7.1 **PROACTIVE OR REACTIVE:**
**THE SEVERE STORM THREAT TO LARGE EVENT VENUES**

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## 1. INTRODUCTION

Tornadoes pose perhaps their greatest risk to life and limb when they threaten festivals, stadiums, speedways, race tracks and other venues where large crowds (in the hundreds to thousands) are gathered. Nontornadic but unusually severe supercells and derechos are of considerably heightened concern when they threaten these same outdoor venues with extremes in hail, winds, flooding rains, and virtually continuous cloud-to-ground lightning.

The existence of this threat has been acknowledged (e.g., Grazulis et al. 1998), but one which remains seldom discussed both within and outside the meteorological community. This article is intended to increase awareness of this very real threat by documenting severe weather hazards for large event venues using both historical examples and available risk assessments (e.g., Rae and Stefkovich 2000). We also suggest a proactive, cooperative, multidisciplinary approach designed to minimize the potential catastrophic threat to human life.

## 2. TORNADOES AND LARGE EVENT VENUES

Significant tornadoes have passed near large-event gatherings on a few occasions. Several photographs (e.g., Fig. 1) were taken from the Ak Sar Ben horse track in Omaha on 6 May 1975, where those in the stands had a largely unobstructed view of a violent tornado. Perhaps the closest we have come to a massive large-venue casualty toll was with the West Memphis, AR, tornado of 14 December 1987, an F3 which passed within about .25 mi (.4 km) of a dog racing track where 7,000 spectators had assembled (Grazulis 1993).

On 8 May 1998, despite an F5 tornado a few miles away and debris falling from the sky in the vicinity, a tornado watch and warning in effect,

Figure 1. Violent (F4) Omaha, NE, tornado of 6 May 1975, looming beyond the grandstands of the Ak Sar Ben horse track. Credit: Bob Dunn

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and sirens sounding throughout the county, a minor league baseball game was continued in Birmingham, AL (Legates and Biddle 1999). The game was not suspended (with some fans moved to an *upper* stadium concourse) until wind and rain from the tornadic supercell made play impossible.

Significant tornadoes have directly stricken venues which were unfinished or empty. On 16 April 1998, an F3 tornado in Nashville, TN, hit the incomplete Adelphia Stadium, now home to the NFL Tennessee Titans (USDOC 1998 and Marshall 2000).

The tornado threat to large venues is not a phenomenon restricted to east of the Rockies. On 11 August 1999, a nonsupercellular (Dunn and Vasiloff 2001), F2 tornado traveled through downtown Salt Lake City, striking a large outdoor convention tent where one person perished, and also damaging the Delta Center, the arena used by the Utah Jazz NBA basketball team and by most major concerts in that part of the nation (USDOC 1999). The location of the latter event, also exemplifies that large event hazards from

severe weather are not confined to regions east of the Rockies (Concannon et al. 2000).

Crowded urban freeways provide elongated open-air targets consisting of thousands of slowly moving or stationary vehicles, which are exceptionally susceptible to tornadic winds, intense downbursts, and destructive hailstorms. The threat is increased by a lack of safe escape possibilities in jammed traffic, leaving motorists the choice between remaining in a vehicle in tornadic winds or fleeing on foot fully exposed to the elements. Rae and Stefkovich (2000) have shown that over 2,000 people may be trapped on Dallas/Fort Worth Metroplex freeways during rush hour during extremely severe weather. Moreover, should the storm move along and parallel to a congested freeway, the problem is exacerbated.

A violent (F4) tornado on 24 April 1993 (USDOC 1993) moved along Interstate 44 from northeastern Tulsa to Catoosa, OK, causing five of its six fatalities along the freeway – in traffic and in a truck stop, with four deaths in one van (Grazulis 1997). One of the authors (RE) was in the associated traffic backup and witnessed the immediate aftermath of this event, with numerous vehicles of all types overturned on and adjacent to the freeway. Emergency vehicles had difficulty reaching some victims because of obstruction by debris and stalled traffic.

## 3. NONTORNADIC THREATS

Nontornadic supercells, bow echoes and other derecho-producing events, and even general thunderstorms can greatly threaten large outdoor crowds. Lemon and Parker (1996) documented an extremely severe thunderstorm inflicting winds over 50 m/s and hail up to 16 cm in diameter over a path more than 100 km in length and ~12 km in width. A similar nontornadic supercell struck the Mayfest riverside festival in Ft. Worth , catching over 10,000 people outdoors and injuring many of them with hail, violent winds and flash flooding, and taking the lives of nearly 20 people (USDOC 1995).

Virtually every derecho event and supercell passing near a town or city also threatens a large venue – such as a fairground, ballpark, stadium or race track of some sort. That violent weather will eventually strike a large venue during a crowded event is a matter of inevitability. We suggest that rather than reacting to such an occurrence that we attempt to prevent or mitigate it in a proactive manner.

## 4. ROLES AND RECOMMENDATIONS

The large event venue hazard may be mitigated through two primary modes of attack: advance preparedness in the form of design and planning of facilities and events, and effective management of large venue crowds once a threat is imminent. In both kinds of hazard mitigation, facility designers and operators can work closely with all elements of the integrated warning system (IWS) – including emergency management (EM), Skywarn and other storm spotter groups, the National Weather Service (NWS), private meteorology companies, and the news media.

Large event venues themselves can play a major role in reducing the potential for mass casualties, beginning as early as conceptual planning for the facilities. Architectural engineering and construction should incorporate safe shelter areas shielded from direct vulnerability to outside winds and flying debris, and of sufficient capacity to hold the largest potential number of people occupying the facility. These shelters should be readily accessible – in the time span of tens of minutes or less – to the most distantly located individuals within the crowd. Admittedly the additional expense for such facilities would add substantially to its cost.

In the event of severe weather, panic can ensue and may not be entirely preventable; however, an orderly and well-publicized plan of shelter can *minimize* panic. Clear marking of escape and evacuation routes – both on-site and in promotional and program materials -- may encourage orderly movement of crowds and reduce potential for panic-induced casualties. A well-designed severe weather plan also may be of great benefit to facilities in promotion and public relations for events –- assuming facility managers are prepared to execute the plan smoothly and quickly.

This planning should be performed in consultation with EM agencies. Even plans preparing for terrorism established since 11 September 2001 could be modified to cover the severe and extreme weather risk.

Although the National Weather Service (NWS) cannot produce venue-specific forecasts and warnings; venue operators can use area public forecasts and severe weather outlooks to guide their preparedness on the day of an event. Some private forecasting firms also may provide customized, event-specific guidance as to the risk of thunderstorms and other hazardous weather. Local and national news media often provide general forecasts for outdoor events too. Such forecasts should also explicitly include any threat of severe local storms; following guidance such as the SPC Day-1 and Day-2 convective outlooks. When the SPC issues watches, the spotter networks are activated. The news media broadcasts the threats to the public; and venue operators can use watches to heighten preparedness. Then, if and when warnings are issued, the plans can be executed. Admittedly false alarms can be costly and can serve to slow or prevent a future response.

Storm spotters have a critical role in the IWS (Moller and Doswell 1988), particularly where large event venues are threatened. Organized networks of storm spotters can be utilized in a cooperative way to keep venue operators and local governments informed of the development and progress of storms. All facets of the IWS, perhaps led by EM, should also focus on “rush hour” threats to commuters, as well.

Ultimately, there is also considerable responsibility on the part of all individuals planning to attend outdoor events. Each person should keep advised of the severe weather threat for the day, and be prepared to miss an event or leave early, in case severe weather may occur (for example, if an area is included in a severe weather watch).

## 5. CONCLUSIONS AND DISCUSSION

Risk reduction of this nature necessarily involves cooperation across a number of organizations. The National Weather Service (NWS), news media, and emergency managers and spotters, should collaborate and coordinate with individual venue operators and local governments to reduce the risk of mass casualties in violent weather. To do this, each large venue operator must openly acknowledge the risk to their facility, and their customers.

We suggest a national multidisciplinary meeting to address this threat directly, in order to mitigate or even prevent, if possible, casualties inflicted by severe convective storms striking a large venue. The intent of this National Casualty-Mitigation Workshop (NCMW) is for a multidisciplinary group of participants to consider all severe convective storm (and high temperature) threats and to produce "templates" for each threat to offer guidance for the venue operators in developing their particular contingency plans. There will be both plenary and small-group committee meetings.

We envision this NCMW to be attended by a wide variety of participants including but not limited to venue owners, managers, emergency management, local and national law enforcement, local government, NWS forecasters and managers (including Warning Coordination Meteorologists), National Centers For Environmental Prediction, NSSL, academia, and insurers. Each small group (six total) would be made up of members from the agencies and organizations just mentioned, and would carefully examine one of the six threats to be considered: heat, flash flooding, hail, damaging winds, lightning and tornadoes.

During the plenary session each threat would be addressed by an invited speaker (an expert in the phenomena). He/she would provide an overview of the threat, its temporal and spatial characteristics, and those specific aspects that make the hazard so dangerous, as well as historical events illustrating the problem. Then the meeting chair would give instructions to the committees and make clear expectations of them. Within the confines of the smaller groups, other presentations can be made; but the principal responsibility of each group is to produce a template: a guide that each venue owner and operator can use and tailor to its local conditions and peculiarities. While a draft report is due from each group by the end of the week, the final draft would be due approximately six weeks after the close of the National Casualty-Mitigation Workshop.

Some of the venue operators have stated to NWS representatives and others that if and when potential disasters of one of these types occur, they would consider it "an act of God;" and as such they cannot be held responsible. It is because of these passive responses and the fact that many venues at risk have done nothing

to prepare for the severe-weather disasters, that action is needed to encourage or convince owners/operators to prepare for these dangers. It is hoped that insurers would refuse to cover these venues unless they develop meaningful catastrophe plans for each of these threats. In this way, we can mitigate potentially catastrophic casualty tolls that each threat can inflict.

There exists a very real risk of massive casualties if a large outdoor activity is hit by a tornado, large hail, or violent winds -- or even by flash flooding and/or frequent cloud-to-ground lightning during the event -- even with a warning in effect. The photo in Fig. 1 vividly illustrates the danger, which may be even greater for tornadoes cloaked in rain or otherwise obstructed from view. Under these circumstances, many spectators may not know about the warning, and even if they do, evacuation problems and resulting panic may produce casualties with or without a direct severe storm strike. **In fact, we believe that this is not a threat that may occur but one that *will occur* unless there are proactive measures to prevent a catastrophic loss of life and and many injuries.**

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