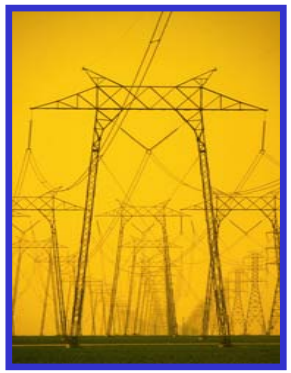
Natural Hazard Risk Management for Critical Infrastructure



M. Lehmann

ABS Consulting/ EQECAT

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Summary of Presentation

- Overview ABS Consulting
- Methodology for Managing Natural Hazards
  - Global Risk Modelling
  - Onsite Risk Assessment
  - Mitigation
- Projects Examples
  - Telecommunications
  - Electrical Power (Transmission & Distribution)
  - Water Distribution
  - Transport Infrastructure

ABS Group - A Global Practice

Worldwide:

- **$340+ Million revenue**
- **2,200+ employees**
- **58 Offices**
- **32 countries**

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ABSC Core Competency

MANAGING RISK

Identify → **Evaluate** → **Manage**

Natural Hazards
- Earthquakes
- Hurricane / Windstorms
- Flood
- Tornado / Hail / Ice
- Wildfire

Man-Made Hazards
- Sabotage
- Human error
- Equipment Failures
- Process Failures
- Fire / Explosions
- HAZMAT release
- Terrorism

Property Damage:
- Buildings
- Equipment
- Inventory

Business Interruption

Environmental Impacts

Non-Owned Assets
- Supply Chain Analysis
- Suppliers
- Infrastructure
- Customers

Financial
- Insurance
- Insurance Captives
- Retention
- Securitization

Operational
- Improve Procedures
- Risk Mitigation
- Cost / Benefit Analysis
- Retrofit Design
- Emergency Recovery
- Training

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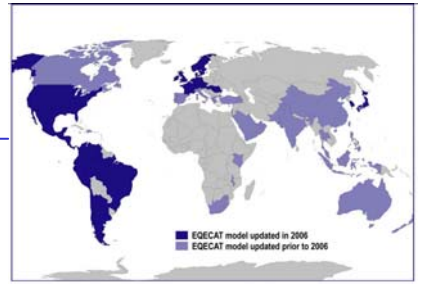
ABS Methodology
Natural Hazard Risk Reduction

Analysis of Global/Regional Portfolio

The EQECAT models cover over 88 countries worldwide.



Single Site Risk Assessment

On-site risk survey; evaluation of hazard level and physical and operational vulnerabilities.

Phase 1

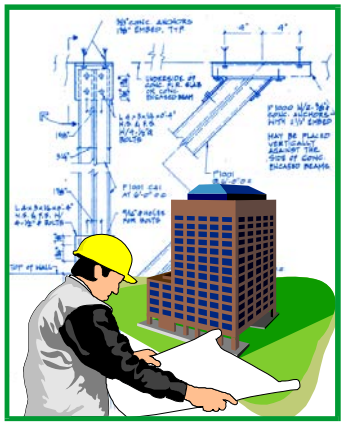
Phase 1 Report

Estimate of Potential Loss (PML & BI). Recommendations to reduce the risk

Cost/ Benefit Analysis

- Detailed study of Options
- Feasibility Study
- Cost/benefit Analysis

Phase 2



Phase 2 Report

Estimate of costs for proposed Risk Reduction measures.

Implementation

Selection of preferred option. Implementation of Risk Reduction Plan.

Phase 3

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Global Portfolio Analysis

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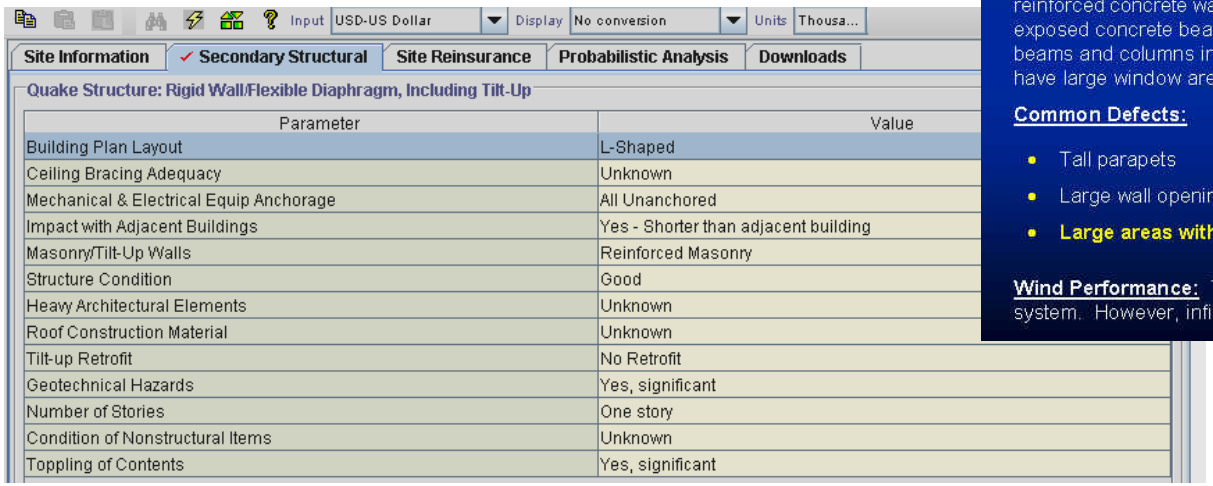
Global Portfolio Analysis

EQECAT Model Components

"State of the Art" catastrophe models comprise key scientific/engineering components to develop expected damage

- **Hazard Module**
- **Portfolio of assets dataset**
- **Vulnerability Module**
  - ⇨ Engineering judgment
  - ⇨ Historical asset damage
  - ⇨ Asset response analyses
  - ⇨ Secondary Features
- **Financial Loss Module**

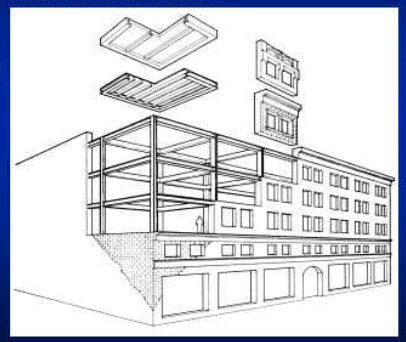


Parameter	Value
Building Plan Layout	L-Shaped
Ceiling Bracing Adequacy	Unknown
Mechanical & Electrical Equip Anchorage	All Unanchored
Impact with Adjacent Buildings	Yes - Shorter than adjacent building
Masonry/Tilt-Up Walls	Reinforced Masonry
Structure Condition	Good
Heavy Architectural Elements	Unknown
Roof Construction Material	Unknown
Tilt-up Retrofit	No Retrofit
Geotechnical Hazards	Yes, significant
Number of Stories	One story
Condition of Nonstructural Items	Unknown
Toppling of Contents	Yes, significant

Unreinforced Masonry (URM)

Description: Steel or concrete frame, with unreinforced brick, concrete block, or hollow clay tile walls; may be low-rise to high-rise, and serve commercial, institutional, or residential tenants; floors generally concrete or steel.

Key Identifiers: Visible brick, concrete block, or hollow clay tile walls; no reinforced concrete walls; may have exposed concrete beams and columns; beams and columns in grid pattern; may have large window area on all sides;



Common Defects:

- Tall parapets
- Large wall openings
- **Large areas with unreinforced infill**

Wind Performance: Typically **moderate** to **high risk** to structural system. However, infill is generally lost and poses life safety concerns.

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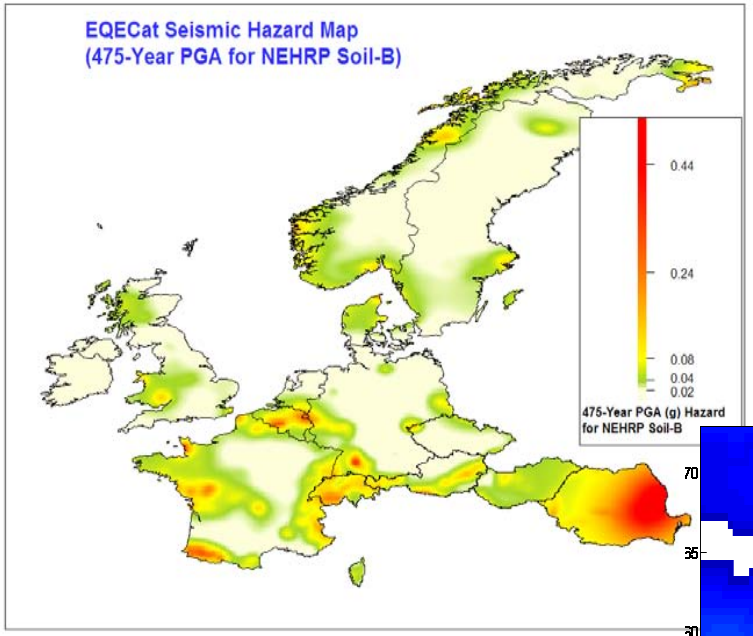
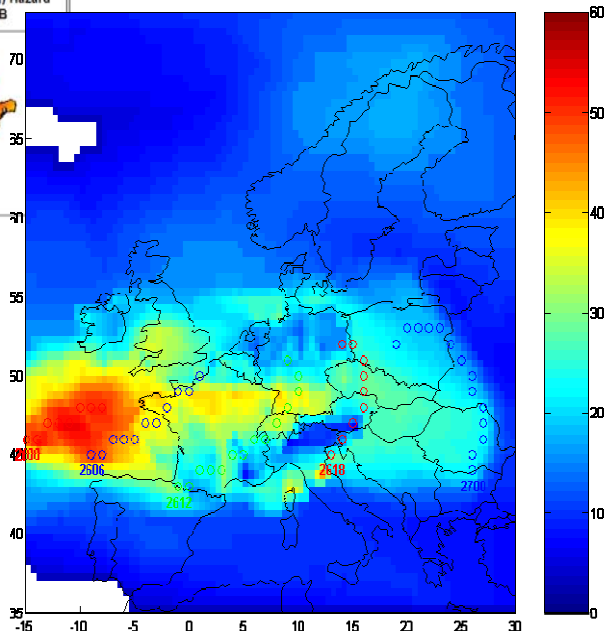
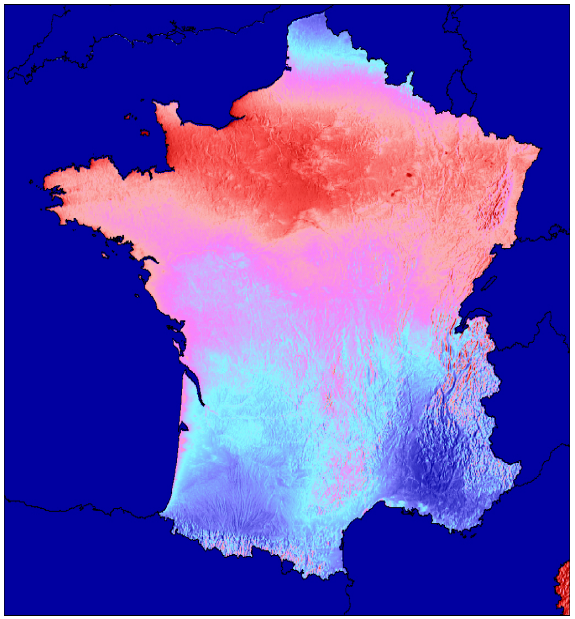
Global Portfolio Analysis



Windstorm

European Earthquake





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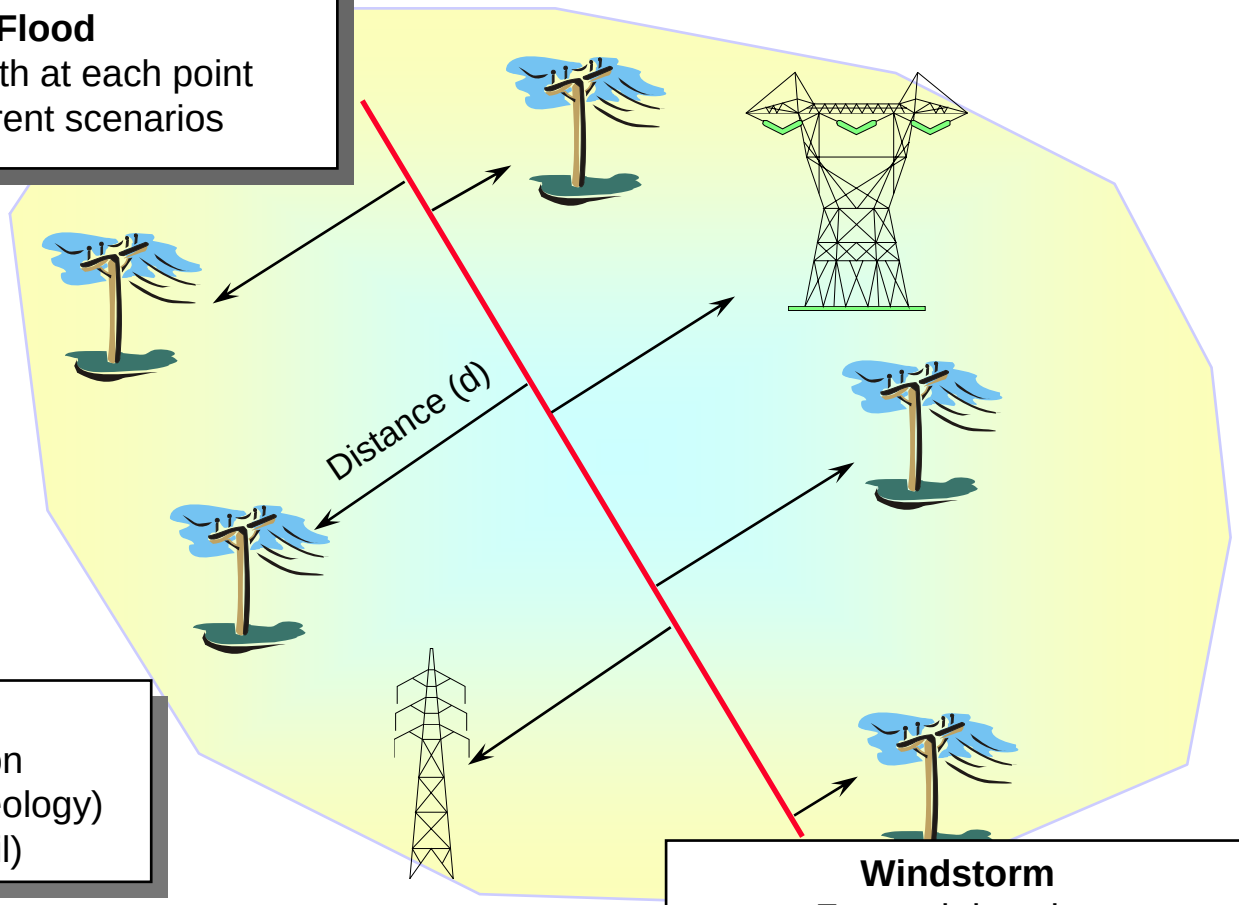
Global Portfolio Analysis

Flood
Water depth at each point
for different scenarios



Earthquake
For each location
PGA= f(M,d, local geology)
MMI=f(PGA, soil)

Windstorm
For each location
$V_w = f(P_c, d, \text{topography})$

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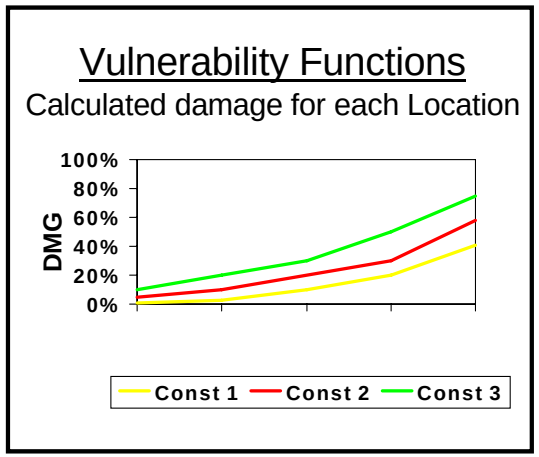
Understanding Vulnerability - Developing Damage Functions

impacts from
- Earthquake
- Windstorm
- Flood
- Tsunami



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Global Portfolio Analysis – Sample Output

ernet Explorer provided by ABS

s Help

Input EUR-Euro | Display USD-US Dollar | Units Ones

Primary Portfolio | Exposure | Probabilistic Analysis | Event by Event | Downloads

Peril: - Hurricane\Typhoon\Cyclone

Results type: Summary

Apply demand surge

Damage/Loss type: Ground Up Damage

Grouped by: Sub-Region

Show snapshot of previous results

Country, Region	Sub-Region	TIV	Mean Annual Ground Up Da...	Standard Deviation	COV	100 Year Ground Up D...	250 Year Ground Up Da...	500 Year Ground Up D...
All Countries, All Regions	All	560,071,610	843,379	3,676,046	4.36	13,315,643	24,206,518	34,760,859
United States, Texas	Jefferson	149,764,542	348,012	3,121,738	8.97	8,232,442	18,505,553	31,023,785
United States, Louisiana	Calcasieu	58,671,783	71,915	648,506	9.02	1,675,943	4,301,052	6,409,828
United States, Texas	Harris	33,008,229	58,341	435,232	7.46	1,428,201	3,094,181	4,678,270
United States, Florida	Bay	50,000,000	62,923	518,757	8.24	1,387,789	3,069,288	4,890,323
United States, Florida	Miami-Dade	35,231,000	58,346	367,347	6.30	1,338,222	2,562,051	3,590,400
United States, Texas	Nueces	15,231,817	50,470	376,400	7.46	1,282,385	2,965,929	4,435,221
United States, South Ca...	Charleston	90,400,000	43,635	442,156	10.13	1,002,158	2,477,512	4,257,503
United States, Alabama	Mobile	23,655,580	35,797	256,903	7.18	787,334	1,672,577	2,571,507
United States, Texas	Chambers	8,868,654	24,702	183,819	7.44	591,125	1,336,541	2,025,611
United States, Texas	Brazoria	7,247,205	20,731	139,843	[illegible]	[illegible]	[illegible]	[illegible]
United States, Louisiana	Saint Bernard	13,666,990	20,230	144,518				
United States, Texas	Galveston	1,066,141	7,466	49,067				
United States, Louisiana	Saint John the B...	7,825,101	6,191	49,669				
United States, Florida	Lee	973,730	4,690	35,528				
United States, Louisiana	Ascension	3,900,000	4,654	49,261				
United States, Florida	Sarasota	1,995,550	3,462	36,233				
United States, Florida	Pinellas	4,501,093	4,053	51,488				
United States, Louisiana	Orleans	1,642,843	2,963	22,240				
United States, Florida	Broward	387,816	1,895	11,228				
United States, Florida	Martin	438,087	1,695	13,152				
United States, Louisiana	Plaquemines	398,885	1,581	10,392				
United States, Louisiana	East Baton Rouge	2,130,000	1,738	20,180				
United States, Florida	Marion	2,208,990	1,296	11,727				
United States, Florida	Hillsborough	903,912	715	6,545				
United States, Louisiana	Jefferson	925,676	666	5,730	8.60	14,966	34,019	54,996
United States, North Ca...	Granville	2,026,000	591	4,824	8.17	13,157	28,597	46,079
United States, Florida	Lake	2,349,287	574	6,533	11.38	11,751	29,743	51,593
United States, Texas	Milam	4,750,000	626	9,399	15.03	10,558	35,868	70,080
United States, Florida	Palm Beach	117,215	421	2,917	6.92	10,224	20,690	30,330
United States, Alabama	Lee	13,363,782	562	9,669	17.20	8,445	27,545	58,261
United States, Texas	Travis	1,775,000	373	3,909	10.49	8,248	19,106	32,272

Portfolio results as of: January 15, 2007 11:28:12 PM EST (Version 3.8.01)

Schedule analysis to start at: January 19, 2007 08:28 A.M. P.M.

Analyze all policies | Include region results | Include postal code results

Analyze all sites | Include sub-region results | Include corporate results

Advanced Options... | Analyze

Damage Losses can be grouped by:

- Country
- Region, Division, Postcode etc
- Loss Type (Annual Gross, Ground Up, Aggregate..)
- Single or Combined Perils
- Multiple Return Periods (100, 250, 500 year..)

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Phase 1 – On-Site Risk Assessments

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Phase 1 – On-Site Risk Assessment

Key Recommendations to help Reduce the Risk (Action Plan):

- Strengthening of vulnerable assets (buildings/ equipment/ tanks/ pipelines etc) to better resist against Earthquake or Windstorm loading.
- Flood protection systems for below and above ground assets.
- Anchorage of Back-up power supplies, utilities and communication systems essential for production
- Identification of alternative transport routes into and out of the site.
- Enhancement of Business Continuity and Emergency Response Planning.
- Training of Local Site Staff.

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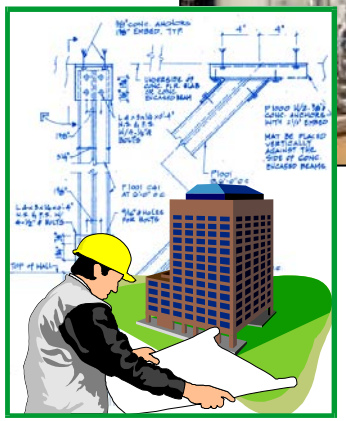
Phase 1 - On-Site Risk Assessment

Site Risk Analysis for the Key Contributing Facilities in the Portfolio:

- Detailed Quantification of the Local Site Hazard for single or multiple perils (Earthquake, Flood, Windstorm,..)
- Start Up Meeting with local Site Staff and Facility Management to discuss key operations at the site and dependencies on local infrastructure and business-critical lifelines (power, water, communication systems etc).
- Survey of the facility by ABS Consulting Engineers to identify the critical Vulnerabilities of key assets including:
  - Buildings
  - Equipment
  - Stock
  - Tanking & Pipe work
- Evaluation of the Financial Loss Expectancy based on the findings from the site visit.



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Phase 2 – Cost/Benefit Analysis

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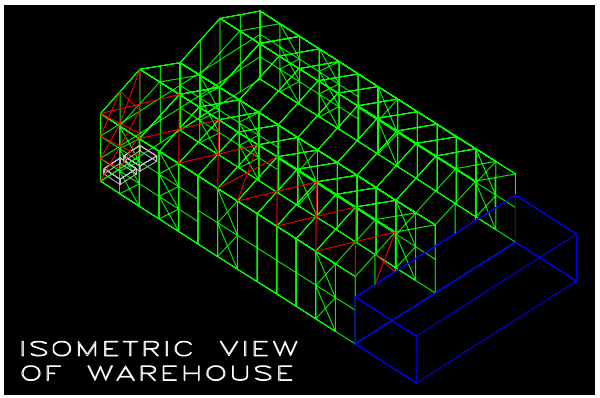
Phase 2 – Cost/ Benefit Analysis

For the Selected Recommendations:

- Detailed Assessment of the Costs required to undertake the proposed improvement measure(s).
- Re-evaluation of the Financial Loss Expectancy for the facility assuming the measures are in place.
- Cost-Benefit Analysis of the proposed options to assist in identifying most economic solutions and to optimise the risk management program.



Option	Loss Estimate Before Strengthening A = PD+BI		Loss Estimate After Strengthening B = PML+BI		Estimate Cost of Strengthen-ing	Cost/Benefit Ratio
	Property Damage (PD)	Business Interruption (BI)	Property Damage (PD)	Business Interruption (BI)	C	[A-B]/C
1	$7,800,00	$25,000,000	$3,500,00	$15,400,000	$700,000	**20**
2	$ 12,350,000	$42,550,000	5,580,000	$23,550,000	$2,300,000	**11**

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Phase 3 – Implementation of Recommendations

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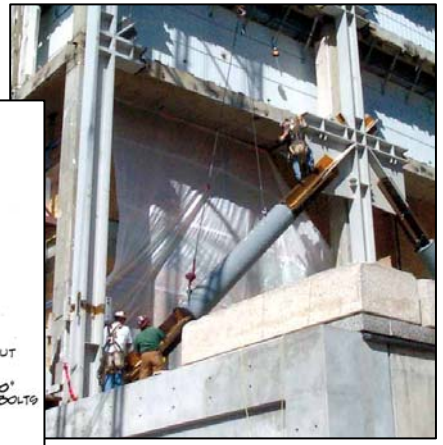
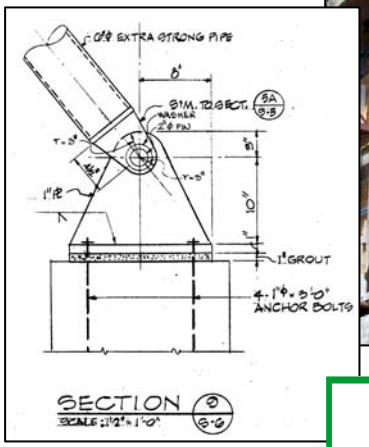
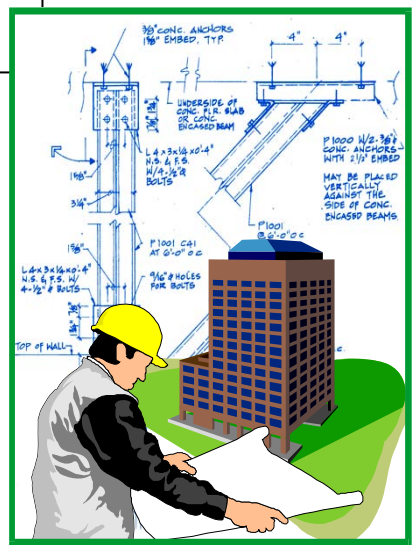
Phase 3 – Implementation

To execute the proposed recommendations ABS Consulting Engineers can provide:

- Detailed engineering analysis
- Production of technical drawings and specifications where required
- Assistance in the tendering process for selecting contractors
- Supervision of installation works on site
- Guidance manual on future maintenance







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Selected Examples

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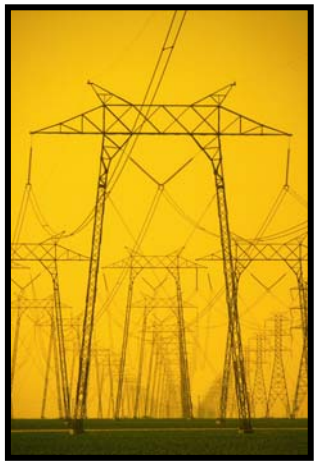
Power/ Telecommunications



Major UK Power Distributor - All Hazard Risk Assessment

MFL, NLE and BI loss estimates due to catastrophe events for a major UK utility provider. This also covered employer, public and third party liability exposures.

UK Telecommunications Client- Windstorm Loss Exposure

Quantification of windstorm loss exposure of the Radio Mast network, currently estimated at a capital value of £100 million.

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Water Utilities

Water Utility – Europe
Earthquake Risk Assessment

Detailed assessment of the local seismic hazard and on-site engineering surveys to determine key asset vulnerabilities. Estimation of property damage and business interruption losses / provision of recommendations.

Water Utility – UK
Multi-Hard Risk Assessment

Loss evaluations for Fire/Explosion/Terrorism/ Earthquake/ Windstorm and Flood exposures at key production facilities in support of the clients insurance renewal program. Proposal of improvement measures to reduce the risk.

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Transport

Rail - Earthquake Insurance Study

Focus: Detailed Risk Assessment during the construction of the new Tramway System to evaluate the Earthquake risk exposure (PD and BI) as part of the insurance policy requirements, South of the Tagus, Portugal.

Roadway Bridges - Seismic Retrofit Program

Focus: Preliminary seismic assessment of 26 bridge structures located in five Northern California counties. Proposal of Retrofit Strategies to minimize potential.

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Electrical Transmission & Distribution Networks