

Earthquake Resilience: Building Resilient Communities

Oregon Seismic Safety Policy Advisory Commission

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September 20, 2011



Healthy Cities



Require jobs, heritage, urban planning, progressive governance, sustainability and disaster resilience



Oregon Seismic Safety Policy Advisory Commission

September 20, 2011

PPD-8: Resilience - A Near Term National Issue

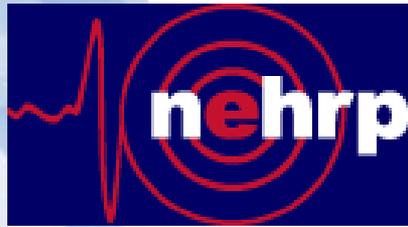


Resilience: *the ability to prepare for, withstand, and rapidly recover from a disruption, and adapt to changing conditions (White House 2010)*

Presidential Policy Directive/ PPD – 8: National Preparedness March 30, 2011

Directs actions to

- *strengthen security and resilience through built and sustained capabilities*
- *to prevent, protect against, mitigate the effects of, respond to, and recover from those threats that pose the greatest risk*
- *Report goals within 180 days*
- *Report systems within 240 days*
- *Annually report progress*



National Earthquake Hazards Reduction Program

Vision :

A nation that is earthquake-resilient in public safety, economic strength, and national security

Earthquake Resilient Communities

Requires a Holistic Approach

- **Physical Resilience** is the foundation
- Environmental sustainability is a parallel goal
 - eliminate the deconstruct/reconstruct cycle.
- Integrated with urban design
- Supportive of Social issues
- Conscience of Institutional and governance constraints
- Supported by new financial mechanism and incentives

Earthquake Resilient Communities

Physical Resilience

- Credible Disaster Response Plan that includes continuity of operations
- A place, ability and procedures to govern
- Building and lifeline design standards that support continuity and recovery
- Repair standards for reconstruction

How Much Damage Can a City Endure?



Haiti - 2010



Katrina - 2005



Chile - 2010



L'Aquila - 2009



SAN FRANCISCO
PLANNING + URBAN RESEARCH
ASSOCIATION



The Resilient City:

*Defining what San Francisco needs from its
seismic mitigation policies for three phases*

Before the Disaster, Response, Recovery



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Seismic Mitigation Task Force

Urban Planners:	<u>Laurie Johnson</u> , George Williams
City Officials:	Laurence Kornfield, Hanson Tom, Debra Walker
Public Policy Makers:	<u>Sarah Karlinsky, Laura Dwelley-Samant, Tom Tobin</u>
Engineers:	Chris Barkley, David Bonowitz, Joe Maffei, Jack Moehle, Robert Pekelnicky, Chris Poland
Labor:	Michael Theriault
Developers:	John Paxton, Ross Asselstine
Economist:	Jessica Zenk
Contractor:	Jes Penderson
PG&E:	Kent Ferre

A unique gathering of Earthquake professionals and Stakeholders



Oregon Seismic Safety Policy Advisory Commission

September 20, 2011

Approach:

- Define concept of **resilience** in the context of disaster planning and recovery, not a measure of the status
- Establish **performance goals** for the physical infrastructure for the “**expected**” earthquake that supports the definition of resilience
- Define transparent **performance measures** that help reach the performance goals

Performance Goals for the “Expected” Earthquake

Phase	Time Frame	Condition of the built environment
I	1 to 7 days	Initial response and staging for reconstruction
II	7 to 60 days	Workforce housing restored – ongoing social needs met
III	2 to 36 months	Long term reconstruction

Lifelines and workforce are the key elements

Transparent Hazard Definitions

Category	Hazard Level
Routine	Likely to occur routinely in San Francisco (M = 5.0, 50/50)
Expected	Reasonably expected to occur once during the useful life of a structure or system (M= 7.2, 10/50, 500)
Extreme	Reasonably be expected to occur on a nearby fault (M=7.9, 2/50, 2500)

Transparent Performance Measures for Buildings

Category	Performance Standard
Category A	<i>Safe and operational:</i> Essential facilities such as hospitals and emergency operations centers
Category B	<i>Safe and usable during repair:</i> “shelter-in-place” residential buildings and buildings needed for emergency operations
Category C	<i>Safe and usable after repair:</i> current minimum design standard for new, non-essential buildings
Category D	<i>Safe but not repairable:</i> below standard for new, non-essential buildings. Often used as a performance goal for existing buildings .
Category E	<i>Unsafe – partial or complete collapse:</i> damage that will lead to casualties in the event of the “expected” earthquake - the killer buildings

What is Safe?

What is Useable?



Observed Damage
L'Aquila, Italy
May 2009

ATC 20 Tagging

Green tag – May be used for continuous occupancy

Yellow tag – Safe enough to remove contents and do repair work

Red tag – Unsafe for entry during aftershock sequence

ATC 20 Criteria for Continued Occupancy

Noticeable leaning

Beams or girders shifted on their supports

Floors and roofs pulled away from their supports

Lateral loads system badly damaged

Nails on plywood walls withdrawn

Severe concrete damage – cracks over 3/8", rebar exposed,
concrete fallen away

Braced steel frames buckled

Exterior facade unstable – falling away

Transparent Performance Measures for Lifelines

Category	Performance Standard
Category I	Resume 100% service within 4 hours
Category II	Resume 90% service within 72 hours 95% within 30 days 100% within 4 months
Category III	Resume 90% service within 72 hours 95% within 30 days 100% within 3 years

Target States of Recovery for Building & Infrastructure

Phase	Time Frame	Focus of Attention
I	1 to 7 days reconstruction	Initial response and staging for

*EOC's,
City Buildings,
Hospitals,
Police and Fire Stations,
Shelters*



Peter O Kohler Pavilion

Building Category A: "Safe and Operational"

Life Line Category I: "Resume essential service in 4 hours"

Target States of Recovery for Building & Infrastructure

Phase	Time Frame	Focus of Attention
II	7 to 30 days	Workforce housing restored – ongoing social needs met

*Residential structures,
Schools,
Community retail centers,
Doctors offices*



Building Category B: “Safe and usable while being repaired”

Life Line Category II: “Resume 100% workforce service within 4 months”

Target States of Recovery for Building & Infrastructure

Phase	Time Frame	Focus of Attention
III	2to 36 months	Long term reconstruction

Industrial Buildings

Commercial buildings

Historic buildings



Building Category C: “Safe and usable after repair”

Life Line Category III: “Resume 100% commercial service within 36 months”

Target States of Recovery for San Francisco's Building & Infrastructure

TARGET STATES OF RECOVERY FOR SAN FRANCISCO'S BUILDINGS AND INFRASTRUCTURE									
INFRASTRUCTURE CLUSTER FACILITIES	Event occurs	Phase 1 Hours			Phase 2 Days		Phase 3 Months		
		4	24	72	30	60	4	36	36+
CRITICAL RESPONSE FACILITIES AND SUPPORT SYSTEMS									
Hospitals								X	
Police and fire stations			X						
Emergency Operations Center	X								
Related utilities						X			
Roads and ports for emergency				X					
CalTrain for emergency traffic				X	X				
Airport for emergency traffic				X					
EMERGENCY HOUSING AND SUPPORT SYSTEMS									
95% residence shelter-in-place								X	
Emergency responder housing				X					
Public shelters							X		
90% related utilities								X	
90% roads, port facilities and public transit							X		
90% Muni and BART capacity						X			

Phase I

TARGET STATES OF RECOVERY

Performance measure	Description of usability after expected event
	BUILDINGS LIFELINES
	Category A: Safe and operational
	Category B: 100% restored in 4 hours during repairs
	Category C: 100% restored in 4 months after moderate repairs
	Category D: 100% restored in 3 years after major repairs
	Expected current status

Note: Categories A–D are defined on page 10.

Target States of Recovery for San Francisco's Building & Infrastructure

Phase II

TARGET STATES OF RECOVERY FOR SAN FRANCISCO'S BUILDINGS AND INFRASTRUCTURE									
INFRASTRUCTURE CLUSTER FACILITIES	Event occurs	Phase 1 Hours			Phase 2 Days		Phase 3 Months		
		4	24	72	30	60	4	36	36+
		HOUSING AND NEIGHBORHOOD INFRASTRUCTURE							
Essential city service facilities							X		
Schools							X		
Medical provider offices								X	
90% neighborhood retail services									X
95% of all utilities								X	
90% roads and highways							X		
90% transit							X		
90% railroads								X	
Airport for commercial traffic						X			
95% transit							X		

TARGET STATES OF RECOVERY

Performance measure	Description of usability after expected event
	Category A: Safe and operational
	Category B: 100% restored Safe and usable in 4 hours during repairs
	Category C: 100% restored Safe and usable in 4 months after moderate repairs
	Category D: 100% restored Safe and usable in 3 years after major repairs
	Expected current status

Note: Categories A–D are defined on page 10.

Target States of Recovery for San Francisco's Building & Infrastructure

Phase III

TARGET STATES OF RECOVERY FOR SAN FRANCISCO'S BUILDINGS AND INFRASTRUCTURE										
INFRASTRUCTURE CLUSTER FACILITIES	Event occurs	Phase 1 Hours			Phase 2 Days		Phase 3 Months			
		4	24	72	30	60	4	36	36+	
COMMUNITY RECOVERY										
All residences repaired, replaced or relocated										X
95% neighborhood retail businesses open									X	
50% offices and workplaces open										X
Non-emergency city service facilities									X	
All businesses open										X
100% utilities										X
100% roads and highways										X
100% travel										X

Source: SPUR analysis

TARGET STATES OF RECOVERY

Performance measure Description of usability after expected event

BUILDINGS LIFELINES

 **Category A:** Safe and operational

 **Category B:** 100% restored Safe and usable in 4 hours during repairs

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 Expected current status

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Achieving Resilience

New Buildings

- Establish seismic performance targets for new buildings that allow us to recover quickly.
- Make improvements to the Building Code to provide cost-effective improvements in seismic performance.
- Declare the expected seismic performance that will be achieved by the current Building Code.
- Develop optional code provisions for Seismic Silver and Gold to quantify improved seismic performance.
- Develop strong incentives related to taxes, fees, zoning, or planning that encourage building to higher seismic standards.



Achieving Resilience

Existing Buildings

- Retrofit or redundancy for designated shelters.
- Mitigation program for essential city services.
- Mitigation program for un-reinforced masonry buildings
- Mitigation program for critical non-ductile concrete buildings.



Achieving Resilience

Lifelines

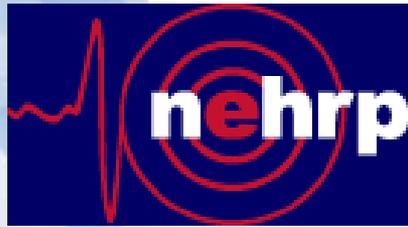
1. Establish a “Lifelines Council” to provide a mechanism for comprehensive planning.
2. Conduct a seismic performance audit of lifelines in the region and establish priorities for lifeline mitigation.
3. Establish partnerships with regional, state and private sector entities to address multi-jurisdictional and regional systems.



Need New Design Codes and Standards

Requires a Transparent Approach

- Next generation hazard definitions
 - Expected earthquake for building resilience
 - Extreme earthquake for lifelines and building safety
- New Vocabulary to describe damage in terms of response and recovery
 - Describe in terms of safety and usability
- Performance Objectives to support resilience
 - Add an intermediate “shelter-in-place” goal
- Mandatory mitigation, but only as needed



National Earthquake Hazards Reduction Program

2009-2013 Strategic Plan

Vision : A nation that is earthquake-resilient in public safety, economic strength, and national security

2011 NRC Report

**National Earthquake Resilience,
Research, Implementation, and Outreach**



National Earthquake Hazards Reduction Program

Vision : A nation that is earthquake-resilient in public safety, economic strength, and national security

Advisory Committee on Earthquake Hazards Reduction

- Established in 2004 to assess
 - Trends and Developments
 - Effectiveness of NEHRP
 - Need to Revise NEHRP
 - The management, coordination, implementation activities



National Earthquake Hazards Reduction Program

Advisory Committee on Earthquake Hazards Reduction

Walter Arabasz

Jon Bray

Jim Harris

Mike Lindell

Chris Poland (Chair)

Anne vonWeller

Brent Woodworth

Jim Beavers

Richard Eisner

John Hooper

Tom O'Rourke

Susan Tubbesing

Yumei Wang



National Earthquake Hazards Reduction Program

Achieving National Disaster Resilience through Local, Regional, and National Activities

A White Paper for the White House Senior Director for Resilience Policy

www.nehrp.gov



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September 20, 2011

Achieving National Disaster Resilience through Local, Regional, and National Activities

A White Paper
Advisory Committee on Earthquake Hazards Reduction
National Earthquake Hazards Reduction Program

Terrorist attacks, earthquakes, and other natural hazards pose a serious threat to our society at the national, regional, and local levels. These events threaten our people, our physical infrastructure, our economy, and our national security.

The National Earthquake Hazards Reduction Program (NEHRP) has been committed since its inception in 1977 to protecting lives through pre-event planning and mitigation of risks. Many tools, such as seismic monitoring and mapping, building code development, risk mitigation, and emergency preparedness provide a solid framework for community development and disaster planning. Yet, serious gaps exist. For example, the vast majority of the existing physical infrastructure was constructed to inadequate standards, well below current standards for new construction; even the new standards focus on life safety and are not sufficient to achieve resilience. Most buildings will suffer costly damage in a major earthquake, and critical lifelines (e.g., highways, ports, water supply systems, electricity grids, and telecommunications networks) will not provide their intended services immediately after such an earthquake.

Disaster-resilient communities must have credible response plans that include places and abilities to govern after a major disaster. Power, water, and communication systems need to resume operations shortly after a disaster. Residents need to be able to stay in their homes, travel to where they need to be, and resume fairly normal living routines within weeks, so they can restore their community within a few years.

The NEHRP Advisory Committee on Earthquake Hazards Reduction (ACEHR) participated in a discussion regarding disaster resilience with the White House Senior Director for Resilience Policy at the committee's November 23, 2009 meeting at the National Science Foundation in Arlington, VA. Consistent with that discussion, the ACEHR provides this white paper to summarize briefly the committee members' views about earthquake disaster resilience: current conditions, needs for fundamental changes, and recommendations for future actions.

Current Status of the Nation with regard to Disaster Resilience

While the contemporary national model building code has been adopted by some communities in every state and is effective for safeguarding life and protecting first responders, state and local adoption is neither universal nor comprehensive. There is an enormous diversity in the way codes are implemented that range from full enactment, to limited adoption, to areas that strip out disaster-resilience provisions, to communities that actually prohibit the application of building codes to homes. Building codes are of little use if they are not adopted and enforced by well-qualified building departments and their inspectors.

Furthermore, a major earthquake striking a U.S. city that was constructed in full compliance with current building codes would cripple the city's ability to recover quickly, because its buildings and lifeline systems have not been designed for post-disaster performance. They have only been designed to safeguard life, and, in some cases, support emergency response.





Achieving National Disaster Resilience

- NEHRP has provided many tools
 - Seismic monitoring and mapping
 - Building code development
 - Risk mitigation
 - Emergency preparedness
- Serious gaps still exist
 - Existing physical infrastructure is inadequate
 - Building standards are not sufficient to achieve resilience
 - Critical lifelines will not provide needed services



Achieving National Disaster Resilience

- Current Status of the nation with regard to Resilience
 - Code adoption is neither universal nor comprehensive
 - Enormous diversity exists in how model codes are adopted and enforced
 - Even with full compliance, current codes would not provide resilience.
 - Codes are designed to safeguard life and support emergency response
 - Codes do not provide for post-disaster performance
 - There is no such thing as a fully compliant city



Achieving National Disaster Resilience

- Change is needed
 - Resilience starts locally and encompasses the built environment along with the socioeconomic and cultural needs
 - National Resilience can not be achieved with out supporting local measures
 - Cities need to be empowered and funded to build resilience neighborhood by neighborhood
 - Develop human infrastructure for response and recovery
 - Plan for effective lifeline response
 - Advance building standards to a resilience level
 - Eliminate “killer buildings”



Achieving National Disaster Resilience

- Unified support is required from all levels of government
 - Federal Government
 - Set performance standards for all construction
 - Insist that states adopt and enforce the codes
 - Provide financial incentives to stimulate mitigation
 - Support research that leads to cost effective mitigation, response, and recovery



Achieving National Disaster Resilience

- Unified support is required from all levels of government
 - State and local governments
 - Identify and mitigate regional lifeline system vulnerabilities
 - Local Governments
 - Adopt and enforce appropriate Building codes
 - Current Expand preparedness planning
 - Develop mandatory mitigation programs

Creating Earthquake Resilience

- **Craft a Mitigation Program**
 - New generation of national codes and standards based on expanded research
 - Develop mandatory, incentive driven, encouraged, and voluntary rehabilitation programs based on resilience.
 - Development of resilient state and national networks of lifelines.
 - Strengthen adoption and enforcement
- **Refine Emergency Response planning**
 - Add neighborhood response ability including posting.
- **Plan for Recovery**
 - Set goals for livable-sustainable cities.
 - Develop plans for governance