AIRCURRENTS: SITE-SPECIFIC CATASTROPHE RISK ASSESSMENT: BENEFITS OF ENHANCED UNDERSTANDING OF RISK ACROSS THE RISK MANAGEMENT CHAIN

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***EDITOR'S NOTE:** A previous AIR Current, Site-Specific Catastrophe Risk Assessment and Mitigation for Industrial Facilities, outlined the methodology by which site-specific engineering assessments are performed for industrial facilities. This article speaks to the distinct benefits of such an approach for commercial, industrial, and supply chain risks for key stakeholders across the risk management chain.*

THE ARTICLE: Overviews the distinct benefits of site-specific, engineering-based catastrophe risk assessments to key stakeholders in the risk management chain.

HIGHLIGHTS: Two case studies—for industrial and commercial exposures, respectively—illustrate how detailed assessments by AIR's Catastrophe Risk Engineering service provide risk managers, insurance underwriters and brokers with the insight needed to best manage, communicate and price their catastrophe risk.

INTRODUCTION

Conventional catastrophe risk modeling continues to evolve in terms of both the complexity and reach of models; indeed, catastrophe models today reflect the most current scientific and engineering research in the industry and address more regions and perils than ever before. Thus, for a large segment of the property insurance industry, conventional modeling is an excellent risk assessment solution.

Certain commercial and industrial exposures, however, may not lend themselves to standard catastrophe modeling techniques. They may be unique in their physical characteristics (e.g., wind turbines); affected by conventionally non-modeled perils (e.g., tsunami); exceptionally costly; spatially concentrated and thus highly correlated; or critical to an organization's continued operations, such as important supply chain nodes.

Stakeholders across the risk management chain faced with developing risk transfer or mitigation programs for such exposures can greatly benefit from site-specific, engineering-based catastrophe risk assessments—evaluations that build on standard modeling techniques but draw more heavily on site- and organization- specific details. These comprehensive assessments—customized to an individual organization's unique concerns and exposures—combine state-of-the-art hazard modeling, detailed structural evaluations performed by experienced engineers, and explicit network modeling of process flows and supply chains to provide the best possible estimate of an exposure or operation's true catastrophe risk.

Equipped with the risk metrics these analyses produce, all stakeholders can more accurately manage, communicate, and price their catastrophe risk. Corporate risk managers, for example, can use the results to make informed decisions regarding mitigating risk financially (through insurance purchasing), mitigating risk physically (through redundancy or retrofit investments), and appropriate tradeoffs between the two.

The benefits of site-specific catastrophe risk assessments are not limited to corporate risk managers, however, but are realized across the property insurance value chain—including by brokers in their role as risk management advisors to corporate clients and by underwriters as they develop and price their insurance solutions or contemplate how their long-term view of risk will change if certain mitigation controls are adopted. Though each of these groups faces distinct challenges, they are also highly interdependent, sharing common goals that risk metrics and information provided by on-site risk assessments, such as those offered by AIR's Catastrophe Risk Engineering (CRE) service, can uniquely address.

BENEFITS TO CORPORATE RISK MANAGERS AND FINANCIAL EXECUTIVES

Site-specific catastrophe risk evaluations offer compelling value propositions for corporate risk managers and financial executives—individuals responsible for developing complex risk management programs. This is particularly true in cases where site-specific evaluations provide results that can vary significantly from those of classical modeling solutions; an example is a commercial portfolio in which a few assets dominate the risk, and for which developing a detailed and reliable assessment of these assets would assist in structuring the overall risk management program.

Corporate risk managers and financial executives must not only secure adequate insurance—a task requiring absolute confidence in modeled loss estimates—but, as the exposures they manage become more complex, new issues emerge, such as the risk to enhanced engineered systems or to growing supply chain networks. While the desktop modeling tools currently available comprehensively address portfolios that are large and disperse, these tools can be enhanced for small portfolios or for networked exposures that diverge from what is considered an "average" exposure or condition.

Site-specific risk evaluations are highly granular—often at the constituent asset level—and can therefore significantly improve exposure data quality and vulnerability modeling. They can provide in-depth assessments of an organization's process flow and supply chain risk—explicitly evaluating complex, integrated exposures using organization-specific input. And they allow for the assessment of hypothetical mitigation solutions from a cost-benefit standpoint.

Risk managers and senior executives should consider these evaluations a part of the due diligence process in their risk management practices, especially when dealing with complex exposures. Reliable catastrophe risk metrics and a thorough understanding of their exposure and operations can assist in structuring, managing, and communicating their catastrophe risk to shareholders, brokers, rating agencies and underwriters.

BENEFITS TO BROKERS

Brokers are tasked with understanding their clients' exposures and operations, communicating what they learn to insurance underwriters, and developing risk management solutions that meet the risk tolerance and pricing strategies of their clients.

As the complexity of client exposures and operations increases, and specific client needs (e.g., emergency response planning, business continuity, and risk from non-modeled perils and regions) must be addressed, brokers can leverage site-specific catastrophe risk assessments to increase their own value as trusted advisors; the results from these assessments offer a distinct competitive advantage, particularly to brokers who service clients with unique exposures.

Assessment results provide highly granular information, such as the loss exceedance probability curve by specific return periods at a site-specific resolution and, if required, at the individual asset level-resolution. By clearly delineating the likelihood of various critical loss levels—by asset, by location, and/or by peril—results from site-specific studies help brokers confidently structure layered property insurance and risk management programs to best reflect clients' needs. Site-specific assessments not only help brokers develop a deeper understanding of their clients' exposures; they put more reliable risk metrics at their disposal for insurance cover placements. This increases the credibility of brokers' analyses with insurance underwriters, facilitating discussions about insurance pricing and cover.

Site-specific catastrophe risk evaluations can help brokers develop risk metrics beyond the scope of traditional modeling tools. Brokers can even use these advanced evaluations to support work in markets/areas that may previously have been considered uninsurable or economically unfeasible. Ultimately, site-specific results help brokers reduce uncertainty surrounding their clients' catastrophe risk.

BENEFITS TO INSURANCE UNDERWRITERS

Although sitting across the table from the corporate risk manager and broker, insurance underwriters are faced with similar concerns regarding the exposures they underwrite. The same information that is beneficial to one side of the transaction—including improved exposure information, more detailed risk metrics, and the ability to evaluate mitigation options or perform sensitivity analyses—enables underwriters to better determine pricing, and to take a long-term view of a risk.

These benefits are even more pronounced when dealing with complex exposures and perils for which observational or experiential data may be limited, or for which conventional modeling solutions may not exist (for example, for tsunami risk associated with facilities in Indonesia). In each case, a site-specific evaluation can provide the best estimate of the true risk, thereby reducing the need to be overly conservative with the insurance product or pricing. Underwriters should also see the results of these evaluations as a means to positively influence their risk-adjusted profitability.

Insurers today typically rely on engineering assessments conducted by in-house loss control or engineering departments, which have limited resources for performing such an evaluation. An AIR Catastrophe Risk Engineering site-specific assessment can be used to supplement in-house information and to develop an improved risk view that helps insurers price, structure, and negotiate complex or previously un-modeled risks with confidence.

CASE STUDIES

The following case studies represent a composite of projects conducted by AIR's CRE team. Note that the exposure details and results presented below do not represent any single organization.

CASE 1: EARTHQUAKE AND TSUNAMI RISK ASSESSMENT FOR INDUSTRIAL FACILITIES

An energy company with global facilities retained AIR's CRE team to conduct site-specific earthquake risk assessments for its exposures susceptible to earthquake shake and tsunami. The team's primary objectives were to probabilistically evaluate potential physical damage and business interruption losses to the individual facilities and to the portfolio as a whole; to evaluate the potential losses by peril and by location in order to assist the corporate risk manager and the broker in structuring an insurance program (i.e., to identify which subsets of facilities to insure to what levels and for what perils); and to identify any obvious physical vulnerability issues at the individual facilities.

Notably, the catastrophe risk analysis this company had commissioned several years prior had been fairly simplistic, with a single output speaking to tsunami risk: "for tsunami risk, add 25% to your losses." The company rightly felt that this metric was of insufficient detail. It therefore asked AIR to include an explicit site-specific tsunami risk evaluation.

Given this evaluation's overall risk management objectives, the high exposure value associated with the individual facilities, and the non-modeled nature of the tsunami peril, an advanced analysis by AIR's CRE team was the clear choice. The evaluation would leverage existing catastrophe models for the region and enhance the results with improved exposure data and site-specific engineering input and analysis.

To start, the CRE team embarked on an exposure data initiative, which included reviews of reports on individual facilities as well as discussions with the company's personnel; a detailed questionnaire was provided to the company to solicit relevant exposure information for each of the various facilities being evaluated. This information was then supplemented by site investigations performed by AIR's CRE engineers to further inform their understanding of the vulnerability of the individual facilities' assets to the perils being considered.

Using AIR's proprietary earthquake catalogs for the regions in question, the team obtained a detailed site-specific view of the earthquake-induced ground shaking risk to each facility. A carefully selected subset of this catalog was then used to explicitly model the flood height (from tsunami) at each plant location.

The results of the CRE team's probabilistic hazard analysis revealed that, overall, the facility locations are expected to experience low to moderate levels of earthquake ground shaking. Some locations may experience more severe ground shaking, but that intensity is associated with a low annual probability—on the order of less than 0.025%. Tsunami flooding was a more significant hazard; the CRE analysis revealed that the wave height associated with a 500-year mean return period at a shoreline location closest to one of the facilities was on the order of 50 feet—which would result in flooding on the order of 10 feet at portions of the facility, given its elevation relative to sea level. Figure 1 and Figure 2 present the results of the hazard analysis, illustrating that the individual facilities are subjected to the two different perils to different extents. These variations significantly impact each facility's overall loss profile.

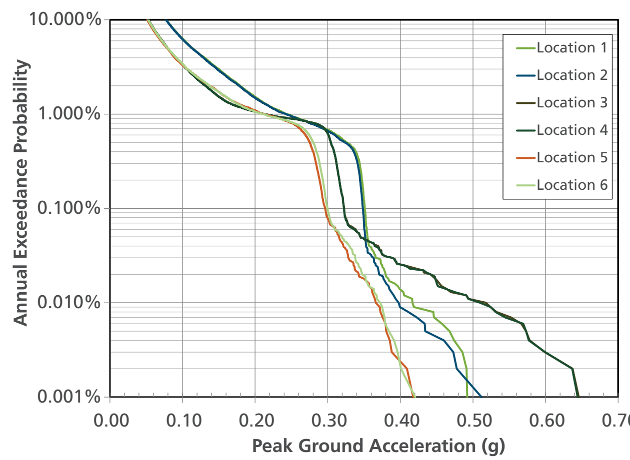

Figure 1 Site-specific mean earthquake ground-shaking hazard curves at facility locations. (X-axis values are not shown to preserve confidential nature of this information).

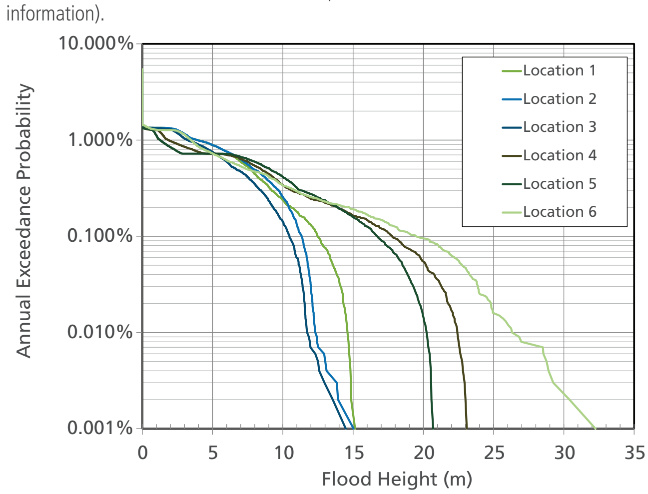

Figure 2 Site-specific mean tsunami flood hazard curves at shoreline locations close to the facilities. (X-axis values are not shown to preserve confidential nature of this information).

Hazard intensity measures for both ground shaking and tsunami flood were convolved with the team's highly detailed information about the vulnerability of the assets comprising the individual facilities to result in physical damage and loss potentials. In catastrophe models, the relationship between hazard and loss is expressed through damage functions.

Figure 3 shows examples of damage functions for assets typically observed at industrial facilities, for the earthquake ground shaking peril. (Vulnerability functions for the tsunami -induced flooding peril were similarly developed.) In the CRE team's analysis, these asset damage functions were customized for each facility, taking into account its site-specific characteristics and exposure values, and resulting in site- and facility-specific vulnerability functions. As Figure 4 shows, given the same intensity of earthquake-induced ground shaking, the CRE team discovered that the damage potential varied significantly between facilities. For example, at a peak ground acceleration of 0.8g, the damage potential between facilities could vary by a factor of 3. Such details are difficult to identify without site-specific evaluations.

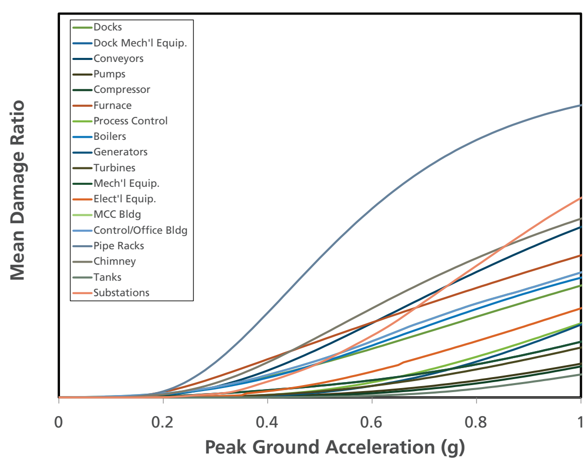

Figure 3 Example of damage functions developed by AIR for the earthquake peril for assets typically comprising industrial facilities. (Y-axis values are not shown to preserve the proprietary nature of this information).

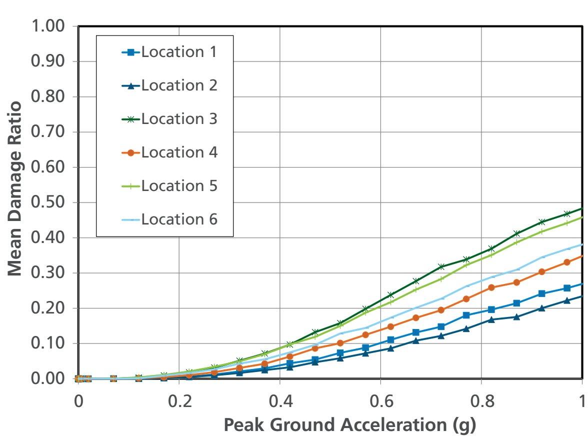

Figure 4 Vulnerability of different facilities as calculated from study; note significant differences between seemingly similar facilities. (Y-axis values are not shown to preserve confidential nature of this information)

Using a combination of the site-specific exposure, hazard and vulnerability computations outlined above, the CRE team evaluated earthquake-induced loss potential for both the individual facilities and the portfolio as a whole. This was done in terms of physical damage, business interruption (BI)1 and the two combined. The combined loss potentials at each location are presented in Figure 5. Note that the relative contribution of different facilities to the portfolio-level losses varies significantly by return period—information critical for corporate risk managers and brokers when developing risk management programs.

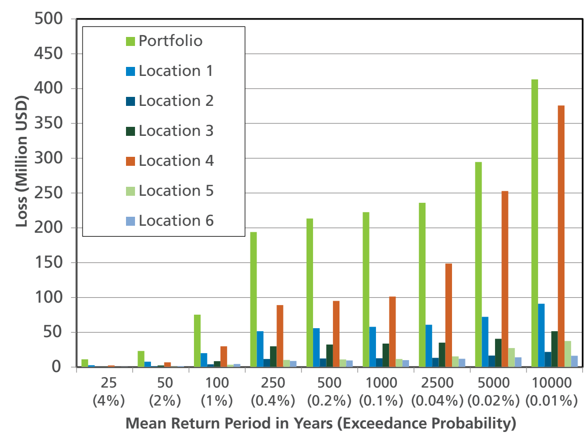

Figure 5 AIR discovered that the earthquake-induced damage potential varied significantly between the different plants and the relative contribution of different facilities varied by return period.

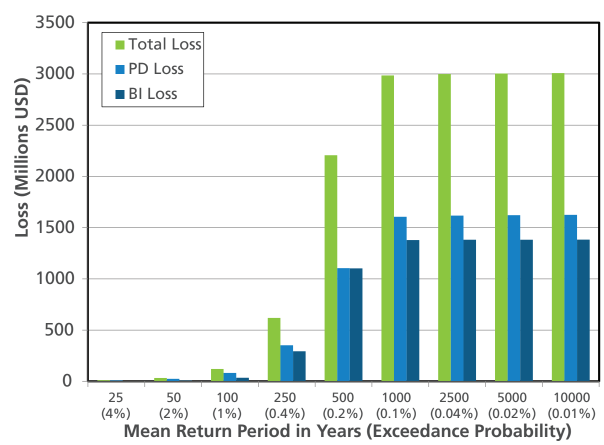

Figure 6 Distribution of portfolio losses amongst physical damage (PD) loss and business interruption(BI) loss.

Distribution of the losses in terms of physical damage and business interruption is presented in Figure 6, which suggests that the loss potentials are evenly split between physical damage and business interruption—again, an important consideration for risk managers.

Figure 7 shows the distribution of portfolio losses by peril; clearly the tsunami- induced flood hazard dominates the loss potentials beyond about the 250-year mean return period. Furthermore, a disaggregation of the portfolio-level loss amongst individual locations and by peril indicated that while some locations had negligible loss associated with the tsunami flood hazard, for other locations, it dominated almost the entire loss. This kind of result is invaluable when deciding on insurance cover, physical mitigation, and general risk management plans.

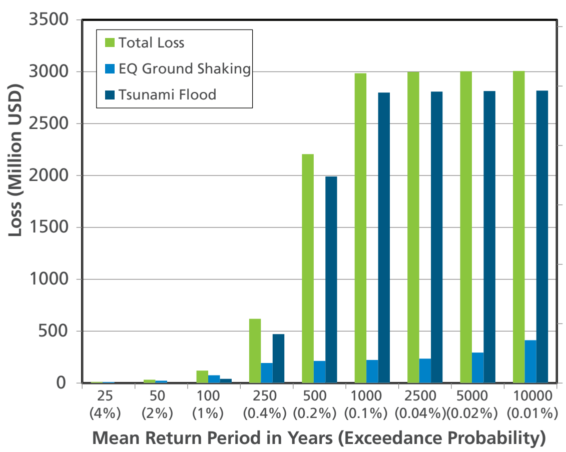

Figure 7 Portfolio mean loss estimates for earthquake-induced ground shaking and tsunami flood.

Overall, average annual loss was dominated by the tsunami peril by a ratio of almost four to one—a result in stark contrast to that derived by the first study the company had commissioned.

As part of AIR's evaluation, many other detailed risk metrics were generated to satisfy specific client requirements. Various sensitivity studies were also carried out, including studies changing the elevation of key assets in several locations in order to quantitatively assess the impact of such mitigation measures on both location-specific and overall portfolio loss potential. Costs associated with such mitigation measures were developed by the client, allowing for direct cost-benefit evaluations. Such measures might be implemented right away for critical facilities or incorporated into long-term plans as equipment and assets are relocated or replaced.

The study outlined above shows that clarity in catastrophe risk information and metrics is absolutely vital for corporate risk managers and brokers striving to develop optimal risk management programs. Also, having access to such information and metrics can be quite beneficial in structuring the right financial and physical mitigation for a company's assets.

Furthermore, discussions with the underwriters for this particular portfolio of properties indicated that they would welcome the detailed risk information generated through the site-specific study, as it would give them a clear and quantitative view of the risk, which would in turn allow them to be less conservative with their own risk evaluation in the face of uncertainty.

CASE 2: EARTHQUAKE RISK ASSESSMENT FOR REAL ESTATE PORTFOLIO

A prominent real estate management firm with a portfolio of many properties in which three locations constituted nearly 80% of the total replacement value retained AIR's CRE team to perform a seismic risk assessment study. As with the previous case, this assessment's primary objectives were to evaluate and enhance the quality of exposure data for selected properties, and thereafter assess the potential seismic loss associated with the individual properties and the portfolio as a whole. Furthermore, prior to the study, the company's corporate risk managers suspected they were underinsured—a hypothesis they wanted the CRE study to test.

The CRE team subjected different locations within the portfolio to varying levels of data improvement, identified as basic, intermediate, or advanced, where advanced analyses involved explicit structural modeling and site investigations. The level of data improvement applied to a particular location was based primarily on a location's replacement value and its site-specific hazard values; as might be expected, the three high-value locations dominating the portfolio's replacement value—a luxury shopping center, and two high-rise luxury hotels—warranted the most advanced level of evaluation, while the other assets were assigned to the intermediate or basic levels of evaluations.

Using results of the explicit structural engineering assessments, the CRE team prepared custom damage functions for each of the three high-value properties for use in the AIR earthquake model for the region. These damage functions were generated in an effort to obtain the most accurate loss estimates possible for each of the three critical structures.

For all other locations, those that warranted lesser levels of data improvement based on the above criteria, the unmodified damage functions within the AIR earthquake model were utilized. Hazards evaluated in the analysis included earthquake-induced ground shaking, fire-following and sprinkler leakage.

The CRE team evaluated the impact of different levels of data quality on the portfolio-level loss estimates (Figure 8). The impact of the advanced data quality improvement was evident. In every instance where advanced analyses were performed, losses were higher than they would be with basic analyses, and this was true at every point on the loss exceedance curve, thus validating the firm's suspicion that they were underinsured.

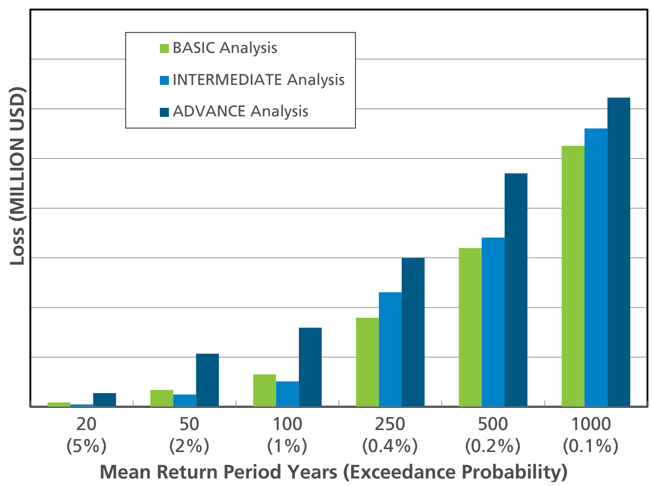

Figure 8 Comparison of portfolio mean loss results for different levels of data quality. (Y-axis values are not presented to preserve the confidential nature of this information).

A more critical result from the study was that, for the two similarly valued and located luxury hotels, the loss estimates differed by an order of magnitude at the higher mean return periods; in other words, one of the buildings exhibited a higher physical damage potential at higher intensities of ground shaking—a distinction that would have been impossible to discern without the site-specific evaluation.

The data from the CRE analysis included probabilistic mean loss estimates for specific return periods, annual average loss (AAL), and loss estimates broken out by location. Notable from among the results, the portfolio AAL was about 0.07% of the total insured value. Despite the small fraction, it was actually higher than the AAL the company had previously utilized in calculations—once again validating this firm's suspicion that they were not buying adequate insurance cover.

The CRE study showed that the results of a site-specific assessment can be markedly different from results obtained using more conventional approaches. They can also highlight differences between seemingly similar exposures. Furthermore, this study not only resulted in improvement in the data characteristics for locations that dominate the current total replacement value of this company's

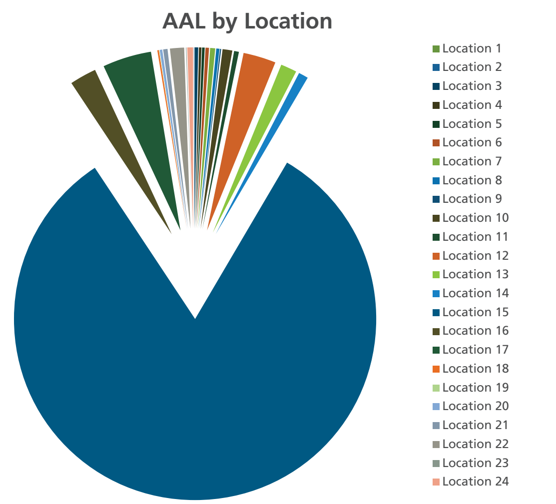

Figure 9 Average Annual Loss, by location, for the majority of properties in the portfolio. Note that while three properties dominated from an insured value perspective, from an AAL perspective, the view was different. The study revealed that the AAL of one of the three high-value properties was significantly lower than originally thought; indeed, the AAL for Property 3 was on par with that of Property 4.

portfolio, it provided a detailed engineering-based loss assessment at the location- and portfolio- levels—information that can be used for informed decision-making related to risk management. Indeed, it is in everyone's best interest (that of the risk manager, broker and underwriter) to have confidence in the results so as to appropriately manage the risk.

CONCLUSION

Informed decision making is an integral component of any sound risk management program. In the context of catastrophe risk management, informed decision making requires a thorough understanding of the exposure and reliable, defensible quantitative estimates of the risk. Services like AIR's Catastrophe Risk Engineering practice are designed to help corporate risk managers, brokers, and underwriters develop a clear understanding of the catastrophe risk associated with complex, high-value exposures and operations. These services are especially critical when dealing with exposures and operations that do not lend themselves to standard modeling techniques, or in cases when custom risk mitigation solutions need to be developed.

1 The bi loss potentials were calculated using air's proprietary relationships between physical damage and downtime for facilities similar to those considered in this study; however, explicit network modeling remains the best approach for development of asset physical damage to operational interruption (or bi) relationships.

ABOUT AIR WORLDWIDE

AIR Worldwide (AIR) is the scientific leader and most respected provider of risk modeling software and consulting services. AIR founded the catastrophe modeling industry in 1987 and today models the risk from natural catastrophes and terrorism in more than 90 countries. More than 400 insurance, reinsurance, financial, corporate, and government clients rely on AIR software and services for catastrophe risk management, insurance-linked securities, detailed site-specific wind and seismic engineering analyses, agricultural risk management, and property replacement-cost valuation. AIR is a member of the Verisk Insurance Solutions group at Verisk Analytics (Nasdaq:VRSK) and is headquartered in Boston with additional offices in North America, Europe, and Asia. For more information, please visit **www. air-worldwide.com**.