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Guild of Tentmasters

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APPROVED CODE OF PRACTICE

ERECTION OF MEMBRANE STRUCTURES. MAY 1999

1. The Tentmaster agrees to conduct his work practice in a professional manner, which ensures the safety of the public above all else.

2. He/she shall endeavour to provide an installation of the structure under their control, that provides a healthy and safe work environment for the erection crew, for clients, and for co-workers.

3. The Tentmaster will ensure that the equipment in their control is in good working order and meets the designers and or manufactures published specifications.

4. The Tentmaster shall ensure that transportation equipment, loading methods and on-site materials handling is conducted in a right and proper manner.

5. The Tentmaster will ensure that laying out of materials on site is performed to a pre determined method and that marking out meets all designers and/or manufactures published specifications.

6. The Tentmaster will make sure that they and their site crew treat the structure, the rigging and the anchoring equipment with respect and in a manner that prolongs the life of the equipment.

7. DOCUMENTATION

The Tentmaster should have full documentation for any structure which is their responsibility. This

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documentation should form an operations manual which must contain as a minimum:

7.1. Design documentation, marking out plans, and suitable scale drawings.

7.2. A design statement stating maximum site wind speeds in which the structure may be occupied.

7.3. Additional statements on any other loads or operating restrictions that may be encountered.

7.4. Full structural calculations showing typical wind loading under differing load cases, showing reaction loads from the loaded membrane to the supporting masts or framework and ground anchors. In addition, any load carrying capabilities, suspended or other wise must be covered.

7.5. Any other certificates, e.g. flame retardancy certificates, winch test certificates, cable tests, electrical equipment etc.

7.6. Typical method statement for erection and dismantling.

8. FLAME RETARDANCY CERTIFICATION

Flame retardancy certificates should be available for all materials used in the structure. All fabric materials used in structures must meet stringent requirements regarding flammability. Materials should meet as a minimum, local standards and preferably international standards. Suggested standards include:

8.1. Great Britain - British Standard BS 5438 Tests 2A and 2B with a ten second flame application in each case. Future standards include BS 7157. British Standard 6661 is applicable to air supported structures. All structures must meet the guidelines in government publications; Home office/The Scottish Office, Guide to Fire Precautions in Existing Places of Entertainment and Like Premises (ISBN 0-11-340907-9), The Health and Safety Commission; Guide to Health Safety and Welfare at Pop Concerts and other Similar Events (ISBN 0 11 341072 7.

8.2. Germany: DIN 4102 - B1

8.3. France: Classement : M2

8.4. United States: NFPA 701, California State Fire Marshall - T19

8.5. Italian CSC RF 1/75/A - PRIMA

9. SAFETY POLICY

9.1. The Tentmaster, (or more specifically the company he/she is working for), must have a clear safety policy, and issue copies to all crew. Also, ensure that fork lift licensing and first aid certificates are in place.

9.2. Protective clothing must be used where condition require it.

9.3. Access equipment must be provided for hazardous tasks.

9.4. Safety harnesses must be worn when climbing the structure.

10. SITING

10.1. Structures should be sited on only on known ground conditions. If installed on grass, checks must be made to ensure that installations are only made on cohesive soils, such as medium or hard clays. Acceptable ground bearing pressures are a minimum of 200 kN/m2. The Tentmaster should ensure that ground conditions are acceptable for the structures. Ground and weather conditions may change during the length of any installation, therefore inspection procedures should be in place to recognise this. The Tentmaster should ensure that there are no obstructions such as power lines.

10.2. The Tentmaster should ensure that the site provider has provided adequate access for the transport to be used and has ensured that the area where the structure is to be erected is free from underground obstructions for ground anchors and pressure bearing mast base plates.

11. ERECTION GUIDELINES

11.1. Whilst it is not the intention of this code to be specific about installation methods, some working practices and tensioning methods can be used in most installations such as large marquees, big tops and portable membranes. (see guild approved code of practice for frame structures for other types of tent)

11.2. There must be an awareness of the tensile and compressive forces involved in all stages of the erection process. Large structures will have a level of forces out of proportion to the size of the

structure. Large single span structures tend to have greater forces involved than structures with multiple suspension points closer together.

11.3. The Tentmaster must be aware of the erection methodology of the structure he/she is working on. A formal erection method statement should be available from the designers of the structure. The Tentmaster should study the method statement and keep a copy on site.

11.4. All structural components such as membrane, steelwork and rigging should be subjected to regular examination during the life of the structure. All winches, cables and rigging components must be tested and test certificates carried with the operation manual.

11.5. All Tentmasters must be intrinsically aware of the consequence of failure of the structure. This can be ascertained from the designers manual of the structure they are working on.

11.6. Once the site is marked out, large sections of poles, King Poles and trussing may be moved around the site into position. The public or other trades should not be allowed into the working area during this period or when the poles are being hoisted. Where fork lift trucks are being used, care must be taken by all staff.

11.7. Large poles may require additional footing or pads to spread loads on soft ground conditions. Loads may increase when tension is applied to the roof.

11.8. Anchors are the most likely cause of failure of a temporary structure. These must be installed to the guidelines of the designer or manufacturer. Any forces higher than 1,500 kilograms (3,300 pounds), should have a representative test applied to a sample number of anchors.

11.9. The Tentmaster should examine the membrane before hoisting to ensure there are no tears, fraying, or defects in the fabric, and that lacings and hardware are in good condition. Any faults must be made good before erection of the structure.

11.10. All guys, tie-backs, or webbing tensioners must be made safe from the membrane to the anchors before raising the roof onto side poles.

11.11. Care must be taken when lifting the first part of the membrane off the ground if the wind is brisk. Where possible, side poles should be attached to the roof.

11.12. Once the roof is raised, the structure should be pretensioned as soon as is practical and made

safe. If not, poor wind performance and the chance of ponding can result.

11.13. Wind can affect the performance of the tent in many ways. Up wind sides of the structure can have greater downward loads than down wind sides, but the combination of wind leaking under side walls, (or no side walls), will cause the structure to generally have more uplift than downward pressures.

11.14. The effect of a down load on the up wind side and up lift on the down wind side can generate enormous loads on the fabric and reinforcements in-between.

11.15. Even with walling attached, the structure will normally be subject to high suction loads which can mean areas of the structure exhibit greater local loads than a simple division of the perimeter loads would suggest.

12. PRE-TENSION

12.1. A certain amount of tautness is needed in any fabric structure to accept loads such as wind and to minimise and damp deflection and movement. This is known as pre-tension, i.e. tension prior to loading. This pre-tension is absolutely crucial to the structure's performance. If an area of a membrane is loose or gathered, it is not accepting any load and is not contributing to the stability of the membrane, this may allow it to collect water or "pond". For this reason, all tensioning guys or tiebacks must be equally pre-tensioned which in turn equally pre-tensions the roof.

12.2. Where known, the pretension in the roof should be checked at the tie-backs with a suitable gauge or load cell.

13. INTERNAL POLES AND MASTS

13.1 Some structures may have intermediate or 'Quarter' poles. These are used to tension the flat roof to damp and control the movement of the surface. These poles are usually, long, slender tubes which do not meet slenderness ratios common in structural engineering. They are considered acceptable only because practical experience shows that they are suitable. These poles should not normally be staked at the base, as when the roof lifts under gusting conditions, the pole lifts also and 'jacks' the roof maintaining tension. The quarter poles should typically be 'normal' or 'regular' to the roof, i.e. approximately 90 degrees to the plane of the roof.

13.2 While it may seem logical to use King Poles or centre masts for the suspension of rigging and loads, this may only be done if the poles or masts are fit for that use and have structural calculations

to prove the load carrying capabilities. Under no circumstance can lateral or sideways loads be placed upon masts unless the masts are specifically designed to accept the imposed loads.

13.3 Where internal masts need to interact with rigging for performance or exhibition use, the above restrictions apply. It is possible for quarter poles to have the bases moved to clear staging, scenery etc, provided the tension is maintained on the roof.

14. INTERNAL AND EXTERNAL TRUSSES, CUPOLAS, AND DOMES

14.1 Often structural metal components are used to support the apex of the structure. These are usually fabrications which must be capable of carrying membrane loads including wind, and any environmental or suspended load capacity must be clearly shown in the operation manual.

15. ANCHORS AND GROUND CONDITIONS

15.1. The Tentmaster should be aware of the site conditions he is working on. The site must be suitable for the structure being erected. The ground or soil conditions must be ascertained and checked for suitability for the structure being installed. Rain or other environmental changes may change the structural or load bearing capabilities of the soil.

15.2. Only anchors of the correct specification should be used. Anchors of differing lengths will appear the same when driven into the ground.

15.3. When placed under load, the ground in front of the anchor compresses and takes up the load. This can affect the tension in the side guys or tie backs. Excessive movement of the anchor is unacceptable, and usually is a sign of impending failure.

15.4. If an area of a membrane is loose or gathered, it will move under wind and cause the anchors to be pulled back and forth with a loosening effect on the anchor.

15.5. Rain water can loosen the soil and change the load bearing capabilities of the anchor.

16. EXAMINING THE ERECTED STRUCTURE

16.1. The first pointer to the examination of the structure is a simple visual check or 'walk round'. Simple visual inspection should show that symmetrical parts of the structure are in line. For example, a side pole on one side of the structure should normally line up with the centre poles and side poles

on the other side when looked at through the line of poles.

16.2. An even distribution of surface loads is important to the stability of the structure.

16.3. On a large marquee or Big Top, the side guys should normally tension in line with the seams of the structure. The rim or perimeter of the structure should be well tensioned to accept lateral (radial?) loads.

16.4. Main guys or centre pole stabilising cables, are not always necessary to the stability of the membrane, and if tight when the structure is erected may restrict the need of the membrane to move slightly under load.

16.5. The inspected structure should be examined (preferably) with the client who will be responsible for the safe use of the structure. This formal handover should be registered in a site installation log and kept for future examination.

17. MAINTENANCE

17.1. The Tentmaster has many duties other than merely erecting the structure. Perhaps the most important of these is the need to inspect all structural components as they are being unloaded, positioned on site and erected. Any cuts, ties or abrasions in the structural fabric must be repaired or replaced. These repairs will not be as strong as the original structure, therefore, repairs should cover a greater area than the damaged section. Plastic coated fabrics rely on the strength of the adhesion of the plastic to the base cloth to provide structural joins.

17.2. Repairs can be made using hand held hot air guns or a hand held hot airgun, provided that the repairer has a working knowledge of the membrane force at the point of repair, and that commensurate allowance is make in the repair. Where woven fabrics are used, and in particular those using synthetic fibres. Care must be taken when carrying out repairs. If an unsealed edge is near the repair extra care must be taken and additional measures taken to strength the unsealed edge, either by bonding the stitched area with a flexible adhesive or by multiple rows of stitches.

This code of practice is subject to constant revue, and suggestions are welcomed to the guild address.