EERI Policy White Paper

Earthquake Engineering Research Institute
499 14th Street, Suite 220
Oakland, CA 94612-1934
510-451-0905

Contact: **Heidi Tremayne**
Program Manager
heidi@eeri.org

Improve Reliability of Lifeline Infrastructure Systems

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EERI Policy Position

Programs to improve the reliability and resilience of lifeline infrastructure systems in earthquakes should identify the systems' vulnerabilities and interdependencies in earthquakes, prioritize mitigation actions, implement system improvements over time, and communicate system vulnerabilities to lifeline customers, other lifeline operators, and affected local, state, and federal governments.

Background

Lifeline infrastructure systems include utilities (electric power, natural gas, telephone and other communication systems, water and wastewater) and transportation systems (roads and highways, passenger and freight rail systems, and ports and airports). These systems often include several essential facilities in one location, such as highway bridges and interchanges, electrical substations and water treatment facilities, and linear components that span long distances such as highways, pipelines, and power lines.

Lifeline infrastructure system components can be vulnerable to damage in strong earthquakes, which can result in extended periods of service outages. Exposure to hazards is unavoidable because lifeline infrastructure systems often cannot avoid high hazard locations, such as fault zones and areas with liquefaction and landslide hazard. Urban and regional lifeline infrastructure systems are interconnected and interdependent such that damage to one system can impact the functionality, repair, and recovery of other systems. These systems also tend to be located in the same areas. For example, water, sewer, and natural gas pipelines typically run under local roads; communications and electrical cables are often located under those roads or adjacent to them.

Construction of the replacement of the seismically-vulnerable San Francisco-Oakland Bay Bridge (source: CalTrans, 2002).

In modern urban communities that have been struck by damaging earthquakes, residents and businesses have often experienced interruption of vital lifeline services, sometimes with long wait times before services are restored. Minimizing such interruptions promotes community resiliency. The short-term (a few hours to a few days) loss of services is unnerving, inconvenient, and even life-

threatening to some. Longer-term service outages of weeks to months for water and sewer services and months to years for transportation outages can significantly impede community recovery and affect quality of life. The impacts of earthquake-caused outages can extend into areas undamaged by the earthquake shaking. These outages can disproportionately harm the young, the elderly, those with special needs, and other vulnerable populations. Affected utility organizations, who pride themselves on safe and reliable service, can be overwhelmed by utility and transportation system damage.

Lifeline infrastructure providers are familiar with frequent natural hazards such as seasonal high winds, wildfires, and flooding. However, damaging earthquakes are infrequent in most parts of the US, and system operators are generally not familiar with mitigating the earthquake risks to their systems. Furthermore, individual lifeline infrastructure service providers often do not communicate information about system vulnerabilities and interdependencies with other system providers or local governments in the communities served, which limits the ability to coordinate risk reduction and emergency planning. However, a number of major lifeline systems have in-depth experience in assessing and reducing their systems' risks and their experiences are a valuable resource for future mitigation efforts in other communities.

Needed Action

Individual public and private utility and transportation system operators and owners should take the following steps:

1. Assess the likely performance of their systems in potential significant earthquakes.

   This involves identifying significant seismic hazards, including likely earthquakes and associated seismic shaking and ground failure in the lifeline service region. The next step is to perform functional assessments of the expected loss of function of the lifeline system components and the resulting loss of service in the community, including the impact of damage to other lifeline systems on which they depend.

2. Develop a prioritized work plan to reduce future earthquake damage and loss of service.

   Mitigation actions should be prioritized considering the severity and consequences of service disruption by likely earthquakes and the probability of occurrence of different earthquake scenarios.

3. Implement system improvements to minimize the loss of lifeline services in earthquakes.

   This involves identifying and securing funding sources for a long-term capital improvement program.

The National Institute of Standards and Technology (NIST), the American Society of Civil Engineers (ASCE), federal and state Departments of Transportation, and other organizations should develop and implement guidance for achieving acceptable utility and transportation performance in earthquakes that are consistent and appropriate for all of the lifeline infrastructure systems.

Local and state governments in seismically hazardous areas should establish Lifeline Infrastructure Councils of the service providers in their area. The Councils would be charged with improving communication about expected lifeline performance, coordinating plans for emergency response and recovery, and encouraging the funding of improvements in those systems to achieve desired performance levels.

References

The American Lifelines Alliance, a Federal Emergency Management Agency (FEMA) Project, used utility input to develop a set of guidelines for utility performance assessment in natural hazard events, which can be obtained at http://www.americanlifelinesalliance.com/Products_new3.htm

- American Lifelines Alliance, 2005, *Guideline for Assessing the Performance of Electric Power Systems in Natural Hazard and Human Threat Events* and *Commentary,* draft, supported by Federal Emergency Management Agency, Department of Homeland Security, and National Institute of Building Sciences.
- American Lifelines Alliance, 2005, *Guideline for Assessing the Performance of Oil and Natural Gas Pipeline Systems in Natural Hazard and Human Threat Events* and *Commentary,* draft, supported by Federal Emergency Management Agency, Department of Homeland Security, and National Institute of Building Sciences.
- American Lifelines Alliance, 2005, *Guidelines for Implementing Performance Assessments of Water Systems, Volumes I and II,* draft, supported by Federal Emergency Management Agency, Department of Homeland Security, and National Institute of Building Sciences.
- American Lifelines Alliance, 2004, *Wastewater System Performance Assessment Guideline Part I and II,* draft, supported by Federal Emergency Management Agency, Department of Homeland Security, and National Institute of Building Sciences.

NIST is the national agency responsible for developing guidance to improve the nation's resiliency to earthquakes and other natural hazards. NIST recently published the NIST Community Resilience Planning Guide for Buildings and Infrastructure Systems, which provides a practical and flexible approach to help communities improve their resilience by setting priorities and allocating resources to manage risks for their prevailing hazards. NIST is currently preparing "Community Resilience Implementation Guidelines" to support the Planning Guide (From the web site: www.nist.gov/el/resilience/index.cfm)

- National Institute of Standards and Technology (NIST), 2015, *Community Resilience Planning Guide for Buildings and Infrastructure Systems Volumes I and II,* NIST Special Publication 1190.
- NEHRP Consultants Joint Venture, 2014, *Earthquake-resilient Lifelines: NEHRP Research, Development and Implementation Roadmap,* NIST GCR 14-917-33.

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