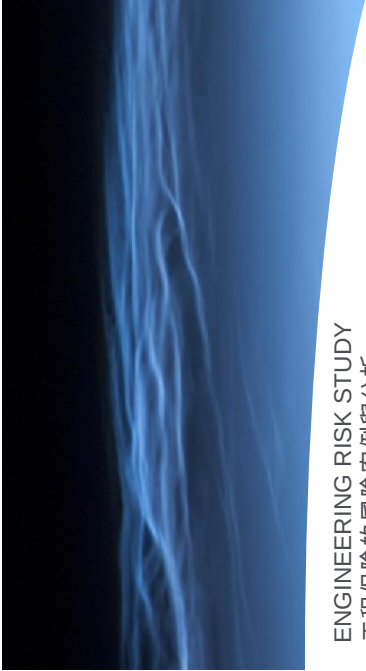




ENGINEERING RISK STUDY 工程保險的風險案例與分析

姚大鈞 博士
Dr. Daniel Yao, P.E., AVS.



Agenda 講程

1. Prelude
2. Engineering Risk Management (ERM)
3. Engineering Risk Study
4. Conclusion
5. Q & A



Daniel Ta-Chun Yao, Ph.D., P.E., AVS
姚大鈞 博士



首席總監
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學歷 EDUCATION

- 美國加州大學博士 Ph.D. University of Colorado at Boulder, U.S.A.
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- 美國密西根大學 碩士 M.S. University of Michigan, U.S.A.
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經歷 EXPERIENCE

- Eos Rhea Metals, Ltd., 台北 (專任)
- 桃園大眾捷運股份有限公司, 桃園 (專任)
- 潤興科技股份有限公司, 台北
- 中國核工業集團有限公司, 北京
- 中國核工業集團有限公司, 台北
- 亞細亞火油有限公司, 香港
- 亞細亞火油有限公司, 台北
- Engineering Consulting Services, Ltd., Buffalo Grove, IL, U.S.A.
- Rupo West, Inc., Ventura, CA, U.S.A.
- NTH Consultants, Ltd., Farmington Hills, MI, U.S.A.
- 台北市政府捷運工程局, 台北

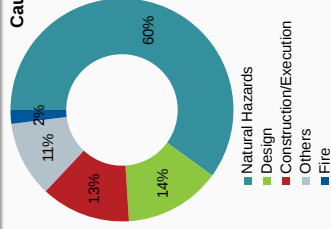
著作 PUBLICATIONS
40餘件專業論文及著作

Lessons Learned from Insurance in Engineering Work (CAR) 工程保險的統計資料

ERM

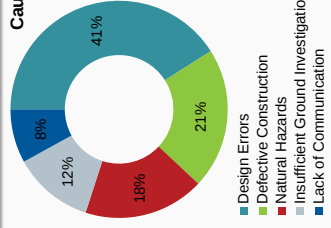
Road Construction by Causes (Line Structures)

Causes



Underground Construction by Causes (Non Line Structures)

Causes



Loss Data from Munich Reinsurance Company

20/05/2015

20/05/2015

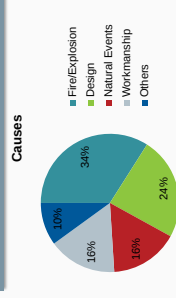
7

Lessons Learned from Insurance in Engineering Work 工程保險的統計資料

ERM

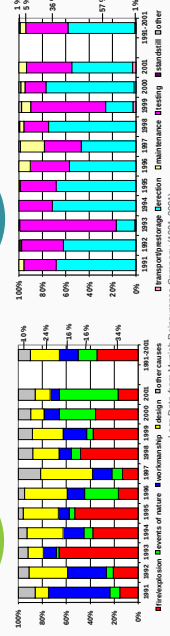
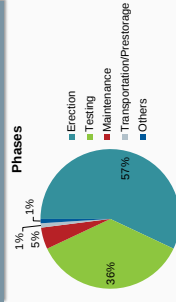
EAR by Causes

Causes



EAR by Phases

Phases

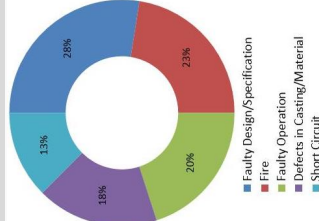


Loss Data from Munich Reinsurance Company (1981-2004)

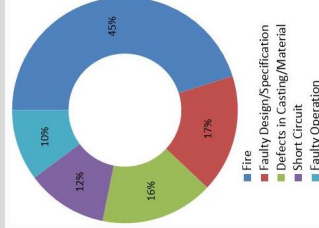
Lessons Learned from Insurance in Engineering Work EAR by Hazards 工程保險的統計資料

ERM

EAR Loss by Numbers



EAR Loss by Monetary Values



Loss Data from Munich Reinsurance Company

20/05/2015

20/05/2015

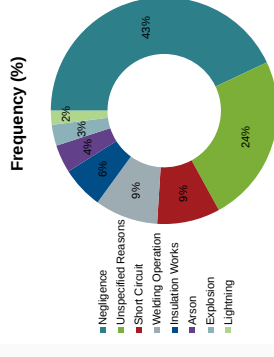
8

Lessons Learned from Insurance in Engineering Work 工程保險的統計資料

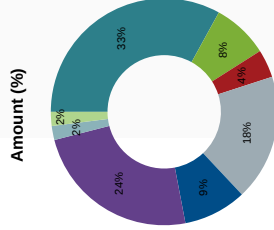
ERM

Causes of Fire on Construction Site

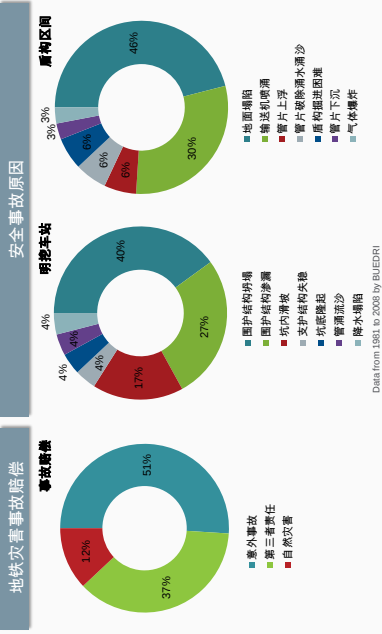
Frequency (%)



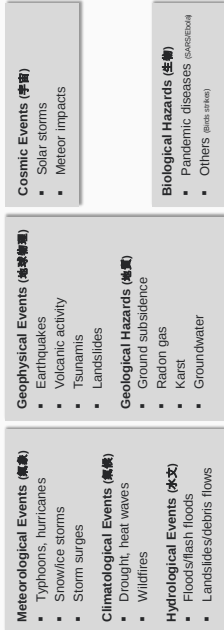
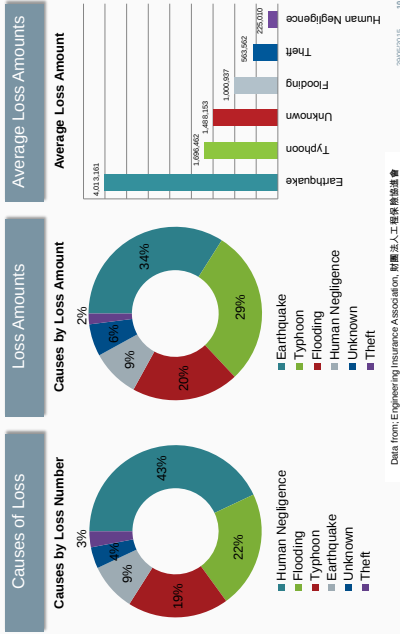
Amount (%)



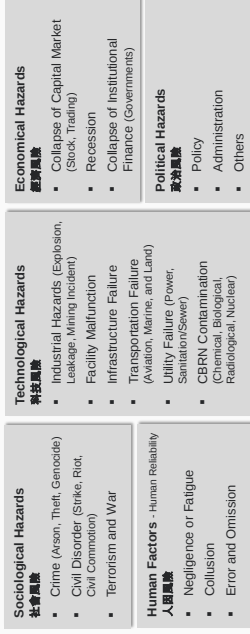
Data from Munich Reinsurance Company



ENGINEERING RISK MANAGEMENT

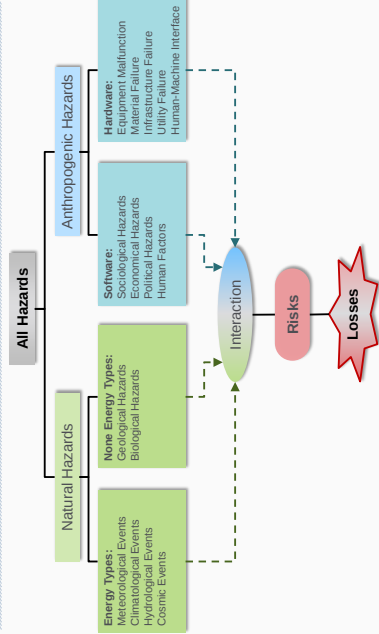


Anthropogenic Hazards (Man-made Hazards) 人為風險因子



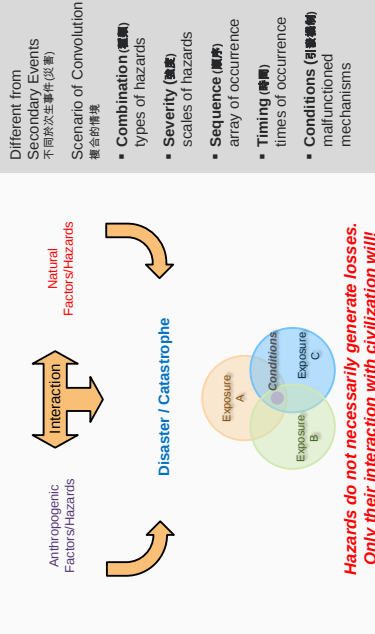
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All Hazards 全風險



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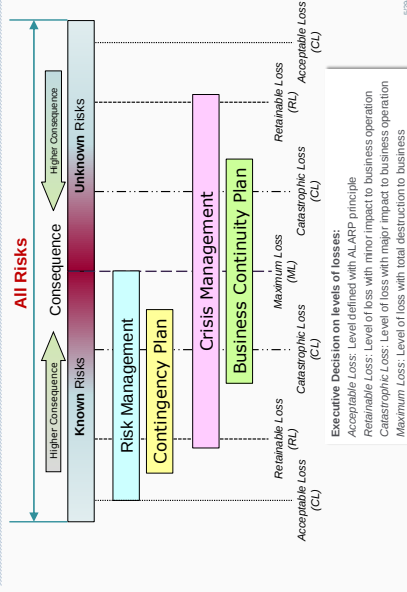
Risk Convolution 風險複合



Hazards do not necessarily generate losses. Only their interaction with civilization will!

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Spectrum of All-Risk Management 全風險管理的圖譜



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All-Risk Category 全風險分類

All Risks 全風險			
Insurable Risks 可保險風險		Non-insurable Risks 不可保險之風險	
Insured Risks 保險風險	Not insured Risks 未保險之風險	Non-indemnifiable Losses 不可求償之損失 For example: • Business Interruption • Terrorism etc.... • Part of Exclusions etc....	
Indemnifiable Losses 可求償之損失 Insurance Liability for • Known Risks • Unknown Risks	Non-indemnifiable Losses 不可求償之損失 • Deductibles • Loss over limits • Under-insurance • Depreciation	Lower-level Management Risk Ownership (管理層風險責任) High-level Loss Reduction Application (減損管理) Risk Management/Enterprise Risk Management (Contingency Plans) Business Continuity Management (Business Continuity Plans) Crisis Management	

Where are your organization's risks?
Are you prepared at your best?

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How are Engineering Risks Managed? 現在工程風險是如何管理?

Principal's Risks	Consultant's Risks	Contractor's Risks	Site Supervisor's Risks
- Schedule delay - Budget overrun - Quality defect - Defective contract - Political issues - Compliance issues - Risk of change - Goal and mission - Natural hazards	- Faulty design - Design schedule delay	- Construction method - Construction Material - Construction Management (QA/QC/HSE) - Construction monitoring - Third party liability - Natural hazards - Contingency plans	- Quality issues - HSE issues - Integrity & ethics

Whose risks?
Whose resource?
Who is managing?

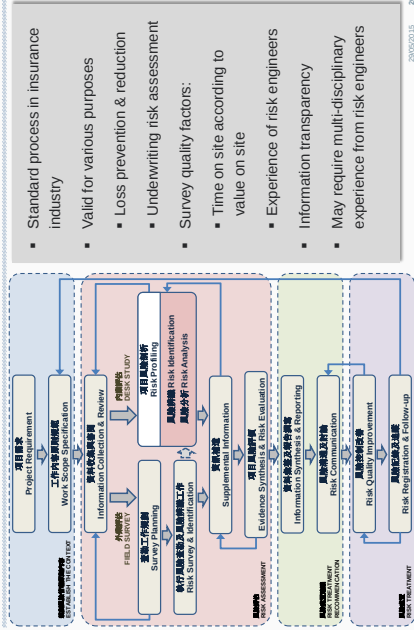
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Risk Owner-Specific Risk Category for EPC Projects EPC專案的風險責任類別

Staff Workers 施工人員	Principal 業主	Contractor 承包商
- Occupational Health - Occupational Safety - Occupational Environment	- Schedule - Shareholders' Interests - Quality	- Cost - Third Party Liability

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Engineering Risk Survey 工程風險查勘



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Issues Considered in Engineering Risk Management
工程風險管理需要考慮的重點



Document Review

- Information of All Project Stakeholders
- Project Management and Organization
- Natural Hazards
- Site Location and Site Layout
- Breakdown of Total Sum Insured
- Full Insurance Policy Wordings
- Design and Process
- Geotechnical/Hydrogeological Information
- Construction/Erection Method Statement
- Testing and Commissioning Plan
- Schedule
- Risk Management Plan (Contingency Plan)
- Equipment Suppliers and Manufacturers
- Major Construction/Erection Machinery

On-site Assessment

- Site Management
- Health, Safety, Environment (HSE)
- Security
- Temporary Work
- Preparedness of Contingency
- Quality of Working Staff
- Housekeeping
- Management of Hazardous Material
- Fire and Explosion Hazards
- Construction Activities
- Third Party Liability
- Land formation and surface vegetation
- Temporary Storage (yard/warehouse)
- Fabrication (Assembly) Yard
- Quality of work

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Tunnel Failure Case



- São Paulo Metro Line 4, Pinheiros Station, São Paulo, Brazil (15/1/2007)
- Failure at the access tunnel (collapse of crown and crushing invert)
- 7 killed, delay 2 years
- Probable Cause:
 - Poor management
 - Geology variation
- Hangzhou Metro, China (15/11/2008)
- 21 killed, 24 injured
- Insurance loss: CNY81,789,834
- Failure in earth retaining system
- Probable Cause:
 - Adverse environmental and geological conditions
 - Faulty workmanship
 - Possibly faulty design



ENGINEERING RISK STUDY

Explosion During Tunnel Construction
隧道施工中的爆炸事故



Chengdu, 2015/2/24
Probable Cause: Gas Explosion

Hunan, 2012/05/19
Probable Cause: Mistake in Transportation

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Collapse of Works During Construction 施工坍塌

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During Forming Work
Willow Island Power Plant (27/04/1978)

During Reinforcement Work
Haiyang Nuclear Power Plant (2/10/2009)

Probable Causes

- Willow Island Power Plant** (51 fatality)
- New technology (Jump-form scaffolding)
 - Low concrete strength due to low temperature
 - Missing crucial bolts anchored to the concrete

Haiyang Nuclear Power Plant (Official: 5 fatality)
Detail not disclosed, probably poor support of formwork

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Equipment Faulty Design at Nuclear Power Plant 核電廠的設備設計問題

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- San Onofre Nuclear Generating Station (SONGS), San Diego County, CA, USA
- January 2012
- Premature excessive wear on heat transfer tubes of steam generator, fluid-induced vibration, leak of radioactive coolant
- Faulty design on steam generator (the largest RSG in USA by Mitsubishi)
- Potential Gross Negligence on design analysis/modeling of steam generator
- Potential loss of more than USD 4 billions
- 24 July 2013, permanently shut-down

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Fire During Building Construction 高層建築施工中的火災

ERM



- CCTV North Tower, Beijing
- Fire work ignited construction material
- 2009/29

- Tamweel Tower, Dubai
- Cigarette butts ignited construction waste material
- 2012/11/18

- Residential Building, Shanghai
- Renovation, 53 Fatality
- 2010/11/15

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Defects in Casting/Material 鍛造的缺陷

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Pressure Vessel Failure
During post-fabrication testing

Casting Defects

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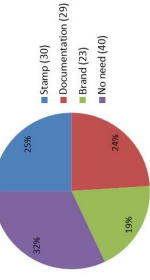
Counterfeit Items in Construction/Erection Projects 工程使用的仿冒材料

Faked couplings (oil well failure, \$2M loss)

5' stop-check valve for US nuclear power plant

Counterfeit Locations			
Country/Area	No. of Sites	AS Quantity	Order Quantity
Canada	36	6	5
China	35	12	20
India	7	—	—
Italy	2	—	3
Malaysia	2	2	3
Philippines	—	—	—
Singapore	—	2	—
US	6	40	38
Mexico	2	—	—
Taiwan	2	—	—
Romania	2	—	—
SOUTH KOREA	2	—	—

Certification Methods on Counterfeit Products



Data from PHILLIPS on WCCO Meeting – Seattle, WA, May 31, 2012

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Faulty Material/Fabrication (Counterfeit Material) 仿冒材料問題

- Huadian Datong Coal-fired Power Plant, Datong County, Xining, Qinghai, China
- 31 Oct 2006, 22:10
- Main steam pipe ruptured during commissioning (Rupture 900mmx40–60mm, 2200mm to the nearest welding point)
- Counterfeit P91 pipe (ASTMA335P91)
- 2 fatality, several injured
- Subgrade/counterfeit material, defective fabrication, and loopholes in supply chain

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Counterfeit Products 仿冒材料

Item	Item's Number of Case	Percentage	Item's Number of Case	Percentage	
Steel	17	14%	Gaskets	1	1%
Valves	13	11%	Glass	1	1%
Pipe	12	10%	Ground rods	1	1%
Fasteners	10	8%	Hand tools	1	1%
Circuit breakers	7	6%	Heavy equipment parts	1	1%
Routing equipment parts	6	5%	Masonry	1	1%
Pipe fittings	6	5%	Network routers	1	1%
Pressure vessel	6	5%	O-rings	1	1%
Cement	5	4%	Paint	1	1%
Electrical conduit fittings	4	3%	Safety equipment	1	1%
Electrical equipment	3	2%	Sprinkler heads	1	1%
Flanges	2	2%	Subsea system	1	1%
Rebar	2	2%	Tires	1	1%
Waterproofing	2	2%	Titanium bar stock	1	1%
Welding rods	2	2%	Turbine	1	1%
Capacitors	1	1%	Blades	1	1%
Cement Kiln	1	1%	Weld wire	1	1%
Copper wiring	1	1%	Conduit fittings	1	1%
Door panic bars	1	1%	Switchgear	1	1%
Fan belts	1	1%	Refractory	1	1%

Data from PHILLIPS on WCCO Meeting – Seattle, WA, May 31, 2012

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Heavy Lifting and Hoisting – Review of Taichung Metro Accident on 10 April 2015 (From Risk Management Points of View)

- Accident Fact Sheet:**
- Taichung Metro Green Line (10/04/2015)
 - Erection of girder at curved section
 - 4 fatality, 4 injured
- From risk management points of view:**
- Erection method statement (Lifting Plan)
 - Erection execution – HSE staff and construction supervision
 - Traffic control – restricted area security

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Recommended Outlines for Lifting Plan 吊裝計畫的主要內容

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- Key information
 - Object data (size/weight/material)
 - Lifting equipment data (crane specifications)
 - Lifting device data (lifts and specifications)
- List of operation and safety staff
- Falsework
 - Site condition
 - Ground condition/preparation
 - Working environment (clearance, obstruction)
 - Lifting procedure
- Lifting diagram (scaled drawings)
- Safety process
 - HSE & device check
 - Allowable work condition (wind/rain/visibility)
- Lifting contingency plan
- Structural analysis report

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Natural variability and limited knowledge 自然變異與有限的知識

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Data Scattering

Formation Variation



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Man-made variability and limitation of theory/model 人為變異與理論模型的限制

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Limitation of Theory/Model

Man-made Variability

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Variation over Space and Time 空間與時間上的變異

ERM

Precipitation Variation over Space

Precipitation Variation over Time

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Effect of Climate Change on Engineering Risks 氣候變遷對工程的影响

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- Increasing number of events and amounts of losses
自然災害的事件及損失有逐年增加的趨勢
- Increasing number of extreme events and magnitudes of severe weather
極端事件的數量(頻率)及規模(損失)有逐年上升的趨勢
- Trend of more losses and higher loss amounts than historical record on engineering risks
導致工程損失的數量及金額也有逐年上升的趨勢(較歷史數據為高)
- Abnormal becomes normal – facing the unexpected: **Contingency Plan & Crisis Management**
異常事件的發生成為常態 – 面對不預期的事件: **緊急應變計畫與危機管理**

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Concluding Remarks for Engineering Risk Management 結論

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- Murphy's law, "If anything can go wrong, it will."²
- Nothing is risk free but risk can be managed.
- To risk owners, risks reveal themselves in two ways, and you pay for them either way!
 - Cost – price for risk management and treatment
 - Loss – price for lesson learned
- Contingency plan should be a part of risk management program.
- Watch out for the effect of climate change.
- Have all risk owners managed due diligently their risks?
- Ask *not* for the *price* tag of a *good risk management*, but *do ask* for the *one without*.**

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CONCLUSION

THANK YOU VERY MUCH FOR
YOUR ATTENTION

Q & A

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