



# Safe Installation and Maintenance of Tents and Fabric Structures

Procedural Handbook

Organized by



Tent Rental  
Division

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the Tent Rental Division of the Industrial Fabrics Association International**

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This manual supplements any instructions or warnings that are provided by the manufacturer of the tent. You should consult the manufacturer's instructions and warnings each time you install a tent. This manual does not replace the manufacturer's instructions and warnings. If you are unable to locate any instructions or warnings, consult your rental agent or the manufacturer. To avoid personal injury or property damage, read and follow the manufacturer's instructions and warnings and the supplemental information contained in this manual before you install a tent. In the event there is a conflict between the manufacturer's instructions and warnings and the instructions contained in this manual, always follow the manufacturer's instructions and warnings.

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## INTRODUCTION

The purpose of this document is to provide a source of information aimed at installers, foremen and company owners that explains, in layman's terms, safe procedures for installing tents and industry accepted best practices for their maintenance and care.

This handbook is the product of several years of work by the Education Committee of the Tent Rental Division of IFAI, which was charged with the creation and acceptance of an industry-wide installation and maintenance document.

It is designed to educate novices as well as experienced tent renters on installation theory, with an emphasis on safety. This handbook may be used as a basic guide for tent installation. The goal is to clarify specific tenting theories, verifying as well as dispelling common tenting myths. The information presented here is based on the combined experience of the all-volunteer Education Committee, with validated engineering data from industry experts.

The committee was composed of volunteer tent installers and manufacturers, all of whom sought technical review of this document from a wide spectrum of the tent rental industry over the course of nine years.

The committee was founded as part of a continuing study to address the growing need in the industry for basic tenting knowledge. The members volunteered their time and expenses in an effort to educate all members of the Tent Rental Division of IFAI. The ultimate goal is to elevate quality and safety standards in the industry as a whole.

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# Safety

## 1.1 Overview

The purpose of this section of the Procedural Handbook is to outline generally accepted standards for the safety of the employee, customer, and general public when working with commercial tent products.

### “Tents” as an all-encompassing category

For the purposes of simple writing, we know each tent company also provides a variety of add-on products (flooring, stage, lights, wiring, tables/chairs and even dishware). The words “Tent”, “Tents” or “Tenting” will assume inclusion of all of a company’s deliverables.



### Working around your warehouse and parking lot

Safety starts at the at the warehouse and adjacent parking lots, where where crew mates may be loading anything from a pickup truck to a semi-tractor trailer, utilizing tools of the trade ranging from hand trucks and pallet jacks to large material-handling lift trucks. As a warehouseman or trucking crewmate, a large portion of your time will be spent in and around your facility, both in the warehouse, and outside processing loads on trucks. Everyone must be diligent and ensure that not only are his or her activities safe, but also to be sure everyone is watching out for others working in the same areas. Always be aware of what others are doing.

Occasionally, customers may pick up and return equipment at your business location. Be especially watchful, as they are not as attuned to safety hazards. It is likely that the majority of these customers have never set foot in a large warehouse, and find it an awkward experience.

Finally, if you see something that is unsafe, take corrective action. It is better to get involved and prevent a potential accident than to risk someone getting injured.

### Working around your customer site

Safety awareness extends to the customer site, where trucks, crew mates, forklifts and reach lifts may be deployed to support an installation. All the principles which are applied at your warehouse can be applied at the customer site.

However, there is an added exposure, or risk. The public may have access to your construction site, but has little or no awareness of the potential risks involved while walking around an installation or takedown. Each and every crew member must be constantly aware of this fact, to look out for the lives and safety of the general public and customers. One classic example often occurs at colleges, where students will often wear headphones, phone in hand, and may walk right across assembled tent frames or tent fabric oblivious to the fact that there might be work going on overhead, or that they are walking into the path of a man lift with the operator 25 feet in the air.

### General guidelines

Always follow your company safety policies and procedures and keep the following basic safety measures in mind:

- Maintain a slow and controlled driving speed when operating trucks, forklifts, and man lifts at all times. If the site warrants it, stop your movement and require a ground guide before proceeding.
- Follow all posted speed limit signs when on customer sites as well as public roadways.
- Watch for teammates while driving or moving around the job site or yard.
- Be on the lookout for the general public without safety training, and equipment approaching your work area.
- Be aware of equipment being moved anywhere within 20 feet of your proximity.
- Avoid equipment blind spots.
- Always give the right-of-way to people and equipment being moved on the jobsite.
- Inspect the area around your vehicle and the equipment before it is moved for hidden or protruding equipment and other hazards.
- Perform a 360° walkaround before moving your vehicle or equipment to verify all is safe.
- Always check for overhead obstacles, especially around buildings, overhead utilities, tent frames, aerial lifts and forklifts.
- Always buckle up and wear a harness when required.

## 1.2 Personal Protective Equipment

### Personal Protective Equipment (PPE)

PPE is defined as all equipment intended to be worn by a person while performing an installation, and which protects them against one or more risks to his or her health or safety.

- Eye protection is used when there is a risk of flying debris such as driving stakes in blacktop.
- Shoes or boots should be outfitted with slip-resistant soles.
- Safety-toed footwear is worn to prevent crushed toes when working around heavy equipment, tents, structures, and rental equipment.
- Hand protection is worn when assembling tubing and structure to avoid pinch points. Gloves should fit snugly.
- Hard hats are worn during setup and take down of all types of tents, fork lifting, operating reach lifts, and climbing of any type. Routinely inspect hard hats for dents, cracks or deterioration; replace after a heavy blow.
- Hearing protection should be used by anyone working in the vicinity of a powered stake driver. Use earplugs/earmuffs in high noise work areas where heavy equipment is used; clean or replace earplugs regularly.
- Worker safety vests are on tent sites to increase the visibility of the crews on the job site. When the entire crew is wearing safety vests, it makes it obvious when someone enters the jobsite who will not be aware of the work environment, or overhead risks that might be present.
- Fall protection is used anytime the crew is working on aerial platforms. It is also used on construction sites where work is done on a platform with an elevation of six feet or higher.

### Protective Equipment Recommended

Type of Activity	Head Protection: Safety Hat	Eye Protection: Safety Glasses Sun Glasses	Hearing Protection: Ear Plugs Ear Muffs	Foot Protection: Work boots with toe guard	Hand Protection: Gloves	Work Visibility: Safety Vest	Fall Protection: Safety Harness & Lanyard
Frame Erection	X			X	X	X	
Pole Tent Erection	X			X	X	X	
Driving Stakes		X	X	X	X	X	
Pulling Stakes				X	X	X	
Driving Fork Truck	X			X		X	
Operating Aerial Work Platform	X			X		X	X
Climbing of all type	X			X		X	X



# 1.3 Underground and Overhead Utilities and Obstructions | Site Safety inspections

## Underground Public Utilities

The tent company should arrange an underground public utility search 72 hours before the installation. If this search has not been conducted, you should not drive stakes into the ground.

Before a tent is installed on a customer site using tent stakes, the rental company must conduct an underground notification and marking to the 811 organization that serves your state or region. If the call is made by any organization, person or customer other than the rental company, and the rental store strikes an underground service, the rental store will be found responsible for all losses and cost to restore those services. If, on the other hand, the rental company makes the same call and strikes an unmarked underground service, the rental company is afforded protection under the law for having done their part to identify the underground services.



While all states use the 811 phone number, the name of the service varies. Searching the web for “underground utility locator 811” and the name of the state will reveal the organization’s website. Simply calling 811 will connect you to them.

## Underground Private Utilities and Lines

The 811 service does not mark private underground utilities. They will mark from their transmission source up to the customer meter. From there it is considered a private utility, where the markings must be provided by the home owner, or whomever they might hire to identify the utilities. As examples, electric lines from the house to an out building, an irrigation system, or building-to-building piping would be considered private utilities.

Similarly, school installations will involve more private utilities than public, as the services are linked from one building or area to another. A typical university will either subcontract the marking, or have the ability to perform the service with their staff.

APWA UNIFORM COLOR CODES	
	RED: Electric power lines, cables, conduit and lighting cables
	ORANGE: Communications, alarm or signal lines, cables or conduit, traffic loops
	YELLOW: Gas, oil, steam, petroleum, gaseous materials
	BLUE: Potable water
	PURPLE: Reclaimed water, irrigation, slurry lines
	GREEN: Sewers and drain lines
	WHITE: Outlining dig site
	PINK: Temporary survey marks

The marks are approximate. Dig carefully near them.



## Site Safety Inspections – Day of Installation

The crew lead should conduct a site safety inspection as the first step when arriving on the job site. They can look for marked private utilities that need to be avoided. Included in that site inspection should be a walk-around with the client to confirm that they have marked their public utilities. Following that inspection, they should make any last-minute moves of the tent to stay clear of utilities.

## Overhead Utilities and Obstructions

These items should be noted during the site survey, and then again by the crew lead while he is confirming the underground utility status. Things to look for include electric wires, overhead trees and buildings. If you determine that there is an electric overhead wire in the vicinity, you should consult with an electrical contractor to determine safe distances under and away from the wire. High-voltage lines have large fields of electricity which can arc when a conductor comes into proximity with the wire.

In a 15-year period ending in 2016, there were at least two accidents involving commercial tents resulting in five deaths when the center pole was pushed up into an overhead wire. A similar risk exists when using heavy mobile equipment to erect structures and move large materials on a job site.

## 1.4 Using Power Equipment, Heavy Mobile Equipment and Trucks

### Introduction

Employees operating any type of power equipment, large or small, must have proper training. Operating heavy equipment introduces a greater degree of risk to life and property that must be mitigated by management and training. To ask an employee if they are experienced in how to operate a given type of equipment is asking for trouble, because the answer does not leave any basis on which the management can validate the employee's capability. Who is to know if that employee based their answer on having 100 hours of time in the machine, but never had textbook training to cover certain exposures that could exist when they are using the machine day-to-day?

Many different types of machines and equipment are available for the tent installer to help move equipment around the job site, load and unload trucks, drive and pull stakes, lift heavy objects, and elevate employees into positions well above ladder heights. All of these machines and equipment are aimed at elevating safe working conditions on the job site, reducing employee fatigue, and reducing labor needs for moving large amounts of equipment around a job site. Regardless of the size of the machine or piece of equipment, proper training on its operation and the usage of the required personal protective equipment during its operation are critical.

### Small Power Equipment

Power equipment generally refers to smaller equipment that can be carried or moved by one or two people, such as a stake driver, stake puller, or power saw. Other types of power equipment might include an air compressor or generator. Many of these have their own wheels or can be moved about with a hand truck or pallet jack.

Power equipment is often the first type of equipment a new employee might encounter in the course of his job with a tent rental company.

Like with heavy mobile equipment and trucks, all power equipment should be incorporated into the company safety and training program. Generally, the manufacturer's operations manual is a good source of training material, because it is written on the assumption that this is the operator's first time using a given piece of equipment. It would be very easy to incorporate five or six different pieces of power equipment into a monthly safety meeting, and document the attendees, so you know who is trained.



### Heavy Mobile Equipment and Trucks

Heavy mobile equipment generally refers to the larger support equipment necessary to conduct the business of a tent rental company. As companies' sizes range from small to large, so too do the types and sizes of equipment that might be utilized to support its tent rental business.

Operating this equipment represents a greater exposure to the employee and public because they involve powerful engines, working from high elevations above the ground, or involve speed and motion, such as trucks traveling down a crowded highway.

Training is conducted by either a training and/or safety coordinator, or is contracted to a company who specializes in the type of equipment used, such as with aerial work platforms and forklift trucks.

It would be inappropriate for the IFAI to conduct training for such a wide range of equipment. That is the role of your company's training and safety coordinator. They in turn will determine if the training should be done in-house, or contracted out based on your company's resources and business model.

## Types of Heavy Equipment that we might encounter

### Trucks

- Light duty - class 1 to 3 with GVWR (Gross Vehicle Weight Rating) up to 10,000#
- Medium duty - class 4 to 6 with GVWR up to 26,000# (may require CDL)
- Heavy duty - class 7 to 8 with GVWR greater than 26,000# (always requires a CDL)

### Trailers - for transporting machines or material

- Utility trailer
  - 1 or 2 axle trailers with GVWR up to 10,000#
  - Mostly used for moving small loaders or rental product
- Semi Trailer
  - Enclosed or flatbed trailers hauled by heavy duty trucks which typically carry upwards to 50,000# of rental material such as
    1. Structure beams and parts
    2. Tables or chairs
    3. Ballast for weighting tents and structures

### Fork Trucks

- Reach lift - warehouse
- Sit-down lift - warehouse, parking lot, grass
- All-terrain lift - tele-handlers, truck/trailer mounted



### Loaders

- Skid steer
- Articulated

### Aerial Work Platform - for personnel lifting, with or without materials

- Platform/scissor lift - flat, hard surfaces
- Reach lift - can be smooth or rough terrain



## Management's role in training and safety

- Senior management of each company must make the first commitment to safety, setting the tone with management staff that employee safety comes first.
- Designate one person, reporting to the owner or general manager, the roll of Training and Safety Coordinator.
- Allocate the budget, time and resources for this individual to carry out that responsibility.
- Post and publicize the company's commitment to safety.
- Promote an environment where any employee can stop a work activity if there is reason to think that the activity cannot be conducted without avoidable risk to an employee, customer, bystanders, or property.



## Training and Safety Coordinator’s role

### Policy development

To develop a policy that is appropriate for the type of equipment used, and business being conducted.

### Accident investigation

To perform a timely investigation, so that management can take steps to avoid a repeat occurrence based on lessons learned.

### Safety training and operator training

To perform the appropriate training for the specific task or equipment that is being handled.

### Safety inspections

To conduct periodic inspections to insure that the policies which have been established are being subscribed to. Deficiencies found in an inspection should cause the coordinator to revisit the policy, and training, and take corrective actions as needed to ensure the ultimate goal.

### Documentation

OSHA has required notices that must be posted for every employee to read advising them of their rights as an employee.

OSHA requires employers to complete and publish Form 300 for every employee to see. This log provides a list of all work-related injuries and illnesses.

### Training and Safety Coordinator

The role might be separated, where one person has full responsibility for training, and another for safety, so there is full accountability by one person for each role.

### Employees' Rights

*taken directly from OSHA site as stated 11/30/16*

### Know Your Rights

Under federal law, you are entitled to a safe workplace. Your employer must provide a workplace free of known health and safety hazards. If you have concerns, you have the right to speak up about them without fear of retaliation. You also have the right to:

- Be trained in a language you understand
- Work on machines that are safe
- Be provided required safety gear, such as gloves or a harness and lifeline for falls
- Be protected from toxic chemicals
- Request an OSHA inspection, and speak to the inspector
- Report an injury or illness, and get copies of your medical records
- See copies of the workplace injury and illness log
- Review records of work-related injuries and illnesses
- Get copies of test results done to find hazards in the workplace

## 1.5 Engineering

The term “engineering” commonly refers to a physical document, set of calculations, or blueprints that are prepared by a structural engineer to summarize a structural analysis for a tent system. This term is also used to describe a tent system that has been analyzed by a structural engineer and that engineering documentation exists for the product. The individual structural analysis can be conducted using a given set of parameters (often determined jointly by the tent manufacturer and structural engineer) in a generic form, or be conducted using parameters or requirements for a specific installation of a specific tent at a specific jobsite. The tent system’s manufacturer is the primary source for supplying this documentation and information.

Different Authorities Having Jurisdiction (AHJ's) have different requirements from city to city and state to state (See Codes and Compliance Section 1.6), so it is prudent to understand compliance needs prior to working with your manufacturer or independent engineer. The analysis of the tent system follows guidelines and equations for the analysis that are pulled from the building code. These guidelines and equations are used by the engineer to develop and simulate the loads that will be encountered by the tent system under use and check the individual components of the tent system to assure they will resist the loads encountered without failure.

The typical analysis will also provide reaction loads at the points where the tent system touches the ground. These reaction loads are often vector loads that include a vertical load and a horizontal load element. In layman's terms, these loads will represent the maximum forces that would be pushing down on a baseplate, pulling up on a baseplate, causing a baseplate to slide sideways, pulling on an external guy strap, etc., when the tent encounters full load forces. These forces need to be resisted for the entire system to function at full load.

While a tent system's engineering might represent a document to support a product's stability under load, not all engineering is equal. Different installations and different installation sites have tangible differences that make them unique. The following is a list of common variables or parameters that can affect the equations used for analysis:

#### **Building Code**

The actual building code determines the equations for evaluation. Thus, different building codes need to be analyzed separately. It is not uncommon to have jurisdictions in the same region with separate requirements for their building codes.

#### **Wind Speed**

The wind speed requirement has a large effect on the pressures and forces developed during analysis. Please note that individual jurisdictions have the ability to set their own requirements with respect to wind speed requirements.

#### **Exposure**

Different areas have different natural obstructions that can help reduce the effect of wind forces on a tent system. These areas are categorized in the following exposure values:

**Exposure B.** Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger. Exposure B shall be assumed unless the site meets the definition of another type.

**Exposure C.** Open terrain with scattered obstructions, including surface undulations or other irregularities, having heights generally less than 30 ft. ... this exposure shall also apply to any building located within Exposure B-type terrain where the building is directly adjacent to open areas of Exposure C-type terrain in any quadrant for a distance of more than 600 ft. This category includes flat open country, grasslands and shorelines in hurricane-prone regions.

**Exposure D.** Flat, unobstructed areas exposed to wind flowing over open water for a distance of at least one mile ... inland waterways, the Great Lakes and coastal areas of California, Oregon, Washington and Alaska. This exposure shall apply only to those buildings and other structures exposed to the wind coming from over the water ... extends inland 1,500 feet or 10 times the height of the building or structure, whichever is greater.

#### **Duration of Installation**

The actual length or duration of a tent installation can have an impact on the success or failure of a product to meet the engineering. Most building codes have specifications for how temporary structures should be handled versus permanent buildings. Under some building codes, allowances also exist to make reductions in loads based on the temporary nature of an installation and a correlated reduction in probability that a full code-requiring wind event will actually occur.

#### **Hanging Load**

The raising, or conversely reduction, of any loading specified for suspended equipment, lighting, etc., which can dramatically affect the performance of the tent system.

### Leg Height

Commonly, a tent structure is analyzed using a specific leg column height. It should be understood that raising a tent's leg column will have an effect on the overall loading encountered by the tent system. This increase in leg height can also dramatically decrease the allowable load that can be supported by the leg column. In other words, the longer the leg column, the less it can support. The alternative holds true when comparing a shorter leg. The shorter the leg the stiffer it becomes, and the greater its allowable capacity for support.

### Elevation of installation

Not all installation locations are alike and the engineering analysis is only valid for the conditions and parameters used for the specific engineering analysis. If a tent system has been analyzed in a generic format for installation on the ground, be assured that the loading encountered might be significantly different if the tent is installed on an elevated floor or elevated position such as a parking garage or rooftop.

## 1.6 Codes and Compliance

Each tent installation site location falls within a jurisdictional boundary that is administered by an Authority Having Jurisdiction (AHJ). These AHJ's can be Fire Marshals, Building Officials, city/township employees, state officials, government institutions, and many other individuals who enforce national/state/local ordinances and building codes in a specific geographic region. In some instances, there might be more than one AHJ that would cover a specific tent installation.

From the widest perspective, codes are created by large independent governing bodies on a national and sometimes regional level, like the International Code Council (ICC) in the United States, the National Research Council (NRC) in Canada and the European Committee for Standardization in Europe. In general terms, these organizations develop different codes which then are adopted by cities, states, and municipalities. As codes are adopted by a specific jurisdiction, they can be adapted to include special provisions encountered in a specific jurisdiction. Rarely will any local adaption lessen a requirement set forth in the original adoptive code, but often these changes will heighten a requirement to make it more stringent.

Once codes are adopted, it is the AHJ's responsibility to interpret and enforce the codes. In most situations, the AHJ's and their governing bodies will develop a plan check or permitting process to guide the tent installer through a process to obtain a permit. In some situations there might be multiple permits required from different AHJ's for a single installation. A particular installation might require a permit from a Fire Marshal, a permit from the Building and Safety Department, and possibly others. The process of permitting varies greatly from location to location as different AHJ's have different requirements, fees, and time frames.

It is essential for the installer of any tent to know and understand the code requirements for their installation site. It is also imperative to follow the procedures for construction set forth by the AHJ and follow and obtain any and all permits required for the installation of the tent.

## 1.7 Safety Inspections

### Introduction

This term can be applied to several different activities performed by a tent company:

- **Pre-site inspections**—these are covered in Chapter 2.2, entitled "Tent Site Evaluation". The safety aspect of this inspection is done to understand site conditions that so that alternative arrangements can be made that could not be accomplished if the site inspection was performed the same day as installation.
- **Day-of-setup safety inspection**—this is performed by the installer. His job is to review safety concerns raised during the pre-site inspection, and to lend a second set of eyes if an issue was discovered that needs to be dealt with before proceeding. This will include review of any marked underground utilities and confirmation that no overhead obstructions exist in the work area.

- **Ongoing safety inspection**—this is really the “quality control” aspect of the technical installation. A crew will often contain varied levels of skill from the crew chief to experienced installers to laborers, so the crew chief or designee should double-check the technical aspects of the structural elements. These include tenting, stage, raised flooring, electrical hookups, and anchoring. This double-check might discover any number of issues: for example, a lace that has been dropped on a large sectional pole tent, a pin which is not fully seated, inadequate cross bracing on a stage, or staking which needs to be augmented to provide the holding power that is appropriate for the site conditions, time of year, and length of time the tent will be in place.
- **Final Safety Inspection**—this is performed just before the completed job is turned over to the client and/or other contractors who might be doing decorating, etc. This is a good time to walk the site with the client, so you can point out the safety elements of the installation such as exit points, power runs, how to operate the generator or power distribution, and who to call if there is an emergency. This is very important so the tent company can stay ‘in the loop,’ rather than having someone try to fix a problem which they do not have the knowledge to attempt.

## 1.8 Evacuation Planning

The concept of evacuation planning speaks to the need for rental companies to cause their customer to arrange and execute an emergency evacuation plan for their events.

The tent rental company’s role in the emergency plan is to cause them to take this necessary action, as well as to ensure the client signs the rental store’s paperwork or rental agreement accepting the responsibility to protect the rental store should they ever be drawn into a lawsuit.

### Why is an Emergency Plan important to a tent rental company?

Follow this scenario:

- The customer calls for a tent
- The rental store delivers the tent
- Multiple subcontractors decorate the tent
- Several other service providers and company’s work under the tent
- The guests or public arrive
- The forecast is for severe weather
- Severe weather causes the tent to move, fall or blow around
- Damage occurs, including injuries and loss of life

The minute the damage includes injuries and lives lost, it sets a chain of events in motion which could include:

1. Emergency services are called into action including fire/rescue and police
2. Everyone is assessing blame
3. News stories with pictures and video make the TV in minutes
4. Radio stations and newspapers interview attendees and may not be entirely accurate
5. Social media can make videos and pictures viral almost immediately
6. Law firms seek out clients within 24 hours
7. Lawsuits are filed, which could last three to five years or longer in processing claims through the courts
8. News media replays the history as it updates steps in the legal process

In the lawyers’ mind, everyone involved with putting on the event is part of the chain of players, but only one company installed the tent. The tent company is the one in the chain of players who is easiest to find responsible. Yes, everyone in the planning and execution chain is connected in some way, but the person who contracted the rental company and the rental company itself are most directly tied to the reasons why the public was gathered around or under the tent before the severe weather event occurred.

Therefore, the tent rental company needs to clearly and cleanly transfer the responsibility for guest safety to the client's hands after they finish installing the tent.

The paperwork that serves to convey this responsibility includes two (2) documents. They are:

• **The Guideline for Planning Emergency Evacuation for a Tented Event**

This is a three-page document with two copies needed. The customer signs one, which is retained by the rental store. The second copy stays with the customer as a tool. This guide spells out the method and reason behind establishing an emergency plan.

• **The Checklist**

This two-page checklist, when filled out, turns the process from a concept into a planning tool or document. It names the key person who is responsible for planning and execution, taking into account the specific site and event variables. For a small event, this document might be confined to the customer holding the event. For large events, this document would likely be distributed between people or departments planning or executing it. In some larger events, the municipality or fire department where the event is held might require a copy of such a document so they will know the "go-to" person, should an emergency situation occur.

The most important aspect of the emergency planning by the rental store is to communicate the need for an evacuation plan to the customer and to transfer the responsibility of executing the evacuation plan to the client. The tent rental company should obtain their signature to the "Guideline for Planning" showing that they have properly informed the client of such need. This document can reside in the same place as a signed contract.

This way, if a catastrophic event occurs involving the public and your tent, you can look to the signed copy of what was provided to the customer to protect you from being expected to evacuate the tent, when you are not even there.



**Lollapalooza Evacuates Due to Storm Threat**



**Circus Tent Collapses Killing 2, Injuring 22**

# Guidelines for Developing an Emergency Evacuation Plan for a Tented Event

The rented tent will be erected to exacting standards to provide temporary accommodations for your event. Tents can provide protection from moderate weather, but are not designed for use as a shelter in severe weather because such conditions could exceed their ability to protect occupants. In addition, tents may need to be evacuated for other types of emergency situations.

It is your responsibility to ensure your guests' safety. The rental company recommends that you develop an emergency evacuation plan so you are prepared to act decisively in the event of an emergency during your event. Following are suggested guidelines for developing an emergency evacuation plan.

## Prior to the Event

### Point Person(s)

Designate someone who will be in charge of the emergency evacuation plan and on site for the entire event. The point person(s) will assist in developing the plan and be responsible during the event for monitoring the weather, determining whether a situation calls for evacuation, and if so, acting decisively and authoritatively to instruct guests to evacuate. The point person(s) can be an individual or a small group. For example:

- For a wedding: A family member, member of the wedding party, etc.
- For a corporate event: An event planner, company representative, etc.
- For a public event: A show manager, representative of the venue, the fire chief, etc.

These Guidelines for Developing an Emergency Evacuation Plan for a Tented Event (these "Guidelines") developed by the American Rental Association and ARA Insurance Services, Inc., a wholly owned subsidiary of the American Rental Association (collectively, the "ARA"), are intended to provide general guidance to assist you with emergency evacuation planning when using tents and related rental equipment. The ARA does not purport to include in these Guidelines all possible scenarios which may require evacuation or all possible safety measures and procedures that could be used in each evacuation scenario. You should use your own independent judgment and discretion in successfully implementing these Guidelines to best fit the unique needs of your event and your particular use of the tent and other rental equipment.

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## Emergency Conditions

Work with the point person(s) to determine the emergency conditions that will trigger an evacuation of the tent structure. Following are some examples of situations in which it is unsafe to remain in a tent:

Hazardous Situation	Why Evacuate
<b>Damaging winds</b>	The tent could collapse and injure occupants; the tent cannot protect occupants from flying debris.
<b>Fire or explosion</b>	The tent cannot protect occupants from excessive heat, flames or flying debris.
<b>Lightning</b>	Lightning poses a risk of electrocution, electric shock or fire.
<b>Hail or sleet</b>	Excessive weight could cause the tent to collapse and injure occupants.
<b>Excessive rainfall</b>	Saturation of ground with water may compromise securement. The tent could collapse and injure occupants.
<b>Flash flooding</b>	Saturation of ground with water may compromise securement. The tent could collapse and injure occupants.
<b>Snow accumulation</b>	Excessive weight could cause the tent to collapse and injure occupants.
<b>Ice storm</b>	Excessive weight could cause the tent to collapse and injure occupants.
<b>Gas leak</b>	Atmospheric conditions may not be suitable for occupants.
<b>Earth movement (e.g., tremor, landslide)</b>	Ground conditions may not be suitable for occupants and may compromise the tent's securement.

## Evacuation Location

Work with your point person(s) to predetermine where guests will go and how they will get there if the tent must be evacuated:

- Identify a nearby permanent building large enough to accommodate your guests, make sure it will be open and accessible during your event, and make a note of its address in case you have to call for emergency assistance. If there is no building nearby, consider using vehicles, an open area away from the tent or locations recommended by the National Weather Service or Emergency Alert System. Of utmost importance is that the tent should never be used as a shelter in an emergency situation.
- Determine how guests will get to the evacuation location (e.g., the route to take, travel by foot or car, etc.). Consider preparing a sketch of the event site.

## Communication

Plan how you will communicate with your guests in an emergency. Depending upon the size of the event, consider backup methods of communication for situations in which there is no electrical power, cellphone signals are interrupted, etc.

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## Prior to and During the Event

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### Weather Monitoring

Beginning at least two hours before the start of the event, the point person(s) should begin monitoring a source of weather information such as the National Weather Service. If any of the weather emergency conditions listed previously are predicted, you may need to postpone or cancel the event.

### Tent Structure

After the tent has been installed, monitor the tent structure for various changes. These would include stakes or augers pulling out of the ground; tent weights moving; loose poles, ropes or straps, etc. If you notice any of these occurring, contact the rental company immediately.

## During the Event

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### Announcement

Based on weather forecasts and other circumstances, you may wish to make an announcement to participants regarding the identification of the point person(s), location of exits and the emergency evacuation location.

### Evacuation

Continue to monitor the weather and be alert for other emergency situations during the event. Implement your evacuation plan for any of the following conditions:

- A severe weather alert is posted by the National Weather Service.
- Dark clouds are approaching.
- Lightning strikes within one mile (less than a five-second count between lightning and thunder).
- Hail or sleet falls.
- Twigs break from trees or large trees sway.
- Any of the tent anchoring devices fail or the tent begins to move (e.g., tent poles wobble, ropes snap, tent top rips or tears, etc.).
- Rain falls so hard it runs off tent walls in sheets.
- Water is running through the tent or surrounding area.
- Snow or ice is accumulating.
- An explosion, excessive heat, smoke or fire is in the vicinity of the event.
- There is ground movement of any kind.
- Other conditions exist as previously determined in developing your emergency plan.

### Call for Help

After instructing guests to evacuate, you may need to call for police, fire or medical help as the situation warrants.

## After an Evacuation

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Even if the tent appears intact, it may not be safe to return. If stakes or augers have pulled out of the ground, tent weights have moved, or there are loose poles, ropes or straps, contact the rental company so that the tent may be re-secured before resuming the event.

Accepted by (customer): \_\_\_\_\_

Reservation/Rental Contract number: \_\_\_\_\_

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# Checklist for Developing an Emergency Evacuation Plan for a Tented Event

This checklist can help in developing your emergency evacuation plan.

## Prior to the Event

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### Designated Point Person(s)

Name \_\_\_\_\_ Cell Number \_\_\_\_\_

Name \_\_\_\_\_ Cell Number \_\_\_\_\_

**Emergency Conditions** to be aware of (check what may apply to your region/seasonality):

- |   |  |  |
|---|--|--|
| <input type="checkbox"/> Lightning      | <input type="checkbox"/> Heavy rainfall    | <input type="checkbox"/> Ice storm         |
| <input type="checkbox"/> Hail or sleet  | <input type="checkbox"/> Flash flooding    | <input type="checkbox"/> Fire or explosion |
| <input type="checkbox"/> Damaging winds | <input type="checkbox"/> Snow accumulation | <input type="checkbox"/> Gas leak          |
| <input type="checkbox"/> Earth movement | <input type="checkbox"/> _____             | <input type="checkbox"/> _____             |

### Emergency Evacuation Location

Name \_\_\_\_\_ Phone No. \_\_\_\_\_

Location/address \_\_\_\_\_

Route to evacuation location \_\_\_\_\_

Confirmed the shelter will be open and available:  Yes  No

### Backup Method of Communication

PA  Cellphone  Walkie-talkie  Bullhorn Other \_\_\_\_\_

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## During the Event

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An initial announcement of location of emergency evacuation location will be made.

Yes     No

If yes, by whom: \_\_\_\_\_

### Weather Monitoring

Weather alert radio     Radio     TV     Cellphone app

### Evacuation Cues

During the event, implement your evacuation plan for any of the following conditions:

- A severe weather alert is posted by the National Weather Service.
- Dark clouds are approaching.
- Lightning strikes within one mile (less than a five-second count between lightning and thunder).
- Hail or sleet falls.
- Twigs break from trees or large trees sway.
- Any of the tent anchoring devices fail or the tent begins to move (e.g., tent poles wobble, ropes snap, tent top rips or tears, etc.).
- Rain falls so hard it runs off tent walls in sheets.
- Water is running through the tent or surrounding area.
- Snow or ice is accumulating.
- An explosion, excessive heat, smoke or fire is in the vicinity of the event.
- There is ground movement of any kind.
- Other conditions exist as previously determined in developing your emergency plan.

### Emergency Phone Numbers

Pre-program these numbers into your cellphone:

Fire Dept. 911 or \_\_\_\_\_      Police Dept. 911 or \_\_\_\_\_

Rental store \_\_\_\_\_      Venue \_\_\_\_\_

Event/wedding planner \_\_\_\_\_      Rental customer \_\_\_\_\_

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# Site Survey and Tent Placement

## 2.1 Overview

The site evaluation or inspection is the first of several critical steps in helping to ensure a safe tent rental function regardless of the complexity of the tenting equipment or overall event. A site visit is essential in order to obtain firsthand knowledge about the tent site. This will enable you to make accurate equipment and placement recommendations in a way that will best satisfy the client's needs.

Gathering all the appropriate information and location details during a thorough site visit can also help set you apart from your competition, as well as adding to your client's overall confidence level.

A site evaluation should be completed by a qualified professional such as a sales consultant, tent installer, crew chief or job foreman. In all cases the individual has to have a good understanding of what to look for at the site and how the proposed equipment will be laid out and used.

### The major objectives of a proper site evaluation

- Obtain all relevant information about the function/event with specific measurements and details in regard to the site and proposed equipment.
- Organize all information so that it can be an effective and clear means of communication for all parties involved. This includes (but is not limited to) the customer, sales, operations, crew chief and tent installers.
- Be certain that the appropriate equipment gets recommended to the client that is best suited to their location and function as well as making sure all the proper installation tools and equipment needed for the installation are detailed.
- Serve as a permanent record of the entire event which will serve as a great resource for possible future events at this site or other events in general.

## 2.2 Evaluating the Tent Site

### Safety First

Ensuring that every tent event is a safe event is really the overall goal of inspecting a site and completing a site evaluation. The following is a list of some of the important items that should receive consideration while conducting the site inspection and should be included in the individual rental company's Site Survey Checklist.

- Location of site
- Job Description (to include time of day and time of year the event is taking place)
- Job Profile (level of complexity of the overall job)
- Size (dimensions) of site with notation of obstacles for best placement of tent(s)
- Access to site
- Weather considerations
- Wind exposure
- Levelness of the tent site (See important information below on elevation variance)
- Obstructions
  1. Ground-level
  2. Above-ground
  3. Below-ground
- Type of ground surface (i.e. grass, blacktop, concrete, etc.)
- Condition/Stability of ground for drainage and proper anchoring
- Need for alternate anchoring or ballasting
- Proximity and possible connection to other structures at the site
- Adherence to relevant building and fire codes and regulations including need for type and quantity of exits, fire extinguishers, etc.
- Other considerations

### Tent Site Elevation Variance

One should always choose the most level tent location possible in order to ensure both a safe installation and practical use of the tent and accessories. It can be easy to overlook changes in elevation especially on very large job locations and where the change is gradual and over long distances. During the site visit it is of critical importance to carefully note these deviations in the terrain and to record them as accurately as possible in inches/feet. This is especially important when considering where tent structural components will be located including perimeter side poles, center poles, or gable uprights.

Special consideration needs to be given for ancillary items like tables, chairs, dance floors, and stages that generally need to be placed on a fairly level surface. If a tent is required to be fully floored with a level sub-structure it becomes very important to accurately measure the drop or rise of the ground so that the proper equipment is ordered and supplied to satisfy the customer's request. The degree of "unevenness" of the ground is a factor in determining whether adjustments are needed to be made to the site prior to the install to insure a safe job.

This can also be a factor in deciding what type of tent product should be recommended to the customer that will best satisfy their needs. Some tents are more suited for slight to moderate degrees of ground slope and are a better choice when it comes to ease of installation and overall job safety. For example, some of the traditional and trac style frame tents can come with adjustable uprights that account for unevenness in the ground where as the Clear Span Structures generally do not (other steps to level the base plates prior may be required).The need for other special equipment like custom length side or center poles, longer side walls, etc. should be noted as well. These considerations are all an integral part of the quotation process that after a careful site analysis clearly outlines in detail the proposed tent and other needed equipment.

# Site Survey Checklist

## LOCATION, SURFACE, UNDERGROUND & OVERHEAD

For simplification, just mark appropriate boxes. Function Date \_\_\_\_\_

Function \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

### Surface

- grass
- asphalt
- gravel
- concrete
- wood
- Level?  Yes  No
- Clear?  Yes  No (has constructions)
- Describe \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

### Underground (one answer minimum)

- electrical
- gas (including BBQ)
- telephone
- septic
- sprinklers
- pool lines
- none of the above

Describe \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

Person responsible for marking \_\_\_\_\_

Site Contact \_\_\_\_\_

Describe ground \_\_\_\_\_

*(i.e., hard, soft, sandy, clay, etc.)*

### Overhead (one answer minimum)

- electrical
- telephone
- trees/branches
- other
- none of the above

Describe \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

### Job Profile

- straightforward job
- technically difficult
- over trees
- attach to house
- cable for anchoring
- multiple levels
- over pool
- other

Describe \_\_\_\_\_

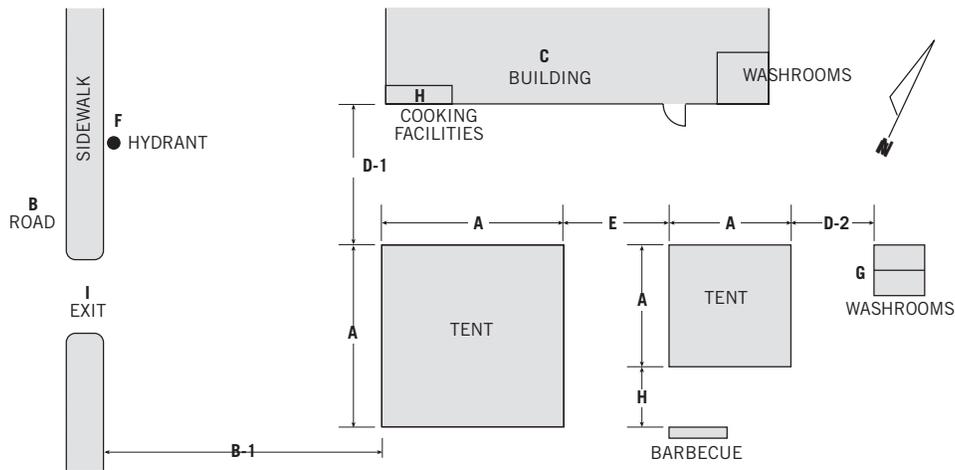
\_\_\_\_\_  
\_\_\_\_\_

### Special Equipment Considerations

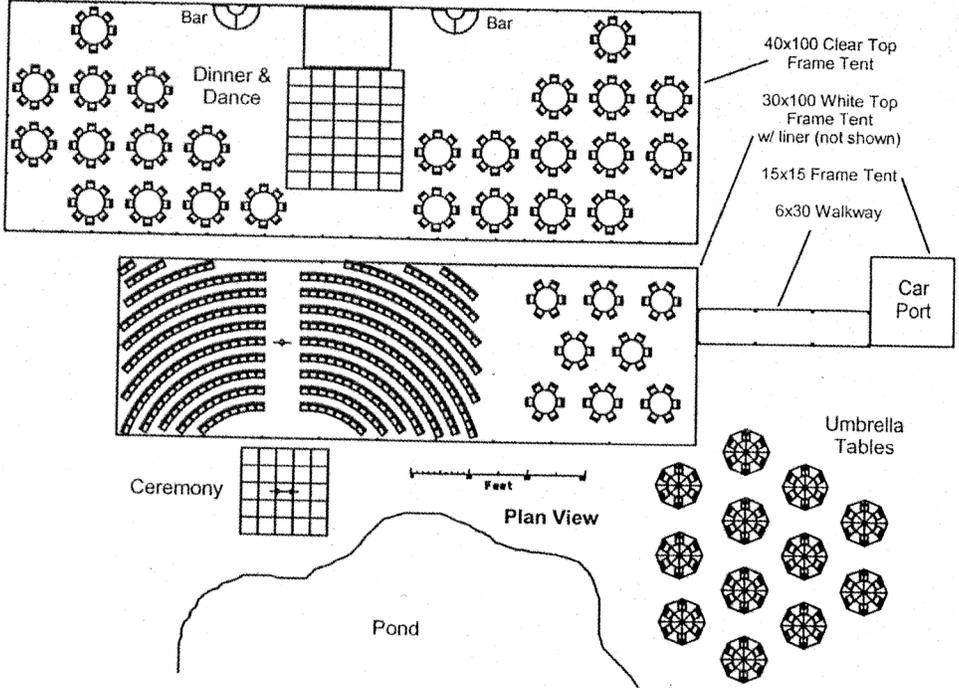
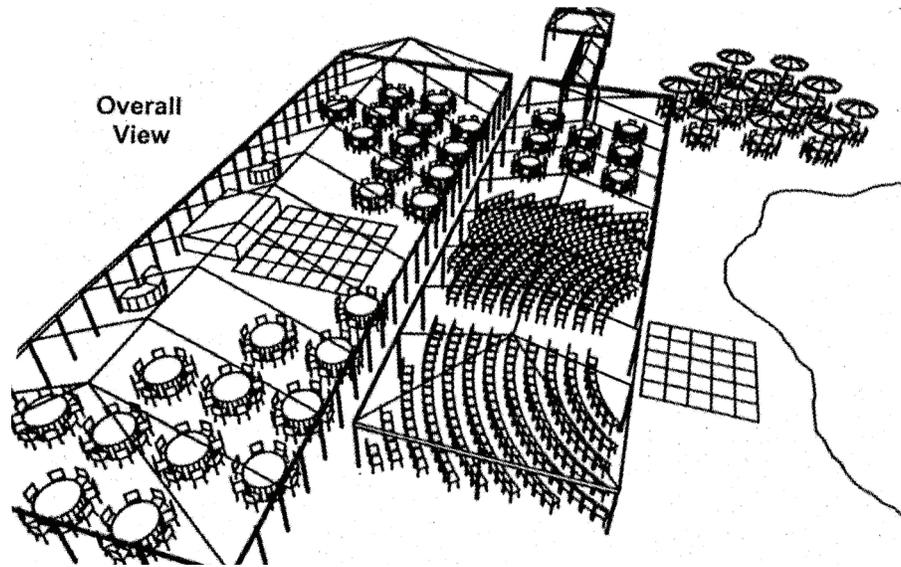
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

### Site Plan/Drawing

A detailed, scaled drawing of the tent site depicting the proposed equipment will assist both the rental company and the customer to accurately view all the important details and considerations for the event. This is a mandatory step in initiating clear communication with the customer and with the involved individuals within the rental company. Today a large percentage of companies will use a CAD software program to perform this function. There are huge advantages to this approach over the traditional paper and pencil when it comes to making modifications to the plan and/or making a more professional presentation. Furthermore, providing a detailed CAD drawing with the sales proposal helps gain your customer's confidence about your understanding of their needs and will increase your chances of earning their business. CAD programs specifically for the event industry are readily available in the marketplace today.



- A** Location of tent or tents (show sizes of tents)
- B** Roadways—give names. Note: Distance from sidewalks should be approximate
- C** Adjacent buildings—show exits and facilities if being used
- D** Dimensions between tent and adjacent buildings
- E** Dimensions between tents
- F** Location of fire hydrants
- G** Location of washrooms
- H** Locations of cooking facilities
- I** Fire route



**Notes:**

On larger events, it is often a good idea to use more than one piece of paper to show the plan, the overall view and snapshots of your design. Putting everything on one sheet, as here, may make for a crowded looking presentation.

## 2.3 Layout Procedures for Tent Structures

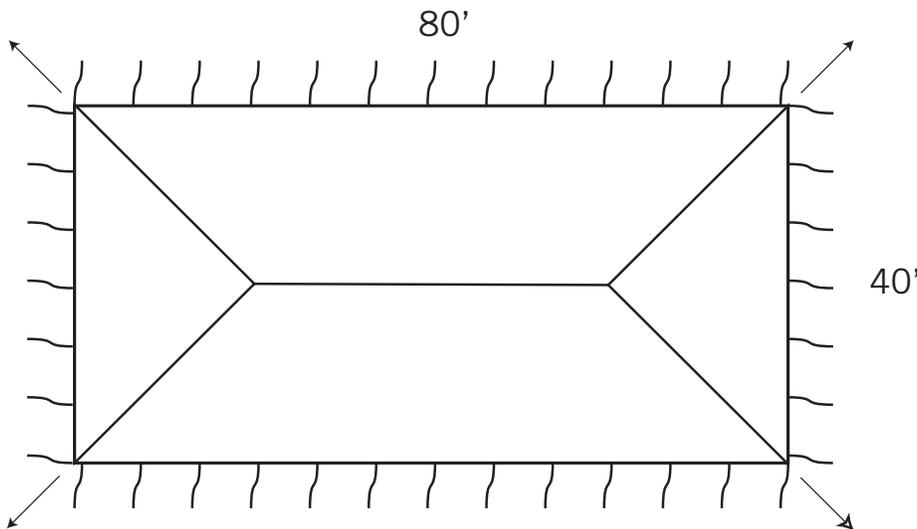
The purpose of this section is to provide the tent installer with the basic layout process for the different types of tents. Proper layout goes a long way in ensuring an overall efficient and safe tent installation, regardless of the type of tent product.

### Pole-Supported Tents (For Rope and Pole, and Tension Style)

#### Square-End Style Tents

##### Method I-“Traditional”

The traditional method of laying out the tent via stretching the tent vinyl prior to the staking process is still commonly used today, especially with smaller lightweight canopies, single-section tents, and some larger multi-piece or sectional tents. This process begins with placing the tent or tent sections on the ground in accordance with the site plan. If necessary, the tent sections are all laced together following the manufacturer’s installation instructions. Once the tent is fully laced, it is now necessary to completely stretch out the entire tent. The object is to make the perimeter of the tent as taut as possible by evenly pulling out all four corners of the tent.



Smaller tents can be stretched by pulling the corners simultaneously. Larger tents that contain more fabric and weight require a different method.

For larger multi-section tents, first place one end where desired; then drive a small stake near each corner where the tent can be temporarily secured via web or rope guy. After the tent is laced, proceed down the length of the tent (both sides simultaneously), stretching the tent out lengthwise. Proceed all the way to the other end, making sure as much slack as possible is pulled straight out. With this traditional method you are using your experienced eye to try to get the overall tent fabric to be in square as much as possible, but note that this is not a true squaring method which will be covered in the next section.

Once this process is completed the tent is now ready for staking. Starting with each corner, measure out the appropriate distances according to the manufacturer’s specifications. When all corners have been staked, run a string line from each corner stake to corner stake –all four corners (two per each corner) approximately 4” off the ground -- making sure the line is tight and forming a “box” around the entire tent perimeter. Now all of the other stakes can be set at perpendicular points from the side pole locations of the tent slightly outside of the string. It is important not to affect the line as you are setting all of the other stakes. Set all stakes prior to driving them so that the string is not accidentally broken in the driving process prior to the time that all stakes are accurately set.

**Method II-The Diagonal Method of Tent Squaring**

This has increasingly become the prescribed method for laying out all types of pole-supported tents as well as some frames, and certainly clear-span structures. The Diagonal Method is an essential procedure in truly squaring a tent. A properly squared tent is aesthetically more pleasing and structurally sound. Another benefit is that for the installer, it takes away the guess work and the need to have a very experienced eye. This step-by-step process is straightforward and easy to follow, and is highly recommended by the tent manufacturers as the initial step in the layout process for the majority of their tent products. It is often included in their installation and assembly instructions.

The big difference between this layout method and the “Traditional” method is that this process takes place prior to stretching out the fabric or laying out the poles, frame, structure, etc. Thus, you aren’t relying on the tent top to set the location of the stakes and poles. With large tent installations this gives you the option to measure out and even pre-stake a tent hours or day(s) before you start laying out the fabric. This can be a huge advantage when dealing with heavy rain or severe inclement weather by allowing you to keep the fabric protected from unnecessary exposure.

Most often, squaring a tent is performed by using diagonal measurements to find the four corner locations of the tent and then using this as the precursor to locating all the other pole and stake locations. It should also be noted that, if desired, one can use this same method to find the corner stake locations first and then all the other stake locations. This is referred to as squaring the “stake line” as opposed to squaring the actual tent fabric.

**The Diagonal Measurement**

Defined as the measurement from one corner diagonally across to the opposite corner of a tent location. Each size tent will have a different diagonal measurement and it is important to know how to determine this measurement. The formula for determining this diagonal measurement is the following:  $A^2 + B^2 = C^2$ , known as the Pythagorean Theorem.

The step-by-step process of squaring a tent, locating all four corners using the diagonal measurements, is below. Also below is a Matrix Chart that includes diagonal measurements for most size tents for your convenience.

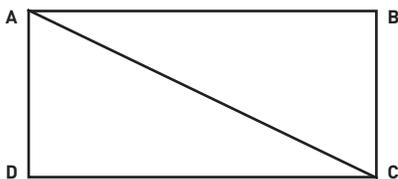
This is a very handy tool to provide your tent installers in the field, so they don’t always need to figure out the math on an install.

**SQUARE YOUR TENT!**

The numbers within the matrix are stated in measurements of feet and inches. They represent the exact diagonal measurement required to square a rectangular tent as chosen by the width and length.

**Here’s how to use this chart in the field:**

- Step 1:** Locate the corner of one end of the tent site, corners A and B.
- Step 2:** Secure the end of one tape measure exactly at Point A (Tape A) and then end of Another tape measure at Point B (Tape B).
- Step 3:** Using the matrix, determine the diagonal (where the desired width column and length row intersect.) Use Tape A for the diagonal measurement and Tape B
- Step 3:** for the desired length. Point C is located where the diagonal measurement (Tape A) and the length (Tape B) intersect. Next use Tape B as the diagonal measurement and Tape A as the length. Point D is located where the diagonal measurement (Tape B) and the length (Tape A) intersect.
- Step 4:** Check the distance between C and D to make sure it meets the desired width.



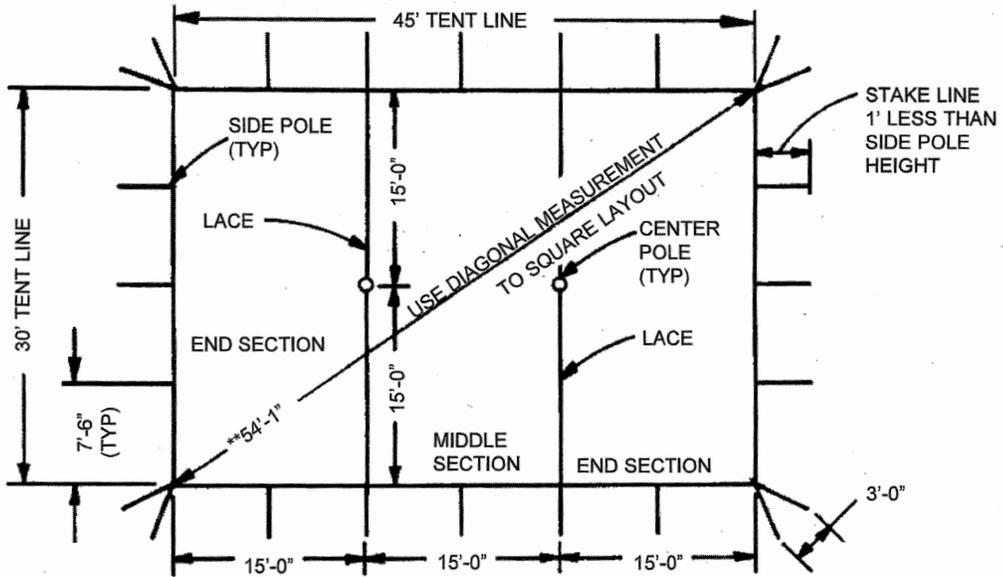
**Pole Tent Layout Matrix**

		WIDTH OF TENT								
		20'	30'	40'	50'	60'	70'	80'	90'	100'
		DIAGONAL MEASUREMENTS								
LENGTH OF TENT	20'	28-3	36-1	44-9	53-10	63-3	72-10	82-6	92-2	102-0
	30'	36-1	42-5	50-0	58-4	67-1	76-2	85-5	94-10	104-5
	40'	44-9	50-0	56-7	64-0	72-1	80-7	89-5	98-6	107-8
	45'	49-3	54-1	60-3	67-3	75-0	83-3	91-9	100-7	109-8
	50'	53-10	58-4	64-0	70-9	78-1	86-0	94-4	102-11	111-10
	60'	63-3	67-1	72-1	78-1	84-10	92-2	100-0	108-2	116-7
	70'	72-10	76-2	80-7	86-0	92-2	98-6	106-4	114-0	122-1
	75'	77-7	80-9	85-0	90-2	96-0	102-7	109-8	117-2	125-0
	80'	82-6	85-5	89-5	94-4	100-0	106-4	113-2	120-5	128-1
	90'	92-2	94-10	98-6	102-11	108-2	114-0	120-5	127-3	134-6
	100'	101-0	104-5	107-8	111-10	116-7	122-1	128-1	134-6	141-5
	110'	111-10	114-0	117-1	120-10	125-4	130-5	136-0	142-2	148-8
	120'	121-8	123-8	126-6	130-0	134-2	138-11	144-3	150-0	156-2
	130'	131-6	133-5	136-0	139-3	143-2	147-8	152-8	158-1	164-0
	140'	141-5	143-2	145-7	148-8	152-4	156-6	161-3	166-5	172-0
	150'	151-4	153-0	155-3	158-1	161-7	165-6	170-0	174-11	180-3
	160'	161-3	162-9	164-11	167-7	170-11	174-8	178-11	183-6	188-8
	170'	171-2	172-8	174-8	177-2	180-3	183-10	187-11	192-4	197-3
	180'	181-1	182-6	184-5	186-10	189-9	193-2	197-0	202-3	205-11
190'	191-1	192-4	194-2	196-6	199-3	202-6	206-2	210-3	214-9	
200'	201-0	202-3	204-0	206-2	208-10	211-11	215-5	219-4	223-7	
210'	211-0	212-2	213-9	215-10	218-5	221-4	224-8	228-6	232-7	
220'	221-0	222-0	223-7	225-7	228-0	230-10	234-1	237-8	241-8	

NUMBERS IN MATRIX ARE STATED AS FEET AND INCHES

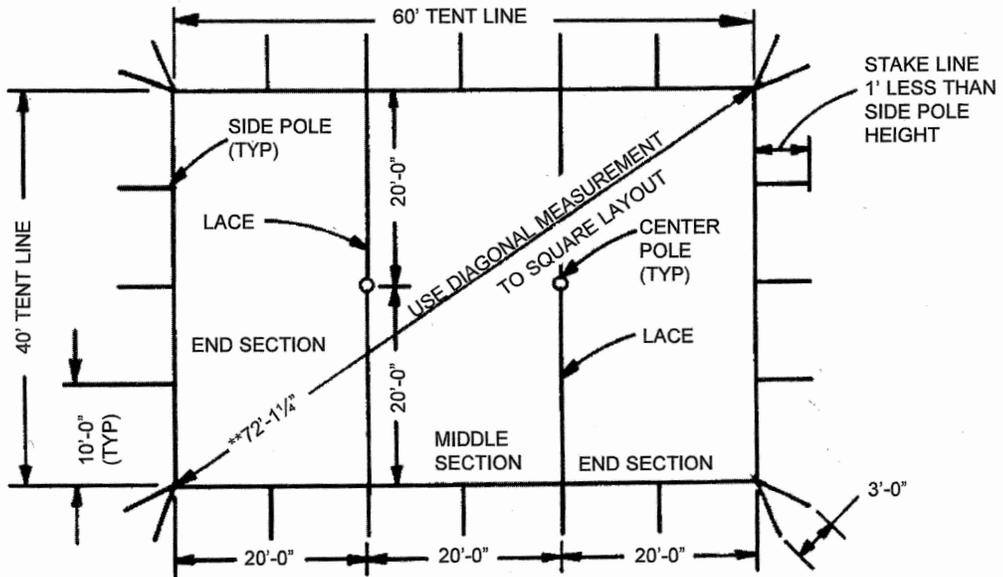
### 30' EXPANDABLE

30' X 45' used as an example.



### 40' EXPANDABLE

40' X 60' used as an example.



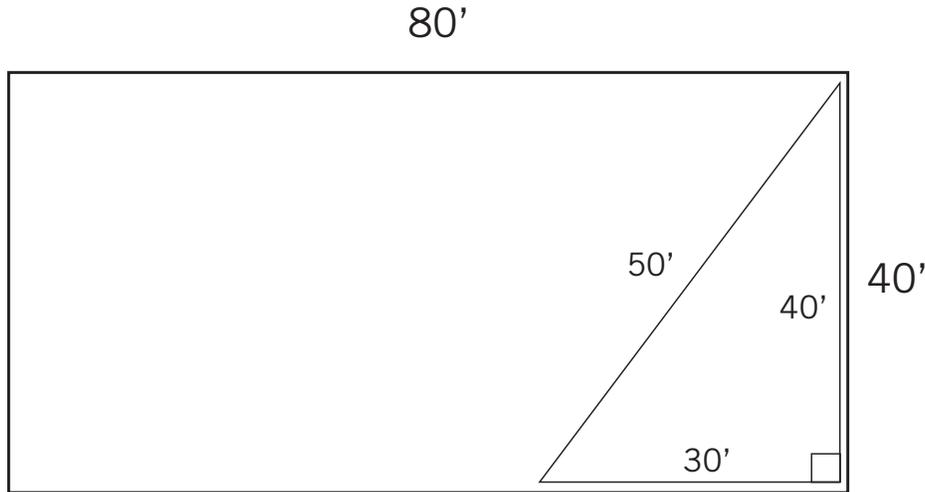
**The 3-4-5 Method**

There can be situations when a tent is just too long or wide and measuring for the diagonal is not practical. When this is the case, an alternative is the method known as the “3-4-5”.

This method uses the same triangulation, but on a much smaller scale. See the example below with a 40’w x 80’ tent as an example. Lay out the first two corners along the 40’ width.

This will become the “four” side. Next measure down the length 30’ which becomes the “three” side. The distance from this point back to the first corner should be 50’ (“five”). It may be necessary to move one or two of the points in order to achieve an accurate 3-4-5 triangle.

This method can be adapted to much larger tents quite easily.



**Note**

The Diagonal Measurement Method for squaring a tent is a great tool that should even be used during the Site Evaluation Process. This technique is a fail-safe method of determining truly accurate corner locations of the tent and most importantly will help you determine if the tent is going to fit in tight situations. Anyone involved in the measuring process and/or installation of tents should understand and be able to perform a Tent Square. All that is needed is two tape lines and the diagonal measurements (Matrix card) and something to mark the corner locations.

**Round-End Style Pole Tents**

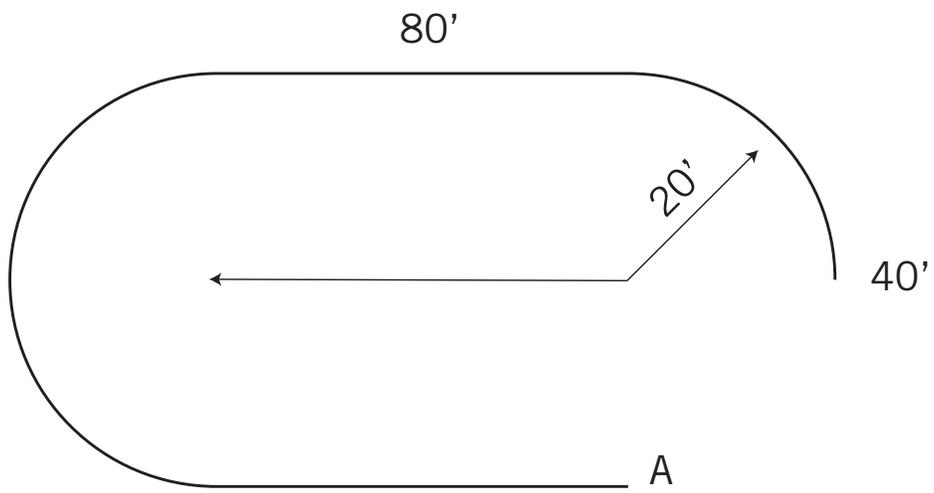
**Method 1-“Traditional”**

Stretching out a round-end tent uses virtually the same methods as a square-end tent except the tent should be stretched diagonally from the lace lines adjoining the end sections. After the middle sections are stretched out, pull the perimeter of the round ends. It is important not to “over” pull or the middles will be out of line. Remember, there will always be excess fabric left in the interior portion when finished.

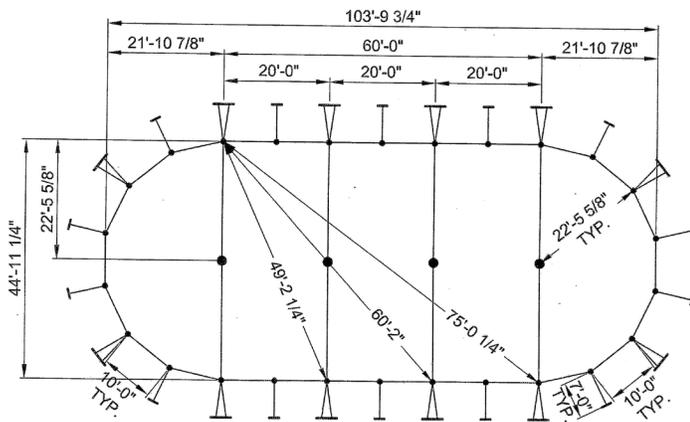
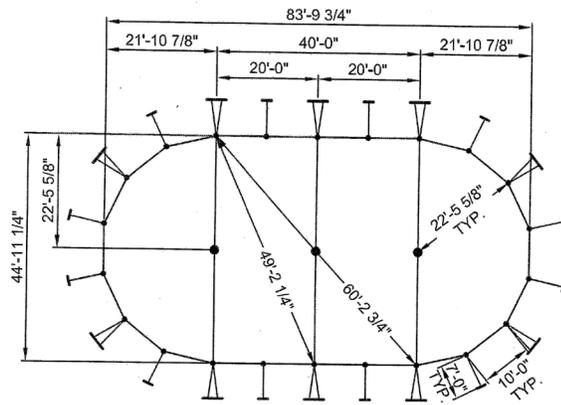
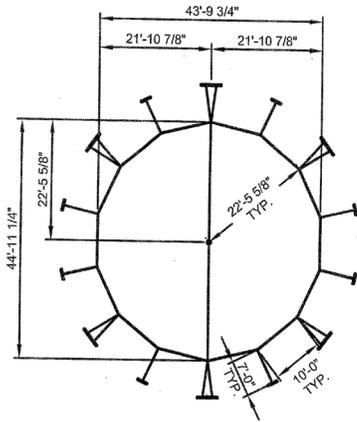
Staking a round-end tent using this traditional method is done also in a similar fashion to the square-end tent, making the appropriate adjustments for the placement of the stakes in line with the side pole locations on the round end.

**Method II - The Diagonal Method of Tent Squaring**

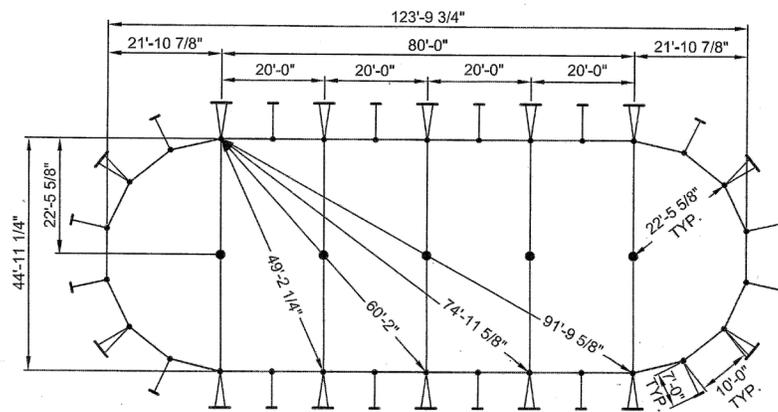
When measuring for a round-end tent, it is important to first square the middle sections using the diagonal method previously described. Establish the location of the end center pole (See Figure 7b) by measuring a distance equal to one-half the width of the tent from point A of the last lace line. Place the tape at that location and measure a half circle (arc) from one side to the other side recreating the perimeter of the round end. When the tent perimeter has been established, proceed to place the stakes and poles as determined by the manufacturer's instructions for appropriate spacing.



Manufacturers of round-end style tents usually offer a special installation cable layout set that assists the installer in laying out both the side poles and stakes for the round ends. Generally, the above method is utilized for squaring the middle sections of the tent. Then the cable tool is set at the end of the squared box and rotated around the axis to determine the location of the poles and anchor locations.



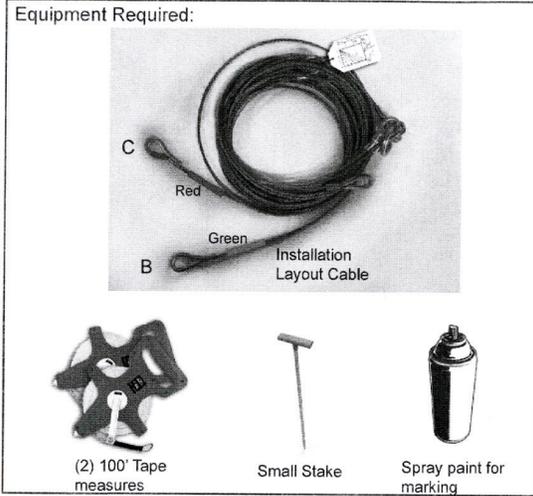
**Note:** Layouts shown for 8'-0" side pole height. Stake guys out at 1'-0" less than side pole height.



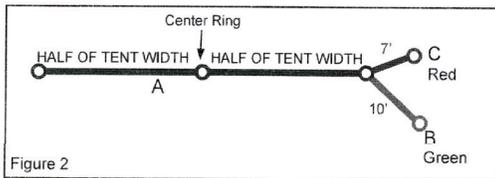
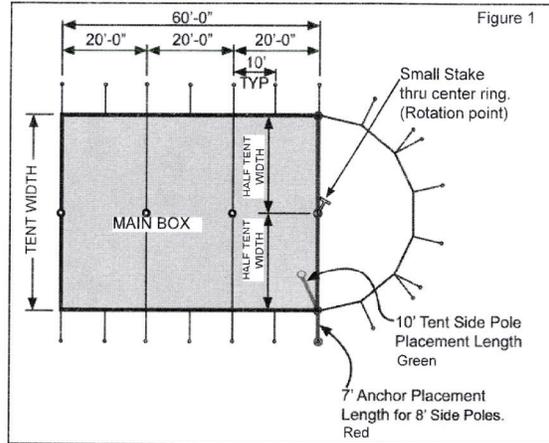
### Sample for Roundend Tents

Manpower Required: 2

Equipment Required:



1. Start by squaring the MAIN BOX of the tent. Use the laminated card on the cable jig for diagonal dimensions for each box size.



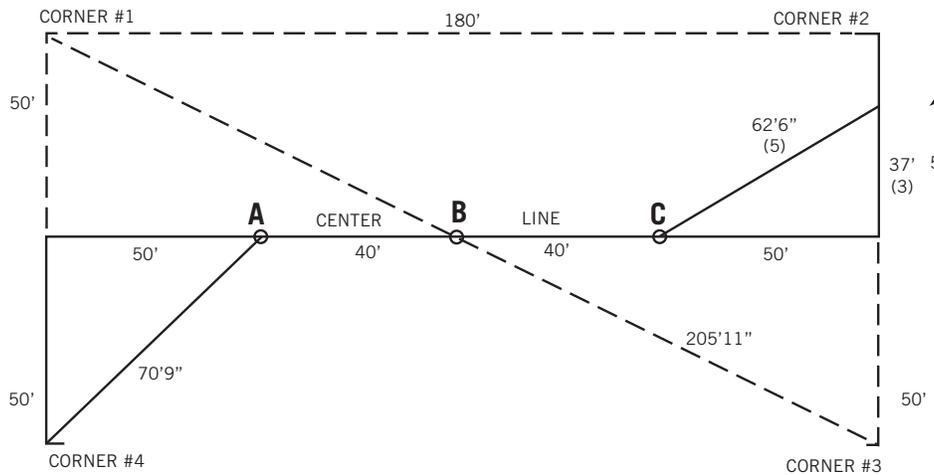
**Bail-Ring Style Tents**

For bail-ring supported tents, the pre-staking method of layout is recommended because of the importance of positioning the center pole bases in exactly the correct location and because of the significant size of most bail-ring tents.

There are generally two preferred systems to properly layout a bail-ring style tent. The first is to determine the center line of the tent and work off the center pole positions to determine the corner locations. The second is to locate the corner positions and to use them to determine where the center poles need to be. In both cases it is crucial to carefully determine the center pole and corner pole base positions to allow the tent to go up easily and to be pulled out square. Note that round-end tents require use of the first method, finding the center line and center pole positions and then determining the side pole positions at the lace lines. After this is accomplished one can follow the rest of the layout instructions for round-end tents.

**Center Line Method**

First, determine the center line of the tent. Then, measure to determine the actual location of the bases of the center poles (See Figure 36). Once a center line has been established, mark the center pole locations (A, B, C, etc.) so they are centered exactly at the sectional lace lines. If the center poles are too far apart, the bail-rings will not pull up easily or to their full extent. If the center poles are too close together, the ridge line will not pull out and the tent will not have the correct pitch to facilitate drainage and maintain structural integrity.

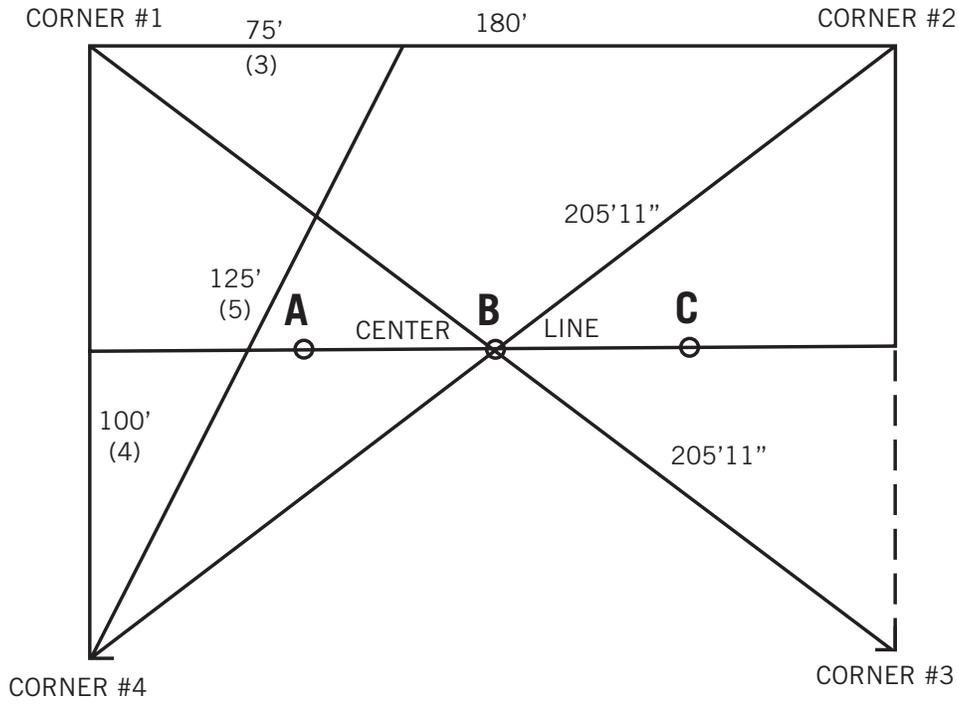


Then measure out at each end of the tent to establish the perimeter of the tent itself. From these points, find the four corners of the tent by using the diagonal measurement or the 3-4-5 method. Once the four corners are established, it is recommended that they be double-checked by measuring the distance between corner poles 1 and 3 and between corner poles 2 and 4. The perimeter of the tent is now established.

**Perimeter Method**

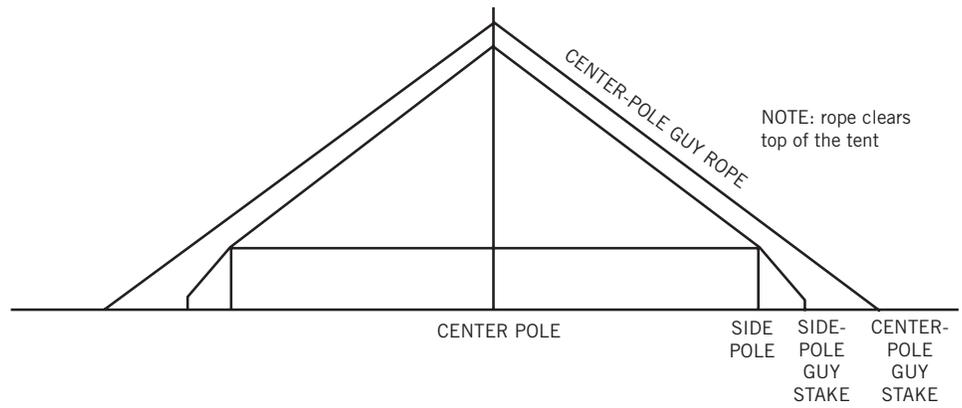
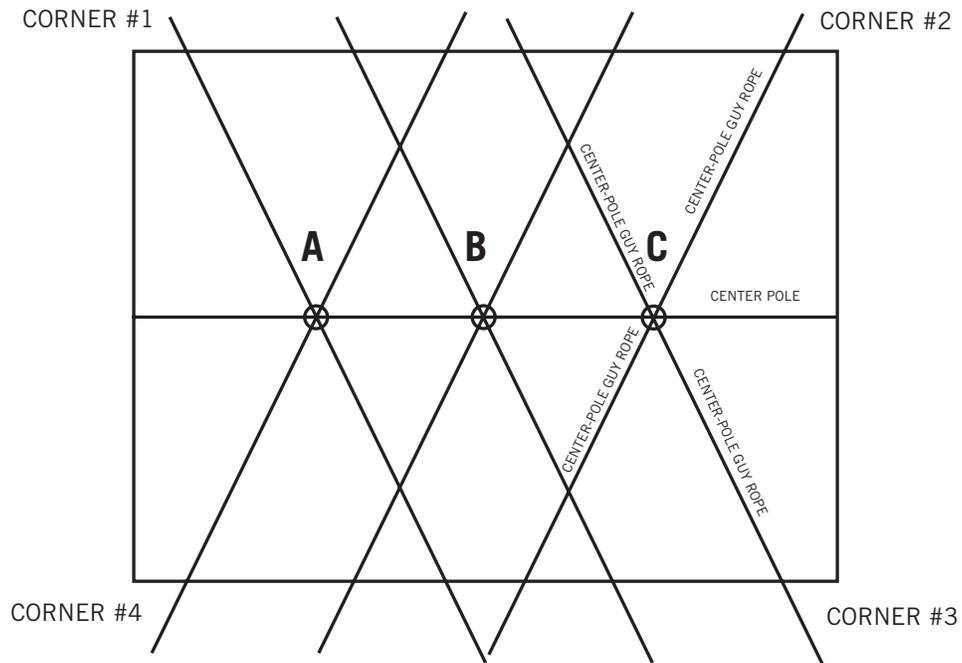
Determine a starting corner pole point and then another corner pole location to determine a side.

From these points, using either the diagonal or 3-4-5 method, locate the 3rd and 4th corner pole locations (See Figure 37). Again, verify accuracy by measuring the diagonals. Once all the corners have been determined, measure to the center points of the two end sides and run a tape measure down the center line. Measure out the center pole base points along this line and mark them.



Once the perimeter and the center pole points of the tent have been established, stakes can be set at the appropriate distances specified by the manufacturer.

In addition to the stakes corresponding to the side poles for this tent, it is also necessary to drive stakes for the center pole guy ropes. These stakes are traditionally placed to give support in all four directions and are far enough outside the perimeter stakes so that, when the poles are vertical, the center pole guy ropes are not laying on the tent top. (See Figure 38 and 39).



**Frame Tents -- Non-Track and Track Style**

The general layout procedure for this type of tent is fairly similar across the different product lines.

However, it is always best to lay out the tent in accordance with the specific manufacturer's instructions. In general terms, this begins with laying all frame components on the ground in the approximate location that they will be when the frame is assembled. On very large sizes of these products it is always a good idea to first square the overall area, marking the corner and all other upright positions, so that all other corresponding frame components can efficiently be laid out in the correct positions.

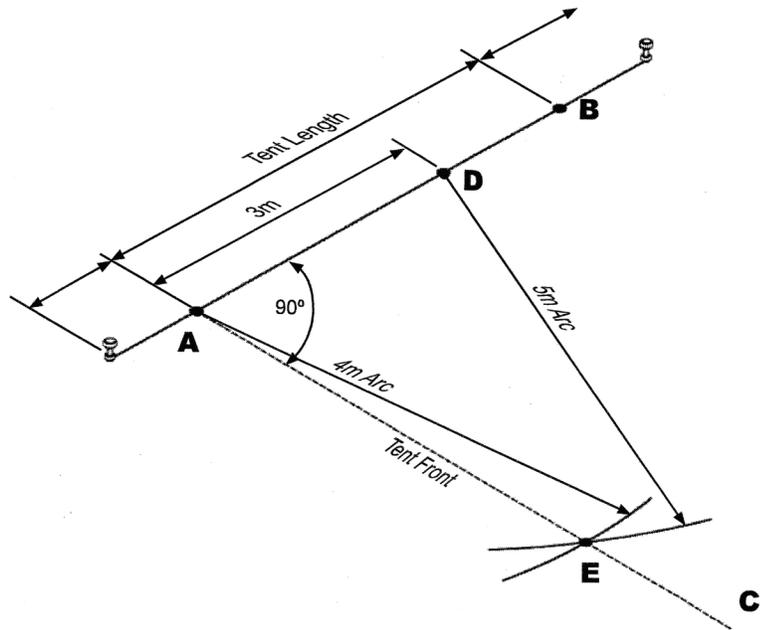
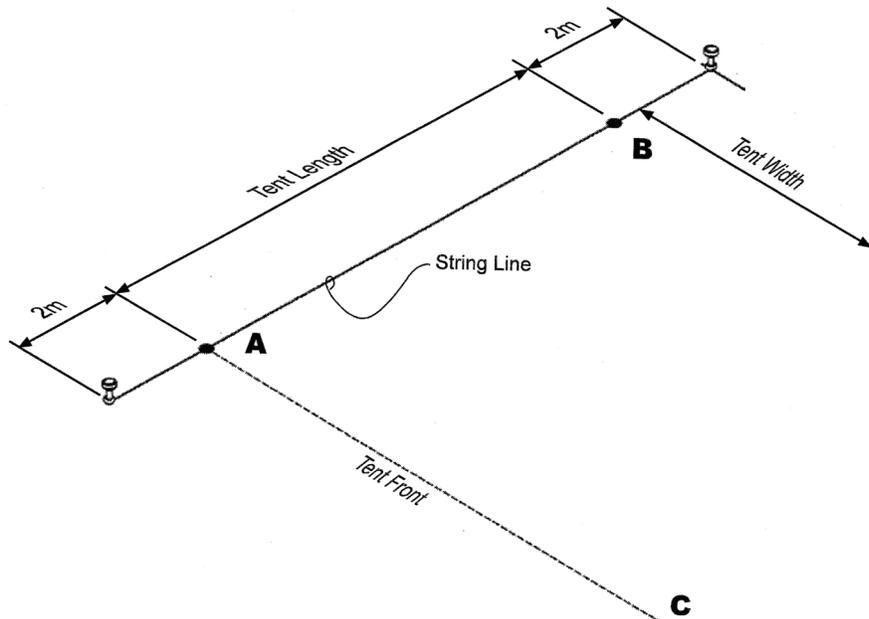
More precision is generally required with Track Style frames, especially in the larger sizes (40' and up), because exact upright locations become more critical. The tent fabric slides through channels in the rafters which have to be on the right center dimensions. This is a big factor when it comes to ease of pulling the fabric through the channels in the frame. Thus, squaring this type of tent and marking all the base plate locations of the uprights will definitely aid in the overall installation process.

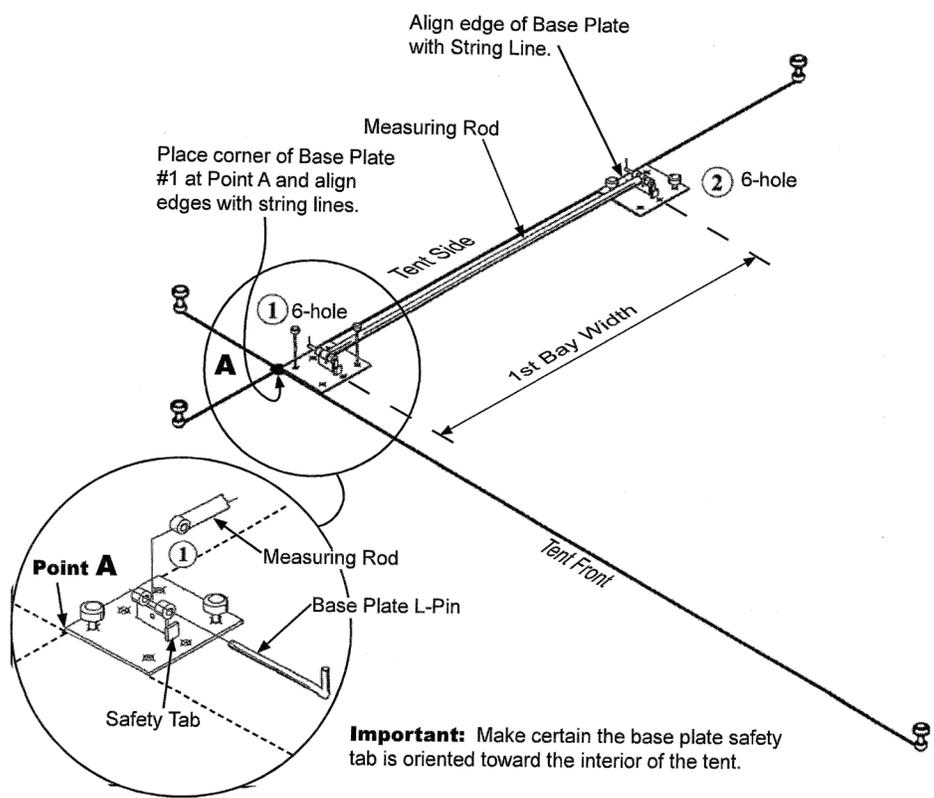
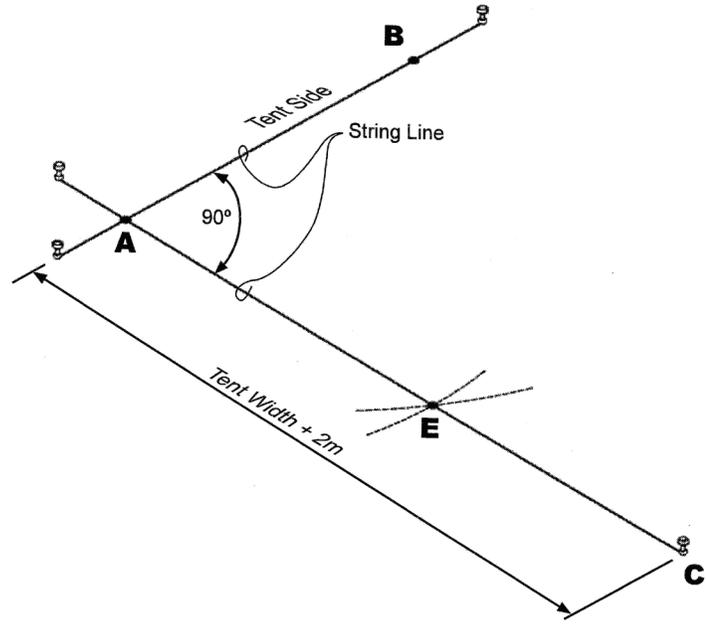
**Clear-span Structures**

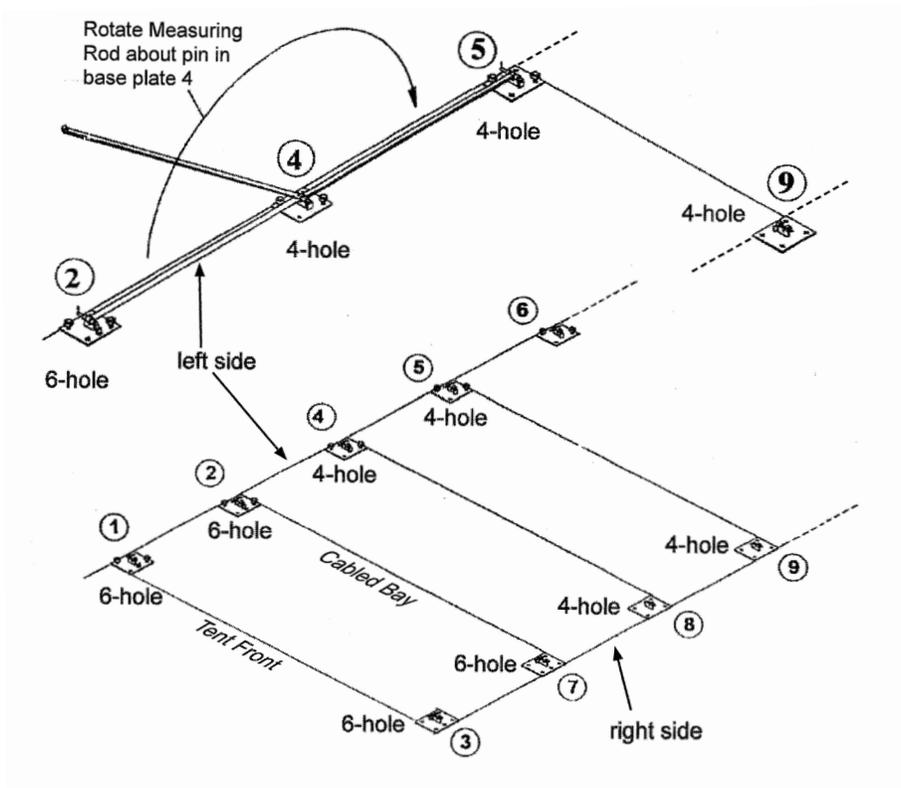
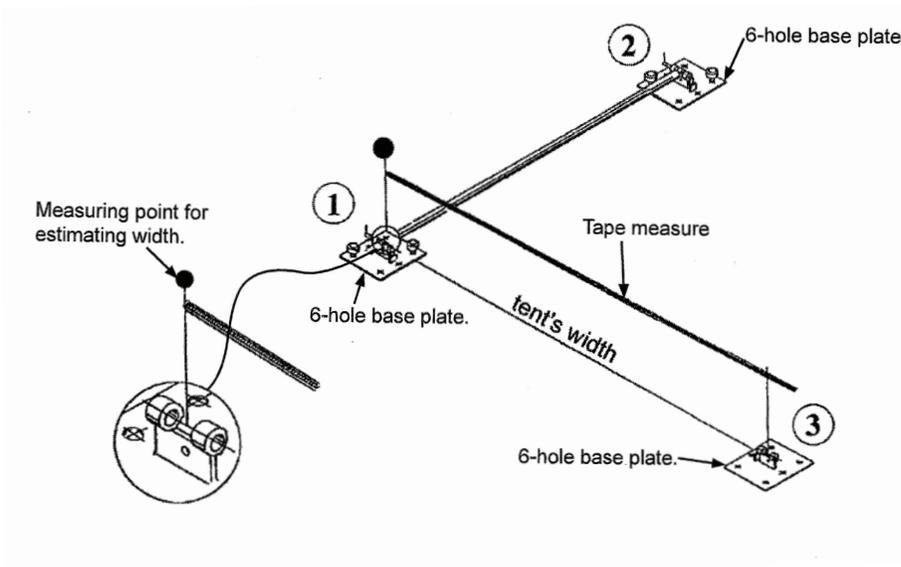
It is imperative that the Clear-span is fully measured out, and done so with precision. The design of this tent is such that the base plates of the structure take all the loading straight down, so they be properly located in the correct positions. Also like the Track Style Frames, the fabric slides through channels in the rafters and must be located on the center of each bay.

First, the overall location of the structure is measured out and squared using the diagonal measurement technique. Once the first corner of the structure is located, run a measuring tape or string line from this corner down the length of one side of the tent. Temporarily secure the first corner plate. Place the remainder of the base plates down this first side by using a spacing bar usually provided by the manufacturer. Temporarily mark or stake all base plates as you go so they don't inadvertently move out of place.

Next, determine the other two corner base plates by using the 3-4-5 Method or the full diagonal measurement. Run a string line between these two corner base plates and set the remaining base plates along this side using the spacing bar. It is always a good idea to check diagonal measurements as you go for individual bays. Have the diagonal dimensions figured out ahead of time so you can easily check them on the job as you go. This is especially important on sloping ground as you may have to re-measure and make adjustments. Unlike a Pole Style Tent, there is very little tolerance for being off, thus it is important to take your time, and if needed, measure again.







**Safety Inspection**

After completing the layout of any tent structure it is always best to perform a Safety Inspection before moving on to the next step of the tent installation.

If the tent fabric is already laid out check the surface thoroughly making sure there are no rips, tears, or defects in the fabric, paying special attention to seams and weld locations. Check all hardware, grommets, webbing, cables, etc. for any signs of fatigue or deterioration. Inspect each web guy/rope for fraying or mechanism issues. Also, take a good look at any of the other equipment already laid out for any problems with pipe or frame components. If stakes are already driven, make sure they are driven in the appropriate locations and at the appropriate depths.

Should any irregularities be noticed, stop and repair or replace the needed sections or parts. Failure to do so could compromise the overall process and structural integrity of the tent.

Whatever layout method is used, the manufacturer's instructions should always be followed. Those instructions take precedence over any conflicting information that may be contained in this manual. In the event of a conflict please first follow the manufacturer's instructions and all warnings.

## 3.1 Overview

This part of the handbook addresses anchoring the tent to the ground on which it sits. Generally speaking, a tent can be anchored to the ground in two ways: either by penetrating the ground surface with stakes, augers or cables, or by attaching to ballast (s) which sit on the ground and use their weight to counteract the forces being applied to the tent. A tent will not remain erect unless it is properly anchored to the ground on which it sits. Anchoring involves attaching sufficiently strong ropes or straps between the tent and the anchor system, whether it is a stake or a ballast system.

The adequacy of such anchoring is fundamental to the safe and proper function of a tent. For example, when a tent is subjected to the forces of wind, it takes on a new shape. This new shape significantly affects the forces which the anchor system must resist in order to keep the tent from collapsing.

The manufacturer's instructions must be followed and take precedence over any conflicting instructions that may be contained in this manual. In the event of a conflict, follow the manufacturer's instructions and warnings.

### SAFETY FACTORS

In order to account for the inevitable uncertainties which occur in the design, manufacture, installation, and use of structures of all kinds, safety factors must be employed. There is always at least a small chance that the loads imposed on a tent stake (or tent anchor in general) will exceed its ability to resist that load.

For example, if test data indicates that a stake has a 1000-pound capacity at a certain pull angle, and if the tent guy rope load has been determined to be 500 pounds acting at the same angle (and in the same kind of soil) then:

$$SF = \frac{1000\#}{500\#} = 2.0$$

In conventional building design the normal safety factor is approximately 1.7. For wind, this figure is approximately 1.3.

For tents, practice varies, but most industry groups feel that a safety factor of somewhere between 1.5 and 2.0 is appropriate for staking.

Stake failure can occur in two primary ways:

- The first way to fail is in tension. Here the resisting frictional forces between the soil and the stake are insufficient to keep the stake from yielding to pull-out forces along its axis.
- The second most common way for a tent stake to fail results when the sideways force imposed by the stake against the surrounding soil is greater than the soil can push back; so the soil yields by bulging up above the surface. Consequently, the stake simply pushes the unconfined soil out of its path.

The most common tent stake, which is a slender cylindrical shaft of steel, must be regularly, easily, and economically installed, removed, and reinstalled.

The ground conditions in which the tent stake must perform its function are not a constant. These variables will cause the same stakes on the same tent to perform differently depending upon the following:

1. Soil (geological—possibly) variations
2. Water table variations—month-to-month and seasonal
3. Surface and subsurface variations and man-made disturbances
4. Paved sites

By soil variations, we mean those site factors which arise from the fact that a tent will usually be installed at many different sites. For example, tent stakes installed in clay will not perform in the same way when installed in sand. The water table is relatively close to the ground surface in many parts of the world. Where this is true, month-to-month and seasonal variations can mean the difference between staking a tent in soil that is saturated one day and dry the next.

When we refer to surface and subsurface variations and man-made disturbances, we are referring to alterations in the subsurface which would not be apparent to the tent installer when he inspects the site. For example, a site that had been used for dumping refuse or debris would have underlying soil of unknown (and probably non-uniform) properties.

Another example involves a site that has been altered by bringing in fill material to raise the surface. This kind of site is suspect because of the unknown quality of compaction which was accomplished when the fill material was added.

Many tent installations occur on asphalt-paved or compacted stone upper crusts. This kind of upper crust has a significant effect on the performance of the stake.

### 3.2 A Systematic Approach to Staking

Here we lay the groundwork for a systematic approach to staking of the tent. This involves, primarily, two general activities:

- The first activity focuses on developing a systematic approach to staking which necessitates a discussion of the general engineering principles at work in the performance of a tent stake.
- The second activity concerns the evolution of a method for obtaining, accumulating, correlating, and presenting data on stake performance. In time a large bank of data will be developed that will be reliable and, consequently, will take much of the guesswork out of the process.

By equipping the tent installer with these two types of technical information, tent staking safety should be enhanced.

#### Engineering principles

This section of the chapter presents a general explanation of some of the engineering principles which relate to establishing the best stake position for a tent.

#### The larger the stake diameter, the greater the holding power.

Logic would seem to dictate that the larger the stake diameter, the greater the holding capacity of the stake. (See Figure 8). Stake capacity is a direct function of stake diameter.

In the first place, a larger diameter stake will displace more earth as it is driven in than the smaller stake. (See Figure 9). This greater compaction should produce greater soil pressure against the side of the stake. This greater sideways pressure will increase the friction acting along the sides of the stake and provide more resistance to pullout due to stake tension. Since the sideways earth pressure on the stake is directly proportional to the surface area of the stake, there is more resistance to stake pullout due to tension in the larger diameter stake. Finally, when a stake pushes laterally against the earth due to sideways pull of the guy rope, a pressure results.

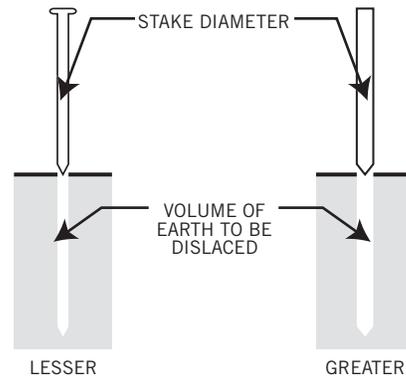


Figure 8. Stake Performance & Volume of Displaced Earth

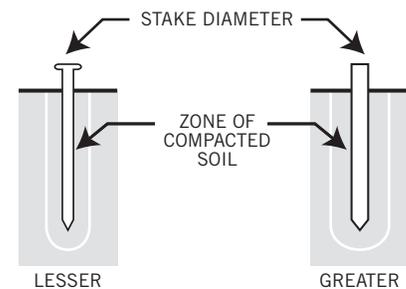


Figure 9. Stake Performance & Zone of Displaced Earth

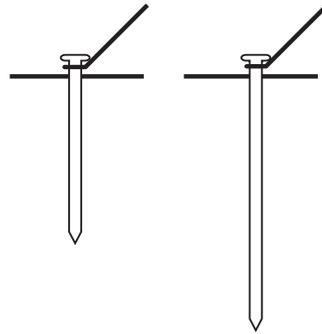
**The deeper the stake, the greater the holding power.**

Stake pullout strength is directly related to stake depth. See Figures 10 and 11. This is true for several good engineering reasons.

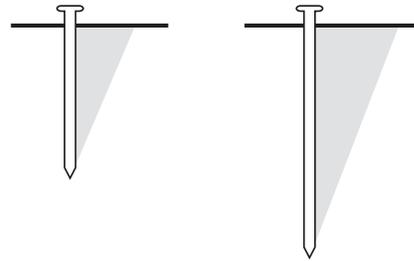
- Greater surface area
- Soil pressure usually increases with depth
- Larger soil wedge (bulb)

The holding capacity of a tent stake is due to a significant degree to friction developed between the stake and the soil which surrounds it. It follows that the deeper the embedment of the stake in the soil, the greater the surface area of the stake which is in contact with the soil; thus the greater the holding power. Therefore the deeper the tent stake, the more the earth presses up against the stake and produces greater forces, which increases its holding power.

The sideways component of forces on the tent stake, produced because of the angle of the guy rope, is resisted by a wedge of earth in front of it. This wedge of earth deepens the farther into the earth the stake is driven. The larger the wedge (bulb), the more sideways resistance it exerts to keep the stake from failing by pulling over.



*Figure 10. Stake Holding Power and Stake Depth*



*Figure 11. Soil Wedge(Bulb) Size and Sideways Resistance*

**Optimum guy rope angle provides optimum holding power.**

A number of factors must be taken into account in the process of finding the right angle in any given situation. (See Figure 14.) Significant factors include:

- Tent geometry—unloaded
  - Tent geometry—wind factor
  - Tent geometry—ponding factor
  - Presence or absence of sidewalls
  - Soil type
  - Ground moisture
  - Presence or absence of pavement
  - Need to keep side poles in compression
- Note: When staking against wind lift forces, the guy rope must be at an angle that will keep the side poles from jumping. Consequently, the stake should be located relatively closer to the tent. A pull angle of 45 degrees produces vertical forces on the stake which are equal to the lateral forces. At 45 degrees or slightly steeper, the pole tent could reasonably be expected to withstand the forces of wind uplift while maintaining a balance between vertical and lateral stake forces. If alternate side pole heights are used, that should be taken into account in maintaining proper guy rope angles. (See figure 14.)

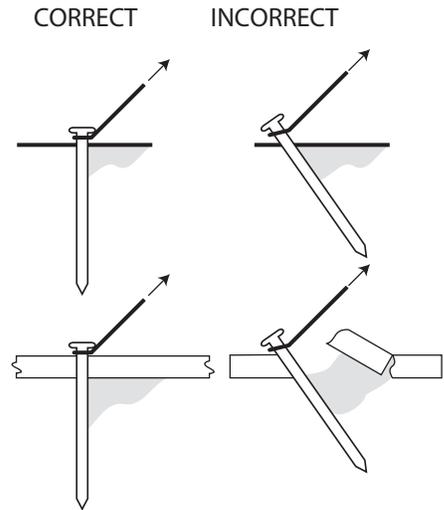


Figure 13. Stake Driving Angle

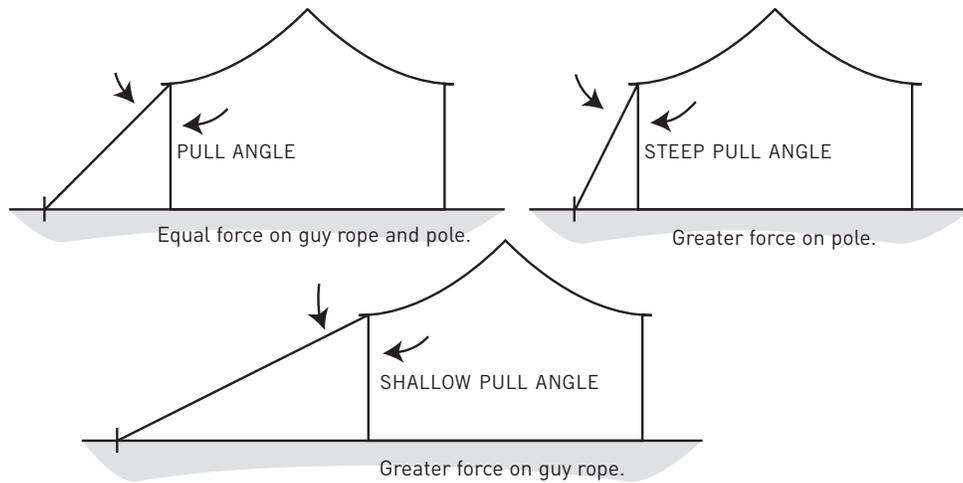


Figure 14. Pull Angles and Stake Location

**Increasing the height of the stake knot above the ground decreases stake holding capacity.**

The overturning moment generated on the stake varies with the distance above the ground where the guy rope is secured to the stake. (See Figure 15). The greater this distance, the greater the overturning moment on the stake. It is absolutely essential that the guy rope be kept as low as possible on the stake, not higher than two or three inches, to minimize the overturning moment.

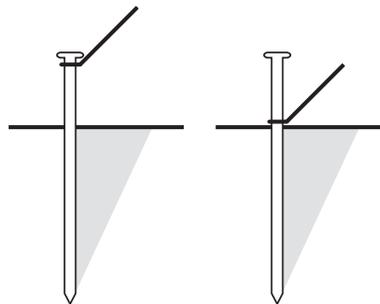


Figure 15. Stake Knot Height

**Holding power varies with anchor types.**

The basic straight shaft, steel “nail head” type of tent stake is the basis of most of the discussion in this chapter. Several other types are in common use throughout the industry. (See Figure 16.) Aside from the simple straight shaft stakes, most others function on the general “deadman” principle of gathering a cone or similar block of heavy earth above the projecting element on the stake, thereby impeding pullout. These have the potential of generating much greater holding power.

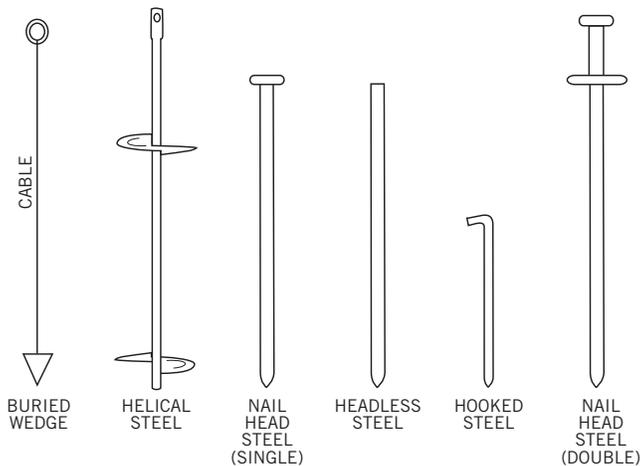


Figure 16. Various Tent Stakes

## ESTIMATING PULLOUT CAPACITY OF TENT STAKES

A method for estimating pullout capacity for tent stakes is described in this section. The method is based on results of 489 stake pullout tests which were conducted at nine different field sites. A detailed report describing test details, results and additional methods for estimating capacity can be obtained from the IFAI Tent Rental Division.

### Pullout Capacity for a Single Stake

The method estimates the stake pullout capacity for a “baseline” stake, and then applies correction factors for conditions that vary from the baseline case. The baseline case for a tent stake is as follows:

1. Stake diameter is 1.0 inch
2. The side of the stake is smooth
3. The steel stake is driven vertically
4. The stake is embedded (driven) 36 inches into the ground
5. The load is fastened at two inches above the ground surface, and
6. The load is pulled at a 45-degree angle.

### Estimates of Pullout Capacity for Baseline Case

Strength of the soil is an important detail in estimating pullout capacity. The penetration resistance offered by the tent stake during installation provides a rough estimate for the strength of the soil and is based on the average penetration of the stake per blow (for the first 20 inches of embedment) with a 16 lb. sledge hanger using a normal swing. The table below provides a rough relation- ship between penetration resistance, soil consistency, and pullout capacity for a baseline case.

**Table 1. Simple Method for Estimating Pullout Capacity for Baseline Case**

Consistency	Field Identification*		Pullout Capacity for Baseline Case, P (lbs)
	Soil Resistance	Stake Penetration Resistance (inches per blow**)	
Hard (Very Dense)	Indented with difficulty by thumbnail	less than 0/2"	2500
Very Stiff (Dense)	Readily indented by thumbnail	0.2-0.5"	1600
Stiff (Medium-Dense)	Readily indented by thumb but penetrated only with great effort	0.5-1.5"	800
Medium (Medium)	Can be penetrated several inches by thumb with moderate effort	1.5-3"	400
Soft (Loose)	Easily penetrated several inches by thumb	3-6"	200
Very Soft (Very Loose)	Easily penetrated several inches by fist	greater than 6"	100

\*note - Field identification is subjective. For fine-grained soils, use both the verbal description and the inches per blow to select the appropriate consistency of soil in determining the baseline capacity. For coarse-grained soils, use the penetration per blow to assess soil consistency.

\*\*note - Stake Penetration Resistance is based on the average penetration of the stake per blow with a 16 lb. sledge hammer with a normal swing.

Two important details and cautionary notes about using Table 1 for estimating capacity are:

1. Table 1 requires a subjective measure (Stake Penetration Resistance) for estimating pullout capacity. More accurate and precise methods available and are given in the IFAI Tent Staking Report. However, the more accurate methods require greater effort for determining soil strength.
2. Table 1 provides a relationship between driving resistance and baseline stake capacity for the soil conditions at the time of driving. If the stake is driven during dry conditions, and then the ground becomes saturated, a loss of soil strength and pullout capacity will result. The loss of soil strength is not possible to predict with confidence without an extensive soil testing or stake pullout testing program. However, results from the IFAI tent staking study indicate that the pullout capacity of stakes driven in saturated ground are about one-half the capacity of the stakes driven in the same ground under dry conditions.

**Adjusting Estimated Capacity for Conditions Different than Baseline Case**

The pullout capacity for a stake that is different from the baseline case can be estimated as the baseline capacity multiplied by factors that adjust for the variation in conditions from the baseline (such as a different stake embedment, stake inclination, stake diameter, fastening height, and pull angle). The pullout capacity for the stake can be determined as the baseline capacity, multiplied by the appropriate adjustment factors as follows:

$$P = P_b \times C_e \times C_f \times C_i \times C_l \times C_d < 2500 \text{ lbs}$$

Where P = pullout capacity for a single stake, P<sub>b</sub> = pullout capacity for a standard stake (the baseline case), C<sub>e</sub> = correction factor for embedment depth, C<sub>f</sub> = correction factor for fastening height, C<sub>i</sub> = correction factor for stake inclination, C<sub>l</sub> = correction factor for load angle, and C<sub>d</sub> = correction factor for stake diameter. The appropriate correction factors can be obtained from the tables below.

**Correction Factor for Embedment**

Stake Embedment (in)	C <sub>e</sub>
36	1.00
34	0.92
32	0.84
30	0.76
28	0.69
26	0.61
24	0.54

**Correction Factor for Fastening Height**

Fastening Height (in)	C <sub>f</sub>
2	1.00
4	0.98
6	0.98
8	0.94
8	0.92
12	0.90

**Correction Factor for Stake Inclination**

Stake Inclination	C <sub>i</sub>
for stake angle from 0 to 15 degrees	1.00
for stake angle = 30 degrees	0.77

**Correction Factor for Load Angle**

Angle of Pull (from horizontal)	C <sub>l</sub>
45 degrees (1H:1V)	1.00
53 degrees (2H:3V)	0.85

**Correction Factor for Stake Diameter**

Stake Diameter (in)	C <sub>d</sub>
1.000	1.0
1.125	1.1

Results of the testing program showed no significant difference in pullout capacity between 1-inch diameter steel stakes with smooth sides and a 1-inch diameter steel stake with ribs for most pullout tests. However, structural yielding in the ribbed stakes occurred at pullout loads lower than the smooth steel stakes because of the difference in the structural strength. Accordingly, the pullout capacity of ribbed stakes should be limited to a pullout capacity no greater than 1600 lbs

### 3.3 Alternate Staking Methods

Some popular methods may be employed generally for increasing staking capacity.

#### Double Staking

Double staking is the practice of driving another stake a short distance behind the primary stake and close-tying both stakes together with the free end of the guy rope. Triple and/or quadruple staking may also be used in applying the same concept.

The stake in Figure 17 is loaded to the point where it is on the verge of failing. But as it creeps forward, and at the same time rises as if to pull out, the close-tie to the secondary stake tightens. At this point, the secondary stake resists the tendency for the primary to move sideways or up.

Note the void which has developed behind the primary stake in Figure 18, which depicts various staking errors.

If the secondary stake is too close to the primary stake, it will have only limited side-load resistance since the earth in front of it will collapse forward into the void. On the other hand, if the secondary stake is too far away from the primary stake, the close-tie will be fairly long and may actually allow the primary stake to pull free which is undesirable. See Figure 18. A rule of thumb for double staking suggests that the distance between stakes be equal to one-third of the depth of the stake in the ground.

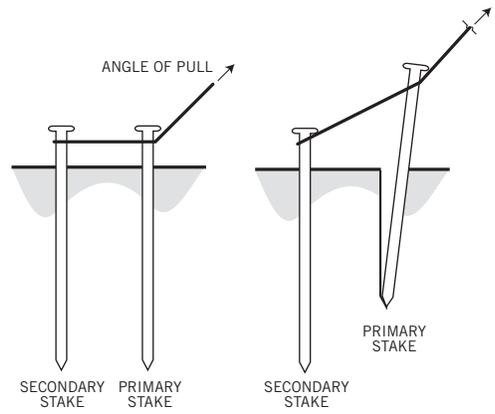


Figure 17. Double Staking

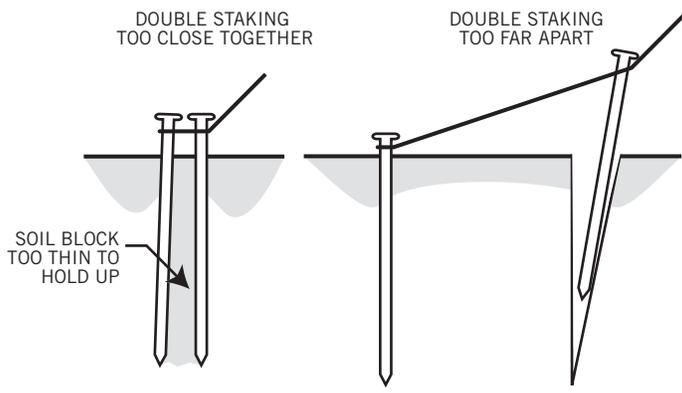


Figure 18. Double Staking Errors

### Gang Staking

A staking technique related to double staking, in that it also increases staking capacity, is called gang staking. There are several different techniques.

These involve the use of a rigid ground plate or bar with holes punched in it for the stakes. This is schematically shown in Figures 19 and 20.

Multiple staking methods will probably grow in popularity as designs meeting specific higher wind speed criteria are required.

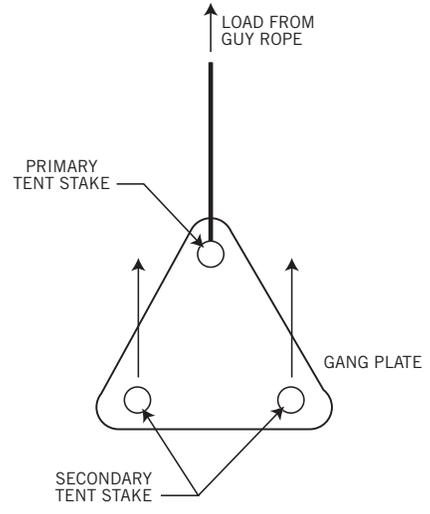


Figure 19. Gang Staking

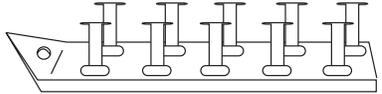
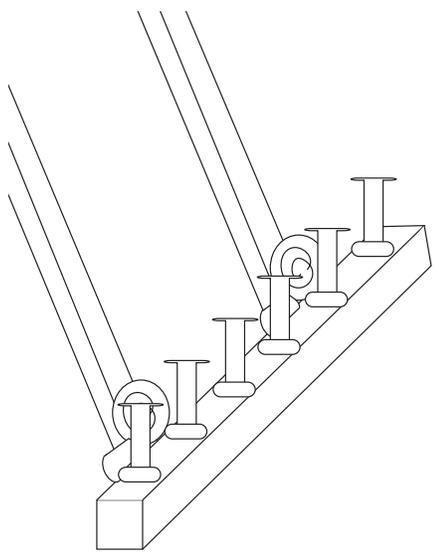


Figure 20. Stake bar & gang plate

### Determination of Capacity for Group Stakes

The pullout capacity of group stakes can be estimated by multiplying the baseline capacity of a single stake by an “effectiveness factor” as follows:

$$P_g = P_b \times E_f$$

Where  $P_g$  is the capacity of the stake group,  $P_b$  is the pullout capacity for a single stake under baseline conditions, and  $E_f$  is the effectiveness factor for the group of stakes. The effectiveness factors for a group of stakes can be determined using the table below.

**Table 2. Effectiveness factor for Group**

Group Configuration	Effectiveness Factor
Double Staking	1.22
Three Stakes installed in a line perpendicular to direction of pull	2.76
Three Stakes installed in a line perpendicular to direction of pull, stakes are inclined at 15 degrees	2.46
Six Stakes installed in a line perpendicular to direction of pull	4.68
Four Stakes installed in two columns and two rows and connected with a gang plate	3.48
Six Stakes installed in two columns and three rows and connected with a gang plate	4.56

Table 2 requires the stakes in the group to satisfy the conditions set for the baseline case.

Figure 25 states the importance of following manufacturer’s instructions and warnings.

The manufacturer’s instructions must be followed. Those instructions take precedence over any conflicting instructions that may be contained in this manual. In the event of a conflict, follow the manufacturer’s instructions and warnings.

*Figure 25. Manufacturer’s Instructions*

### 3.4 Ballasting

Ballasting can be accomplished in multiple ways:

1. Weight can be positioned on top of a plate that is attached to the baseplate of the tent.
2. Weight can be attached via a web and ratchet or rope to the eave of a tent.
3. Weight can be attached to both the baseplate and attached via a web and ratchet or rope to the eave of the tent.
4. Weight can be positioned on top of a plate that is attached to the eave of the tent via a web and ratchet or rope to the eave of the tent.

A number of factors have to be considered in order to properly ballast a tent:

1. Type of tent and configuration required
2. Ground type or surface condition
3. Required load for the tent
4. Type and geometry of ballast to be used

**Factors to Consider When Determining the Required Load for the Tent**

The load can be obtained from:

- 1. Manufacturer of tent. Manufacturer’s written guidance supersedes all other recommendations.
- 2. Engineering Certification or respective codes.

**Ballasts and Ground Surfaces**

Ground Type and Surface Conditions Tested:

- 1. Asphalt (dry and wet)
- 2. Smooth concrete (dry and wet)
- 3. Rough concrete (dry and wet)
- 4. Grass (dry and wet)
- 5. Dirt (dry and wet)
- 6. Gravel (dry and wet)

The ballasts under investigation included:

- 1. Plastic water barrels (least effective means of ballasting)
- 2. Steel drum filled with concrete
- 3. Plastic barrels filled with concrete
- 4. Concrete block

Several surface modifiers were considered between ballast and ground:

- 1. Steel plate
- 2. Plywood
- 3. Rubber mat
- 4. Neoprene pad

**Safety Factors**

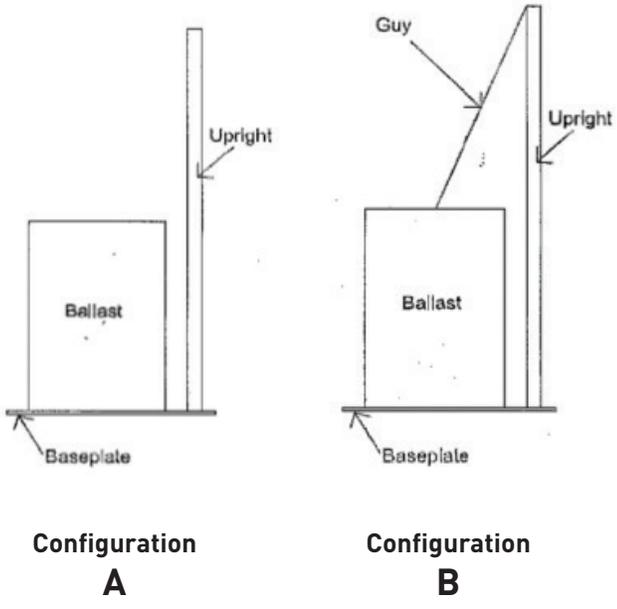
In order to account for the inevitable uncertainties which occur in the design, manufacture, installation, and use of structures of all kinds, safety factors must be employed. There is always at least a small chance that the loads imposed on tent ballast in general will exceed its ability to resist that load. For example, if test data indicates that the load capacity at a certain pull angle, and if the tent guy rope load has been determined to be 500 pounds acting at the same angle then: in conventional building design, the normal safety factor is approximately 1.7. For wind, the safety factor is approximately 1.3. For tents, practice varies. But most industrial groups feel that a safety factor of somewhere between 1.5 and 2.0 is appropriate for ballasting.

**Ballast Configurations that are in Practice Today**

**Description:** Ballast plate attached to the base plate-upright assembly. Ballast(s) on top of ballast plate with ballast plate on surface. Only the horizontal and vertical reaction forces are considered.

**Usage:** Tents with base plates (not to be confused with ballast plates) that do not require guy out for structural stability.

**Tents:** Clearspan.



**Configuration A: Clearspan**

Configuration A consists of a steel plate connected to the upright with the ballast completely above the plate.

Among all columns (uprights) of the tent and all the loading conditions, the study identified the worst case corresponding to the greatest horizontal reaction force  $F_X$ .

1. The study identified the surface on which the tents are located.
2. The study identified the type of surface contact.
3. The study determined the friction coefficient.
4. The study determined the total ballast weight, using an established formula.

**Description:** Ballast plate attached to base-upright assembly for tents that require both guy attached to the eave at a specific angle and a base plate for installation. Reaction forces horizontal, vertical and guy tension are all considered.

**Usage:** Tents that require both base plates for anchorage and guy out for structural stability.

**Tents:** Frame, Tilt-Up or Hybrid Frame

**Configuration B: Frame and Clearspan**

Among all columns (uprights) of the tent and all loading conditions, identify the worst case corresponding to the greatest internal force  $F_1$ .

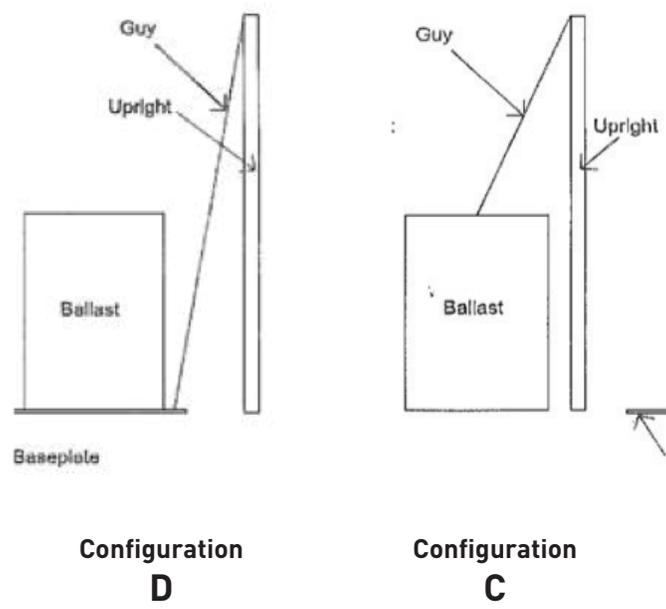
**Notes:**

1. The study identified the surfaces on which the tents are located.
2. The study identified the configuration (case A, B, C), ballast type and intermediate layer.
3. The study determined the friction coefficient.
4. The study determined the total ballast weight.

**Description:** Guy attached to eave of tent at a specific angle directly attached to ballast(s) with ballast(s) on surface. Guy tension is the only reaction force considered.

**Usage:** Tents that generally derive their structural stability and anchorage from the eave of the tent.

**Tents:** Frame and Pole



**Configuration C: Frame and Pole Supported Tent**

Among all columns (uprights) of the tent and all loading conditions, identify the worst case corresponding to the greatest tension force T.

1. The study determined the friction factor, C for a given guy angle “a”.
2. The study determined the total ballast weight following the ballasting equation.

**Description:** Guy attached to eave of tent at a (specific) angle then attached to the leading edge of a ballast plate with ballast(s) on top and plate on surface but not attached to upright. Guy tension is the only reaction force considered.

**Usage:** Tents that generally derive their structural stability and anchorage from the eave of the tent and when ballast plate usage is desired or where Configuration C proves impractical because of the number of ballast units required.

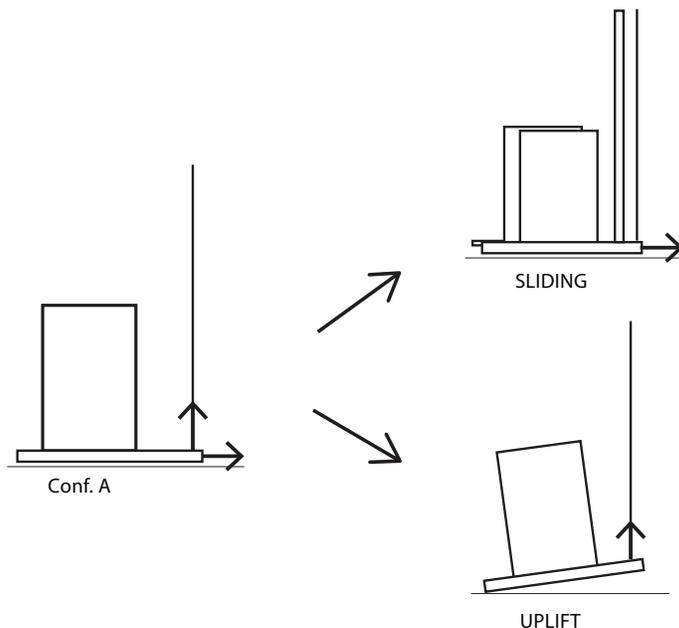
**Tents:** Frame and Pole

**Configuration D: Frame and Pole Supported Tent**

Among all columns (uprights) of the tent and all loading conditions, identify the worst case corresponding to the greatest friction force Ff.

### Failure Modes for Each Configuration

**Important Note:** Ballast failure is any movement from its installed position.



The first failure mode corresponds to the plate sliding on the ground. When this occurs, the friction force equals the overall force perpendicular to the ground multiplied by the friction coefficient.

The second failure mode corresponds to the plate lifting off the ground. Figure 11 shows the corresponding free-body diagram. Lifting of the plate occurs when the moment of the lifting force about point A equals the moment of the ballast weight about point A.

The third failure mode corresponds to the ballast sliding on the plate or on the ground surface on which it sits.

The fourth failure mode corresponds with the ballast tilting on the plate or tilting on the ground surface on which it sits.

### Type and Geometry of the Ballast Being Used

Each of the surface types is reported separately for the various ballast/modifier and dry/wet combinations.

#### Observations: Asphalt Surface

The modifiers are improvements on the steel plate. Rigid ballasts, such as steel barrel and concrete blocks (without modifiers or platforms), perform the best. Dry and wet variations are not significant. When a modifier is used under the steel plate, sliding occurs between the modifier and the plate, which suggests that the resistance coefficient between the modifier and the ground surface is greater than the resistance coefficient between the modifier and the plate. This is confirmed by the large resistance coefficient of plywood on asphalt compared to plywood under a steel plate. Therefore, one recommendation is to rigidly connect the plywood and all other modifiers to the steel plate.

#### Guidelines

Modifiers and rigid ballasts > plywood direct > steel plate direct > plastic barrel

**Observations: Smooth Concrete**

Rubber and neoprene modifiers demonstrated significant improvement over other combinations. Dry/wet variations had some impact on rigid ballasts only. Direct underlayments of steel plate and plywood had comparable performance to plywood modifiers. Barrels (plastic and steel) perform the worst of all ballasts. The modifiers of rubber and neoprene moved with the steel plate (the slip was between the modifier and the base surface). This suggests that the plywood-to-steel resistance coefficient is greater than the plywood-to-smooth concrete resistance coefficient. Therefore, the two plywood coefficients should be comparable.

**Guidelines**

**If Dry:** Elastic modifiers > plywood modifier AND underlayment > barrels

**If Wet:** Concrete block AND steel plate direct > steel barrel > plastic barrel

**Observations: Rough Concrete**

Dry/wet variations have no discernible impact on the performance of the resistance coefficients. Rigid ballasts and plywood direct are preferred to steel plate direct and plastic barrel.

**Guidelines**

Rigid ballasts AND plywood direct > steel plate direct > plastic barrel

**Observations: Dirt**

No modifiers were tested. While dry/wet variations had significant impact on rigid ballasts (steel barrel and concrete blocks), they had little to no influence on plastic barrel and steel plate.

**Guidelines**

**If Dry:** Rigid ballasts > steel plate direct > plastic barrel

**If Wet:** Steel plate direct > all others

**Observations: Grass**

While dry/wet variations had significant impact only on plastic barrel, generally wet conditions (except for steel plate) were better and the ballast type had little impact on performance.

**Guidelines**

**If Dry:** Steel barrel > concrete block AND steel plate direct > plastic barrel

**If Wet:** Barrels > steel plate direct

**Observations: Gravel**

Gravel generally has lower resistance coefficients than other surface types. Dry/wet variations have little impact on the performance for rigid ballasts and no impact for plastic barrel and steel plate direct.

**Guidelines**

Concrete block > steel plate > steel barrel > plastic barrel

**Key Findings**

1. When using a plate, secure the ballast to the plate.
2. Weight positioned closer to the tents, while maintaining manufacturer's requirements, optimizes performance.
3. Higher density ballasts are optimal.
4. Modifiers reduce the chance of failure due to sliding.
5. Staking is a much more cost-efficient way to secure a tent.
6. Steel barrels are much better than plastic in terms of ballasting weight.
7. Concrete blocks are better than steel barrels in terms of ballasting weight.
8. Concrete fill is a better source of ballast than water fill for barrels.
9. Ballast can be offset, without any change in the required ballast weight, by up to half the width of the ballast, for entrances and other obstructions.

**Note:** In order to safely ballast your tents you need to reference the following:

1. Manufacturer's guidelines.
2. IFAI Ballasting Study.

## 4.1 Overview

The purpose of this section of the Procedural Handbook is to outline generally accepted standards for the ongoing maintenance of commercial tent products. Over the given life of any rental tent product it will be installed, removed, and then returned for storage until the next time it is utilized. There are very specific conditions that need to be maintained for safety, storage, cleaning, inspection and eventually some basic repairs that can be administered by the owner of the tent system to keep the product in its best possible condition for the life of the product.

The manufacturer's instructions must be followed. Those instructions take precedence over any conflicting instructions that may be contained in this manual. In the event of a conflict, follow the manufacturer's instructions and warnings.

## 4.2 Storage

The fabric for a commercial tent system is best stored dry in a cool, dry place in a protective storage bag or other type of closed container. Other types of bags are acceptable as long as they can protect the fabric from the environmental elements of the storage area.

The hardware for the tent system should be stored dry in a cool, dry place. Anodized aluminum components can be stored outside, but should be covered to prevent foreign matter from collecting on the components that might stain or damage the fabric membrane during installation or use. Any/all steel components should be stored indoors in a dry/low humidity environment.

## 4.3 Cleaning

### Fabric Cleaning

Cleaning your tent fabric is imperative to achieve the largest return on your investment in these products. Soiled tent fabric often contains microscopic mildew spores and other organic matter present in most climates that settle onto the membrane during use. The combination of mildew spores and organic matter only requires water and moderate temperatures to allow for growth to spread throughout the fabric. Other stains can further penetrate the membrane if not cleaned immediately and can result in permanent staining of the fabric membrane.

### Hand Cleaning

The preferred and arguably the best way to clean the vinyl tent fabric is with a soft towel or soft bristled brush immersed in a diluted solution of warm water and a tent cleaning solution. The process of hand cleaning the fabric will allow you to apply only enough diluted solution to get the fabric clean. This will help limit the amount of water placed on the fabric to expedite drying time and will minimize damage caused by other more aggressive methods that could damage the fabric and or shorten its lifespan. Cleaning products developed specifically for cleaning tent vinyl are available and your tent manufacturer may sell or recommend a source for this product. A diluted and mixed solution of a tablespoon of traditional dish soap with a gallon of warm water will also work, but extra caution should be placed on insuring that this cleaning solution is thoroughly rinsed from the fabric especially with clear vinyl (See special notes on working with clear vinyl).

For best results, you will need a large, smooth, flat space slightly larger than the section of fabric. This space should be covered with a ground protecting layer to avoid damaging the tent membrane when moving in the washing area. Small impediments, sharp objects and rough surfaces all have the potential to damage the membrane you are trying to clean.

Follow the instructions for the proper dilution ratio of your cleaning product. Apply the diluted solution directly to the fabric using 1) a towel immersed in the solution, or 2) a spray bottle or larger pressurized spraying apparatus to evenly cover the fabric with the solution. Let this sit on the fabric for about one minute to allow the mixture to penetrate the fabric. Using a soft towel or soft bristled polypropylene brush (some can be mounted to a long handle to allow you to stand while working), gently work the cleaner into the fabric using only mild pressure. While harder bristled brushes can work, they will end up microscopically scratching the fabric, potentially causing permanent damage and making it harder to clean the next time. Never allow the tent cleaner to dry on the fabric. For this reason, it may be better to clean larger tents in sections. Once the cleaning is complete, be sure to rinse away any cleaning solution completely from the tent membrane.

### Machine Cleaning

The process of machine cleaning can be a very large labor saver for those that need to clean large amounts of tent fabric. Once loaded, a tent cleaning washing machine can operate without labor, allowing the cleaning staff to work on hanging, folding, or other maintenance while the machine load is running. Although there are many positive attributes to machine cleaning, this method comes with a several drawbacks. These machines can cause an excessive amount of stress with an increased amount of abrasion to the fabric during the washing cycle and can force water into the fabric membrane, causing increased occurrences of mildew growth and shortening the life of the fabric. Full immersion of the fabric in water is generally not recommended. The use of commercial front-loading or top-loading washing machines should be evaluated by the owner after consulting with the manufacturer of their tent product as the process may void the warranty of the fabric. As with any cleaning, the fabric must be hung to dry completely before folding and storage. Cleaners that include chlorine bleach, and/or any petroleum-based solvents will degrade and discolor the fabric and shorten its life span.

### Clear Membranes

The clear fabric used in window-style sidewalls, clear sidewalls, and clear tent tops needs to be managed differently than standard tent fabric. Polyester scrim is what gives standard tent fabric its strength, stability and durability. Standard tent fabric enjoys the benefit of encasing this woven layer of rip-stop polyester between the layers of colored vinyl film. Clear vinyl does not enjoy those benefits. Because of this, clear vinyl has a very low tolerance to ultraviolet ray exposure, wind, airborne particulate matter, hot or cold temperatures, and elasticity due to wind and rain and handling. Any or all of these factors will cause clear fabric to underperform when compared to traditional tent fabric.

Special attention should be paid to the cleaning of these items. Use only the softest towels when cleaning the clear membrane to avoid scratching the highly polished surface, and wipe dry to avoid water spots. Use standard diluted tent cleaning solution. **DO NOT USE OTHER CHEMICALS.**

Exposure to ultraviolet rays for an extended amount of time over the life of the product will cause the fabric to appear milky or opaque. Putting away and storing damp or wet clear vinyl will result in an amber hue in the clear film. Steady wind can whip clear vinyl back and forth and cause surface or through cracks in the fabric. Heat in excess of eighty-five degrees can cause clear vinyl to change shape, bubble, shrink or stretch. Although clear vinyl has a cold crack rating near freezing, that rating is for a static environment. Any introduction of wind or manipulation by handling will cause failure (cracking like glass) at nominal temperatures above freezing. Airborne particulate matter will abrade the surface and cause the finish to become less translucent.

### Spot Cleaning Difficult Stains

If you have a difficult stain that cannot be removed with traditional cleaning, please consult with the manufacturer before trying any other chemicals that might end up damaging the material further. Do not use other chemicals or cleaners unless instructed by your manufacturer.

### Fabric Drying

The best way to dry the vinyl tent fabric is to hang-dry in a low humidity environment. Circulating air around the surface of the hanging fabric with the use of fans will also speed the drying process and improve drying time in more humid environments. Assure that subassemblies and other components within the tent system are dry before folding. These subassemblies can be reinforcements, lace lines, webbing, rope, thread, and/or any other part that is permanently affixed to the main tent membrane. The use of commercial drying equipment and any drying using heat may void the warranty of the fabric. **DO NOT STORE YOUR FABRIC WET.** Fabric folded and stored wet will mildew.

## Fabric Mildew Treatment

Most commercial tent fabric is pretreated with mildew inhibitors that help prevent the growth and spreading of mildew and fungus. Although treated, proper care should be given to prevent potential growth. If you see mildew, wipe it away immediately with a clean towel and diluted soap solution. Never fold your fabric for storage if the fabric is even slightly wet. Mold/Mildew spores in the air and on the ground will come into contact with the fabric while installed. To grow, all the mildew needs is moisture and some source of food (often found in dirt that might be on the tent). Your best bet is to keep your fabric clean and dry to prevent mildew growth.

## Hardware Cleaning

It is very important to keep your hardware components clean and free of dirt, oxidation, and other chemicals especially if those hardware components come into contact with any fabric components during installation, use, or takedown of your product. Any dirt, oxidation, or chemical on the surface of the hardware member can transfer the contaminant to the fabric causing permanent staining, or permanent damage to the fabric membrane. If hardware components are found to be soiled, wipe down immediately to remove the foreign matter.

## Hardware Oxidation

The hardware components for your tent system have been supplied to you with specialty coatings to help limit oxidation. With usage, these coatings will need to be maintained in order to limit oxidation and for the product to reach its full intended lifespan. With plated or powder-coated steel components, any rust should be removed immediately with a stiff wire brush and sprayed with either a galvanizing spray or durable paint to seal the steel from the elements. Anodized aluminum components will get scratched over time and these scratched areas can develop a thin black oxidation common with mill finish aluminum. This black oxidation can cause staining to any fabric components that come in contact with the pole/component. Your best preventative measure is to avoid scratching of the anodized coating by avoiding any sharp edges that might come into contact with the aluminum member.

## 4.4 Inspection

### FABRIC INSPECTION

Prior to each use, each component of the tent system needs to be thoroughly inspected to assure its structural stability has not been compromised. Fabric components that are ripped, torn, frayed, or damaged should be immediately replaced and not used. Structural components of the fabric membrane are the most critical, including but not limited to the main fabric membrane, structural reinforcements and webbing, web termination plates/rings/fasteners, and connection points from fabric panel to fabric panel or connection points between the fabric panel and the hardware support system.

### HARDWARE INSPECTION

Prior to and after each use, each component of the tent system needs to be thoroughly inspected to assure its structural stability has not been compromised. Hardware components that are bent, cracked, frayed, or damaged should be immediately replaced and not used. Specific attention should be paid to any devices used for anchoring including ratchets, ropes, cables, and web straps. Additionally, any hardware components that come into contact with the tent's fabric membrane should be inspected for sharp edges, burrs, or any other conditions that could rip or cut the fabric membrane when installed. This is especially true for any products that have keder connections. These anomalies can often be corrected with a fine file or fine-grit sandpaper.

## 4.5 Basic Repair

Some basic fabric repairs can be achieved for non-structural components by the owner of the product. Often these repairs involve patching of small tears, pinholes, or abrasions to the membrane itself or sewing of non-structural components, buckles, D-rings, etc. that might have been torn off a tent top or wall section.

There are three primary methods utilized for patching small holes and tears in the tent membrane; patching with vinyl and glue, patching with vinyl and heat, and patching with a liquid vinyl adhesive. The first two methods utilize a small piece of the same vinyl used for the construction of the tent section to be repaired and two different methods of attachment. When patching with glue you will use a special, pliable vinyl adhesive to glue a patch over the damaged area. Drying time can vary, but generally will take several hours until fully cured. When patching with heat, the most common tool to utilize is a hot air gun with a specialized flat nozzle to spread the heat widely between the patch and the damaged section. Curing time when using heat to make the repair is almost instantaneous. Under both methods, special care should be made to not further damage the tent section to be repaired. It is highly recommended to practice with both methods on a scrap section of the tent material prior to repairing the actual damaged tent section. The final method for very small holes and minor tears is the use of a liquid vinyl. Often, this is the easiest method for fixing small areas of concern. Curing time for the liquid vinyl is generally less than an hour.

Any larger repairs and maintenance on any structural components of the membrane is best suited for repair by the original product manufacturer.

# Tent Styles, Basic Installation and Equipment Requirements

## 5.1 Overview

### Tent--Defined

A *tent* is a temporary structure comprised of a covering made of pliable materials or fabric that is supported by mechanical means such as poles, metal frames, beams, air, columns, arches, ropes and/or cables.

The tents that we see today in the Tent/Event Rental market come in a wide variety of colors, shapes, materials and styles. There have been many industry changes and trends over the past 35 years that have affected the design, engineering, and aesthetics of tents. Probably the single biggest change occurred in the early 1980's with the huge switchover from tents being manufactured with gala canvas to the new fabric of choice -- vinyl -- and of course predominantly white vinyl. Some of the key characteristics or advantages of vinyl over canvas today include; increased durability, inherent flame retardancy (no need to be retreated), and ease of maintenance and cleaning.

In the mid 80's and early 90's the major tent manufacturers began designing and manufacturing the "high peak" center-pole supported "tension" tent. This dramatic-looking tent really changed the landscape of the tent rental business both from aesthetic and structural standpoints. These tents reduced the number of overall support poles (eliminating quarter poles) and were offered with engineering in most cases. High-peak frame tents quickly followed, giving the rental company the option of having the same look with small to medium-size frame tents as well.

Although the first "European" clear-span style structures arrived in the U.S in the late 1970's/ early 1980's, the real growth of this product into a "mainstay" rental product wasn't until many years later. Now this product is definitely a tent style that many of the medium-to-large rental companies inventory and rent for a multitude of different types of events and long-term projects. One of this product's key features is top and wall panels sliding or "tracking" in the frame. This helped propel another new product introduction--the hybrid, or trackable frame tent. This has been and will probably continue to be the single biggest growth segment of the tent rental industry. The most recent trend or significant change in our market has been the offering of pole-supported tents including fabric that is truly translucent. This provides more of an "old world" appearance with round ends, wood poles, and a very elegant and unique look often referred to as "sailcloth" tent.

In this chapter we will explore the different styles of tents that are available to tent rental companies and their customers, review the unique features of these tents and cover what sets them apart from other tent products.

Before we get into the various styles of tents it is important to distinguish frame tents from pole or rope and pole tents. All of the tent styles described in the following pages are either frame, pole, or a combination of both.

### Frame Tent

A tent comprised of some type of frame (aluminum, steel, etc.) which typically has no center pole supported on the ground and where the frame supports the roof fabric. These tents are typically "free standing" but still need to be guyed out and anchored to be properly installed.

### Pole Tents

A tent supported in the middle and at other perimeter points by poles and is tensioned with either ropes, web guys, or cables that are required to keep the tent erect. These tents are not "free standing" and depend on the tension from the guylines and anchors to hold the shape of the tent system.



## 5.2 Traditional Frame-Supported Tents

What is referred to as the traditional frame tent (nicknamed ‘conventional’ or ‘west coast style’) is still the most common frame, and probably most common tent in the marketplace. They typically range in sizes from 10’ wide up to 40’ wide and can come in lengths of up to 100’ (and in some cases larger). What makes them still very popular today is the variety of size options available, their simplicity, and their relatively low investment cost. It is a product that every manufacturer of rental tents offers which provides the renter with numerous purchasing options. The traditional frame tent often serves as a great “entry level” product for the new rental company for the reasons cited above. It often becomes a real workhorse for the renter because of its multifaceted functionality as a popular rental product.

The traditional frame is normally comprised of an aluminum frame which may consist of aluminum members that are either round, oval shaped, rectangular, or square. The size of the frame members can vary from 1” to 2” in diameter (round tubing) to rectangular or oval stock that is 2” x 4” in size. The configuration or shape is usually defined as a “hip roof” (corner to peak at a diagonal). The fabric top is installed over the frame and is secured at the perimeter with straps, budgies, webs, etc. This product can come with a variety of different options such as adjustable uprights, expandable frame and tops (coming in sections so it can expand in length), side walls, rain gutters, etc.

Even as rental companies expand their tent inventory to larger and more sophisticated products they still will continue to rent a lot of these traditional frames at events that call for large quantities of smaller size tents (i.e. festivals and fairs). They are also great for auxiliary purposes such as catering tents, bathroom tents, and storage areas.

**Installation Basics**

Conventional frame tents are installed by laying out the frame members, fittings, and other bracings on the ground using your manufacturer’s diagram. Then the frame is assembled by pinning or bolting the frame members to the center hubs (crowns, spiders), and intermediate fittings (brackets, T-fittings) to form a square or rectangular-shaped frame structure. Smaller frames can be built from the perimeter in to the center hub, but most larger-size frames are built from the center hub out. All of the frame members should be pinned or bolted in place and any cables, braces, or other required hardware should be added before the vinyl top is attached to the frame and it is lifted into the air. Once the frame is complete, the vinyl top can be laced together (if sectional) or placed over the frame (if one-piece). The tops typically lay over the frame and are attached by a series of 1” or 2” webs to the frame perimeter. Once the top is in place and secure, the entire frame can be lifted on to the legs either manually (small frames) or with tent lifts (canopy jacks, tent jacks). The legs should be attached and then the frame properly secured and anchored to the supplier’s instructions.

**Equipment Requirements**

- PPE – hard hats, gloves, eye and ear protection if using jackhammers
- Tent jacks or lifts
- Sledgehammers or jackhammer
- Stakes to meet the required anchoring loads
- Hand truck or dollies to move large tent bundles around





### 5.3 Hybrid Frame-Supported Tents

Hybrid frame-supported tents (also called track-style frame tents) are traditional frame tents that have intermediate rafters with channels manufactured into the tubing members. This allows the fabric tops to be produced with a fabric bead (“kedar”) that slides through the channel in the tubing. By sliding the tops, the installer does not have to lace the tent, reduces the overall wear and tear on the fabric, and has a system in which the fabric becomes part of the structure itself. One can also realize labor savings when handling and installing the tops of a “track” style top versus the large traditional ‘lace together’ tops. These systems use some of the clear-span installation techniques and technology but are available in the traditional frame tent sizes. They range from 10’ – 50’ wide and can be installed using tent lifts or by swiveling up the arches based on the supplier.

## Installation Basics

Hybrid frame-supported tents are installed by laying out the frame members, fittings, and other bracing on the ground using your manufacturer's diagram. Then the frame is assembled by pinning or bolting the frame members to the center hubs (crowns, spiders), and intermediate fittings (brackets, T- fittings) to form a square or rectangular-shaped frame structure. Smaller frames can be built from the perimeter in to the center hub, but most larger-size frames are built from the center hub out. All of the frame members should be pinned or bolted in place and any cables, braces, or other required hardware should be added before the vinyl top is attached to the frame and it is lifted into the air. The method of lifting these tents and installing the tops varies based on the supplier but these tents can be built like a conventional frame and then raised in the air using tent jacks or lifts. Some of these types of frames can be swiveled up like a clear-span structure. The common method of installing the vinyl tops is by sliding what is known as keder (beads on both sides of the vinyl pieces) into channels on the aluminum frame members. This is done on the ground for some versions of this tent and in the air for others. These structures typically have sidewalls that slide into the channels as well.

## Equipment Requirements

- PPE – hard hats, gloves, eye and ear protection if using jackhammers
- Tent jacks or lifts
- Pull ropes to pull the tops through the channels and a return rope to bring them back
- “Keder feeders” to help feed the keder into the frame member channels
- Sledgehammers or jackhammer
- Stakes to meet the required anchoring loads
- Hand truck or dollies to move large tent bundles around





## 5.4 Cross-Cable Peaks

This is a popular style tent that originated in Canada but is used widely around the United States. It is truly a hybrid as it consists of a tension supported fabric top (like a tension pole tent) and frame members in the eave, legs, and foot plates. These types of tents provide the users with the curved shape of a tension pole tent, but the unobstructed interior and useable space of a traditional frame tent. Having very few pieces makes this product both a simple and easy tent to install as well as a great entry-level product. These tents range in size from 10' wide to 40' wide and are available in both one-piece tops and sectional tops. They are also great for auxiliary purposes such as catering tents, entrance tents, festivals (arts and crafts) and backyard parties.

### Installation Basics

Cross-cable peak tents are typically installed by laying out the frame members on the ground using the supplier's diagram. This typically starts with the perimeter tubing pieces, the corner and intermediate fittings, the center peak frame member, and the cross cables. The frame perimeter is built using the frame members, the brackets, and the cross cables. Then the vinyl top is attached to the corner and intermediate brackets (rectangular tent) using webbed loops. Once these are attached, the center support tube is inserted through the grommet in the top and wheels along the cables until secured in the center. Once the tent is secured, it can be lifted onto the legs either manually (with smaller tents) or using tent jacks (with larger tents). The tent should then be tensioned down and properly anchored and secured to the supplier's instructions.

### Equipment Requirements

- PPE – hard hats, gloves, eye and ear protection if using jackhammers
- Tent jacks or lifts
- A tool or bracket to attach the vinyl webs to the frame
- Sledgehammers or jackhammer
- Stakes to meet the required anchoring loads
- Hand truck or dollies to move large tent bundles around





## 5.5 Box Beam Clear-Span Supported Tents

This style of tent can easily be identified by its large aluminum beams that come to a sharp peak or a more gradual peak creating more of a curve. This product is often referred to as a “structure” with framework comprised of aluminum or steel box beam arches. The fabric slides through channels in the beams and is then typically tensioned at the eave. The substantial construction of this frame makes it very strong, where it can often meet stringent requirements in regard to building codes and engineering. This makes it a great choice for seasonal and long-term rentals.

In addition, these types of structures provide at least two other benefits to users. One such benefit is the safety of being able to install the fabric roof members after the frame is safely secured and anchored. This provides a more controlled installation environment and less chance of a tent blowing down or away. The other major benefit is the ability to “button up” the tent by having sidewalls (either fabric or hard wall) that are tensioned and secured so that they neither move in the wind nor allow significant airflow in either direction. This provides the user with better climate control and better energy efficiency when providing heating and air conditioning. The popularity of this product has increased significantly over the last 20 years with many renters now seeing this as a market that represents substantial growth and versatility. This allows for logical choices if a renter looks at expanding his frame tent business beyond 50’w. However, more and more rental companies today are looking at the entire product line that is available to them from 3m or 10’ widths all the way up to 60m or almost 200’ widths.

Many different factors should be analyzed before diving into this market segment, such as market size in terms of opportunity for typically larger events and the pricing that goes with it; available skilled labor; warehousing and trucking; and of course the capital needed to make a substantial financial investment. If this is not the product for you to own but you have customers that need this type of tent, there are companies in most parts of the country that are willing to subrent this product. Companies stocking especially large structures often travel long distances if needed for subrental opportunities.

## Installation Basics

Clear-span structures require the installer to focus on some key measurements and specifications in order for them to be installed properly and to function correctly. This starts with the measurement of the footplates (baseplates). These plates need to be positioned correctly and to the required measurements in order to assure that the frame will assemble correctly and the vinyl components will fit correctly. Once the baseplates' locations have been identified and the plates are in position and staked, frame assembly can begin. This involves laying out the frame members to the supplier's diagram. Once the frame members, leg-to-rafter fittings, center hub (crown) and other hardware are bolted or pinned in place, the frame can be swiveled up into the air. This has to be done very carefully to assure that it does not fall and damage the equipment. The proper sequence on the first two arches is to swivel the first into place, hold it in position, and then swivel the second into place until the purlins and cables are properly securing the arches. Then any additional purlins (cross members) and roof cables can be installed to secure the first bay (two arches). Once that is in place the installer will continue to raise arches until the entire frame is in the air. Additional bracing and gable legs will need to be in place before the vinyl fabric is pulled through the frame member channels using the keder beads (on the roof panels) and pull ropes. Once the vinyl is in place, it is tensioned down and the sidewalls are installed using the channels.

### Equipment Requirements

- PPE – hard hats, gloves, eye and ear protection if using jackhammers
- Fork lift (large structures) and/or push bar (smaller structures)
- Pull ropes and a return rope to install the vinyl tops
- Wrenches for the bolts
- Sledgehammers or jackhammer
- Stakes to meet the required anchoring loads
- Hand truck or dollies to move large tent bundles around





## 5.6 Traditional Pole-Supported Tent

This traditional pole tent, that some refer to as the rope and pole tent, has been around even longer than traditional frame tents. This tent features center poles (or in some cases quarter poles), perimeter side poles, and stakes (or other anchoring devices) to attach to ropes or web guys for tensioning. In essence the poles support the fabric and define its shape through the tensioning to the anchoring system. The traditional pole tent is still used today by many circuses, leading to its still-frequent nickname of “circus-style tent”. Its uses and available sizes are too numerous to mention and it is still the go-to tent for some rental companies. These tents can typically be identified by the increased number of support poles in the roof and in many cases colorful vertical striping patterns. It is still a popular and premium end-product for some manufacturers and with the advent of web guys, ratchets, and stake bars, it is still a durable tent which can perform quite well in inclement weather conditions.

### Installation Basics

Traditional pole tents are installed by first laying the fabric pieces on the ground. Sectional tents will need to be laced together. Once the tent is laced together to make one piece, the corners are pulled out to capacity. The stakes are then positioned and driven based on the supplier’s recommended diagram. This typically requires multiple guylines at the corner positions and single guylines at the other positions. Once the guylines are attached to the tent and the stakes, the sidepoles are installed. This is done by starting in the corners and working around the tent to form a “bathtub” shape. Once the sidepoles are in position, the quarter poles and center poles are installed. The tent will then be loosely positioned in the air. The installer will then need to work his or her way around the tent to properly tension the guylines and dress out the tent properly. Proper preparations and care should be taken when lifting the center poles and before the tent is properly dressed out as it is very susceptible to wind at those times.

### Equipment Requirements

- PPE - hard hats, gloves, eye and ear protection if using jackhammers
- Fork lift (for large tents)
- Hurricane ropes - these are ropes that go over the top of the vinyl to hold it down
- Sledgehammers or Jackhammer
- Web and ratchets
- Stakebars
- Stakes to meet the required anchoring loads
- Hand truck or dollies to move large tent bundles around





## 5.7 Bail Ring Tent

The Bail Ring tent is a specific type of the traditional rope and pole-style tent. Bail rings are not as popular as they once were, but are still worth mentioning since they are a unique part of the history and evolution of our industry. They come in a wide variety of sizes but are more common in the larger sizes (100'w and larger) and are available with both round and square ends. Many of the traveling circuses in existence today still use this type of tent where they can provide as much coverage as 50-75,000 square feet or more.

What really sets this tent apart from the standard pole tent is its installation procedure – more specifically, the installation of the center poles. Unlike the standard pole tent, the center poles on a bail ring tent are always installed first and are held in a vertical position with a series of ropes or cables. Much care has to be taken to properly measure out the center pole locations as well as the placement for staking the necessary center pole external guy ropes that are required to provide support in all four directions for these poles. Bail ring center pole assemblies typically consist of several parts: a base plate of some type, a sectionalized center pole, a bail ring, one or two sets of block and tackle, and a set of center pole guy ropes. Safety precautions are imperative during the center pole raising process. An experienced supervisor must oversee this procedure providing the necessary instructions all the way through in order to ensure that all center poles are raised correctly and safely.

The next step is to lay out the tent top and lace it together. Once completed, the top is now attached to the bail rings that are near ground level around the bottom of each center pole. Side poles are now raised around the perimeter and loosely tied off to the corresponding stakes. Next, the crew from underneath the fabric at each center pole raises the bail rings approximately half way up the poles and temporarily ties off the lines. Quarter poles are next installed to their almost upright position and once this is done the top can then be pulled the rest of the way up to the manufacturer's specified height. Final step is tensioning all of the guy lines and pushing the quarter poles to their final locations. It is always critical to double check the blocks and tackles are properly tied off and the bail rings are in the correct locations.

**Equipment Requirements**

- Measuring tape lines and marking paint or chalk
- Center pole guy lines
- Blocks and tackles and bail rings
- A frame or device to position/lift center poles off the ground prior to raising the poles
- Vehicle or skid steer to raise center poles and fabric for larger-size tents
- Hand truck or dollies to move large tent bundles around
- Ladders
- Mechanical stake driver





## 5.8 High-Peak Pole-Supported Tents

### 5.8.1

This series of tents combines the technology and beauty of large tensile fabric structures (such as at Denver International Airport) with commercial tent installation equipment and techniques. When first released, the goal of these tents was to eliminate the quarter poles of the traditional pole-supported tents, making them more aesthetically pleasing and increasing the usable space within the tent. The other benefit that these tents provided the tent renters was the addition of engineering documentation and ratings to the larger versions of these structures. These tents can be recognized by their “peaky” appearance and tightly-tensioned top fabric. These tents range from 20’ wide to 60’ wide in the non wind-rated versions and up to 120’ wide in the wind-rated versions.

They are elegant looking, structurally sound, and relatively easy to install versus a frame-type structure of the same size.

### 5.8.2

“Sail Cloth High-Peak Pole-Supported Tents” – These tents utilize the same concepts as standard high-peak pole-supported tents but are typically manufactured from sail cloth or vinyl and have rounded ends. These tents became popular in New England about ten years ago and continue to gain in popularity with event planners, brides, and other special events people. They are available in a wide range of sizes and are typically installed with wood poles. The tops are manufactured with either sail cloth or translucent fabric (where light passes through) to give them an elegant look. Many of the structures are made with special designs welded into the roof patterns.

### Installation Basics

High-peak supported tents are installed very similarly to traditional pole tents. The main difference is that most of these tents dress out better if the installer pre-measures the stake lines and side pole positions before laying out the tent. Begin by completing the stake lines and installing the stakes. Once this task is completed, the tents are installed by laying the fabric pieces on the ground. Sectional tents will need to be laced together. Once the tent is laced together to make one piece, the corners are pulled out to capacity towards the stake line. The tent should be centered in the stake line at that time. As in traditional pole tents this typically requires multiple guylines at the corner positions and single guylines at the other positions. Once the guylines are attached to the tent and the stakes, the side poles are installed. This is done by starting in the corners and working around the tent to form a “bathtub” shape. Once the side poles are in position, the quarter poles and center poles are installed. The tent will then be loosely positioned in the air. The installer will need to work his or her way around the tent to properly tension the guylines and dress the tent out properly. Proper preparations and care should be taken when lifting the center poles and before the tent is properly dressed out as it is very susceptible to wind at those times.

### Equipment Requirements

- PPE – hard hats, gloves, eye and ear protection if using jackhammers
- Two to three tape measures long enough to accommodate the size of the tent
- Fork lift (for large tents)
- Sledgehammers or jackhammer
- Web and ratchets
- Stakebars
- Stakes to meet the required anchoring loads
- Hand truck or dollies to move large tent bundles around



# Appendix A

## Building Code Sources



### **International Building Code**

5203 Leesburg Pike, Ste. 600

Falls Church, VA 22041 [www.intlcode.org](http://www.intlcode.org)

### **National Fire Protection Association (NFPA)**

PO Box 9191

Quincy, MA 02269-9101 [www.nfpa.org](http://www.nfpa.org)

### **American Society for Testing and Materials (ASTM)**

100 Barr Harbor Dr.

West Conshohocken, PA 19428-2959 [www.astm.org](http://www.astm.org)

### **National Association of State Fire Marshals (NASFM)**

PO Box 8778

Albany, NY 122208 [www.firemarshals.org](http://www.firemarshals.org)

# Appendix B

## Glossary of Tent Terms

**B****Anchor**

(n) any device used to secure or hold in place. (v) to hold stable to keep from drifting or moving.

**Apex**

The highest point or peak.

**Auger Anchor**

A generic name for a family of screw-like tent anchoring devices featuring a helical projection on the shaft that provides holding power. Also referred to as a helical anchor or earth anchor.

**Bail-Ring Tent**

A type of pole-supported tent where the fabric top is lifted to its peak and held in place at the top of a pre-erected center pole by means of ropes or cables and a metal ring, called a bail ring, attached to the center of the fabric top.

**Base Plate**

A device used at the base of a tent pole or column that distributes the load of the pole to a wider surface area. They can facilitate rotating the pole or column up into position during the installation process and also can incorporate holes to allow for anchoring of the tent pole or column to the ground.

**Base Scrim**

A firm open-weave fabric used in the construction of laminated and coated materials.

**Becket**

Loops of rope laced through tent fabric sections to attach them together. Also known as Dutch lacing, lace, lace loop or lace line.

**Block**

A wooden or metal case enclosing one or more pulleys and having a hook, eye, or strap by which it may be attached. When used in conjunction with tackle, it provides a mechanical advantage that is effective in raising tents—part of the phrase block and tackle.

**Box Beam Frame-Supported Tent**

A type of tent where an assembled framework of box beams, I-beams, or truss arches supports the fabric roof and defines the shape of the structure. Also referred to as a clear-span or free-span tent.

**CAD**

An acronym for Computer Aided Design or Computer Aided Drafting. Also used to refer to a drawing that was generated via a Computer Aided Design program.

**Canopy**

An architectural fabric projection that provides weather protection, identity, and/or decoration and is ground-supported in addition to being supported by the building to which it is attached. The term also can refer to a small tent, a tent without sidewalls, or an awning.

**Canvas**

A coarsely woven natural fabric, commonly used in treated form, for tent coverings. It is traditionally 100 percent cotton, but is often used as a generic term for any tent fabric, regardless of its makeup. Also referred to as duck.

**Center Pole**

One or more poles that lie on the longitudinal centerline of the tent and which are used to push the tent fabric up to its highest point, providing a watershed and occupiable space within the tent. Also called an end mast.

**Clear-Span Tent**

A type of tent where an assembled framework of box beams, I-beams, or truss arches supports the fabric roof and defines the shape of the structure. Also referred to as a clear-span or free-span tent.

**Clove Hitch**

A type of knot used for attachment of rope to pipe, piling or stake.

**Cold Crack**

The temperature at which vinyl becomes brittle.

**Dead Load**

The load on a structure produced by its own weight.

**Deadman**

A type of uplift anchor, normally buried in the ground (hence its name), which provides anchorage by a combination of its own weight and the weight of the soil captured above it.

**Dressing Out**

The final tensioning process after the tent has been raised.

**Dutch Lacing**

Loops of rope laced through tent fabric sections to attach them together. Also known as lacing, lace, lace loop or lace line.

**Eave**

The lower edge of the tent roof. Also referred to as the rim or perimeter.

**Eave Belt**

The reinforcement in the fabric at the tent eave.

**Eave Guy**

A rope, cable or chain attached from the tent eave to the ground-anchoring device, normally at the location of the side pole. Also referred to as the side guy.

**Egress**

The planned avenue to leave the tent safely. Also referred to as the exit.

**End Mast**

One or more poles that lie on the longitudinal centerline of the tent and which are used to push the tent fabric up to its highest point, providing a watershed and occupiable space within the tent. Also called a center pole.

**Exit**

The planned avenue to leave the tent safely. Also referred to as egress.

**Eyelet**

A ring or loop, usually metal or plastic, embedded into a piece of fabric to reinforce a hole. Also referred to as a grommet.

**Flame Resistance**

A measure of a material's property to resist or retard combustion.

**Flange**

A rib or rim for strength, for guiding, or for attaching tent poles together.

**Free-Span Tent**

A type of tent where an assembled framework of box beams, I-beams, or truss arches supports the fabric roof and defines the shape of the structure. Also referred to as a clear-span or free-span tent.

**Gang Staking**

A cluster, or multiple stakes bound or attached together, so as to function as a single unit.

**Gore**

A special cut, made on the edge of a strip of tent fabric, to produce the desired finished geometry of the surface. It is sometimes used to adjust fabric stress distribution.

**Grommet**

A ring or loop, usually metal or plastic, embedded into a piece of fabric to reinforce a hole. Also referred to as an eyelet.

**Guy**

A rope, cable, or other tie-down element that transfers loads from the tent to the anchoring system, such as stakes or augers embedded into the ground. Also referred to as guy rope or guy line. Types of guys include the eave guy or the top guy.

**Guying Out**

The process of tensioning the tent, while installing, by tightening and adjusting guy ropes.

**Helical Anchor**

A generic name for a family of screw-like tent anchoring devices featuring a helical projection on the shaft that provides holding power. Also referred to as an auger anchor or earth anchor.

**Hip**

The line of the tent roof running from the top of the center pole down to the corner side pole.

**Hip Band**

The reinforcement of the tent fabric along the hip of the tent.

**Hip Pole**

A quarter pole located on the hip of the tent.

**Hitch**

Any one of a family of adjustable knots, such as a clove hitch, used to fasten a guy rope to a stake.

**Hub Assembly**

Peak intersection hardware assembly of a pipe frame tent.

**IFAI**

Industrial Fabrics Association International, a trade association for the industrial and technical fabrics industry, which has a Tent Rental Division dedicated to issues of concern to the tent industry.

**Jack**

A portable mechanism for lifting or supporting a tent frame during the raising process.

**Jump Rope**

A device that fastens to the top of the tent pole to keep it from disconnecting from the tent.

**Kip**

A unit of force equal to 1,000 pounds.

**Lace**

Loops of rope laced through tent fabric sections to attach them together. Also known as Becket, Dutch lacing, lace loop or lace line.

**Lace Line**

Loops of rope laced through tent fabric sections to attach them together. Also known as Becket, Dutch lacing, lace, or lace loop.

**Lace Loop**

Loops of rope laced through tent fabric sections to attach them together. Also known as Becket, Dutch lacing, lace, or lace line.

**Lacing Band**

The reinforcement in the fabric at the edge of a tent section that is used to lace two sections together. Also referred to as the seam.

**Liability**

Legal bind to make good on any loss of damage that occurs due to accident or negligence.

**Live Loads**

The force imposed on a structure by its use, composed of the wind load, snow load, and earthquake load.

**Manila**

A general term used to describe rope or cordage made from natural manila hemp fiber.

**Marquee**

- 1) A canopy projecting over an entrance or doorway.
- 2) A connecting canopy between two tents.

**Module**

A standardized tent unit that can be added on to make a tent of any length.

**Mud Shoe**

A device used at the base of a center pole or column that distributes the load of the pole to a wider surface area. They facilitate rotating the pole up into position during the installation process of a bail ring supported tent and can also incorporate holes to allow for anchoring of the tent pole or column. Also referred to as a tabernacle.

**NFPA**

National Fire Protection Association, publishers of NFPA 102 and NFPA 701, which are fire codes governing the use of rental tents.

## **Occupant Load**

The total number of people permitted to occupy a structure at any one time.

## **Pavilion**

A temporary structure composed of a covering made of a pliable membrane or fabric and supported by mechanical means such as poles, metal frames, beams, columns, arches, ropes and/or cables. Also referred to as a marquee, canopy or tent.

## **Perimeter**

Any location along the outermost edge of a tent.

## **Pin**

The tip of a tent pole that allows it to slip through an eyelet in the tent fabric and which holds the pole top in place. Also a hardware member used to connect two or more components together.

## **Pipe Frame-Supported Tent**

A tent with an assembled framework made of aluminum or steel pipes, tubes, or other extrusions that supports the fabric roof and defines the shape of the structure.

## **Pitch**

The degree of slope in the tent roof, measured by the vertical distance between the tent eave and the peak height of the tent roof.

## **Pole Dolly**

Device with wheels to assist on installation of center poles.

## **Pole Grommet**

A reinforced ring fabricated into the tent fabric to accept a pole-pin assembly. Also referred to as a leathered-eye, post hole or side pole hole.

## **Pole Horse**

Tool which is temporarily connected to the bottom of center poles and used to raise and take down center pole style tents.

## **Pole-Supported Tent**

A tent with a set of individual poles arranged beneath the fabric roof to support and define the shape of the structure. The fabric roof is tensioned over the poles and attached to ropes and/or cables at designated spots around the fabric's edge. The ropes and/or cables are anchored to the ground using stakes, augers, or weights around the perimeter of the tent. Different types of pole supported tents include push-pole tents, bail-ring tents, and tensile style tents.

## **Ponding**

The accumulation of water on the tent top.

## **Purlin**

A horizontal member in the roof of a structure that supports the rafters.

## **Push-Pole Tent**

A tent with a set of individual poles arranged beneath the fabric roof to support and define the shape of the structure. The fabric roof is tensioned over the poles and attached to ropes and/or cables at designated spots around the fabric's edge. The ropes and/or cables are anchored to the ground using stakes, augers, or weights around the perimeter of the tent. The primary difference between a push-pole and a bail-ring pole-supported tent is that the fabric is pushed up from underneath in a push-pole tent instead of being hoisted up a vertically standing center pole as in a bail-ring pole-supported tent.

**Quarter Band**

The reinforcement of the tent fabric that connects the quarter poles and hip poles continuously around the tent. Also referred to as the sweep band, storm band, or wind band.

**Quarter Pole**

The poles intermediate between the center poles and side poles.

**Ratchet**

A mechanical device used with webbing to easily adjust tensioning to a stake, baseplate, or other anchoring device

**Ridge**

The line defining the longitudinal axis of the tent roof. This line runs along the center locations at the highest point on the tent roof.

**Ridge Band**

The reinforcement of the tent roof along the ridge.

**Rim**

The lower edge of the tent roof. Also referred to as the rim or perimeter.

**Rope**

Strands of fiber, braided or twisted together, that are used to tie and secure tents. They are made from natural fibers or synthetic fibers such as polypropylene, polyethylene and nylon.

**Saddle**

The low point in the curve of the fabric roof between center poles of a doublecurved tensile tent. Also referred to as a swale.

**Safety Factor**

A coefficient used to take into account such uncertainties as variations in material properties, weather, load experience, fabrication, construction tolerances, etc. It is a mandatory factor used in architectural design.

**Seam**

The location at which sections of tent fabric are laced together. See also Becket.

**Section**

A tent roof sub-assembly.

**Side Guy**

A rope, cable or chain attached from the tent eave to the ground-anchoring device, normally at the location of the side pole. Also referred to the eave guy.

**Side Poles**

Poles that support the perimeter of the tent roof.

**Sidewall**

Sections of fabric attached to the tent at the eave to create tent walls, enclosing the interior space.

**Sidewall Rope**

Rope attached at the tent eave used to secure the sidewalls to the tent.

**Snow Load**

The weight of snow on the tent top.

**Spider**

A California frame tent—poles joined overhead resemble a spider.

**Stake**

A wooden or metal shaft driven into the ground as a tent anchoring device.

**Stake Driver**

A mechanical device used to put stakes into the ground.

**Stake Puller**

A mechanical device used to remove stakes from the ground.

**Static Load**

The basic load of the fabric structure, components and hanging components. A load that accumulates and stays put.

**Storm Band**

The reinforcement of the tent fabric that connects the quarter poles and hip poles continuously around the tent. Also referred to as the sweep band, quarter band, or wind band.

**Stress**

Force per unit area.

**Swale**

The low point in the curve of the fabric roof between center poles of a double curved tensile tent. Also referred to as a saddle.

**Sweep Band**

The reinforcement of the tent fabric that connects the quarter poles and hip poles continuously around the tent. Also referred to as the storm band, quarter band, or wind band.

**Tabernacle**

A device used at the base of a center pole or column that distributes the load of the pole to a wider surface area. They facilitate rotating the pole up into position during the installation process of a bail ring supported tent and can also incorporate holes to allow for anchoring of the tent pole or column. Also referred to as a mud shoe.

**Tackle**

The arrangement of rope and associated devices used to lift or pull elements of the tent into position during the installation process—part of the phrase block and tackle. See also Block.

**Temporary Structure**

Any structure, such as a tent, which will be in place for less than 180 consecutive days. This definition may vary according to individual building codes.

**Tensile Structure**

A permanent fabric structure that relies on the tensioning of the fabric roof for its structural integrity and shape. Also referred to as a tension structure or tensioned-membrane structure.

**Tensile Tent**

A temporary fabric structure that shares some characteristics with the pole-supported tent, but relies more on the tensioning of the fabric roof for its structural integrity and shape. The use of tensioned fabric to resist applied loads and to shape the fabric membrane means less of a traditional support structure is needed to maintain it.

**Tensioned Membrane Structure**

A permanent fabric structure that relies on the tensioning of the fabric roof for its structural integrity and shape. Also referred to as a tension structure or tensile structure.

**Tent**

A temporary structure composed of a covering made of a pliable membrane or fabric and supported by mechanical means such as poles, metal frames, beams, columns, arches, ropes and/or cables. Also referred to as a marquee, canopy or pavilion.

**Tent Rental Division**

A division of the Industrial Fabrics Association International dedicated to issues of concern to the tent rental industry.

**3-4-5 Method**

The method used to square (90 degrees) a right angle triangle. The corner of a 3-4-5 triangle is:  
 $A + B = C$ .

**Top Guy**

An external rope, cable or chain used to install and secure bail-ring tent center poles.

**Utility**

Company, or the public service it provides, such as gas, electric, water, telephone, cable, fiber optic, etc.

**Vinyl**

Durable synthetic material commonly used in the manufacturing of tents. Also a generic term to refer to the tent top regardless of its specific make up.

**Webbing**

A strong, narrow, closely-woven tape designed for bearing weight and used for straps, harnesses, tie-backs, tie-downs, etc., in the tent assembly.

**Wind Band**

The reinforcement of the tent fabric that connects the quarter poles and hip poles continuously around the tent. Also referred to as the storm band, quarter band, or sweep band.

**Wind Load**

The load exerted on a structure by wind.

