The ESG Report

WINTER 2009

OPERATIONS MANAGEMENT PLANS

The summer 2008 edition of ESTA's *Protocol* contained an article about seismic considerations for temporary outdoor structures that referred to the only standard written specifically for them, ANSI E1.21-2006 *Temporary Ground-Supported Overhead Structures Used to Cover the Stage Areas and Support Equipment in the Production of Outdoor Entertainment Events*. A related article about the general philosophy of Operations Management Plans will publish in the spring edition of *Protocol*. This edition of the ESG Report is a companion article, a synopsis of what your specific Operations Management Plan should include.

Spring is almost here, so roof system owners are preparing for the inevitable rush of outdoor events. If they are standards proponents, then E1.2-2006 *Design, Manufacture and Use of Aluminum Trusses and Towers* is defining their inspection procedures for all truss and tower elements. Machinery is being tested, routine maintenance performed, and – hopefully – operations management plans are being reviewed.

Just as some of our readers are already ramping up for their summer event circuits, we're offering this article to help them get prepared.

ASSESSING RISK

In case you haven't seen *Protocol* yet, here's an overview: The Operations Management Plan (OMP) is a culmination of several smaller process analyses – identify the activities, assess the risks associated with those activities, remove the risks or monitor the conditions that cause or add to risk, and have a plan to mitigate those risks. Don't overlook the obvious training aspects.

E1.21 section 3.4 is entitled *Engineering Documentation*, driving almost every other requirement in the system OMP. Subsection 5.2.3 requires that "*the User shall prepare proper layout drawings, engineering documentation, and Operations Management Plan as described in section 3.5.3 of this document."* Section 3.5.3 is entitled *Operations Management Plan*, and is the basis for our discussion here. Among other things, it requires that the OMP define *"…actions to be taken for different parts of the structure…with particular regard to wind loads."*

REQUIREMENTS

What are the basic requirements? This is what's required by section 3.4:

1. Engineering reports, including analytical calculations, for the system as it is intended for use. Most systems are comprised of one specific assembly method, but there are also many systems that can be configured in multiple ways. The engineering report will define the system in each of its unique configurations. It will detail the system payload, allowable load distributions and design wind speed used for each application.

2. Engineering data describing in detail the lateral force resisting system, which includes components like ballast, guy wires, x-bracing, etc that help stabilize the system against lateral loads such as wind.

3. Site requirements for proper foundations or cribbing for the tower bases. Obviously, a tower base that sinks into soft soil isn't desirable, so the engineer must either design a method to accommodate changes in soil bearing pressures from event to event, or more commonly, will stipulate a minimum soil bearing pressure required for the established system load criteria.

These engineering controls help establish safe analytical limits for the system, but they are intended to be used in conjunction with administrative controls too. Tasks such as checking the soil site classification, erecting the towers safely, setting up the roof system, attaching and using guy wires, and monitoring the weather for high wind potential, are all examples of administrative controls – they boil down to operational procedures. Once the engineering is complete, the next step is to document those procedures. The key element here is DOCUMENTATION, and the first step in documenting is in...

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Kudos to Daniel J. Clark, P.E., S.E. for passing his California Structural Exam! Daniel is now a registered Structural Engineer in the State of California.

Continuing to increase our licensure, we now have two registered structural engineers (S.E.) in California. Companywide we are licensed in all fifty states and Puerto Rico, with thirty-four engineers.

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actually assessing what you need to document. Section 5 *Use and Care* helps us with this. Subsection 5.2.7 requires that the *"…user shall develop a risk assessment plan and make all workers aware of the hazards involved with erection, use and dismantling of the structure."* The requirement is clear: identify the activities, assess the hazards, and train the staff. Sound familiar?

Procedural documentation includes verification of basic site information required to fulfill the system's loading requirements. It contains step-by-step installation, use and dismantling procedures, and will also include preventative or mitigating contingencies in the event of an emergency. One easily recognizable example of this is what we refer to as a High Wind Action Plan (HWAP). By now you've probably read about wind and lateral loads enough to understand that a) high winds and roof systems don't go well together, and b) your system has a wind speed threshold at which it is likely to fail. Let me qualify that statement: maybe the exact wind speed that would cause a failure is a little elusive, but trust me on this – your engineer has analyzed the system and can say with reasonable assurance that your system passed an analytical check at some specified wind speed threshold. It's a component of the engineering documentation, required by Section 3.4.4.2 *Design Wind Speed*.

The wind speed threshold is derived using the effective wind surface area, which is the combined surface area of your roof skin, the exposed surface area of the truss and any side walls you may have attached to it. Sometimes, the equipment suspended from the roof system also contributes to the total effective wind surface area. Speaker arrays are an excellent example of this.

Restating in general OMP terms: the hazard is high wind; the mitigating action is to lower the effective wind surface area, if possible. If you use sidewalls (also referred to as cladding in E1.21) the quickest, easiest way to minimize the wind surface area is to remove the cladding from wind exposure. Raising or lowering cladding might be just as effective as detaching them, as long as you have a way to do it quickly. Actually, subsection 3.5.2.5 permits a reduction in effective wind surface area equal to the area of any exposed cladding that can be removed in less than five minutes, which in this case is considered a reasonable response time when weather monitoring indicates the likelihood of unacceptable wind speeds. Every E1.21 compliant roof system has an associated Operations Management Plan describing what to do in an emergency situation.

Actually having and using monitoring equipment is a prerequisite to any HWAP. You can't accurately predict high wind speeds unless you're actually measuring the wind speed on-site, in real time. Anemometers (devices that measure wind speed) don't cost very much, especially considering the advantage they provide in a safety plan. For little extra, weather stations that are programmable with audible and visual alerts are available. Have the equipment, and use it for every event.

The next step is defining your system's thresholds for action, and what to do when wind speeds reach them. Many HWAP's have multiple thresholds. At some point well below the maximum wind speed, system personnel are put on notice, with awareness elevated to a higher state of readiness. According to plan, they are trained in what to do, how to do it, and to act accordingly on a moment's notice. At the next highest level, action usually occurs. Perhaps cladding is removed to reduce the effective wind surface area, thus reducing the overall forces acting on the structure. At yet higher levels, perhaps the show is stopped, and the immediate area is evacuated – but who knows what to do for certain, and when? You know because it's in your safety plan and lives depend on it. Your staff also knows because it's in the safety plan and they're trained to know it and to implement it.

FINAL NOTE

I began my research for this article by reading the E1.21 standard. It's available from the ESTA Foundation, and I encourage you to read it too. In fact, if you're reading this article and you use roof systems, you're hereby put on notice that you have a very valuable resource available to you, in the form of a well written standard that explains it all to you. Please don't overlook it.

Last spring, we also published a white paper on Operations Management Plans for temporary outdoor roof systems. It's available for download under the White Papers section of our website, at www.entertainmentstructures.com.

Have comments or suggestions? Send them to us. We're listening. Contact Richard Nix at 800-542-3302 or richard.nix@entertainmentstructures.com

About the Author

Richard Nix is the Division Project Coordinator. His range of expertise includes rigging system design and installation, as well as several years as a stagehand and staff rigging supervisor. He is the author of many technical articles and has participated in ESTA's standards development efforts for over twelve years.