

State of California
Seismic Safety Commission

Memo

To: Seismic Safety Commissioners

From: Henry Reyes, Staff Structural Engineer
Seismic Safety Commission
1755 Creekside Oaks Drive, Suite 100
Sacramento, CA 95833
(916) 263-5506 x 225

Date: May 2, 2013

Subject: Fire Following Earthquakes (FFE) – Phase II
Project Title: *Coordinated Planning and Preparedness for
Fires Following Earthquakes*

Background

On November 10, 2011 the Commission voted to provide funding for \$49,000 from the California Research and Assistance fund to the Pacific Earthquake Engineering Research Center (PEER) on the above subject project. The goal of this project is to follow-up on activities recommended on the Fire Following Earthquake Report – Phase I Report. This report entitled: *Water Supply in regard to Fire Following Earthquake* was completed in November 2011.

The report found (a) Most larger urban fire and water departments are ill informed as to the specifics of their earthquake risk; (b) Water department system vulnerabilities is not well understood by fire departments, although water and fire departments both generally believe most municipal water supply systems are unreliable in a major earthquake; and (c) While some water departments and fire departments have vigorously addressed this issue, many have not.

The purpose of the project is to cooperate with key urban fire and water departments in California, in order to encourage coordinated planning and preparedness for fires following major earthquakes. Cooperation will be fostered via preparation of ‘white papers’ on the issues

PEER started work on the project on January 1, 2012. Conducting the study for PEER is Dr. Charles Scawthorn, a visiting scholar at PEER, as the lead researcher. End date is June 30, 2013.

Progress Update

Enclosed: Dr Scawthorn’ memo on the FFE project status and presentation to the FIRESCOPE Board of Directors (BOD) at the Burbank Fire Training Center on April 10, 2013.

memo**Charles Scawthorn, S.E.****To: Seismic Safety Commission, Att: Henry Reyes****30 April 2013****Cc: Richard McCarthy****Re: FFE project status**

This memo reports the status of the subject project as of 30 April 2013. The project's Goals are:

1. Highlight the problem to the California Fire Service
2. Enlist the Water Community via a joint meeting of key senior fire chiefs and water department managers,
3. Develop draft state-wide post-earthquake firefighting water target goals

with specific planned activities towards these goals being:

1. Continue Discussions with FDs, CalEMA, fine-tune the draft Performance Goals
2. Convene SoCal and NoCal meetings FDs (April)
3. Involve WDs in discussion (April-May)
4. Finalize Performance Goals (May - June)
5. Outline Plan Preparation Guidance Document (June)
6. Project Report (June)

The draft Performance Goals were presented to the Commission at the 14 March meeting. Following feedback, Activity 1 was pursued, engaging CalEMA and selected fire departments to receive their reaction, which in general was favorable.

Activity 2 was moved forward with a presentation (attached) to the FIREScope¹ Board of Directors (BOD) at the Burbank Fire Training Center on 10 April. The presentation was facilitated by CalEMA Secretary *Mark Ghilarducci* and Cal EMA State Fire and Rescue Chief Kim Zagaris. The purpose of the presentation was to present the BOD with the draft Voluntary Performance Goals (VPGs) and to ask their support (support = considering, modifying as needed, adopting and promoting the VPGs) with FIREScope members, particularly the larger urban fire agencies. The presentation was well received and was followed by a good discussion and Recommendation to support the VPGs. Subsequent discussions with Chief Zagaris confirm that FIREScope has taken this on as a task, and I indicated my readiness to assist FIREScope in any way.

Activity 3 has been initiated with contacting and discussions with several major WDs.

A new dimension was added to the project with a meeting with representatives of the California Hospital Association on 29 April, arranged by Director McCarthy. CHA's members are concerned that they don't have an adequate and reliable post-earthquake supply of potable water. The Project's Concept of a state-wide standardized Portable Water Supply System (PWSS) was presented, and clearly can play a key role in improving this situation. Discussions with CHA will continue, towards a possible goal of expanding the Project Concept from fire-only to seismically reliable fire and potable water supply.

¹ Under Health and Safety Code Section 13070, the Office of Emergency Services (OES), California Department of Forestry and Fire Protection (Cal Fire) and the State Fire Marshal (SFM) jointly administer the FIREScope (FIrefighting RESources of California Organized for Potential Emergencies) Program, which represents all facets of local, rural, and metropolitan fire departments, in order to unify these various fire agencies together into one voice and direction. See <http://www.firescope.org/> for more information.

Water Supply in regard to fire following earthquake

Firescope BOD
10 April 2013

Charles Scawthorn, S.E.
Visiting Scholar
Pacific Earthquake Engineering Research Center
University of California at Berkeley



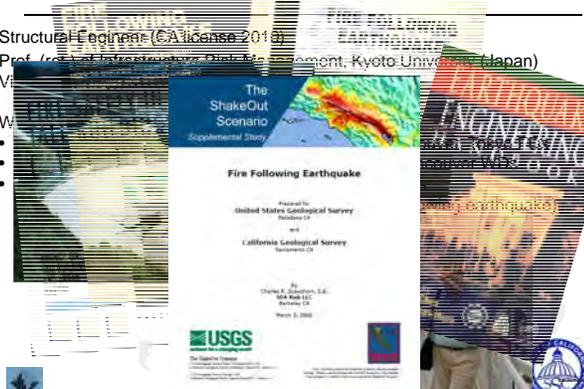

Outline

- Self-Introduction
- The Problem
- Phase 1 Method and Findings
- Phase 2 Purpose and Activities
- Next Steps
- Q&A



Charles Scawthorn

Structural Engineer (CA license 2013)
Prof. (grad. of Infrastructure Risk Management, Kyoto University, Japan)





The Problem – *reliability of water for fire following earthquake*



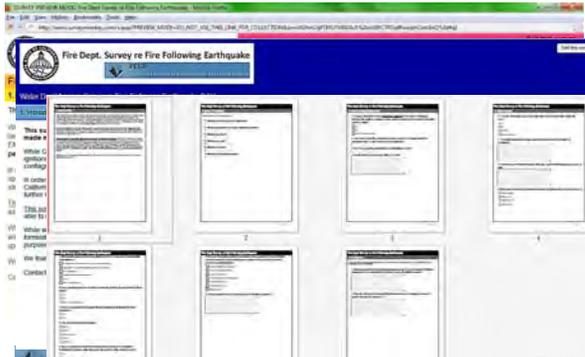

Do we have reliable water supply for FFE?

Questions:

- how well do water departments understand the potential damage to their distribution system? (focus to date has been on transmission)
- what are their current estimates of post-event firefighting water reliability?
- how well do fire departments understand this situation?
- how well are fire departments prepared for alternative water supply?
- how can this situation be improved?



2012 Online Surveys




Key Findings from the Fire Agencies Survey

- ❑ See earthquake as a very important issue.
- ❑ But, could be better informed as to earthquake risk
- ❑ Have infrequent communication with their water departments.
- ❑ Consider their normal water supplies as seismically unreliable.
- ❑ Are improving water supply capability but efforts are piecemeal, not coordinated and often are 'reinventing the wheel'.
- ❑ Have identified alternative water sources, but These sources are often not particularly well documented, nor kept up to date nor regularly drilled.
- ❑ The very difficult task of moving water from these sources to the fire scene is in many cases not well thought out, not adequately equipped and not regularly drilled.



Key Findings from the Water Agencies Survey

- ❑ Most larger urban water agencies not aware of the specifics of the earthquake risk they are exposed to (i.e., two thirds had had no analysis in the last ten years).
- ❑ Earthquake is seen as a key issue by most water departments, but that provision of potable water has a higher priority in some cases than firefighting.
- ❑ Even where water departments have knowledge of the vulnerabilities of their systems, this is not often (only 22%) communicated to fire departments.
- ❑ Both water and fire departments expect major loss of water supply in a major earthquake, with the water department informing the fire department of the details of this about half the time.
- ❑ Many water departments are currently addressing their seismic vulnerabilities with significant engineering programs.
- ❑ Information on when water would be restored is sparse.
- ❑ Some water departments have alternatives given loss of normal water supply, but only a fraction (~1/3) are reasonably equipped to actually move water.
- ❑ Fire and water department liaison is not very good, and are often somewhat indirect, through larger enterprise-wide coordination meetings. Emergency water supply is not a focus.



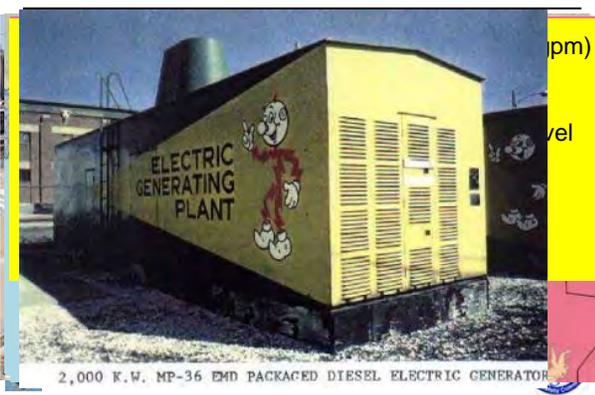
Solutions



Which solution where?



LA Basin HP system - feasibility



Phase 1

Phase 2 Purpose / Goals

- ❑ Highlight the problem to the California Fire Service
- ❑ Enlist the Water Community via a joint meeting of key senior fire chiefs and water department managers,
- ❑ Develop state-wide requirements for development of post-earthquake firefighting water target goals

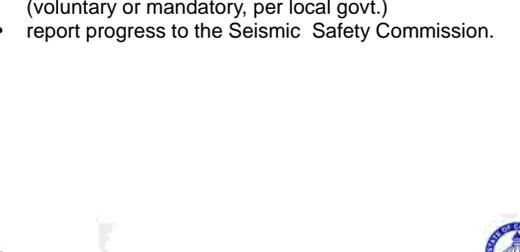



13

Goals – *Draft Concept*

URM ~ SB 547 passed in 1986 (section 8875 of the California Code)

- required jurisdictions in Zone 4 inventory URM by 1990
- adopt a loss reduction program (voluntary or mandatory, per local govt.)
- report progress to the Seismic Safety Commission.




14

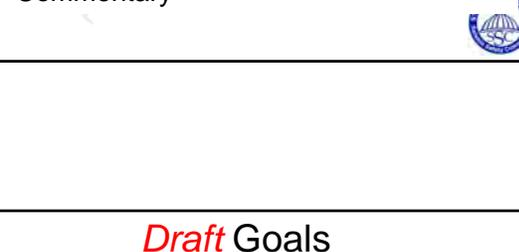
Draft Goals – Target / Structure

Target Fire Departments

- 70 FDs (of 789 total in state)
- Associated Water agencies
- protecting total population of 15 million

Four parts

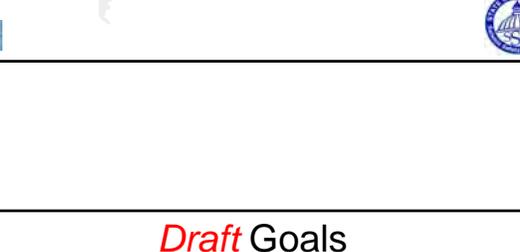
- Preamble
- Goals
- Definitions
- Commentary




15

Draft Goals

Preamble: California is earthquake-prone and its cities consist predominantly of wood frame buildings, so that the risk of fire following earthquake in urban areas is very high. In order to reduce that risk, the Seismic Safety Commission and the California Emergency Management Agency are working to improve the availability of water for fires following major earthquakes in California. A first step towards reducing this risk is to set a goal for assured post-earthquake firefighting water supply.




16

Draft Goals

Goals: Incorporated cities in California with a population exceeding 100,000 and having at least a portion of their jurisdiction subject to a Maximum Considered Earthquake (MCE, as defined below) shall:




17

Draft Goals

c. Based on the Plan, publish and present to the Mayor, City Manager, City Council and other top officials, a quantitative estimate of the median and 90th percentile upper bound number and zipcode location of buildings and property likely to be damaged and/or destroyed due to the fires determined in 1. above.



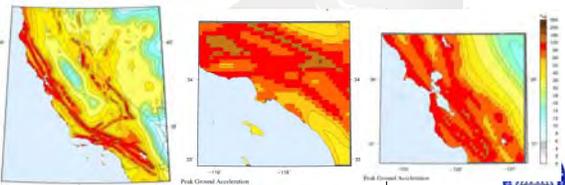

18

Definitions

Definitions

Maximum Considered Earthquake (MCE)

the pattern of peak ground acceleration of 0.50g or greater with associated probability of 2% in 50 years, as shown on the most recent National Seismic Hazard Maps prepared by the U.S. Geological Survey (see Figure 1, and commentary). (could also be defined as the pattern of Maximum Considered Earthquake Ground Motions for the Department's protection area, as defined in Chapter 16 of the 2010 California Building Code, Title 24 Part 2, but these are older).



19

Commentary

Commentary

Nature of the Goals: The Goals do not arbitrarily specify a maximum permitted level of fire loss given an earthquake, but rather anticipate local governments will individually determine their acceptable risk of loss due to fire following earthquake. It is anticipated this will be facilitated by having:

- a clear estimate of the fires that are likely to occur following a major earthquake,
- a Plan for suppressing those fires,
- the public understand the likely fire losses (given the actions assumed to occur in the Plan)
- the Plan exercised annually, and it and the loss estimates updated every five years.

It is anticipated that, if the losses due to fire following earthquake are known to the public, a public debate will occur as to their acceptability. The outcome of that debate will either be acceptance of the risk, or implementation of mitigation measures to reduce the fire following earthquake risk to an acceptable level.

Currently, most cities have no estimate of their fire following earthquake, and only general plans lacking a quantitative basis for dealing with fires following a major earthquake.

20

Commentary

Size of Cities: Only cities with populations more than 100,000 need meet the goals. Smaller cities are less likely to have an overwhelming number of fires.

21

Commentary

Estimation of Fires: Table 1 provides a quick reference for estimating the number of ignitions as a function of population and MCE ground motions. Taking the City of Berkeley as an example (population 114,000), from Figure 3 we see that the City is likely to be subjected to about 1g PGA, so from Table 1 we see that Berkeley will on average have about 14 ignitions ($1.14 \times 12 = 13.7$), which is a significant challenge for that jurisdiction's Fire Department (7 fire stations and 7 fire engines, plus reserve engines). Table 1 is only a quick reference, and the analysis should consider variability due to wind, humidity, time of the earthquake, season and other factors. In this regard (TELE, 2005) is a useful resource. The analysis should actually be performed at a smaller resolution (city zipcode) taking into account the variation of ground motions as a function of soil conditions and other factors. For larger cities, such as Los Angeles, a more detailed analysis is particularly important.

It is not sufficient to estimate the average (mean) number of ignitions - an upper bound (90th percentile) as well as their location and subsequent fire growth: should also be estimated, in order to arrive at an estimate of the mean and upper bound quantities of firefighting water and other resources that will be required. In this regard (FCI, 2005) is a useful resource.

22

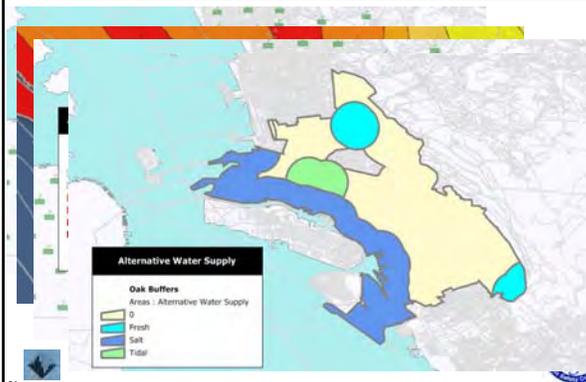
Commentary

Table 1 Average number of Ignitions as a function of PGA and Population source: (SPA Risk, 2009)

Population	Peak Ground Acceleration (g)								
	0.5	0.6	0.7	0.8	0.9	1	1.2	1.4	1.6
100,000	3	4	6	7	10	12	17	24	31
200,000	6	8	11	15	19	24	34	47	62
300,000	8	12	17	22	29	36	52	71	93
400,000	11	16	23	30	38	47	69	94	124
500,000	14	21	28	37	48	59	86	118	155
600,000	17	25	34	45	57	71	103	141	185
700,000	20	29	40	52	67	83	120	165	216
800,000	22	33	45	60	76	95	138	188	247
900,000	25	37	51	67	86	107	155	212	278
1,000,000	28	41	57	75	95	118	172	236	309
1,500,000	42	62	85	112	143	178	258	353	464
2,000,000	56	82	113	150	191	237	344	471	618
2,500,000	70	103	142	187	238	296	430	589	773
3,000,000	84	123	170	224	286	355	516	707	927
3,500,000	98	144	198	262	334	414	602	824	1,082
4,000,000	112	164	227	299	381	474	688	942	1,236

23

Quant. Est. Ignitions - example



24

Commentary

Sources of Water: In every large earthquake, underground water mains typically sustain a significant number of breaks, due to the earthquake shaking and, even more so, the failure of the ground in soft soil areas, due to liquefaction, land sliding and other forms of permanent ground failure. The estimation of the residual capacity of the Normal water supply system given these breaks is a complex matter, which the local water agency is best qualified to do. In some jurisdictions, local water agencies have been aware of and responding to this problem (for example, the East Bay Municipal Utility District, EMBUD, which serves Berkeley, has had a major seismic retrofit program). Nevertheless, the potential for all breaks cannot be eliminated, and it should be expected that portions of the Normal water supply will not provide the required firefighting water following the earthquake. Again, which portions will fail and what their impact will be on the remaining capacity is best estimated by the water agency.

Fire departments understand that Normal water supplies may sometimes fail, so that they make contingency plans for Alternative water supplies. The Goals require that both the Normal and the Alternative water supply sources be reviewed, regarding their ability to reliably provide adequate supplies of firefighting water.

However, even if they are adequate to the demands, it is not sufficient to simply identify supplies of water. The Goals require that a Plan be developed that identifies:

- where the likely locations of fires will be, and their growth,
- as each fire grows, from where the required firefighting water will be supplied, and
- how the water will be transported from the source to the fire

The latter aspect is crucial. Under non-earthquake conditions, the typical contingency plan for transporting firefighting water from the source to the fire is a 'relay' system, in which the water is pumped through hose. Because of friction in the hose, the water pressure drops and has to be boosted by 'relay' pumpers placed along the hose line, for example at about 1,000 ft spacing. To move a significant quantity of firefighting water a mile therefore requires perhaps six fire engines, which may all or most of the engines in a jurisdiction - for one fire! If there are several fires, there won't be enough fire engines, and other means have to be found. The Goals call for a Plan to identify what these means are, and annual practicing with them.



25

Initial Feedback

I like it. I'm not sure how to get the cities to buy into a mandated program like this (I guess that it depends on just what is mandated). I see this document being read by two different audiences. Engineers will understand peak acceleration, but fire chiefs will simply nod like they understand and their eyes will soon glaze over. They should understand shaking intensities.

Commentary revised to provide shaking intensities



26

Phase 3

What will still be required:

- Continued support FD/WD community, re adoption
- Technical support
 - Plan Preparation Guidance Document (software?)
 - Implementation of Goals
 - Development of state-wide PWSS (specs...)
 - Consideration of S. Calif. water supply system



27



Thank You

cscawthorn@berkeley.edu

Phase 1 report URLs:

173 pg Report:
http://www.seismic.ca.gov/pub/CSSC_2011-02_WaterSupply_PEER.pdf

4 pager:
http://www.seismic.ca.gov/pub/CSSC_2011_4_PAGER_Water_Supply_PEER_Report.pdf



28

<http://www.seismic.ca.gov/pub.html>

Alfred E. Alquist
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PUBLIC INTEREST

- Frequently Asked Questions
- Mitigation Plan
- Tsunami Information

Publications

Inquiries: Alfred E. Alquist Seismic Safety Commission, 1765 Creekside Oaks Drive Suite 100, 4th floor of charge. For printed copies, make checks payable to: Seismic Safety Commission (see 49 CFR 101.116)

Pub No.	Publication Name
13-02	ShakeOut Recommendations
13-01	2012 Annual Report
12-02	Post-Disaster Rapid Economic Recovery Plan Project
12-01	2011 Annual Report
11-03	4-Page Water Supply in regard to Fire Following Earthquake (PEER)
11-02	Water Supply in regard to Fire Following Earthquake Report (PEER)
11-01	2010 Annual Report



29