New Developments in Modeling of Catastrophic Events

AIR Terrorism Loss Estimation Model

Jack Seaquist
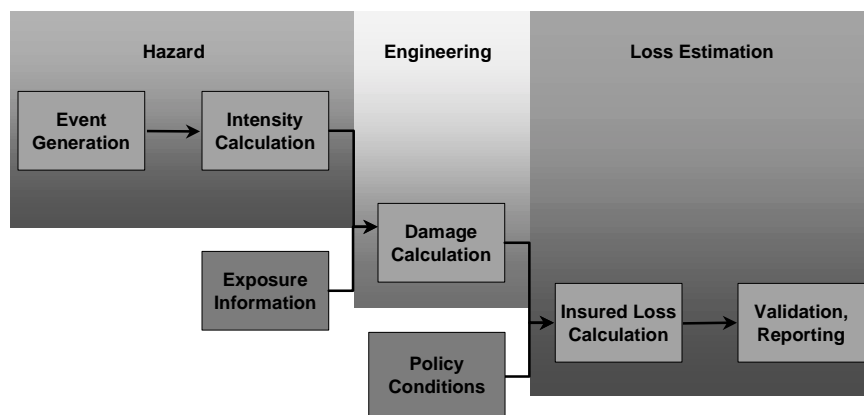
Terrorism Model Product Manager

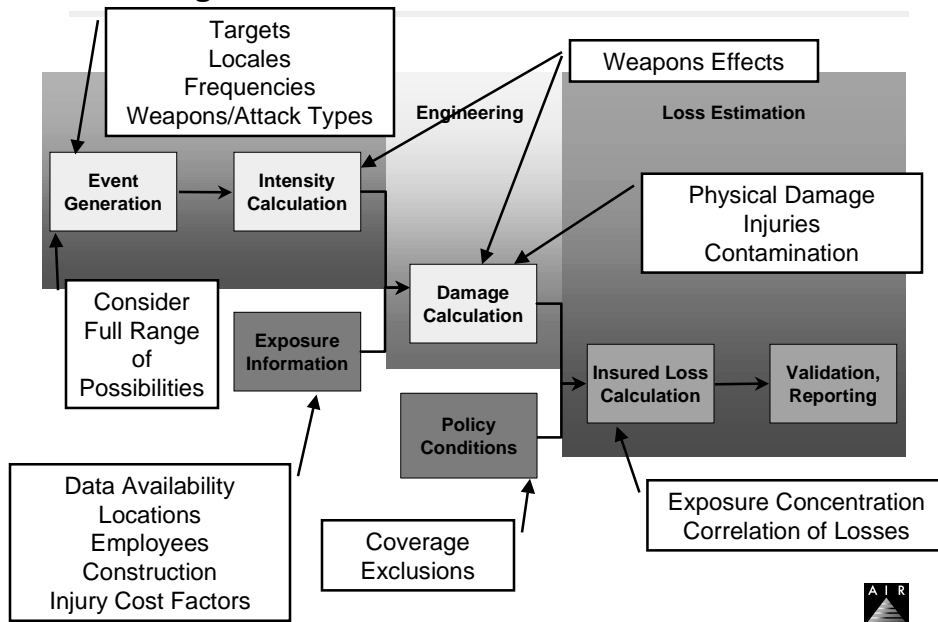AIR Worldwide Corporation

B E T T E R   T E C H N O L O G Y
B E T T E R   D A T A
B E T T E R   D E C I S I O N S

Components of Catastrophe Models

Hazard	Engineering	Loss Estimation
Event Generation → **Intensity Calculation**	**Damage Calculation**	**Insured Loss Calculation** → **Validation, Reporting**
Exposure Information		
	Policy Conditions	

Components of Catastrophe Models - Terrorism Challenges

Targets
Locales
Frequencies
Weapons/Attack Types

Weapons Effects

Engineering

Loss Estimation

Event Generation → **Intensity Calculation**

Consider Full Range of Possibilities

Exposure Information

Damage Calculation

Physical Damage
Injuries
Contamination

Insured Loss Calculation → **Validation, Reporting**

Policy Conditions

Data Availability
Locations
Employees
Construction
Injury Cost Factors

Coverage
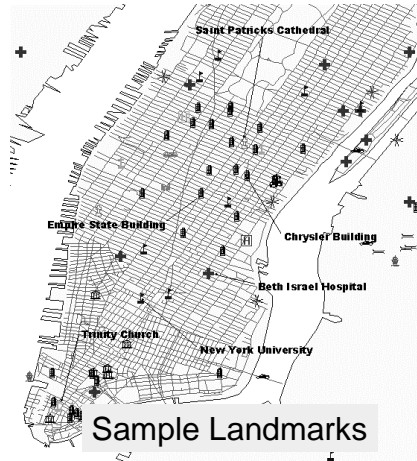Exclusions

Exposure Concentration
Correlation of Losses

Event Generation and Intensity Approach

❏ Generate comprehensive landmark database

❏ Use expert opinion for attack frequency and allocation to landmarks
  ➤ Delphi Method used to solicit expert opinion
  ➤ Individual terrorist groups considered independently

❏ Resulted in attack likelihood distribution for each individual landmark (Landmark Attack Vector)

❏ Generates full range of events that could happen

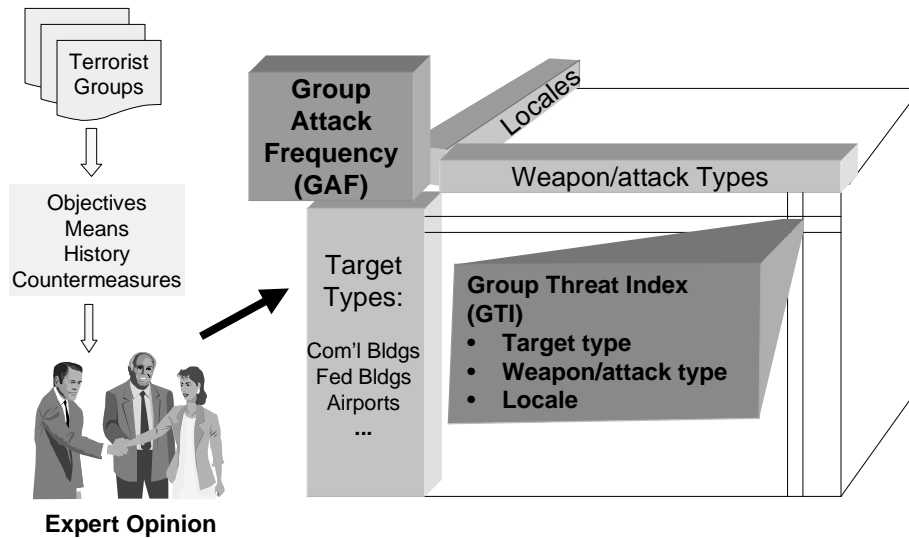## Landmark Database - Classification of Potential Terrorist Target Types

❑ Commercial facilities
  ➤ Prominent buildings
  ➤ Corporate headquarters
  ➤ Transportation facilities and critical infrastructure
  ➤ Industrial facilities
  ➤ Energy facilities
  ➤ Retail centers and malls
  ➤ Sport arenas and stadiums
  ➤ Amusement parks

❑ Government facilities
  ➤ Federal office buildings and courthouses
  ➤ Embassies
  ➤ Postal facilities

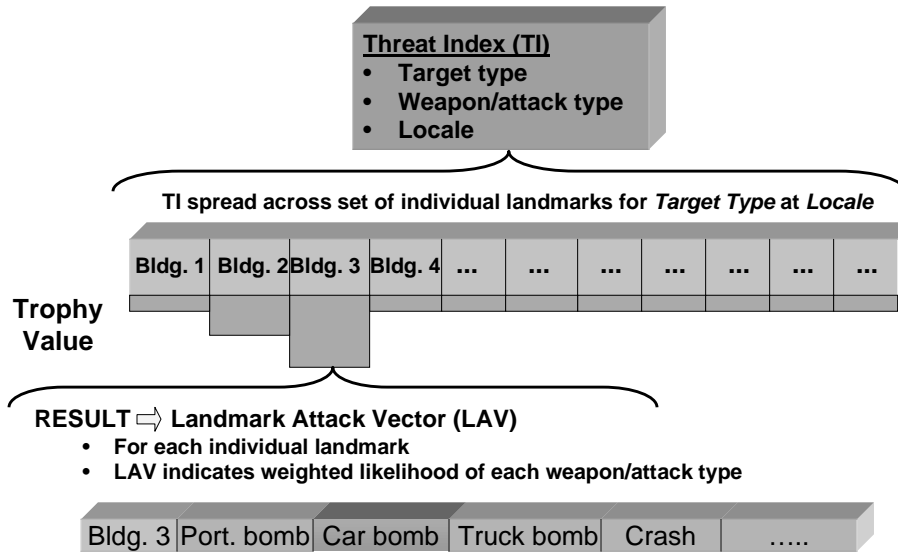❑ Educational, medical, and religious institutions

Sample Landmarks

Landmark Attack Vector (LAV) Development

Terrorist Groups

Objectives
Means
History
Countermeasures

Expert Opinion

Group Attack Frequency (GAF)

Locales

Weapon/attack Types

Target Types:

Com'l Bldgs
Fed Bldgs
Airports
...

Group Threat Index (GTI)
• **Target type**
• **Weapon/attack type**
• **Locale**

Threat Index (TI) is Spread across Individual Landmarks

Threat Index (TI)
- **Target type**
- **Weapon/attack type**
- **Locale**

TI spread across set of individual landmarks for *Target Type* at *Locale*

Bldg. 1	Bldg. 2	Bldg. 3	Bldg. 4	...	...	...	...	...	...	...

Trophy Value

RESULT ⇨ Landmark Attack Vector (LAV)
- **For each individual landmark**
- **LAV indicates weighted likelihood of each weapon/attack type**

Bldg. 3	Port. bomb	Car bomb	Truck bomb	Crash	.....

Weapon Intensity and Damage

Damage Pattern from Oklahoma City Bombing

Collapse

Extensive Damage

Moderate Damage

Slight Damage

April 19, 1995
168 killed
642 injured
$145M insured loss

Source: FEMA, 1996
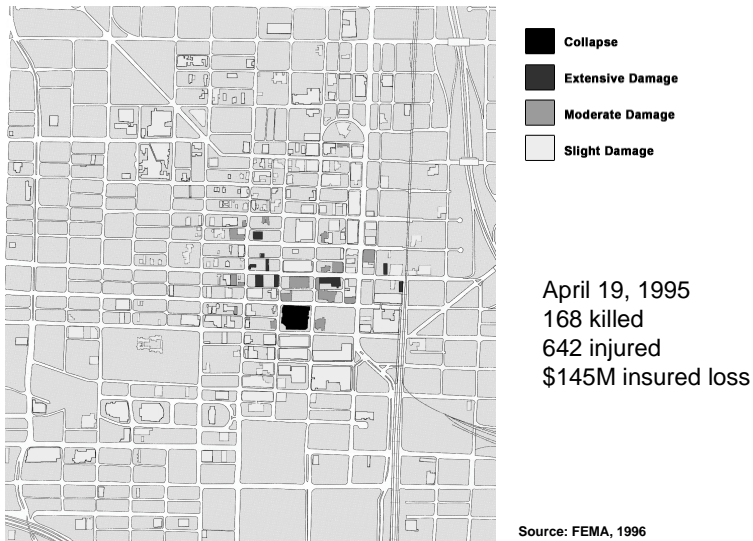
Damage and Casualty Estimates Consider Multiple Effects on the Target and Surrounding Buildings

```
      BOMB            AIRPLANE
      BLAST            CRASH

Shock    Pressure   Fire &    Explosion    Kinetic
Wave      Wave      Smoke                  Energy

Damage
Probability          TARGET BUILDING      →  DAMAGE;
Distributions                                CASUALTIES

          Falling   Projectiles  Falling    Dust
          Debris                 Structure

          SURROUNDING BUILDINGS           →  DAMAGE;
                                              CASUALTIES
```

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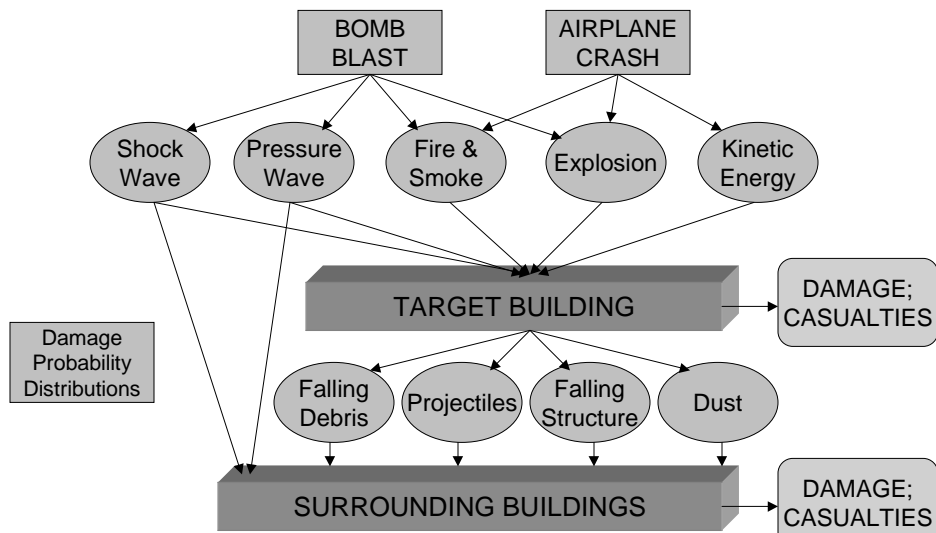
AIR Teams With Weidlinger Associates - Industry-Leading Blast Damage Expertise

- ❑ Leader in defense-related blast effects research and design for 50 years

- ❑ Only firm with experience in high rise, long span structural engineering and blast resistant design

- ❑ Developer of advanced analysis techniques for blast and impact calibrated with extensive field testing

- ❑ Performs terrorism vulnerability assessment and upgrade of major transportation facilities, courthouses, office buildings, and embassies

- ❑ Specializes in assessment of glazing and curtain wall hazards

- ❑ Simplified or detailed analyses

WEIDLINGER ASSOCIATES INC
Over 50 Years of Engineering Excellence

Advanced Blast/Impact Analysis

- ❑ Based on detailed information about building structure and occupancy

- ❑ Advanced analysis of structures using in-house transient nonlinear dynamic finite-element software code

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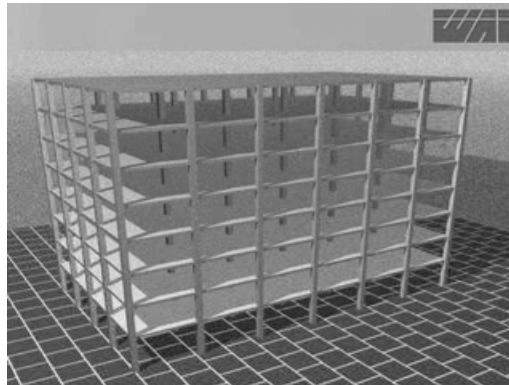
Exposure, Mortality and Damage Contours for CBRN

Sarin
Chemical Attack

Radiological
"Dirty" Bomb

Anthrax
Biological
Attack

Small Nuclear
Bomb
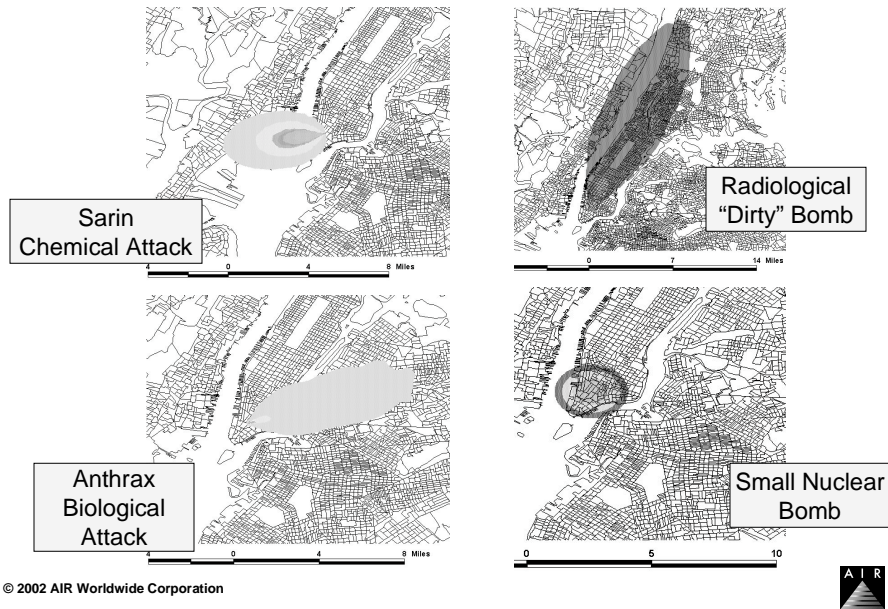
Now Being Used for Property and Workers Compensation Loss Analyses

❑ Evaluation of proximity of exposures to landmarks

❑ Deterministic analysis of specific exposures

❑ Fully probabilistic analysis of a special or general book of business

Concentration of Exposures Analysis

Midtown Manhattan
Rockefeller Center
Empire State Building

Employee Concentration
- Below 100
- Above 100
- Above 500
- Above 1,000
- Exposure Location
- Landmarks
- Park

Deterministic Analysis - Midtown Manhattan

- ❏ Delivery truck bomb
- ❏ 80,000 workers in surrounding area
- ❏ Damage sustained in 29 buildings
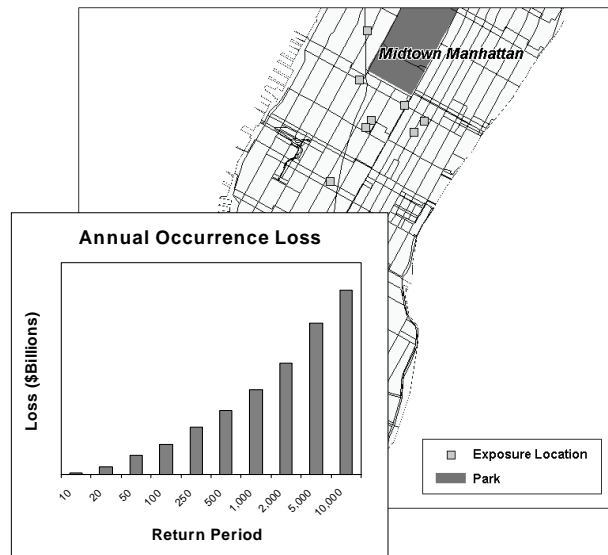- ❏ 5,000 estimated disability and fatality casualties

Sample Exposure Portfolio

Midtown Manhattan

Legend:
- Exposure Location
- Park
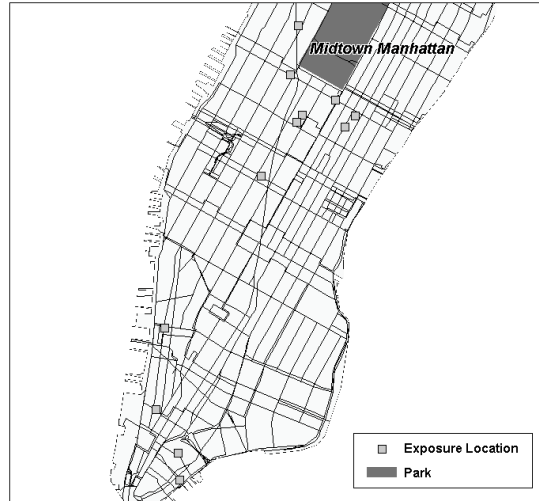
Workers' Compensation Loss Potential

Midtown Manhattan

Annual Occurrence Loss

Loss ($Billions) vs Return Period

Return Period: 10, 20, 50, 100, 250, 500, 1,000, 2,000, 5,000, 10,000

Legend:
- Exposure Location
- Park

Modeling Workers' Compensation

Components of AIR's Workers Compensation Model

Earthquake Events	**Engineering**
Building Information → **Damage ratio distribution** → **Damage state** → **Injury Severity Levels**	**Loss Estimation**
Terrorism Events	**Loss Calculation**
Number of Employees	
Cost of injuries	
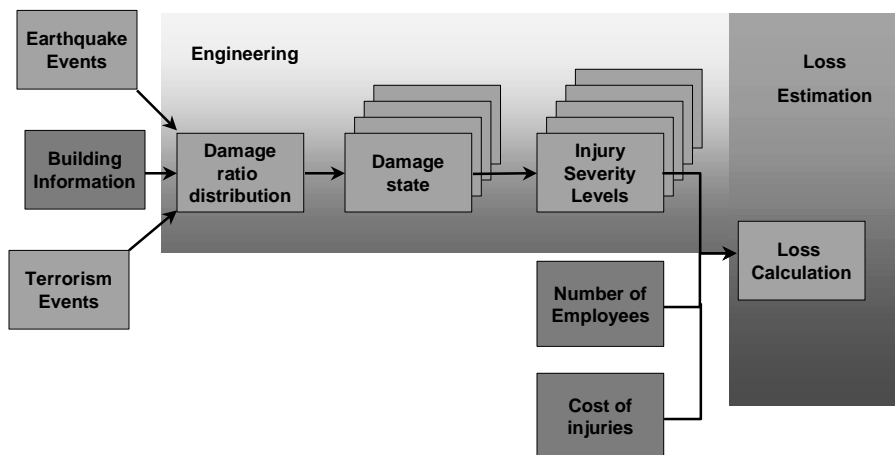
Building Physical Damage Distribution Mapped to Damage States
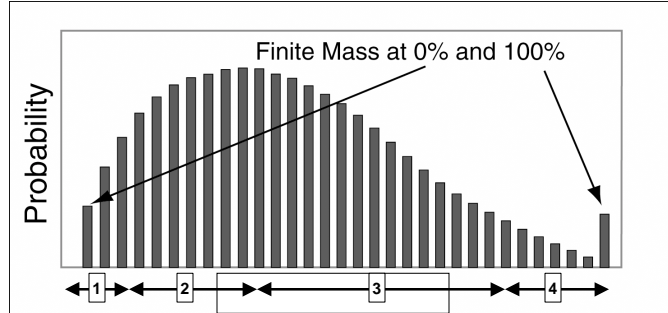
1 - Slight Damage
2 - Moderate Damage
3 - Extensive Damage
4 - Complete Damage
    - collapse
    - no collapse

Injury Severity Levels Defined

Injury Classification Scale

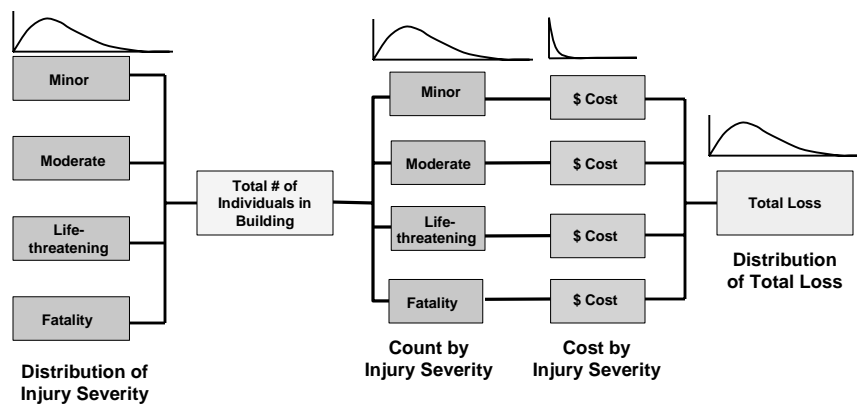| Injury Severity Level	Injury Description
Severity 1: Minor	Injuries requiring basic medical aid without requiring hospitalization
Severity 2: Moderate	Injuries requiring a greater degree of medical care and hospitalization, but not expected to progress to a life threatening status
Severity 3: Life Threatening	Injuries that pose an immediate life threatening condition if not treated adequately and expeditiously. The majority of these injuries are the result of structural collapse and subsequent entrapment or impairment of the occupants.
Severity 4: Fatality	Instantaneously killed or mortally wounded

Source: HAZUS®

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Damage States Determine Injury Severity Distribution
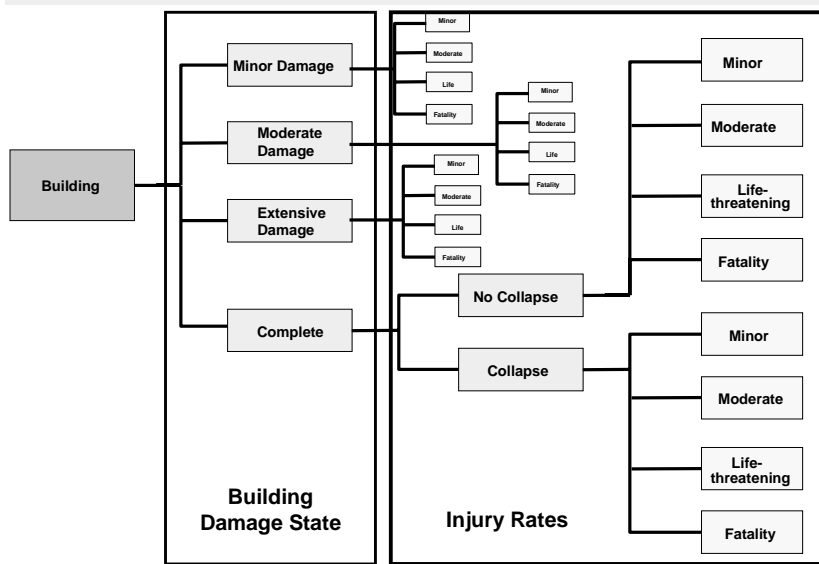
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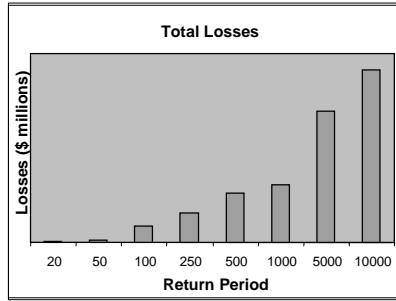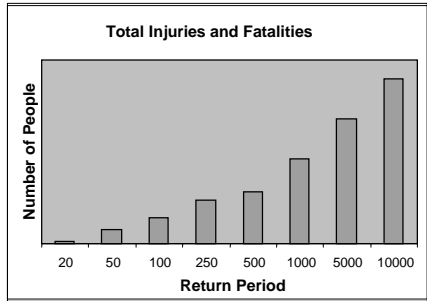# Calculation of Injury/Fatality Loss for Individual Building in One Event

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Total Injury and Loss Distributions

Total Injuries and Fatalities

Number of People

Return Period: 20 50 100 250 500 1000 5000 10000

Total Losses

Losses ($ millions)

Return Period: 20 50 100 250 500 1000 5000 10000

Data Needs

BETTER TECHNOLOGY
BETTER DATA
BETTER DECISIONS

Desired Data Requirements

- ❑ Number of people insured

- ❑ Building information for each location
  - ➤ Address
  - ➤ Construction type
  - ➤ Building age
  - ➤ Number of floors

- ❑ Typical location by time of day
  - ➤ Daytime, nighttime

- ❑ Benefits levels
  - ➤ AIR default values for workers' compensation
  - ➤ Average benefits under a policy
  - ➤ Full distribution from company experience

Typical Data Available

- ❑ Number of employees and payroll

- ❑ Company location

- ❑ Benefit levels under each policy

Geographic Resolution of Input Data

❑ Detailed data, down to the location level, is preferred

❑ If not available the data can also be provided in the following
geographic resolutions
  ➤ ZIP Code
  ➤ County
  ➤ State

❑ Aggregate level data will be distributed to the detail level before
the model is run

Simulated Industry Losses for Historical Earthquakes If They Were to Occur Today

Time of Occurrence	1906 San Francisco*	1811 New Madrid*
Night	76,672	671,789
Day	3,756,918	32,917,748
Commute	1,916,801	16,794,788

*Values in thousands of dollars

AIR Recommends You Use the Best Available Information to Manage Your Exposure to Terrorism

- ❑ Better data results in better analysis
- ❑ Understand your potential losses
- ❑ Evaluate your reinsurance needs
- ❑ Negotiate a better price
- ❑ Manage exposure