Insurance Institute for Business & Home Safety

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Mitigating Fire Following Earthquake Risks

The Insurance Institute for Business & Home Safety (IBHS) is a non-profit applied research organization entirely supported by the property insurance industry to conduct objective, scientific research to identify and promote effective actions that strengthen homes, businesses and communities against natural disasters and other causes of loss. IBHS and its member companies have a keen interest in supporting measures that reduce losses during and after an earthquake.

Research to Date

Several studies have examined both the reality and theory of fires following earthquakes – and these studies paint a somber picture of likely consequences [1,2,3]. One area of great concern centers on preventing fires from becoming conflagrations that consume large geographic areas, and result in high rates of fatalities and injuries. Analyses of fires following past earthquakes clearly show that there are a number of possible scenarios involving fuel and ignition sources which can lead to fires requiring two or more fire department resources to contain the blaze.

It is estimated that natural gas has played, and will continue to play, a role in between 20 percent and 50 percent of fires following earthquakes in California. It is also estimated that electricity plays a role in as much as 50 percent of fires following earthquake. Clearly, taking proactive measures to reduce the number of ignitions will significantly lessen demands on emergency responders and fire departments in the aftermath of a major earthquake. Consequently, it is prudent to take steps to reduce or eliminate ignitions, and to place the highest priority on risk mitigation in areas where there is greatest potential for fires to become conflagrations.

An analysis of fires following the Loma Prieta earthquake in 1989 suggests that the bulk of electricity-related fires are attributed to electrical wiring and electrical equipment [1]. Furthermore, an analysis of repairs carried out by the Southern California Gas Company following the Whittier Narrows Earthquake in1987 indicated that the failure of gas connections to appliances accounted for nearly 40 percent of catastrophe-related repairs.

Reducing Gas-Related Ignitions

1. Manual Shutoff Valves

Historically, the approach to reducing gas-related ignitions has been to educate the public so that they know where the manual gas shutoff valve is located, to have an appropriate tool located near (but not at) the valve, and to know how to turn the gas off.

The instructions generally are accompanied by the direction that homeowners should not turn off the gas unless they smell gas, hear a leak, or have damage to their building or gas appliances.

Nevertheless, it is clear from the large numbers of residences where gas is shut off as a precautionary measure, that the final parts of the instructions are not being communicated effectively. In a couple of recent California earthquakes, as many as 120,000 to 150,000 customer gas outages have occurred, and many of those have been created by homeowners turning off the gas as a precaution. Experience has also shown that a well-coordinated mutual aid system has allowed utilities to check and restore services at a rate of 10,000 to 20,000 customers per day.

2. Automatic Shutoff Valves

Another approach to reducing gas-related ignitions involves the use of automatic shutoff valves. These include motion-activated valves that are triggered by an earthquake, and excess flow-activated valves that sense when the gas flow exceeds that associated with use of the appliances downstream of the valve. Early models of the motion-activated shutoff valves apparently could be tripped by the nearby passage of heavy vehicles or an object striking the valve. However, newer designs are resistant to these sources of false activation. One cautionary note is that the flow valves have to be properly sized for the application, and may not pick up a partial failure or crack that does not result in a significant drop in gas pressure across the valve.

3. Structural and Non-Structural Retrofits

Natural gas leaks inside a building can be reduced by strengthening weak buildings to help prevent structural damage that will lead to leaks, and by anchoring natural gas-fired equipment to the building structure. Houses that are poorly anchored to their foundations or that are supported on poorly braced and anchored cripple walls are among the most vulnerable during an earthquake [2]. Recent experience with California earthquakes has shown that significant reductions in natural gas supply line failures can be achieved by preventing gas-fired equipment from moving relative to the building during the earthquake. Kits are readily available for anchoring water heaters; further guidance can be found in the comprehensive IBHS publication entitled Earthquake Risks around the U.S. - How to Protect Your Property. Other gas appliances can be easily anchored to walls or floors using brackets or materials available at most building supply stores.

Reducing Electricity-Related Ignitions

Despite the fact that fires caused by electricity-related ignitions are equally or even more common than gas related ignitions, the risks and potential mitigation options have received significantly less attention in the existing literature. As is the case with gas-related ignitions, electricity-related ignitions can be reduced by strengthening weak buildings to help prevent structural damage, which can lead to stretched wiring and broken connections. Furthermore, an approach to reducing electrical system-related ignitions could be the installation of arc-fault circuit breakers that would immediately shut off electricity to circuits where arcing was occurring. This might be considered analogous to the automatic shutoff valve approach to limiting gas flow. While modern electric codes are requiring these types of devices in many areas of new housing, more research is needed to determine whether this concept would be cost-effective in actually reducing electricity-related ignitions following an earthquake.

Mitigation Priorities

Based on the reports cited above, and recent wildfire-related research in California [4], IBHS suggests the following order of priorities (from highest to lowest) for mitigating risk of post-earthquake conflagration fires:

1. Two- or more-than-two-story wood frame residential buildings with more than four units that have what is called a “soft story” at the base. These buildings are susceptible to partial collapse that

could trap inhabitants. It may be very difficult to turn off gas lines or quickly shut off electricity in these buildings, and both the trapped individuals and those attempting to rescue them would be at significant risk from fire. NOTE: Some cities are taking steps to identify these types of structures within their communities.
2. Areas with closely packed wood frame structures (residential or commercial), including many city blocks in urban areas. Experience has shown that as population density increases, the risk of large fires also increases dramatically. Damage to structures in these areas could significantly compromise firewalls that are intended to limit the spread of fire between buildings.
3. Areas with high building density or dense, fire-prone vegetation.
4. Residential areas where building separation is less than about 30 feet to 45 feet.

Additional Risk Factors for Conflagration

Beyond these development-related risk factors, it is also clear that a number of other factors will affect the risks that conflagration fires will occur. These include:

- Whether people are present to take action to mitigate risks in the immediate aftermath of an earthquake. Depending on the time of day, the risks could be greatest in residential areas or in commercial areas.
- The extension of the wildfire season in Southern California to what is now a nearly year-round risk clearly points to the increased need to consider that fires which might remain isolated in the absence of strong winds could grow dramatically.
- Damage to water systems that severely limit firefighting capabilities or the operation of automatic sprinkler systems.
- Reduced responsiveness of firefighters due to communication system overload, too few resources, and transportation system impediments that significantly raise response times once an assignment is made.

Targeted Implementation

Given that the greatest risk of a conflagration fire is associated with an ignition that originates in areas with high building density when no one is there, it would seem prudent to require automatic, passive protection of both gas and electrical systems for buildings in these areas. While these steps would not remove all risk of fire ignitions following earthquakes, they might reduce the number of ignitions in the highest risk areas by perhaps 50 percent or so. This would reduce demands on the Fire Services dramatically and free up additional resources to help contain remaining fires that were not avoided.

References

1. State of California Seismic Safety Commission, (July 2002) *Improving Natural Gas Safety in Earthquakes*, CA Seismic Safety Commission Report SSC-02-03.
2. Scawthorn, Charles R., (March 2008) *Fire Following Earthquake*, USGS Open File Report 2008-1150.
3. Association of Bay Area Governments, (2009) *Soft-Story Residential Buildings in Earthquakes – Risk and Public Policy Opportunities for Oakland*, Draft ABAG Earthquake and Hazards Program Report.
4. Institute for Building & Home Safety (2008) “Mega Fires: The Case for Mitigation”