Terrorism Risk in Australia

November 2004

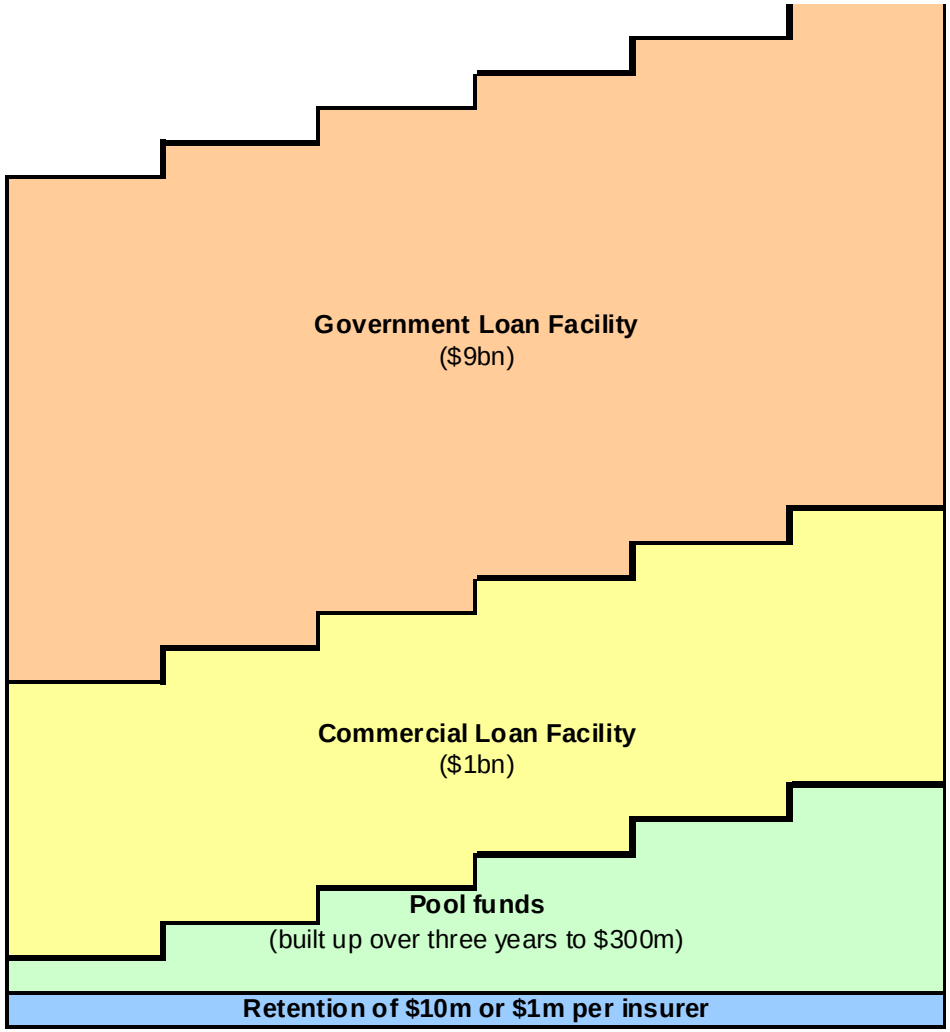
Aon Re Australia Limited

Will Gardner

BEc, FIAA, FSA, MAAA, Affiliate of CAS

Gardner, Will (2004, November). Terrorism risk in Australia. Aon Re Australia Ltd. Presentation, Actuaries Institute (Australia): at http://www.actuaries.asn.au/Library/iaca_presentation_gardner-will.pdf (retrieved 29 July 2016).

Australian Reinsurance Pool



Why Quantify Terrorism?

- Insurers may want to determine
  - How their relative risk of terrorism compares to their peers
  - The maximum potential event loss
  - How much to charge for the Pool retention
  - Whether to retain the risk or not
  - Whether or not to be in the Pool or use reinsurance instead
- Interested parties may want to determine
  - Potential industry losses
  - Key target types driving the losses
  - Key attack types driving the losses

Details of How to Model Terrorism

- Please refer to

"Terrorism Catastrophe Models"

Will Gardner

Institute of Actuaries of Australia

XIV General Insurance Seminar 2003

9-12 November 2003

  - Available from IAA website

Agenda

1. Review of Probabilistic Analysis Methodology
2. Probable Maximum Loss (PML) Analysis of Potential Australian Exposure
3. Review of Components of “Industry” PML
4. Conclusions

Section 1

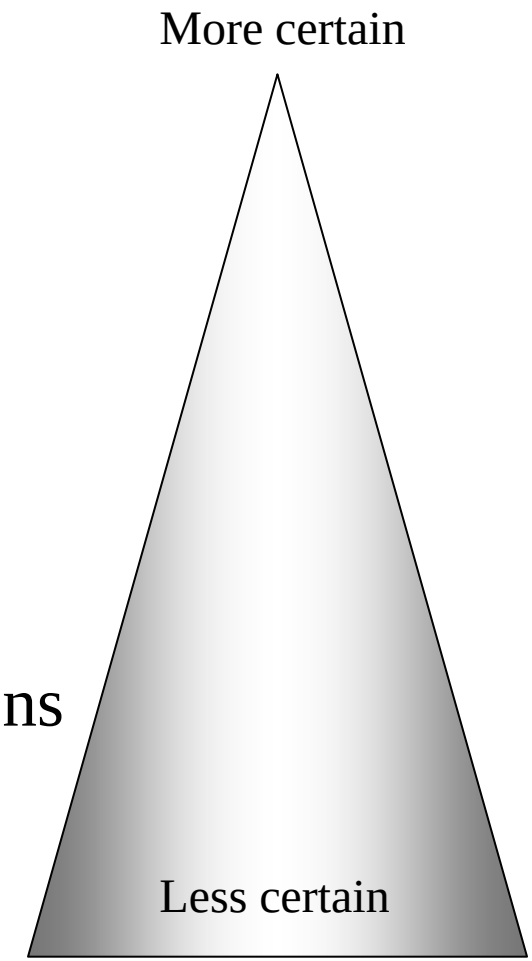
Probabilistic Analysis Methodology

Terrorism – Different to natural perils

	Tropical Cyclone	Terrorism
Where?	Category 5 hurricane crosses over Philippines	Two ton truck bomb detonated at United Nations
What?	Wind speeds at each distance from eye cause given levels of damage, leading to financial and human loss	Shock waves and fire cause damage at each distance, leading to financial and human loss
When?	Based on historic records and scientific analysis, this event is expected once every 250 years	??? Human behaviour ???

Expanding Funnel of Doubt

- Exposure concentrations
- Concentrations at targets
- Relative concentrations
- Potential losses
- Distribution of loss given event happens
- Distribution of loss (PML)



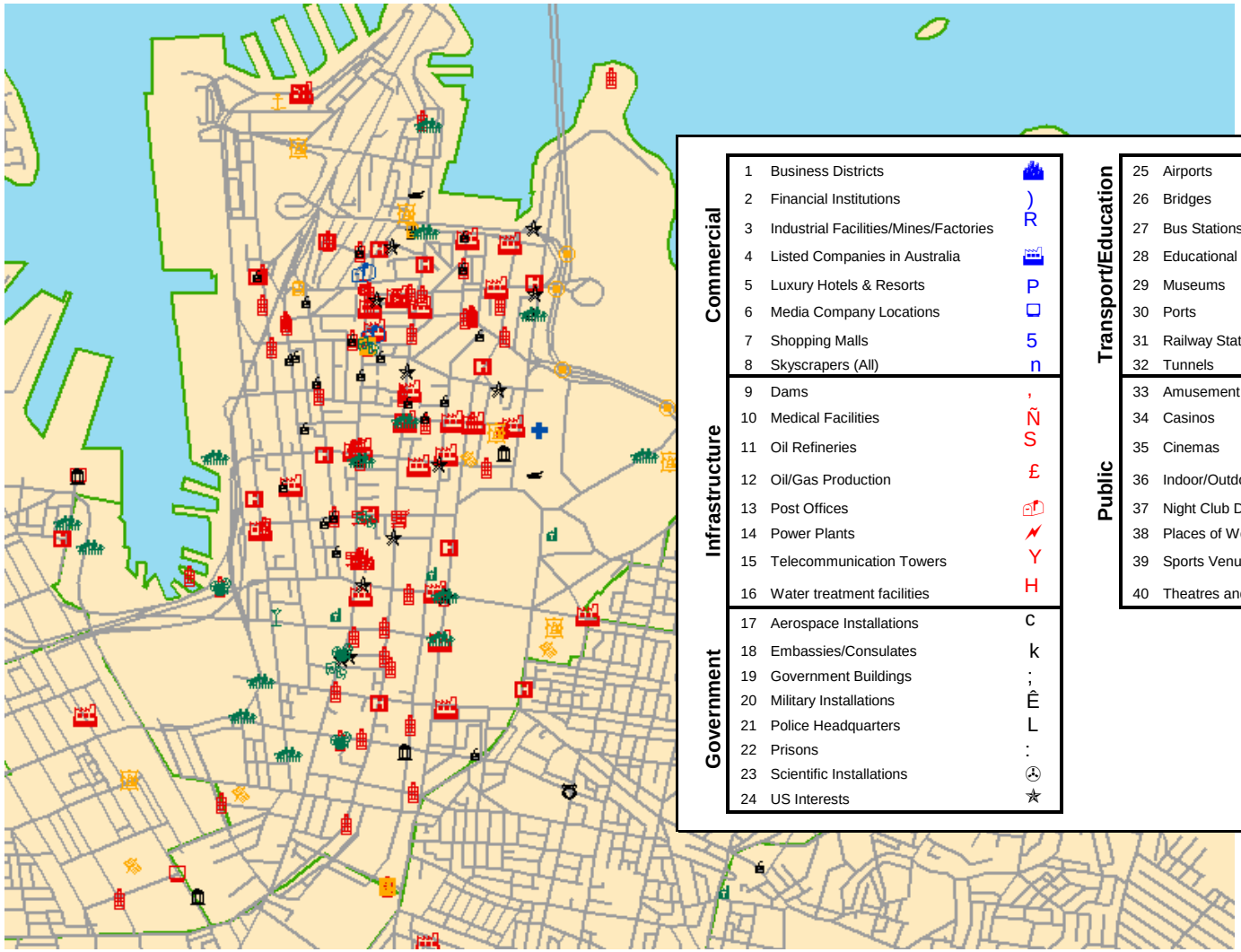
Top 50 Property Concentrations

Rank	Location	Suburb	State	Exposure within 250 metres
1	Postcode 3005	WORLD TRADE CENTRE	VIC	$787,401,575
2	Postcode 2139	CONCORD REPATRIATION HOSPITAL	NSW	$586,510,264
3	Postcode 4006	NEWSTEAD	QLD	$536,452,610
4	Postcode 2129	SYDNEY MARKETS	NSW	$515,463,918
5	Postcode 4029	ROYAL BRISBANE HOSPITAL	QLD	$396,825,397
6	Postcode 2006	THE UNIVERSITY OF SYDNEY	NSW	$355,871,886
7	Postcode 2007	ULTIMO	NSW	$337,837,838
8	Postcode 6701	YANDOO CREEK	WA	$335,465,078
9	Postcode 2061	MILSONS POINT	NSW	$309,119,011
10	Postcode 2296	ISLINGTON	NSW	$267,737,617
11	Postcode 2297	TIGHES HILL	NSW	$244,498,778
12	Postcode 2043	ERSKINEVILLE	NSW	$241,254,524
13	Postcode 3050	ROYAL MELBOURNE HOSPITAL	VIC	$232,558,139
14	Postcode 2050	MISSENDEN ROAD	NSW	$220,264,317
15	Postcode 3254	CORONOOKE	VIC	$213,219,616
16	Postcode 2028	DOUBLE BAY	NSW	$210,084,034
17	Postcode 2008	GOLDEN GROVE	NSW	$208,986,416
18	Postcode 2009	PYRMONT	NSW	$200,601,805
19	Postcode 2027	POINT PIPER	NSW	$182,481,752
20	Postcode 2089	NEUTRAL BAY JUNCTION	NSW	$181,983,621
21	Postcode 2293	WICKHAM	NSW	$177,462,289
22	Postcode 2025	WOOLLAHRA	NSW	$177,304,965
23	Postcode 3835	THORPDALE	VIC	$173,913,043
24	Postcode 2016	REDFERN	NSW	$173,460,538
25	Postcode 2048	WESTGATE	NSW	$169,923,534

Aon Re Australia Terrorism Risk Database

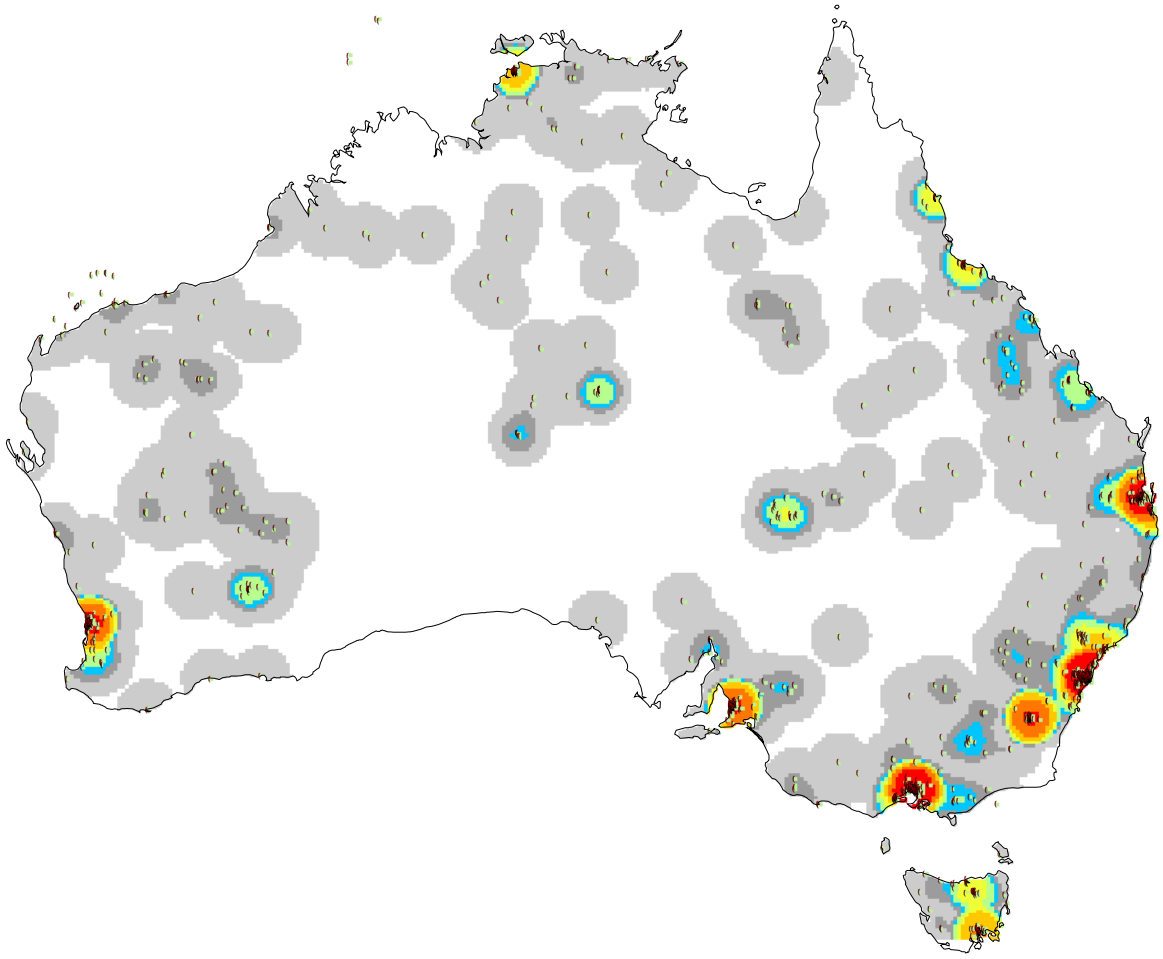
Commercial	
Business Districts	19
Financial Institutions	9
Industrial Facilities/Mines/Factories	156
Listed Companies in Australia	84
Luxury Hotels & Resorts	85
Media Company Locations	47
Shopping Malls	70
Skyscrapers (All)	228
Infrastructure	
Dams	16
Medical Facilities	47
Oil Refineries	9
Oil/Gas Production	50
Post Offices	33
Power Plants	60
Telecommunication Towers	53
Water treatment facilities	39
Government	
Aerospace Installations	15
Embassies/Consulates	179
Government Buildings	50
Military Installations	92
Police Headquarters	9
Prisons	28
Scientific Installations	26
US Interests	31
Transport/Education	
Airports	36
Bridges	54
Bus Stations	23
Educational Facilities	99
Museums	37
Ports	23
Railway Stations	44
Tunnels	28
Public	
Amusement Venues	26
Casinos	14
Cinemas	71
Indoor/Outdoor Venues	69
Night Club Districts	12
Places of Worship	54
Sports Venues	49
Theatres and Concert Halls	33
Grand Total	2107

Close-Up of Potential Targets

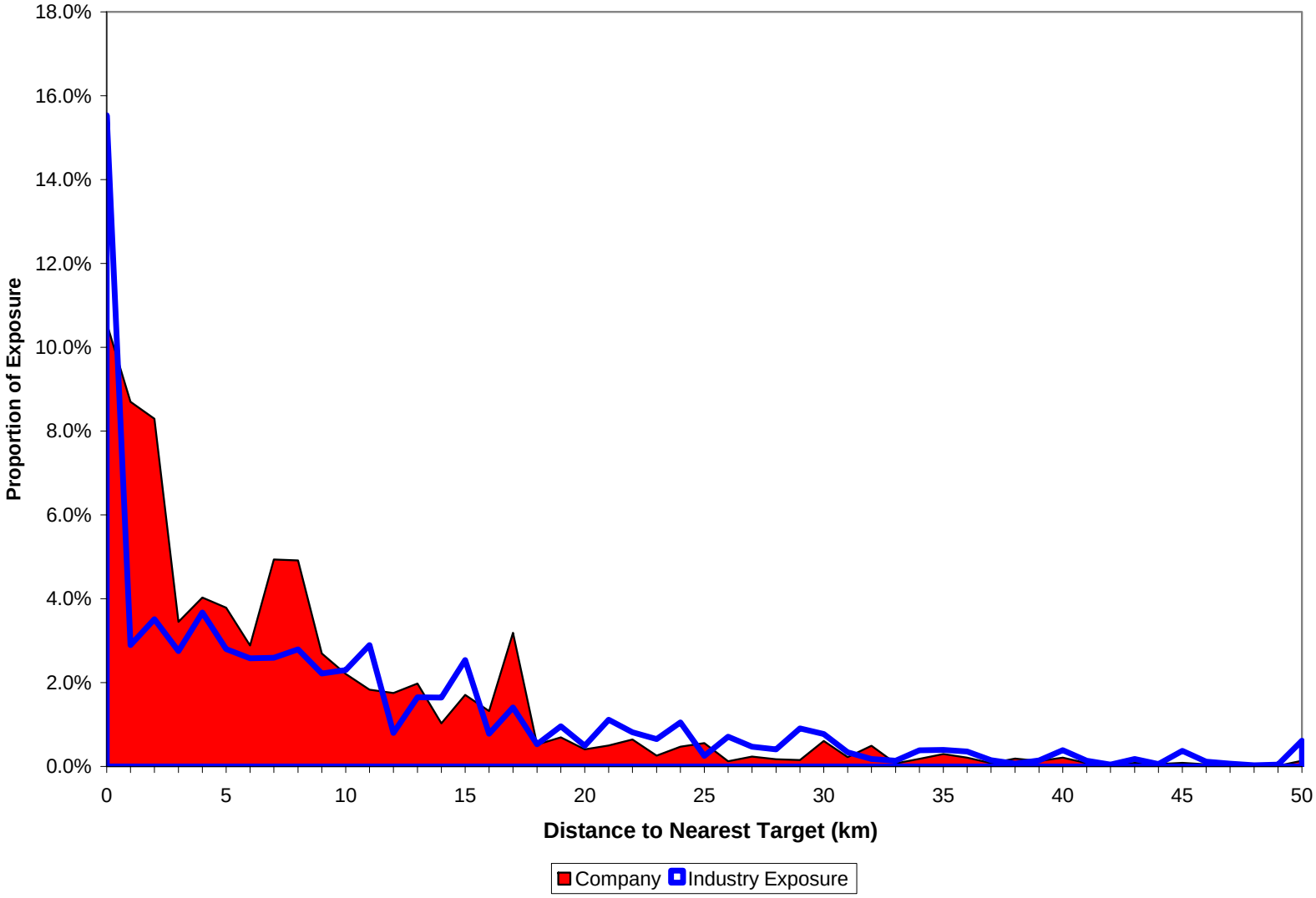


Commercial	1	Business Districts
	2	Financial Institutions
	3	Industrial Facilities/Mines/Factories
	4	Listed Companies in Australia
	5	Luxury Hotels & Resorts
	6	Media Company Locations
	7	Shopping Malls
	8	Skyscrapers (All)
Infrastructure	9	Dams
	10	Medical Facilities
	11	Oil Refineries
	12	Oil/Gas Production
	13	Post Offices
	14	Power Plants
	15	Telecommunication Towers
	16	Water treatment facilities
Government	17	Aerospace Installations
	18	Embassies/Consulates
	19	Government Buildings
	20	Military Installations
	21	Police Headquarters
	22	Prisons
	23	Scientific Installations
	24	US Interests
Transport/Education	25	Airports
	26	Bridges
	27	Bus Stations
	28	Educational Facilities
	29	Museums
	30	Ports
	31	Railway Stations/Facilities
	32	Tunnels
Public	33	Amusement Venues
	34	Casinos
	35	Cinemas
	36	Indoor/Outdoor Venues
	37	Night Club Districts
	38	Places of Worship
	39	Sports Venues
	40	Theatres and Concert Halls

Aon Terrorism Risk Database
Target Density



Company Target Relativity Comparison
Major Skyscrapers



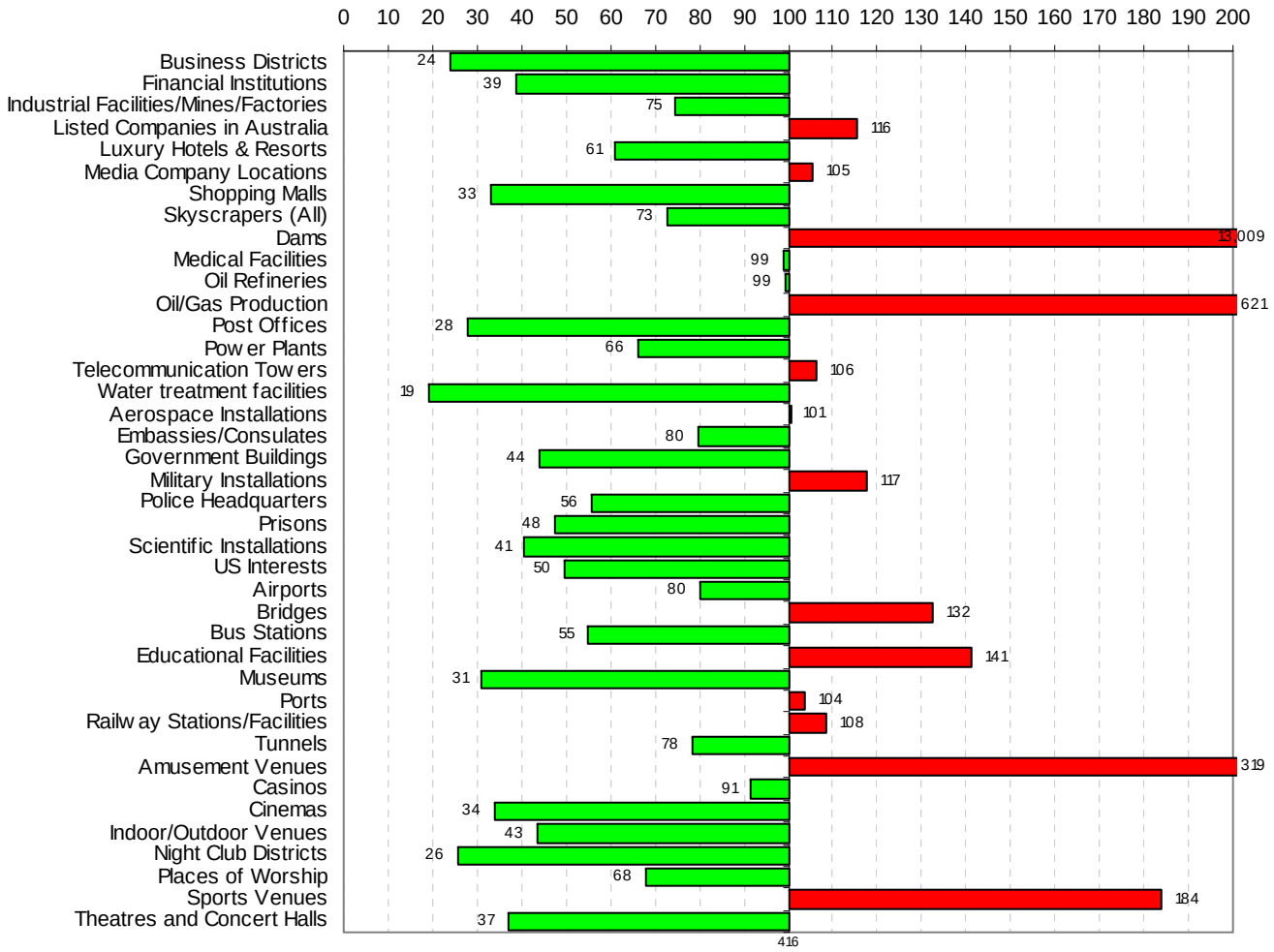
Terrorism Risk Index (TRI)

$$TRI = 100 * \frac{\text{Average distance to nearest target weighted by Industry Exposure}}{\text{Average distance to nearest target weighted by Company Exposure}}$$

TRI > 100	Company exposure located relatively closer to targets
TRI = 100	Company exposure located relatively same as industry
TRI < 100	Company exposure located relatively further from targets

- Industry exposure file is based on Aon Re's proprietary industry exposure database
  - Includes residential and commercial property
  - Includes building, contents and time element coverages

Company Target Relativity Comparison
Terrorism Risk Indices – Exponential Weights



Top 50 Property Concentrations at Targets

Rank	Location	Suburb	State	Exposure within 250 metres
1	Yarras Edge 5	Melbourne	VIC	$787,401,575
2	Yarras Edge 6	Melbourne	VIC	$787,401,575
3	Yarra's Edge 1	Melbourne	VIC	$787,401,575
4	Concord Hospital	Concord	NSW	$586,510,264
5	Royal Brisbane Hospital	Herston	QLD	$396,825,397
6	Royal Prince Alfred Hospital	CAMPERDOWN	NSW	$355,871,886
7	University Of Sydney	THE UNIVERSITY OF SYDNEY	NSW	$355,871,886
8	Sydney Harbour Bridge North	Milsons Point	NSW	$309,119,011
9	Sydney Harbour Tunnel North	North Sydney	NSW	$309,119,011
10	Luna Park Sydney	Milsons Point	NSW	$309,119,011
11	Royal Melbourne Hospital	ROYAL MELBOURNE HOSPITA	VIC	$232,558,139
12	2GB	Pyrmont	NSW	$200,601,805
13	Channel 10 - NSW	Pyrmont	NSW	$200,601,805
14	Tunisia	Edgacliff	NSW	$182,481,752
15	Ukraine	Edgecliffe	NSW	$182,481,752
16	Vietnam	Edgecliffe	NSW	$182,481,752
17	Nepal	Edgecliffe	NSW	$182,481,752
18	Ascham Girls School	DARLING POINT	NSW	$182,481,752
19	TEMPLE EMANUEL	Woollahra	NSW	$177,304,965
20	Redfern Oval	Redfern	NSW	$173,460,538
21	Jessie Street Centre	Parramatta	NSW	$153,846,153
22	The Scots College	BELLEVUE HILL	NSW	$96,246,391
23	Deakin University	DEAKIN UNIVERSITY	VIC	$88,495,575
24	Presbyterian Ladies College	CROYDON	NSW	$78,709,170
25	North Sydney	North Sydney	NSW	$71,275,837

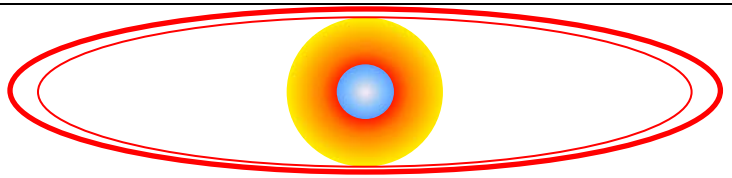
Terrorist Attack Types

4	7	7	3	3
Nuclear	**Conventional**	**Radiological**	**Biological**	**Chemical**
100 kiloton	Cruise missile	Cruise missile	Large event	Large event
20 kiloton	Multiple aircraft	Multiple aircraft	Medium event	Medium event
10 kiloton	Single aircraft	Single aircraft	Small event	Small event
1 kiloton	Large truck bomb	Large truck bomb		
	Small truck bomb	Small truck bomb		
	Car bomb	Car bomb		
	Human bomb	Human bomb		

Total attack types = 24

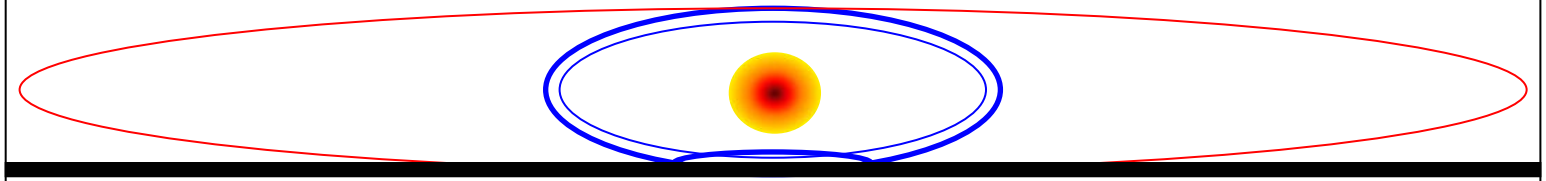
The Four Stages of a Nuclear Blast

1



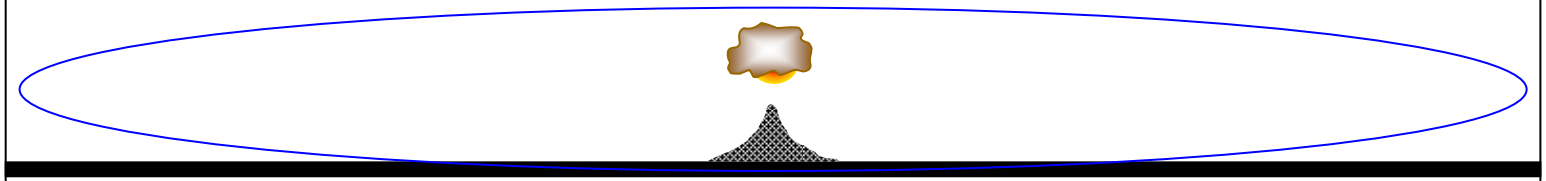
Blinding flash of light. Fireball of 10,000,000 degrees C. Radiant heat traveling at the speed of light.

2



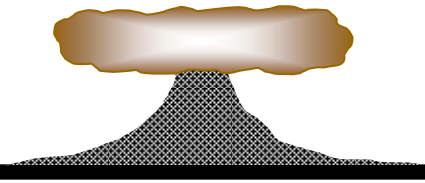
Blast wave of high pressure, moving at the speed of sound. Part of the wave is reflected by the ground.

3



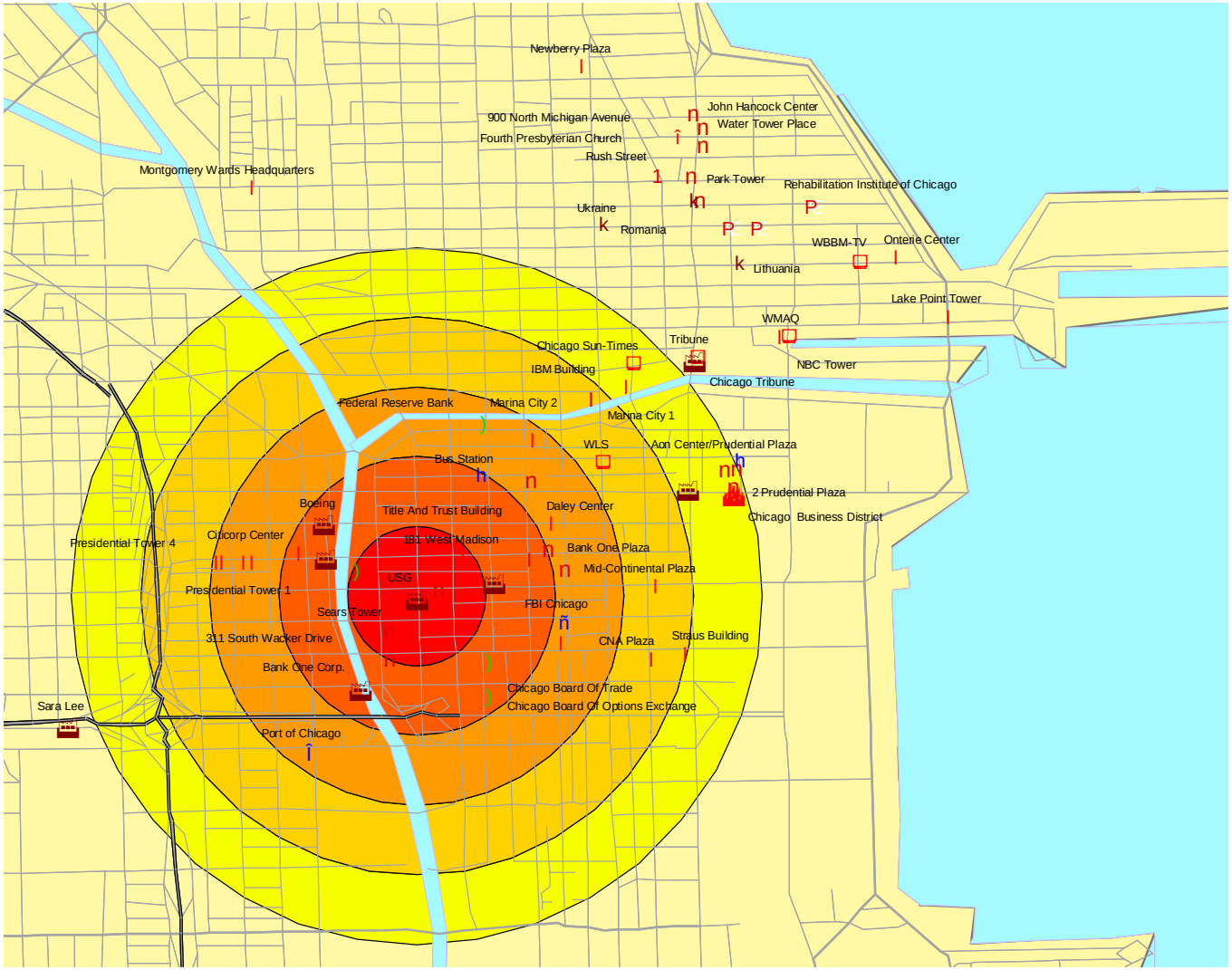
Negative pressure phase drawing winds inwards and upwards. Fireball and hot gases move upwards.

4

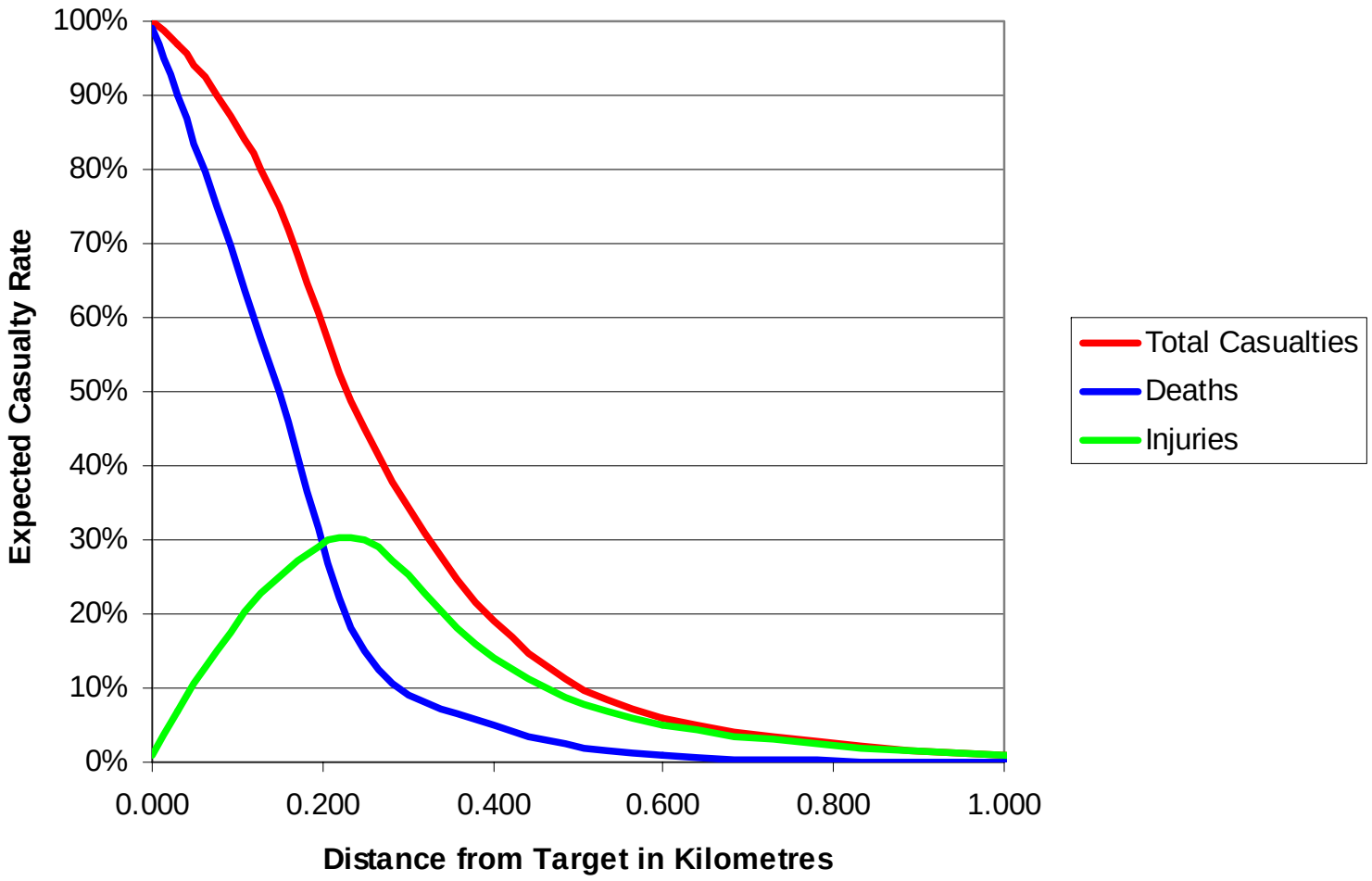


Dirt and debris sucked upward into rising column of hot gases and smoke to form mushroom cloud.

Deterministic Geo-spatial Analysis



Damage Curves
Example: Conventional Attack - Large Truck Bomb



Deterministic Scenario Loss

Target Number	**27**
Name	**Reserve Bank Of Australia - Adelaide**
Address	**182 Victoria Square**
City	**Adelaide**
State	**SA**

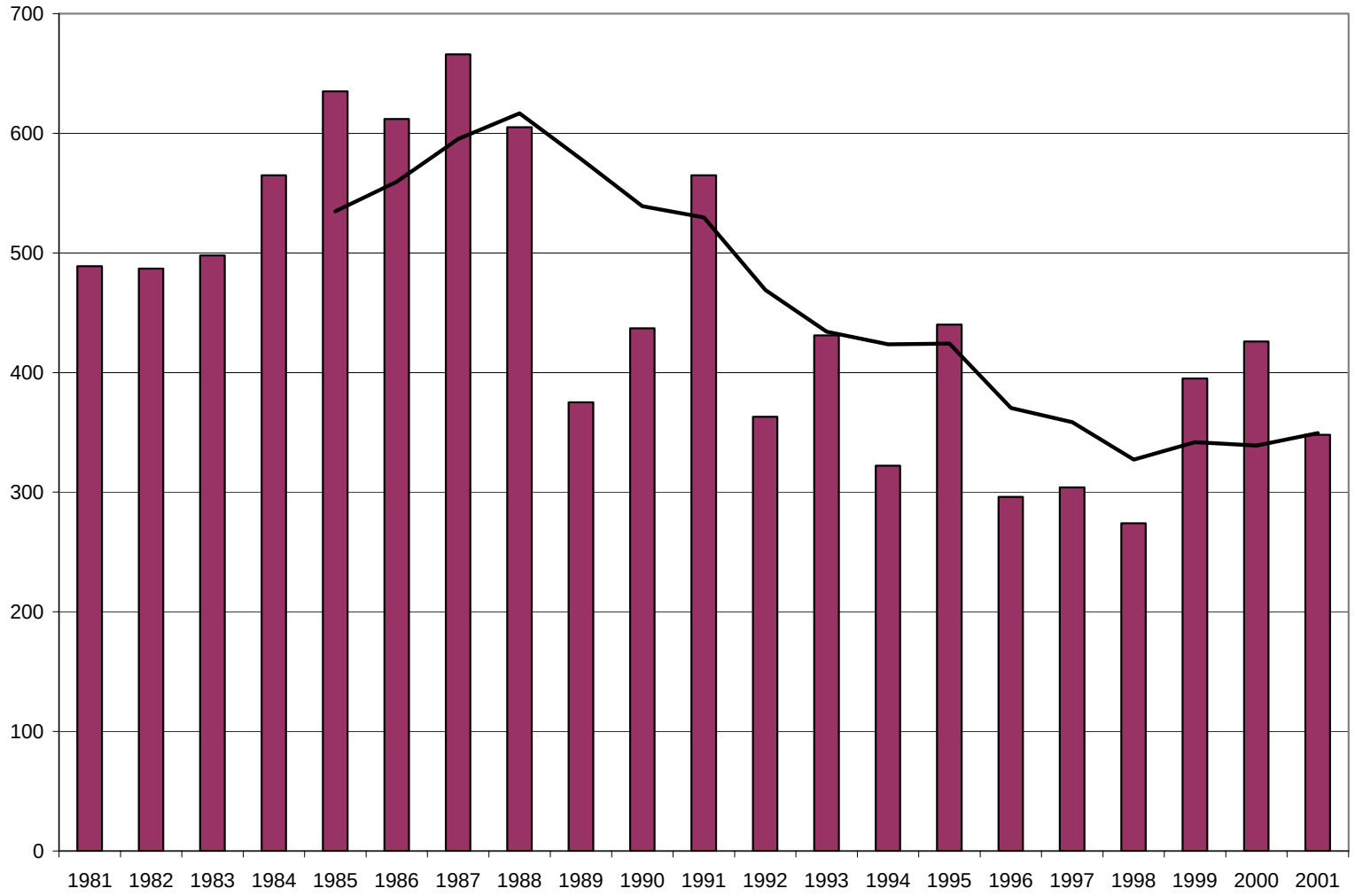
Attack Index	Attack Type	Expected Loss
1	Nuclear - 200 Kiloton	226,501,088
2	Nuclear - 20 Kiloton	174,723,559
3	Nuclear - 10 Kiloton	112,523,093
4	Nuclear - 1 Kiloton	83,752,385
5	Conventional - Cruise Missile Attack	4,037,915
6	Conventional - Multiple Aircraft	5,177,315
7	Conventional - Single Aircraft	3,145,328
8	Conventional - Large Truck Bomb	1,506,309
9	Conventional - Small Truck Bomb	800,224
10	Conventional - Car Bomb	444,037
11	Conventional - Human Bomb	13,320
12	Radiological - Cruise Missile Attack	7,358,117
13	Radiological - Multiple Aircraft	7,424,596
14	Radiological - Single Aircraft	4,141,269
15	Radiological - Large Truck Bomb	3,129,070
16	Radiological - Small Truck Bomb	2,550,403
17	Radiological - Car Bomb	1,866,027
18	Radiological - Human Bomb	1,282,064
19	Biological - Large Attack	8,875,172
20	Biological - Medium Attack	1,452,493
21	Biological - Small Attack	256,539
22	Chemical - Large Attack	16,312,988
23	Chemical - Medium Attack	2,536,491
24	Chemical - Small Attack	304,646

Probability

- Need to estimate
  - Conditional probability by target type
  - Conditional probability by attack type
  - Total annual probability

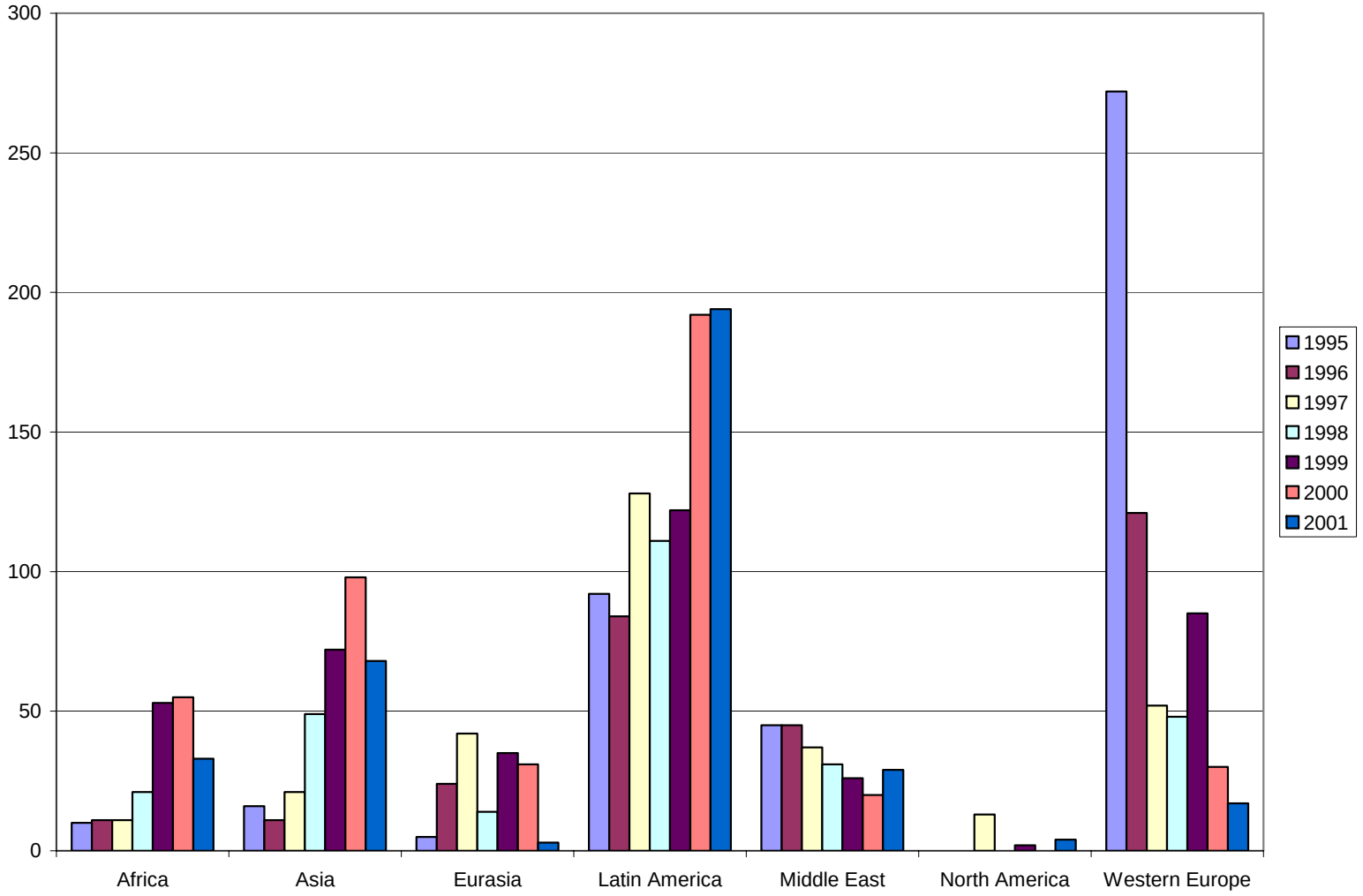
- Problems
  - Lack of “statistics”
  - Stochastic probabilities
    - Typical risk date 0-24 months = average 12 months in future
    - Affected by world events

Total International Terrorist Attacks (1981-2001)



Source : Office of the Secretary of State (April 2001, May 2002)

Total International Attacks by Region (1995-2001)



Source : Office of the Secretary of State (April 2001, May 2002)

Section 2

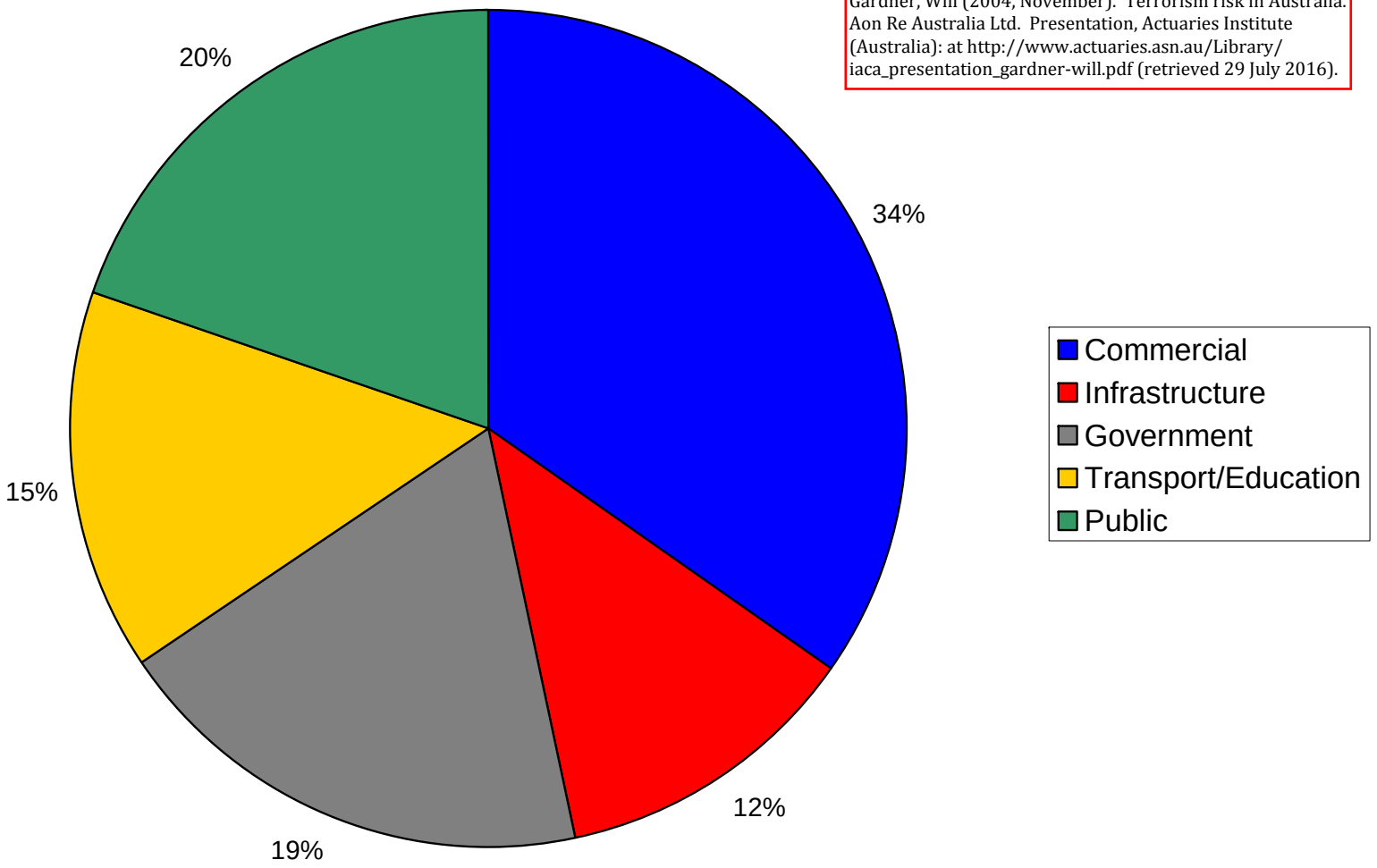
PML Analysis on Australian Exposure

Australian “Industry” Exposure

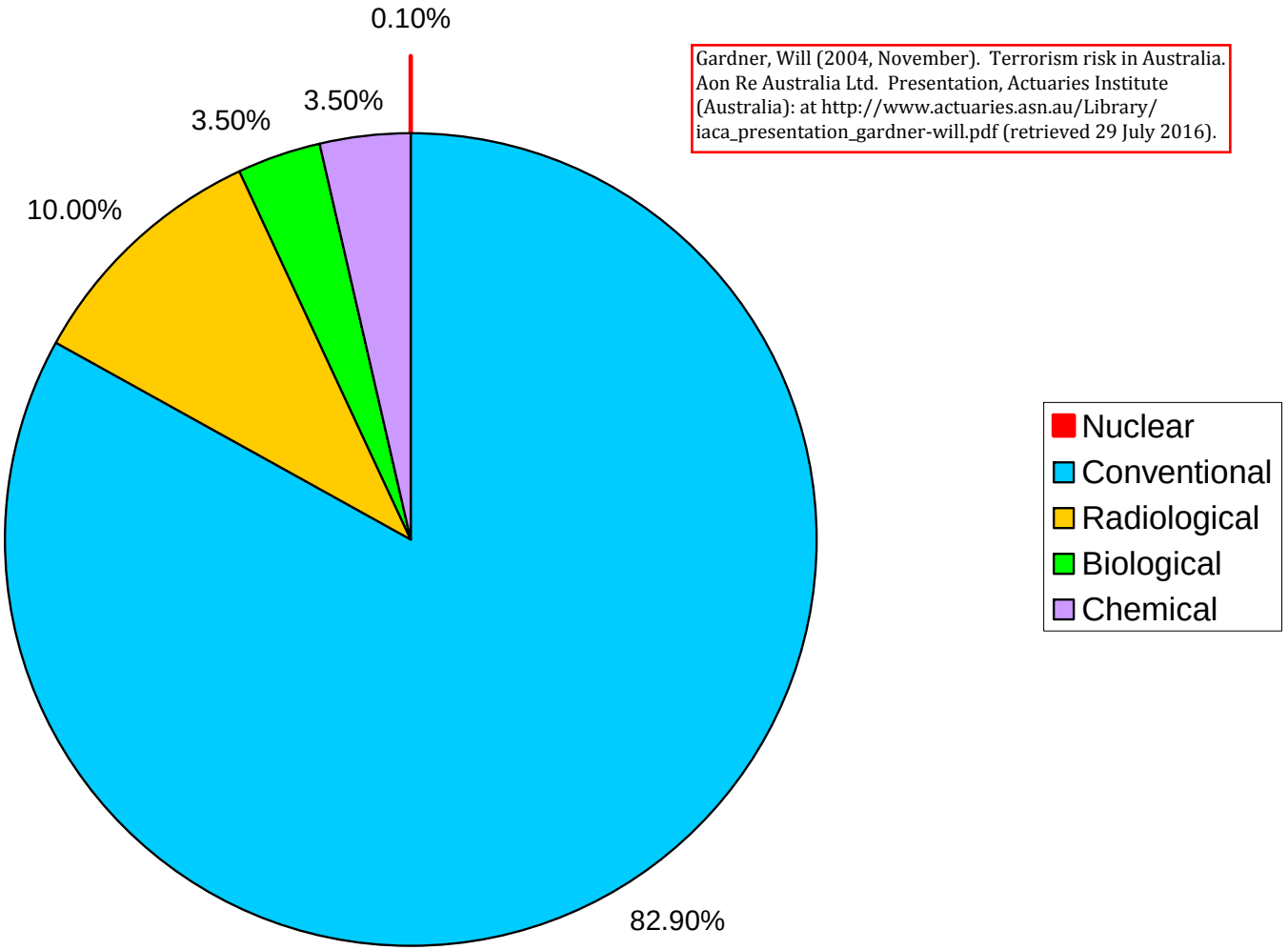
- Commercial Property
  - Building, Contents and Business Interruption
  - Covered by Terrorism ARPC
- Residential Property
  - Building, Contents and Time Element
    - Loss of use includes Rent or Temporary Accommodation
- Government Insured Property
  - Does not include self-insured portion
  - Does not include transport and amenities infrastructure
- Human Lives
  - Assumed average of $300,000 Sum Insured
- Workers Compensation
  - Assumed average of $250,000 per injury or death

Conditional Probability by Target Type

Gardner, Will (2004, November). Terrorism risk in Australia. Aon Re Australia Ltd. Presentation, Actuaries Institute (Australia): at http://www.actuaries.asn.au/Library/iaca_presentation_gardner-will.pdf (retrieved 29 July 2016).



Conditional Probability by Attack Type



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Annual Attack Frequency

- Difficult to determine a fixed frequency assumption
- Estimate "reasonable" range of annual frequency

Annual Frequency	One Attack Every	Pr[No attacks in One year]	Pr[No attacks in Three years]
0.050	20 years	95%	86%
0.125	8 years	88%	69%
0.250	4 years	78%	47%
0.500	2 years	61%	22%
1.250	9.6 months	29%	2%

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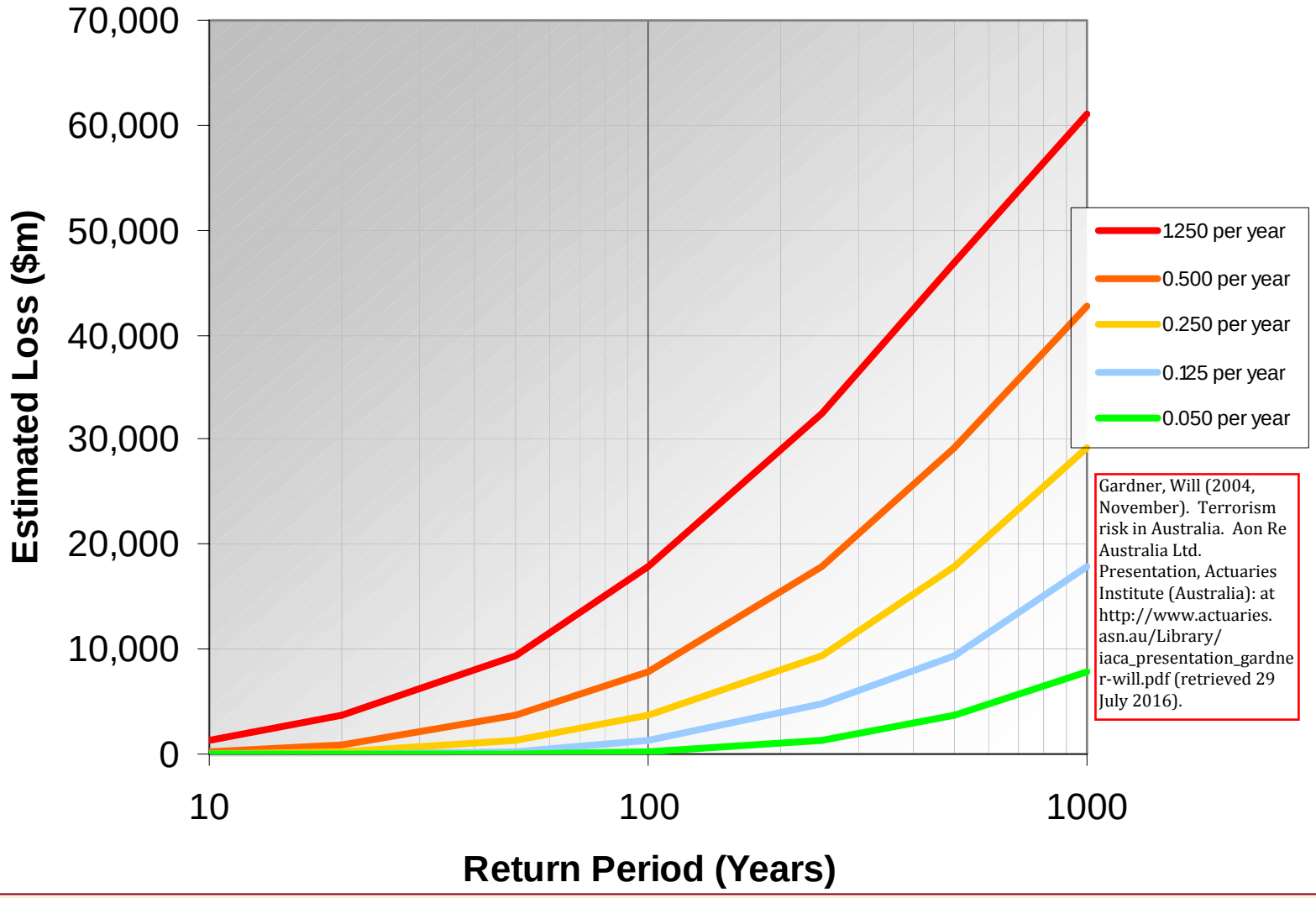
Probable Maximum Loss (PML)

Exceedence Probability	Return Period	0.050 per year	0.125 per year	0.250 per year	0.500 per year	1.250 per year
0.1%	**1000**	**$7,778m**	**$17,950m**	**$29,132m**	**$42,833m**	**$61,132m**
0.2%	500	$3,698m	$9,366m	$17,950m	$29,132m	$46,955m
0.4%	250	$1,251m	$4,727m	$9,366m	$17,950m	$32,567m
1.0%	**100**	**$179m**	**$1,251m**	**$3,698m**	**$7,778m**	**$17,950m**
2.0%	50	$9m	$312m	$1,251m	$3,698m	$9,366m
5.0%	20	$1m	$9m	$179m	$805m	$3,698m
10.0%	**10**	**$1m**	**$1m**	**$9m**	**$179m**	**$1,251m**

Gardner, Will (2004, November). Terrorism risk in Australia. Aon Re Australia Ltd. Presentation, Actuaries Institute (Australia): at http://www.actuaries.asn.au/Library/iaca_presentation_gardner-will.pdf (retrieved 29 July 2016).

Probable Maximum Loss (PML)



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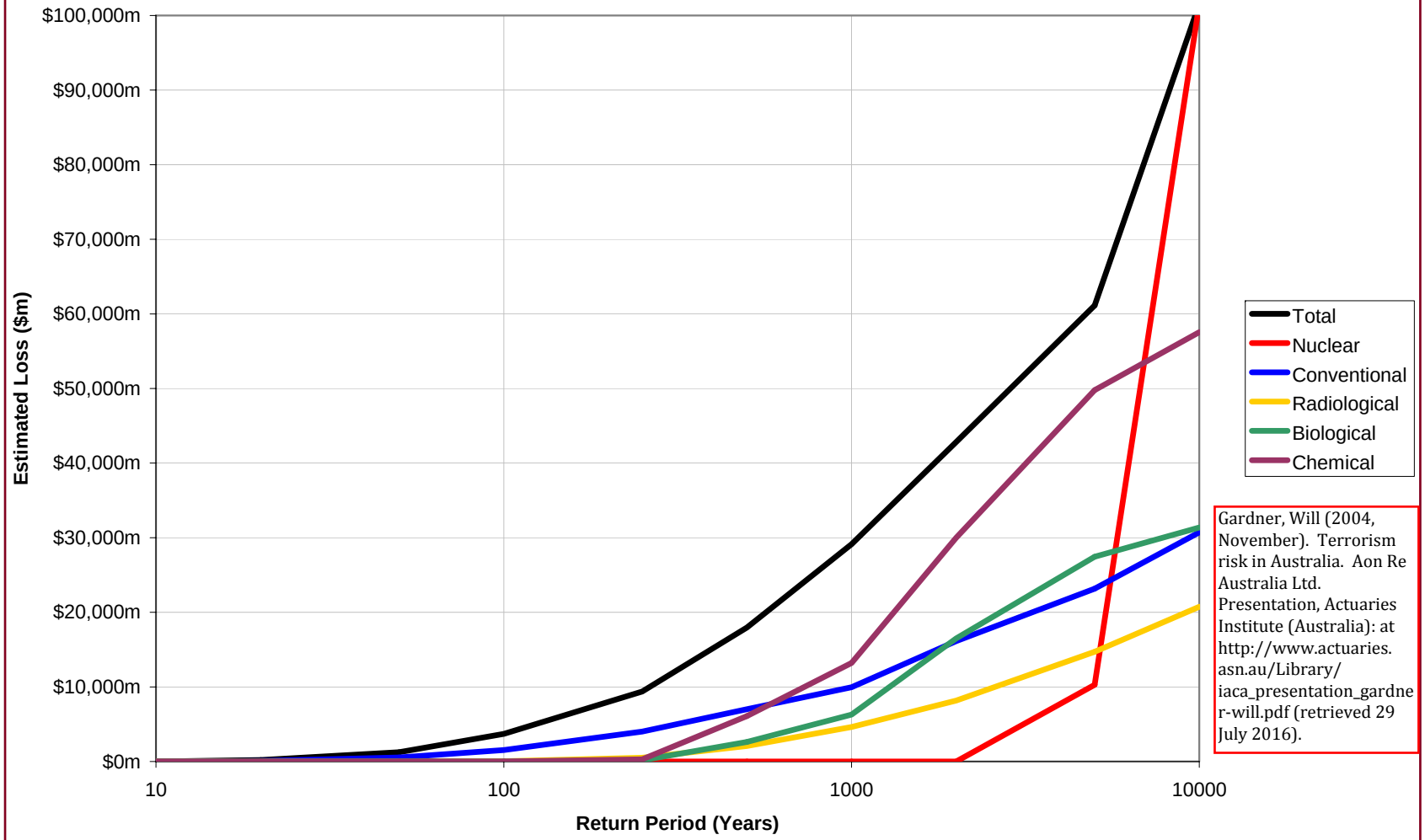
Section 3

Components of Industry PML

PML by Attack Type



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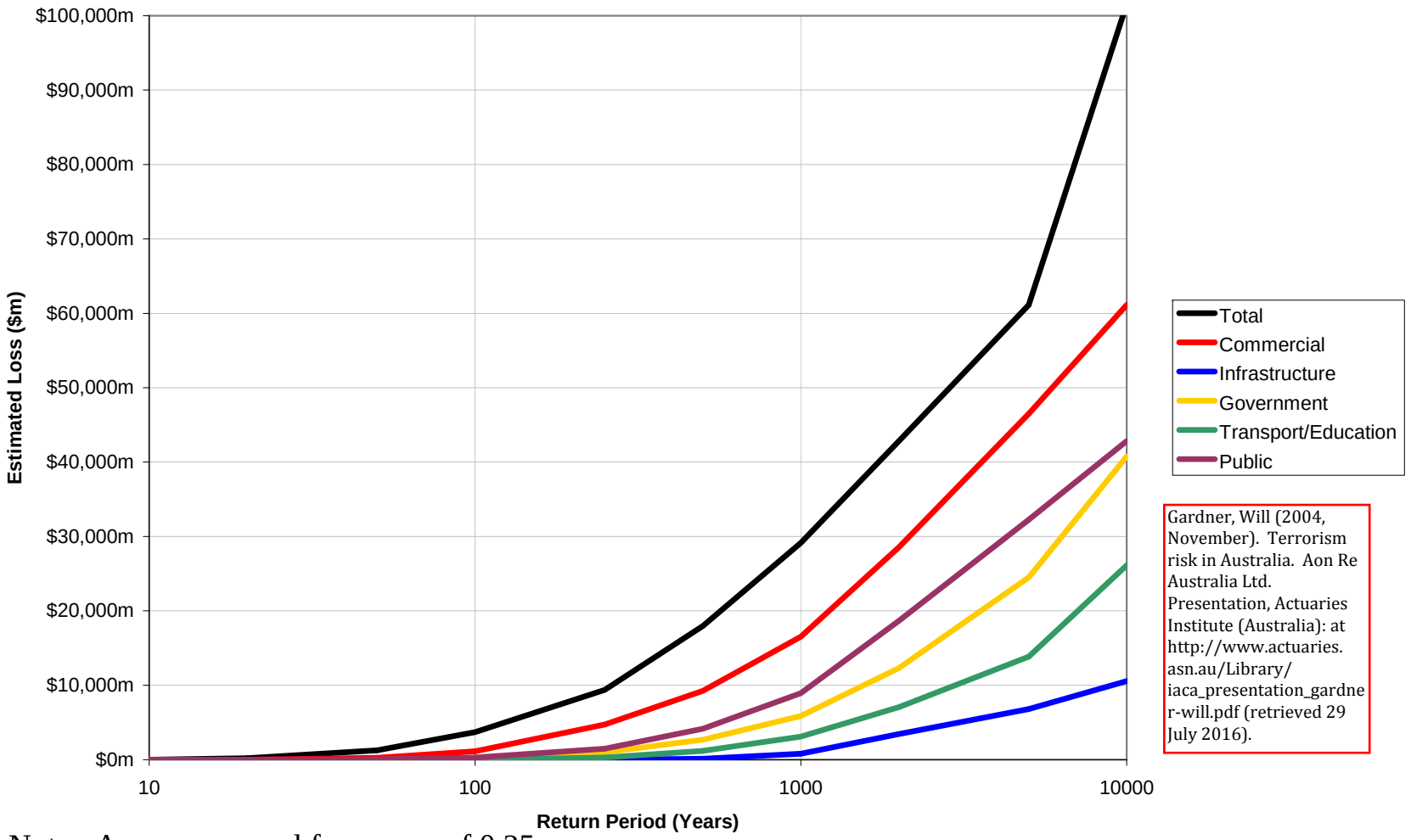
Note : Assumes annual frequency of 0.25

PML by Target Type



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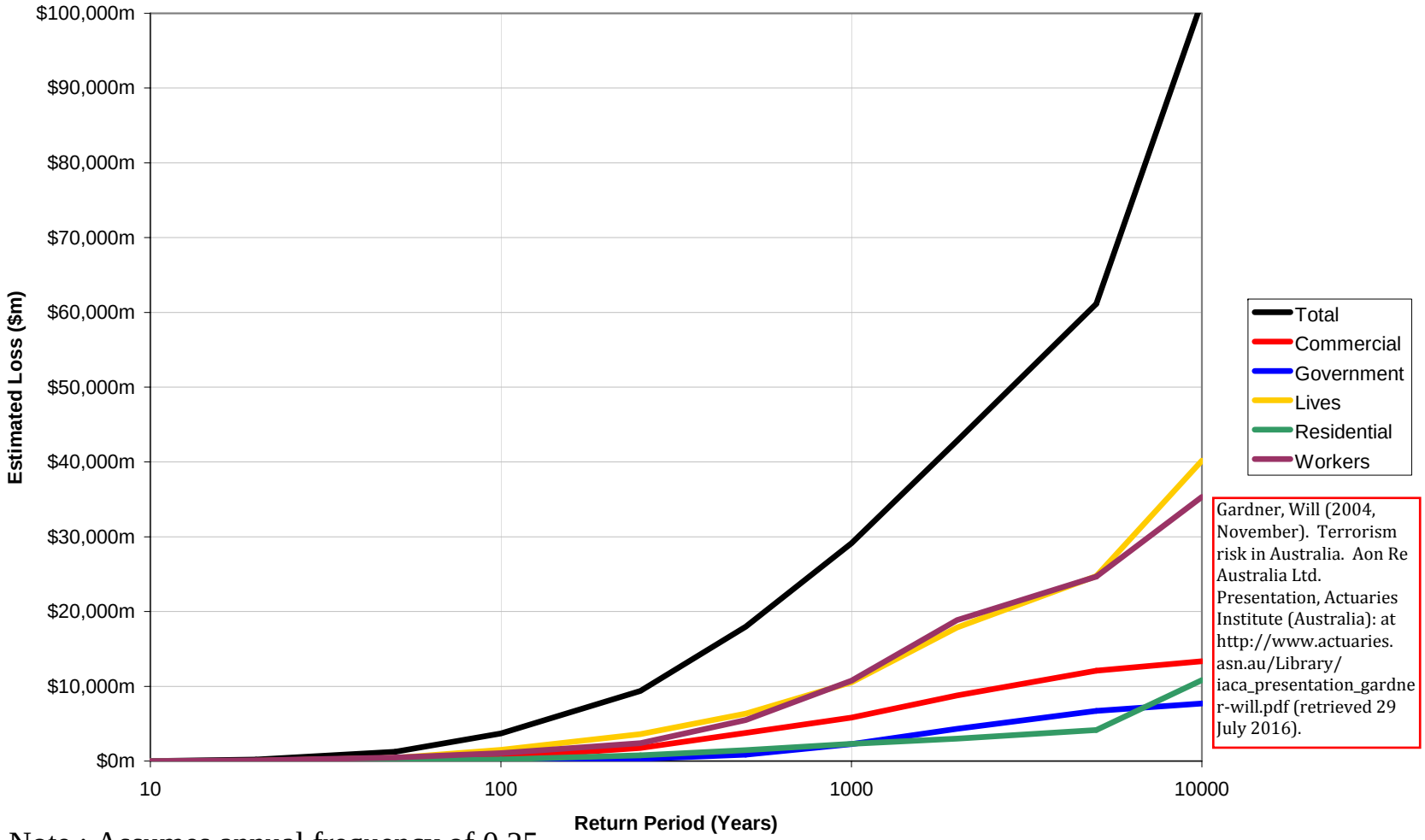
Note : Assumes annual frequency of 0.25

PML by Exposure Class



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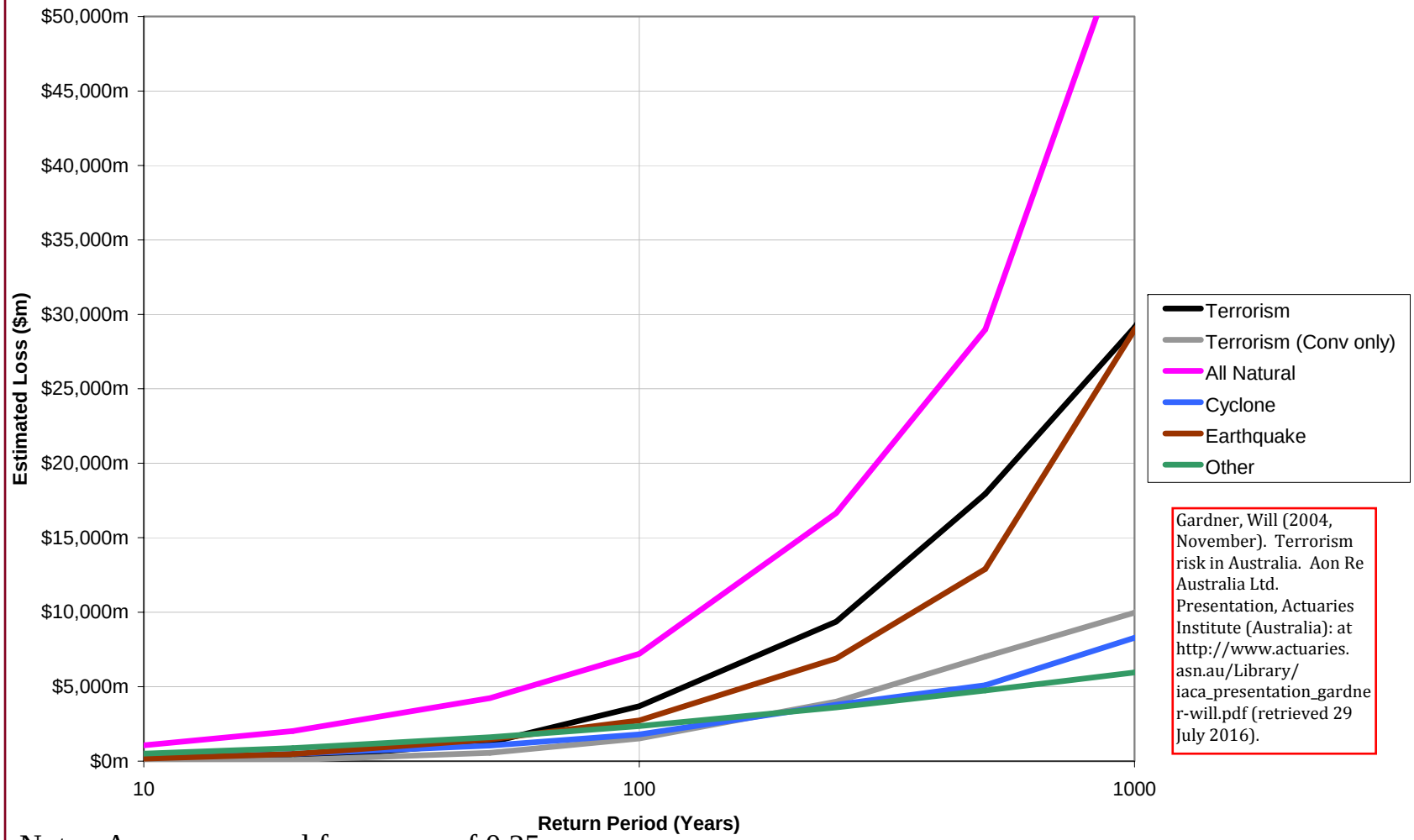
Note : Assumes annual frequency of 0.25

Terrorism PML versus Natural Perils



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Note : Assumes annual frequency of 0.25

Section 4

Conclusions

Conclusions

- Terrorism needs to be treated differently to natural perils
- It is possible to model the potential losses but difficult to estimate probabilities
- Industry PMLs might be
  - 250 years = $10 bn
  - 1000 years = $30 bn

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- Human losses could be more costly than physical damage
- Terrorism could be more of a risk than any of the natural perils
- TERRORISM SHOULD BE CONSIDERED IN RISK ANALYSIS FOR LIFE INSURANCE, WORKERS COMPENSATION AND PROPERTY INSURANCE

Thank You