Edwin Lee, Mayor

City and County of SAN FRANCISCO LIFELINES COUNCIL

Wednesday, April 25, 2012
2:00 PM – 4:00 PM
San Francisco City Hall, Room 305

Naomi Kelly, City Administrator

Lifelines are the systems and facilities that provide services vital to the function of an industrialized society and important to the emergency response and recovery after a natural disaster. These systems and facilities include communication, electric power, liquid fuel, natural gas, transportation (airports, highways, ports, rail and transit), water, and wastewater.
- American Society of Civil Engineering Technical Council on Lifeline Earthquake Engineering (TCLEE), 2009

CO-CHAIRS

Naomi Kelly
City and County of San Francisco
City Administrator
General Services Agency

Chris Poland
Chair, NEHRP ACEHR
Co-Chair, SPUR Resilient Cities Initiative
Chairman, Degenkolb Engineers

REPRESENTED AGENCIES

AT&T
BRMA
California Resiliency Alliance
Caltrain
Caltrans
Comcast
Degenkolb Engineers
Laurie Johnson Consulting
Office of the City Administrator
Office of the Mayor
PG&E
San Francisco Capital Planning Program
San Francisco Department of Emergency Management
San Francisco Department of Public Works
San Francisco Municipal Transportation Agency
San Francisco Public Utilities Commission
San Francisco Risk Management Division
SPUR
URS Corp
Verizon Wireless

MEETING #8 NOTES

1) Welcome and Introductions — Naomi Kelly and Chris Poland, Co-Chairs

Naomi Kelly joins the Lifelines Council as the new City Administrator of San Francisco, sworn in on February 7th, 2012.

The Co-Chairs welcomed the group with a short overview of the background and objectives of the Lifelines Council, as well as synopses of the previous meetings. The Co-Chairs discussed the near-term goals for the Interdependency Study, set in August 2011, and the agenda for Lifelines Council for 2012. Outside of the ongoing Interdependency Study being led by Dr. Laurie Johnson with lifeline providers, the Lifeline Council will focus on the following items in the year ahead:

- Identify and work on issues common to all operators and the City in enhancing response and restoration planning, and in developing a collective set of performance expectations and restoration priorities;
- Continue to serve as a forum for education to help advance our mutual knowledge and guidance for our work;
- Continue to serve as a place for exchange with key agencies and organizations (CalEMA, CHP, WRDA, FEMA) that will be deciding priorities and resources post-disaster.

The group largely approved this agenda, and reactions from agencies highlighted many issues on the forefront of the City's emergency management strategy. Key among them were: the prioritization of access route clean-up, post-disaster, based on the locations of critical facilities; regulations around testing and operating antennas, repeaters, and generators; the location of staging areas for mutual and federal aid; the location of large-scale shelters in relation to cell coverage; and legislation or regulations to promote cooperation among agencies.

2) Lifelines Interdependency Study Pilot

Laurie Johnson, Ph.D., AICP, Principal, Laurie Johnson Consulting | Research

Dr. Laurie Johnson, consultant to the City and County of San Francisco on recovery and lifelines interdependency issues, provided a progress report of the Lifelines Interdependency Study. The study, initiated in 2011, is one of the 4 key objectives of the Lifelines Council: to understand inter-system dependencies to enhance planning efforts for restoration and coordination of reconstruction. Near-term (2 to 5 year) goals for the study, as agreed to by Council members at the August 2011 meeting, are to:

- Build a workable understanding of system interdependencies, and consequences of existing conditions ,to help expedite response and restoration planning among agencies
- Identify key assets and restoration priorities/schemes to prioritize post-disaster restoration and reconstruction activities for the city, and ultimately the region
- Develop a collective set of lifelines performance expectations under current conditions

Furthermore, a key desired outcome, as defined by Council members last August, is to obtain a workable understanding of existing interdependencies by developing a comprehensive scenario of lifeline system impacts and restoration issues following a major disaster.

The interdependency study methodology is modeled after a hybrid of a lifelines interdependency study conducted in Vancouver (Chang et al.) and in Southern California (Porter et al., 2011). The methodology relies upon the use of a maximum credible earthquake scenario, and through the use of a detailed questionnaire lifeline operators are asked to quantitatively describing damage; restoration assumptions, timelines, and metrics; and issues of interdependencies both upstream (factors lifeline depends on) and downstream (customers and dependents) for the scenario. The scenario that is being used for the study is a M7.9 on the San Andreas fault, and data generated by the 2006 EERI study, "When the *Big One* Strikes Again: Estimated Losses Due to a Repeat of the 1906 San Francisco Earthquake." Dr. Johnson reviewed some of the scenario highlights that were previously presented to the Council by Dr. Charles Kircher at its last meeting in November 2011.

She then presented some of the initial insights gathered through the interdependency study interviews that have been conducted to date with PG&E – gas and electric, Caltrans, and SFPUC-Water. For each system, she described some of the likely damage and indicated whether service disruptions in San Francisco would be significant. She also described how each operator would assess impacts and go about setting and implementing restoration priorities. She also identified some of the interdependency issues, both upstream and downstream, that were emerging for each.

Some of the early findings of the study, as of April 2012 are:

- Damage to some of the systems and resulting outages will be extensive;
- While all operators will begin restoration work almost immediately after a major earthquake, the full restoration of some services in San Francisco could take up to 6 months;
- For some systems, the order of system restoration is fairly fixed, starting with major components of the system. For others, the system needs will change as the disaster alters customer demand and thus system restoration will happen more organically in reaction to the new post-disaster demands;
- There are going to be different levels of local, regional, and state interactions among operators with some operators plugging into the state's emergency operations center and more likely to have priorities set at a state, or regional, level, while others will link up more locally and look to San Francisco's leaders to help define priorities.

The study also helped identify the following needs:

- More customer (resident, business) level scenarios of damage, restoration schemes and decision-making are needed, as well as pre-planning of service requirements for essential facilities such as shelters
- Development of pre-designated lifelines routes for operators, a pre-disaster credentialing system for access that includes non-utility contractors/mutual aid providers, and emergency medical services for lifelines restoration personnel
- More regional (multi-city, multi-operator) exercises to consider issues of interdependency between different operators, mass evacuation, regional restoration policy discussions, valve shut-off exercises, and communications outages (such as loss of radios, cell phones, and the internet, as well as use the CalEMA "cloud")
- More system redundancy in some systems to help address critical nodes and interdependency issues

Dr. Johnson closed by discussing next steps for the study. The operator interviews will continue through the summer of 2012 with wastewater, city streets and debris management, transit operators, telecommunications operators, port/airport operators, and a fuel and refineries panel. Following this, the operators input will be integrated into the M7.9 scenario for the region, along with interdependency insights and study results will be sent out to the operators for review and approval in the fall of 2012. The results of interdependency study will be presented to the full Council later in 2012 for further discussion and identification of priority issues and next steps.

3) Lifeline System Interdependencies: Field Observations and Modeling Challenges (Presentation & follow-up discussion on interdependencies)

Leonardo Dueñas-Osorio, Ph.D., Assistant Professor, Rice University

Dr. Johnson then introduced Dr. Leonardo Dueñas-Osorio, who is a leading expert on the modeling of lifeline system interdependencies. Dr. Dueñas-Osorio began his talk by discussing the motivations for lifeline interdependency research. Complex infrastructure systems are

essential for modern societal function, and both the size and vulnerability of these systems are growing. He proposed that the underlying susceptibility of these networks to disruptive events, such as an earthquake, is in large part due to the increasingly complex pattern of interdependencies that tie these civil infrastructure systems together. He also noted that many cities have reached an accelerated phase of aging and deterioration in many critical infrastructure systems. Thus, there is a greater need to understand interdependencies to help optimize system operations both in normal conditions, as well as during disaster. Dr. Dueñas-Osorio also noted that the field of lifeline interdependency modeling is still quite young, with the vast majority of research on the subject has just been published since 2005.

Dr. Dueñas-Osorio first provided an illustration of interdependency from recent field observations following the M8.8 Maule earthquake in Chile in 2010. While much of the electric power system was restored within 48 hours after the earthquake, some observed interdependencies that delayed restoration included the damaged condition of road infrastructure, delays in recovery of telecommunication systems that hampered power repair crew dispatches and communications, and the failed assumptions in emergency plans that affected logistics. Furthermore, some observed actions that were taken to cope with interdependencies that also delayed restoration included problems with private telecommunications, transmission autonomy, decentralized dispatch, and mobile generation.

In another study of a major earthquake's impact on the Memphis power and water systems, Dr. Dueñas-Osorio's modeling showed how water connectivity is vulnerable to its dependence on power. He noted that while the coupling contributes significantly to the water system fragility it does not stress power systems in the same way. Because different infrastructure systems have different levels of vulnerability to different hazards, Dr. Dueñas-Osorio stressed that every aspect of a system must be taken into account for precise modeling.

Both modeling and field observations indicate that a system's fragility increases with degrees of interdependence, therefore the ability of a system to decouple from other systems proves to be an important element of its overall resilience. Dr. Dueñas-Osorio has conducted additional studies on the water and power systems in Chile to quantify the coupling strength of these systems. He modeled a strong operational coupling between telecommunication and power systems, and a weaker but still measurable logistical coupling between power and water systems. These modeling tools provide the predictive capabilities to understand both how the physical (i.e. actual damage) and institutional (i.e. management decisions, communications, and logistics) aspects of lifeline systems affect restoration and interdependence.

His modeling research shows that lifeline interdependencies are significant at specific ranges of hazard intensities and tend to quickly propagate (i.e. cascade) across systems. Furthermore, current system designs do not adequately prevent propagation or promote coordination at the infrastructure interfaces. He hopes he can expand his analyses to assess interdependence effects on system resilience and eventually help prioritize critical components and restoration tasks to achieve multi-system performance levels. He expressed his interest in staying involved with the Lifelines Council and their interdependency study work.

4) Discussion and Q&A — **Laurie Johnson, Ph.D., AICP, Principal, Laurie Johnson Consulting | Research**

Following the two presentations, the group reflected on the complex nature of lifeline interdependencies. The presentations made evident that some interdependencies exist only in theory, and failures at the start of the interdependency chain can make the eventual dependence on another system irrelevant.

Ed Reiskin, Director of Transportation for the SFTMA, pointed out that reliable modeling like the focus of Dr. Dueñas-Osorio's presentation is necessary to determine the most critical mitigation measures, redundancies, or necessary decoupling for a large system.

Jon Frisch, PG&E, pointed out that although in the case of regulated utilities, modeling can be used to indicate where improvement are needed and help make the case to regulatory agencies who ultimately make final decisions about what gets funded. He also emphasized that while there is no power generation in the city, decoupling is unfeasible.

The group ended the discussion by considering how a combination of qualitative analysis and modeling could be useful for the Lifelines Council. It was recommended that the Council first complete the qualitative interdependency study already in progress, and then explore the options for modeling in the future.

6) Adjourn

Meetings will continue on a quarterly basis.