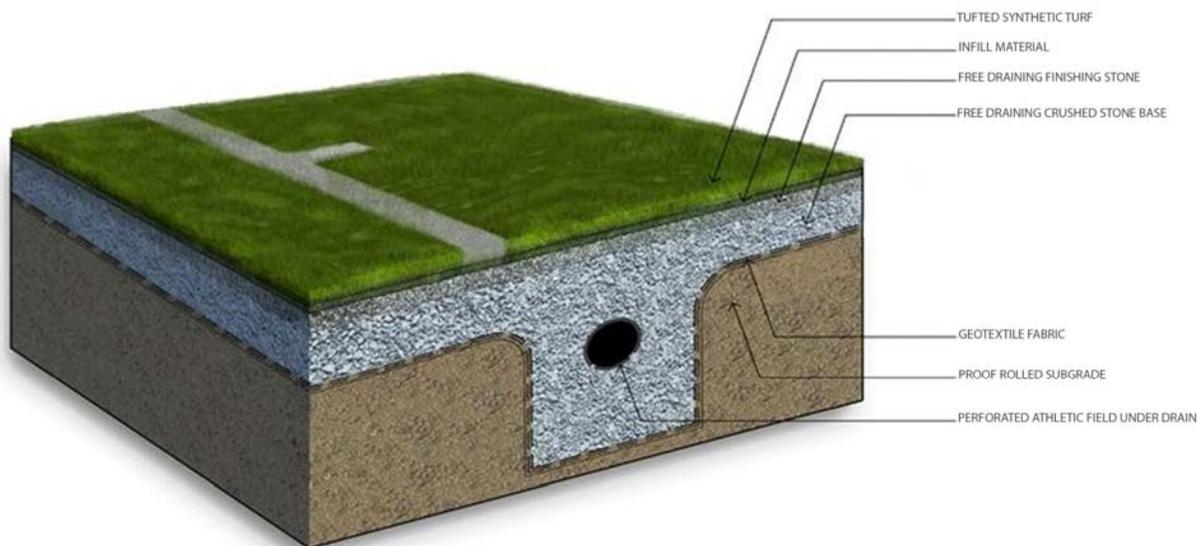




Suggested Guidelines for the Essential Elements of Synthetic Turf Systems





Synthetic TurfSM
C O U N C I L

Suggested Guidelines for the Essential Elements of Synthetic Turf Systems

First Printing May 2003

First Revision May 2004

Second Revision February 2006

Third Revision May 2007

Fourth Revision May 2008

Fifth Revision November 2011

Copyright © 2011 by the Synthetic Turf Council

400 Galleria Parkway, Suite 1500

Atlanta, GA 30339

No part of this document may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording or any information storage or retrieval system now known or to be invented, without permission in writing from the Synthetic Turf Council, except by a reviewer who wishes to quote brief passages in a review written for inclusion in a magazine, newspaper or broadcast. The Synthetic Turf Council is a non-profit, educational organization and possesses all rights pertaining to this publication.

Preface

The Synthetic Turf Council (STC) was formed to guide the selection and use of synthetic turf systems. The STC is a non-profit association dedicated to addressing the desire of the industry to enhance its reputation for quality. It hopes to earn support by developing documents that facilitate communication and good business practice between all parties to the synthetic turf systems including owners, selection teams, architects, designers, specifiers, consultants, testing laboratories, suppliers, manufacturers, installation and maintenance contractors, etc. Every attempt will be made to dispense information that is unbiased, objective, and in the best interest of all the parties and the user/owner in particular. The STC also suggests the utilization of standards and test methods that already exist, whenever applicable, to generate greater understanding in the selection and use of synthetic turf systems domestically and internationally. The STC offers to serve as a neutral platform where all elements of the industry can discuss, mediate or resolve issues.

The initial undertaking by the Synthetic Turf Council has been the development of guidelines for essential elements to be included in an objective non-proprietary specification for synthetic turf systems. Minimums suggested in these guidelines seek to improve the level of confidence in the process of selecting synthetic turf systems by owner/user/clients, selection teams and design professionals. This document facilitates a clearer understanding by all the parties of their expectations and the delivery of systems, products, and services in order to promote genuine satisfaction by the user/owners of synthetic turf systems. These guidelines developed by the STC are a continual work in progress and may be changed at any time through an orderly process that accommodates consideration of documented input. While this document contains minimums, it promotes the use of all systems that not only meet or exceed those minimums, but also encourages innovation.

The development of documents like these suggested guidelines is intended to facilitate constructive input and forge a cooperative atmosphere between users and producers. The STC invites users, professionals, manufacturers, risk managers, school officials, sports authorities, contractors and/or the representative associations of these segments to utilize these suggested guidelines.

Suggested Guidelines for the Essential Elements of Synthetic Turf Systems

Table of Contents

Introduction	1
1. General	1
• Terminology Definition	1
• Abbreviations	3
2. Scope	4
• Synthetic Turf Types	4
• Fiber	4
• Primary Backing Systems	4
• Secondary Backing Systems	4
• Perforations	5
• Infill Materials	5
3. Performance Evaluation of Synthetic Turf	7
• Player-Surface Interface	7
• Ball-Surface Interface	8
• Appearance	8
• Quality Control	8
• Warranty	8
• Maintenance	10
• Work Approvals, Extra Materials, Storage	10
4. Evaluation of System Components	11
• Drainage System	11
• Base Materials	12
• Shock Absorbing Resilient Underlayment Systems	13
• Irrigation System	15
• Synthetic Turf	15
• Infill Material	17
• Lines and Markings	18
• Inserts	19

Table of Contents (*continued*)

5. Construction and Installation.....	20
• Inspection.....	20
• Sub-grade Preparation.....	20
• Aggregate.....	20
• Shock Absorbing Resilient Underlayment Systems.....	22
• Irrigation Systems.....	22
• Synthetic Turf Material Production QA/QC.....	24
• Synthetic Turf Installation.....	24
• Infill Material Installation.....	25
• Fiber Conditioning.....	25
6. Maintenance.....	26
• General.....	26
• Maintenance Monitoring.....	27
• Cleaning.....	27
• Stain Removal.....	27
• Brushing.....	27
• Seam Repair.....	27
7. Post-Installation Testing.....	27
• Schedule.....	27
• <i>g</i> -Max.....	27
• Inspection of Seams and Other Installation Features.....	27
• Governing Organizations.....	27
Appendix A—Tests and Guidelines.....	28
• Table 1: Base Materials.....	29
• Table 2: Turf Characteristics for Tufted Infill Systems.....	30
• Table 3: Turf Characteristics for Knitted Nylon Systems.....	31
• Table 4: Turf Characteristics for Tufted PP, PE or Nylon Systems.....	32
• Table 5: Infill Properties.....	33
• Table 6: Shock Pad Layer Properties.....	33
• Table 7: Performance Guidelines.....	33

Table of Contents (*continued*)

Appendix B—Reference Specifications, Typical.....	34
• Chart 1: Infilled Synthetic Turf Specification.....	35
• Chart 2: Conventional Knitted Synthetic Turf Specification.....	36
• Chart 3: Conventional Tufted Synthetic Turf Specification.....	37
• Chart 4: Shock Pad, Pre-fabricated Pad Systems Specification.....	38
• Chart 5: Shock Pad, <i>In situ</i> Systems Specification.....	38
Legend—Providers of Synthetic Turf Systems.....	39
Disclaimer.....	41
About the Synthetic Turf Council.....	41

Introduction

This document intends to provide reliable guidelines that address the need for essential elements to be included in an objective non-proprietary specification for synthetic turf systems. The minimums suggested in these guidelines seek to improve the level of confidence of the owner/user/client, selection team and design professional in the specifying and selection of synthetic turf systems. Adoption of the provisions in this document is voluntary; however, when utilized, they can assist all parties involved with the selection, design, supply and service of the systems, to generate a clearer understanding of the expected performance, the declared use, the inclusions and exclusions and the warranty coverage of synthetic turf systems. While these suggested guidelines contain minimums, they are not intended to stifle innovation. Enhancements, quality upgrades and proven innovations are encouraged to generate features that enhance the performance characteristics of the system.

1. General

- 1.1 These suggested guidelines provide reliable tools for the selection of synthetic turf systems relative to their declared use and expected performance.
- 1.2 The document is not intended to replace detailed plans and specifications. The provisions contained herein must be augmented by details specific to the project design, the job site, local environmental factors and all applicable laws, regulations and codes before the final specification can be considered comprehensive.
- 1.3 Those adopting or utilizing the provisions in this document have the obligation to determine their full compliance with all applicable international, federal, state and local laws, regulations, and codes. These suggested guidelines are not intended to modify that obligation or to serve as a substitute for compliance.
- 1.4 All Providers of the components of the systems should maintain a comprehensive quality control program to assure that the components meet the suggested guidelines.
- 1.5 These suggested guidelines are a continual work in progress and may be changed without notice to accommodate documented information justifying such changes.
- 1.6 Terminology definitions are specific to this document.
 - 1.6.1 Base Materials: Materials that provide porosity and stability such as crushed aggregate or porous pavement.
 - 1.6.2 Denier: The weight in grams of 9,000 meters of fiber

- 1.6.3 Drainage System: A method of removing surface and subsurface moisture/water.
- 1.6.4 Fiber: A specific form of fibrous textile material that has a length at least 100 times its diameter or width.
- 1.6.5 Fiber Thickness: A measurement in microns (metric) or mils. (U.S.) of the thinnest cross section of a fiber.
- 1.6.6 *g*-Max: A measurement of impact (shock absorption) in terms of gravity units as a ratio of deceleration.
- 1.6.7 Infill: Loosely dispersed materials that are added to the synthetic turf system, typically sand, rubber, other suitable material, or a combination thereof.
- 1.6.8 Knitted: A process in which the yarn fibers of the pile are tied to the backing which was simultaneously constructed by transforming continuous strands of multi-filaments into a series of interlocking loops, each row of such loops hanging from the row immediately preceding it.
- 1.6.9 Water Permeability: The rate at which water flows through a surface or system cross-section or components of the cross-section.
- 1.6.10 Planarity: Uniformity of the surface as compared to certain fixed predetermined points or prescribed slopes.
- 1.6.11 Primary Backing System: A single or multiple layers of woven or non-woven materials, into which the fiber is either tufted or knitted, to provide the initial construction of the synthetic turf.
- 1.6.12 Secondary Backing System: A coating and/or woven or non-woven fabric layer(s) applied to the primary backing after the fiber pile has been tufted or knitted into place, which serves to enhance tuft bind and provide additional structural integrity.
- 1.6.13 Shock Absorbing System: Component(s) that add resiliency to the system.
- 1.6.14 Sub-grade: A stabilized foundation onto which the base materials and field systems are installed.
- 1.6.15 Synthetic Pile Fiber: Grass-like blades made of synthetic materials.
- 1.6.16 Synthetic Turf Systems: These systems are comprised of (a) synthetic grass-like surface piles, tufted or knitted into a primary backing system to which a secondary backing system has been applied; with or without infill material

(s); (b) a shock absorbing system, and (c) suitable base materials with an appropriate drainage system.

1.6.17 Tufted: A process by which the fiber yarns that form the pile are inserted into a previously prepared blanket-like primary backing.

1.6.18 At Installation: A period of time close to the completion date of the turf installation, but not to exceed 30 days.

1.7 Abbreviations referenced in the body of this document.

1.7.1 American Society for Testing and Materials (ASTM)

1.7.2 Deutsches Institut für Normung (DIN)

1.7.3 Federation of International Football Association (FIFA)

1.7.4 International Hockey Federation (FIH)

1.7.5 Fédération Internationale de Rugby Amateur (FIRA)

1.7.6 International Amateur Athletic Federation (IAAF)

1.7.7 National Collegiate Athletic Association (NCAA)

2. Scope

The makeup of the components and the elements to be included, or not to be included, are determined by the design, use and expected performance of the system.

- 2.1 **Synthetic Turf Types:** There are several different types of synthetic turf available. They are distinguishable through the use of different fibers and different construction. Differentiated by construction are the tufted or the knitted synthetic turf systems. Both systems are comprised of synthetic fibers with primary and secondary backing systems and a resilient shock absorbing system. The shock absorbing system can consist of infill, a padding system, or a combination of both.
- 2.2 **Fiber:** Typically, the fiber used in synthetic turf is textured and/or non-textured polypropylene, polyester, polyethylene, nylon or other suitable performing hybrid or copolymer in tape form or monofilament. Minimum fiber sizes are 50 microns for polypropylene or polyester, 100 microns for tape form (slit-film) polyethylene, 140-300 for monofilament polyethylene (shape dependent) and 500 denier for nylon. Fiber sizes for hybrids or copolymer will comply with the most closely related fiber type. Ideally, all fibers should be of the same chemical composition, shape, and texture. Fibers should be compliant to ASTM guideline for total lead content.



Monofilament



Tape form (slit-film)

- 2.3 **Primary Backing Systems Material:** The primary backing materials are of a woven or non-woven fabric in one or more layers which are utilized in the tufting process, or of high strength polyester multi-filament fiber utilized in the knitting process. This backing material provides the initial dimensional stability for the system.
- 2.4 **Secondary Backing Systems Material:** The secondary backing materials are applied through a coating process with a single or multiple applications of one or various materials.

- 2.4.1 Typically, knitted turf fabric receives an initial acrylic coating followed by different options of polyurethane, latex, other suitable coatings or fabrics in various weight and thickness configurations, depending on individual system design. The secondary backing utilized in knitted turf systems provides additional structural integrity to the system.
- 2.4.2 A tufted fabric typically receives a suitable coating of polyurethane, latex, other coatings or fabrics in various weight and thickness configurations, depending on individual system design. The secondary backing provides an additional level of tuft bind, bundle encapsulation and structural integrity to the synthetic turf. Should an increased level of system performance be desired, multiple layers of secondary backing materials with different physical characteristics could be applied.
- 2.5 Perforations: Depending on the final construction of the turf system, the system may or may not be permeable to water. Perforations are typically required of fully coated system backings to provide adequate vertical drainage throughout the system. Some turf systems may allow for drainage without perforations by employing a process of partial coating or other system designs. Developments in coating systems have provided for lighter weight and aqueous permeable chemicals; however, the drainage criteria must be met.
- 2.6 Infill Materials: The most recent generation of synthetic turf systems utilizes a long pile height and needs to be supported with infill materials for directional stability and structural integrity, as well as resiliency. The infill materials commonly used are sand, rubber, other suitable materials, or combinations thereof.
- 2.6.1 EPDM (Ethylene Propylene Diene Monomer) is a polymer elastomer with high resistance to abrasion and wear and will not change its solid form under high temperatures. Typical EPDM colors are green and tan. EPDM has proven its durability as an infill product in all types of climates. Its excellent elasticity properties and resistance to atmospheric and chemical agents provide a stable, high performance infill product.
- 2.6.2 TPE (Thermo plastic elastomer) infill is non-toxic, heavy metal free, available in a variety of colors that resist fading, very long lasting, and 100% recyclable and reusable as infill when the field is replaced. TPE infill, when utilizing virgin-based resins, will offer consistent performance and excellent *g*-max over a wide temperature range.
- 2.6.3 Organics: There are several organic infills available in the North American market, all utilizing different organic components, such as natural cork and/

or ground fibers from the outside shell of the coconut. These products can be utilized in professional sports applications as well as for landscaping. At the end of its life cycle it can be recycled directly into the environment.

- 2.6.4 **Silica Sand:** Pure silica sand is one of the original infilling materials utilized in synthetic turf. This product is a natural infill that is non-toxic, chemically stable and fracture resistant. Silica sand infills are typically tan, off-tan or white in color and—depending upon plant location—may be round or sub-round in particle shape. As a natural product there is no possibility of heavy metals, and the dust/turbidity rating is less than 100. It can be used in conjunction with many other infills on the market to provide a safe and more realistic playing surface. The round shape plays an integral part in the synthetic turf system. It is important that silica sand have a high purity (greater than 90%) to resist crushing and absorption of bacteria and other field contaminants. Silica sand can either be coated with different materials as a standalone product or can be used to firm up in combination with traditional crumb rubber infill systems.
- 2.6.5 **Coated Silica Sand:** This class of infill consists of coated, high-purity silica sand with either a soft or rigid coating specifically engineered for synthetic turf. These coatings are either elastomeric or acrylic in nature (non-toxic) and form a bond with the sand grain sealing it from bacteria to provide superior performance and durability over the life of a field. Coated sand is available in various sizes to meet the application's needs.
- 2.6.6 **Crumb Rubber:** Crumb Rubber is derived from scrap car and truck tires that are ground up and recycled. Two types of crumb rubber infill exist: Ambient and Cryogenic. Together these make up the most widely used infill in the synthetic sports field and landscape market. Crumb rubber infill is substantially metal free, and, according to the STC's *Guidelines for Crumb Rubber Infill Used in Synthetic Turf Fields*, should not contain liberated fiber in an amount that exceeds .01% of the total weight of crumb rubber, or .6 lbs. per ton.
- 2.6.7 **Coated Rubber:** Both ambient and cryogenic rubber can be coated with colorants, sealers, or anti-microbial substances if desired. Coated rubber provides additional aesthetic appeal, reduction of dust by products during the manufacturing process and complete encapsulation of the rubber particle.
- 2.6.8 **Hybrid:** Constitutes the use of sand, rubber, or other suitable materials in various combinations. (This should not be confused with hybrid carpet systems that consist of a combination of fiber types.)

3. Performance Evaluation of Synthetic Turf

(For Tests and Criteria, refer to Appendix A, Tables 1–7)

- 3.1 Player-Surface Interaction: Player-surface interaction describes the performance characteristics of the field that relate to footing, shock absorbency, surface abrasion, and surface stability, for example. These characteristics are determined through testing for vertical deformation, force reduction, traction, slip resistance, energy restitution, and abrasiveness, among others. Proper shoe selection is an important factor in the way a player interacts with the playing surface.
- 3.1.1 Traction: The surface should provide good traction in all types of weather with the use of conventional athletic type shoes applicable to the sports and/or activity specified.
- 3.1.2 Rotational Resistance: The surface should allow for twisting movements as is common in athletic activities. Rotational resistance measures the ability of the user to perform twisting motions when in contact with the surface.
- 3.1.3 Slip Resistance Component: The system should enable a predictable range of movement between the user and the surface uniformly throughout. The surface should balance traction and slippage by way of the sliding coefficient.
- 3.1.4 Surface Abrasiveness: The field surface should have fibers and infill materials that minimize skin abrasions.
- 3.1.5 Impact Attenuation (g -max): The field surface should have the ability to adequately absorb player impact with the surface. The g -max and force reduction tests are two tests typically used. The current ASTM standard for g -max is a maximum value of 200 at each test point. g -Max values may vary from location to location on a playing surface. Such variances shall be taken into account when setting maximum test values. A maximum, not-to-exceed limit, should be specified for the life of the warranty. The STC's guideline is that g -max should be below 165 for the life of the field.
- 3.1.6 Surface Stability (vertical deformation): The surface should provide adequate stability so that the athlete can maintain body control to help prevent or properly control contact between athletes. This is an important consideration that should be balanced with the surfaces' ability to absorb impact. If the surface is too soft, the stability provided by the field may not be optimal for player movement and body control.

- 3.2 Ball-Surface Interaction: Ball-surface interaction describes the performance characteristics of the field that relate to the ways in which the ball reacts to the surface. The field surface should provide consistent and predictable ball performance reaction characteristics.
- 3.2.1 Surface Uniformity: The synthetic turf playing field should be as level as practical. The synthetic surface shall provide a true and uniform playing surface throughout.
- 3.2.2 Ball Bounce: The synthetic turf field should provide a ball bounce as close to the optimal playing characteristics of the sport or sports. The published standards for the regulatory organizations as applicable for each sport should be referenced. The choice of fiber type and infill combination can affect ball bounce and in some cases promote greater “infill splash” which may not be desirable depending on the activity and level of competition.
- 3.2.3 Ball Roll: The synthetic turf field should provide a ball roll as close to optimal playing characteristics of the intended sport or sports. The choice of fiber type and infill combination as well as the level and type of maintenance can affect ball roll. The published standards for the regulatory organizations as may be applicable for each sport should be referenced.
- 3.3 Appearance: Unless otherwise dictated by design, the synthetic turf should have a consistent color, texture, and shade without significantly noticeable streaks or other irregularities when observed in any direction.
- 3.4 Quality Control: The synthetic turf systems builder’s quality control program should be evaluated with the system. There should be an understanding between the owner and the synthetic turf systems builder relative to the initial installation and ongoing testing responsibility, methods, and protocol. At the owner’s option an independent third party testing agency or laboratory experienced with synthetic turf should test for compliance and acceptance.
- 3.5 Warranty: All of the proposed warranty documents should be obtained and the content thoroughly reviewed to ensure adequate coverage is contained therein.
- 3.5.1 Warrantor: The history and warranty performance of each warrantor should be objectively researched.
- 3.5.2 Important considerations in reviewing synthetic turf system warranties are:
- Who will be honoring the warranty when the field is completed?
 - Is the warranty pro-rated or not pro-rated based on the age of the field?

- What is the duration of the warranty (3 years, 5 years, other)
- Has each system component been clearly defined and/or described in the specification and warranty?
- What is specifically included or excluded and what is not mentioned or covered?
- Are there any limitations as to notice, expiration, extenuating circumstances or nature of the remedy?
- Can final warranties be changed unilaterally without mutual consent?
- Have the possibilities of known risks to the users of the system been stated in writing?
- What conditions can void the warranty; e.g. the lack of routine, incorrect maintenance, or the use of unapproved maintenance equipment?
- What monitoring measures are acceptable to all parties?

3.5.3 Warranties for the synthetic turf field systems should be clearly understood and may include the following:

- Acceptable uses for the field
- Expected number of yearly hours of use of the field
- Type of shoes used
- Fading
- Color match within specifications
- Excessive fiber wear
- Acceptable loss of pile height over time
- Wrinkling and panel movement
- Shock absorbency (*g*-max)
- Seam integrity
- Drainage
- Response time for required repairs/replacement
- Approved maintenance equipment
- Other items deemed relevant

3.5.4 Several parties may be involved in providing the finished system. There may be blanket warranty coverage or each party; i.e., vendor, supplier, manufacturer, installation and maintenance contractor may provide separate and limited coverage that should be clearly defined. It should also be clear exact-

ly who covers what, with special attention given to the coverage of the turf fiber as it relates to possible damage during the tufting, coating, installation and maintenance processes.

- 3.5.5 **Qualification:** Consideration should be given to the experience and qualification of the manufacturer and installation contractor of the synthetic turf system, and their maintenance and repair personnel.
- 3.6 **Maintenance:** Maintaining a synthetic turf field is essential for optimum appearance, safety, playing performance, and field longevity. A regular schedule of maintenance should include surface cleaning, debris removal, grooming, and infill replenishment, redistribution, and de-compaction. The maintenance procedures and equipment, as specified by the synthetic turf system builder and required for the system, should be evaluated during the selection process so that the appropriate budget resources for manpower and equipment may be allocated. Note: Refer to the Synthetic Turf Council's *Guidelines for the Maintenance of Infilled Synthetic Turf Surfaces*, January 2013, for additional information.
- 3.7 **Other Considerations:** Provisions that could prevent a breakdown in communication or a delay in the process should be included.
- 3.7.1 **Review and approvals prior to work:** The synthetic turf systems builder, without liability or legal responsibility for the base (unless the base is part of their scope of work) should perform an inspection of the field planarity base on to which the synthetic turf system is to be installed and to examine the finished surface for required compaction, water permeability, and grade tolerances. After any discrepancies between the required materials, application and tolerance requirements noted have been corrected, the owner's representative (architect/engineer) should review and approve for compliance with documents. The acceptance of the base construction should be included in the certification for warranty validation.
- 3.7.2 **Extra Materials:** Upon request and agreed compensation prior to the manufacturing of the field, the synthetic turf manufacturer and installation contractor can provide extra sections of synthetic turf material for future repairs. If necessary, this should include materials for all colors used with any lines, markings, and logos. Quantities to be predetermined. This allows for materials from the same manufacturing run to be utilized for minor repairs.
- **Storage:** Extra Materials should be stored unrolled outside so that any fading as a result of UV exposure will be consistent with the installed material.

4. Evaluation of System Components

(For Tests and Criteria, refer to Appendix A, Tables 1–7)

- 4.1 **Drainage System:** An efficient and effective underground drainage system is an integral component of a synthetic turf system, and is designed to carry away the water that percolates through the turf. The system chosen will depend on the use of the field, climate, amount of rainfall and other factors.
- 4.1.1 **Components:** The drainage system may include the synthetic turf, pad, base materials and collector pipes that collect and remove storm water from the playing field. The design of the drainage system is dependent upon local conditions, climates, and site constraints. The Rational Method, Hydrograph Analysis, or Time Series Method may be used to determine the rainfall runoff that must be accommodated by collector pipes.
- 4.1.2 **Site Conditions:** Rainfall duration intensity curves can be developed from the National Weather Service Technical Paper TP-40 Rainfall Frequency Atlas for the United States or coordinated with the local weather statistics at the location of the project site. Otherwise, unless agreed to by the end user, the design storm frequency should be as required by local regulations. Where no local regulation exists, a minimum 5-year design storm frequency is recommended for playing fields at grade. For fields requiring pump stations, a more conservative design frequency that is compatible with the design capacity of the pump station should be used.
- 4.1.3 **Flow Time:** The time interval for water to flow through the complete system to the collector pipes is based on permeability tests conducted in the laboratory for the design of the complete system. Flow through the base material can be enhanced by the use of composite drainage materials or lateral drain pipes that intercept the normal flow of water in the complete system and flow directly to the collector pipes. Flow rate into the lateral drainage system is dependent on the amount of available open space for water to enter the pipe. The geotextile cover on many composite drains can have varying effects on how fast water can enter the system over time. Care should be taken in evaluating these products and how the chosen base materials can affect water in-flow over time.
- 4.1.4 **Collector Pipes:** Collector pipes are typically perforated polyvinyl chloride (PVC) or polyethylene (PE) pipes. Size and type of perforations are dependent upon the size of the pipe. If perforations are larger than the smallest aggregate in the base material then a geo-textile sock filter may be used to en-

capsulate the pipe—care should be taken to ensure that the openings in the geo-textile fabric are compatible with the granular smaller components so that they do not block the pores and reduce water flow. A qualified civil or geotechnical engineer should be consulted to determine the suitability of using a product with a geo-textile sock in conjunction with the selected base materials as they can clog the sock over time and severely impede the performance of the system. Additionally the compressive strength of various systems can differ greatly and care should be taken to keep construction traffic off of the systems until enough stone has been placed and compacted.

4.1.5 Drainage: The expected performance evaluation and the systems used should undergo an independent engineering analysis.

4.2 Base Materials: The aggregate base on which the synthetic turf is installed provides a structurally sound foundation for field construction, and a media for drainage of the field. The base materials are critical to the performance of the entire system and should contain the necessary components and characteristics to satisfy local conditions. A good geotechnical report will provide essential information for a firm and stable base for the synthetic turf. A base that is properly designed and constructed should give the owner several years of use and last through several turf replacements. The use of design professionals and builders with demonstrated expertise and success in the development of synthetic turf systems is highly recommended.

4.2.1 Soil Separator: Depending on the local site conditions, a geo-textile fabric may be placed over the entire sub-grade and within the pipe trenches prior to the installation of the base materials to minimize contamination of the aggregate and possible clogging of the perforated drainage pipes. Where soil conditions warrant, a polyethylene, PVC, or other impermeable sheet liner may be used in lieu of the geo-textile to inhibit storm water infiltration into the subsoil.

4.2.2 Aggregate: The aggregate materials utilized to construct the field base must be a properly graded washed crushed stone to provide a balance between stability and permeability. A highly fractured material is desirable to provide the surface stability required for the synthetic turf surfacing, supplemental padding or porous paving as applicable. The graded aggregate particle sizes must be tightly controlled to fall within the bandwidth for all specified sieve sizes with just enough fines to provide stability while still allowing for sufficient drainage. Minimum stability and permeability requirements should be determined and confirmed by an independent certified la-

boratory prior to construction of the base course.

- 4.2.3 **Compaction:** The base materials should be thoroughly compacted to prevent differential settlement across the field area. Minimum compaction levels typically should not be less than 95% density as measured by a standard proctor test. Special attention should be given to backfill compaction of any utility trenches that cross the field area. Care should also be taken not to over compact, which could affect drainage.
- 4.2.4 **Pavement:** If pavement is required by design, the base materials may be porous or conventional asphalt. This material is installed over a permeable aggregate base and a subsurface drainage system. The porous pavement material must be manufactured with tight quality control on asphalt content, as well as the gradation of the aggregate used in the mix. This aggregate should have a limited amount of fines to allow for efficient water permeability. Use of conventional asphalt paving will require a sloped field with either a crown or a cross slope. Consideration should be given to the use of a drainage mat or an elastic layer pad system between the turf backing and the surface of the pavement. This, along with the installation of periodic interceptor drains, should allow for horizontal water movement below the field's surface. Without the use of these materials, the infill layer will become saturated during periods of heavy rainfall and there may be migration of the infill materials with the surface water movement.
- 4.2.5 **Water Permeability:** Water permeability rates for both the field's surfacing and the field base materials should be designed to accommodate the local weather patterns and storm water management regulations. The permeability of both the field surface and the base materials will typically decrease over the life of the field. An adequate factor of safety should be utilized to provide initial infiltration rates for the completed field above those required by the local weather conditions.
- 4.3 **Shock Absorbing Resilient Underlayment Systems:** The shock absorbing elements, as part of the overall synthetic turf system, should meet or exceed the performance of the design and specification.
 - 4.3.1 *In situ* Cushion Layer (elastic layer pad): If included in the design, these cushion systems should be installed in place with specialized paving equipment.
 - 4.3.1.1 **Physical Characteristics:** These systems are typically comprised of SBR rubber granules bound with a single component polyurethane

binder. Small rounded pea gravel aggregate or other suitable materials can also be incorporated with the rubber and urethane materials. The firmness of the system can be adjusted with the size and the proportions of the rubber granules and aggregate materials, as well as with the amount of polyurethane binder used and the thickness of the layer.

4.3.1.2 Performance Characteristics: The selection of the cushion layers should be closely coordinated with the performance characteristics of the synthetic turf utilized. The cushion layers should provide shock absorption without compromising footing and surface stability.

4.3.1.3 Water Permeability Rate: The *in situ* cushion-layer systems are typically permeable. The percolation rate for the *in situ* cushion layers should be well in excess of precipitation rates.

4.3.2 Prefabricated Cushion Layers (Pad): If included in the design, these cushion layers are a manufactured product comprised of rolls or tiles of resilient material installed under and occasionally adhered to the synthetic turf backing.

4.3.2.1 Physical Characteristics: Prefabricated cushion layers are typically comprised of rubber, polyurethane foam, or other suitable materials. The rubber pads are SBR rubber fibers or granules bound together with a polyurethane binder and usually come as roll or piece goods and should be permeable. The foam cushion layers are typically polyurethane or polyvinyl chloride and should be water permeable for drainage.

4.3.2.2 Performance Characteristics: The selection of the cushion layers should be closely coordinated with the performance characteristics and requirements of the synthetic turf system utilized. The cushion layers should provide shock absorption without compromising footing and/or surface stability.

4.3.2.3 Water Permeability Rate: Depending on the final construction of the pad system, the system may be or may not be permeable to water. Unless the system is permeable by design with adequate drainage, perforations should be put through all of the cushioning layers to provide for adequate drainage through the system as specified.

4.3.3 Infill Materials: Infill materials are comprised of rubber, sand, elastomers,

organics and/or other suitable materials, or combinations thereof which are placed on top of the synthetic turf backing system and between the synthetic surface fibers. This is needed for resiliency as well as structural integrity and directional stability. This material is utilized today in the vast majority of synthetic turf systems with the exception of the traditional knitted synthetic turf systems. (Also addressed in Section 4.6)

- 4.4 Irrigation System Introduction: The installation of a manual or automatic irrigation system can be considered for synthetic turf installations. Guidelines on whether synthetic fields are watered are determined by factors such as region, climate, turf material, player traffic type and level of games played.
 - 4.4.1 Player Comfort: High field temperatures can prove challenging to players throughout warmer climates. Watering enables the field to be cooled. Tests show approximate reduction in surface temperature of 46 degrees Fahrenheit with 10 minutes of applied watering using a high volume long range pop up sprinklers. (Results derived from a height of 2 inches above infilled synthetic turf.)
 - 4.4.2 Field sanitation: Field cleansing and sanitation can be improved with watering from an irrigation system, particularly in climates that experience very little rainfall for natural cleansing.
- 4.5 Synthetic Turf: The synthetic turf surface should provide the performance characteristics, components, and construction that meet the needs of the declared use and/or functions. The synthetic turf system and all of its components should be resistant to moisture, rot, mildew, bacteria, fungus growth, ultraviolet ray degradation at all field locations, and meet local code and environmental requirements.
 - 4.5.1 Synthetic Turf Construction and Components should be non-toxic and not cause commonly known allergic reactions. Each synthetic turf system should be constructed to provide dimensional stability and resist damage from wear and tear during athletic and recreational usage.
 - 4.5.2 Fibers for Tufted or Knitted Systems: Typically the fiber used in synthetic turf is textured and/or non-textured polypropylene, polyethylene, or nylon in tape form or monofilament. Minimum fiber sizes are 50 microns for polypropylene and polyester, 100 microns for tape (slit film) form polyethylene, 140-300 for monofilament polyethylene (shape dependent) and 500 denier for nylon.
 - 4.5.3 Fibers for Knitted Systems: Typically the fibers used for knitted systems are Nylon 6.6 or Nylon 6 of 500-650 denier, texturized monofilaments.

- 4.5.4 Primary Backing Systems: The primary backing materials should be either high strength polyester multi-filaments utilized in the knitting process, or woven, non-woven, or other suitable materials in one or more layers, utilized in the tufting process.
- 4.5.5 Secondary Backing Systems: The secondary backing materials should be applied through a coating process that can be single or multiple applications of one or several different materials. A knitted turf fabric should receive an initial acrylic coating and could be followed by different options of suitable polyurethane, latex and/or other coatings in various weights and thickness configurations, depending on individual system design. A tufted turf fabric should receive a suitable polyurethane or latex pre-coat or an acceptable performance-based equal, which then can be followed by an attached cushion or a laminated secondary backing utilizing a suitable polyurethane, latex, or acceptable performance-based equal. The purpose of the secondary backing is to enhance the tuft bind and structural integrity of the turf components. In cases where an increased level of system performance is desired, multiple layers of secondary backing materials of different physical characteristics can be applied.
- 4.5.6 Water Permeability Rate: Depending on the final construction of the turf system, the system may be or may not be permeable to water. Unless the system is permeable by design with adequate drainage, perforations should be put through all of the backing coatings to provide for adequate drainage through the system as specified.
- 4.5.7 Seams: New synthetic turf carpets are manufactured in panels or rolls that are typically a nominal 15 feet wide. Each panel or roll should be attached to the next with a seam to form the playing substrate of the field. Seams should be glued with a supplemental backing material or sewn with high strength sewing thread. The bonding or fastening of all system material components should provide a permanent, tight, secure, and hazard-free athletic playing surface.
- 4.5.8 Adhesive: Industrial adhesives, products not found in home supply stores, are used to bond synthetic turf seams and inserts, and, in some applications, for a total glue down of the synthetic turf to the base. Synthetic turf adhesives should be applied by experienced, professional installers. The adhesives should provide a strong, hazard-free, and durable bond between the adjacent turf panels or sections and to be usable for installation under variable weather conditions. The adhesive should also be resistant to water,

fungus, and mildew. Synthetic turf adhesives include: one-part adhesives (urethanes), two-part (epoxy or urethane), hot melt, and water-based (latex).

- 4.5.9 **Seaming Tape:** Seaming tape is commonly used for seams and/or inlaid lines and markings. The tape is comprised of a fabric that should be installed below the backing material on both sides of a seam or inlay. The fabric used for seaming tape should provide dimensional strength and enough surface texture and width to bond well with the adhesive and the turf backing material on each side of the seam.
- 4.6 **Infill Material:** Infill materials are comprised of rubber, sand, elastomers, organics and/or other suitable materials, or combinations thereof which are placed on top of the synthetic turf backing and between the synthetic surface fibers.
- 4.6.1 **EPDM (Ethylene Propylene Diene Monomer)** is a polymer elastomer with high resistance to abrasion and wear and will not change its solid form under high temperatures. Typical EPDM colors are green and tan. EPDM has proven its durability as an infill product in all types of climates. Its excellent elasticity properties and resistance to atmospheric and chemical agents provide a stable, high performance infill product.
- 4.6.2 **TPE (Thermo plastic elastomer)** infill is non-toxic, heavy metal free, available in a variety of colors that resist fading, very long lasting, and 100% recyclable and reusable as infill when the field is replaced. TPE infill, when utilizing virgin-based resins, will offer consistent performance and excellent *g*-max over a wide temperature range.
- 4.6.3 **Organics:** There are several organic infills available in the North American market, all utilizing different organic components, such as natural cork and/or ground fibers from the outside shell of the coconut. These products can be utilized in professional sports applications as well as for landscaping. At the end of its life cycle it can be recycled directly into the environment.
- 4.6.4 **Silica Sand:** Pure silica sand is one of the original infilling materials utilized in synthetic turf. This product is a natural infill that is non-toxic, chemically stable and fracture resistant. Silica sand infills are typically tan, off-tan or white in color and—depending upon plant location—may be round or sub-round in particle shape. As a natural product there is no possibility of heavy metals, and the dust/turbidity rating is less than 100. It can be used in conjunction with many other infills on the market to provide a safe and more realistic playing surface. The round shape plays an integral part in the syn-

thetic turf system. It is important that silica sand have a high purity (greater than 90%) to resist crushing and absorption of bacteria and other field contaminants. Silica sand can either be coated with different materials as a standalone product or can be used to firm up in combination with traditional crumb rubber infill systems.

- 4.6.5 Coated Silica Sand: This class of infill consists of coated, high-purity silica sand with either a soft or rigid coating specifically engineered for synthetic turf. These coatings are either elastomeric or acrylic in nature (non-toxic) and form a bond with the sand grain sealing it from bacteria to provide superior performance and durability over the life of a field. Coated sand is available in various sizes to meet the application's needs.
- 4.6.6 Crumb Rubber: Crumb Rubber is derived from scrap car and truck tires that are ground up and recycled. Two types of crumb rubber infill exist: ambient and cryogenic. Together these make up the most widely used infill in the synthetic sports field and landscape market. Crumb rubber infill is substantially metal free, and, according to the STC's *Guidelines for Crumb Rubber Infill*, should not contain liberated fiber in an amount that exceeds 0.01% of the total weight of crumb rubber, or 0.6 lbs. per ton.
- 4.6.7 Coated Rubber: Both ambient and cryogenic rubber can be coated with colorants, sealers, or anti-microbial substances if desired. Coated rubber provides additional aesthetic appeal, reduction of dust by products during the manufacturing process and complete encapsulation of the rubber particle.
- 4.6.8 Hybrid: Constitutes the use of sand, rubber, or other suitable materials in various combinations. (This should not be confused with hybrid carpet systems that consist of a combination of fiber types.)
- 4.7 Lines and Markings: Construction and materials used should be harmonious with the synthetic surface.
 - 4.7.1 Installation: Lines and markings should be installed on the synthetic turf surface in one of three methods: with paint, with colored fiber that is either tufted or knitted into the synthetic turf panels, or installed as inlays. Tufted-in or inlaid lines and markings are a permanent part of the surface.
 - 4.7.2 Permanency: Painted lines and markings installed with either permanent or temporary paint require maintenance. Even permanently painted lines require additional paint on a periodic basis.
 - 4.7.3 Consistency: Synthetic turf and fibers utilized for the tufted or inlaid lines

and markings should be similar to that used in all other areas of the field and installed to the same tolerances.

4.8 Inserts: They are typically used on multi-sport fields. They can include covers for goal sleeves and anchors and conversion of baseball infield clay areas to synthetic turf.

4.8.1 Consistency: The synthetic turf used for the inserts should be similar to that used in the area adjacent to the insert.

4.8.2 Installation: The inserts should be anchored securely to the surrounding areas so that they cannot be displaced by the activities occurring on the field and installed to the same tolerances.

5. Construction and Installation

- 5.1 Inspection: Synthetic materials should be inspected prior to installation for:
- Damaged or defective goods
 - Missing goods or quantities
 - Correct fiber type
 - Correct turf pile height and weight
 - Proper tuft bind
 - Correct backing perforation diameter and spacing, if applicable
 - Materials out of tolerance with the specification
- 5.2 Sub-Grade Preparation: The sub-grade should provide a stabilized foundation upon which base materials and subsequent components of playing field systems will be installed.
- 5.2.1 Function: It should also provide the pitched surface on which storm water is directed toward the active drainage system for evacuation.
- 5.2.2 Shape and Compaction: Prior to placement of base materials, the sub-grade should be shaped to an appropriate profile and compacted by proof rolling to obtain a firm even surface. Depressed areas should be filled and unsuitable materials removed and replaced with clean fill or aggregate. Compaction should be performed to achieve a minimum of 95% in accordance with ASTM D698 Standard Proctor Method. The appropriate moisture content must be maintained in the field sub-grade to allow for optimal levels of compaction.
- 5.2.3 Sub-Grade (Rough) Planarity: The tolerances for the finished sub-grade should not exceed one-half (1/2") inch as measured by a 10-foot straight edge (13mm in 3m). Grading of the sub-grade shall minimize ponding to the extent practical. The use of laser guided and controlled equipment is highly recommended for sub-grade preparation.
- 5.3 Aggregate: Installation of the aggregate base should provide a close, evenly textured surface meeting the required tolerances.
- 5.3.1 Construction: Extreme care should be taken to ensure that there is no disturbance to the sub-grade and that there is no displacement of the soil separator. All disturbed, displaced, or damaged material is to be repaired or replaced.

- 5.3.2 Placement: The aggregate base should be placed in a manner that will produce a uniform and evenly graded mass to the specified depth. The material should be placed and spread by the appropriate equipment and methods in successive horizontal layers not exceeding six (6) inches in depth. Care should be taken to avoid overworking the material, which can affect gradation and uniformity, resulting in detrimental performance and drainage characteristics. Pockets that occur as a result of stone segregation during installation should be removed and replaced. After correct placement, each lift shall be uniformly compacted with a self-propelled roller to achieve the specified density.
- 5.3.3 Compaction: The field base materials should be thoroughly compacted to prevent any significant differential settlement across the area of synthetic turf surfacing. Typical minimum compaction levels are 95% Standard Proctor for the base materials. The appropriate moisture content must be maintained in the base materials to allow for optimal levels of compaction.
- 5.3.4 Finish-Grade Planarity (surface tolerances): Irregularities in the surface of the base materials are typically reflected in the finished field surface. Therefore, it is important to install the base materials to controlled tolerances. The use of laser guided and controlled equipment is highly recommended for sub-grade preparation. The local deviation of the finished surface of the base stone should not exceed $\frac{1}{4}$ in. in any direction when measured beneath a 10-foot long straight edge (6mm in 3m). Hollows and depressions, which may have developed during the process of compacting the base, should be filled with acceptable material and re-compacted.



- 5.4 Shock Absorbing Resilient Underlayment System: The design of these systems varies and each approach should be carefully installed to meet the requirements of the user.
- 5.4.1 *In situ* Cushion-Layer (Elastic Layer Pad) Installation: If required by design, the *in situ* cushion layers should be installed with specialized paving equipment used only for *in situ* pad or rubberized running tracks. The paving machine should be operated by a minimum of two skilled technicians at all times. All paving seams should be hand rolled and troweled. All cold joints in the pad should be pretreated with a polyurethane primer. The specified thickness of the *in situ* pad should be continuously monitored for consistency. The components of the *in situ* cushion layers should be thoroughly mixed. The mixing ratios should also be monitored for consistency. The cushion-layer system should be securely placed on the field base materials. The *in situ* cushion surface should not vary more than $\frac{1}{4}$ in. in 10 ft. as measured in any direction with a string line or straight edge (6mm in 3m).
- 5.4.2 Seam Installation: If required by design, prefabricated cushion-layer systems are typically installed as roll or piece goods. The head seams at the end of each roll should be staggered across the field. When required by the padding manufacturer, all glued cushion-layer seams should be butted together and a permeable or mesh type fabric should be adhered to the surface of the cushion layer at all seam locations to bridge the cushion-layer joints. (This does not apply to sewn seams).
- 5.4.3 Resilient Infill: If required by design, the infill material should be applied when in a dry condition and should not be applied unless the synthetic turf is also dry. The infill material should be applied in consistent layers with multiple applications. It is critical to insure that synthetic fibers are not trapped underneath the infill. After application of each layer, the synthetic turf should be dragged and/or brushed according to the manufacturer's recommendations in order to lift the fibers and distribute the infill material into the turf system in a consistent manner. Equipment is however available that can install the infill materials and simultaneously brush them into the carpet pile in a single pass.
- 5.5 Irrigation System Design Considerations: When the inclusion of an irrigation system is deemed necessary or appropriate for a particular field installation it is highly recommended that it be designed, reviewed, and approved by a recognized irrigation consultant/designer. An experienced irrigation designer can provide necessary support, advice and foresee any pit falls resulting in costly re-work and an under performing system.

- 5.5.1 Requirements: A field watering system may be required to meet the demands of the game, such as high level field hockey competition. Each project and situation is unique. Factors such as the time allocated to irrigate before, during and sometimes after a match need consideration, this practice is common to ensure the players are offered a safe and controllable game.
- 5.5.2 Sprinkler Head Layout: Sprinklers located inside the field of play are not generally considered acceptable. Players falling on sprinklers through tackles and other play activities are subject to injury risk. The installation of multiple infield sprinklers is and can affect the turf's adhesion to the field base. This can have a negative affect on the completed turf planarity and consistency. Use of agricultural, long range sprinkler guns mounted on riser posts has until recently been a common practice. Manufacturers now produce long range perimeter pop-up sprinklers. Buried at grade level, the pop-up sprinklers provide discrete, low level, unobtrusive, long range performance with the ability to throw beyond the half way line.
- 5.5.3 Layout Considerations: Typical sprinkler installation design would allow for minimum spray disruption for slight wind conditions. Consideration for the spectators should be met to ensure they do not become unnecessarily wet during a watering cycle caused by incorrectly adjusted arcs or ill-positioned sprinklers.
- 5.5.4 Control Valves: High flow, low pressure loss electric solenoid valves should be installed, these are designed to ensure sprinkler performance is not prohibited and necessary for high volume perimeter sprinklers.
- 5.5.5 Controls: Conventional irrigation scheduling is not often necessary with artificial field watering. Manually operating the irrigation system proves more popular than traditional timers. A simple controller mounted in a cabinet with buttons programmed to switch on solenoid valves for a pre-set time or sequence is adequate for the ground personnel. Remote control is useful for field operation and allows the operator to ensure the field is clear of personnel hazard prior to operation.
- 5.5.6 Adequate safety precautions on the field such as warning notification sound and visual safety measures should be observed to ensure players, spectators and service personnel are not at risk from the water jet as the sprinklers are activated.
- 5.5.7 As an additional safety precaution, a security key restricting access to the control panel will ensure authorized use only of the watering system.

- 5.6 Synthetic Turf Material Production Quality Assurance/Quality Control: Testing of materials should be performed prior to shipment of product to the job site to avoid additional costs or delay.
- 5.6.1 Quality Assurance Testing: Prior to shipment of the synthetic turf and components to the job site, the synthetic turf rolls should be randomly sampled and tested by the manufacturer who will certify that they meet the specification.
 - 5.6.2 Relevant Characteristics: Testing to be conducted should be a provision in the agreement between the parties and may include pile composition, pile weight, total weight, pile height, tuft bind (without infill), and grab/tear strength.
 - 5.6.3 Labeling: The manufacturer, at his option, should convey in writing the test results of the relevant characteristics and certify that they meet or exceed the specification requirements.
- 5.7 Synthetic Turf Installation: All synthetic turf systems should be installed to provide stability that will prevent panels from shifting or bunching.
- 5.7.1 Seaming Method: The synthetic turf panels should be securely fastened together for the warranted life of the system. These seams are typically glued or sewn, the method for which varies from system to system. Specialized synthetic turf systems with are periodically removed and replaced may have seams, which are comprised of hook and loop fasteners or other easily attachable materials. Seam gaps should be minimal and uniform. For tufted infill systems the gap between the fibers should not exceed the gauge of the tufting. For other synthetic turf systems, the seam gaps should not exceed $\frac{1}{16}$ in. (2mm).
 - 5.7.2 Edge Anchoring: The anchor may consist of a concrete curb, a treated wood header, a composite material or a trench drain. These may vary by design and region, but should always provide a secure anchor.
 - 5.7.3 Inlaid Lines and Markings: Inlaid lines and markings should consist of synthetic turf with contrasting colored fiber installed in lieu of painted fiber. Inlay gaps should be uniform. For tufted systems, the gap between the fibers should not exceed the gauge of the tufting. Lines and markings must conform to the appropriate association or organization suggested guidelines for the intended level of use.
 - 5.7.4 Temperature: Care should be taken during installation to account for rapid

fluctuations in temperature to avoid expansion and/or contraction which can affect the final installation. Temperature extremes should also be carefully monitored. The carpet should never be rolled or unrolled when frozen, which can cause cracking and irreparable damage to the secondary backing.

5.8 Infill Material Installation: Correct installation is critical to performance of these systems and should follow the manufacturer's recommendations.

5.8.1 Environmental Conditions: It is recommended infill materials should be installed under dry field conditions.

5.8.2 Method of Application: The infill material should be installed uniformly. The equipment used for the application of the infill materials should erect the fiber, place the infill materials, and should incorporate a metering method to provide consistent distribution. The equipment utilized should not distort or displace any base materials or damage the system in any way.

5.8.3 Infill Depth: The depth of infill can be measured by taking the depth from the top of the primary backing to the top of the infill or subtracting the length of exposed fiber from the known pile height.

5.8.4 *g*-Max Testing: *g*-Max testing should always be performed by an independent testing company or lab.

5.9 Fiber Conditioning: It is essential to maintain the integrity and uniformity of the fiber throughout the manufacturing, shipping and handling, installation and maintenance processes in order to prevent damage, which could alter the specified performance and void the warranty.

6. Maintenance

Maintaining a synthetic turf field is essential for optimum appearance, safety, playing performance, and field longevity. A regular schedule of maintenance should include surface cleaning, debris removal, grooming, and infill replenishment, redistribution, and de-compaction. The maintenance procedures and equipment, as specified by the synthetic turf system builder and required for the system, should be evaluated during the selection process so that the appropriate budget resources for manpower and equipment may be allocated. Note: Refer to the STC's *Suggested Guidelines for the Maintenance of Infilled Synthetic Turf Surfaces*, April 2007, for additional information.



- 6.1 The synthetic turf installation builder should provide detailed written maintenance instructions, suggested guidelines for the system, and training of maintenance personnel. Maintenance of the systems typically consists of cleaning, stain removal, minor seam repair, dragging or redistribution of any infill material, and management of infill compaction. A primary goal of grooming maintenance is to keep the fibers standing in an upright position, which minimizes wear and UV degradation and can have a beneficial effect on performance, playing characteristics and longevity of the field. Specialized equipment is typically required for the maintenance of the surface and should be included with the field contract. Utilizing this equipment as recommended by the installation builder will generate the proper maintenance in relation to any future warranty claims.

- 6.2 **Maintenance Monitoring:** The owner/user shall be responsible to maintain a log of maintenance performed on the field as recommended and warranted by the builder.
- 6.3 **Cleaning:** The periodic use of a vacuum or a sweeper should be applied to keep the synthetic surface clean. This equipment should be compatible with synthetic turf fields. This typically means wider tires and softer nylon type brushes. The cleaning activities should conform to the written maintenance suggested guidelines provided by the synthetic installation builder.
- 6.4 **Irrigation System Maintenance:** As with any irrigation system, maintenance and winter drain-down and preparation in cold climates should be observed.
- 6.5 **Stain Removal:** Stains such as tobacco, gum, etc. should be removed as soon as possible as per the installation builder's recommendations.
- 6.6 **Brushing:** The infill material and fibers should be periodically brushed depending on use to even out any low areas of infill materials and to brush the fibers back to a more vertical alignment. The sand and rubber infill materials can also have the compaction reduced with the use of metal tines. The brushing activities should conform to the written maintenance suggested guidelines provided by the installation builder.
- 6.7 **Seam Repair:** Seams that open or become loose may require some immediate and temporary gluing until they can be inspected and corrected by the installation builder. The gluing should conform to the written maintenance suggested guidelines provided by the synthetic turf vendor.

7. Post-Installation Testing

- 7.1 **Schedule:** It is recommended that a minimum schedule for on-going testing be included and understood by the parties to be at least at the end of year one and at the end of year three. Testing thereafter is at the owner's option.
- 7.2 The *g*-max should be tested in accordance with the above schedule.
- 7.3 Inspection of the seams and other installation features should be mutually agreed to by the parties but should be completed no less than one time per year or as stated in the manufacturer's warranty.
- 7.4 **Governing Body Certification:** Additional post construction performance testing may be required for fields used for high level competition. Contact the respective governing bodies for the current guidelines.

Appendix A—Tests and Guidelines

- A. Test Protocols and their respective STC minimums are for specific purposes such as the following.
- Performance of the system and/or its essential components is the primary objective.
 - Quality control and delivery of the materials as specified.
 - Failure diagnosis, preventative measures, comparative evaluations, safety, appearance, and compliance with codes and regulations, etc.
- B. Not all tests are required for every installation. A design professional can best advise on what site tests should be conducted under given circumstances.
- C. Tests in the laboratory and in the field are to be utilized for a specific purpose and their protocols should be followed as published by their respective standards organizations.
- D. Architects, design professionals, engineers, and consultants have the responsibility to refer only to the tables and charts in this Guideline document that apply specifically to the needs of the design, site, and the requirements of the intended use as indicated by the owner/end user and/or as may be required to validate the warranties offered.
- E. All minimum values should be evaluated as they relate to the system performance.
- F. Site testing shall be at ambient shaded air temperature of 40–100°F. Laboratory testing shall be at ambient indoor temperature unless otherwise specified by the test method.
- G. Unless otherwise specified, field test measurements shall be made at a minimum of 6 locations (must avoid areas where 2 glued seams cross). Test locations shall conform as closely as possible to the test sites specified in ASTM F1936 (field used primarily for North American Football) or FIFA Handbook 3-06 (fields marked for Soccer).
- H. All minimum and maximum values take into account acceptable industry manufacturing tolerances of +/- 2% of the variance.

Table 1: Base Materials

Test Property	Method of Determination	STC Guidelines	Lab/Field Test
Size of Particle Mix	ASTM D422 Particle-Size Analysis	As per specification	Lab (on site material)
Drainage	ASTM F1551/DIN 18035:6 Permeability to water * ASTM D2434 Permeability of granular soils (constant heat)	Min. of 0.01 cm/s (14 in. per hour)	Lab/Field **
Compaction (density)	ASTM D698 Compaction using standard effort ASTM D2922 Compaction of soil in place by nuclear methods	To set criteria for ASTM D2922 Min. 95% standard proctor	Lab/Field
Final Grade	ASTM F2157 Test method for base material evenness	Less than ¼ in. over 10ft. (6mm over 1m)	Field

- * Determination in the lab: It is necessary to seal the test ring to the base of the sample. The edges of the sample must also be sealed to prevent any water from flowing around rather than through the sample.
- ** Determination in the field: An exact seal is typically not attainable and the test is not as accurate/reproducible due to the lateral flow of water and the problems of determining the areas through which the water is flowing.

Table 2: Turf Characteristics for Tufted Infill Systems

(Typical for high school, collegiate, and professional play fields)

Test Property	Method of Determination	STC Guidelines	Lab/Field Test
Manufacturer of System (name)	Manufacturer declaration	Not specified	N/A
Pile Fiber ID	Manufacturer declaration	Not specified	N/A
Primary Backing System ID	Manufacturer declaration	Not specified	N/A
Secondary Backing System ID	Manufacturer declaration	Polyurethane/Latex/Fabrics	N/A
Pile (face weight)	ASTM D5848	Min. 30 oz./sq. yd. (2" product) Min. 38 oz./sq. yd. (2.5" product)	Lab
Primary Backing System Weight	ASTM D5848	Min. 5.5 oz./sq. yd.	Lab
Secondary Backing System Weight	ASTM D5848	Min. 16 oz./sq. yd.	Lab
Pile Height	ASTM D5823	Sport specific or as specified	Lab/Field
Pile Height above Infill	Measurement	Must meet systems specs	Lab/Field
Yarn Thickness	ASTM D3218	Min. 100 microns (slit-film) Min. 130 micron (monofilament)	Lab
Yarn Denier	ASTM D1577	Min. 500 (nylon)	Lab
Grab Tear Strength	ASTM D5034	Min. 150 lbs.	Lab
Tuft Bind	ASTM D1335	>6.8 lbs. or 30N	Lab
Flammability	ASTM D2859 Pill Burn	Passing result tested as installed	Lab
Color Uniformity	Visual	No significant change	Lab/Field

Table 3: Turf Characteristics for Knitted Turf Systems

Test Property	Method of Determination	STC Guidelines	Lab/Field Test
Manufacturer of System (name)	Manufacturer declaration	Not specified	N/A
Pile Fiber ID	Manufacturer declaration	Not specified	N/A
Primary Backing System ID	Manufacturer declaration	Not specified	N/A
Secondary Backing System ID	Manufacturer declaration	Glued: Acrylic Loose laid: Polyurethane or acrylic	N/A
Pile (face weight)	ASTM D5848	Min. 55 oz./sq. yd.	Lab
Primary Backing System Weight	ASTM D5848	Min. 8 oz./sq. yd.	Lab
Secondary Backing System Weight	ASTM D5848	Glued: Min. 3 oz./sq. yd. Loose laid: ¼ in. (6mm) pre-coat and attached cushion weight combined is min. 50 oz./sq. yd.	Lab
Pile Height	ASTM D5823	Min. 0.5 in.	Lab/Field
Pile Height above Infill	Measurement	N/A	Lab/Field
Yarn Thickness	ASTM D3218	Min. 100 microns PE Min. 50 microns PP	Lab
Yarn Denier	ASTM D1907	Min. 500 (nylon)	Lab
Grab Tear Strength	ASTM D5034	Min. 350 lbs.	Lab
Tuft Bind	ASTM D1335	>6.8 lbs. or 30N	Lab
Flammability	ASTM D2859 Pill Burn	Passing result tested as installed	Lab
Relative Abrasiveness	ASTM F1015	Measurement	Lab
Color Uniformity	Visual	No significant change	Lab/Field

Table 4: Turf Characteristics for Tufted Polypropylene (PP), Polyethylene (PE), or Nylon Systems (non-infill systems)

Test Property	Method of Determination	STC Guidelines	Lab/Field Test
Manufacturer of System (name)	Manufacturer declaration	Not specified	N/A
Pile Fiber ID	Manufacturer declaration	Nylon 6 or 6.6; PP, PE	N/A
Primary Backing System ID	Manufacturer declaration	Not specified	N/A
Secondary Backing System ID	Manufacturer declaration	Polyurethane	N/A
Pile (face weight)	ASTM D5848	Min. 48 oz./sq. yd.	Lab
Primary Backing System Weight	ASTM D5848	Min. 6 oz./sq. yd.	Lab
Secondary Backing System Weight	ASTM D5848	Min. 16 oz./sq. yd.	Lab
Pile Height	ASTM D5823 or D6859	Min. 0.45 in.	Lab/Field
Pile Height above Infill	Measurement	N/A	Lab/Field
Fiber Conditioning	Manufacturer declaration	Texturized	N/A
Yarn Thickness	ASTM D3218	Min. 75 microns PE Min. 50 microns PP	Lab
Yarn Denier	ASTM D1907	Min. 500 (nylon)	Lab
Yarn Elongation	ASTM D2256	N/A	Lab
Grab Tear Strength	ASTM D5034	Min. 150 lbs.	Lab
Yarn Breaking Load (tensile strength)	ASTM D2256	Manufacturer recommended specification	Lab
Tuft Bind	ASTM D1335	>6.8 lbs. or 30N	Lab
Flammability	ASTM D2859 Pill Burn	Passing result tested as installed	Lab
Color Uniformity	Visual	No significant change	Lab/Field

Table 5: Infill Properties

Test Property	Method of Determination	STC Guidelines	Lab/Field Test
Material Identification	Manufacturer declaration	Must meet system specifications	N/A
Grain Size (particle size)	ASTM D422 (soil) ASTM D5644 (rubber)	Must meet system specifications	Lab
Depth	Measurement from top of infill to surface of fabric	Must meet system specification at all locations $\frac{3}{8}$ in. (± 9 mm)	Lab/Field
Flammability	ASTM D2859 Pill Burn	Passing result tested as installed	Lab
Color Uniformity	Visual	No significant change	Lab/Field

Table 6: Shock Pad Layer Properties

Test Property	Method of Determination	STC Guidelines	Lab/Field Test
Material Identification	Manufacturer declaration	Must meet system specifications	N/A
Mix Design	Manufacturer declaration	Must meet system specifications	N/A
Drainage	ASTM F1551/DIN 18035-6 Water Permeability	Min. 14 in./hour	Lab/Field
Component Size Rubber/Stone (gravel)	ASTM F1508 Sieve Analysis	Must meet system specifications	Lab
Evenness	ASTM F2157 Test method for base material evenness	Less than $\frac{1}{4}$ in. over 10 ft. (6mm over 3m)	Field
Thickness	Measurement	Must meet system specifications at every point measured ($+\frac{1}{4}$ in./-0) (+6mm/-0) cushion layer	Lab/Field

Table 7—Performance Guidelines

The Synthetic Turf Council's *Guidelines for Synthetic Turf Performance* are included by reference. For a free copy, please visit the STC Resource Center at www.syntheticurfCouncil.org.

Appendix B—Reference Specifications (typical minimums)

Charts 1–5

- A. The reference specifications noted in Appendix B are “typical” examples of minimums that are most commonly encountered and have fulfilled reasonable expectations for successful performance. Deviations from these minimums can be expected due to product innovations or quality upgrades and can be considered when properly justified in terms of their expected performance.
- B. All tests prior to, during, or after installation are to be specifically listed and understood by all parties as to their execution and financial responsibility.
- C. Environmental Conditions: Suitable weather conditions are important for the successful installation of the systems.
- D. In the event of questionable conditions, the manufacturer’s recommendation should be obtained to prevent the possible voiding of any warranties (particularly as it applies to adhesives).

Chart 1: Infilled Synthetic Turf Specification

Fiber	
Material	PE, PP, Nylon 6 or Nylon 6.6
Denier	Must meet system specifications
Backing (primary/secondary)	
Weight Primary	Not less than 5.5 oz./sq. yd.
Weight Secondary	Not less than 16 oz./sq. yd.
Additional Backings	Optional
Fabric	
Width	12 ft. to 15 ft.
Tuft Bind	>6.8 lbs. or 30 N
Pile Height	Sport specific or as specified
Pile Weight	Not less than 30 oz./sq. yd. Must meet system specifications
Grab Tear Strength	Not less than 150 lbs.
Pill Burn Test	Passing results tested as installed
Infill System (Depending on manufacturer's recommendation, refer to definition section)	
Depth of Infill	Nominal, per manufacturer's recommendation
Impact Attenuation	Current ASTM standard for <i>g</i> -max is a maximum value of 200 at each test point. <i>g</i> -Max values may vary from location to location on a playing surface. Such variances should be taken into account when setting maximum values. The STC's guideline is that <i>g</i> -max should be below 165 throughout the life of the field.
Water Permeability	Turf/cushion layer: min. 10 in./hour Base materials: min. 14 in./hour

Chart 2: Knitted Synthetic Turf Specification – Short pile

Fiber	
Material	PE, PP, Nylon 6 or Nylon 6.6
Denier	Min. 500 Nylon
Thickness	Min. 75 microns PE or PP
Backing (primary/secondary)	
Ground Yarn	Polyester multi-filaments
Weight Primary	Min. 8 oz./sq. yd.
Acrylic	Min. 3 oz./sq. yd.
Polyurethane attached cushion	Optional
Fabric	
Width	Typically 15 ft.
Tuft Bind	N/A
Pile Height	Sport specific or as specified
Pile Weight	Min. 55 oz./sq. yd.
Grab Tear Strength	Min. 350 lbs.
Pill Burn Test	Passing results tested as installed
Total Weight	Min. 66 oz./sq. yd. (without attached cushion)
Infill System (Depending on manufacturer's recommendation, refer to definition section)	
Impact Attenuation	Current ASTM standard for <i>g</i> -max is a maximum value of 200 at each test point. <i>g</i> -Max values may vary from location to location on a playing surface. Such variances should be taken into account when setting maximum values. The STC's guideline is that <i>g</i> -max should be below 165 throughout the life of the field.
Water Permeability	Turf/cushion layer: min. 10 in./hour Base materials: min. 14 in./hour

Chart 3: Tufted Synthetic Turf Specification – Short pile

Fiber	
Material	PE, PP, Nylon 6 or Nylon 6.6
Denier	Min. 500 Nylon
Thickness	Min. 75 microns PE Min. 50 microns PP
Backing (primary/secondary)	
Woven PP/non-woven	Single or multiple
Weight	Min. 6 oz./sq. yd.
Scrap Coat	Min. 16 oz./sq. yd.
Attached cushion Secondary and/or cushion	Min. 32 oz./sq. yd. (as required)
Fabric	
Width	12–15 ft.
Tuft Bind	>6.8 lbs. or 30 N
Pile Height	Sport specific or as specified
Pile Weight	Min. 48 oz./sq. yd.
Grab Tear Strength	Min. 150 lbs.
Pill Burn Test	Passing results tested as installed
Total Weight	Depending on individual construction
System (Depending on manufacturer's recommendation, refer to definition section)	
Impact Attenuation	Current ASTM standard for <i>g</i> -max is a maximum value of 200 at each test point. <i>g</i> -Max values may vary from location to location on a playing surface. Such variances should be taken into account when setting maximum values. The STC's guideline is that <i>g</i> -max should be below 165 throughout the life of the field.
Water Permeability	Turf/cushion layer: min. 10 in./hour Base materials: min. 14 in./hour

Chart 4: Shock Pad–Pre-Fabricated Pad Systems Specification

Typical Requirement	
Thickness	0.375 in. ± 10%
Density	4.0 lbs./cu. ft. ±10%
Weight	38 oz./sq. yd.
Width	4 ft.
25% Compression Resistance (ASTM D1667)	10–12 psi
Tensile Strength (ASTM D412)	Typically 75 psi
Elongation to Break (ASTM D412)	Typically 125%

Chart 5: Shock Pad–*In Situ* Systems Specification (typical ranges)

Thickness:	35 mm	25 mm	20 mm
Density:	2 lbs./cu. ft.	1.5 lbs./cu. ft.	1.2 lbs./cu. ft.
Weight:	56 lbs./sq. yd.	40 lbs./sq. yd.	32 lbs./sq. yd.
Component:	SBR	Aggregate	PU Binder
	1–5 mm	1–3 mm	
Percentages (by weight):	60–63%	30–32%	5–10%

* Mix Design (all percentages by weight)

Note: Typically the mix design is determined first, to satisfy the needs of the field in relation to its declared use. The mix design then will determine the weight, density, and thickness which should fall within the parameters indicated.

- SBR granules to be dust free, no elongated particles are allowed.
- Aggregate to be washed/clean, preferably round (pea gravel).
- Application to be performed by the use of continuous mixing device and suitable paving equipment.

Legend—Providers of Synthetic Turf Systems

Material/Component Manufacturers & Suppliers

Companies whose primary business is to provide materials or manufacturing services to the synthetic turf industry. These organizations do not provide turn-key installation of the synthetic turf systems nor provide the overall warranty for an installation. Examples include:

- Adhesives and fasteners
- Backing systems
- Components of synthetic turf systems
- Drainage systems
- Infill (crumb rubber, sand, etc.)
- Logos and field graphics
- Pigments and masterbatches
- Synthetic turf
- Shock pads and underlayments
- Yarn and fiber

Builders, Installers & Contractors

Companies whose primary responsibility is installing synthetic systems either directly or indirectly through a subcontractor or distributor. Builders often have turn-key responsibility for the synthetic turf installation and provide the overall warranty for the installation. It is recognized that some companies in this category may be manufacturers. Examples include:

- Builders and installers of sports fields, landscape, golf and/or recreation synthetic grass
- General contractors (drainage, field removal, irrigation, e-layer, etc.)
- Sub-base contractors

Independent Professionals & Consultants

Firms with legally registered or licensed design professionals who are officially designated as such as well as those with non-licensed practitioners or consultants that represent or advise the owner/end-user with surface and systems selection information, technical specifications, system designs, bid and construction documents, etc. Examples include:

- Landscape architects and civil engineers
- Independent synthetic turf consultants

Specialty Manufacturers & Services

Maintenance organizations, equipment manufacturers, professional service organizations, and other companies, typically independent, which sell their products and services primarily to the buyer or end-user. Examples include:

- Business & scientific consulting
- Field marking and paint
- Field removal equipment
- Insurance (third-party warranty, bonding, etc.)
- Irrigation systems
- Maintenance installation equipment
- Protective field covers
- Repairs and maintenance services
- Sports field hardware & equipment
- Synthetic turf and yarn extrusion equipment

Testing Labs, Services & Equipment

Independent companies that are capable of testing synthetic turf and its components:

- Onsite testing service providers
- Testing equipment manufacturers and/or suppliers
- Testing laboratories

Disclaimer

The *Suggested Guidelines for the Essential Elements of Synthetic Turf Systems* are voluntary. This document does not, in any way, imply, suggest or guarantee that a warranty, environmental, or performance issue could not arise if the system, product or component meets the suggested guidelines, nor does it imply or suggest that if any of the guidelines are not met that the product will fail to perform. These guidelines are not standards and are not to be used as the basis for warranty or other claims. The guidelines have been suggested to enhance the use of synthetic turf sports surfaces; however, they are not intended to be, and are not, safety standards and this document does not imply that an injury is less likely to occur if the synthetic sports surface meets the conditions and suggested guidelines contained herein.

About the Synthetic Turf Council

Based in Atlanta, the Synthetic Turf Council was founded in 2003 to promote the industry and to assist buyers and end users with the selection, use and maintenance of synthetic turf systems in sports field, golf, municipal parks, airports, landscape and residential applications. The organization is also a resource for current, credible, and independent research on the safety and environmental impact of synthetic turf. Membership includes builders, landscape architects, testing labs, maintenance providers, manufacturers, suppliers, installation contractors, infill material suppliers and other specialty service companies. For more information, visit the STC's Online Buyers' Guide and Member Directory at www.syntheticurfCouncil.org.



Synthetic Turf Council
400 Galleria Parkway, Suite 1500
Atlanta, GA 30339
Phone: 678.385.6720 | Fax: 678.385.6501
www.syntheticurfCouncil.org

Online Buyer's Guide and Member Directory
www.stc.officialbuyersguide.net