LIGHTNING, OUTDOOR STADIUMS, AND SPECTATOR SAFETY

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with Erik Noble & Ryan Church

February 25, 2005
Virginia Tech

What happened?

- Lightning struck the ground, 6/10-mile
- During next ten minutes, 16 strikes occurred within one mile of the center of the stadium

Fans?

- Reacted immediately
  - Ran out of the stands
  - Crowded stadium tunnels and exits
  - Braved the elements
Virginia Tech

Carol Hart- Roanoke Times Columnist

“What I saw disturbed me. The tunnels leading from the stands to the concourse were packed solid, Ushers, emergency, or security should have been clearing those people out. Some fans tried leaving the stadium, but could not get through the tunnels. They were forced to find protection in the open.”
How did this occur?

- Game management did not heed threat of approaching storm
- Police and ushers were still tending tickets
- Inadequate loud speaker system
- There was no stadium lightning evacuation policy.
The Problem

Large outdoor stadiums face a significant and growing vulnerability to lightning due to increased size and frequency of events. This growth is not paralleled in the knowledge and management of spectator safety.
University of Oklahoma
September 14th, 2002, OU vs UTEP

- 1st quarter
  - Lightning struck within 6 miles
  - Officials removed players from field
  - Management informed crowd of 75,000
  - Crowd evacuated
  - Fans stayed in seats
1st quarter
- Lightning struck 5 miles away
- Officials removed players from field
- Management asked crowd of 84,227 fans to exit stadium
- Crowd evacuation very slow
- Fans stayed in seats while lightning flashed overhead
1st quarter, football staff located lightning within 6 miles using lightning detection software.

- Game officials notified
  - Halted game within one minute
- Players were removed from field
- 84,000 fans were given an option to leave stadium
Just before kickoff

- Lightning struck 3 miles away

Warning issued to management by National Weather Service

Officials removed players from the field

Fans asked to leave

- most were already leaving

Fans crowded tunnels and blocked some exits
Louisiana State Univ.
September 4th, 2004, Nationally Televised Game

- Thunderstorm just before kickoff
- Players sent back to the locker rooms
- Game delayed for ~1 hour
- Any announcement to the fans?
  - What were they doing during the ~1 hour?
88 minute delay

Players immediately moved from the field

“Fans flocked for cover, others went to the parking lot, some back to their tailgate parties or to local restaurants and bars”

~85% reported attendance (50,000)
NCAA Division-I Football Attendance

- Total Attendance in 2002 was 34,384,264 people
- Attendance increased 7.38% annually since 1999
- 117 teams in Division-I football
  - more than 16% of them have reported 100% or higher attendance at home games thus far in 2003.
  - 42.7% of schools averaged over 90% of capacity so far during the 2003 season
NCAA Division-I Football Event

**Frequency**

- 117 teams in Division-I football in 2002
  - 775 home games
- 3 teams added to D-I football since 2001
NCAA Guidelines

Recommend that all individuals should have left the athletics site and reached a safe structure or location by the time the monitor obtains a flash-to-bang count of 30 seconds.

- Lightning can ‘jump’ six miles from strike to strike
NCAA Guidelines are recommendations

In-house policies/procedures are highly variable and do not always follow NCAA recommendations!
ALTERNATIVES

A

Make existing NCAA guidelines MANDATORY

All persons in safe place BEFORE LIGHTNING IS 6 MILES AWAY

B

In-Situ protection

Retrofit stadiums to protect all areas - no evacuation necessary
CROWD DYNAMICS

Can you fit people in safe locations?

3 ft$^2$ per person = involuntary contact

How long will it take to move people?

Lightning Detection lead time > Evacuation time

Make existing NCAA guidelines MANDATORY

SAFETY ACHIEVED BEFORE LIGHTNING WITHIN 6 MILES
In Situ Protection

AUGMENT EXISTING STRUCTURAL PROTECTION

Additional Lightning Rods

Suspended Thin Wires over Open Locations

STADIUM PROTECTED = SPECTATORS DO NOT MOVE
In Situ Protection
In Situ Protection

Andrews, 2003
In Situ Protection

Andrews, 2003
In Situ Protection

Andrews, 2003
RECOMMENDATION

NCAA guidelines

Fear of Repeat from Past Lightning Problems

Satisfies Human Desire to Seek Shelter

In-Situ Protection

No Planning/Resources for Crowd Control

Leverages Inertia: Fans Won’t Move Anyway

USER DECISION

A

B
GETTING THE WORD OUT

Weatherwise 2005, Jan/Feb: “Safeguarding the Spectator”

AMS San Diego 2005, Poster at the Lightning Conference

Submitted to BAMS

FOR MORE:
http://ucsu.colorado.edu/gratz/
-> research
-> lightning & large stadiums
Questions?