws.

**Alternative D:** Grind or pulverize the existing hard surface material to a particle size no larger than 3/4". Regrade the existing base and pulverized surface establishing a new slope as required by the guide specification for construction of fast dry type tennis courts. Install a minimum of 2" of new base material as detailed in the specification. Install the fast dry surfacing per specification.

**Advantages:** A smaller quantity of new stone may be required depending on existing base beneath hard surface. The hard surface material would not require disposal.

**Disadvantages:** There may be limits to the availability of a pulverizer in a project location and to the accessibility for equipment to work in a confined area. Cost is also a consideration.

**Note:** Following conversion, if the existing fence remains, the height relative to the surface will be less than 10' in most cases. Gates may require adjustment to conform to the new court elevation. A tennis ball will not rebound as high on a fast dry court as it will on a hard court and, therefore, the reduced fence height may not adversely affect the play of the game.

The net posts will need to be adjusted to conform to the new surface elevation.

## 6.0 Court Construction Subsurface Irrigation System

The four alternatives described above will be acceptable in preparation for subsurface irrigated fast dry systems. The base construction will vary with the selected subsurface irrigation system. Refer to applicable Guidelines and system manufacturer's



recommendations.

## **7.0 Base Materials and Fast Dry Court Construction**

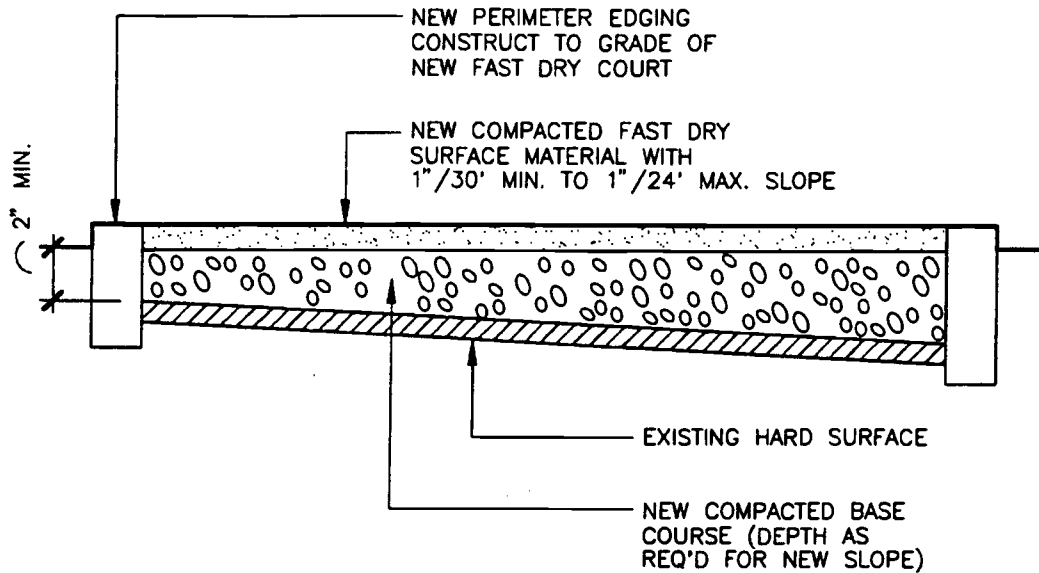
For base material and fast dry court construction, consult the Guidelines for construction of fast dry tennis courts (Above Surface Irrigation or Subsurface Irrigation).

**Note: Refer to Guidelines for:**

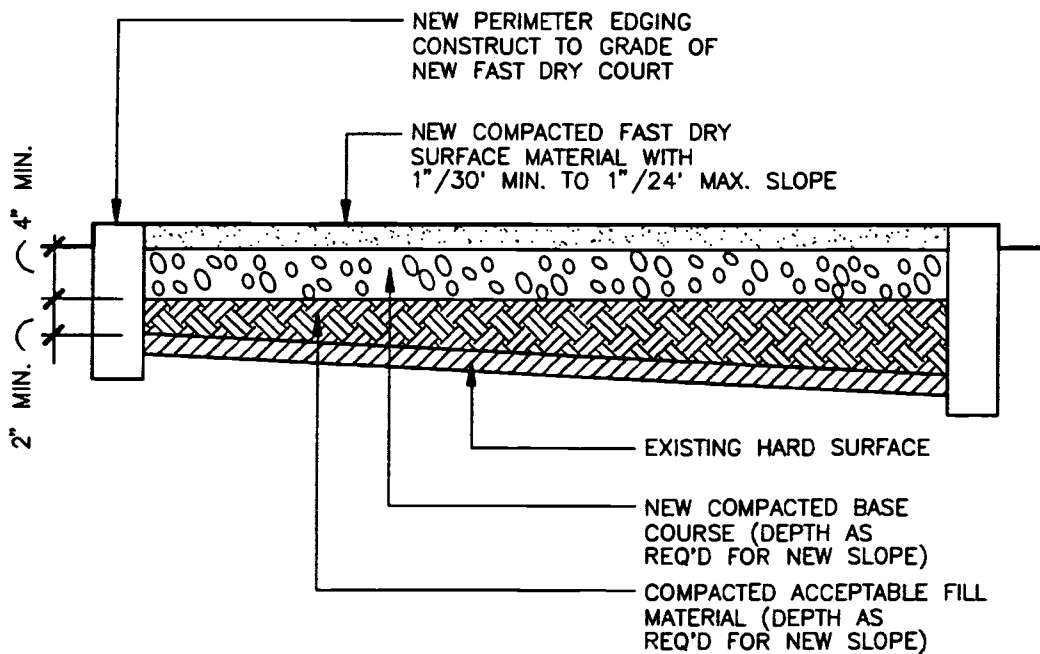
- I.A. General Conditions for Construction**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurement**
- II.D.1. Fast Dry Tennis Courts for Use with Above Surface Irrigation**
- II.D.2. Fast Dry Tennis Courts for Use with Subsurface Irrigation**
- II.F.1. Above Surface Irrigation Systems for Clay and Fast Dry Tennis Courts**

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and tennis court owners. Parties not experienced in tennis court construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

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ADJUSTING SLOPE WITH BASE COURSE



ADJUSTING SLOPE WITH FILL MATERIAL

## CONVERSION OF HARD COURT TO FAST DRY COURT

NOT TO SCALE



CONVER—1

DRAWINGS ARE ILLUSTRATIVE ONLY AND USTC&TBA  
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SECTION	I.L.S.	PAGE	1
TITLE  INDOOR TENNIS AIR STRUCTURE CONSTRUCTION	REVISION DATE		1998
	COPYRIGHT © 1998 BY U.S. TENNIS COURT & TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.		
1.0 Introduction			
This guideline will provide information for the proper construction of an air supported structure for indoor tennis relative to the size, fabric selection, stress relief systems, liners, heating systems, inflation systems, standby power systems, anchorage systems, pressurization control, insulation systems, doors and accessories, operation and maintenance, and lighting systems.			
2.0 Purpose			
A well-constructed air structure facility can provide a seasonal or permanent enclosure. The purpose of these Guidelines is to assist the owner/operator in constructing a facility that serves the needs of the tennis players as well as being efficient to own and/or operate.			
3.0 Size			
A. Dimensions given for an air structure should be from center of anchorage to center of anchorage. Dimensions should include the overall width, length and height of the structure. It is important to note that the dimension 5' above the floor can vary significantly depending upon how each structure is patterned. In the sport of tennis, interior playing area is very important and this should be discussed in detail with the vendor.			
B. Dimensions can be modified from a single court size or any multiple of courts. Multiple courts inside one bubble require careful planning to ensure a safe and proper playing environment. Access to and from the courts needs to be considered in the beginning stages of design.			
C. The distance from the wall adjacent to the nearest court should be a minimum of 12' and there should be a minimum of 18' between the courts. The distance behind the baseline should be a minimum of 18' in the clear or to a walkway or exterior wall, although a distance of 21' is preferred.			
D. The height of the structure should be a minimum of 21' over the baseline, 35' minimum, 38' recommended over the net and care should be taken to ensure the maximum height over the alleys adjacent to the end walls.			
4.0 Fabric Selection			
A. The fabric should be a high strength vinyl coated polyester material that exhibits long life, strength, stability and resistance to ultraviolet ray degradation.			
B. All fabric used should meet the tensile strength, tear strength and other design criteria approved by the engineer for the project.			
C. The most commonly used fabrics are approximately 28 oz. per square yard and			

- have tensile strengths of 300-600 lb./in.
- D. Translucent fabrics allow natural light to enter the structure. A translucent outer fabric needs to be combined with a translucent inner fabric to accomplish natural lighting of the facility. It is not unusual for tennis players to request the lights be turned on during the winter months due to the inconsistency of natural lighting. Translucent fabrics can also allow some solar gain that can be a benefit in the heating season, but can be almost impossible to ventilate in the spring/fall seasons in most regions.
  - E. Opaque fabrics provide the most consistent lighting results and temperature control is more consistent in all seasons.
  - F. The fabric utilized should be electronically welded at the structural seams and must be capable of developing the full strip tensile design load. Each seam should be capable of passing a 'dead load seam strength test' of not less than four hours duration with no visible failure or slippage when subjected to a continuous load of 200% of the maximum calculated design load at 70° F and 100% of the maximum calculated design load at 160° F.

#### 5.0 Stress Relief Systems

- A. There is a variety of systems available to decrease the stress on the fabric. These systems can provide enhanced structural integrity and may allow for the use of lighter weight fabrics.
- B. The stress relief system (cables or webbing) will indent the structural fabric and transfer the loads that would normally be carried by the fabric alone, therefore relieving some of the accumulated stress on the fabric.
- C. Fabric used in a stress-relieved structure should have a safety factor of six times the calculated design stress.
- D. Special consideration should be given to the patterning and shape of a stress relieved structure. The stress relief members should be secured directly to the anchoring system.
- E. Stress relieved structures do not reduce the need for quality field seams and junctions.

#### 6.0 Liners

- A. An interior liner fabric should be a minimum of 12 oz. for durability and should provide additional insulation value. The fabric chosen will affect the heating and cooling costs.
- B. The liner should be a contrasting color (usually green or blue) to a height of approximately 12' to provide a visual backdrop for the sport of tennis. The remainder of the liner is generally white to maximize lighting.
- C. The method of attachment for the liner and the patterning of the liner should be called for in the specifications as it will affect the aesthetics of the finished structure.

#### 7.0 Heating Systems

- A. The heating system should be sized after accounting for the cfm loss of the

structure and all related accessories, the U-value of the fabrics selected, the area of the fabrics selected, the area of the fabric enclosure, the desired design temperature, and any losses related to delivering the heated air into the structure.

- B. The system should allow for thermostatic controls and recirculation of heated air from within the structure.
- C. The system should introduce the heated air either between the courts or at the netline to minimize interference with the sport of tennis.

#### **8.0 Inflation Systems**

- A. The purpose of the inflation system is to pressurize the structural fabric, to define the shape of the structure and to enable it to withstand the wind conditions as it was designed.
- B. The structure should be equipped with no less than two blower systems, with each one having the capacity to maintain the appropriate inflation pressure.
- C. The secondary blower system should be designed to start and operate automatically in the event of loss of pressure or loss of power to the primary blower.
- D. Each blower system should have back draft dampers to minimize air leakage when that unit is not functioning.
- E. Each blower system should be non-overloading to prevent excessive pressure within the structure.
- F. For appropriate sizing of the blower systems, calculations should include all potential air leakages including but not limited to the anchorage system, access openings, accessory equipment, venting, sectionizing seams.

#### **9.0 Standby Power Systems**

- A. The auxiliary power system should have its own independent supply of power to operate separate from the primary inflation system.
- B. The system should operate the primary inflation system blowers or a supplementary blower connected to the standby power system.
- C. The system should start and operate automatically to ensure uninterrupted inflation pressure.
- D. The system should operate for a minimum of 24 hours upon starting.

#### **10.0 Anchorage Systems**

- A. The anchorage system should be designed to withstand all existing soil conditions and uplift forces created when the structure is inflated, as well as aerodynamic wind pressures.
- B. The loading for the anchorage systems should be designed in accordance with the size, height, building codes, anchor spacings and should be submitted by an architect and/or engineer licensed in the state of the project.
- C. Anchorage design should provide for simple and easy set-up and dismantling if the structure is to be used on a seasonal basis.

**11.0 Insulation Systems**

- A.** The insulation system utilized should be able to withstand exposure to moisture and abuse from tennis balls without damage.
- B.** The insulation system must either be easily removed for seasonal structures, or may be permanently installed for fixed structures.

**12.0 Doors and Accessories**

- A.** The number and location of entry and exit doors should be consistent with local codes and standards with the following Guidelines:
  - 1. Revolving doors should be used for frequent access.
  - 2. Emergency exit doors should only be used for emergency exit and must be self-closing to a positive latch, accounting for the internal inflation pressure.
  - 3. Personnel air locks should be used for medium traffic.
  - 4. Exit doors should be minimum 34" wide and equipped with panic hardware.
- B.** Structural loads around doors and accessories should be evenly distributed to the anchorage system.
- C.** There should be adequate slack in the fabric to allow for structure movement against any rigid attachment to the structure.
- D.** Accessory items that may/may not be included are windows, walkway tunnels or canopies, smoke detectors, alarm systems, remote control panels, magnetic sensors and snow detectors.

**13.0 Installation**

- A.** Site preparation should include all mechanical and electric hookups as well as preparing the site for the tennis courts and receiving the anchorage system.
- B.** Anchorage system must be completely installed and field verified prior to accepting the loads of the air structure.
- C.** Mechanical equipment must be completely installed and field verified as to proper working condition prior to installation of the air structure.
- D.** Doors and accessories must be completely installed and in proper working condition prior to installation of the air structure.
- E.** Fabric envelope should be delivered on pallets, placed appropriately, rolled out into position, and field sections must be completed prior to installation.
- F.** Visual inspection should be made of all connections to doors, accessories, sectionalizing, and anchorage systems prior to inflation.
- G.** All blowers should be switched on, a second and third visual inspection as indicated in (F) above should be made when the structure is at .25 and .5 inches water column pressure.
- H.** After one hour of continuous operation, a final check of all components of the structure should be made prior to turning the automatic controls on.
- I.** Punch list items should be reviewed and agreed to at this time.

**14.0 Operation and Maintenance**

- A.** Owner and/or operator should check the following items monthly when the structure is in use:
1. Anchorage system secure at all points.
  2. Concrete and/or ground conditions show no deterioration.
  3. Inflation pressure is proper (should be verified daily).
  4. No excessive air leakage around base or accessory attachments.
  5. No holes, tears or damage to the structural fabric.
  6. Sectionalizing seams show no damage or weakness.
  7. Access equipment is firmly attached and level at base.
  8. All doors are in proper working condition.
  9. Fabric is not overstressed at any connections.
  10. Emergency power system is in proper working condition.
  11. Fuel level and/or batteries are in proper working condition.
  12. Nothing is closer than 3 ft. to the structural fabric.
  13. Blower intakes are clean and free of debris.
  14. Blower motors, belts, bearings are properly lubricated and in good working conditions.
  15. Repair kit, instructions and snow rope are readily available.
- B.** Owner and/or operator should review the checklist again whenever there is a forecast of inclement weather that may pose a threat to the integrity of the structure.

**15.0 Lighting Systems**

- A.** For more complete information regarding lighting, refer to the Guidelines for lighting indoor tennis courts available from the United States Tennis Court & Track Builders Association.
- B.** Light levels should provide for initial readings in the range of 75-150 footcandles metered within the playing lines per tennis Guidelines.
- C.** Lighting variance from average to minimum and average to maximum should be less than 20%.
- D.** Light fixtures utilized should minimize glare.
- E.** Light fixtures utilized should be easy to clean, relamp and maintain.
- F.** Light fixtures should be strong enough to support the weight of the fabric and snow if the structure comes down in a storm.
- G.** Light fixtures should be designed to minimize damage due to condensation that may form within the structure.
- H.** Ballasts for the light fixtures should be remote mounted outside of the air structure or placed in a location that poses no hazard to a tennis player.
- I.** Lamps used should provide high efficiency per watt used to maximize lighting results relative to operating costs.
- J.** Light fixtures should be U.L. approved for damp locations.

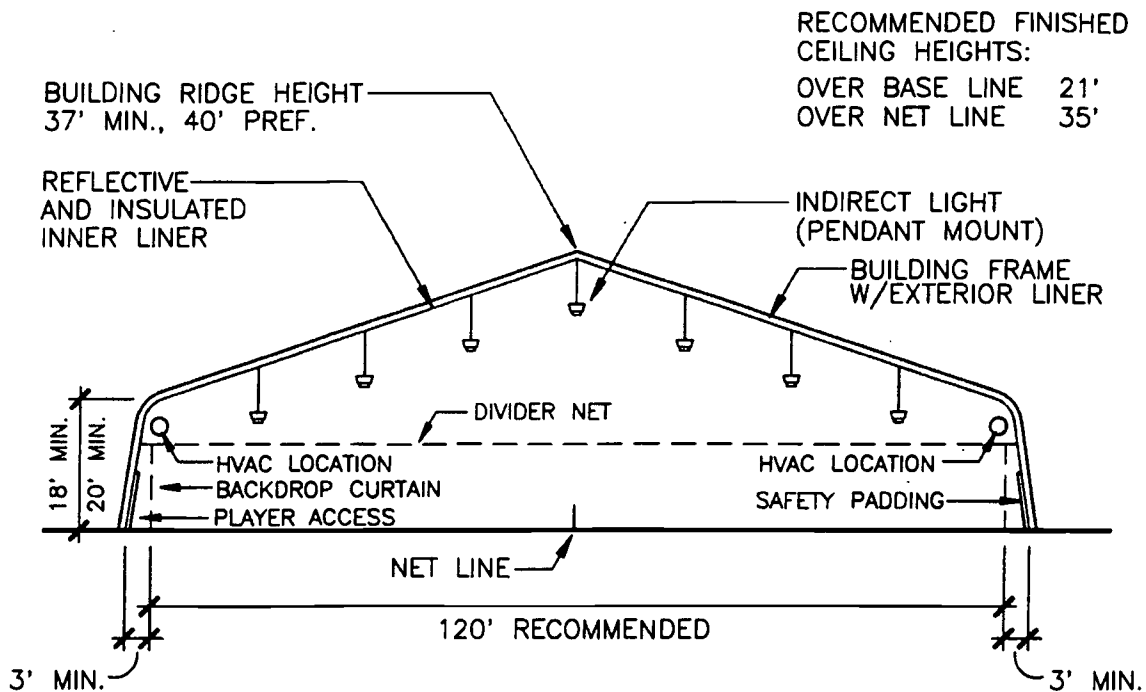
**Note:** Refer to Guideline for:

- I.A. General Conditions for Construction**
- II.A. Tennis Court Orientation**
- II.B. Tennis Court Dimensions and Related Measurement**
- II.K.2. Indoor Tennis Curtains, Dividers and Pads**
- II.M.2. Lighting Indoor Tennis Courts**

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and tennis court owners. Parties not experienced in tennis court construction are advised to consult a qualified contractor, consultant and/or design professional. Experienced contractors, consultants and/or design professionals can be identified through the U. S. Tennis Court and Track Builders Association. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

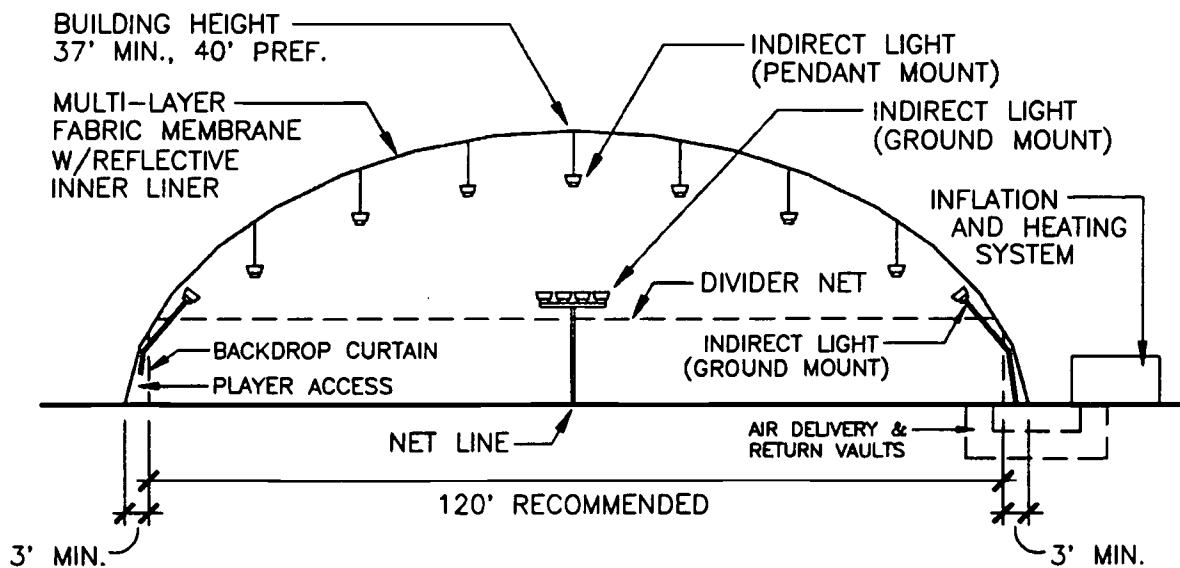
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## FABRIC FRAME COURT BUILDING SECTION

NOT TO SCALE



## AIR SUPPORTED STRUCTURE COURT BUILDING SECTION

NOT TO SCALE



INDOOR—3

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SECTION	III.A. PAGE 1
TITLE <b>BASIC LAYOUT,            DIMENSIONS AND SITE            CONSIDERATIONS FOR 400            METER RUNNING TRACK            CONSTRUCTION</b>	REVISION DATE 1999  COPYRIGHT © 1999 BY U.S. TENNIS COURT & TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.
<div>1.0 Scope</div> <div> <p>The purpose of this section is to aid in selecting an appropriate site for a running track facility. Once an appropriate site has been identified, proper layout and dimensioning can be established to provide a quality facility.</p> </div> <div>2.0 Site Selection Considerations</div> <div>A. Area of Site</div> <div> <p>The standard for the width of the site, preferably in the east/west direction, may be from 70m to 104m and the length may range from 193m to 170m. For an equal quadrant track, using a single radius design and lanes at 1.067m each, these dimensions are approximately 183m x 83m for an eight lane track and 179m x 79m for a six lane track.</p> </div> <div>B. Additional Facilities</div> <div> <p>Additional area for grandstands, bleachers, site fencing and/or other facilities need to be added to the basic size of site.</p> </div> <div>C. Utilities and Obstructions</div> <div> <p>In the investigation of the site, it is essential to determine the locations of all utility lines, (i.e. electric, gas, water, sewer and telephone) and to avoid construction over them when possible. Note other obstructions such as fences, trees, buildings, grandstands and bleachers.</p> </div> <div>D. Orientation</div> <div> <p>If possible, the facility should be laid out so that the straightaways are parallel to the prevailing winds. This is especially important for all dashes and hurdle races as they need to be run either with the wind or against.</p> </div> <div>E. Drainage</div> <div> <p>A major concern in site selection is to acquire proper drainage away from the track. Attempt to locate the track on a relatively level plane higher than the surrounding terrain in order to avoid excessive earth balancing. Extensive fill is not recommended and excessive cuts usually are cost prohibitive. <i>Note: The rules of track construction allow for a maximum longitudinal slope of one tenth of one percent in the running direction.</i></p> </div> <div>F. Accessibility</div> <div> <p>A location should be selected that will allow for accessibility for both construction and use.</p> </div> <div>G. Soil Conditions</div> <div> <p>After review of the available sites, evaluate the stability of the soil conditions by running a soil analysis on the available locations. Select the site with the best soil for a good, hard, non-heaving subgrade. Avoid peat, topsoil, clay, shear sand or other recomposed materials. High ground water conditions also should be avoided.</p> </div>	

### 3.0 Dimensioning and Configuration

#### A. Representative Track Configurations:

In the design portion of the project, four basic concepts can be followed:

1. **Equal Quadrant Tracks** - which are 400m or 1312.34' (minimum distance) tracks with 100m along each curve and 100m along each straightaway, measured along the measure line of lane one.
2. **Non-Equal Quadrant Tracks** - which are 400m or 1312.34' (minimum distance) tracks, measured along the measure line of lane one, with two curved ends of equal radius and two straightaways equal in length but longer or shorter than the curves.
3. **The IAAF Track** - which specifies a 400m or 1312.34' (minimum distance) track, measured along the measure line of lane one, with two curves of equal radius measuring 36.80m and two straightaways measuring 84.39m.
4. **Double-Bend Tracks** - which are 400m or 1312.34' (minimum distance) tracks measured along the measure line of lane one, with two straightaways of equal length and two curves that are formed with two different radii. This configuration allows for a wider infield to accommodate a broader range of sports activities.

#### B. Measure Line

The measure line is defined as a theoretical line from which the distance of a running track is determined. This line is located 20cm from the running side of the painted line for each lane. In the case of a raised curb, the theoretical line is located 30cm from the running side of the raised curb for lane one.

#### C. Allowable Radius Length

The radius to the measure line of lane one is recommended to be not less than 90' or more than 130'.

For a world record to be set, the radius of the outside lane should not exceed 50m (164.04') except where the bend is formed with two different radii, in which case, the longer of the two arcs should not account for more than 60 degrees of the 180 degree turn.

It is recommended that the radii be permanently marked with a fixed monument.

#### D. Playing Fields

The official sizes and needs of the interior playing fields should be a major consideration in dimensioning the running track:

##### MINIMUM FIELD SIZES

	Min. Length	Max. Length	Min. Width	Max. Width
High School Football	360'	360'	160'	160'
High School Soccer	300'	360'	165'	225'
College Soccer	330'	360'	195'	240'

Field events located inside the track oval will have an effect on available playing surface for other sports activities. Should space allow, every effort should be made to locate the long jump, triple jump and pole vault outside the track oval.

**4.0 Governing Body**

In determining dimensions of the track, the rules of the governing body of events to be held should be consulted:

International Amateur Athletic Federation (IAAF)  
17 Rue Princesse-Florestine  
BP359, MC 98007  
Monaco  
011-377-931-0888

USA Track & Field (USATF)  
Suite 140  
Hoosier Dome  
Indianapolis, IN 46225  
317-261-0500

National Collegiate Athletic Association (NCAA)  
6201 College Boulevard  
Overland Park, KS 66211  
913-339-1906

National Federation of State High School Associations (NFSHSA)  
P. O. Box 20626  
Kansas City, MO 64195  
816-464-5400

**5.0 Field Events**

The location and configuration of the event areas will have a direct bearing on the configuration of the track. See Guideline III.D.

**6.0 Layout Considerations****A. Finish Line**

It is important to determine where the common finish line will be located in order to allow sufficient area in the chutes for staging. Finish line is recommended at the P.C. (point of curve). Every effort should be made to start the 200m at PC 3. Chute length should be determined by measuring at least 115m back from the finish line.

**B. Accessibility and Ease of Set Up**

When laying out the facility, consideration of proximity to storage sites for equipment and distances to transport large pads is important.

**C. Meet Administration**

Consideration should be given to efficient administration of like events, location of timing devices and staging areas for the athletes.

**D. Spectators**

The facility should be assessed from the spectator's point of view with regard to accessibility of restrooms, concession areas and unobstructed view of all events.

See also Guidelines for:

I.B. Site Investigation

I.C. Site Preparation, Earthwork, Drainage and Subbase Construction

I.D. Vegetation Control or Vegetation Regrowth Prevention

- I.E. Subsurface and Surface Drainage for Recreational Areas
- III.D. Field Event Construction
- III.I. Drawings

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and owners. Parties not experienced in track construction are advised to consult a qualified contractor and/or design professional regarding their interpretation and application. Experienced contractors can be identified through the U. S. Tennis Court and Track Builders Association (USTC&TBA), which offers a Certified Track Builder program. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

<b>SECTION</b>	<b>III.B.</b>	<b>PAGE</b>	<b>1</b>
<b>TITLE</b>	<b>HOT MIX ASPHALTIC CONCRETE CONSTRUCTION</b>	<b>REVISION DATE</b>	<b>1999</b>
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**1.0 Scope**

This guideline covers the components and methods of installation to complete the construction of a hot mix asphaltic concrete base course and leveling course for a running track and/or field events areas. It does not cover proper subbase construction or drainage considerations. The success of any installation is dependent upon a properly constructed subbase and good drainage. Please see the appropriate USTC&TBA guidelines for details.

**2.0 Design**

**A. Minimum Recommended Base Course Thickness**

As recommended by geotechnical engineer.

**B. Minimum Recommended Leveling Course Thickness**

As recommended by geotechnical engineer.

**C.** If the asphalt exceeds 2" in total thickness, it should be installed in two lifts.

**3.0 Quality Assurance**

For installation of running track and field event hot mix asphalt, utilize only thoroughly trained personnel experienced and familiar with running track and field event paving and with the tolerances required by the appropriate governing body.

**4.0 Asphalt**

The proper type of asphalt used will vary from state to state if using the standard norm of the Department of Transportation (DOT) or State Highway Department standards. The following is a typical mix design for example only:

Thickness: No less than 1".

Liquid Asphalt or Bitumen: 5.5% by weight (+/- 0.5%).

Asphalt Penetration or Type: 85 - 100 penetration.

Aggregate Type: Crushed stone, gravel, shale, limestone, etc. Slag is unacceptable unless other materials cannot be obtained, and then only blast furnace slag is acceptable.

**Aggregate Sieve Analysis:**

	% Passing
1/2"	100%
3/8"	70 - 80%
1/4"	60 - 80%
No. 4	60 - 70%
No. 8	50 - 70%
No. 12	40 - 60%
No. 16	30 - 50%
No. 30	20 - 40%
No. 50	20 - 30%
No. 100	10 - 20%
No. 200	2 - 6%
Washed	0 - 2%

**5.0 Plant, Equipment, Machines and Tools****A. General**

The bituminous plant should be capable of producing the quantities of bituminous mixtures required. Hauling, placing and compaction equipment should be provided in sufficient numbers that the placement capacity at the site is equal to, or greater than, the planned plant output to the site.

**B. Paver**

All pavement, where applicable, should be placed with a self propelled asphalt paver. The screed width should be adjustable to no less than eight feet (8'). Only hydraulic screed and auger extensions to achieve widths greater than that of the main screed are acceptable.

**C. Compaction Equipment**

Compaction equipment should consist of steel drum asphalt rollers of sufficient size and width to properly compact the hot mix asphalt to the required compaction, while providing a smooth surface free from bumps, marks and creases.

**D. Transportation Equipment**

Transportation of the hot mix asphalt to the site from the asphalt plant should be in trucks having tight, clean, smooth beds lightly coated with an approved releasing agent. Each load should be covered with a canvas or other approved material of ample size to protect the mixture from cooling.

**E. Straightedge**

The contractor should furnish and maintain at the site, in good working condition, one 10' straightedge for each paver.

**6.0 Placement and Compaction**

**A.** Hot mix asphalt courses should only be placed on the specified base, free from contamination and with no free water on the surface.

**B.** Paving operations should not be scheduled unless there is ample time to place, compact and finish roll the hot mix asphalt.

**C.** The range of temperatures for mixtures to be dumped into the paver should be determined by State Department of Transportation guidelines, and in no case should they be cooler than 225 degrees F.

- D. Paving operations should provide a mat that is smooth, dense and of the proper thickness, slope and planarity.
- E. The leveling course should be placed such that the longitudinal joints of the leveling course are offset from that of the base course. Transverse joints should be offset a minimum of 24".
- F. In placing each succeeding pass after the initial one, the screed of the paver should be set so that it overlaps the preceding pass by 2" and be sufficiently high so that when compacted, a smooth joint is produced. Prior to pinching the joint, the excess material should be pushed onto the edge of the new pass with a lute. Excess material should be removed and wasted.
- G. Breakdown rolling should begin as soon after the placement as the mixture will allow without undue displacement. No delays in rolling should be permitted. After breakdown rolling has been completed, preliminary testing of grade, slope and planarity should be done. Any deficiencies should be immediately corrected in accordance with "Acceptability of Work." When the paving contractor is assured that all tolerances are being met, finish rolling should begin.
- H. Deficient areas within the base course should be corrected by sawcutting or milling high spots and/or by truing and leveling low spots.
- I. Deficient areas in the leveling course should be corrected by sawcutting or milling to a depth equal to the thickness of the mat. Tack coat should be applied to all edges and the pavement should be replaced. Skin patching of the leveling course should only be done with materials acceptable to the track surfacing contractor.

#### 7.0 Acceptability of the Work

- A. **Grade**  
Grade conformance tests should be conducted on both the base course and the leveling course. The entire surface should have positive drainage.
- B. **Planarity**  
After completion of the finish rolling operations on each course, the compacted surface should be tested with a 10' straightedge. Measurements should be made perpendicular to and across all mats at a distance not to exceed 25' feet. The track surfacing contractor or representative should be present when these measurements are made. The maximum allowable planarity deviation within a pass should be 1/4" in 10' when measured in any direction.

#### See also Guidelines for:

- I.A. General Conditions for Construction
- I.B. Site Investigation
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction
- I.D. Vegetation Control or Vegetation Regrowth Prevention
- I.E. Subsurface and Surface Drainage for Recreational Areas
- III.A. Basic Layout, Dimensions and Site Considerations for 400 Meter Running Track Construction
- III.G. Track Surfacing
- III.I. Drawings



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<b>SECTION</b>	<b>III.C.</b>	<b>PAGE</b>	<b>1</b>
<b>TITLE</b>	<b>CONCRETE CONSTRUCTION</b>	<b>REVISION DATE</b>	<b>1999</b>
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#### 1.0 Scope

This guideline covers the components and methods of installation to complete the construction of a concrete running track, curbs and/or field events areas. It does not cover proper subbase construction or drainage considerations. The success of any installation is dependent upon a properly constructed subbase and good drainage. Please see the appropriate USTC&TBA guidelines for details.

#### 2.0 Materials

##### A. Cement

Cement should comply with the standards of ASTM C-150 or the specification for blending hydraulic cements, ASTM C-595, excluding slag cements (Types S & SA), and with ASTM Specifications for weight variations and length of storage. Use no caked cement. Deliver the cement in bags for site-mixed concrete and use only one brand of cement in any one-structure placement.

##### B. Water

Furnish clean, potable water free from injurious amounts of oils, acids, alkalis or other deleterious substances.

##### C. Coarse Aggregate

Provide crushed stone which is clean, hard, durable and well graded within specified limits. When tested by standard laboratory methods, coarse aggregate must conform to the following requirements:

1. Worn no more than 45% when tested according to AASHTO T96.
2. Conforming to the following grading requirements for aggregate tested on a standard square-opening sieve:

<u>Sieve</u>	<u>Percent Retained</u>
1 3/4"	0%
1 1/2"	30 - 65%
3/4"	70 - 90%
3/8"	95 - 100%

##### D. Fine Aggregate

Provide washed sand having clean, hard, durable grains, well graded from coarse to fine. The sand must be free from soft or flaky particles or other injurious matter. When tested by standard laboratory methods, fine aggregate must conform to ASTM C-33 requirements.

##### E. Mineral Filler

The addition of stone dust or sand of acceptable quality and cleanliness may be required as mineral filler to improve workability or plasticity of the concrete mixture. When mineral filler is used, it must be batched and weighed separately. Filler may be used in amounts not to exceed 15% of weight of fine aggregate. When tested with standard laboratory sieves, mineral filler must meet the following requirements:

Retained on No. 30 sieve 0%  
Retained on No. 200 sieve 0% to 35%

**F. Air Entraining Agent**

Should conform to ASTM C-260.

**G. Reinforcement**

1. Deformed bars should conform to ASTM A-615, grade 60 or 40. For concrete work that is 5" thick, the recommended bars should be No. 5 size in both directions at 12" on center. For concrete work that is 4" thick, the recommended bars should be No. 5 size in both directions at 15" on center.
2. Smooth bars should conform to ASTM A-675.
3. Welded wire mesh should conform to ASTM A-185.
4. Reinforcing fiber should be 100% virgin polyurethane, collated fiber. Use 1.5 lbs. of fibermesh per cubic yard of concrete.

**H. Bar Supports**

Provide chairs made of plastic or metal to provide concrete cover as specified.

**I. Expansion Joint Material**

Should conform to ASTM D-994. An approved sealant should be used in all construction and expansion joints and should be compatible with the joint material. All heart cypress or all heart cypress redwood can be used in areas not to receive track surface materials. *Note: Expansion joints may open and reopen.*

**J. Liquid Membrane Forming Compounds for Curing Concrete**

Should conform to ASTM C-309. *Note: Concrete curing compound should not be applied to areas receiving track surface material.*

**3.0 Concrete Mix and Design**

**A. Concrete Mix**

Provide a concrete mix that is uniform and workable. Design of mix should be in accordance with ASTM C-94 and produce concrete with the following properties:

1. Compressive strength a minimum of 3,500 psi at 28 days. Some applications may require higher strength concrete.
2. Slump range: 2" to 4".
3. Air Content: 3% to 5%.

The minimum cement content for finishability should not be less than 470 lbs. per cubic yard for 1 1/2" maximum size coarse aggregate or 520 lbs. per cubic inch for 1" aggregate. In freeze-thaw environments, the minimum cement content should not be less than 560 lbs. per cubic yard.

**4.0 Execution****A. Subgrade Preparation**

The subgrade should be uniform in composition and compaction of material and should comply with the geotechnical investigation recommendations. This may include lime stabilization, flexible base course or cushion sand. All organic material should be removed. The subgrade should be in a moist condition at the time concrete is deposited thereon.

**B. Forms and Screeds**

Set forms to the required grades and lines, rigidly braced and secured. Use nominal 2x wood forms or metal forms. A form should be placed as deep as the pavement edge. Install a sufficient quantity of forms to allow continuous progress of the work so that the forms can remain in place at least 24 hours after concrete placement. If a slip form is used, it can be removed while the concrete is still plastic.

**C. Weather Conditions**

Place concrete only when the air temperature is above 35 degrees F and conform to the standards set forth in ACI-306. Retardant may be required when the temperature exceeds 85 degrees F. Hot weather concrete should conform to the standards set forth in ACI-305.

**D. Placement**

Minimal concrete thickness should be 4". Concrete work should be 5" thick if the location is such that it will be subject to more than three freeze-thaw cycles annually. Bars should be accurately positioned at mid-depth, terminating 2" away from edges and joints, and should be adequately supported by chairs, with sand plates provided, to prevent bar supports from sinking into the subbase. Bars should be lapped 18" and should also be securely tied or otherwise secured so that there is no displacement. Bars should be free of loose, flaky rust and other coatings or films that could interfere with bonding to the concrete.

**E. Finishing**

Concrete should be spread, consolidated, screeded, bull-floated and finished in accordance with Section 7.2 of ACI Standard 302, Recommended Practice for Concrete Floor and Slab Construction. When concrete is sufficiently set to withstand foot pressure with only about a 1/4" indentation and the water sheen has left the surface, the slab should be uniformly finished by floating and troweling. The final finish texture should be in accordance with the surface manufacturer's recommendations, but must have at least a medium broom finish to improve mechanical bond to the surface.

The concrete surface should be finished so that the tolerance should not vary more than 1/4" inch in 10' when measured with a 10' straightedge in all directions.

**6.0 Curing**

It is recommended that immediately after brooming, the concrete be kept continuously moist for 7 days by covering with polyethylene film or waterproof curing paper. Curing compounds should not be utilized. Curing time should be in accordance with surfacing system manufacturer's recommendations, but in no case less than 28 days.

ASTM specifications are available from American Society of Testing Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428, 610-832-9500.

ACI specifications are available from American Concrete Institute, 22400 W. Seven Mile Road, Detroit, MI 48219, 248-848-3700.

**See also Guidelines for:**

- I.A. General Conditions for Construction**
- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**
- III.A. Basic Layout, Dimensions and Site Considerations for 400 Meter Running Track Construction**
- III.G. Track Surfacing**
- III.I. Drawings**

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and owners. Parties not experienced in track construction are advised to consult a qualified contractor and/or design professional regarding their interpretation and application. Experienced contractors can be identified through the U. S. Tennis Court and Track Builders Association (USTC&TBA), which offers a Certified Track Builder program. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

SECTION	III.D.	PAGE	1
<b>TITLE</b> <b>BASIC LAYOUT, DIMENSIONS</b> <b>AND SITE CONSIDERATIONS</b> <b>FOR FIELD EVENT</b> <b>CONSTRUCTION</b>		<b>REVISION DATE</b> 1999  COPYRIGHT © 1999 BY U.S. TENNIS COURT & TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.	
<p><b>1.0 Scope</b>          The purpose of this section is to aid in construction of individual field events. The location of the field events is often determined by the area available for construction of the facility as well as other sports and recreational programs being held at the facility. Factors to be taken into consideration should be safety, drainage and location.</p> <p><b>2.0 Safety</b></p> <p><b>A.</b> Keep landing areas away from spectators and the edge of the track.</p> <p><b>B.</b> Hammer and discus throwing circles must be protected with an energy absorbing net.</p> <p><b>C.</b> All throwing areas should be protected by fencing or flagging.</p> <p><b>D.</b> Runways and landing areas should not interfere with start and finish lines on the running track. An effort should be made to locate runways outside of the track infield.</p> <p><b>E.</b> Protective coverings should be placed over landing areas where other sports activities can come in contact with the area.</p> <p><b>3.0 Drainage</b>          All water should drain away from the event areas. See also Guideline I.C.</p> <p><b>4.0 Location</b>          The location of the field events is often determined by the area available for construction of the facility.</p> <p><b>A. Prevailing Winds</b>          Jumping events are normally run with the wind. Avoid cross winds for pole vaulting. Throwing events are held into the wind, although new styles of javelin can be thrown with the wind.</p> <p><b>B. Sun or Lighting Reflection</b>          Consideration must be given to sun and light reflection so that the athlete's vision is not blurred during competition or practice.</p> <p><b>C.</b> Events should be accessible to storage shelters.</p> <p><b>D.</b> Events need to be placed so that spectators can safely see the competition.</p> <p><b>E.</b> Events need to be accessible for athletes.</p> <p><b>F.</b> Grouping the events makes participation and administration easier.</p> <p><b>5.0 Field Event Specifications</b>          All dimensions should meet the criteria specified by the appropriate governing body; i.e.,</p>		<p style="text-align: center;">167</p>	

International Amateur Athletic Federation (IAAF) which governs international competition; USA Track & Field (USATF) which governs open competition in the United States; National Collegiate Athletic Association (NCAA) which governs college competition; or National Federation of State High School Associations (NFSHSA) which governs high school competition.

International Amateur Athletic Federation (IAAF)  
17 Rue Princesse-Florestine  
BP359, MC 98007  
Monaco  
011-377-931-0888

USA Track & Field (USATF)  
Suite 140  
Hoosier Dome  
Indianapolis, IN 46225  
317-261-0500

National Collegiate Athletic Association (NCAA)  
6201 College Boulevard  
Overland Park, KS 66211  
913-339-1906

National Federation of State High School Associations (NFSHSA)  
P. O. Box 20626  
Kansas City, MO 64195  
816-464-5400

**A. High Jump**

**IAAF**

The minimum length of the runway should be 15m except in certain large international competitions where the minimum length should be 20m. When conditions permit, the minimum length should be 25m. The maximum overall inclination of the runway and take-off area should not exceed 1:250 in the direction of the center of the cross-bar. The take-off area should be level.

**USATF**

The apron is a 15m semicircle surrounding the standards. In championship competition, the suggested minimum length is 20m. The maximum overall inclination of the runway and take-off area should not exceed 1:250 in the direction of the center of the cross-bar.

**NCAA**

It is recommended that the approach be an octagon or square with a surface of at least 21m. The minimum length provided should be 15m. The maximum overall inclination of the runway and take-off area should not exceed 1:250 in the direction of the center of the cross-bar. The take-off area is the semicircle enclosed by a 3m radius whose center point is directly under the center of the cross-bar.

**NFSHSA**

The approach should consist of a semicircle or rectangle of level and unvarying surface. The center of the semicircle or rectangle is to be the midpoint between the standards. The depth of the approach should be a minimum of 50'. The inclination in the approach should not exceed 1:100. Hard and unyielding surfaces, such as concrete, wood, or asphalt that extend out from beneath the

sides and back of the high jump landing pad should be padded with a minimum of 2" dense foam or other suitable material. *Note: It is recommended that hard and unyielding materials, such as asphalt and concrete, that extend out from beneath the landing pad be removed.*

**B. Pole Vault**

**1. Runway**

IAAF

The minimum length of the runway should be 40m, when conditions permit 45m. The minimum width should be 1.22m and with a maximum width of 1.25m. The runway should be marked by white lines 5cm in width. A white line 1cm wide may be drawn at right angles to the axis of the runway at the level of the inside edge of the top of the vault box. This line should be prolonged as far as the outside edge of the uprights. Maximum allowance for lateral inclination of the runway is 1:100. Overall inclination of the runway in the running direction should not exceed 1:1000.

USATF

Same as IAAF.

NCAA

The minimum length of the runway should be 38.1m. Recommended width is 1.22m. Maximum allowance for lateral inclination of the runway is 1:100. Overall inclination of the runway in the running direction should not exceed 1:1000.

NFSHSA

Recommended minimum length of the runway should be 40m, when conditions permit 45m. Width of the runway should be 1.07m whenever possible. Maximum allowance for lateral inclination of the runway is 2:100. Overall inclination of the runway in the running direction should not exceed 1:1000.

**2. Vaulting Box**

IAAF

Should be constructed of suitable rigid material sunk level with the runway. Should be 1m in length, measured along the inside of the bottom of the box. Should be 60cm in width at the front end, tapering to 15cm in width at the bottom of the stop board. The length of the box at runway level and the depth of the stop board are determined by the angle of 105 degrees formed between the base and the stop board. The base of the box should slope from runway level at the front end to a vertical distance below ground level of 20cm at the point where it meets the stop board. The box should be constructed in such a manner that the sides slope outwards and end next to the stop board at an angle of approximately 120 degrees to the base. *Note: If the box is constructed of wood, the bottom should be lined with 2.5mm sheet metal for a distance of 80cm from the front of the box.*

USATF

Same as IAAF.



NCAA

Same as IAAF except it should be painted white.

NFSHSA

Same as IAAF except it should be painted a contrasting color.

3. Landing AreaIAAF

The landing area should measure not less than 5m by 5m. The sides of the landing area nearest the box should be placed 10cm to 15cm from the box and should slope away from the box at an angle of approximately 30 degrees. *Note: The approximate length of the pad should be 1.3m. This is in addition to the previously identified 5m.*

USATF

Same as IAAF.

NCAA

The landing area should measure a minimum of 4.88m wide by 3.66m deep. The front portion should be the same width as the back, 4.88m, extending from the back edge of the stop board to the front edge of the vaulting box. The maximum cutout for the vaulting box should be 91.44cm measured across the bottom of the cutout. The back of the cutout should be placed no farther than 36cm from the vertical plane of the stopboard. Suitable padding should be placed around the base of the standards.

NFSHSA

Same as NCAA. All hard and unyielding surfaces should be padded with a minimum of 2" of dense foam or other suitable materials. *Note: It is recommended that all excess material, such as asphalt or concrete, that extends out from beneath the landing pad be removed.*

C. Long Jump1. RunwayIAAF

The minimum length of the runway should be 40m and where possible 45m. The minimum width should be 1.22m with a maximum width of 1.25m. The runway should be marked by white lines 5cm in width. The maximum allowance for lateral inclination of the runway should not exceed 1:100. Overall inclination of the runway in the running direction should not exceed 1:1000.

USATF

Same as IAAF.

NCAA

Same as IAAF with exception of minimum length of runway should be 39.62m. When the runway is not distinguishable from the adjacent surface, it is to be lined as IAAF.

NFSHSA

Same as IAAF with following exceptions: Width of runway should be

1.07m when possible. Lateral inclination should be a maximum of 2:100. *Note: All runway lengths are measured to the respective foul line.*

2. Takeoff Board

IAAF

The takeoff should be marked by a board sunk level with the runway and the surface of the landing area. The edge of the board which is nearer to the landing area should be called the takeoff line. Immediately beyond the takeoff line there should be placed a plasticine indicator board for the assistance of the judges. The takeoff board should be rectangular, made of wood or other suitable rigid material. It should measure 1.21m to 1.22m long, 20cm (+/- 2mm) wide and 10cm deep. It should be painted white. The distance between the takeoff board and the far end of the landing area should be at least 10m. The takeoff board should be placed between 1m and 3m from the nearer end of the landing area. The plasticine indicator board should consist of a rigid board, 10cm wide (+/- 2mm wide) and 1.21m to 1.22m long and be made of wood or other suitable rigid material. The board should be mounted in a recess or shelf in the runway, on the side of the takeoff board nearer the landing area. The surface should rise from the level of the takeoff board to a height of 7mm (+/- 1mm). The edges should either slant at an angle of 30 degrees with the edge nearer to the runway covered with a plasticine layer along its length 1mm thick or should be cut away such that the recess, when filled with plasticine, should slant at an angle of 30 degrees. When mounted in this recess, the whole assembly should be sufficiently rigid to accept the full force of the athlete's foot. The surface of the board beneath the plasticine should be of a material in which spikes of an athlete's shoe will grip and not skid.

USATF

Same as IAAF.

NCAA

Same as IAAF with following exceptions: Length of takeoff board should be at least 1.22m long. Width of the takeoff board should be 19.8cm to 20.32cm and it should be not more than 10cm thick. Distance between the takeoff board and the nearer edge of the landing area should be not less than 1m or greater than 3.66m. The plasticine indicator board, not mandatory, should be prepared so that the top of the plasticine is level with the takeoff board. The plasticine should be of a contrasting color.

NFSHSA

The takeoff area should be marked by a rectangular shaped takeoff board, manufactured of wood or synthetic material. The takeoff board must be set firmly in the ground and level with the runway and the surface of the landing area. It must provide a firm base. The width should be between 8" (minimum) and 24" (maximum). It should be at least 4' long. If the takeoff board is 8" wide, an additional 8" of firm, resilient material may be placed so that it abuts against the edge of the takeoff board farthest from the scratch line. On hard surfaced runways, a painted scratch line of contrasting color and with the same size specifications may be used in lieu of a takeoff board. The boys' scratch

line should be located 12' from the nearer edge of the landing area. The girls' scratch line should be located 8' from the nearer edge of the landing area. *Note: These distances may be adjusted to accommodate different levels of competition.*

3. Landing Area

IAAF

The landing area should have a minimum width of 2.75m and a maximum width of 3m. The landing area, if possible, should be so placed so that the middle of the runway, if extended, would coincide with the middle of the landing area. The landing area should be filled with soft damp sand, the top surface of which should be level with the takeoff board. *Note: For those landing areas that do not conform to the width and centerline requirements, then tape dividing lines are placed so that the dimensions are achieved.*

USATF

Same as IAAF.

NCAA

The landing area should be not less than 2.74m in width and should be identical in elevation with the takeoff board. The area should be filled with sand level with the takeoff board.

NFSHSA

The landing area is to have a minimum width of 9' and a minimum length of 15'. The landing area should be filled with sand level to the takeoff board and of sufficient depth to ensure a safe landing.

D. Triple Jump

IAAF

Same as for Long Jump with following exceptions: Distance between the takeoff board and the far end of the landing area should be at least 21m. Recommended takeoff board locations for international competitions: Men - not less than 13m from the nearer end of the landing area. Women - not less than 11m from the nearer end of the landing area. *Note: For other competition the distance should be appropriate for the competition.*

USATF

Same as IAAF with the following exception: The women's takeoff board location should be at least 10m from the nearer end of the landing area.

NCAA

Same as for NCAA Long Jump with the following exceptions: Men - The distance from the foul line to the nearer edge of the landing area should be at least 10.97m (recommended is 12.5m). Women - The distance from the foul line to the nearer edge of the landing area should be at least 8.53m (recommended is 10.36m).

NFSHSA

Same as for NFSHSA Long Jump with the following exceptions: The boys' scratch line should be located 32' from the nearer edge of the landing area. The girls' scratch line should be located 24' from the nearer edge of the landing area. The length of the runway is measured from the long jump foul line.

**E. Shot Put, Discus and Hammer Throw****1. Circle****IAAF**

Circles should be made of band iron, steel or other suitable material. The top of the circle should be flush with the ground outside. The interior of the circle may be constructed of concrete, asphalt or some other firm but not slippery material. The surface of this interior should be level and 14mm – 26mm lower than the upper edge of the rim of the circle. A portable circle meeting with these specifications is permissible. The rim of the circle should be at least 6mm thick. The rim of the circle should be painted white. A white line 5cm wide should be drawn from the top of the metal rim extending for at least 75cm on either side of the circle. It may be painted or made of wood or other suitable material. The rear edge of the white line should form a prolongation of a theoretical line through the center of the circle at right angles to the center line of the landing sector.

**USATF**

Same as IAAF with following additions: The metal rim should have a height of 76mm. Inclination for the circle should be 1:100 lateral and 1:1000 in the throwing direction.

**NCAA**

The circles in the throwing events should be made of a band of metal or suitable rigid material (rubber is not suitable) and should be secured flush with the throwing surface. The interior should be of concrete or similar material. The surface of the interior should be 19.05mm +/- 6mm lower than the surface outside the circle. All other information is the same as USATF except the shot put ring height is 19mm.

**NFSHSA**

The throwing circles should be marked with a metal, wood or plastic band which should not rise more than 3/4" (19mm) above the level of the circle. If the circle has a surface of asphalt, concrete, wood or other hard material, a painted line 2" (5cm) wide may be substituted for the band. A concrete surface with a 1/64" (1mm) roughness is recommended. Projecting lines 2" (5cm) wide and 8" (20cm) in length lying on the diameter extended and outside the circumference, should be used to designate the back half of the throwing circle.

**2. Circle Measurements****IAAF**

Shot Put:	Inside diameter 2.135m +/- 5mm
Discus:	Inside diameter 2.50m +/- 5mm
Hammer:	Inside diameter 2.135m +/- 5mm

**USATF**

Same as IAAF.

**NCAA**

Same as IAAF.

NFSHSA

Same as IAAF, but no tolerances.

*Note: When a white line borders any circle, the lines are not a part of the circle measurement.*

3. Shot Put Stop BoardIAAF

The board should be white and made of wood or other suitable material. It should be made in the form of an arc so that the inner edge coincides with the inner edge of the circle. The board should be placed and securely anchored to the ground midway between the sector lines. The board should measure 11.2cm to 30cm wide, 1.22m (+/- 1cm) long on the inside, and 10cm (+/- 2mm) high in relation to the level of the inside of the circle. *Note: Stop boards to previous specifications remain acceptable.*

USATF

Same as IAAF.

NCAA

Same as IAAF with following exceptions: It should measure 112mm to 116mm in width and 98mm to 102mm in height.

NFSHSA

The board should be constructed of concrete, fiberglass, metal, wood or other hard-surfaced material. It should be made in the form of an arc so that the inner edge coincides with the inner edge of the circle and firmly secured in this position. The board should measure 1.22m long along the inside, 10cm in height and 11.4cm in width. The inside edge of the line or band is the limit of the putting circle.

4. Implement Landing AreasIAAF

The landing sector should consist of cinders, grass or other suitable material on which the implement makes an imprint. The overall downward inclination of the landing sector should not exceed 1:1000 in the throwing direction. The landing sector should be marked with white lines 5cm wide at an angle of 40 degrees such that the lines, if extended, would pass through the center of the circle.

USATF

Same as IAAF.

NCAA

Same as IAAF.

NFSHSA

Inclination from the throwing area to the landing area should not exceed 1:100. The shot put throwing sector angle should be 65.5 degrees. The discus throwing sector angle should be 60 degrees. *Note: When college facilities are used, the 40 degree sector angle is allowed.*

5. Safety CagesIAAF

Shot Put: No cage required.

Discus and Hammer: Required. Detailed options are explained in *IAAF Handbook* as well as in the *IAAF Track and Field Facilities Manual*.

USATF

Shot Put: No cage required.

Discus and Hammer: Required. Detailed options are explained in the *USATF Rules* book.

NCAA

Shot Put: No cage required.

Discus and Hammer: Required. See Drawings, Guideline III.I.

NFSHSA

Shot Put: No cage required.

Discus: Required. See Drawings, Guideline III.I.

*Note: All cages are designed to provide limited protection for spectators, officials and competitors. Cages do not ensure the safety of these personnel.*

F. **Javelin**1. RunwayIAAF

The minimum length of the runway should be 30m. When conditions permit, the minimum length should be 33.5m. The maximum length of the runway should be 36.5m. The runway should be marked by two parallel white lines 5cm wide and 4m apart (lines are not a part of the 4m measurement). The throw should be made from behind an arc of a circle drawn with a radius of 8m. The arc should consist of a strip painted or made of wood or metal 7cm wide. The arc should be painted white and be flush with the ground. Lines should be drawn from the extremities of the arc at right angles to the parallel lines marking the runway. These lines should be white, 75cm long and 7cm wide. The maximum lateral inclination of the runway should be 1:100 and 1:1000 downward in the running direction.

USATF

Same as IAAF.

NCAA

Same as IAAF with following exceptions: All measurements are not rounded off. Recommend that the runway be an artificial surface. When artificial surface is used, then extend the runway 1m past the foul line for safety.

NFSHSA

Same as NCAA without comment regarding artificial surface. Lateral inclination is not more than 2:100 and not more than 1:100 from the throwing area to the landing area.

2. Implement Landing AreaIAAF

The landing sector should consist of cinders, grass or other suitable material on which the javelin makes an imprint. The maximum allowance for the overall inclination of the landing sector in throwing direction should not exceed 1:1000. The landing sector should be marked with white lines 5cm wide such that the inner edge of the lines, if extended, would pass through the two intersections of the inner edges of the arc and the parallel lines marking the runway and intersect at the center of the circle which the arc is part. The sector is thus about 29 degrees.

USATF

Same as IAAF.

NCAA

Same as IAAF.

NFSHSA

Same as IAAF except inclination from the throwing area to the landing area should not exceed 1:100.

*Note: The USTC&TBA makes every effort to keep up to date on the various rules changes from each association. All rules information has been taken from the various associations' rules books. However, these rules are subject to change without notice to the USTC&TBA, and there is no assurance that the current rules are included in this guideline. If you need to make a specific rules determination, you are advised to contact the appropriate governing body for its current rule book.*

**See also Guidelines for:**

- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**
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SECTION	III.E.	PAGE	1
TITLE <b>METRIC CONVERSION</b>		REVISION DATE 1999  COPYRIGHT © 1999 BY U.S. TENNIS COURT & TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.	
<p>1.0 <b>Scope</b> The purpose of this section is to aid in converting an existing 440 yard running track to a 400 meter track.</p> <p>2.0 <b>Dimensions</b> All dimensions should meet criteria as specified by IAAF, USATF, NCAA and NFSHSA.</p> <p><b>A. Calculation of Existing Dimensions</b> If possible, locate the existing radius monuments to determine the distance between these points. Measure the distance from the measure line (20cm from a painted line or 30cm from a raised curb) on lane one to the radius point. Multiply the distance between radius points by two. Add that number to the total of two times the radius to measure line times 3.1416. The result of this calculation will be the distance that the track is shorter than, equal to or longer than 1,312.34' or 400 meters at the measure line of lane one.</p> <p><b>B. Conversion Methods</b> If the track's physical measurement is exactly 440 yards, or 1,320', the conversion can be made by decreasing the distance between radius points 3.835'. This will decrease the measuring distance in lane one by 7.67'. It is suggested the conversion be done on one end of the track only. If the track measures more or less than 1320', make the proper adjustment to the above numbers.</p> <p>To prevent instability of a narrow new subbase or rough joints between old and new material in the base, leveling and surface courses, it is recommended that conversion be accomplished by cutting and removing the existing surface at the inside of new lane three so that the joint between old and new material will occur on a lane line. This method will require approximately 220 sq. yds. of new paving.</p> <p><b>C. Problems in Conversion</b> Other issues must be addressed to complete a successful conversion:</p> <ol style="list-style-type: none"> <li><u>Curb Replacement</u> It may be necessary to remove part of an existing curb and relocate it in accordance with the conversion measurements. Approximately 330' of new curb will be required.</li> <li><u>Drainage</u> Check the drainage and slope in the area where any modification is going to take place. Conversion must be accomplished without interfering with surface or subsurface drainage.</li> <li><u>Excavation, Subbase, Base, Leveling and Surface Courses</u> All courses of new construction, as well as the slope of the finished track, must be in accordance with the appropriate guidelines.</li> </ol>		<p style="text-align: center;">177</p>	



**See also Guidelines for:**

- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**
- III.A. Basic Layout Dimensions & Site Considerations for Track Construction**
- III.B. Hot Mix Asphaltic Concrete Construction or**
- III.C. Concrete Construction**
- III.G. Track Surfacing**
- III.I. Drawings**

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SECTION	III.F.	PAGE
<b>TITLE</b>  <b>FENCING</b>	<b>REVISION DATE</b>  <b>1999</b>  <b>COPYRIGHT © 1999</b> <b>BY U.S. TENNIS COURT &amp; TRACK BUILDERS</b> <b>ASSOCIATION. ALL RIGHTS RESERVED.</b>	<b>1</b>
<p><b>1.0 Purpose</b> The primary purpose of fencing for a running track facility is to protect the facility against unauthorized use, vandalism, theft, etc. Fencing also may be necessary or useful for crowd control and direction, and to provide for the safety of athletes and spectators.</p> <p><b>2.0 Scope</b> This guideline covers material and construction requirements for PVC (vinyl) coated, aluminized or galvanized fence fabric with galvanized steel framework.</p> <p><b>3.0 Placement</b></p> <p><b>A. Running Track</b> It is usually desirable to surround the outside of the running track with a fence approximately 4' high. This fence can be used to keep spectators away from the competition areas, to confine athletes to the areas they are using, and to protect the track surface from excessive foot traffic, wheeled vehicles and implements.</p> <p>For safety reasons, it is recommended that there be a 1m clearance between the fence and the outermost lane line of the track. Normally, it is not desirable to have any fencing inside of the running track itself.</p> <p><b>B. Site Fencing</b> Perimeter fencing is normally 6' to 8' high and is designed to provide overall protection for the facility. It may enclose just a portion of the facility, such as the running track and the football field, or it may enclose a complete athletic facility. Its purpose is to restrict the use of the facility to the persons and to the equipment for which it was designed.</p> <p><b>4.0 Chain Link Fence Fabric</b></p> <p><b>A. Types</b></p> <p>1. <u>PVC Coated (Fused)</u> Coated over galvanized wire: ASTM F-668, class 2B, 7 mil (0.18 mm) thermally fused polyvinyl chloride in a color to be selected from the manufacturer's choices. Galvanized steel core wire should meet ASTM A-641, tensile strength 75,000 psi (571 MPA), 11 gauge [0.120" (3.05 mm)].</p> <p>2. <u>PVC Coated (Extruded)</u> Coated over galvanized wire: ASTM F-668, class 1, 15 mil (0.38 mm) extruded polyvinyl chloride in color to be selected from manufacturer's choice. Galvanized steel core wire should meet ASTM A-641, tensile strength 75,000 psi (571 MPA), 11 gauge [0.120" (3.05 mm)].</p>		<p style="text-align: center;">179</p>

3. Aluminum Coated Wire  
ASTM A-491, 11 gauge, 0.35 oz./s.f. coating.

4. Zinc Coated Wire  
ASTM A-392, 1.2 oz./s.f. coating.

**B. Size**

Helically wound and woven to a chosen height of 4' (1.219m), 6' (1.828m), or 8' (2.438m). Fabric should be diamond mesh of 11 gauge (0.120" [3.05mm]) core wire and a break load of 850 lbs.

**C. Selvage**

Fabric should be knuckled at the top and bottom.

**5.0 Steel Fence Framing**

**A. Framing Types**

1. Type 1  
ASTM F-1083, standard weight schedule 40; minimum yield strength of 25,000 psi (170 MPA); sizes as indicated. Hot-dipped galvanized with minimum average 1.8 oz/s.f. (550 g/m<sup>2</sup>) of coated surface area.
2. Type 2  
Cold formed and welded steel pipe complying with ASTM F-1043, Group IC, with minimum yield strength of 50,000 psi (344 MPA), sizes as indicated. Protective coating per ASTM F-1043, external coating Type B, zinc with organic overcoat, 0.9 oz/s.f. (275 g/m<sup>2</sup>) minimum zinc coating with chromate conversion coating and verifiable polymer film. Internal coating Type B, minimum 0.9 oz/s.f. (275 g/m<sup>2</sup>) zinc or Type D, zinc pigmented, 81% nominal coating, minimum 3 mils (0.08 mm) thick.
3. Formed Steel "C" Sections  
Roll formed steel shapes complying with ASTM F-1043, Group II, produced from 45,000 psi (310 MPA) yield strength steel; sizes as indicated. External coating per ASTM A-525. "C" section post may have ASTM F-1043, Type C, external coating consisting of 0.9 oz/s.f. (275 g/m<sup>2</sup>) zinc 5% aluminum-mischmetal alloy.
4. Steel Square Sections  
[ASTM A-500, Grade B.] Steel having minimum yield strength of 40,000 psi (275 MPA); sizes as indicated. Hot dipped galvanized with minimum 1.8 oz/s.f. (550 g/m<sup>2</sup>) of coated surface area.

**B. Framing Specifications**

1. Structure  
End, corner and/or gate post: 2.875" OD (76mm), 5.79 lbs./ft. (8.6 kg/m) or 2.375" OD (54 mm), 2.72 lbs./ft. (4.0 kg/m)  
Line (intermediate) post: 2.375" OD (54mm), 2.72 lbs./ft. (4.0 kg/m) or 2.25" x 1.7" "C" (57.15 x 43.18 mm) 2.72 lbs./ft. (4.0 kg/m)  
  
Rail and/or brace: 1.580" OD (42.2 mm), 2.27 lbs./ft. (3.4 kg/m) or 1.660" OD (42.2 mm), 2.27 lbs./ft. (3.4kg/m)

2. Gates  
Chain link swing gates as specified in Section 02831C and/or chain link cantilever slide gates as specified in Section 02831D and/or chain link vertical lift gates as specified in Section 02831E and/or chain link overhead slide gates as specified in Section 02831F.
3. Chain Link Fence Accessories  
Provide items required to complete fence system. Galvanize each ferrous metal item and finish to match framing.
  - a. Post Caps  
Formed steel, malleable cast iron, or aluminum alloy weathertight closure caps for tubular posts. For each line post, provide tops to permit passage of top rail.
  - b. Top Rail and Brace Ends  
Formed steel, or malleable cast iron, for connection of rail and brace to terminal posts.
  - c. Top Rail Sleeves  
5" (150 mm) sleeve allowing for expansion and contraction of top rail.
  - d. Wire Ties and Clips  
10 gauge [0.135" (3.43 mm)] galvanized steel wire for attachment of fabric to line posts. Double wrap 13 gauge [0.092" (2.324 mm)] for rails, and braces. Hog ring ties of 12-1/2 gauge [0.0985" (2.502 mm)] for attachment of fabric to tension wire.
  - e. Brace and Tension (stretcher bar)
    - i. Bands  
Pressed steel.
    - ii. Tension (Stretcher) Bars  
One-piece lengths, equal to 2" (50 mm) less than full height of fabric with a minimum cross-section of 3/16" x 3/4" (4.76 mm x 19 mm) or equivalent, fiber glass rod. Provide tension (stretcher) bars where chain link fabric meets terminal posts.
    - iii. Bottom Tension Wire  
Bottom tension wire should be used except where continuous bottom rail is specified. Bottom tension wire should be in accordance with ASTM A-824.
    - iv. Truss Rods  
Steel rods with minimum diameter of 5/16" (7.9 mm).
    - v. Nuts and Bolts  
Galvanized.
4. Setting Material  
Concrete - minimum 28 day compressive strength of 3,000 psi (20 MPA).

**6.0 Execution****A. Examination**

1. Verify areas to receive fencing are completed to final grades and elevations.
2. Ensure property lines and legal boundaries of work are clearly established.

**B. Chain Link Fence Framing Installation**

1. Install chain link fence in accordance with ASTM F-969 and manufacturer's instructions.
2. Locate a terminal post at each fence termination and/or change in horizontal or vertical direction of 30 degrees or more.
3. Space line posts uniformly at a maximum of 10' (3.04 m) on center. Posts may be spaced uniformly at a closer distance (for example, 8' [2.44 m]) for greater strength.
4. Concrete set posts  
Drill holes in firm, undisturbed or compacted soil. Holes should have diameter 4 times greater than the outside dimension of the post, and depths approximately 6" (150 mm) deeper than the post bottom. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 36" (900 mm) below surface when in firm, undisturbed soil. Place concrete around posts in a continuous pour. Trowel finish around the post. Slope to direct water away from posts.
5. Gate hardware  
Set keepers, stops, sleeves, and other accessories into concrete.
6. Alignment  
Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.
7. Bracing  
Install horizontal pipe brace at mid-height for fences 6' (1830 mm) and over, on each side of terminal posts. Firmly attach with fittings.
8. Tension wire  
Provide tension wire at bottom of fabric and at top, if top rail is not specified. Install tension wire before stretching fabric and attach to each post with ties or clips. Secure tension wire to fabric with 12-1/2 gauge [.0985" (2.502 mm)] hog rings 24" (609.6 mm) on center.
9. Top rail  
Install full 21' (640 m) lengths whenever possible. Connect lengths with sleeves for rigid connections under expansion/contraction conditions. Top rail with swaged ends may be joined directly.
10. Mid rails for fabric height 12' (3660 mm) and over  
Install mid rails between posts with fittings and accessories.

11. Bottom rails  
Install bottom rails between posts with fittings and accessories.

**C. Chain Link Fabric Installation**

1. Fabric  
Install fabric on the inside toward the track, and attach so that fabric remains in tension after pulling force is released. Leave approximately 1" (25 mm) between finish grade and bottom selvage. Attach fabric with wire ties to line posts at 15" (380 mm) on center and to rails, braces, and tension wire at 24" (600 mm) on center.
2. Tension (Stretcher) Bars  
Pull fabric taut; thread tension bar through fabric and attach to terminal posts with bands or clips spaced maximum of 15" (350 mm) on center.

**D. Gate Installation**

1. Install gates plumb, level, and secure for full opening without interference.
2. Attach hardware by any means which will prevent unauthorized removal.
3. Adjust hardware for smooth operation.

**E. Accessories**

1. Tie Wires  
Bend ends of wire to minimize hazard to persons and clothing.
2. Fasteners  
Install nuts on side of fence opposite fabric side for added security.

**Note Regarding Related ASTM Specification:**

ASTM specifications are available from the American Society of Testing Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428, 610-832-9500. For more information on materials pertaining to or related to those covered in this specification, please see the following ASTM specifications:

- A. Section 02500 - Paving and Surfacing
- B. Section 03300 - Cast-In-Place Concrete
- C. Section 04200 - Unit Masonry

**See also USTC&TBA Guidelines for:**

- I.A. General Conditions for Construction
- I.B. Site Investigation
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction
- I.D. Vegetation Control or Vegetation Regrowth Prevention
- I.E. Subsurface and Surface Drainage for Recreational Areas
- III.A. Basic Layout, Dimensions & Site Considerations for Track Construction
- III.I. Drawings

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<b>SECTION</b>	<b>III.G.</b>	<b>PAGE</b>	<b>1</b>
<b>TITLE</b> <b>TRACK SURFACING - LATEX</b>		<b>REVISION DATE</b>	<b>1999</b>
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**1.0 Scope**

This guideline covers the components and methods of installation of latex track surfaces. Latex surfaces are generally defined as rubber particles of a specified size, shape and composition, bound together by a water-based resin binder. They are resilient, all weather surfaces. Most are permeable.

**2.0 Materials**

A variety of products are required for proper construction of latex surfaces. The terms defined below are to clarify the language used in this guideline and in proprietary specifications.

**A. Water**

Water used in dilution must be fresh and potable.

**B. Primer**

Most latex systems require a primer application to promote adhesion between the resilient surface and the asphalt or concrete base. Depending on the proprietary system, the binder may be latex or an asphalt emulsion.

**C. Asphalt Emulsion**

Asphalt emulsion is an asphaltic cement suspended in a water vehicle.

**D. SBR Latex Binder**

SBR latex is the most prevalent type of water-based resin used to bind rubber particles. It is comprised of varying proportions of styrene and butadiene monomer in a water vehicle. Other types of latex binders used as track binders include vinyl, acrylics and a variety of combinations.

**E. SBR Rubber Particles**

SBR rubber particles are generally post-industrial by-products that have been shredded or chopped to a specific size, shape and gradation. The characteristics of the rubber particles selected must be enumerated in the specification.

**F. EPDM Rubber**

EPDM rubber is generally a highly pigmented rubber compound chopped to a specific size for use as a wearing surface. It is available in a wide range of colors and sizes. It is important that the compatibility of the EPDM granules and the latex binder be determined prior to installation.

**G. Surface Coating**

Surface coating is the final wearing finish applied to the resilient surface. It is used to provide protection from ultraviolet light degradation and to provide additional wear resistance and color uniformity. The coating may be formulated with a variety of binder types, including SBR, acrylic latex or polyurethane. The system installer should insure compatibility.



**3.0 Systems**

The materials listed above may be used in a wide variety of combinations to meet the needs of owners. They are best described in four general categories. In no case should the recommended thickness of the system selected be less than 1/2" (12.5mm) when measured in accordance with USTC&TBA standards.

**A. Black Mat**

A black mat system is composed of black SBR rubber or black EPDM rubber particles bound by SBR latex or an approved alternate water-based resin. The surface coating is a highly pigmented black SBR or acrylic latex.

**B. Colored Binder**

This system consists of black EPDM or black SBR rubber particles bound by a pigmented latex binder or an approved alternate water-based resin. The surface coating should be a highly pigmented UV stable coating of adequate thickness and durability to resist wear patterns with normal use.

**C. Color Sandwich**

This system of black EPDM or black SBR rubber particles bound by latex has a wearing course of at least 1/8" (3mm) of pigmented (other than black) EPDM granules bound by pigmented SBR latex binder or an approved alternative water-based binder. The surface coating should be a highly pigmented, UV stable coating to provide uniform color to the system.

**D. Full Depth Color**

This system consists of colored EPDM granules (not black) bound by pigmented SBR latex binder or an approved alternative water-based binder. The surface coating should be a highly pigmented, UV stable coating to provide strength and color uniformity. This system is used in high traffic areas in conjunction with either the Color Sandwich or the Colored Binder System.

**4.0 Surface Specifications**

Surface specifications should include:

Color

Depth

Type of facility: Governing Body, International Properties or Competition Properties

Events to be Marked

Surface properties for consideration:

Flatness and Imperfections Thickness

Modified Vertical Deformation; Force Reduction

Friction; Wet Spike Resistance

Tensile Properties; Elongation

Weathering Color

Flammability

Testing Methods

**5.0 Thickness and Specific Gravity**

Each surface system should be at least 1/2" (12.5mm) in total thickness to allow for variation in the underlayment and to prevent spiked shoes from penetrating to the base layer, potentially disrupting the bond. Both SBR and EPDM rubber particles will vary in specific gravity and bulk density value of rubber. This coupled with the application methods, shape and size will affect the rubber required to achieve 1/2" thickness. The chart below is intended for guidance:

For 1/2"			
Color/Type	Size/Shape	Specific Gravity	Lbs./Sq. Yd.
Black SBR	Granules	1.15 - 1.40	10.0 - 12.0
Black SBR	Medium Strands	1.15 - 1.25	8.5 - 10.0
Black EPDM	Granules	1.30 - 1.50	10.5 - 12.0
Colored EPDM	Granules	1.40 - 1.60	13.0 - 15.0

#### 6.0 Variety of Shape, Size & Composition

Each system manufacturer makes specific recommendations on the ratio of binder to rubber particles. The variety of particles, their shape, size and composition will cause the volume of binder to vary. Each system should specify the ratios required in the following format:

- (\_\_\_) total dry pounds of latex undiluted binder.  
 (\_\_\_) total pounds of the specified rubber particle.

Also included for colored binder and color sandwich systems:

- (\_\_\_) quantity of pigment per 55 gallons of latex binder.

#### 7.0 Surface Coating

Each manufacturer specifies a volume of protective surface coating to be used. It should be expressed in the following format:

- (\_\_\_) total gallons applied in (\_\_\_) applications.  
 Type of product being used \_\_\_\_\_.

#### 8.0 Material Delivery

All material must be delivered to the job site in labeled and marked containers. Quantities needed to complete the project in accordance with the manufacturer's specifications should be verified. All materials should be located to allow for work to proceed without interruption.

#### 9.0 Installation Equipment

All installation equipment including mixers, pavers, sprayers and hand tools should be kept free of moisture while in use. Equipment should be cleaned daily. No equipment or vehicles used in the installation process should leak any gas, petroleum products, solvents, etc.

#### 10.0 Surface Preparation

The asphalt or concrete base should be sufficiently cured and cleaned in order for work to progress. Recommended cure times - 14 days for asphalt, 28 days for concrete.

Prior to installation of the latex track system, the entire base should be checked for planarity and surface tolerance. Any areas that vary +/- 1/4" measured with a 10' straightedge in any direction should be patched with a compound compatible with the asphalt or concrete base and approved by the latex track manufacturer. After patching, the surface should not allow water to stand greater than 1/16" deep one hour after rain has ended.

#### 11.0 Installation

Latex track surfacing may be applied successfully by a variety of application methods.

Each manufacturer must specify the approved methods of installation. In all methods, the following items must be addressed.

**A. Layered Installations:**

Layered installations will specify the volume/lbs. of surfacing to be placed in each layer.

**B. Temperature & Humidity**

Latex track surfacing is dependent on evaporation for drying and curing. No material may be placed if ambient temperature is not at least 50 degrees F and rising. Relative humidity above 50% will increase the drying time. Low temperature and high humidity may lead to incomplete curing.

**C. Surface Thickness**

Before the final surface coating is applied, the owner and the contractor will determine that the desired surface thickness has been achieved by checking the surface in accordance with USTC&TBA test methods.

**12.0 Line Markings**

The surface system manufacturer must approve the type and brand of marking paint used. All lane and event markings should be in accordance with the applicable governing body.

**13.0 Cautions**

- A.** All packaging and excess materials must be disposed of in accordance with state, local and federal standards and regulations.
- B.** Do not allow liquid binders to freeze.
- C.** Resilient surfacing systems will not resolve inadequacies in the base or asphalt mix.
- D.** This guideline does not cover proper subbase and base construction or drainage considerations. The success of any surface is dependent upon a properly constructed base and good drainage.

**See also USTC&TBA Guidelines for:**

- I.A. General Conditions for Construction**
- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**
- III.A. Basic Layout, Dimensions & Site Considerations for Track Construction**
- III.B. Hot Mix Asphaltic Concrete Construction or III.C. Concrete Construction**
- III.I. Drawings**
- III.J. Quantitative Analysis of Installed Track Surfaces**

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SECTION	III.G.2	PAGE	1
TITLE	REVISION DATE 1999		
TRACK SURFACING - POLYURETHANE TRACKS BASEMAT (PERMEABLE)	COPYRIGHT © 1999 BY U.S. TENNIS COURT & TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.		
1.0	Scope		
	This guideline covers the components and methods of installation of polyurethane base mat track surfaces. A polyurethane base mat system is a homogenous blend of EPDM or SBR rubber granules and polyurethane binders that are evenly spread in a monolithic application over an asphaltic or concrete base. The system is a resilient all weather surface designed to allow moisture to pass through the surface. The system has a smooth finish and may be applied for both indoor and outdoor use.		
2.0	Materials		
	A variety of products may be used in the construction of the track surface. The terms defined below are to clarify the language used in this guideline and in proprietary specifications.		
A.	Primer		
	The primer is a mixture of polyurethane binder and a viscosity reduction vehicle that allows for a light film application.		
B.	Polyurethane		
	The polyurethane binder is a single component, 100% solids, moisture cure, elastic pre-polymer, designed to bind rubber granules together.		
C.	SBR/EPDM Black Rubber		
	Fully cured rubber granules that may either be ambient or cryogenically ground from post-industrial by-products to a size of not less than 1 nor more than 4mm. The general cut of the granules should be cubicle. They should contain less than 4% dust and be free of foreign debris. They should not contain any other color within the granule.		
D.	Colored EPDM Rubber		
	Colored EPDM granules should be ground from fully cured virgin slabs of peroxide- or sulfur-cured rubber (the curing process must be compatible with the polyurethane chemicals being used). The EPDM content should be not less than 20%. The general cut of the granules should be cubicle and they should contain less than 4% dust.		
3.0	Surface Specifications		
	Surface specifications should include:		
	Color		
	Depth		
	Type of facility: Governing Body, International Properties or Competition Properties		
	Events to be Marked		
	Surface properties for consideration:		
	Flatness and Imperfections Thickness		
	Modified Vertical Deformation; Force Reduction		
	Friction; Wet Spike Resistance		
	Tensile Properties; Elongation		
	Weathering Color		
	Flammability		
	Testing Methods		
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**4.0 Thickness, Weight and Specific Gravity**

Each surface system should be at least 1/2" (12.5mm) in total thickness to allow for variation in the underlayment and to prevent spiked shoes from penetrating to the base layer, potentially disrupting the bond. The total weight of the system is contingent upon the depth of the surface and the specific gravity of the materials. Both SBR and EPDM rubber particles will vary in specific gravity and bulk density value of rubber. This coupled with the application methods, shape and size will affect the rubber required to achieve 1/2" thickness. The chart below is intended for guidance.

Per 1/8"				
Color/Type	Size/Shape	Specific Gravity	Shore A Hardness	Lbs./Sq. Yd.
Black SBR	1-4mm Granules	1.15-1.40	55-70	3.6-4.1
Black EPDM	1-4mm Granules	1.20-1.50	55-70	3.8-4.5
Colored EPDM Granules	1-4mm	1.40-1.60	55-70	4.5-4.9

**5.0 Installed Materials**

The installation contractor should provide the owner with a manifest listing the quantities of materials to be used for surfacing in the following format:

( ) lbs. of primer ( ) number of drums ( ) weight/drum  
 ( ) lbs. of binder ( ) number of drums ( ) weight/drum  
 ( ) lbs. of rubber ( ) number of bags ( ) weight/bag

**6.0 Material Delivery**

All materials should be delivered to the job site in labeled and marked containers. Quantities needed to complete the project in accordance with the manufacturer's specifications should be verified. All materials should be located to allow for work to proceed without interruption.

**7.0 Installation Equipment**

All installation equipment including mixers, pavers, sprayers and hand tools should be kept free of moisture while in use. They should be cleaned daily. No equipment or vehicles used in the installation process should leak any gas, petroleum products, solvents, etc.

**8.0 Surface Preparation**

The asphalt or concrete base should be sufficiently cured and cleaned in order for work to progress. Recommended cure times - 14 days for asphalt, 28 days for concrete.

Prior to installation of the track surface system, the entire base should be checked for planarity and surface tolerance. Any areas that vary +/- 1/4" when measured with a 10' straightedge in any direction should be patched with a compound compatible with the base material and approved by the manufacturer of the track surfacing system. After patching, the surface should not allow water to stand greater than 1/16" deep one hour after rain has ended.

**9.0 Installation****A. Primer**

The surface should be primed with the appropriate polyurethane primer using spray equipment or rollers. Application rates range between 0.18 - 0.27 lbs. per square yard. For an asphalt base, primer application may be reduced by the contractor when extreme heat conditions soften the asphalt. Some manufacturers' systems will not require a primer.

**B. Mixing**

The rubber granules and polyurethane binder should be accurately measured and placed in a clean dry mixer and mixed until all granules are thoroughly coated with the polyurethane binder. No evidence of water may exist during the mixing process. The mixing ratio of rubber to binder should not be less than 5 parts rubber to 1 part binder as determined by the weight of the products. The pot life of the mix should not be less than 45 minutes. No agents are to be added to extend pot life.

**C. Placement of Base Mat**

The prepared material is placed evenly in front of the paving machine. The machine should be operated at a speed and with the screed bar at an angle to provide a tight and smooth surface, free of chatter marks and voids. The screed bars are to be constantly heated and should oscillate. The power source may be either electric or fuel generated. Material should be placed at the specified depth in a single application and allowed to cure.

**D. Trowel Work**

All seams are to be troweled smooth within the pot life of the material. All edges should be straight and rounded by turning the trowel. All cold dry seams should be cut straight at an inward angle and primed prior to commencing with subsequent work.

**E. Arid Climates**

To aid in the curing process in arid climates, it may be necessary to mist the surface with water upon completion of the day's work.

**F. Line Markings**

The surface system manufacturer must approve the type and brand of marking paint used. All lane and event markings should be in accordance with the applicable governing body.

**10.0 Cautions**

- A.** All packaging and excess materials must be disposed of in accordance with state, local and federal standards and regulations.
- B.** Do not allow liquid binders to freeze.
- C.** Resilient surfacing systems will not resolve inadequacies in the base or asphalt mix.
- D.** This guideline does not cover proper subbase and base construction or drainage considerations. The success of any surface is dependent upon a properly constructed base and good drainage.

See also USTC&TBA Guidelines for:

- I.A. General Conditions for Construction
- I.B. Site Investigation
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction
- I.D. Vegetation Control or Vegetation Regrowth Prevention
- I.E. Subsurface and Surface Drainage for Recreational Areas
- III.A. Basic Layout, Dimensions & Site Considerations for Track Construction
- III.B. Hot Mix Asphaltic Concrete Construction or III.C. Concrete Construction
- III.I. Drawings
- III.J. Quantitative Analysis of Installed Track Surfaces

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and owners. Parties not experienced in track construction are advised to consult a qualified contractor and/or design professional regarding their interpretation and application. Experienced contractors can be identified through the U. S. Tennis Court and Track Builders Association (USTC&TBA), which offers a Certified Track Builder program. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

SECTION	III.G.3	PAGE	1
TITLE	REVISION DATE 1999		
TRACK SURFACING - POLYURETHANE TRACKS BASEMAT STRUCTURAL SPRAY (PERMEABLE)	COPYRIGHT © 1999 BY U.S. TENNIS COURT & TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.		
1.0	<b>Scope</b> This guideline covers the components and methods of installation of polyurethane base mat structural spray track surfaces. The polyurethane base mat structural spray system is a homogenous blend of EPDM or SBR rubber granules and polyurethane binders. The base layer is spread evenly in a monolithic application over an asphaltic or concrete base and followed with a structural spray-applied polyurethane and rubber blended coating. The system is a resilient all weather surface designed to allow moisture to pass through the surface. It has a textured finish and is used primarily in outdoor applications.		
2.0	<b>Materials</b> A variety of products may be used in the construction of the track surface. The terms defined below are to clarify the language used in this guideline and in proprietary specifications.		
A.	<b>Primer</b> The primer is a mixture of polyurethane binder and a viscosity reduction vehicle that allows for a light film application.		
B.	<b>Polyurethane</b> The polyurethane binder is a single component, 100% solids, moisture cure, elastic pre-polymer, designed to bind rubber granules together.		
C.	<b>SBR/EPDM Black Rubber</b> Fully cured rubber granules that may either be ambient or cryogenically ground from post-industrial by-products to a size of not less than 1 nor more than 4mm. The general cut of the granules should be cubicle. They should contain less than 4% dust and be free of foreign debris. They should not contain any other color within the granule.		
D.	<b>Colored EPDM Rubber</b> Colored EPDM granules should be ground from fully cured virgin slabs of peroxide- or sulfur-cured rubber (the curing process must be compatible with the polyurethane chemicals being used). The EPDM content should be not less than 20%. The general cut of the granules should be cubicle and they should contain less than 4% dust.		
E.	<b>Colored EPDM Rubber (Structural Spray)</b> Same as D, above, but the gradation of the granules should range from 0.5mm to a maximum of 3mm.		
3.0	<b>Surface Specifications</b> Surface specifications should include:  Color Depth Type of facility: Governing Body, International Properties or Competition Properties Events to be Marked Surface properties for consideration:		

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Flatness and Imperfections Thickness  
 Modified Vertical Deformation; Force Reduction  
 Friction; Wet Spike Resistance  
 Tensile Properties; Elongation  
 Weathering Color  
 Flammability

#### Testing Methods

#### 4.0 Thickness, Weight and Specific Gravity

Each surface system should be at least 1/2" (12.5mm) in total thickness to allow for variation in the underlayment and to prevent spiked shoes from penetrating to the base layer, potentially disrupting the bond. The total weight of the system is contingent upon the depth of the surface and the specific gravity of the materials. Both SBR and EPDM rubber particles will vary in specific gravity and bulk density value of rubber. This coupled with the application methods, shape and size will affect the rubber required to achieve 1/2" thickness. The chart below is intended for guidance. The spray coating weights have been previously described and are added to the weight of the base layer. The chart below is intended for guidance.

Per 1/8"				
Color/Type	Size/Shape	Specific Gravity	Shore A Hardness	Lbs./Sq. Yd.
Black SBR	1-4mm Granules	1.15-1.40	55-70	3.6-4.1
Black EPDM	1-4mm Granules	1.20-1.50	55-70	3.8-4.5
Colored EPDM	1-4mm Granules	1.40-1.60	55-70	4.5-4.9

#### 5.0 Installed Materials

The installation contractor should provide the owner with a manifest listing the quantities of materials to be used for surfacing in the following format:

( ) lbs. of primer ( ) number of drums ( ) weight/drum  
 ( ) lbs. of binder ( ) number of drums ( ) weight/drum  
 ( ) lbs. of rubber ( ) number of bags ( ) weight/bag

##### Structural Spray Layer:

( ) total lbs. of structural spray mix  
 ( ) lbs. of 1 comp. spray ( ) number of drums ( ) weight/drum  
 ( ) lbs. Part A color ( ) number of drums ( ) weight/drum  
 ( ) lbs. Part B binder ( ) number of drums ( ) weight/drum  
 ( ) lbs. of colored EPDM ( ) number of bags ( ) weight/bag  
 ( ) size of colored EPDM granules

#### 6.0 Material Delivery

All materials should be delivered to the job site in labeled and marked containers. Quantities needed to complete the project in accordance with the manufacturer's specifications should be verified. All materials should be located to allow for work to proceed without interruption.

**7.0 Installation Equipment**

All installation equipment including mixers, pavers, sprayers and hand tools should be kept free of moisture while in use. They should be cleaned daily. No equipment or vehicles used in the installation process should leak any gas, petroleum products, solvents, etc.

**8.0 Surface Preparation**

The asphalt or concrete base should be sufficiently cured and cleaned in order for work to progress. Recommended cure times - 14 days for asphalt, 28 days for concrete.

Prior to installation of the track surface system, the entire base should be checked for planarity and surface tolerance. Any areas that vary  $\pm 1/4$ " when measured with a 10' straightedge in any direction should be patched with a compound compatible with the base material and approved by the manufacturer of the track surfacing system. After patching, the surface should not allow water to stand greater than 1/16" deep one hour after rain has ended.

**9.0 Installation****A. Primer**

The surface should be primed with the appropriate polyurethane primer using spray equipment or rollers. Application rates range between 0.18 - 0.27 lbs. per square yard. For an asphalt base, primer application may be reduced by the contractor when extreme heat conditions soften the asphalt. Some manufacturer's systems will not require a primer.

**B. Mixing**

The rubber granules and polyurethane binder should be accurately measured and placed in a clean dry mixer and mixed until all granules are thoroughly coated with the polyurethane binder. No evidence of water may exist during the mixing process. The mixing ratio of rubber to binder should not be less than 5 parts rubber to 1 part binder as determined by the weight of the products. The pot life of the mix should not be less than 45 minutes. No agents are to be added to extend pot life.

**C. Placement of Base Mat**

The prepared material is placed evenly in front of the paving machine. The machine should be operated at a speed and with the screed bar at an angle to provide a tight and smooth surface, free of chatter marks and voids. The screed bars are to be constantly heated and should oscillate. The power source may be either electric or fuel generated. Material should be placed at the specified depth in a single application and allowed to cure.

**D. Trowel Work**

All seams are to be troweled smooth within the pot life of the material. All edges should be straight and rounded by turning the trowel. All cold dry seams should be cut straight at an inward angle and primed prior to commencing with subsequent work.

**E. Arid Climates**

To aid in the curing process in arid climates, it may be necessary to mist the surface with water upon completion of the day's work.

**F. Mixing of the Structural Spray**

Using dry containers, weigh out in accordance to the manufacturer's specification a quantity of the two component parts (A and B) of the structural

spray and mix them thoroughly. Add the specified quantity of colored EPDM rubber granules to the mixed material, or in the case of a single component structural spray, to the weighed out portion of that single component material. Mix thoroughly.

**G. Application of the Structural Spray**

Place the mixed material into a spray machine and spray apply the material to the base mat. Apply a second coat of material over the first by spraying in the opposite direction. The total rate of application of two coats of spray will range from 3.4 to 4.4 lbs. per square yard.

**H. Line Markings**

The surface system manufacturer must approve the type and brand of marking paint used. All lane and event markings should be in accordance with the applicable governing body.

**10.0 Cautions**

- A.** All packaging and excess materials must be disposed of in accordance with state, local and federal standards and regulations.
- B.** Do not allow liquid binders to freeze.
- C.** Resilient surfacing systems will not resolve inadequacies in the base or asphalt mix.
- D.** This guideline does not cover proper subbase and base construction or drainage considerations. The success of any surface is dependent upon properly constructed base and good drainage.

**See also USTC&TBA Guidelines for:**

- I.A. General Conditions for Construction**
- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**
- III.A. Basic Layout, Dimensions & Site Considerations for Track Construction**
- III.B. Hot Mix Asphaltic Concrete Construction or III.C. Concrete Construction**
- III.I. Drawings**
- III.J. Quantitative Analysis of Installed Track Surfaces**

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and owners. Parties not experienced in track construction are advised to consult a qualified contractor and/or design professional regarding their interpretation and application. Experienced contractors can be identified through the U. S. Tennis Court and Track Builders Association (USTC&TBA), which offers a Certified Track Builder program. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

SECTION	III.G.4	PAGE	1
TITLE <b>TRACK SURFACING -            POLYURETHANE TRACKS            BASEMAT/SANDWICH            (IMPERMEABLE)</b>	REVISION DATE <b>1999</b>  COPYRIGHT © 1999 BY U.S. TENNIS COURT & TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.		
<p><b>1.0 Scope</b>            This guideline covers the components and methods of installation of polyurethane base mat sandwich system track surfaces. The polyurethane base mat sandwich system is a homogenous blend of SBR rubber granules and polyurethane binder base layer spread evenly in a monolithic application followed by sealing. The sealant layer is a massive application of polyurethane coating with colored EPDM granules broadcast or encapsulated into the coating. This sealant layer makes the system impermeable. The system is a resilient all weather surface. It is textured and is used in both indoor and outdoor applications.</p> <p><b>2.0 Materials</b>            A variety of products may be used in the construction of the track surface. The terms defined below are to clarify the language used in this guideline and in proprietary specifications.</p> <p><b>A. Primer</b>            The primer is a mixture of polyurethane binder and a viscosity reduction vehicle that allows for a light film application.</p> <p><b>B. Polyurethane</b>            The polyurethane binder is a single component, 100% solids, moisture cure, elastic pre-polymer, designed to bind rubber granules together.</p> <p><b>C. Polyurethane Coating and Sealers</b>            Two component 100% solids polyurethane coating consisting of a Part A colored polyol and a Part B isocyanate activator. Specific gravity of 1.15 to 1.30. The coating may be used for the top layer as well as the sealant layer.</p> <p><b>D. Polyurethane Sealer</b>            Two component 100% solids thioxotropic polyurethane coating consisting of a Part A colored polyol and Part B isocyanate activator. Specific gravity of 1.45 - 1.60. The coating is applied without the adding of rubber dust and is used only as a sealer.</p> <p><b>E. Polyurethane Aliphatic Top Coating</b>            A single or two component aliphatic top coating applied to structural surfaces that need to be protected from UV degradation.</p> <p><b>F. SBR/EPDM Black Rubber</b>            Fully cured rubber granules that may either be ambient or cryogenically ground from post-industrial by-products to a size of not less than 1 nor more than 4mm. The general cut of the granules should be cubicle. They should contain less than 4% dust and be free of foreign debris. They should not contain any other color within the granule.</p> <p><b>G. Colored EPDM Rubber</b>            Colored EPDM granules should be ground from fully cured virgin slabs of peroxide- or sulfur-cured rubber (the curing process must be compatible with</p>			

the polyurethane chemicals being used). The EPDM content should be not less than 20%. The general cut of the granules should be cubicle and they should contain less than 4% dust. Colored EPDM rubber dust graded to 0.0 - 0.5 may be used as a thickener for the polyurethane coating in the sealing process.

### 3.0 Surface Specifications

Surface specifications should include:

Color

Depth

Type of facility: Governing Body, International Properties or Competition Properties

Events to be Marked

Surface properties for consideration:

Flatness and Imperfections Thickness

Modified Vertical Deformation; Force Reduction

Friction; Wet Spike Resistance

Tensile Properties; Elongation

Weathering Color

Flammability

Testing Methods

### 4.0 Thickness, Weight and Specific Gravity

Each surface system should be at least 1/2" (12.5mm) in total thickness to allow for variation in the underlayment and to prevent spiked shoes from penetrating to the base layer, potentially disrupting the bond. The total weight of the system is contingent upon the depth of the surface and the specific gravity of the materials. Both SBR and EPDM rubber particles will vary in specific gravity and bulk density value of rubber. This coupled with the application methods, shape and size will affect the rubber required to achieve 1/2" thickness. The chart below is intended for guidance.

Per 1/8"				
Color/Type	Size/Shape	Specific Gravity	Shore A Hardness	Lbs./Sq. Yd.
Black SBR	1-4mm Granules	1.15-1.40	55-70	3.6-4.1
Black EPDM	1-4mm Granules	1.20-1.50	55-70	3.8-4.5
Colored EPDM Granules	1-4mm	1.40-1.60	55-70	4.5-4.9

### 5.0. Installed Materials

The installation contractor should provide the owner with a manifest listing the quantities of materials to be used for surfacing in the following format:

Base Layer

( ) lbs. of primer ( ) number of drums ( ) weight/drum

( ) lbs. of binder ( ) number of drums ( ) weight/drum

( ) lbs. of rubber ( ) number of bags ( ) weight/bag

Seal Layer

( ) lbs. coating Part A ( ) no. of drums ( ) weight/drum

( ) lbs. coating Part B ( ) no. of drums ( ) weight/drum  
Is coating thixotropic? \_\_\_ Yes \_\_\_ No  
( ) lbs. of binder ( ) number of drums ( ) weight/drum  
( ) lbs. of EPDM dust ( ) no. of drums ( ) weight/drum

**Top Layer (A)**

( ) lbs. coating Part A ( ) no. of drums ( ) weight/drum  
( ) lbs. coating Part B ( ) no. of drums ( ) weight/drum  
( ) lbs. of colored EPDM ( ) no. of bags ( ) weight/bag  
Size of EPDM granules \_\_\_\_\_

**Top Layer (B)**

( ) lbs. coating Part A ( ) no. of drums ( ) weight/drum  
( ) lbs. coating Part B ( ) no. of drums ( ) weight/drum  
( ) lbs. of colored EPDM ( ) no. of bags ( ) weight/bag  
Size of EPDM granules \_\_\_\_\_

**Aliphatic Layer (when applicable)**

( ) lbs. coating Part A ( ) no. of drums ( ) weight/drum  
( ) lbs. coating Part B ( ) no. of drums ( ) weight/drum  
( ) lbs. 1 component ( ) no. of drums ( ) weight/drum

**6.0 Material Delivery**

All materials should be delivered to the job site in labeled and marked containers. Quantities needed to complete the project in accordance with the manufacturer's specifications should be verified. All materials should be located to allow for work to proceed without interruption.

**7.0 Installation Equipment**

All installation equipment including mixers, pavers, sprayers and hand tools should be kept free of moisture while in use. They should be cleaned daily. No equipment or vehicles used in the installation process should leak any gas, petroleum products, solvents, etc.

**8.0 Surface Preparation**

The asphalt or concrete base should be sufficiently cured and cleaned in order for work to progress. Recommended cure times - 14 days for asphalt, 28 days for concrete.

Prior to installation of the track surface system, the entire base should be checked for planarity and surface tolerance. Any areas that vary +/- 1/4" when measured with a 10' straightedge in any direction should be patched with a compound compatible with the base material and approved by the manufacturer of the track surfacing system. After patching, the surface should not allow water to stand greater than 1/16" deep one hour after rain has ended.

**9.0 Installation**

**A. Primer**

The surface should be primed with the appropriate polyurethane primer using spray equipment or rollers. Application rates range between 0.18 - 0.27 lbs. per square yard. For an asphalt base, primer application may be reduced by the contractor when extreme heat conditions soften the asphalt. Some manufacturer's systems will not require a primer.

**B. Mixing**

The rubber granules and polyurethane binder should be accurately measured

and placed in a clean dry mixer and mixed until all granules are thoroughly coated with the polyurethane binder. No evidence of water may exist during the mixing process. The mixing ratio of rubber to binder should not be less than 5 parts rubber to 1 part binder as determined by the weight of the products. The pot life of the mix should not be less than 45 minutes. No agents are to be added to extend pot life.

**C. Placement of Base Mat**

The prepared material is placed evenly in front of the paving machine. The machine should be operated at a speed and with the screed bar at an angle to provide a tight and smooth surface, free of chatter marks and voids. The screed bars are to be constantly heated and should oscillate. The power source may be either electric or fuel generated. Material should be placed at the specified depth in a single application and allowed to cure.

**D. Trowel Work**

All seams are to be troweled smooth within the pot life of the material. All edges should be straight and rounded by turning the trowel. All cold dry seams should be cut straight at an inward angle and primed prior to commencing with subsequent work.

**E. Arid Climates**

To aid in the curing process in arid climates, it may be necessary to mist the surface with water upon completion of the day's work.

**F. Seal Coat**

The seal coat is a mixture of the two component coating and EPDM rubber dust that is mixed and squeegee-applied to the base mat. Alternatives are to squeegee-apply two component thixotropic polyurethane coating without rubber dust or spray binder and brush EPDM rubber dust into the base mat. In all cases, sufficient material is to be applied to render the surface impermeable. It is extremely important that the base mat and base are completely void of moisture before commencing with application of the seal coat.

**G. Top Coat**

1. The top coat is a massive flow application of the two component coating that is mixed according to the ratios of part A and B listed by the manufacturer. The material is to be self leveling and should be free of ridges. Prior to initial set, colored EPDM rubber granules are broadcast with sufficient excess granules being applied to assist in the embedding process. Normally 5 to 5.5 lbs. of granules per square yard will be embedded. All loose excess granules are removed after initial cure.
2. The alternative top coating is a spray application of a two component coating and encapsulated EPDM rubber granules applied at an approximate ratio of 60% coating to 40% rubber to sufficiently protect the base.

**H. Aliphatic Top Coating**

If the encapsulated top coating is unprotected for UV resistance, then a thin mil layer of one or two component aliphatic top coating should be spray-applied, normally in two applications, over the surface in accordance to the manufacturer's recommendation.



**I. Line Markings**

The surface system manufacturer must approve the type and brand of marking paint used. All lane and event markings should be in accordance with the applicable governing body.

**10.0 Cautions**

- A.** All packaging and excess materials must be disposed of in accordance with state, local and federal standards and regulations.
- B.** Do not allow liquid binders to freeze.
- C.** Resilient surfacing systems will not resolve inadequacies in the base or asphalt mix.
- D.** This guideline does not cover proper subbase and base construction or drainage considerations. The success of any surface is dependent upon properly constructed base and good drainage.

**See also USTC&TBA Guidelines for:**

- I.A. General Conditions for Construction**
- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**
- III.A. Basic Layout, Dimensions & Site Considerations for Track Construction**
- III.B. Hot Mix Asphaltic Concrete Construction or III.C. Concrete Construction**
- III.I. Drawings**
- III.J. Quantitative Analysis of Installed Track Surfaces**

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and owners. Parties not experienced in track construction are advised to consult a qualified contractor and/or design professional regarding their interpretation and application. Experienced contractors can be identified through the U. S. Tennis Court and Track Builders Association (USTC&TBA), which offers a Certified Track Builder program. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.



SECTION	III.G.5	PAGE	1
TITLE <b>TRACK SURFACING - POLYURETHANE TRACKS FULL POUR (IMPERMEABLE)</b>		REVISION DATE <b>1999</b>  COPYRIGHT © 1999 BY U.S. TENNIS COURT & TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.	
<div>1.0    <b>Scope</b> This guideline covers the components and methods of installation of full pour polyurethane system track surfaces. A full pour polyurethane system is the application of multiple layers of polyurethane coating and rubber, which may either be black SBR or colored EPDM. The top layer is a massive application of polyurethane coating with colored EPDM granules broadcast or encapsulated into the coating. The system is a resilient all weather surface. It is textured and impermeable and is used in both indoor and outdoor applications.</div> <div>2.0    <b>Materials</b> A variety of products may be used in the construction of the track surface. The terms defined below are to clarify the language used in this guideline and in proprietary specifications.<div>A.    <b>Primer</b> The primer is a mixture of polyurethane binder and a viscosity reduction vehicle that allows for a light film application.</div><div>B.    <b>Polyurethane Coating</b> Two component 100% solids polyurethane coating consisting of a Part A colored polyol and a Part B isocyanate activator. Specific gravity of 1.15 to 1.30.</div><div>C.    <b>Polyurethane Aliphatic Top Coating</b> A single or two component aliphatic top coating applied to structural surfaces that need to be protected from UV degradation.</div><div>D.    <b>SBR/EPDM Black Rubber</b> Fully cured rubber granules that may either be ambient or cryogenically ground from post-industrial by-products to a size of not less than 1 nor more than 4mm. The general cut of the granules should be cubicle. They should contain less than 4% dust and be free of foreign debris. They should not contain any other color within the granule.</div><div>E.    <b>Colored EPDM Rubber</b> Colored EPDM granules should be ground from fully cured virgin slabs of peroxide- or sulfur-cured rubber (the curing process must be compatible with the polyurethane chemicals being used). The EPDM content should be not less than 20%. The general cut of the granules should be cubicle and they should contain less than 4% dust.</div></div> <div>3.0    <b>Surface Specifications</b> Surface specifications should include:  Color Depth Type of facility: Governing Body, International Properties or Competition Properties Events to be Marked     Surface properties for consideration:</div>			

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Flatness and Imperfections Thickness  
 Modified Vertical Deformation; Force Reduction  
 Friction; Wet Spike Resistance  
 Tensile Properties; Elongation  
 Weathering Color  
 Flammability  
 Testing Methods

#### 4.0 System Thickness, Weight and Specific Gravity

Each surface system should be at least 1/2" (12.5mm) in total thickness to allow for variation in the underlayment and to prevent spiked shoes from penetrating to the base layer, potentially disrupting the bond. The total weight of the system is contingent upon the depth of the surface and the specific gravity of the materials. Both SBR and EPDM rubber particles will vary in specific gravity and bulk density value of rubber. This coupled with the application methods, shape and size will affect the rubber required to achieve 1/2" thickness. The chart below is intended for guidance.

Per 1/8"			
Color/Type	Size/Shape	Specific Gravity	Shore A Hardness
Black SBR	1-4mm Granules	1.15-1.40	55-70
Black EPDM	1-4mm Granules	1.20-1.50	55-70
Colored EPDM	1-4mm Granules	1.40-1.60	55-70

#### 5.0 Installed Materials

The installation contractor should provide the owner with a manifest listing the quantities of materials to be used for surfacing in the following format:

( ) lbs. coating Part A ( ) no. of drums ( ) weight/drum  
 ( ) lbs. coating Part B ( ) no. of drums ( ) weight/drum  
 ( ) lbs. of base granules ( ) no. of bags ( ) weight/bag  
 Type of Base granules \_\_\_\_\_ Size of Base granules \_\_\_\_\_  
 ( ) lbs. of colored EPDM ( ) no. of bags ( ) weight/bag  
 Size of Top granules \_\_\_\_\_

Aliphatic Layer (when applicable)

( ) lbs. coating Part A ( ) no. of drums ( ) weight/drum  
 ( ) lbs. coating Part B ( ) no. of drums ( ) weight/drum  
 ( ) lbs. 1 component ( ) no. of drums ( ) weight/drum

#### 6.0 Material Delivery

All materials should be delivered to the job site in labeled and marked containers. Quantities needed to complete the project in accordance with the manufacturer's specifications should be verified. All materials should be located to allow for work to proceed without interruption.

#### 7.0 Installation Equipment

All installation equipment including mixers, pavers, sprayers and hand tools should be

kept free of moisture while in use. They should be cleaned daily. No equipment or vehicles used in the installation process should leak any gas, petroleum products, solvents, etc.

#### **8.0 Surface Preparation**

The asphalt or concrete base should be sufficiently cured and cleaned in order for work to progress. Recommended cure times - 14 days for asphalt, 28 days for concrete.

Prior to installation of the track surface system, the entire base should be checked for planarity and surface tolerance. Any areas that vary  $\pm 1/4$ " when measured with a 10' straightedge in any direction should be patched with a compound compatible with the base material and approved by the manufacturer of the track surfacing system. After patching, the surface should not allow water to stand greater than  $1/16$ " deep one hour after rain has ended.

#### **9.0 Installation**

##### **A. Primer**

The surface should be primed with the appropriate polyurethane primer using spray equipment or rollers. Application rates range between 0.18 - 0.27 lbs. per square yard. For an asphalt base, primer application may be reduced by the contractor when extreme heat conditions soften the asphalt. Some manufacturer's systems will not require a primer.

##### **B. Mixing**

All two component polyurethane coatings are to be mixed in a manner to accurately measure and thoroughly mix all materials to the ratios specified by the manufacturer.

##### **C. Applying Base Materials**

The two component self leveling polyurethane coating is flow applied to the base in multiple layers with either black SBR or colored EPDM granules being applied into the coating to attain the specified base depth. The ratio of base rubber will be between 15% and 35% of the total weight of the finished surface.

##### **D. Top Coat**

1. The top coat is a massive flow application of the two component coating that is mixed according to the ratios of part A and B listed by the manufacturer. The material is to be self leveling and should be free of ridges. Prior to initial set, colored EPDM rubber granules are broadcast into the coating with sufficient excess granules being applied to assist in the embedding process. Normally 5 to 5.5 lbs. of granules per square yard will be embedded. All loose excess granules are removed after initial cure.
2. The alternative top coating is a spray application of two component coating and encapsulated EPDM rubber granules applied at an approximate ratio of 60% coating to 40% rubber to sufficiently protect the base.

##### **E. Aliphatic Top Coating**

If the encapsulated top coating is unprotected for UV resistance, then a thin mil layer of the one or two component aliphatic top coating should be spray-applied, normally in two applications, over the surface in accordance to the manufacturer's recommendation.

**F. Line Markings**

The surface system manufacturer must approve the type and brand of marking paint used. All lane and event markings should be in accordance with the applicable governing body.

**10.0 Cautions**

- A.** All packaging and excess materials must be disposed of in accordance with state, local and federal standards and regulations.
- B.** Do not allow liquid binders to freeze.
- C.** Resilient surfacing systems will not resolve inadequacies in the base or asphalt mix.
- D.** This guideline does not cover proper subbase and base construction or drainage considerations. The success of any surface is dependent upon properly constructed base and good drainage.

**See also USTC&TBA Guidelines for:**

- I.A. General Conditions for Construction**
- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**
- III.A. Basic Layout, Dimensions & Site Considerations for Track Construction**
- III.B. Hot Mix Asphaltic Concrete Construction or III.C. Concrete Construction**
- III.I. Drawings**
- III.J. Quantitative Analysis of Installed Track Surfaces**

**NOTICE:** These Construction Guidelines are for use by architects, engineers, contractors and owners. Parties not experienced in track construction are advised to consult a qualified contractor and/or design professional regarding their interpretation and application. Experienced contractors can be identified through the U. S. Tennis Court and Track Builders Association (USTC&TBA), which offers a Certified Track Builder program. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.

SECTION	III.G.6	PAGE	1
TITLE <b>TRACK SURFACING - PREMANUFACTURED RUBBER TRACKS</b>		REVISION DATE <b>1999</b>  COPYRIGHT © 1999 BY U.S. TENNIS COURT & TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.	
<b>1.0 Scope</b> This guideline covers the components and methods of installation of premanufactured rubber track surfaces. Premanufactured rubber track surfaces can be classified into three distinct systems: a prefabricated rubber base layer with a structural spray top coating (permeable structure); a prefabricated rubber base layer with massive pour of polyurethane coating with embedded colored EPDM rubber granules (impermeable structure), and a prefabricated, vulcanized rubber product that is installed in a single layer (impermeable structure).			
<b>2.0 Materials</b> A variety of products may be used in the construction of the track surface. The terms defined below are to clarify the language used in this guideline and in proprietary specifications.			
<b>A. Primer</b> The primer is a mixture of polyurethane binder and a viscosity reduction vehicle that allows for a light film application. Primer may vary with the specifications provided by the manufacturer of the surface.			
<b>B. Adhesive</b> The adhesive is a single or two component polyurethane or other material specified by the manufacturer that is used to bond the prefabricated materials to the prepared base.			
<b>C. Prefabricated Rubber Mat</b> The prefabricated rubber mat is a rolled sheet good product that is comprised of rubber particles and a polyurethane binder.			
<b>D. Prefabricated Vulcanized Rubber Mat</b> The prefabricated mat is calendered and vulcanized with a base of natural and synthetic rubber, stabilizing agents and pigments at a prescribed thickness and finish texture.			
<b>3.0 Surface Specifications</b> Surface specifications should include:  Color Depth Type of facility: Governing Body, International Properties or Competition Properties Surface properties for consideration: Flatness and Imperfections Thickness Modified Vertical Deformation; Force Reduction Friction; Wet Spike Resistance Tensile Properties; Elongation Weathering Color  Flammability Testing Methods			

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**4.0. System Thickness and Weight**

Each surface system should be at least 1/2" (12.5mm) in total thickness to allow for variation in the underlayment and to prevent spiked shoes from penetrating to the base layer, potentially disrupting the bond. The total weight of the system is contingent upon the depth of the surface and the specific gravity of the materials, as well as the weight of the colored EPDM granules embedded in the top coating.

**5.0 Installed Materials**

The installation contractor should provide the owner with a manifest listing the quantities of materials to be used for surfacing in the following format:

**Sheet Goods Product**

( ) number of square yards ( ) thickness ( ) weight/sq. yd.  
( ) lbs. of primer ( ) number of drums ( ) weight/drum  
( ) lbs. of adhesive Part A ( ) no. of drums ( ) weight/drum  
( ) lbs. of adhesive Part B ( ) no. of drums ( ) weight/drum

**Structural Spray**

( ) lbs. structural spray A + B ( ) no. of drums ( ) wgt./drum  
( ) lbs. of EPDM rubber ( ) number of bags ( ) weight/bag

**Flood Coat**

( ) lbs. of sealer A + B ( ) no. of drums ( ) weight/drum  
( ) lbs. of coating A ( ) number of drums ( ) weight/drum  
( ) lbs. colored EPDM ( ) no. of bags ( ) weight/bag

**6.0 Material Delivery**

All materials should be delivered to the job site in labeled and marked containers. Quantities needed to complete the project in accordance with the manufacturer's specifications should be verified. All materials should be located to allow for work to proceed without interruption.

**7.0 Installation Equipment**

All installation equipment including mixers, pavers, sprayers and hand tools should be kept free of moisture while in use. They should be cleaned daily. No equipment or vehicles used in the installation process should leak any gas, petroleum products, solvents, etc.

**8.0 Surface Preparation**

The asphalt or concrete base should be sufficiently cured and cleaned in order for work to progress. Recommended cure times - 14 days for asphalt, 28 days for concrete.

Prior to installation of the track surface system, the entire base should be checked for planarity and surface tolerance. Any areas that vary +/- 1/4" when measured with a 10' straightedge in any direction should be patched with a compound compatible with the base material and approved by the manufacturer of the track surfacing system. After patching, the surface should not allow water to stand greater than 1/16" deep one hour after rain has ended.

**9.0 Installation****A. Primer**

The day's work should be primed, if required, in accordance with the manufacturer's specifications. Normal application procedures call for the primer to be either spray or roller applied.

**B. Placement of the Mat**

Most manufacturers call for materials to be laid out and relaxed prior to installation. Adhesive is then mixed and troweled in place using a notched trowel. Apply rates should be in accordance with the manufacturer's specifications. Adhesive should be applied only to the area to be covered by one roll at a time.

When the adhesive is tacky, the mat is then placed onto the surface making sure that each sheet is placed in a straight line or around a curve at a constant radius. All butt joints are to be staggered. The mat should be rolled out so that all entrapped air is removed. Seams and butt joints are to be level and not pinched. Place weights as necessary to hold the mat in place. Remove any excess adhesive that protrudes above the seams and joints.

**C. Structural Top Coating**

Should the surface require a structural spray coating, proceed as follows: (See also III.G.3. Track Surfacing - Polyurethane Tracks - Basemat Structural Spray.)

**1. Mixing**

Using dry containers, weigh out in accordance to the manufacturer's specification a quantity of the two component parts (A and B) of the structural spray and mix them thoroughly. Add the specified quantity of colored EPDM rubber granules to the mixed material, or in the case of a single component structural spray, to the weighed out portion of that single component material. Mix thoroughly.

**2. Application**

Place the mixed material into a spray machine and spray apply the material to the base mat. Apply a second coat of material over the first by spraying in the opposite direction. The total rate of application of two coats of spray will range from 3.4 to 4.4 lbs. per square yard.

**D. Flood Coat and Embedded Rubber Top Coating**

Should the surface require a flood coat and EPDM rubber top coating, proceed as follows. (See also III.G.4. Track Surfacing - Polyurethane Tracks - Basemat/Sandwich.)

1. The top coat is a massive flow application of the two component coating that is mixed according to the ratios of part A and B listed by the manufacturer. The material is to be self leveling and should be free of ridges. Prior to initial set colored EPDM rubber granules are broadcast with sufficient excess granules being applied to assist in the embedding process. Normally 5 to 5.5 lbs. of granules per square yard will be embedded. All loose excess granules are removed after initial cure.
2. The alternative top coating is a spray application of two component coating and encapsulated EPDM rubber granules applied at an approximate ratio of 60% coating to 40% rubber to sufficiently protect the base.

**E. Single Sheet Good Installation**

Should the specification call for the product to be vulcanized and calendered with a textured finish; proceed to line marking.



**F. Line Markings**

The surface system manufacturer must approve the type and brand of marking paint used. All lane and event markings should be in accordance with the applicable governing body.

**10.0 Cautions**

- A.** All packaging and excess materials must be disposed of in accordance with state, local and federal standards and regulations.
- B.** Do not allow liquid binders to freeze.
- C.** Resilient surfacing systems will not resolve inadequacies in the base or asphalt mix.
- D.** This guideline does not cover proper subbase and base construction or drainage considerations. The success of any surface is dependent upon properly constructed base and good drainage.

**See also USTC&TBA Guidelines for:**

- I.A. General Conditions for Construction**
- I.B. Site Investigation**
- I.C. Site Preparation, Earthwork, Drainage and Subbase Construction**
- I.D. Vegetation Control or Vegetation Regrowth Prevention**
- I.E. Subsurface and Surface Drainage for Recreational Areas**
- III.A. Basic Layout, Dimensions & Site Considerations for Track Construction**
- III.B. Hot Mix Asphaltic Concrete Construction or III.C. Concrete Construction**
- III.I. Drawings**
- III.J. Quantitative Analysis of Installed Track Surfaces**

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SECTION	III.H.	PAGE	1
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<p><b>1.0 Paint</b> Various types of running surfaces have different characteristics. These may require different types of paint such as latex, urethane or enamels. It is imperative that the proper paint is used. The track surfacing manufacturer's recommendations should prevail.</p> <p><b>2.0 Layout</b></p> <p><b>A. General Method</b> Layout should be accomplished using an accurate steel chain, corrected for temperature. A theodolite with a minimum capability of accurate direct readings (to the nearest twenty seconds) should be used for markings placed in the curves. Other methods, providing the same or greater accuracy, may be used if prior approval is obtained.</p> <p><b>B. Measure Line</b> The measure line is defined as a theoretical line from which the distance of a running track is determined. This line is located 20cm from the running side of the painted line for each lane. In the case of a raised curb, the theoretical line is located 30cm from the running side of the raised curb for lane one. There is to be no variance to adherence to the rules for use of this line.</p> <p><b>C. Tolerances</b> When the lane lines and starting lines are placed, no minus tolerance is acceptable.</p> <p><b>3.0 Painting</b></p> <p><b>A. Placement</b> The location of the finish line determines the location of all other markings such as starts, hurdles and exchange zones. Consult the governing body requirements and recommendations for finish line placement. Generally, it is recommended that the finish line be placed at the P.C. (point of curve). Every effort should be made to start the 200m at PC 3. Chute length should be determined by measuring at least 115m back from the finish line.</p> <p><b>B. Markings</b></p> <p>1. <u>Lane Lines, Start and Finish Lines</u> Lane line markings should be 2" (5 cm) wide depending on the rules of the governing body. In areas where chute and curve lines intersect, chute lines should be dashed or broken with some other means to indicate the curved lines have priority. Start and finish lines should also be 2"(5 cm) in width. The NCAA and IAAF require finish line blackouts.</p> <p>2. <u>Exchange Zones</u> Exchange zones are typically marked using triangles or rectangles, squares or triangles, painted on both sides of each lane.</p>			

3. Hurdle Placements

Hurdle placements can be identified by use of small rectangles, squares or triangles, painted on both sides of each lane.

4. Other Markings

Other markings such as event identification, shadowed lane numbers, school logos or sprint race markings for running in back straight or reverse direction may be added to enhance the usability and appearance of the track.

**C. Colors**

Individual governing bodies have recommended or required colors for each event. School colors may be incorporated into the track for lane numbers or lines where governing bodies allow.

**D. Paint Application**

Paint may be rolled, brushed or sprayed. It is most commonly sprayed because on many surfaces, spraying provides a more satisfactory result.

**E. Paint Coats**

The manufacturer's recommendations for paint coverage should be followed. An excessive thickness of paint may cause cracking and curling.

**4.0 Certification**

Depending on the governing body and the intended use of a particular facility, a certification of accuracy of calculations or markings by the track striper, a Certified Track Builder, a Professional Engineer or Registered Land Surveyor may be required.

**5.0 Involvement of School/Facility Personnel**

Many states and even individual schools may have needs specific to their use of the facility. For this reason, it is important to involve the end users (the track program personnel) in the design and construction process.

**6.0 Governing Bodies**

The owner should determine the primary and potential uses of the facility. A current track and field rules book for the highest intended level of competition, should be used as rules, requirements and recommendations change from year to year.

International Amateur Athletic Federation (IAAF)  
17 Rue Princesse-Florestine  
BP359, MC 98007  
Monaco  
011-377-931-0888

USA Track & Field (USATF)  
Suite 140  
Hoosier Dome  
Indianapolis, IN 46225  
317-261-0500

National Collegiate Athletic Association (NCAA)  
6201 College Boulevard  
Overland Park, KS 66211  
913-339-1906

National Federation of State High School Associations (NFSHSA)  
P. O. Box 20626  
Kansas City, MO 64195  
816-464-5400

**See also USTC&TBA Guidelines for:**

**III.A. Basic Layout, Dimensions & Site Considerations for Track Construction**

**III.I. Drawings**

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<p>See also USTC&amp;TBA Guidelines for:</p> <p>I.E. Subsurface and Surface Drainage for Recreational Areas</p> <p>III.A. Basic Layout, Dimensions &amp; Site Considerations for Track Construction</p> <p>III.H. Layout &amp; Striping of Running Tracks</p>	
<p><b>NOTICE:</b> These Construction Guidelines are for use by architects, engineers, contractors and owners. Parties not experienced in track construction are advised to consult a qualified contractor and/or design professional regarding their interpretation and application. Experienced contractors can be identified through the U. S. Tennis Court and Track Builders Association (USTC&amp;TBA), which offers a Certified Track Builder program. Due to changing construction technology and techniques, only the most recent version of these Guidelines should be used. Variances in climate, soil conditions, topography and other factors may make these Guidelines unsuitable for certain projects.</p> <p style="text-align: center;">213</p>	

SECTION	III.J.	PAGE	1
<b>TITLE</b> <b>QUANTITATIVE ANALYSIS OF INSTALLED TRACK SURFACES</b>		<b>REVISION DATE</b> 1999  COPYRIGHT © 1999 BY U.S. TENNIS COURT & TRACK BUILDERS ASSOCIATION. ALL RIGHTS RESERVED.	
<p>1.0 <b>Purpose</b> The purpose of this guideline is to describe test procedures which provide customers a means of quantitatively comparing track surfaces as installed to manufacturer's specifications or to general bid specifications.</p> <p>2.0 <b>Surface Thickness Measurement</b></p> <p>A. <b>General Comments</b> The thickness of the track surface is specified in the construction documents. This test allows the customer to verify that the finished thickness is as specified.</p> <p>B. <b>Test Method</b></p> <p>1. <b>Equipment</b> The recommended instrument is a hand-held three-prong calibrated measuring device known as the FT3 Floor Tester as manufactured by SMG. The instrument should be calibrated in both millimeters and inches. An equivalent instrument is acceptable.</p> <p>2. <b>Number and Location of Readings</b> The running track should be divided into four (4) quadrants, i.e., two (2) straightaways and two (2) curves. Using the FT3, a minimum of 100 readings should be taken on the running surface. One fourth (1/4) of the readings should be taken in each quadrant of the track with an approximately equal number of readings taken from each lane of the track. All readings should be taken between the lane lines. A sufficient number of readings should be taken in the field event areas to verify thickness.</p> <p>3. <b>Use of the Instrument</b> The instrument should be placed upright on the track surface, prongs fully retracted. Using care to keep the instrument perpendicular to the track surface, moderate hand pressure is applied causing the prongs to penetrate the track surface. As soon as the operator feels the prongs contact the asphalt or concrete layer beneath the track surface, the instrument is withdrawn from the track surface, using care not to extend or retract the prongs until the reading has been recorded.</p> <p>C. <b>Recommended Standard</b> An average of the readings taken should meet or exceed the minimum thickness specified. Nowhere can the thickness be less than 65% of the minimum thickness specified.</p> <p>3.0 <b>Weight per Unit Area</b></p> <p>A. <b>General Comment</b> The weight per unit area provides a way for the customer to insure that the relative proportions of materials (i.e., rubber, binder) in the completed track are as specified by the manufacturer of the surfacing system.</p>			

**B. Test Method**

During construction of the track, an 18" by 18" independent sample should be made on a strippable medium from the same materials, method and technique used in the construction of the track. The sample should be of the specified thickness, and should have the same texture and appearance as the completed track. The sample should be removed from its medium and weighed on a certified analytical scale or laboratory balance. The weight per unit area should then be calculated using standard mathematical methods.

**C. Recommended Standard**

The weight per unit area of the sample should be at least 95% of the weight per unit area specified by the manufacturer.

**See also USTC&TBA Guidelines for:**

- III.A. Basic Layout, Dimensions & Site Considerations for Track Construction**
- III.B. Hot Mix Asphaltic Concrete Construction or III.C. Concrete Construction**
- III.G.1 Track Surfacing - Latex Tracks**
- III.G.2 Track Surfacing - Polyurethane Tracks - Basemat**
- III.G.3 Track Surfacing - Polyurethane Tracks - Basemat Structural Spray**
- III.G.4 Track Surfacing - Polyurethane Tracks - Basemat/Sandwich**
- III.G.5 Track Surfacing - Polyurethane Tracks - Full Pour**
- III.G.6 Track Surfacing - Premanufactured Rubber Tracks**
- III.I. Drawings**

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