

Chile: One Year On

February 2011

reDEFINING

Capital | Access | Advocacy | Innovation

Table of Contents

Introduction	3
The Science Behind the Earthquake	4
The seismology	4
The tsunami	5
Looking forward	6
The Reinsurance Market	7
Before Maulé	7
Impact of a mega earthquake	7
Lessons Learned	8
Insurance companies	8
Challenges	8
Claims	9
Regulatory Framework	10
Future modifications	10
Catastrophe Modeling	10
The Future for Chile and Beyond	11
Catastrophe models	11
Data quality	11
Non-modeled peril: tsunami	11
Contact Information	12
About Aon Benfield	13

Introduction

The Maulé earthquake was the event of the decade for insured natural catastrophes in Latin America. Ultimate insured losses are expected to settle at USD8.5 billion making Maule the costliest insured earthquake since the 1994 Northridge event in California.

The event served as a test of the Chilean insurance market, throwing into the spotlight its contingency plans, the regulatory framework, construction codes and ultimately the effectiveness of the reinsurance market. Overall, the system designed to protect the public and insurance companies proved effective.

From a reinsurance perspective, insurance companies were able to see that their cover not only provided an accretive form of capital, but that they had purchased sufficient limits to protect their balance sheets and meet their obligations to the insureds of Chile. The majority of the insured losses were reinsured in the international market; roughly 95% of which were ceded via reinsurance.

This report examines the science behind the event, lessons learnt for the insurance industry and future expectations. Aon Benfield's goal is to deliver relevant research to insurers and reinsurers underwriting risks in both Chile and some of the world's most earthquake prone areas. We aim to create a more risk aware world so clients, governments and non-governmental groups are better able to protect and grow their organizations in the face of natural hazards and accompanying socio-economic risks.

Expertise is drawn from Aon Benfield's broking and Analytics teams, including onsite visits, coupled with scientific knowledge from the Aon Benfield UCL Hazard Centre.

The Science Behind the Earthquake

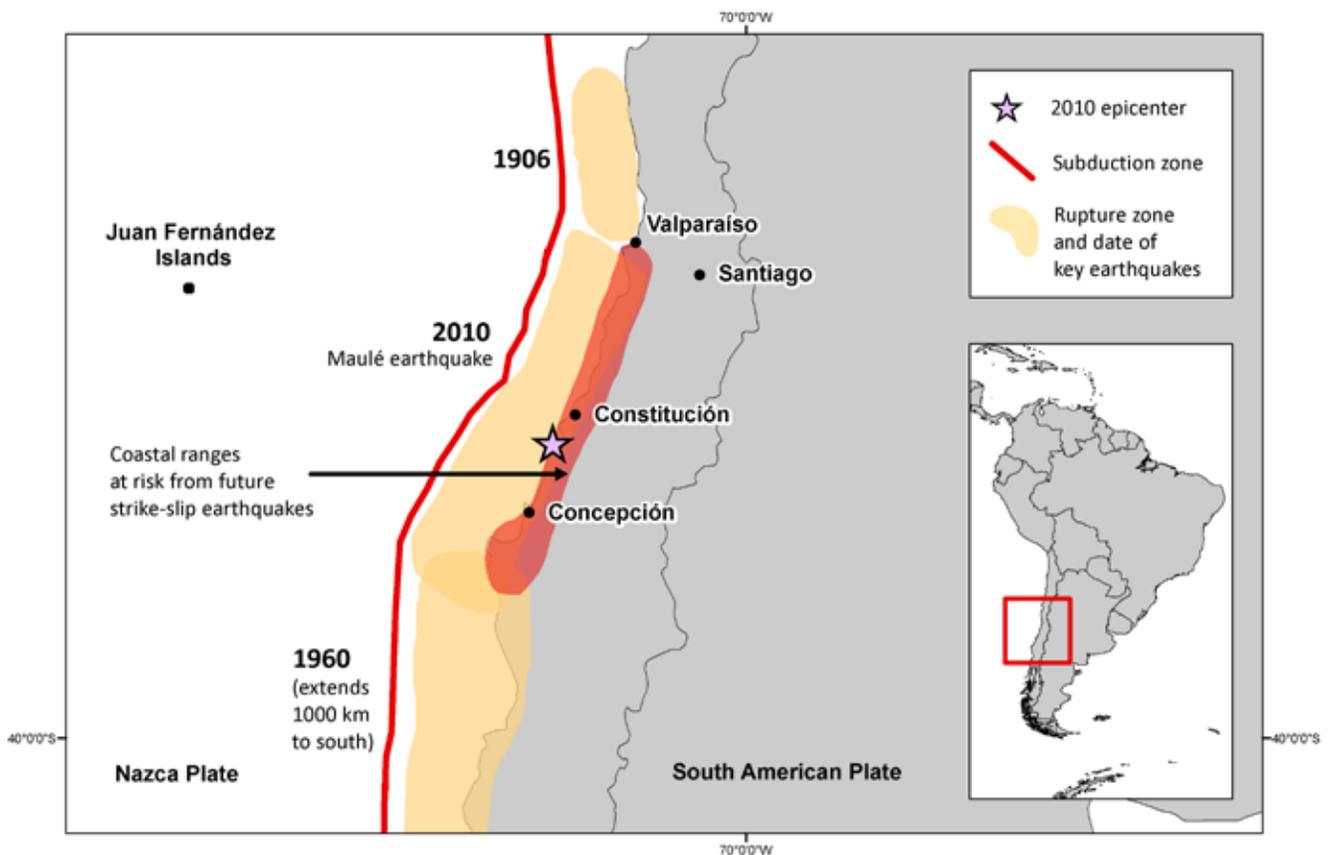
The first anniversary of the Maulé earthquake in Chile on 27 February 2010 provides a useful point on which to review the results of the first wave of scientific investigations. These are focused mainly upon post-event surveys aimed at understanding the damage from the earthquake and tsunami, in addition to the effects on the landscape of the region.

The earthquake has now been assessed as the fifth largest to have occurred since 1950. In this period, its moment magnitude (M_w) of 8.8 has been exceeded only by the 1952 Kamchatka, 1960 Chile, 1964 Alaska and 2004 Sumatra earthquakes. All of these, including the Maulé earthquake, were interplate subduction zone earthquakes produced by slip on the interface between a down-going oceanic plate and an overlying continental margin: in this case, between the Nazca oceanic plate beneath the eastern Pacific Ocean and the South American plate.

Ongoing advances in seismic monitoring and the interpretation of seismic records mean that the Maulé earthquake and the Sumatra earthquake are by far the best understood of the five.

The seismology

The earthquake occurred along a 650km long section of the subduction zone, between the rupture zones of the 1906 earthquake to the north and the 1960 earthquake to the south. This section had previously ruptured, at least partially, in earthquakes in 1730, 1751, 1822 and 1835.



The 2010 rupture began in an area between these two segments and propagated mainly to the south-south-west in the first 40 seconds of the earthquake. It then developed bilaterally with a major rupture propagating into the northern segment. The whole earthquake rupture only lasted 110 seconds, with velocities in the order of 2.5 to 3km per second. The 2010 earthquake was therefore a multi-segment rupture and analogies may be drawn between central Chile and the multi-segmented Nankai trough subduction zone off Japan.

The northern segment saw the largest fault displacements, with up to 16m of slip just off the coast southwest of Valparaíso. Elsewhere slip was only about 5m, with a notable minimum in the area to the west of the initial rupture. Intense earthquake damage in certain areas, such as Constitución (close to the northern high-slip area) and Talcahuano – Concepción (at the southern end of the rupture) may be related to features of the fault rupture process.

A second notable feature of the 2010 earthquake was that the slip was confined to a relatively narrow depth along the subduction zone, with about 30% of the rupture zone located landwards of the Chile coast. The positions of both the down-dip (landwards) and up-dip (seawards) limits of the rupture zone were important in controlling the effects of the earthquake. The down-dip boundary is important because it controlled the landward limit of the most intense seismic shaking and therefore reduced the intensity of shaking experienced in inland cities such as Santiago. The up-dip limit of rupture was not far offshore, where the plate interface was well below the surface, and may have been important in reducing the size of the tsunami.

The position of the fault rupture relative to the coastline also controlled the distribution of uplift and subsidence along the coast. The deformation influenced the tsunami damage, which was greatest on coastlines that had just subsided in the earthquake and least in areas that had just been uplifted.

The tsunami

The 1960 earthquake produced major tsunami damage and deaths as far away as Hawaii and Japan. By contrast, the destructive effects of the tsunami from the 2010 earthquake were largely confined to the coast of Chile in and near the rupture zone. In addition, the islands of Juan Fernández (700km offshore) and Marquesas (in French Polynesia to the west-north-west) suffered because they lay in the path of the “main beam” of the tsunami.

Post-event surveys have established that maximum tsunami run-ups were around 10m on the coast of Chile and 5m at Juan Fernández. Tide gauge records, coastal observations and data from offshore tsunami detection system showed that wave heights and run-ups further afield were almost all below 1m and mostly below 0.5m, causing little or no direct damage. The Maulé earthquake is in fact the only one of the five largest earthquakes of the last 60 years not to have caused significant direct tsunami damage at transoceanic distances.

The fault did not rupture significantly seawards of the coast so the size of the tsunami was limited in comparison to those generated by other subduction zone earthquakes. These include the 1952 Kamchatka, 1960 Chile, 1964 Alaska and 2004 Sumatra earthquakes. While the earthquake produced strong seismic waves and intense shaking, the actual uplift of the seabed in the Chile trench was relatively small and, as a result, the earthquake was not an efficient tsunami source.

Looking forward

The 2010 earthquake and its effects have important implications for similar events in the future, both in Chile and around the world.

Mapping of deformation provides insight into its potential effects upon likely future earthquake occurrences in Chile. The earthquake will have placed extra stress on strike-slip faults in the upper plate, along the coastal ranges of Chile. Whilst such strike-slip earthquakes would be small compared to the 2010 earthquake, proximity to population centers increases the potential for local damage.

It has been proposed (Lorito, 2011*) that the area near the epicenter, which experienced relatively little slip in the earthquake, may also be at significant risk from a further earthquake on the plate interface itself. However, it is unlikely that such an earthquake would be larger than Mw 7.5, as demonstrated by the recent earthquakes in this region of Chile during early 2011.

Aftershock distributions from the earthquake also provide evidence of its effects upon adjacent fault segments. Recent aftershocks south of the main rupture in the region affected by the 1960 giant earthquake mean that it is unlikely to occur again in the future as a significant part of the stress accumulated since 1960 has been released. In contrast, the subduction zone segments to the north, particularly that which last ruptured in 1906, did not have any significant aftershocks so may have experienced seismic-loading and therefore have the potential to produce large earthquakes in the future.

Significant aftershocks also occurred in the oceanic plate to the west of the Chile trench, indicating that this area has also been additionally loaded by the westward movement of the overriding plate in the 2010 earthquake.

* Lorito, S., Romano, F., Atzori, S., Tong, X., Avallone, A., McCloskey, J., Cocco, M., Boschi, E. & Piatenesi, A. (2011). Limited overlap between the seismic gap and coseismic slip of the great 2010 Chile earthquake. *Nature Geoscience* (online 30 January 2011) DOI:10.1038/NGEO1073

The Reinsurance Market

Before Maulé

Insurance take-up in Chile is one of the highest in Latin America. In Chile, more than 75% of larger industrial and commercial operations buy fire and earthquake cover, while coverage is less comprehensive for small medium sized companies with only 30% buying earthquake specific cover. On the residential side, the Chilean Insurance Association (AACH) states that only 24% of the country's homes have earthquake insurance. The vast majority (90%) of these properties are mortgaged.

With limited appetite amongst the domestic insurance market to hold onto earthquake risk, coupled with strict regulatory requirements, much of it is ceded to the international reinsurance market. This in turn means that reinsurance terms and conditions, and pricing, are a key driver for the primary pricing of earthquake cover in Chile. Before the Maulé earthquake the market was softening for both insurance and reinsurance. For the last four to five years, rates had been declining at around 5–10% year on year for both commercial and residential properties and with little change in terms and conditions.

Impact of a mega earthquake

Aon Benfield estimates an ultimate industry insured loss figure of USD8.5 billion from the earthquake – with some possible increases as the currency strengthens. Some 95% of this loss fell to reinsurers. For a comparable US event only 50% would be ceded. The Chile loss is split:

- Facultative 60%
- Treaty 40% with a 50/50 split between treaty and XL.

The impact of the earthquake has clearly led to significant hardening of reinsurance terms within Chile. However, despite the size of the loss, the Maulé earthquake has only provided a respite in sliding rates for earthquake cover across Latin America and has not affected global rates.

Within Chile, excess of loss reinsurance programs initially renewed with increases of 75% or more, but recent increases have now stabilized at around 50%. In addition, insurers seeking to secure proportional treaty capacity remain under pressure to reduce event limits and incorporate minimum rates for earthquake. This increase in reinsurance cost has resulted in a trickledown effect with higher pricing being passed on to original insureds.

Aon Benfield expects firm market conditions to be maintained through 2011 with some softening to reflect reductions in original loss estimates and/or improvements in the underlying portfolios.

Lessons Learned

Analysis of the 2010 earthquake highlights the effective response of the insurance industry, in addition to the challenges from which we can learn and improve upon. This section looks at the role of insurance companies, claims challenges, regulatory changes, the implications for catastrophe models and scientific lessons to help manage the hazard in the future.

Insurance companies

The system proved effective following the Chile earthquake, which can be defined through the following key criteria:

- No insurance companies faced insolvency or bankruptcy.
- There were relatively few coverage issues; most were seen on large risks.
- The claims development or tail will be short as most of the claims were filed within two months of the loss. More than 95% of residential and 80% of commercial losses have been paid in less than a year.
- Reinsurers have met their obligations, particularly for a loss that is mostly ceded to the international market.
- Contingency plans were rolled out within hours of the earthquake and worked well so insurers could handle an event of this size in a timely fashion.
- The benefit of insurance for the country's infrastructure. Many of the projects built via concession deals with the private industry were insured, providing recovery from the reinsurance system that otherwise would have fallen on the state.

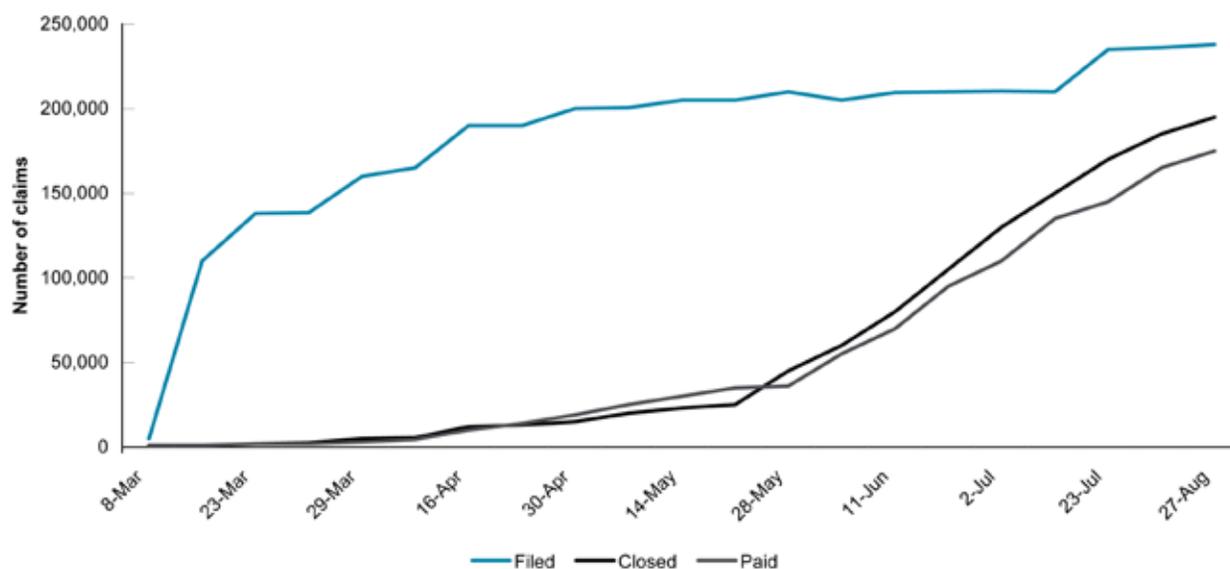
Challenges

Some areas still presented challenges to insurance companies, which include:

- Understanding of catastrophe deductibles. There is an expectation from personal lines insureds that the loss is covered in full; it is primarily an education issue as some clients do not understand the insurance policy.
- Claims settlement. The sheer volume of claims created a bottle neck in the management and settlement of claims. This was partly due to strict regulations in Chile regarding the use only of registered claims adjusters.
- Concurrent policies. This was the case in many mortgage related policies and those purchased by condominium associations. There was an overlap in cover for damages to the structure and interior walls where it was not clear if it was common areas or individual units affected.
- Mortgage policies. A standard wording does not exist for mortgage or homeowners' policies. Each insurance company has developed its own policy form for this type of risk which creates an additional claims settlement challenge.
- There was concern within the first 72 hours that the infrastructure damage might have hindered the implementation of contingency plans, such as primary or secondary building sites and basic services such as electricity, water, roads and communications.

Claims

The regulator set a deadline of 30 April 2010 for policyholders to file claims. Therefore, most claims were filed two months after the event and there has been relatively minor claim development. This proved to be a very positive step for the insurance industry, particularly in contrast to very drawn out claim settlement process from the Northridge earthquake.



The latest statistics issued by the Chilean Insurance Association show there have been close to 240,000 claims filed. Over 95% of personal lines and 80% of commercial lines claims have been paid and closed.

Of the 240,000 claims filed, almost 62,000 have been closed without payment as these monetary losses fell within the earthquake deductible. The standard deductible at the time of loss was 1% for personal lines and 2% for commercial and industrial policies.

The settlement of mortgage related claims was a relatively smooth process as the insureds were the banking institutions. Once a property was inspected and damages established, the payments were made directly by the insurance company to the banking institution and not the mortgagees directly.

Insurance companies dealt with mortgage and commercial claims internally. For industrial and more complex claims, insurance companies turned to the expertise of specialized local and international claims adjusting companies. Some of these unique risks were ports, infrastructure (roads, bridges, airports etc), paper manufacturers and wineries.

Insurers must prepare for future catastrophe events in terms of efficiently dealing with the volume of claims and ensuring that the right procedures are in place. The regulator is expected to review how insurers can have access to a sufficient volume of approved claims adjusters in future.

Regulatory Framework

The regulatory framework provided a solid platform to confront the Chile loss. This is illustrated through the following factors:

- Minimum reinsurance purchase requirements for insurance companies to protect their net retentions. This level is based on the Cresta zone that has the largest amount of exposure. Companies purchase between 10 and 11.5% of the CRESTA Zone 3 where Santiago is located. This loss affected up to 3% of the key zone aggregates for personal lines and up to 5% for commercial and industrial portfolios. Based on current reported and estimated ultimate losses no company in the market is expected to exhaust its reinsurance limits.
- Requirement by lenders that financed assets via mortgages must be insured. For this reason, the take up rate for earthquake insurance for personal lines is almost 24%, compared to just 12% in California.

Future modifications

The regulator is looking to make potential changes to further strengthen the regime. These include:

1. The regulator, in conjunction with the local association of insurance companies, has commissioned the development of a comprehensive risk map for Chile. The purpose of this study is to generate a full inventory of all physical property for future urban planning and risk management purposes.
2. The minimum reinsurance purchase requirements are under review and may change from a rigid system based on the percentage of each insurer's peak CRESTA zone exposures to a modeled loss approach that takes into account the individual exposures for each company. This is currently the case in Mexico and Peru. The goal is that each company buys reinsurance for their probable maximum loss depending on the inherent exposure of each portfolio.
3. The Chilean government is reviewing and analyzing the available data to gauge how well the current construction code worked. In general, the code worked very well in terms of preventing loss of life. However, there are some specific deficiencies which will need to be modified or further enforced. For example, reviewing how columns behaved during the event.
4. Insurance companies must establish a catastrophe reserve and this could potentially include the cost of reinstatements on future calculations. The current calculation is based only on the net retention of each insurance company after any proportional and excess of loss reinsurance.
5. The regulator is focused on reducing the significant commissions for earthquake cover on mortgage insurance that banks have enjoyed via their sales channels. The goal is to create more competition among insurers for this market segment, while at the same time curtailing some of the built-in costs transferred to insureds.

Catastrophe Modeling

In the immediate aftermath of the event, a financial perspective was provided to clients using existing portfolio data, which was modeled against the event footprints from the modeling firms. The original modeled estimates generated a wide range of losses from 5% to over 13% of key zone aggregates (KZA), which are the base aggregates used by an insurer to determine the amount of reinsurance to be purchased. This meant that for some of the event footprints, the loss would have exceeded the regulatory minimum reinsurance requirement of 10.5% of KZA.

A year after the event, the issue of model miss is evident. In contrast to the US hurricane events where catastrophe models have underestimated actual losses, the situation is reversed in Chile. For personal lines, we have observed modeled losses to be as much as 100% higher than the actual loss. For commercial lines portfolios, the model miss ranges from 10% to over 100%. The model miss in Chile is likely driven by modeling firms underestimating the quality of construction and how it would perform during an earthquake.

Going forward the focus will be on the model calibration, particularly in light of the actual claims data. Model changes may be needed if the Chilean regulator decides to change the current fixed percentage rules to a modeled based approach. To that end, the users of these models will need to feel comfortable with the vulnerability and hazard components of the models, including time dependency, post loss amplification and industry exposure databases.

The Future for Chile and Beyond

The Maulé earthquake demonstrates how the reinsurance system works effectively and highlights the value of reinsurance as an accretive form of capital to protect balance sheets. The lessons learned can be utilized to prepare for future events both in Chile and in other countries with similar loss potential from natural hazards.

The key next steps for the industry to prepare for the future are:

Catastrophe models

Modeling firms must work to understand the drivers of model miss. Improving tools to reduce the gap between estimated and actual losses will build insurers' confidence in using models as a risk assessment tool.

Business interruption has proved a more challenging area to estimate and this will need to be addressed in future updates as the vendor catastrophe models become increasingly sophisticated.

Data quality

While regulation evolves in Chile, insurers must take a proactive approach to risk management. A crucial area is improving the quality of exposure data, which will in turn improve the accuracy of the model results.

Non-modeled peril: tsunami

The small size of the Chilean tsunami, relative to the large magnitude earthquake, is a key lesson for future research. The industry needs to better understand the tsunami potential from earthquakes, in addition to building vulnerability to tsunami, to achieve a more complete view of catastrophe risk in areas such as Chile.

Tsunamis are not included in commercially available catastrophe models but they are correlated with earthquakes. Therefore insurers need to consider potential tsunami damage in addition to output from catastrophe models' earthquake analysis.

As insurers prepare for the next catastrophe, a strong regulatory system aimed at protecting consumers – coupled with a robust seismic code – can enable countries globally to mitigate damage and economic loss.

Contact Information

Paul Felfle

Head of Analytics – Latin America

Aon Benfield

+1 305 961 6177

paul.felfle@aonbenfield.com

Joseph Smith

Treaty Director – Chile

Aon Benfield

+56 (2) 5199525

joseph.smith@aonbenfield.com

John Moore

Head of International Analytics

Aon Benfield

+44 20 7522 3973

john.moore@aonbenfield.com

Dr Simon Day

Aon Benfield UCL Hazard Centre

+44 20 3108 6014

ucfbsjd@ucl.ac.uk

Nicola Diment

Latin American and Caribbean team

Aon Benfield

+44 20 7522 4026

nicola.diment@aonbenfield.com

David Robbins

Treaty Managing Director – Miami

Aon Benfield Latin America

+1 305 961 6032

david.robbs@aonbenfield.com

About Aon Benfield

As the industry leader in treaty, facultative and capital markets, Aon Benfield is redefining the role of the reinsurance intermediary and capital advisor. Through our unmatched talent and industry-leading proprietary tools and products, we help our clients to redefine themselves and their success. Aon Benfield offers unbiased capital advice and customized access to more reinsurance and capital markets than anyone else. As a trusted advocate, we provide local reach to the

world's markets, an unparalleled investment in innovative analytics, including catastrophe management, actuarial, and rating agency advisory, and the right professionals to advise clients in making the optimal capital choice for their business. With an international network of more than 4,000 professionals in 50 countries, our worldwide client base is able to access the broadest portfolio of integrated capital solutions and services. Learn more at aonbenfield.com.

Copyright 2011 Aon Benfield Inc.

This document is intended for general information purposes only and should not be construed as advice or opinions on any specific facts or circumstances. The comments in this summary are based upon Aon Benfield's preliminary analysis of publicly available information. The content of this document is made available on an "as is" basis, without warranty of any kind. Aon Benfield disclaims any legal liability to any person or organization for loss or damage caused by or resulting from any reliance placed on that content. Aon Benfield reserves all rights to the content of this document.



200 E. Randolph Street, Chicago, Illinois 60601
t: +1 312 381 5300 | f: +1 312 381 0160 | aonbenfield.com

Copyright Aon Benfield Inc. 2011 | #5670 - 02/2011