



ISSUE 4 : 2013

[Reason]

PROPERTY RISK AND INSURANCE SOLUTIONS FOR A COMPLEX WORLD

NIGHTMARE ON MAIN STREET

WHAT HAPPENS TO A BUSINESS WHEN ITS WORST-CASE
SCENARIO **BECOMES A DEVASTATING REALITY**

LAB PARTNERS

*The Jackson Laboratory finds that good
partnership is the cure for mitigating risk*

MEGAQUAKES!

*Are scientists better able to understand the
likelihood of massive seismic events?*

Research Matters

Kristin L.T. Jamison

SENIOR RESEARCH ENGINEER
LARGE-SCALE FIRE RESEARCH

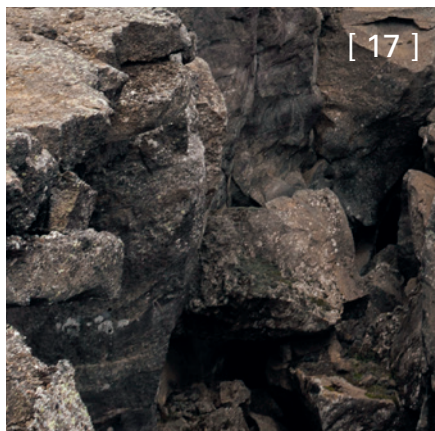
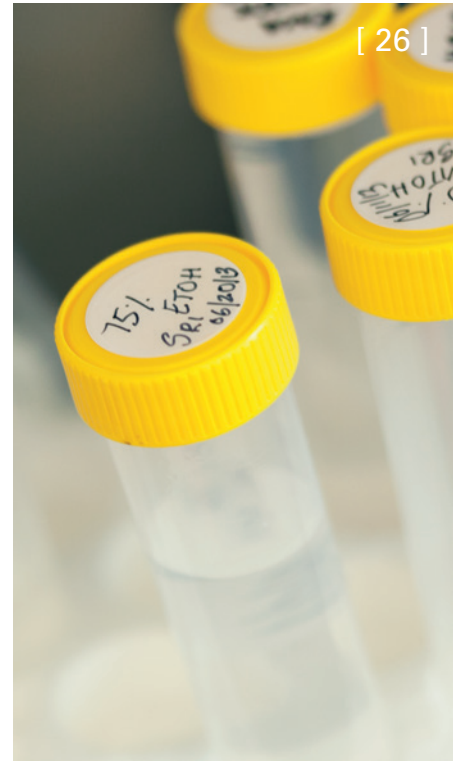


Kristin designs and analyzes fire tests to find cost-effective fire-protection solutions for FM Global clients and to generate data for computer-model input and validation. "We have amazing knowledge we've accrued in nearly two centuries as a company and I get to work with world-renowned scientists on a daily basis. We can come up with really interesting solutions to complex problems that aren't being addressed anywhere else."

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To view *Reason* magazine online, visit fmglobal.com/reason. To download FM Global's Risk Essentials app for your iPad, visit itunes.com/apps/riskessentials.



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- BOOK: *That Used to Be Us: How America Fell Behind in the World It Invented and How We Can Come Back*, by Thomas Friedman and Michael Mandelbaum
- MOVIE: *Hoosiers*, directed by David Anspaugh
- ALBUM: Pearl Jam *Ten*



YUFANG RONG is a senior research scientist working on projects related to earthquake hazard and risk, including updating earthquake risk maps, studying maximum earthquake magnitudes and implementing Global Earthquake Model (GEM) products into the work flow.

- BOOK: *The Black Swan: The Impact of the Highly Improbable*, by Nassim Nicholas Taleb
- MOVIE: *Cinema Paradiso*, directed by Giuseppe Tornatore
- MUSICAL ARTIST: Leonard Cohen



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- BOOK: *The Why Axis: Hidden Motives and the Undiscovered Economics of Everyday Life*, by Uri Gneezy and John A. List
- MOVIE: *Across the Universe*, directed by Julie Taymor
- MUSICAL ARTIST: Frank Sinatra



STEFANO TRANQUILLO is senior vice president, division manager, Asia/Pacific, with responsibility for helping the company to grow its business in that region and be better prepared to respond to client needs.

- BOOK: *Never Go Back*, by Lee Child
- MOVIE: *Shawshank Redemption*, directed by Frank Darabont
- ALBUM: Gilberto Gil *Banda Dois*



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- BOOK: *Unbroken*, by Laura Hillenbrand
- MOVIE: *The Deer Hunter*, directed by Michael Cimino
- MUSICAL ARTIST: Kenny Chesney

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Sharing the Wealth

Here's a way you can take advantage of the bountiful content found on *RiskEssentials*



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We hope that you, as a risk management pro, find value in the content presented in *Reason*. If you'd like to share a story or a nugget of information with a colleague, you can do it easily through our app on a tablet or smart phone.

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**Scientifically based.
Technically sound.
Universally applied.**

Engineering and property loss prevention research are at the heart of the FM Global business model. And wherever your business operates, you have access to our engineering capability. This means your company receives the same quality of service—whether in core or future core markets—from engineers who are locally based and can offer solutions customized to the local business environment. Because our standards are universally applied, you can be sure the advice from your local FM Global engineers is consistent for all your facilities.

Sometimes, more of the same is just what you need.





Are you resilient?

Our company's recent ad campaign has been a pretty big hit. The series, done in photo and video, depicts an array of athletes competing in global-type sports (soccer, rugby, boxing) that are quite obviously dealing with adversity in their respective matches. All muddled and battered, they are either down or under intense pressure. You certainly don't have to be an avid Manchester United fan to get the message: In order to be a winner, you have to hang in there, get up after being knocked down, or break loose when under pressure.

The message translates quite easily to the business of protecting property. Getting back on your feet after absorbing a blow means getting back in business after a catastrophe. Everyone knows that stuff happens. When it does, how effective are you at brushing yourself off and getting back to it?

This resilience advertising campaign resonates in real life and in so many of the stories we tell in *Reason* magazine. In one of our stories in this issue we describe the aligned partnership with The Jackson Laboratory, a cornerstone facility in mammalian genomic research in which scientists perform ever-important work in curing diseases like cancer and Alzheimer's. JAX, as they call themselves, is a prepared and attentive partner in risk mitigation and loss prevention. The Maine (USA)-based research facility had a fire back in the '80s that destroyed nearly everything, including valuable in-progress research. Knowing the pain of having a loss, they are more prepared than ever to prevent a future one. And today they even back up their genetic strains with a unique cryopreservation technique, which you can also read about in this issue.

As our cover story, we've included a fascinating story about a Canadian company, a former client, that thought they were ready for anything, until "anything" happened. In short, there was a freak oversight, a terrible fire, and a frantic, ultimately futile effort to get back in business.

In the end, it's a sad story indeed. The fire not only destroyed the company, but it devastated the community around it. It's a cautionary tale that should serve to, if nothing else, prove the importance of having a reliable continuity plan in place should "anything" happen to you. And that's what we at FM Global mean when we talk about resilience.

Bob Gulla, managing editor
reason@fmglobal.com



[*the* **LATEST**]

Television Discovers the Research Campus

A Discovery Channel broadcast segment took viewers inside the FM Global Research Campus in West Glocester, R.I., USA, to witness the powerful effects of fire, wind, explosions and earthquake. As explained in the August 2013 segment, the dramatic simulations expose why and how building materials fail and, in turn, help clients understand how to shield themselves from disaster. ►

UPDATES



SCAN this QR code
for more information.



(continued from page 9) “A decade ago we embarked upon a mammoth mission: to build a campus that helps to keep our clients resilient in the face of business disruptions and job-killing catastrophes,” says Dr. Louis Gritz, vice president, research manager. “No day is the same, as we apply innovative tools to research, engineer and invent solutions to protect our clients from devastation.”

The segment, available online, aired on Discovery Channel affiliates throughout the world.

For more information about the Research Campus, go to fmglobal.com/research.

PLC 101

FM Global contributes to important RIMS paper

FM Global was recognized for its support of a report recently released by the Risk and Insurance Management Society (RIMS), “Introduction to Property Loss Control.”

Based on the notes of acclaimed property loss control engineer Thomas J. Repking and co-authored by risk management expert Donna Galer and members of the RIMS Member and Chapter Services Committee, the paper reports it is critical for risk professionals to have a clear understanding of property loss control (PLC) to sustain an organization’s finances, profitability, employee well-being, customer service and reputation.

Additionally, the report explores the effects of hazards, best practices for working with service providers, PLC success stories, as well as additional considerations for plan development.

The full report is free to members of RIMS and can be downloaded at: rims.org/RiskKnowledge.



Hail and Farewell

Davey retires after four decades of service

Ken Davey, FM Global senior vice president, division manager, Europe, Middle East and Africa (EMEA), is retiring after 40 years of service to the company.

“I’ve been incredibly lucky to have a great number of roles within the organization that allowed me to live and work in many cities across the globe,” says Davey. “Every two or three years, something new has come up to challenge me, and that’s been the most stimulating.”

A graduate of Trinity College in Dublin, Ireland, Davey’s career with FM Global began in 1973 as a loss prevention engineer. Now known for leading the company through rapid international growth, Davey played a large part in developing

the company’s WorldReach® partner network and in maintaining relationships with regulators in the many areas where FM Global is located.

“Every two or three years, something new has come up to challenge me, and that’s been the most stimulating.”

Ken Davey

FM GLOBAL SENIOR VICE PRESIDENT
DIVISION MANAGER, EUROPE, MIDDLE EAST AND AFRICA

“Ken is the originator of our international operations at FM Global,” says Tom Lawson, executive vice president, FM Global. “He shepherded us through a huge expansion and developed our capabilities and networks, worldwide. We thank him for his years of dedication to the company.”



ARE YOU SERIOUS?

New white paper explains why executives should take natural disaster risk more seriously

With the anniversary of Superstorm Sandy now behind us, CEOs need to take natural disaster risk more seriously, according to FM Global's newly released white paper, *Prepare for the Expected: Achieving Business Resiliency in an Era of Severe Natural Disasters*.

Outlined in the white paper are "Seven Costly Sins Committed by CEOs," as well as the short-term and long-term effects that natural disasters can have on businesses and on economies. It also highlights companies that have successfully faced and stood up to natural disasters through proper preparation and prevention.

According to the white paper, CEOs "otherwise tempt the possibility of long business disruptions, loss of market share, financial instability, customer dissatisfaction and severe reputational issues."

"CEOs own risk for their organization, yet many only have a tenure of a few years," said Tom Lawson, FM Global executive vice president. "However, a once-in-a-century event like Sandy has a 1 percent chance of occurring each year a chief executive serves. The colossal financial losses that can arise should make even a 1 percent threat a top-of-the-agenda item."

Find it: fmglobal.com/assets/pdf/PrepareExpected_whtpaper.pdf

"CEOs own risk for their organization, yet many only have a tenure of a few years. However, a once-in-a-century event like Sandy has a 1 percent chance of occurring each year a chief executive serves. The colossal financial losses that can arise should make even a 1 percent threat a top-of-the-agenda item."

Tom Lawson, FM GLOBAL EXECUTIVE VICE PRESIDENT



SCAN this QR code for more information.

With insights from business and academic experts about lessons learned since Sandy a year ago, the white paper pushes chief executives to address natural disaster risk to their infrastructure, operations and supply chains.

Enhancing Fire Prevention Awareness in France

FM Global Senior Engineering Specialist Vincent Vanderheyden and Senior Learning Specialist Pierre Garcia speak to the benefits of the Fire Prevention Grant Program in a recent video, published online for the risk management community in France. The promotional video highlights the intent of the FM Global Foundation-funded program, and its relevant applications, including pre-fire planning, fire prevention education, and fire and arson investigation.

In the second half of the video, Vanderheyden and Garcia describe a recent project financed by the Fire Prevention Grant, awarded to a local French fire brigade and used to train incoming brigade officers.

"As a communication tool, this video increases awareness of fire prevention, proving that the majority of loss is preventable," says Vanderheyden. "It encourages good corporate citizens to apply for the grant, and provides additional support to the local community."

To view the video, visit fmglobal-touchpoints.fr. For more information about FM Global's Fire Prevention Grant Program, visit fmglobal.com/grants.

UPDATES



FIRST PLACE FINISH

Best Insurer "Overall"

FM Global has been named the best commercial property insurer "overall" as well as for "service" and "expertise," in Business Insurance magazine's 2013 Buyers Choice Awards. Nearly 300 insurance buyers participated in the research.

The magazine noted FM Global's "approach is straightforward" and "set(s) it apart from its competitors." As far as FM Global is concerned, loss isn't inevitable; it's preventable. That attitude, backed by engineering service and research, helped make FM Global the winner in this year's "commercial property insurance" category.

According to the magazine, the most important service attributes identified by commercial property insurance buyers were "demonstrating reliable customer service and responsiveness," "timely claims payments," and "communicating effectively on key customer concerns and issues."

Executive Vice President Tom Lawson pointed out that FM Global's relationship with its clients has led to the highest client retention rate in the industry.

"Our focus is solely on our existing policyholders," Lawson said. "They're our owners. Unlike a stock company, there's never a conflict between the needs of our clients and the needs of our owners."

On The AGENDA

AMRAE

Association pour le Management des Risques et des Assurances de L'Entreprise
Deauville, France
Feb. 5 – 7, 2014

The AMRAE is a professional association whose members are the major players of business risk in the workplace. With the exchange of information and experience among members, through numerous meetings and technical committees, AMRAE aspires to increase the professionalism and credibility of its members in order to better protect the results and optimize the costs of the risk of their businesses.

INTERNATIONAL ROOFING EXPO 2014

Las Vegas, Nevada, USA
Feb. 26 – 28, 2014

As the largest roofing industry gathering, the International Roofing Expo brings segments of the roofing construction and maintenance industry together for interaction, product review, education and networking.

RIMS 2014

Risk and Insurance Management Society Annual Conference
Denver, Colorado, USA
April 27 – 30, 2014

Launched in 1963, RIMS attracts some 10,000 risk and insurance professionals at all experience levels, business executives with risk management interests, brokers, insurers and service providers for the ultimate educational and networking experience. The event offers

120 educational sessions, keynote presentations and exhibits.

FIRE SPRINKLER INTERNATIONAL 2014

London, England
May 20 – 21, 2014

Hosted by the European Fire Sprinkler Network and British Automatic Fire Sprinkler Association, Fire Sprinkler International 2014 shares the benefits and capabilities of sprinkler technology and develops sprinkler advocacy throughout Europe.

SPS/IPC/DRIVES ITALIA

Parma, Italy
May 20 – 22, 2014

SPS/IPC/Drives Italia is the leading event for industrial automation in Italy. This new sister event to the SPS/IPC/Drives exhibition in Germany, offers a wide range of seminars, conferences and workshops focused on current topics within the industry.

AIRMIC

Association of Insurance and Risk Managers in Industry and Commerce
Birmingham, England
June 16 – 18, 2014

AIRMIC is a member association supporting those responsible for risk management and insurance within their own companies. AIRMIC has more than 1,000 individual members representing 450 companies. The conference offers quality networking opportunities for risk and insurance professionals, brokers, adjusters, treasurers, finance directors, claims managers and many insurance professionals.



The Water Is Wide

Subramaniam: Is locating in a flood zone really necessary?

Flood risk threatens more people than any other natural catastrophe. River flooding, in particular, poses a threat to more than 379 million people. More than 283 million are likely affected by earthquakes and more than 157 million are in the path of strong winds. Coastal storm surge, the kind experienced with Superstorm Sandy, could affect about 33 million, and tsunamis pose a threat to nearly 12 million people. Metropolitan areas, including Tokyo/Yokohama, Japan, Manila, Philippines, the Pearl River Delta, Kolkata, India, and Jakarta, Indonesia, are among the most imperiled areas. Less familiar regions, including Central Asia and along the Northern Anatolian fault in the Middle East, are overlooked but still at risk, as are a number of cities, including Doha, Baghdad, Paris, and Mexico City. Flooding can bring ruin to an entire economy. Famously, the Chai Phraya River event in Bangkok, Thailand, resulted in a loss of approximately 10 percent of the country's gross domestic product, not to mention deep and far-ranging repercussions to supply chains globally.

This information is especially relevant to corporations located in flood-prone areas. Shivan Subramaniam, FM Global's chairman and CEO, gets to the point. "The questions businesses need to ask themselves are: 'Do my facilities, currently in vulnerable areas, truly need to be there? Is there a purpose for my buildings being on or near the water?' These are critical questions even for well-insured businesses."

Seeking Higher Ground

The real challenge for risk management is ensuring effort gets extended across the supply chain



In the past 31 years, the global number of loss-relevant events has increased from about 400 a year to more than 1,000. This loss increase is largely as a result of the globalization of business, leading to more companies locating in, or outsourcing to high risk areas prone to floods, earthquakes and other natural catastrophes. Against this backdrop, corporate resiliency in manufacturing is becoming more of a competitive advantage. For example, following natural disasters in 2010 and 2011, certain automotive manufacturers benefited in terms of gaining market share when they proved to be more resilient than competitors, throughout their supply chains.

Risk by industry

By looking at certain sectors within industry, you can see some of the unique challenges faced by manufacturing. FM Global identified through qualitative, client-based research that the automotive, pharmaceutical and electronics manufacturers have to take particular care when planning against business disruption. Furthermore, it found the reasons for these particular sectors being vulnerable aren't unique and are transferable across multiple industries. Many companies operating within these specific industries have addressed the unique challenges by becoming more proactive in managing the risks they face. This means they often have the ability to completely avoid major losses, such as flooding, earthquake and fire. Equally, when the unavoidable does happen, they are usually able to bounce back quickly. Where companies have successfully mitigated their risks, they've used strategies applicable across the whole of the manufacturing industry. What these examples show is how important it is for manufacturing industries to make sure that risk mitigation is high on their agenda. Many companies can learn lessons from organizations that have shown best practice in risk management, so that they too can retain market share and build competitive advantage.

Just-in-time delivery

As it is familiar to many companies operating in the manufacturing industry, so it is for auto manufacturers. It has now become the norm to rely on just-in-time principles and single-source arrangements to keep costs under control and maintain profitability. This may appear to improve efficiency and output, but from a risk perspective, this kind of operational configuration means that

supply chain disruption is more likely to have immediate and severe consequences. For example, a Japanese manufacturer's largest supplier suffered a devastating fire that resulted in the loss of hundreds of critical machines and tools. Since the supplier provided 90 percent of the manufacturer's cost-efficient brake proportioning valves, the incident halted production across 18 of the company's automotive plants within hours. The impact of this fire loss could be seen up and down the supply chain, with hundreds of utility and trucking companies facing severe disruption as well. Ultimately, it caused an estimated one-percent per-day loss to the country's industrial output, with an overall loss estimated at US\$195 million and 70,000 units of production. However, devastating losses like this are entirely preventable. Loss analysis and engineering data have shown that, to prevent a fire in a manufacturing plant, companies should regulate the storage, use and disposal of flammable material, keep mechanical equipment in good working order, and ban smoking on company premises. However, the real challenge lies in making sure that these efforts are extended across the supply chain to include suppliers, shippers and other vendors.

Regulation and R&D

Most manufacturers operate in regulated markets where compliance can prove costly but absolutely essential. There's no better example of tough regulation than in the pharmaceutical industry, which faces a variety of different challenges that makes it vulnerable to business disruption.

For instance, strict regulation means that bringing new drugs to market is extremely expensive and time-consuming. Pharmaceutical and medical products must adhere to some of the highest quality standards and pass numerous quality tests, safety tests and product trials to meet regulation, such as that imposed by the Food and Drug Administration, a process which is likely to take years. Therefore, when a drug enters the market, the company has a limited time in

which to recover the costs of research and development and there's no room for business interruption or a loss in revenue. Moreover, any loss of a key process or supplier used to make a specialty care drug can take up to 18 months to replace, due to the complex processes involved and heavy regulatory approval process needed to get back to full capacity production. As a result, pharmaceutical companies must manage their risks if they don't want to be left vulnerable to losing market share to a competitor or through loss of patent or exclusivity. Indeed, most pharmaceutical companies have highly developed loss prevention strategies that could prove valuable to other industries.

High risk locations

Many manufacturers rely heavily on suppliers located in Asia, or other high risk regions, to stay competitive and, as such, expose themselves to a greater risk of natural disasters, which occur more frequently in these parts of the world. The events in Japan and Thailand in 2013 are good examples, as many electronics companies were affected by both disasters, losing both market share and credibility. Seagate Technology and Western Digital, the leading makers of hard-

disk drives for computers, both located their factories in Thailand. However, Seagate built its plant on higher ground and was hit far less severely by the floods. As a result, it gained a market-leading position ahead of Western Digital because it was able to operate normally when its competitor was out of operation. This shows that risk prevention can have a positive impact in the event of a crisis, in this case, giving a company a market-leading position. Planning for business resilience is becoming all the more important, given the complex business environment in which we live. The concept of building business continuity is particularly significant in the manufacturing industry where complex supply chains are often exposed in high-risk areas. Ultimately, business resilience can build real competitive advantage because preparedness and prevention can ensure that a company can retain its sustained growth and financial long-term sustainability for both themselves and their customers.

Stefano Tranquillo is senior vice president, manager for FM Global's Asia/Pacific division.

Business resilience can build real competitive advantage because preparedness and prevention can ensure that a company can retain its sustained growth and financial long-term sustainability for both themselves and their customers.

On the Record

FM Global executives meet the press and contribute to the public risk management discourse



It's no surprise that ...

“... while companies cannot prevent a natural disaster, they can manage the considerable risks to their property, infrastructure, ongoing business operations and global supply chains, risks of which business leaders are certainly aware. According to a survey of chief executives, a ‘natural disaster disrupting manufacturing and supply chain operations’ was considered the ‘worst impact’ on their organizations by 58 percent. 86 percent described their ability to effectively respond to weather-related risk as a ‘competitive opportunity.’”

– *Shivan Subramaniam, chairman and CEO on Chiefexecutive.net*



Hurricane experience proves ...

“... that remaining resilient during natural disasters is essential in order for businesses and communities to overcome nature’s forces and be able to recover quickly. Property owners in wind- and flood-prone regions should take actions themselves, right now, to understand and address their vulnerabilities. In terms of hurricanes, we have seen that complacency leads to destruction. We encourage being proactive, rather than reactive, to avoid devastation.”

– *Brion Callori, senior vice president, engineering and research on fmglobal.com*



It's vital for business leaders to...

“... identify, assess and mitigate the impact of natural disasters. This risk should be on the radar, along with other substantive risk to ensure corporate stability and health. While many companies rank hazards as low, the possibility of severe and frequent disasters requires these threats be examined in the context of their impact on strategy, operations, finance and people. It’s about taking steps to build resilience so businesses can withstand a natural disaster from the start.”

– *Tom Lawson, executive vice president on fmglobal.com*



If you look around the world ...

“... at the companies that think about resilience at the board level, and considered where they are locating themselves and the specific risks they may face in those countries, many have come through natural catastrophes better than their competitors. This is in part because of the systems they’ve put in place. But it is also, importantly, about the choices they’ve made concerning where they locate. For instance, businesses that have made the strategic decision to locate away from flood zones realize that this can make a significant difference in terms of retaining their market share following an event.”

– *Peter Solloway, vice president, regional sales manager, Northern and Central Europe and EMEA Chemical in Insurance Times*

THE MEGAQUAKE

In the wake of large magnitude tsunamis like Tohoku and Sumatra, are scientists now better able to anticipate massive seismic events?

The magnitude 9.0 2011 Tohoku, Japan, and 2004 Sumatra-Andaman, Indonesia, earthquakes were black swans¹ to many earthquake scientists because of their unexpectedly large magnitudes. The devastating tsunamis triggered by each earthquake killed more than 250,000 people and caused massive economic losses. With the wake-up call from these two megaquakes, scientists and businesses want to know the maximum size earthquake that can occur in a region so that the seismic hazard can be better addressed and businesses can be better prepared. ►

¹Black swan is a metaphor, developed by Nassim Nicholas Taleb in his 2007 book, *The Black Swan*, to describe an event that is considered rare and unpredictable, has a massive impact, but is retrospectively predictable.



The Tohoku and Sumatra-Andaman earthquakes occurred in subduction zones, where one of the tectonic plates comprising Earth's surface dives beneath another plate. The subduction process causes the largest earthquakes in the world. Why were the maximum earthquake sizes in both regions underestimated? Can we find a way to better estimate them? With these questions, FM Global collaborated with Prof. David D. Jackson from University of California at Los Angeles (UCLA), a renowned expert in earthquake research, to evaluate the earthquake magnitude limits along subduction zones.

est earthquakes may not have been recorded or may not have happened yet. Thus $m_{\max}$ can be severely underestimated using this method. For example, none of the known historical earthquakes in Tohoku region before the 2011 event was larger than magnitude 8.4. As a result, most of the prior seismic hazard estimates for the Tohoku regions limited the $m_{\max}$ to below 8.5.

Another way to estimate $m_{\max}$ is by examining the known faults. A fault is a fracture in the Earth's crust along which movement can take place, causing an earthquake. The size of a fault can limit the size of earthquakes occurring on the fault—

with a magnitude just slightly larger is not possible. To overcome the predicaments of $m_{\max}$, we introduced the concept of probable maximum earthquake magnitude within a time period (T) of interest, $mp(T)$. The new concept not only contains the earthquake magnitude information, but also provides how frequently such size earthquakes can happen. In this study, we not only determine the median values of $mp(T)$ but also their uncertainty.

The “Ring of Fire,” and estimating probable maximum magnitude

One of the most simple and useful statistical relationships in seismology is the Gutenberg-Richter (GR) law. It states the relationship between the magnitude and frequency of earthquakes: the number of earthquakes exponentially decreases with the increase of magnitude, and the plot of magnitude vs. logarithm of frequency of earthquakes follows a straight line. The slope of the straight line is called the b-value; it governs the ratio of the number of small to large earthquakes. The GR law is amazingly robust. The b-value is typically about 1.0 in seismically active regions. For example, on average about 1,300 magnitude 5–5.9, 130 magnitude 6–6.9, and 15 magnitude 7–7.9 earthquakes are observed around the globe each year. However, the number of events usually drops more quickly at larger magnitudes, which is not captured by the simple GR distribution. To overcome that shortcoming, scientists created some ways to modify the large magnitude tail distribution.

One of the best modifications of this is called the Tapered Gutenberg-Richter (TGR) distribution, proposed by Yan Y. Kagan, a famous statistical seismologist at UCLA. In the TGR distribution, he added a parameter called the corner magnitude, above which the frequency of earthquakes drops exponentially compared to the GR distribution. Using the TGR distributions, we can determine the most probable maximum magnitude corresponding to different time periods

A fault is a fracture in the Earth's crust along which movement can take place, causing an earthquake. The size of a fault can limit the size of earthquakes occurring on the fault—large earthquakes require large faults. But earthquake ruptures can jump from one fault to another and create earthquakes larger than a single fault can hold.

Maximum earthquake magnitude

The maximum earthquake magnitude ($m_{\max}$) is defined as the largest possible earthquake that could happen on a fault or in a region. In seismic hazard analysis, it is usually treated as a “hard” cut-off magnitude: earthquakes larger than $m_{\max}$ will not be considered in the analysis. As a consequence, the choice of $m_{\max}$ can significantly affect the seismic hazard and risk results. The use of $m_{\max}$ is also convenient for engineers and insurers to make decisions on construction standards or on insurance policies. The most intuitive way to estimate $m_{\max}$ is to examine the earthquake history of a region, and find out the historical maximum earthquake magnitude. However, the period of historic earthquake observation may be short compared with the return time of large earthquakes, so the large

earthquakes require large faults. But earthquake ruptures can jump from one fault to another and create earthquakes larger than a single fault can hold. For instance, the rupture of 2002 magnitude 7.9 Denali Fault Earthquake in Alaska started on a previously unknown fault, now called the Susitna Glacier fault, continued on the Denali Fault, and finally terminated on the Totschunda fault. At present, we don't know what serves as the absolute stopper for such multi-fault ruptures.

As a matter of fact, $m_{\max}$ is ill-defined because it does not specify the time interval over which it is valid. Using the available historical earthquake data, it is neither possible to determine nor to test $m_{\max}$ for the whole 4.5 billion year geologic history of the Earth. Moreover, given an absolute $m_{\max}$, it is difficult to argue why an earthquake

of interest. We applied this methodology to the circum-Pacific “Ring of Fire,” a belt of subduction zones marked by earthquakes and volcanoes surrounding the Pacific Ocean. About 90 percent of the world’s earthquakes occur in the Ring of Fire (Figure 1).

To populate the TGR distributions, first we need to delineate the subduction zones on a map. We use Flinn-Engdahl zones (blue polygons in Figure 1) defined by scientists of the same names back in 1965. We then determine b-value and corner magnitude for each of the zones surrounding the Pacific Ocean. We get the b-value by examining the number of events of different magnitudes in each of the zones. However, the available history (just over one hundred years for most of the zones) is too short for determining corner magnitude because the determination of corner magnitude mainly depends on the magnitude distribution of large earthquakes, and not enough large earthquakes have occurred during the historic period.

To deal with the daunting task of estimating the corner magnitude, we employed a theory called seismic moment conservation principle. Seismic moment is another quantity used by earthquake scientists to measure the size of an earthquake. It has dimensions of energy and it can be tied to earthquake magnitude. If the earthquake magnitude increases by one unit, the seismic moment increases about 30 times. The advantage of using seismic moment is that the moment is additive: a collection of earthquakes produces a total seismic moment equal to the sum of the individual moments. Furthermore, seismic moment can be related to faulting. As tectonic plates push against one another, the stress in rocks increases. Because of the friction on a fault between the plates, the two plates cannot slide freely. Instead, they deform elastically and build up energy, like compressing a spring. When the stress exceeds the friction or the breaking strength of the rocks, the rocks break or slide in an earthquake; and in a short period of time, the elastic energy stored in the deformed rock is released by the earthquake. We refer to this

EARTHQUAKES AND THE “RING OF FIRE,” 1900–2011

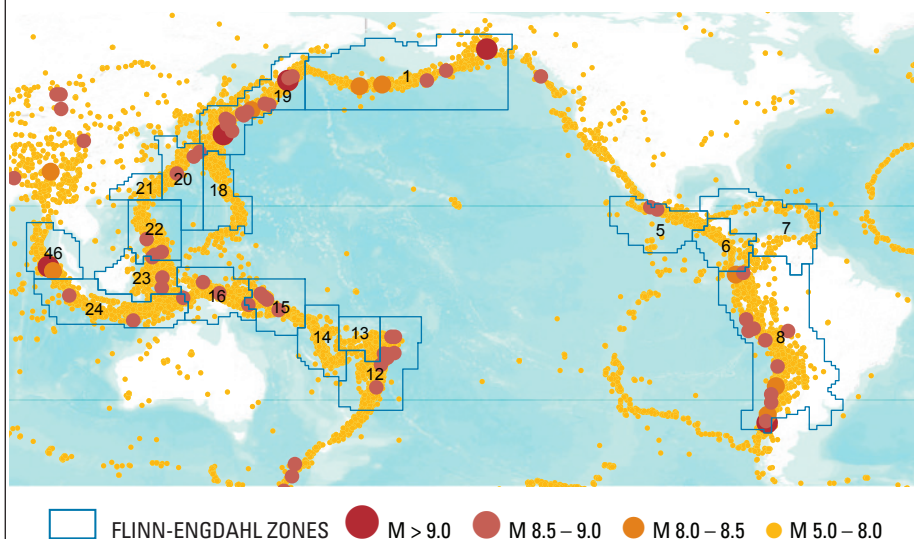


Figure 1. Subduction zones (blue polygons) around Pacific Ocean defined by Flinn-Engdahl and historical earthquakes (colored dots). In the legend, “m” represents magnitude. The Flinn-Engdahl zones are: 1. Alaska-Aleutian Arc 5. Mexico-Guatemala 6. Central America 7. Caribbean Loop 8. Andean S. America 12. Kermadec-Tonga-Samoa 14. New Hebrides Islands 15. Bismarck-Solomon Islands 16. New Guinea 18. Guam-Japan 19. Japan-Kamchatka 20. Japan-Ryukyu Islands 21. Taiwan 22. Philippines 23. Borneo-Celebes 24. Sunda Arc 46. Andaman Islands.

RETURN PERIODS OF SELECT EQ ZONES

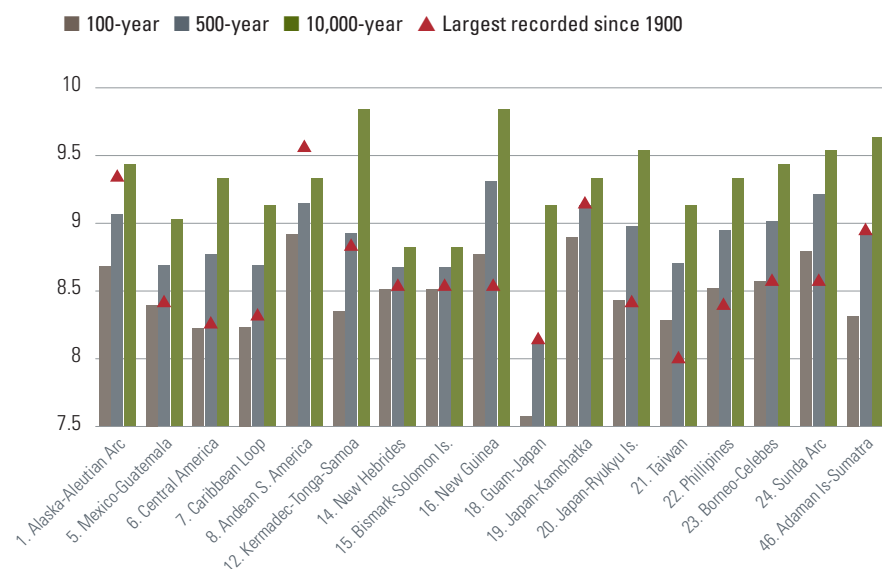


Figure 2. The estimated median values of mp (probable maximum magnitude) for 100-, 500- and 10,000-year return periods for the subduction zones. The historical maximum magnitudes since 1900 are shown by red dots.



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[theSCIENCE]

built-up energy as the “tectonic moment,” which can be estimated from the characteristics of subduction zone faults and the motion of tectonic plates. Over a long period of time, the total seismic moment released by earthquakes in a region should be equal to or less than the tectonic moment. This forms the basis of seismic moment conservation principle.

In summary

Because the traditional methods for estimating $m_{\max}$ are inadequate and $m_{\max}$ itself is ill-defined, we introduced the probable maximum magnitude concept by adding an effective time period to $m_{\max}$. After estimating the probable maximum magnitude for each of the circum-Pacific subduction zones, we concluded that most of

Our results show that most of the circum-Pacific subduction zones can generate $m \geq 8.8$ earthquakes over a 500-year interval and $m \geq 9.0$ earthquakes over a 10,000-year interval. Furthermore, most of the zones have not experienced the probable maximum magnitude earthquakes in the past 110 years, the period of historical observation.

Using the earthquake statistics with the constraint of the estimated tectonic moment rate, we obtained the parameters for constructing TGR distributions for each subduction zone. The TGR distributions tell us the occurrence rate of earthquakes at each magnitude. The reciprocal of occurrence rate is the earthquake return period. Accordingly, a TGR curve tells mp for a different period of interest. The uncertainty of mp varies among zones; however, for most zones it is within ± 0.2 to 0.3 magnitude unit. Figure 2 illustrates the median values of mp for 100-, 500-, and 10,000-year periods for each of the subduction zones. We also plotted the largest historical magnitudes since 1900 in the figure as a comparison. Our results show that most of the circum-Pacific subduction zones can generate $m \geq 8.8$ earthquakes over a 500-year interval and $m \geq 9.0$ earthquakes over a 10,000-year interval. Furthermore, most of the zones have not experienced the probable maximum magnitude earthquakes in the past 110 years, the period of historical observation.

the zones can generate mega earthquakes over a period of social interest. There is hope that earthquake scientists, including seismic hazard modelers, will discard the ill-defined absolute maximum earthquake magnitude and embrace the new concept of probable maximum magnitude.

The available historical earthquake catalogs are too short to validate our results for periods of more than a few hundred years. On this issue, paleoseismic data, that is, the geologic record of ancient earthquakes, can help. Along the Cascadia subduction zone in the U.S. Pacific Northwest, the paleoseismic studies have unearthed an approximate 10,000-year history of great earthquakes. We will discuss how to use those data to further constrain our results in part two of this article in the next issue of *Reason*.

Yufang Rong, Ph.D., is a senior research scientist at FM Global.

THE BENEFITS OF RISK IMPROVEMENT

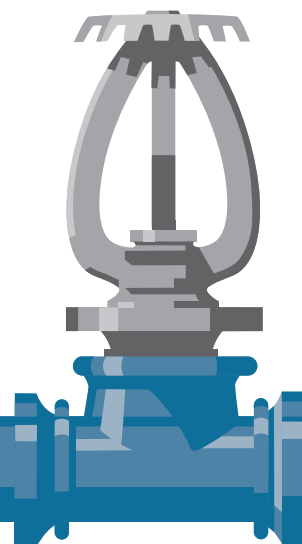
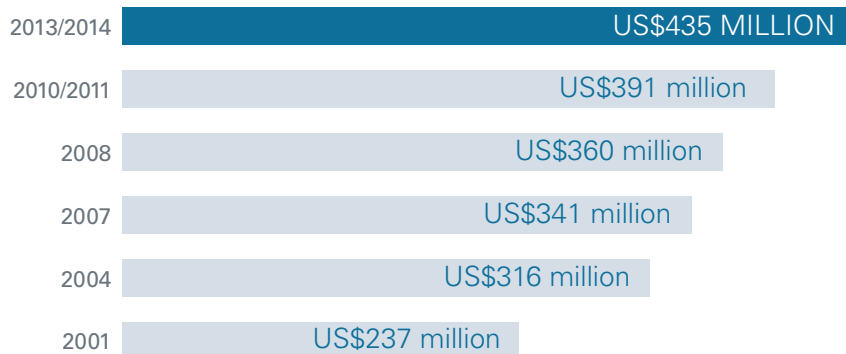
Risk improvement: always a wise investment

At FM Global, sometimes the return is even better than anticipated. Over the past four years, our clients installed automatic sprinklers throughout more than **200 million square feet** (18.6 million square meters) of their properties. That's just one example of the many steps our clients have taken to reduce risk.

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LI-ION TAMING

In part two of our story on lithium-ion batteries, devising a test, generating info, and producing results

How do you test the fire characteristics of a warehouse commodity when the commodity comes in a multitude of shapes and sizes, appears in an ever-expanding list of products, is hard to get in large quantities and is almost too expensive to burn?

These were the challenges presented to FM Global when it began looking into the bulk storage of lithium-ion batteries.

Lithium-ion batteries can be found in just about every portable consumer electronic device, including cell phones, cameras, laptops and tablets. The battery's chemistry, light weight and capacity to store energy have made them the premier rechargeable battery. Billions of the batteries are in use around the world, and they continue to find their way into more and more consumer and commercial products.

Despite their prolific use, there is little information about the potential fire hazards of these batteries when stored in large quantities. FM Global, with the National Fire Protection Association (NFPA), recognized this gap in knowledge and set out to learn more about the batteries' fire hazard and how best to protect warehouses and other battery storage facilities.

With the assistance of NFPA's Property Insurance Research Group (PIRG), which comprises seven major U.S. industrial property insurers, FM Global took on the challenge. PIRG looks at emerging trends in product development, manufacturing, storage and transportation, and identifying potential new hazards for property insurers. The group then turns to research partners like FM Global to expand the industry's knowledge on the subject.

But testing lithium-ion batteries brought with it many challenges. The biggest challenge was to create tests that would generate relevant data. The batteries come in a wide variety of sizes and shapes, they are shipped and stored in a multitude of forms and the technology is still evolving as scientists develop new ways to harness the battery's potential.

Despite all this, FM Global had to devise

tests that would generate information relevant to the commodity as a whole. The research team eventually settled on three types of batteries that represented the most common size, type and use. FM Global tested two “small format” lithium-ion batteries shipped directly from the battery manufacturer and power tool packs like those used in rechargeable drills and saws.

“It is a challenge to get answers beyond the specific batteries tested because there is no universal battery design,” explained Ben Ditch, FM Global senior research engineer, who designed the tests. “The hazard is specific to the battery type and how it is packaged.”

along the path of the initial fire development. This allowed FM Global to measure how long it took the batteries to become involved in the fire as well as the burn characteristics of the batteries themselves.

“We could not conduct our normal, full scale, big commodity classification test,” explained Kathleen Almand, NFPA’s vice president of research and executive director of the Fire Protection Research Foundation. “But FM Global developed a unique research approach to this problem. We were able to minimize the cost of the batteries involved in testing and gather the information we needed to compare the performance

about 1/20th of the commodity we would use in our standard approach.”

The research on lithium-ion batteries in bulk storage is important for several reasons. Lithium-ion batteries have negative (anode) and positive (cathode) electrode material that serve as hosts for the lithium ions. An electrolyte composed of an organic solvent and dissolved lithium salt allows for the transport of lithium ions. This electrolyte is what makes the batteries flammable.

A separator keeps the anode and cathode materials apart within the battery. If the separator is damaged or defective, shorting between the cell electrodes can occur. This can initiate “thermal runaway,” where the internal failure causes the battery to overheat rapidly. There are many dramatic YouTube and other internet videos that show laptops and other devices bursting into flames, which is usually the result of thermal runaway. The testing conducted by FM Global is one of the first steps in understanding if thermal runaway would become a contributing factor in a bulk storage fire.

Another concern is lithium-ion batteries’ potential to “rocket” when heated. A study by the Federal Aviation Administration (FAA) showed that gas venting from the batteries had the potential to move the battery, rocketing it away from the heat source. In a bulk storage facility, this rocketing could send batteries off into other parts of the warehouse, spreading the fire.

And finally, ignition of a lithium-ion battery is essentially a chemical fire. There is little information on the best extinguishing agent for a lithium-ion battery fire, if the chemicals released create a hazard to fire-fighting personnel or what cleanup methods should be used.

“The testing we did is just one piece of the puzzle,” Ditch explained. “This is a commodity that keeps growing and we all want to get ahead of it in terms of mitigating the hazard. This is a case where we really had limited background knowledge and this was an opportunity to learn something significant.”

Lithium-ion batteries have negative and positive electrode material that serve as hosts for the lithium ions. An electrolyte composed of an organic solvent and dissolved lithium salt allows for the transport of lithium ions. This electrolyte is what makes the batteries flammable.

Cost and availability were additional challenges. The material alone for a full-scale test would cost over half a million (U.S.) dollars. Because the batteries are in such high demand, and most manufacturers produce them for just-in-time delivery, there are not a lot of “extra” batteries available.

“It was daunting to amass the quantity needed for a full-scale test,” said David Fuller, manager, protection and special hazards at FM Global.

So the team at its research facility in Rhode Island developed tests using only a fraction of the amount of product typically used in a hazard assessment.

They devised a reduced-commodity fire test to capture the flammability characteristics of the batteries in a rack storage. Normally, FM Global conducts tests with full racks of the test commodity. For these tests, lithium-ion batteries lined only the ignition flue area, strategically locating batteries

of the batteries with other commodities that we understand. With that information, we can compare the sprinkler protection criteria that would be applied.”

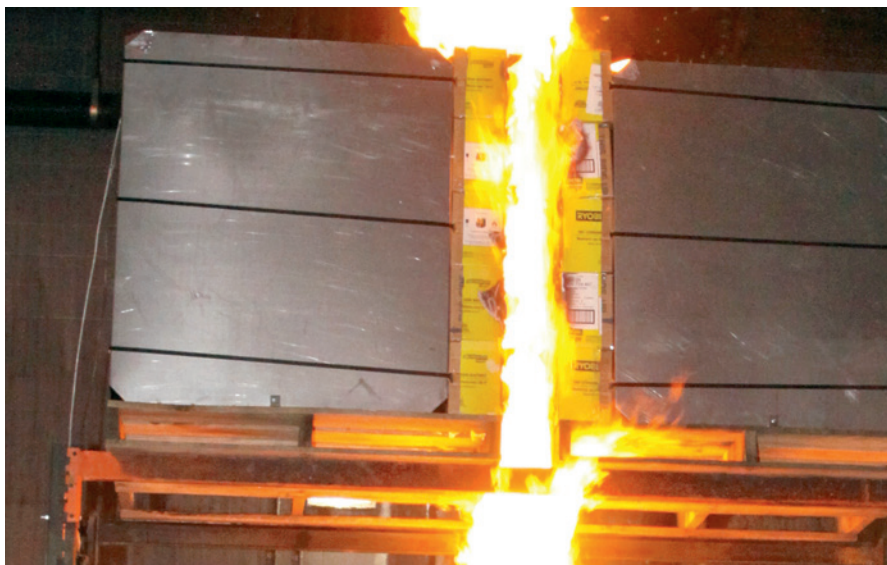
FM Global does not make a financial contribution to PIRG but, instead, it makes a research contribution on what the group identifies as a priority. The lithium-ion battery research was a perfect fit. FM Global had a desire to update its own *Property Loss Prevention Data Sheets* on the subject while advancing the industry knowledge, which, in turn, will help all of FM Global’s clients. It was also a project in which FM Global could contribute beyond simply offering the use of its research facility.

“From a facilities standpoint, there are a few labs out there that can do this testing,” Ditch said. “What we brought to the table is the engineering skill and expertise to do this unique test. We had to figure out how to obtain all the information we gained using

The tests results provided some important information. The tests showed that the initial fire is driven mostly by the burning of the package material and the time it takes for the batteries to become involved is well after the first sprinklers would operate. The tests indicate that a properly designed, water-based protection system would be able to suppress a fire before the batteries became a contributor.

The reduced-commodity tests do not provide the same level of information regarding protection system performance gained through commodity classification or large-scale, sprinklered fire testing; however, it does start to answer questions about how the batteries react in a fire and how to adequately protect facilities where they are being stored.

“We have really just scratched the surface on what drives loss prevention for this hazard,” said Fuller. “But it gives us more information about whether lithium-ion batteries may or may not behave like a standard commodity.”



information it gathers on lithium-ion batteries to set sprinkler standards for storing this commodity in bulk. Currently, the standard governing automated sprinkler systems (NFPA 13) offers no guidance on lithium-ion batteries. FM Global will also use the information to provide guidance to

test results do support analogous protection requirements for commodities with similar hazard characteristics. In consultation with the FM Global Engineering Standards group, which is responsible for the FM Global *Property Loss Prevention Data Sheets*, protection recommendations have been established based on current knowledge and may be amended if additional research specific to the hazard of Li-ion batteries is conducted.

“There is a limit to the applicability of the results, but we did glean some promising data that make us feel comfortable that we can protect the commodity with water in a storage facility,” Almand said. “We are not able to directly correlate the batteries to any other commodity completely. More work needs to be done before we can put specific criteria into NFPA 13.”

But it is a step forward in that understanding. “Because this information is publicly available,” Almand said, “it is influencing decisions insurers and building officials are making today.”

Read the full technical report:
fmglobal.com/researchreports

Watch the test videos:
youtube.com/user/FMGlobalVideos

These tests alone will not lead to full sprinkler recommendations. The NFPA is looking into further small scale and full scale testing to fully understand the hazards of lithium-ion batteries in bulk storage.

The tests provided a host of new information. FM Global measured carbon dioxide, carbon monoxide, total hydrocarbons and depletion of oxygen in the exhaust of the experiments. The team took video, infrared video, and photography. All of this information serves to enhance fire protection guidelines of common battery types in rack storage configurations.

“The science behind the work is important,” Ditch said. “And we set fire to 20,000 batteries. That’s a pretty good day and some pretty critical work.”

Eventually, the NFPA will use the

its customers through its *Property Loss Prevention Data Sheets*.

These tests alone will not lead to full sprinkler recommendations. The NFPA is looking into further small scale and full scale testing to fully understand the hazards of lithium-ion batteries in bulk storage. Further research is needed on the gas leaking and venting from the batteries, the use of water as a fire-suppressant and the recommendations for incident cleanup.

Protection recommendations for Li-ion batteries could not be directly and explicitly developed during this project; however, the



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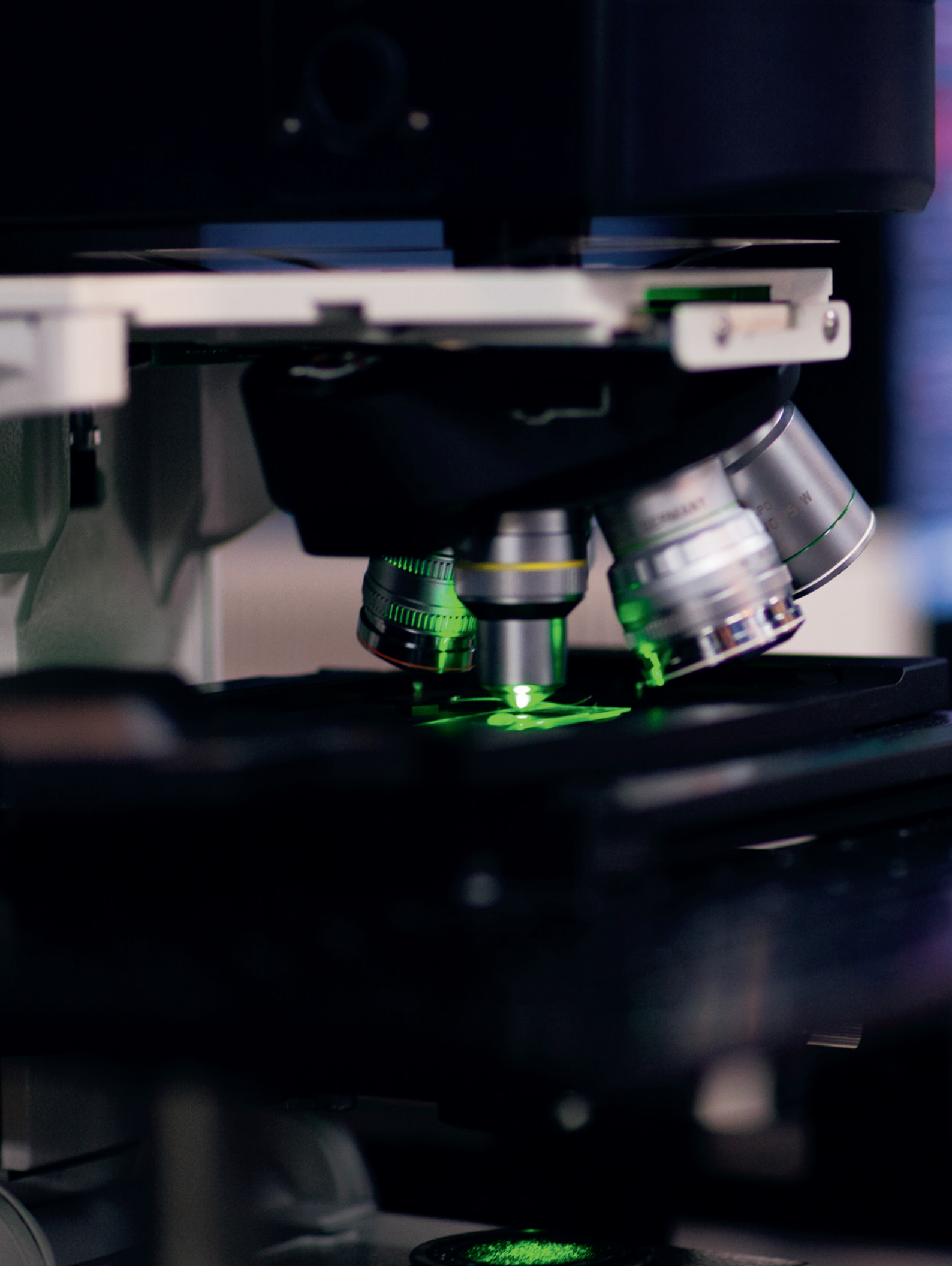
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“

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WITH FM GLOBAL. I KNOW THAT, IN THE
END, THEIR GOAL IS THE SAME AS MINE,
WHICH IS TO HAVE A FACILITY THAT'S
SAFE AND OPERATING 50 YEARS
FROM NOW WITH NO LOSS.**

DAVE KUCHTA

Maintenance and Utility Plant Manager
The Jackson Laboratory, Bar Harbor, Maine, USA

JUST OUTSIDE

the picturesque tourist town of Bar Harbor, Maine, you will encounter an unlikely sight: the Jackson Laboratory, one of the world's cornerstones of mammalian-based genetics research. It is certainly not what you'd expect to find on the remote Mount Desert Island, deep amid the pine trees and steps from the Atlantic Ocean. Its location in the northeast corner of the United States along the road leading to the beautiful, rugged coastline of Acadia National Park is a small part of the Jackson Laboratory's very unique story, but a critical one.

The laboratory was founded in 1929 by Clarence Cook (C.C.) Little, one of the first geneticists in the country. The Harvard-educated Little was a scientific pioneer, believing that the mouse was a near-perfect model for human diseases, and that cancer was actually a genetic disease.

Dr. Little was first and foremost an educator. He served as the president of the University of Maine and the University of Michigan in the 1920s. As a result, he was well connected to the wealthy businessmen and automobile barons of the day. When he was ready to set up his laboratory, wealthy Boston businessman George Dorr provided him land and the funding came from the budding auto industry, including Edsel Ford, president of the Ford Motor Company, and Roscoe B. Jackson (for whom the laboratory is named), president of the Hudson Motorcar Company. Dorr would later organize the gifts of land that became Acadia National Park just down the road from the laboratory.

The laboratory started with eight researchers conducting some of the world's first cancer studies. But the research was just a fraction of Dr. Little's contribution to science. He developed the very first inbred strains of mice.

Those strains live on today in colonies at the Jackson Laboratory. "JAX" mice are now the backbone of scientific research around the world. The lab ships more than three million mice annually to more than 20,000 laboratories in 63 countries.

During the last 10 years, the Jackson Laboratory has seen tremendous growth. Along the way, FM Global has been there, working to understand the lab's indelible history and its vital role in scientific research, and to help mitigate the unique risks the company faces.

Today, more than 1,300 people work at the Maine facility, including more than 200 PhDs, medical doctors and scientists studying a host of human diseases. The Jackson Laboratory now has a campus in California to serve the biomedical community on the U.S. west coast and is building a third facility in Connecticut.

The Jackson Laboratory and FM Global are working together to reduce risk and avoid the kind of business interruption that could jeopardize critical genomic research being conducted around the world.



DAVE KUCHTA

Maintenance and Utility Plant
Manager, The Jackson Laboratory

I manage every aspect of facility operation in the Bar Harbor Campus, which is a 135-acre (55-hectares) campus, with 875,000 square feet (81,290 square meters) of mixed use space. This location had grown continuously since the 1930s so the variety of the types of space here is vast. We have a complex utility structure and to add to the challenge, we're located in Bar Harbor, Maine. It's a fairly remote location and basically at the very end of the supply chain.

I have a wide variety of roles, ranging from grounds maintenance and aesthetics right through to controls and utility plant operations. I have a lot of involvement in financial aspects—budgeting, capital planning, engineering, and I do a lot of project management including roofs, equipment replacement and upgrades. I've done everything from exterior renovations on a 1909 mansion, to industrial roofs, to installing new boilers. Then the next day, I'm writing a five-year capital plan and working with the Environmental Protection Agency, and external agencies like the city's water department. It's an interesting role.

I work with FM Global almost on a daily basis in some capacity, either with them or with the information they have provided. They're involved with us on everything from design and construction to operation of our facilities in all locations. They provide us with really solid guidelines that make projects safer, and less likely to experience loss.

FM Global provides us with very detailed construction and operation standards for equipment within the facility, ranging from roof designs, fire system suppression designs, boiler designs, underground storage tank designs and every aspect of new equipment. FM Global's standards are always very stringent and detailed and they



provide great information for me. When I get a recommendation from FM Global I have confidence because I know it is backed by a large group of subject matter experts.

I especially rely on FM Global for roofing standards. We're in a high-wind area here. We're 300 yards (274 meters) from the Atlantic Ocean on an island, and building the roofs to FM Global's standards assures me that I'm not going to see major losses as a result of a poorly designed roof. It gives me a great sense of comfort. FM Global will visit during construction and inspect these jobs side by side with me. We have a dialogue that we work through to determine the best possible solution we have for complicated problems that are inherent to constructing major facilities.

I began my career out of college as an officer on a nuclear submarine in the Navy, and in that situation, you can't evacuate the burning building and let someone else put it out. Therefore, from the very first day of my career, loss prevention has been of the highest priority, and I've just moved that philosophy to my private industrial experience over the years.

I have a very close partnership with FM Global. I know that, in the end, their goal is the same as mine, which is to have a facility that's safe and operating 50 years from now with no loss.



NATHAN BRIGGS
Senior Treasury Analyst
The Jackson Laboratory

FM GLOBAL'S KNOWLEDGE OF VARIOUS GEOGRAPHIC AREAS AND BUSINESS MODELS HAS BEEN KEY FOR US AS WE MOVE PROJECTS FORWARD AND LOOK TO HAVE SUCCESSFUL COMPLETION OF THOSE PROJECTS.

One of my main responsibilities is handling the renewal process for our insurance program through our brokers, William Gallagher Associates out of Boston (Massachusetts, USA), with Amy Sinclair and her team. We have an annual renewal process that we go through and we're always in communication with the brokers, and ultimately, FM Global as new projects and programs come about.

FM Global provides us with a tremendous amount of value, in terms of plan reviews, as we're working on new projects, renovations or new buildings. They've also taken the time to understand the laboratory and the business model that we have. Because of our uniqueness, we need to have someone who understands what it is we do and how we operate. Whether it's our JAX Mice & Services group, our research, or the courses and conferences we offer. From a treasury standpoint, certainly premium is key with our carrier. But we're also, again, very interested in having a carrier that understands our business and is willing to work closely with us as we expand and grow. We are looking for someone to really

be a resource for the laboratory as we move forward.

There's a lot of new activity occurring at the laboratory. Recently, we put into place a builder's risk program with FM Global to build a new facility in Farmington, Connecticut (USA). There's always a new building or renovation going on in Bar Harbor. We're building a new facility in Sacramento (California, USA) as well.

FM Global and the Jackson Laboratory are always working together. FM Global has worked with us on our cryopreservation division, and Dave Kuchta in our facilities area has been reaching out to FM Global to conduct earthquake shake tests on some of our animal cages. With our Sacramento facility

being located in California, there are earthquake considerations. Dave has had discussions about the possibility of having shake tests at the FM Global Research Campus.

FM Global's experience is key as we expand and grow. Their knowledge of various geographic areas and business models has been key for us as we move so many projects forward and look to have successful completion of those projects.

The relationship between the laboratory and FM Global is probably best exemplified by the lengthy tenure we've had with FM Global. It's been quite a while since we've brought them on as a carrier, and that relationship has continued to grow for the better over the years.



OUR FM GLOBAL ENGINEER WAS CONCERNED ABOUT ITEMS STORED NEAR THE SPRINKLER HEADS. WE FOLLOWED THE ADVICE AND ENDED UP AVOIDING A US\$100,000 CHANGE ORDER. TALK ABOUT COLLABORATION! I WOULD NEVER HAVE EXPECTED THAT FROM AN INSURANCE CARRIER.



NORM BURDZEL

Facilities Engineer, The Jackson Laboratory

(Left to right: JAX's Steve Heckman, Nathan Briggs, David Kuchta, Norm Burdzel and Stephen Linnell)

I handle just about every engineering aspect for the Jackson Laboratory—mechanical, water, sewer, air quality, pellet plant. Whatever people here envision, we make those dreams a reality. I have many facilities projects, and the project requirements are different. Our clean room engineering is beyond any experience you would get anywhere else.

FM Global provides us with checks and balances. You can't know everything there is to know about every system. I can send a design to FM Global and they have the expertise to say, "You need a higher sprinkler yield," or "You haven't fastened this enough."

We have a master plan for the next 25 years where we look at fire lines and water capacity. I can download FM Global data sheets and that helps me make better assessments. And if you're getting the data from FM Global, you know it is right.

I've always looked at the relationship with FM Global as collaborative. They have a seat at the table; that's the only way it works. It all comes down to value and the value we get when FM Global helps us to manage our risk.

We were doing some work on the rack sprinkler system at one of our warehouses and our FM Global engineer came out to the facility. He was concerned about items being stored near the sprinkler heads. We ended up averting a US\$100,000 change order because of that.

Talk about collaboration! It really helps to have that second set of eyes and it's something I never would have expected from an insurance carrier.

Working with FM Global gives us consistency across the country. We're moving into California and that is a different world for us. Out there we have a whole different FM Global team, which is very consistent with the service we get here. We're building in Connecticut and FM Global has helped with the project a great deal, doing on-site inspections to make sure the facility meets their standards. It's easier to be consistent over three campuses knowing FM Global is there looking over our shoulder. I have nine projects right now and they all go to FM Global for review.



STEVE HECKMAN

Fire Protection Specialist
The Jackson Laboratory

My role at the Jackson Laboratory is to make sure that all fire protection systems are operationally ready at any given time, and basically, to protect the facility from the possibility of fire. Unfortunately, the laboratory had a fire in 1989. It was in our production facility and it was quite devastating. I think that really opened our eyes to the fact that fire can happen to us. Since that time, the laboratory has had a strong drive to protect the facility from another fire.

We have about 875,000 square feet (81,290 square meters) under roof. A lot of it is broken up over the entire campus, in individual buildings. So each building has its own fire protection features. A lot of them are the same, but some of them are more unique, such as the pellet boiler. We actually have a spark-suppression system

THE LAB HAD A FIRE IN 1989 AND IT WAS DEVASTATING. IT OPENED OUR EYES TO THE FACT THAT FIRE CAN HAPPEN TO US. SINCE THAT TIME, THE LAB HAS HAD A STRONG DRIVE TO PROTECT THE FACILITY FROM ANOTHER FIRE.

and other special hazards-type systems in that building to protect that facility. In the last 10 years, the Jackson Laboratory has expanded significantly and that has created a situation where we have to always be thinking ahead to provide fire protection and life safety initiatives.

We have more than 25 separate sprinkler risers and systems, and more than 2,300 operational smoke detectors in use at any given time. All fire protection sys-

tems, whether smoke-detection or sprinkler systems, have unique maintenance requirements. Fire protection standards dictate that every single item has to be touched on an annual basis. Working with FM Global, we do testing on a quarterly, monthly and even a weekly basis. FM Global standards are often more stringent than state requirements, but we know that it's done right.

For example, FM Global requires drain-testing on a quarterly basis, whereas the NFPA codes and the state codes require drain-testing on an annual basis. With quarterly testing, we can see a drop in water pressure a lot sooner, whereas, if we waited a year, we may have a hazard that could have gone unchecked.

Our mindsets are the same. FM Global realizes that fire can happen. We realize that fire can happen, and it is one of the only natural disasters that is preventable. Recovering from a fire is devastating, on a businesswide or corporatewide scale. It can be devastating not only to the corporation, but also to every single employee that works for them.

I'm passionate about fire protection. I'm an assistant fire chief in a neighboring town. When the FM Global folks show up, you can tell that they're passionate about property protection and fire protection. I think it's a very good partnership, because we're working toward a common goal of protecting the facility from fire.





JASON ADAMS

Senior Account Manager, FM Global

**WE ARE A PARTNER.
WE ARE A VALUED
PART OF THE DESIGN
AND IMPLEMENTATION
TEAM. WE DON'T BUILD
THE FACILITY, BUT WE
ADVISE CONTRACTORS
THAT DO, AND THAT'S
WHAT THE LAB IS LOOK-
ING FOR FROM US.**

I work with the Jackson Laboratory's risk management department to craft insurance products and policies that meet their unique and challenging risk exposures.

We are their property insurance company, but we're also one of their foremost risk management consultants. They're using the advice that our engineers are giving them on all aspects of their business. Whether it's protecting a roof from a windstorm, or preventing significant damage in an earthquake event. We are working collaboratively with them.

For example, their Sacramento (California, USA) facility was constructed within the last 10 years to service their west coast customer base. We worked with them from the very beginning to design a facility that was going to meet their needs and would also be inherently safe.

We are in the midst of a project with them that is utilizing our research staff to test their cage and racking system for the mice. We are building a model to take to our research campus and putting that model on our shake table. They want to understand whether the cages and the mice within the cages will survive an earthquake. They are turning to FM Global to do the earthquake shake table test because we are the only company, at least in the insurance business, that has this technical ability.

In Farmington, Connecticut they are constructing a laboratory to use their mice model to study the human genome. We have been involved with that facility from the very beginning, from the drawings and the planning stages. We've had our field engineers reviewing

the drawings, making sure that this facility is going to be built to highly protected risk standards.

It is unusual for an insurance company to be involved in the conceptual phase of a new building. What is more typical is the insurance company gets an understanding of the building when it's fully built. The Jackson Laboratory is doing it this way because this is the way they conduct business with us. We are a partner; we are a valued part of the design and implementation team. We don't build the facility, but we guide the contractors that do, and that's what the lab is looking for from us.

One of the great aspects about this relationship is the fact that both of our organizations are steeped in research. FM Global has been around for more than 175 years because of the knowledge base that we provide to customers. The Jackson Laboratory has the same history. They have been serving the healthcare community with their mice models since the 1930s.

They view us as experts in this field of property conservation. They are the experts in creating mice models for research. We are the experts in protecting clients' property.



TOM MEEHAN

Senior Engineering Specialist
FM Global

I'm the designated service provider, or DSP, for the Jackson Laboratory in Bar Harbor. I've been servicing the facility for about six years and my responsibilities involve loss prevention work and project review for new renovations and construction.

What makes the lab unique is the fact that they house and raise mice in environmentally controlled rooms. It's critical to maintain things like electrical, heating, ventilation, and air conditioning. We provide the site with loss prevention services on a whole host of items. It could be facilities hazards, meaning fire, or natural hazards like windstorms. From an equipment hazards standpoint we look at electrical components, maintenance of air conditioning units, boilers, electrical generating equipment, anything that can put them out of business for any significant length of time.

They treat property and loss prevention as a very high priority. They understand the importance of maintaining operations and how all of this plays into it. They understand that these things can adversely impact them.

THE JACKSON LABORATORY HAS SOLICITED OUR ADVICE ON MANY THINGS OVER THE YEARS. REALLY, IT IS A TRUE PARTNERSHIP. THEY WANT TO DO THE RIGHT THING AND THEY REALLY VALUE OUR INPUT.

The Jackson Laboratory at Bar Harbor is very well-aligned with FM Global's core principles. It's highly evident in everything they do, from the human element to physical renovations and modifications. They pretty much follow our standards to a "T." We've worked closely together on many loss prevention items over the course of the year. That commitment to loss prevention is evident in pretty much everything they do.

They have solicited our advice quite a bit over the years. Really, it is a true partnership. They want to do the right thing and they really value our input. It's a real pleasure working in that kind of environment.

I deal with Dave Kuchta, Steve Heckman and others and they are very meticulous. Dave is an ex-Navy nuclear man, who

is very particular with regards to record keeping and he's very much aligned with our core philosophies. He does an outstanding job making sure that everything gets done that needs to be done, in terms of maintenance, inspection, and supervision. Steve is absolutely meticulous as well. He's like a college professor when it comes to inspection, and testing of alarms and equipment. He's just so above and beyond what I usually see. They take their jobs very, very seriously and it makes my job a lot easier.

Both organizations have a common goal: to prevent business interruption and property damage. We've worked very well as partners over the last several years to achieve that.



IF THAT WORK IS SOMEHOW LOST, YOU'D HAVE TO RECREATE SOMETHING UNIQUE AND THEN RE-CHARACTERIZE IT. THAT'S ALMOST IMPOSSIBLE. YOU'RE TALKING ABOUT TIME, MONEY AND YEARS OF LOST RESEARCH AND RESOURCES.

STEPHEN LINNELL

Senior Business Unit Manager
Reproductive Sciences and Breeding Services
The Jackson Laboratory, Bar Harbor, Maine

BACK UP AND RUNNING

The Jackson Laboratory's cryopreservation service is a business continuity plan for lab science

If you own a computer (and who doesn't?) you understand the value of backing up your data to an external hard drive. If you own a business, you understand the value of having a continuity plan in place so that, if something unexpected happens, your organization and its revenue is prepared, preserved and protected.

Of course, not every organization has a viable Plan B. A case in point is laboratories. Many, for whatever reason—financial priorities or time constraints—do not have a solid contingency plan should something crazy happen. Something crazy like, say, Hurricane Sandy.

When Sandy hit in October 2013, it illuminated a yawning gap in contingency planning for a New York City university. The havoc perpetrated by the storm affected the school's animal research center, one of the largest mammalian research labs in the country and a facility critical to the study of heart disease, cancer and neuroscience. The storm knocked out the power supporting the lab's freezers, and water flooded the animal facilities, drowning all the mice. Let's be clear: The storm destroyed thousands of genetically modified mice representing many years of research and substantial funding. Bad luck or bad planning?

In the unlikely event of a flood, a fire or even a loss of power to an active research experiment, the Jackson Laboratory has the solution: prevent the loss of critical work by protecting and preserving an experiment's most valuable component: its mice.

Stephen Linnell (pictured above), senior business unit manager, Reproductive Sciences and Breeding Services at the Jackson Laboratory, is in charge of providing cryogenic preservation services to the research community. Linnell's organization cryopreserves sperm and embryos from research mice so that, if something does happen, the specific strain of mice being studied can be recovered.

"There have been major losses from flooding due to storms such as Katrina, Allison and Sandy that have impacted mouse colonies," Linnell says, "and hundreds of strains were lost. So much is riding on the research based on the work being done

with these unique strains of mice. It can easily take years to replace or recreate these strains and resume research if they are lost from any cause. Cryopreservation is an effective tool for researchers to manage and preserve their colonies, which permits rapid recovery in case of loss."

Linnell explains that it's not unusual for a single strain of mice to cost between US\$80,000 and \$100,000 to create, a price that includes characterizing the strain to ensure it performs according to the standards required by the research.



The Jackson Laboratory, which has been backing up its own work for more than 40 years, houses cryopreserved specimens of more than 7,000 of its own strains, and more than 10,000 strains on behalf of clients. Some of the models that researchers work with are truly unique, and are random integrations of genetics that would be difficult, if not impossible, to replicate if lost. "They're modeled after the human condition," says Linnell. "It can take years to create a model and years to characterize it. If that work is somehow lost, it may be impossible to recreate. You're talking about time, money and years of lost research and resources."



DOWNLOAD the *RiskEssentials* app in iTunes to view the *Working Together* video featuring the Jackson Laboratory



NIGHTMARE



ON MAIN STREET

**THE STORY OF WABASSO LIMITED:
WHEN WORST CASE BECOMES REALITY**

In March 1973, a fire started in a small access panel of a textile manufacturing room. Without properly functioning sprinklers, the fire spread, engulfing a key area of the facility. With no contingency plan and business interruption strategy in place, the company couldn't adequately service its customers, leading to an irrevocable loss of market share. Wabasso, and its community, never fully recovered.



Every day brings news of disasters. Some make the news globally, like the Japanese earthquake and tsunami or the recent typhoon that devastated the Philippines. Others are more localized, perhaps affecting but a single company. Beyond the headlines of each one, however, is a story told much less frequently, the story of recovery, of getting back up and running—a story often full of daunting and unexpected challenges, as well as disappointment and heartbreak.

Four decades ago, FM Global helped document the impact of a fire along with the aftermath and recovery effort at an insured member company, Canadian textile maker, Wabasso Ltd.

Wabasso, based in Trois-Rivières in the province of Quebec, Canada, had made many investments designed to prevent just such a disaster. While some parts of the plant were designed and constructed in the early twentieth century, the newer buildings were of a single-story configuration. Sprinklers were placed throughout the complex.

It was a prosperous operation, benefiting from a strong economy in the midst of a cycle of expansion. On a day-to-day basis, bales of cotton and other raw material were delivered to the company's highly integrated manufacturing process by a stream of Canadian Pacific railroad cars. In a well-oiled process, raw material was subjected to spinning, spooling, weaving, bleaching, washing, printing, cutting, sewing and, eventually, packaging and shipping to customers across Canada.

AN OPEN AND SHUT CASE

One day in March 1973, the company's machinery ground to a halt, literally and figuratively. All it took for the company to become the dominant news story in *Le Nouvelliste* newspaper in Trois-Rivières was the decision to shut a valve—a single valve. Then, unpredicted and unexpected: a fire. While the buildings had been fully sprinklered and the facility adequately protected, a control valve had been shut temporarily due to the expansion project on site. It seemed like a reasonable decision—a short-term situation that no one saw fit to reconsider or deemed worthy of actively monitoring. After all, what were the chances?

Unfortunately, nobody counted on trouble in the heat set machine, which was routinely used to finish synthetic fabrics using steel rollers heated to a blistering 400°F (204°C). To this day, no one is quite certain what went wrong, but on that particular day, while operators were on a lunch break, something malfunctioned or perhaps an accumulation of textile material in the machine overheated and began to smolder.

When the machine operator, Louis Pothier, returned from lunch and opened an access panel to check on the machine's burners, he was knocked back by a surge of flames. Thinking fast, he grabbed a fire extinguisher and shouted for help. However, even when two colleagues joined the battle, it was already too late. Flames were lapping the wooden planks of the floor above and starting to spread to nearby supplies and equipment.

The closed valve prevented sprinklers from emitting their customary stream of frigid droplets, which could have contained or even extinguished the blaze. Soon, the flames spread, creating a firestorm.



Although the Trois-Rivières firefighters arrived within minutes, they were already too late. Indeed, the company general manager, A.J. Fyfe, who was returning to the area when the blaze started, recalled seeing the smoke and glow on the horizon and realizing that Wabasso was facing a true disaster.

It was 24 hours before firefighters finally left the scene. When they did, most of the facility was either in ruins or out of commission.

THE CONSEQUENCES

Although the company was well insured by FM Global, and had carefully assessed the value of its facility, the real consequences of a major disaster had not been fully considered. H. Roy Crabtree, chairman of the board, recalled that, up until the time of the fire, management had been looking forward to a good year, as new equipment came online and demand for products continued to surge.



The fire undid those calculations. The main building loss amounted to 200,000 square feet (18,581 square meters) of floor space and millions of dollars in updated production equipment, including the huge heat set machine where the trouble started. All together, some US\$4.5 million (US\$21.3 million today) in finished product and packaging supplies were destroyed, along with much of the sewing department, located on the floor above. The structure was also a physical linchpin for the entire complex. Its loss disrupted steam and utility connections and the physical movement of product and people. Furthermore, the loss of all of the critical “finishing” operation, which supplied cloth to the printing department, effectively crippled most production activities for the whole company.

THE AFTERMATH

After the fire, the challenge for Wabasso was threefold. First, and foremost, operations had to be restored as much as possible using temporary expedients to keep at least some of the business going and cash flowing. Simultaneously, the company needed to evaluate what could be saved or repaired (and what needed to be discarded). Finally, the company needed to develop plans for a replacement facility immediately.

“Our first priority was to get back in operation. We had about 1,000 people out of work,” said R.G.H. Knight, vice president of operations. “You think because you have insurance that you are well protected against any eventuality, [but] having insurance is only a means for getting some money; the problems of reconstruction fall on the people involved,” he added.

Almost from the moment the fire was extinguished, ad hoc efforts to repair and restore the facility had begun. One of the first challenges was reconnecting the powerhouse to the rest of the plant. Extrapolating from the techniques sometimes used to pass a line between ships at sea, the chief of maintenance services at Wabasso somehow procured a bow and arrow and someone

proficient in its operation. Using this simple device, a small line was passed across the smoldering ruins. From this one connection, ever larger cords were pulled across until one of sufficient strength was available to hoist over replacement electrical power lines. This simple expedient got temporary power in place rapidly. Similarly, about 1,000 feet (304 meters) of piping was extended outdoors to link the power plant to buildings needing steam for process heat and to maintain a comfortable work environment.

Still, group divisional manager Bernard Methot, estimated that, even after power was restored, only 50 percent of the plant was in operation. What's more, management faced the unfamiliar challenge of handling demolition, ordering new construction activities and equipment and, eventually, getting machines coordinated and working effectively as a process. Not simple tasks.

Robert Barbeau, manager of personnel and labor relations, had the longer-term worry of stewarding the human resources. One-third of the company's employees (and more than half at the Trois-Rivières plant) had been idled, among them a high percentage with specialized skills. Many would choose to look for new employment elsewhere—and both old and new employees would need to be trained or retrained on the replacement equipment that the company was ordering. Recalling recent investments in training his workforce in the techniques needed to make increasingly popular denim materials, Barbeau noted, "The fire just wiped it out."

Managers were stretched thin, too—no longer simply "managing" an operation but having to simultaneously rebuild an older operation while constructing a new one. "Necessity is the mother of invention," noted Fyfe. However, with that said, Fyfe and his management team quickly concluded that much of what they were attempting was beyond the scope of their own expertise; a bevy of consultants were called in to supplement the Wabasso team.

BUSINESS REALITIES

Although Wabasso was in a "traditional" industry, it needed to be nimble. Unlike some businesses, which produce a similar range of products, often with little variation from year to year, then as now, textile firms like Wabasso had to be mindful of seasonal factors that drive the demand for different fabrics. Similarly, styles and

fashions constantly shift. Having the right product mix at the right time is the difference between success and failure. And being able to supply market needs for specific materials on relatively short notice is also crucial.



**YOU THINK BECAUSE YOU HAVE
INSURANCE THAT YOU ARE WELL
PROTECTED AGAINST ANY EVENTUALITY,
[BUT] HAVING INSURANCE IS ONLY A
MEANS FOR GETTING SOME MONEY;
THE PROBLEMS OF RECONSTRUCTION
FALL ON THE PEOPLE INVOLVED.**

R.G.H. KNIGHT, VICE PRESIDENT OF OPERATIONS, WABASSO LTD.

What's more, reputation for good products and for reliable and timely deliveries is critical as products enter the supply chain. At the time, Canadian retailers and catalog stores had come to rely on many goods from Wabasso. But without a well-honed and fully functional manufacturing facility, the task of keeping customers happy was daunting—and the perils for the company were enormous.

Director of marketing, A. E. Walden, described the fire as a "severe blow" to the company. "We had several large orders on our books that had to be cancelled," he said. Furthermore, retailers, who had gradually made more space available to show Wabasso products, now reversed direction and filled much of the allotted space with competing goods. Even the sales force, with its trove of valuable personal contacts and industry knowledge, quickly began to evaporate. With little or nothing to sell, they had no choice.

Finally, Walden noted, in order to recover some market share, the company now expected to have to sharply increase spending on advertising.

AN ATTEMPT TO RETURN TO NORMAL

The finishing operation, where the fire started, also needed to be triaged. Here, with so little to work with on site, outside help was critical. The temporary solution turned out to be trucking large



YOU NEED A BUSINESS CONTINUITY AND DISASTER RECOVERY PLAN. BUSINESS DISRUPTIONS CAN COST A LOT OF MONEY, RESULTING FROM LOST REVENUE AND UNEXPECTED EXPENSES. YOU CAN'T REPLACE CUSTOMERS THAT DEFECT TO THE COMPETITION DURING THE AFTERMATH.

DICK WOOD, RISK MANAGER, FM GLOBAL

quantities of cloth hundreds of miles to a contract finisher in South Carolina (USA). Most of the loads were carried in the finisher's trucks, in a process by which they would deliver a completed order and then carry cloth in need of finishing back south. However, in part to develop a working inventory in South Carolina, additional trucks had to be scheduled from Canada. In addition, cross-border shipments meant bureaucratic challenges and delays.

For the sake of further efficiency, printing operations also eventually moved to contract facilities in South Carolina, necessitating even more layoffs of Wabasso workers in Trois-Rivières. On the other hand, the "gray mill," which produced unfinished cloth, was put on three shifts, seven days a week, to keep the supply chain chugging along and to manufacture items not previously made by Wabasso, in an effort to wring some additional revenue from the still-functioning parts of the plant.

The fire likewise destroyed the sewing operation, which had been located above the finishing department. So, new equipment was procured as quickly as possible and 85,000 square feet (7,896 square meters) of temporary space secured at a location a short distance away, in a former shopping mall. But even that took months, as shipment and installation of equipment took time, and additional time was required to regain the full rhythm of production.

Another unexpected problem was the challenge of getting rid of debris and unsalvageable product and equipment. The local landfill simply could not accommodate the volume of material arriving from Wabasso. In total, clearing the site cost US\$350,000 (equal to US\$1,740,000 today).

However, rebuilding presented perhaps the greatest challenge. For one, efficient, modern plant layout as well as fire safety considerations demanded single-story construction. But the site was limited in size and bounded by other existing structures.

Wabasso management and outside consultants began thinking through requirements and possible configurations almost immediately. They were driven to act quickly, even before planning was complete, not only by the necessity of fully restoring operations quickly, but also by the fact that the return of the Canadian winter would make most construction activities next to impossible: A replacement building would have to be up before the snow arrived. Because there was so much cost and inconvenience associated with using a finisher in far away

South Carolina, the finishing area should be completed first.

To meet all those requirements, Wabasso adopted a kind of design-build approach, eschewing competitive bidding and instead selecting reliable local contractors and negotiating their prices in comparison to similar projects. And, whenever possible, the company agreed to use the simplest construction methods; for instance, adopting standard length beams to minimize fabrication delays.

Acquiring building permits posed formidable challenges. Due to pending provincial pollution regulations, the municipality was unsure about the basis for issuing new industrial building permits and, to the usual delays, an unwillingness to act prevailed.

Panicking, and with the goad of necessity, initial construction began without a permit while management took every opportunity to emphasize the gravity of the situation; jobs and the survival of the company were on the line. Faced with the possible loss of a large local employer, authorities eventually provided the needed blessing for construction.

Despite all of these difficulties, December only saw completion of the building's outer shell—a small triumph that allowed additional work to continue inside in the colder months.

All of this represented a tremendous drain on management, which was preoccupied with sourcing, acquiring, and investing millions in new equipment while simultaneously keeping the business afloat and headed back toward "normalcy."

PAINFUL LESSONS

"When a disaster strikes, you must anticipate what needs to be done

in order to get the business running again,” says Dick Wood, vice president and risk manager at FM Global. “That means you need a business continuity and disaster recovery plan. Business disruptions can cost a lot of money, resulting from lost revenue and additional unexpected expenses that reduce profits.” In the case of Wabasso, revenue was down and expenses were up. “And, too often, you can’t replace customers that defect to the competition during the aftermath,” says Wood. In addition to facility losses, Wabasso lost their key sales staff and other trained employees, because people moved elsewhere. And they ran into issues such as the need for environmental permits that would not have otherwise come up.

A business continuity and disaster recovery plan isn’t just about the immediate response, it’s what you must do to recover your business, he explains. “Some people simply call this resiliency planning. In any case, it is a road map for continuing operations under adverse conditions,” says Wood.

The real key, of course, is to make sure you don’t have a loss in the first place.

Ronnie Gibson, FM Global vice president and chief engineer, says an unfortunate truth is that much hasn’t changed since the Wabasso fire in 1973. “The real-life impact of what happens in a business disruption event are the same today, and with the ever-faster pace of business, the challenges may be even greater,” he says. Furthermore, the factors that can contribute to a loss haven’t changed much, either. “In the case of Wabasso, it was an unfortunate combination of events: an unexpected fire, started during a break, when no one was there to notice, during a time when there was an ongoing project which had led to the sprinkler valve being closed,” he said.

At the time, FM Global had recommended locking and checking valves, “but, up to that point, we asked clients to mail in the details of their impairments, and we checked their records during our loss prevention visits,” he notes. Following the Wabasso fire, the process was enhanced; clients were asked to phone in sprinkler system impairments and FM Global would actively monitor the impairment, calling back periodically to make sure the protection had been reinstated, a service that is provided to this day.

“Valve supervision remains central to preventing a runaway fire,” says Gibson. If you install a million dollars worth of sprinkler protection, but leave open the chance of a valve being shut maliciously or in error, that investment runs the risk of being worthless,” he says.

“Although our clients are considered among the most diligent in maintaining their fire protection, our engineers still find over

1,000 improperly closed valves each year during routine loss prevention visits,” he adds.

After its fire, Wabasso management committed to an even higher level of loss prevention. Weekly inspections of sprinkler valves became part of operational routines, and clearly labeled safety equipment and expanded training also became part of the renewed facility.

It was a hard-won lesson, and a lesson still applicable to any industrial facility: Loss prevention is a good investment, and the cost of inadequate loss prevention can be truly devastating to an enterprise.



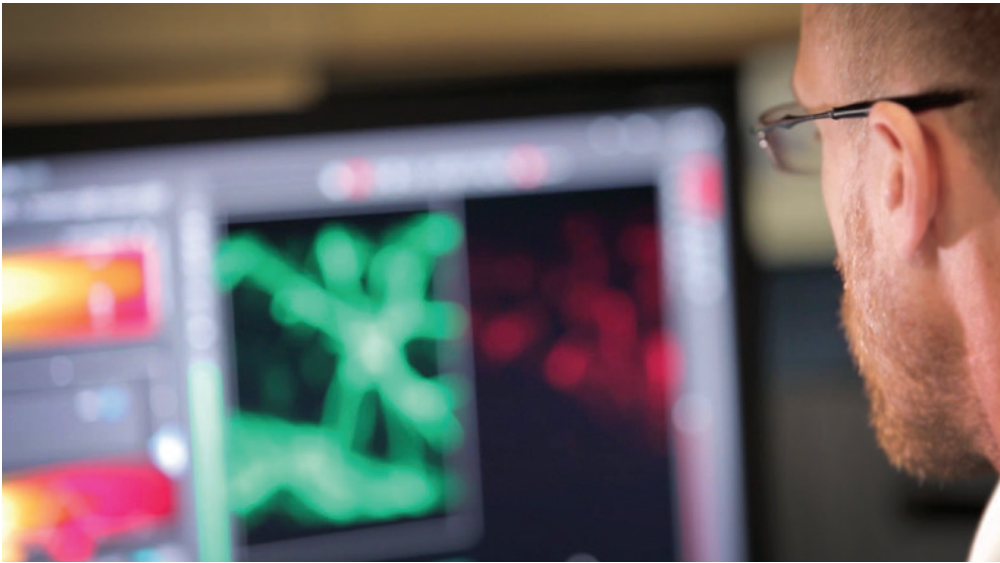
Wabasso was fully back in business in little more than a year. But things were never the same. The aftermath of the fire had done severe damage to market share—and competition had never let up. By the early 1980s, Wabasso was in trouble, was eventually acquired and merged into the operation of a larger organization.

Today, the company is only a memory in Trois-Rivières; the site of its sprawling plant long since turned into a strip mall. But the hard lessons of Wabasso remain instructive for any organization.

To see the original long-form documentary video, visit fmglobal.com/reason.



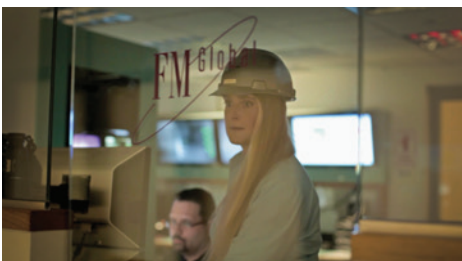
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► Find this exclusive video coverage on our magazine website, fmglobal.com/reason.

Working Together: The Jackson Laboratory

This new installment in our partnership series focuses on the lab's unique risk management challenges and impressive commitment to loss prevention.



Research Matters: Kristin Jamison

Watch Kristin at work as she conducts large-scale fire experiments.



Nightmare on Main Street

This astonishing 1973 documentary traces a company's downward spiral, as it tries desperately to recover from a devastating fire.



Lithium-ion Research

Read part two of our landmark Li-ion battery research, a piece accompanied by this fire-test video.

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