INFRASTRUCTURE RISK MANAGEMENT PROCESSES

NATURAL, ACCIDENTAL, AND DELIBERATE HAZARDS

Edited by
Craig Taylor, Ph.D. and Erik VanMarcke, Ph.D.

ASCE Council on Disaster Risk Management
Monograph No. 1
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A Note on the Cover

Cover photograph description: Los Angeles – Owens Valley Aqueduct damage during the 1920's "Water Wars" following a dynamite attack on a sag pipe (inverted siphon) in the Owens Valley. The pipe collapsed due to suction forces created from water flowing through the pipe following the blast. The collapsed pipe was washed down slope by the continued aqueduct flow coming from the top of slope.
The Los Angeles – Owens Valley Aqueduct was dynamited at least 15 times between 1924 and 1927 as a result of disputes between the City of Los Angeles and Owens Valley residents over land purchases, land prices, water rights, and other matters. During the "Water Wars" the Los Angeles water supply was threatened by hostile attack and domestic terrorism through acts of hostile seizures, bombings, kidnappings, threats, and propaganda. The City of Los Angeles employed the following strategies to counter the terrorist-type activities: negotiation and arbitration, rewards, public and private investigations, increased police and security, increased intelligence and communication technologies, improved transportation capabilities, improving water storage capabilities, and removing unethical financing for the hostile activities. The hostile attacks and the counter activities of the Los Angeles and Owens Valley "Water Wars" are among the precursors to the current nationwide terrorist threats and security countermeasures.

Prepared by: Craig Davis and LeVal Lund

Photo Credits: Los Angeles Department of Water and Power.

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INTRODUCTION AND EXECUTIVE SUMMARY

This introduction and executive summary cover

- The origins of this monograph as a sequel to a previous monograph generated by the joint efforts of the members of two committees of the American Society of Civil Engineers (ASCE) and other volunteers (section 1.0),
- A broad overview of infrastructure risk management procedures and processes, along with a clarification as to why processes and procedures are emphasized in this document (section 2.0),
- Brief synopses of the papers included in this monograph (section 3.0), and
- A list of significant related publications (section 4.0)

1.0 The Monograph as a Sequel

For six years, two committees of ASCE have jointly worked on two monographs whose papers have undergone rigorous peer review. The committees involved are the Seismic Risk Committee of the Technical Council on Lifeline Earthquake Engineering (TCLEE) and the Risk and Vulnerability Committee of the Council on Disaster Risk Management (CDRM). Through these efforts, along with those of other volunteer contributors, the committees produced in March 2002 a monograph entitled *Acceptable Risk Processes: Lifelines and Natural Hazards* (edited by Craig Taylor and Erik VanMarcke).

This previous monograph contained mainly technical papers that evaluated procedures used in these "acceptable risk processes". Considering all the advances in probabilistic seismic hazard analysis over more than three decades, David Perkins elaborated a number of remaining issues having the effect that uncertainties may be significantly higher than the well-developed models indicate. Armen Der Kiureghian presented a paper explaining how to apply Bayesian methods to obtain seismic fragility models for electric power components. Stuart Werner and Craig Taylor presented issues arising when constructing seismic vulnerability models for transportation system components. Adam Rose deals with the complex issue of validating models to estimate higher-order economic losses.

A persistent problem is how to develop prescriptive criteria that provide guidance and goals for acceptable risk procedures. In the previous monograph, Keith Porter reviewed and evaluated life-safety criteria that are available, and Daniel Alesch, Robert Nagy, and Craig Taylor addressed available financial criteria.

Inasmuch as technical procedures do not comprise the full scope of acceptable risk processes, three additional papers covered communication, administration and regulation

issues. From an owner's and then an engineer's perspective, Dick Wittkop and Bo Jensen addressed challenges in communicating risk results. Frank Lobedan, Thomas LaBasco, and Kenny Ogunfunmi discussed the administration of the major wharf embankment and strengthening program at the Port of Oakland. And Martin Eskijian, Ronald Heffron, and Thomas Dahlgren discussed the regulatory process for designing and implementing the engineering standards for marine oil terminals in the State of California.

On February 9, 2002, the two ASCE committees, along with other guests, met in Long Beach, California to discuss the status of the monograph project. Considering many previously proposed papers that had not been completed for the monograph about to be published and mindful that the events of September 11, 2001 had created wide interest in infrastructure risks, the joint committees decided to produce a sequel monograph. In addition, before the meeting, Jim Beavers, then Chair of TCLEE, had suggested that the topic of acceptable risk be a workshop topic for August 10, 2003, as part of the 6th U. S. Lifeline Earthquake Engineering Workshop and Conference (TCLEE2003).

At this workshop, held in Los Angeles on August 10, 2003, all presenters either had contributed to the first monograph or were developing papers for this second. With Erik VanMarcke and Craig Taylor as moderators, the following presentations were given:

- Richard Wittkop, on risk communication
- David Perkins, on earthquake hazard mapping procedures and their uncertainties
- Beverley Adams, on emerging post-disaster reconnaissance technologies
- Keith Porter, on criteria for assessing life-safety risks
- Stuart Werner, on vulnerability modeling for critical components
- James Moore II, on transportation-system risks from tsunamis
- Le Val Lund, on risk-reduction efforts at the Los Angeles Department of Water and Power (LADWP) water system, and
- Jane Preuss, on land use planning and electric power distribution risks from natural hazards

In addition, contributors to the first monograph and authors of the present monograph were asked to make presentations for two sessions, held on October 21, 2004, at the Baltimore ASCE Civil Engineering Conference & Exposition. These sessions covered risk management and acceptable risk for natural, accidental, and malicious threats. Moderated by Erik VanMarcke and Craig Taylor, these sessions featured presentations by:

- Jose Borrero, on costs of a tsunamis generated by a submarine landslide off Palos Verdes, California
- Yumei Wang and Amar Chaker, on geologic hazards affecting the Columbia River Transportation Corridor

- Mihail Popescu, on landslide risk assessment and treatment
- LeVal Lund, on the history of multi-hazard mitigation of the LADWP water system
- Adam Rose, on regional economic impacts of the 2001 electric power blackouts in Los Angeles, and
- Ruben Jongejan, on criteria for risk mitigation in the Netherlands.

2.0 Infrastructure Risk Management Procedures and Processes

Figure 1 provides a simplified outline of acceptable risk procedures for threats to infrastructure systems. According to this outline, an initial inquiry is raised pertaining to the system. This inquiry may arise from within the organization running the system or from the outside—such as by the press, professionals, regulators, or the general public. Technical procedures consist in defining the system of interest to respond to the inquiry, identifying significant hazards, assessing the vulnerability of system components to these hazards, and assessing system performance under conditions of hazard-induced damage.

Formal technical procedures have been shown to be critical in decision-making for many large infrastructure systems and/or key components of these systems (see Taylor et al., 1998). These often permit the evaluation of a range of risk-reduction alternatives and lead to affordable yet effective solutions to infrastructure system weaknesses. As a result, special emphasis has been placed on technical issues in both monographs.

At the same time, infrastructure risk management does not consist merely of making technical evaluations, as complex as these may be. In the first place, as researchers recognize (and may or may not explicitly state), in risk modeling there are always caveats, assumptions, and other contextual issues confining or conditioning the results provided. It is difficult to quantify, for instance, all "costs" of disasters. (See the H. John Heinz III Center for Science, Economics, and the Environment, 2000) It is likewise extremely challenging if not impossible to account for all uncertainties within complex evaluations.

In the second place, there are many occasions in which formal technical evaluations are either cost-prohibitive or else unnecessary. For instance, in local flood protection programs, experience with solutions to reduce flood risks to transportation systems has in some cases led to affordable solutions that do not require extensive detailed evaluations (written communications, Rebecca Quinn and Elliott Mittler, 9/04).

In the third place, the many dimensions of infrastructure risk-informed decision-making include political, social, ethical, administrative, environmental, security, and a host of other considerations that are typically not incorporated into formal technical evaluations. In a series of Earthquake Engineering Research Institute lectures, W. Petak (ATC-58 presentation, 2/24/03) has maintained that seismic risk results and their uses are