

MEMORANDUM

Building & Safety Division



To: Honorable Mayor and Council Members

Through: Tom Williams, City Manager

From: Keyvan Irannejad, P.E, Chief Building Official 

Subject: Automatic Gas Shutoff Valves

Date: April 24, 2007

The Citizens Emergency Preparedness Advisory Commission ("CEPAC") requested submittal of a report to City Council addressing automatic gas shutoff devices installation in residential structures.

This item was brought up to the City Council on August 1, 2006 and staff was directed to review gas shutoff devices and report findings to the Council.

This report summarizes the conclusions of staff research and seeks the Councils direction regarding the development of an ordinance mandating the installation of automatic gas shut-off devices.

Several common characteristics of earthquake impact on natural gas safety are:

1. Earthquake ground shaking will generally lead to substantial number of instances of building damage followed by fire ignitions.
2. Ground motions that are sufficient to damage buildings are most likely to impact utilities and are potential for gas-related fire ignitions.
3. The number of post -earthquake fire ignitions related to natural gas release can be expected to be 20% to 50% of the total post-earthquake fire ignitions.

Nearly every major earthquake in California has demonstrated some seismologic characteristic that was previously unknown. In particular, the number of fire ignitions experienced in past earthquakes may not be a reliable indicator of future ignitions because of the complex relationship between variables such as ground shaking severity, time of the day, and damage sustained by the infrastructure.

The 1906 San Francisco earthquake occurred on April 18 at 5:13 AM, the magnitude of the earthquake was estimated at 7.8. Sixteen fire alarms were reported in widely separated area. Fires raged through the city almost uncontrolled, in part, because water mains had broken due to the quake.

The 1994 Northridge earthquake, on January 17th, at 4:31 AM, had a magnitude of 6.7.

The total number of customers left without service immediately after the main shock and followed aftershocks exceeded 150,000. Approximately 133,000 of the service interruptions were initiated by customers as a precautionary measure. 97 fires were recorded, out of which 54 fires were gas related. Approximately 25% (125,000) of the claims represent damage that could have resulted in gas-related fire ignitions. The rate of fire occurrences, given damage to the gas appliances in the Northridge earthquake, was less than 1 in 3,000.

The 1989 Loma Prieta earthquake, on October 17th, at 5:04 PM, had a magnitude of 7.2.

67 fires were recorded, out of which 16 fires was gas-related.

There are many beneficial alternatives for individuals to improve natural gas safety in future earthquakes that include:

1. Improving appliances integrity
2. Structural integrity
3. Using gas shutoff devices

Each alternative has advantages and disadvantages related to the costs of implementation, level of safety improvement and collateral benefits for non-earthquake emergencies. Because every situation is different, deciding which alternative will improve safety is best done on a case-by-case basis.

The reason for considering the installation of seismic gas shutoff devices and/or excess flow gas shutoff devices is to enhance safety and provide additional protection for residential and non-residential occupants and to first responders from unnecessary threats of injury or death, and reduces property damage from some gas pipeline failures that may result in a fire damage. Under current California law these devices must be certified by the Division of the State Architect prior to sale and installation in a gas piping system.

Seismic Gas Shutoff Device (motion sensitive valves): An earthquake-sensitive gas shutoff device intended to prevent gas flow in a gas piping line following a specified degree of seismic disturbance.

Generally, a single seismic gas shutoff device would be installed in a residential occupancy's gas piping system. This device normally is installed in the main gas line down-stream from the utility company's gas meter and service tee on the outside of the building. It is designed to activate only in cases when building shaking may be sufficient to cause damage to the gas piping system.

Motion sensitive valves are set to trigger and shut off the gas flow in an earthquake with a shaking intensity of approximately 5.4 on the Richter scale. Once the valves automatically shut off gas flow, they must be manually reset by authorized utility personnel or other approved professionals. They can leave a large number of homes without natural gas for an extended period of time.

Basis of Operation: Senses shaking in a building that is above predetermined level of shaking and automatically shuts off gas.

Benefits: Activate only in cases when building shaking may be sufficient enough to cause damage to the gas system. Someone does not need to be present to ensure shutoff.

Drawbacks: Can activate even if damage and hazards do not exist. Aftershocks can cause the device to activate after service has already been restored. May be activated from shaking not related to earthquakes.

Excess Flow Gas Shutoff Device: A device or system designed to automatically shut off gas flow in a piping system in the event of significant overpressure surge or rupture of the gas supply line down-stream of the device or system. Basically, excess flow devices shut off when the pressure differential on opposite sides of the device exceeds a certain threshold. Excess flow devices will automatically reset once the pressure differentials reach the normal operational level. The effectiveness of an excess flow valve depends on the valve's location in the gas piping system.

Individual excess flow gas shutoff devices generally are installed at each appliance outlet between the gas piping system and the appliance connector. In addition, a main excess flow gas shutoff device is installed in the main gas line down-stream from the meter and service tee. The purpose of these devices is to shut off the flow of gas to individual appliance or the entire system when the flow of gas through the device is increased beyond its predetermined operating flow rate. When an excess flow valve is installed at the meter, the valve would close only when a major break or leak occurs and would not respond to smaller gas leaks. This could cause a false sense of security. However, when an excess flow valve is installed at an appliance, the valve is more likely to detect a smaller leak.

Basis of Operation: Senses gas flows that are above predetermined shutoff flow rate and automatically shuts off gas.

Benefits: Activates only in cases when excess gas flows down stream of the device. Someone does not need to be present to ensure shutoff.

Drawbacks: Will not shut off gas if leakage is below predetermined shutoff flow rate, even if a slow leak exists. May not activate if the occupant changes gas systems downstream without modifying the device.

In January 2002, California Seismic Safety Commission (CSSC) published the report, "Improving Natural Gas Safety in Earthquake". The CSSC report addresses post-earthquake fires related to natural gas line failures and concludes that the likelihood of fire caused by a broken gas line is no greater than that of fire caused by other sources such as electrical short circuits. The CSSC Report provides a relatively detailed study of different gas shut-off valves and devices and outlines the benefits and potential drawbacks of each one. The CSSC report does not make any recommendation regarding the mandatory installation of these devices and leaves the decision to local jurisdictions.

In March 2005, the State of California, Department of Housing and Community Development published "Information Bulletin 2005-02" in which it concluded after careful consideration of all currently available information, including a study commissioned by a manufacturer, that there was insufficient evidence to support a statewide requirement for the installation of seismic

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gas shutoff devices and/or excess flow gas shutoff devices, but recognized that some jurisdictions, particularly those in “seismically active” regions may wish to require usage of such devices.

PG&E has taken no position in relation to adoption of a mandatory shut-off valve ordinance. However, their representative warned that the number of requests to restore gas service could increase markedly as a result of the mandated installation of these devices, resulting in longer overall restoration of services citywide. Experiences in past earthquakes suggest that, even in the absence of shut-off devices, most owners will shut off gas services manually as a precautionary effort to reduce the risk of fire.

Currently the following Cities and Counties in California adopted local ordinances and enforce installation of seismic or excess flow shut-off valves on downstream of meter (customer owned gas piping) for new construction, remodeling and addition:

- City of Brentwood
- City of Los Angeles
- City of West Hollywood
- Alameda County
- Contra Costa County
- Marin County.

Please see attached table for detailed information on various cities adoption of automatic gas shut-off devices.

In January 24, 2006 City and County of San Francisco had special meeting and public discussion regarding Seismic Shut-off valve and will have second meeting in response to the interest in this topic.

The approximate costs of installing various devices are provided in the table below. The range in hardware cost is primarily related to variation among manufacturers and the size of the gas service line to the building.

Device ²	Hardware Cost	Installation Cost ¹
Restrain Individual Gas Appliance	\$15-\$50	\$0 - \$100
Manual Shutoff Valve and Wrench	\$5-\$20 ³	\$0
Earthquake Shutoff Valve	\$100 - \$300	\$100 – over \$300 ^{4,5}
Excess Flow Valve at Meter	\$20 - \$100	\$100 – over \$300 ^{4,6}
Excess Flow Valve at Appliance	\$5 - \$15	\$0 - \$100

NOTES:

1. All costs are approximate and do not include permit and inspection fees that may range from \$50 to \$200.
2. Significant differences exist in the operation of the various devices listed.
3. Cost of a suitable wrench
4. Installation costs do not include cost of a gas system survey, which can cost more than \$200.
5. Higher installation costs may occur if substantial modifications of plumbing and valve support are necessary.
6. Higher installation costs may occur if substantial plumbing modifications are necessary.

Conclusions:

The presence of natural gas supply to any building will always be a potential for providing fuel source to any fire. Any reasonable attempt to mitigate this potential is in the best of the general public.

The availability of different types of gas shut-off devices provides the customer with a broad range of products to choose from, which, in turn, diminishes the impact of drawbacks that the wide-scale installation of a particular product could cause. For example, because not all customers will choose to install motion sensitive valves, the possibility of having a large number of houses without natural gas service after a strong tremor is accordingly lessened.

Likewise, the lower cost of flow-sensitive valves enables the customer to install one device at each gas appliance, greatly reducing the possibility of having small leaks go unnoticed. Further, customers will be able to install devices, which detect gas leakages as well as major ruptures, providing yet another option in improving natural gas safety.

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The City of Milpitas is likely to suffer less damage due to earthquake or earthquake-caused fires. The majority of the construction has taken place in the last 25 years, and designed in compliance with more current seismic codes. This has resulted in better-built structures.

In most apartment buildings the length of the interior walls to the overall area of the building is high which reduces the chance of a major structure failure during the earthquake. The same, however, is not true for older apartment buildings constructed above carports.

Restraining appliances against movement and improving the structural integrity of buildings are highly effective methods in stopping or reducing damage caused by natural gas leaks. Restraining gas appliances from major movement is an inexpensive and, if done properly, effective preventive measure against damages to gas pipelines. Earthquake-induced movement of gas appliances or toppling of water heaters can cause gas pipeline breakage. In addition strapping or any other system that restrains the movement of an appliance or water heater during an earthquake can also save the cost of replacing or repairing the appliance or water heater. State law requires installing bracing for water heaters at the time of the sale of real property or replacing water heaters.

However, a fire caused by a ruptured gas line in Fire Hazard Zone has a higher possibility of turning into a major conflagration than in other areas of the City. This possibility is even higher if a post-earthquake fire occurs during high winds, especially if the access routes of fire trucks are blocked and water flow is interrupted causing fire sprinkler systems to fail. Therefore, the relatively low cost of installation and the considerable increase in safety weighs in favor of mandating the installation of shut-off valves in all new structures and in those existing structures that located in fire hazard zone.

Encl.

Gas Shut-off Valve Survey

Jurisdiction	Type of Valve Required	When Required				Where Required	
		New Construction	Remodeling	Addition	Resale	Downstream of Meter	Point of Appliance
City of Brentwood	Seismic or Excess Flow	X	X ^{a,b}	X		X	
City of Clayton	Seismic or Excess Flow	X	X	X		X	X
City of Hercules	Seismic or Excess Flow	X	X	X		X	
City of Lafayette	Seismic or Excess Flow	X	X	X		X	
City of Los Angeles	Seismic	X	X ^c	X	X	X	
City of Martinez	Seismic or Excess Flow	X	X	X		X	
City of Orinda	Seismic or Excess Flow	X	X	X		X	
City of Pittsburg	Seismic or Excess Flow	X	X	X			
City of West Hollywood	Seismic	X	X	X	X	X	
Town of Moraga	Seismic or Excess Flow	X	X	X		X	
Alameda County	Excess Flow	X	X	X		X	
Contra Costa County	Seismic or Excess Flow	X	X ^{d,e}	X	X	X	
Marin County	Seismic or Excess Flow	X	X	X		X	

- a. In any existing residential, commercial or industrial building, when any addition or alteration is made to the interior of a building that contains gas piping.
- b. When any plumbing permit issued for gas piping.
- c. In any existing residential, commercial or industrial building, when any addition or alteration valuation of greater than \$10,000.
- d. When any plumbing permit issued for gas piping with a valuation of greater than \$5,000.
- e. In any existing residential, commercial or industrial building, when any addition or alteration valuation of greater than \$15,000.

MEMORANDUM

Office of the Fire Marshal



Date: April 17, 2007
To: Keyvan Irannejad, Chief Building Official
From: Patricia Joki, Fire Marshal
Through: Clare Frank, Fire Chief
Subject: Residential seismic gas shut-off & excess flow devices

The Citizens Emergency Preparedness Advisory Commission (“CEPAC”) requested a report to City Council from the Building Inspection Division addressing seismic gas shutoff device installation on residential structures. To assist you in making a recommendation, you requested some feedback from the fire department regarding the potential advantages and/or drawbacks of installing the different types of devices available.

Below is a synopsis of (1) the types of devices available, (2) advantages and drawbacks from the fire department’s perspective, and (3) the fire department’s recommendation regarding installation of seismic devices.¹

1. Types of Devices

There are two categories of devices currently available: excess-flow and shut-off. The excess-flow devices can be placed on the “house-line” or at the appliance connection (water heater, stove, furnace, etc). Shut-off devices are placed on the “house-line.” There are advantages and drawbacks to each.

2. Advantages & Drawbacks of Installing the Devices on Residential Structures

- **Shut-off and/or excess flow devices** on the house gas service line would likely lower the number of post-earthquake natural gas fires and explosions.
- **Shut-off** devices could reduce the number of 9-1-1 calls to police and fire dispatch centers. The reduction in calls will allow emergency responders to target efforts where needed at a time when calls for service will increase. However, if **excess-flow** devices are used, the number of calls may not decrease significantly if a homeowner smells or hears leaking gas.
- **Shut-off** devices will likely lessen the hazard exposure to surrounding structures in the event a fire situation occurs, and if implemented with some level of retroactivity, as needed, could decrease the potential for life-loss in older more prone multi-residential buildings and mixed-use structures. (See CSSC Report § 6.)
- **Shut-off devices** have a drawback in that a homeowner may not understand the purpose of the devices, why they activate, or how they should be reset.

¹ To compile this synopsis, fire department staff reviewed the California Seismic Safety Commission (CSSC) report entitled *Improving Natural Gas Safety in Earthquakes*, adopted July 11, 2002, Informational Bulletin 2005-02 from the California Department of Housing and Community Development. Staff also attended a public hearing in January 2007, presented by the City of San Francisco Department of Building Inspection in relation to this issue, met with CEPAC, and reviewed the materials with building staff.

- **Shut-off devices** may have the potential to activate without a seismic event, although no documentation could be found that substantiates this drawback.
- **Excess-flow** devices may give homeowners a higher level of comfort when they are away from home and lessen unnecessary shut-offs with its ability to “self-actuate.”
- **Excess-flow** devices have the potential to lessen the utility company’s number of calls for service if the homeowner is educated in how to reset the devices safely.
- Installation of either a **shut-off or excess flow** device tends to make citizens more conscious of the areas’ natural hazards and the importance of being prepared for a disaster. This awareness may also lead homeowners to become more self-sufficient for a potentially long period of time, which in-turn lessens the long-term impact on public services caused by sheltering displaced residents due to interruption of gas service. (See CSSC Report §§ 6 & 9.)
- A drawback for **all the devices** is with lengthy utility service restoration times, the homeowner, or non-qualified person may attempt to re-establish gas service without the proper training. This could increase explosion risk if the gas line is not checked for leaks, and inadequate venting conditions are not recognized and corrected. (See CSSC Report § 6.5)

3. Fire Department Recommendation

The fire department staff research indicates that installing seismic devices would reduce the potential for fire and explosions from broken and/or leaking natural gas lines and would keep residents safe while reducing unnecessary calls for emergency service. Installation of seismic gas shut-off devices is also likely to educate residents in disaster preparedness and make them more self-sufficient and able to survive a disaster situation when it occurs. Because the research also delineated some drawbacks to installation, any ordinance requiring installation should be narrowly drawn and measured to address areas most likely to realize the benefits of installation. As to type of device, the fire department research indicates that each type of device could be useful but that the layout of the home and the gas lines dictates which device would provide the most protection to its residents.