SEISMIC REHABILITATION OF EXISTING BUILDINGS IN OREGON

Report to the Sixty-Ninth
Oregon Legislative Assembly

September 30, 1996

Seismic Rehabilitation Task Force
Created by Senate Bill 1057

**"No, but I'll tell you,
I'd rather be in L.A. when it [the big earthquake] hits
than in Portland because,
relatively speaking, they are not prepared at all."**
—Richard Eisner, California Office of Emergency Services,
quoted in *Rolling Stone*, August 8, 1996

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September 30, 1996

The Honorable John Kitzhaber
Governor of Oregon
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Salem, OR 97310

The Honorable Gordon H. Smith
President of the Senate of the State of Oregon
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The Honorable Bev Clarno
Speaker of the House of Representatives of the State of Oregon
269 State Capitol
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Subject: Senate Bill 1057

Senate Bill 1057, passed in the 1995 Legislative Session, directed the Governor and State Geologist to appoint a Seismic Rehabilitation Task Force, asking that they address a series of issues related to the rehabilitation of existing buildings for protection against possible seismic events. The Task Force was requested to make recommendations to the Legislature by September 30, 1996. The attached report is being submitted in response to that directive.

The 13-member Task Force began its work in the fall of 1995 and reviewed efforts already underway by a similar Task Force in Portland (Bureau of Buildings, Task Force on the Seismic Strengthening of Existing Buildings). The Task Force has also drawn upon experience with seismic rehabilitation being conducted both nationally and in other states, particularly California. The recommendations contained in the report reflect wide public comment which was offered in response to a draft report that was issued for comment in May 1996 and public meetings that were held throughout the state.

The conclusions of the Task Force are reflected in the Findings, which are found in Section III of the report.

The following summarizes our principal recommendations:

1. Oregon should adopt a long-term goal that would achieve rehabilitation of unreinforced masonry (URM) buildings, those considered to be the most dangerous, within 30 years of the adoption of these measures. All other buildings should be rehabilitated within 70 years.
2. A statewide inventory of all buildings covered by these recommendations should be conducted and completed by July 1, 2004. This inventory is necessary to fully understand the scope of the problem, to establish a baseline against which progress can be measured, and to identify buildings requiring mandatory corrective actions. The inventory should be conducted under the direction of the Building Codes Division and is estimated to cost approximately $1.7 million.

3. A mandatory seismic strengthening program should be adopted for those facilities considered to be most critical, in particular:
    a. Parapets, signages, and other appendages that could create a falling hazard in the event of an earthquake should be repaired within 15 years of notification through the statewide inventory. These appendages have historically represented one of the major seismic risks.
    b. All URMs that are "Essential and Hazardous" should be rehabilitated by July 1, 2019. "Essential" facilities, such as fire and police stations and emergency communications centers, are needed immediately after any major emergency to provide essential services. "Hazardous" facilities are those housing hazardous or toxic materials that could create a significant public health risk if released during a seismic event.
    c. A program for rehabilitation of hospitals is also proposed, given the critical role hospitals play following a major emergency. The proposed program is based upon recommendations from the Hospital Coalition which also worked with the City of Portland Seismic Task Force.
4. The Task Force also proposes language to clarify existing statutes governing requirements for retrofit following a seismic event.
5. All other buildings should be rehabilitated through a set of "passive triggers"; that is, actions within the control of the owner that would "trigger" a need to make seismic upgrades. These triggers would fall into three categories:
    a. Changes in use that increase the occupancy risk; or
    b. Renovations that are substantial relative to the value of the building; or
    c. Renovations or building additions that weaken the existing structure.
6. To encourage rehabilitation and facilitate these recommendations, the following incentives should be adopted:
    a. A tax credit (a statewide incentive) equal to 35% of the investment for seismic rehabilitation that would carry forward for ten years and be retroactive to 1993, the year the seismic zone requirements were increased; and
    b. A property tax abatement (a local incentive), also equal to 35% of the seismic rehabilitation investment. This proposal is modeled after programs that have successfully been used for historic buildings.
7. Public and private schools as well as all other public agencies that own buildings would be required to:
    a. Inventory their buildings;
    b. Identify exempt and nonexempt buildings within the parameters suggested by the Task Force;
    c. Classify buildings according to use;
    d. Select buildings to be evaluated;
    e. Estimate rehabilitation costs; and

f. Develop plans for seismic rehabilitation in cooperation with local building officials.

g. This information should be provided to the Oregon Department of Geology and Mineral Industries (DOGAMI) by January 1, 2004.

8. DOGAMI should be authorized and directed to oversee the implementation of this program and make bi-annual reports of progress to the Legislature. In addition, DOGAMI should prepare a comprehensive report of the progress being made and report to the Legislature by January 1, 2005. This report should include an assessment of the progress being made to achieve the long-term goals proposed by the Task Force and recommendations for program adjustments if necessary.

Recommendations are also included in the report to address historic buildings, quality control of geotechnical reports, liability issues, public education, the need for a structural engineering specialty license, and standards for rehabilitation. The Task Force did not offer proposals for upgrading infrastructure such as bridges and highways and made only limited comments concerning issues related to tsunamis.

Costs associated with this program are addressed in Section V of this report. The principal impacts to the state will be:

1. The costs of conducting inventories ($1.7 million, estimated),
2. Administration (Building Codes Division estimates $445,000 for the 1997-99 biennium; DOGAMI estimates costs at $370,000 for the same biennium),
3. The cost to the State of offering a tax credit for seismic investments (these costs have not yet been estimated), and
4. The actual costs of rehabilitating State buildings. Without an existing inventory, those costs are unknown, although estimated costs for conducting a seismic evaluation and subsequent rehabilitation are provided on a per square foot basis.

These recommendations are intended to assure that the people of the State of Oregon are protected from the potential of a seismic event. Therefore, as reflected in Finding No. 5, a standard of life safety is recommended as these proposals are implemented. While further upgrades which could provide protection against economic loss may, in many cases, be the wisest course of action, the Task Force did not recommend that such upgrades be required.

We believe these proposals address the concerns outlined in SB 1057 and respectfully submit them for your consideration. The Task Force will be available to offer additional information or other testimony as legislation adopting these measures is considered.

Sincerely,

Paul G. Lorenzini

Chair, Seismic Rehabilitation Task Force

SIGNATURE SHEET

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David Bugni	8/21/96	Matthew Mabey	8/26/96
Michael Cliburn	8/21/96	Ronald McMillan	8/21/96
Peggy Collins	8-21-96	Thomas Sjostrom	8/21/96
Dennis Hellesvig	8/21/96	John Tess	8/21/96
Dell Isham	8/21/96	Rob Theodorson	8/21/96

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Paul G. Lorenzini, Chair, Senior Vice President, PacifiCorp, Portland, representing the public

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ACKNOWLEDGMENTS

The Task Force wishes to express its appreciation to the following organizations and individuals for their assistance in the work of the Task Force and preparation of this report:

- The Oregon Department of Geology and Mineral Industries, including staff members Angie Karel, Executive Assistant, for staff support; and Beverly F. Vogt and Klaus K.E. Neuendorf, for editing and preparing this report.

- The City of Portland Bureau of Buildings, including staff members Margaret Mahoney, Director, and Michael Hagerty, Chief Engineer, for encouragement and support; and Jane Hawkes, Project Coordinator, and Cathie Carlisle, Program Coordinator, for staff support.

- The many individuals and organizations who offered advice and comments, particularly Ugo Morelli, Federal Emergency Management Agency (FEMA); Diana Todd, formerly of the National Institute of Science and Technology; Cynthia Hoover, Seattle Department of Construction and Land Use; and Bill Elliott, Portland Water Bureau.

- PacifiCorp, for printing the draft report; and the City of Portland Bureau of Buildings, for printing the final report.

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SEISMIC REHABILITATION OF EXISTING BUILDINGS IN OREGON

I. BACKGROUND

Oregon has not been historically viewed as a state with high seismic risks. As a result, most existing buildings were constructed under codes that did not provide significant seismic protection. As seismic risks have become better understood, concern for seismic safety has increased.

Since the adoption of the Uniform Building Code in 1974 as the state building code (called the Oregon Structural Specialty Code), seismic design criteria for buildings in Oregon have gradually evolved to higher standards. In 1974, the entire state was Seismic Zone 2. Because of new scientific data, in 1988, the entire state was reclassified by the International Conference of Building Officials (ICBO) as Seismic Zone 2B. This change was adopted in the Oregon Structural Specialty Code in 1990. More recently, in 1993, the classification for western Oregon was changed as an Oregon amendment from Seismic Zone 2B to Seismic Zone 3 (see Figure 1). The change from Seismic Zone 2B to 3 means that new buildings in western Oregon are now being constructed to higher standards to protect building occupants from earthquake hazards. Figure 2 shows the relation of building code changes to forces produced by earthquakes for a hypothetical building. (See Appendix A for more detailed description of earthquake legislation in Oregon.)

With the adoption of these higher standards, serious questions have been raised about the safety of older buildings. Since they were not designed to the current code requirements, what risks exist to occupants in the event of an earthquake? What standards should be followed in upgrading buildings? Should mandatory building upgrades be required? What costs are involved, and what incentives should be offered to offset them?

Recent earthquakes elsewhere in the world have shown the importance of appropriate building design. Both the 1994 Northridge, California, and the 1995 Kobe, Japan, earthquakes were crustal earthquakes with magnitudes less than 7. Due to California's long history of earthquake resistant building requirements, only 57 lives were lost in the Northridge earthquake, with $30 billion of damage. In the case of Kobe, however, which was severely damaged during World War II and rebuilt quickly before Japan's stringent modern building codes were in place, over 5,000 people lost their lives, and damage is estimated at over $100 billion. These differences in numbers of deaths and amounts of damage may indicate what could happen in Oregon if serious consideration is not given to the appropriate seismic design of buildings.

The State of Oregon has limited authority within the existing statutes to require upgrades to existing buildings even if they are determined to be unsafe. Local jurisdictions have the authority to adopt dangerous building codes that give local authority to require seismic upgrades, and some have adopted them. In the case of Portland, however, raising the seismic zone was interpreted to make a large number of buildings dangerous within the definition of local ordinances. For this reason, the City of Portland Task Force on Seismic Strengthening of Existing Buildings (called the Portland Seismic Task Force hereafter in this report) amended the Portland Dangerous Building Code to remove the link between it and the seismic provisions of the State Building Code and replaced the link with an interim seismic ordinance.

The existence of a safety hazard to Oregonians caused by buildings that are inadequately designed, the significance of the costs associated with building rehabilitation, the need for incentives to offset costs, and the lack of guidance within existing codes all surfaced as issues in the last session of the Legislature. The result was Senate Bill 1057 (Appendix B), which created this Task Force and which requested that it review these issues and make recommendations to the Legislature by September 30, 1996.

See discussion of earthquakes in Appendix C for detailed information about why earthquakes occur in Oregon, where they have happened in the historic past, and where and how often they are most likely to occur in the future.

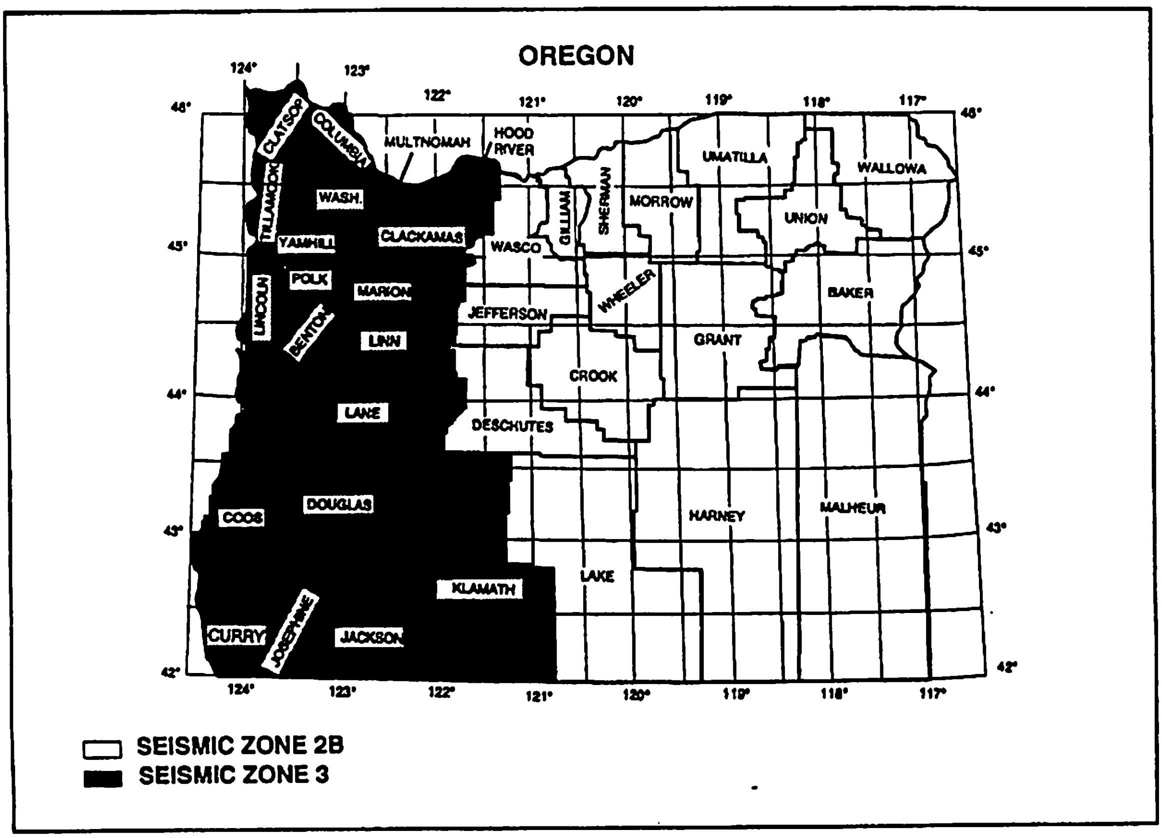

Figure 1. Seismic zone map of Oregon after 1993.

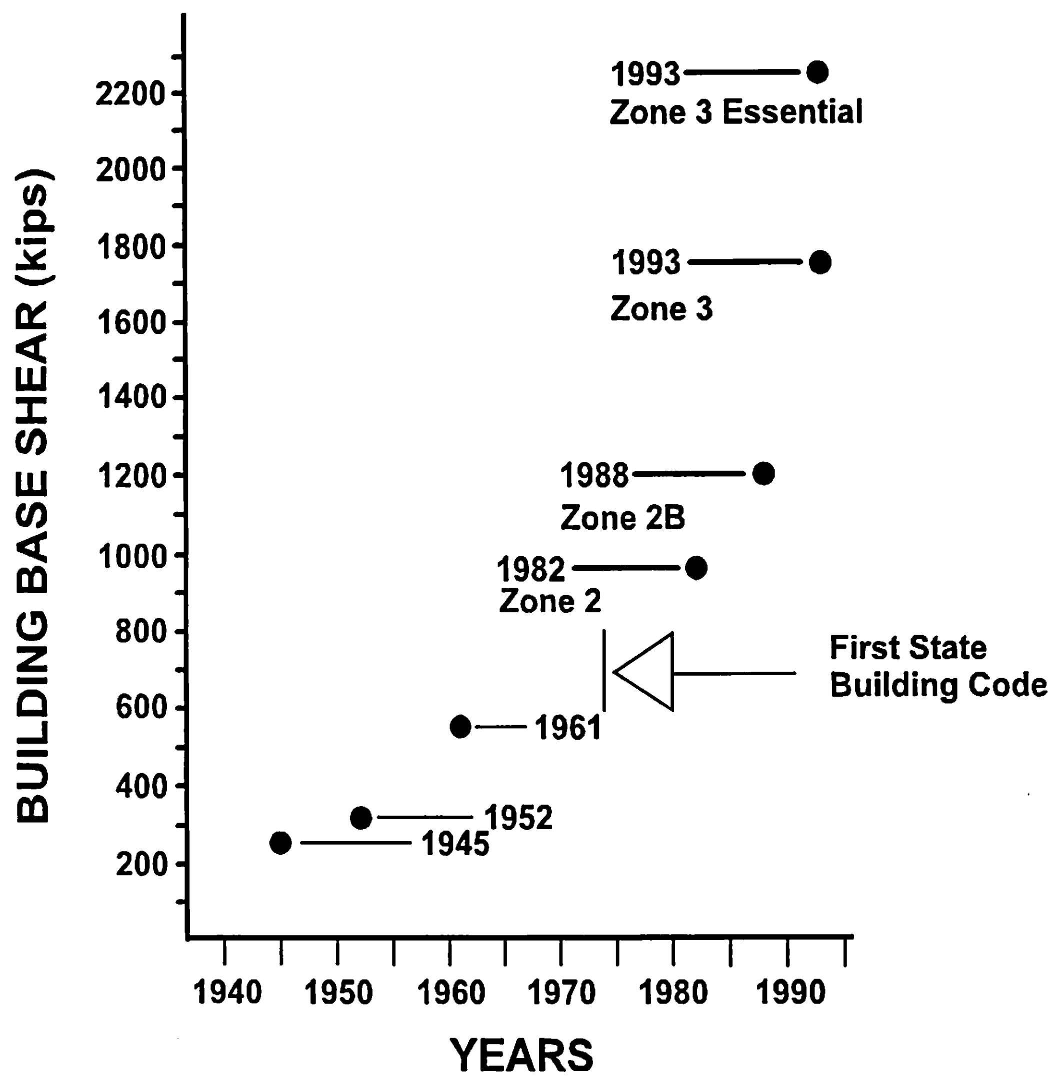

Figure 2. This figure shows how design forces for earthquakes have changed with building codes for a typical mid-rise building with a seismic base shear of approximately 1,000 kips. 1 kip = 1,000 lbs. Base shear is the total lateral (either seismic or wind) force or shear at the base of a structure. The graph indicates how much the forces to which buildings have been designed to withstand earthquakes have gone up over the years. It also shows why buildings constructed under different codes vary in their ability to withstand earthquakes. This figure was produced by Grant Davis, KPFF Consulting Engineers, and made available to the Task Force by Dr. Franz Rad, Department of Civil Engineering, Portland State University.

II. TASK FORCE PROCESS

The names of members of the Task Force are listed in the front of this report. The Task Force includes representation from major communities, private interests, State agencies, and the general public.

The Task Force and various subcommittees held public meetings between October 31, 1995, and August 21, 1996. Dates and locations of these meetings, names of invited speakers, and other details of the process followed by the Task Force are listed in Appendix A. The Task Force drew upon existing information, much of which was developed in California as well as by the Federal Emergency Management Agency (FEMA) and by the Portland Seismic Task Force.

Based on information gathered throughout this process, other data as indicated in the body of the report, and experience from within the Task Force, a draft report was prepared and printed. Copies were distributed to 41 public libraries for public viewing and to 200 people or organizations for comment. A press release announcing the report was sent to newspapers around the state. In addition, over 600 interested persons received written notification of the report's availability. Written comments were submitted by various interested persons and groups and supplemented by input at public meetings held in Portland, Salem, Eugene, Newport, and Klamath Falls (see Appendix A for a list of people and organizations who submitted written and oral comments). The Task Force considered the comments, held further deliberations, and developed its final recommendations, which are presented in this report.

The findings and recommendations presented in this report reflect the views of the entire Task Force. Task Force members were invited to add any qualifying comments if they wished to do so, and an additional statement from one Task Force member has been included in Appendix A.

III. FINDINGS

1. Oregon has a large number of buildings which are unsafe because they were not built to withstand earthquakes that can be expected to occur in the state.

2. The life safety risk varies widely depending upon the building type and local soil conditions. Rehabilitation policies should emphasize the identification and rehabilitation of buildings and building features posing the greatest life safety risks.

3. Information on the current building inventory is not adequate to identify buildings that are most hazardous, to reliably assess total rehabilitation costs, and to establish appropriate benchmarks.

4. Current Oregon law does not give authority to State agencies to mandate the rehabilitation of existing buildings unless they are damaged by a seismic event or changes are made to the occupancy or building structure.

5. The standard or seismic performance objective for rehabilitation of existing buildings should be life safety unless a higher standard, such as that of immediate occupancy, is required to achieve other public safety goals. Examples of such goals include the operation of emergency facilities following an earthquake and assurance that facilities housing hazardous and toxic materials are secure.

6. Seismic risks increase in proportion to the time period over which the exposure to the associated hazard occurs. The probability of a seismic event occurring in a particular year is relatively small. The risk increases as the years of exposure increase. Public policies requiring seismic rehabilitation of existing buildings should be directed toward time periods that are consistent with these risks.

7. An education program is needed to raise public awareness of seismic risk.

8. Costs of rehabilitation are significant, and incentives are needed to offset costs associated with rehabilitation requirements.

9. Benchmarks and performance measures will be needed to direct policies and monitor progress.

10. On-going oversight and monitoring of seismic rehabilitation programs are needed. Seismic rehabilitation policies should be reviewed for effectiveness after inventories of existing buildings have been completed and experience has been gained with rehabilitation proposals outlined in this study.

11. The State of Oregon will need to adopt statewide standard methodologies for conducting seismic evaluations and engineering standards for determining needed rehabilitation actions. These methodologies and standards are needed to assure consistency and to achieve seismic rehabilitation policy objectives.

12. Appropriate methodologies and standards for the seismic rehabilitation of existing buildings that are emerging on a national level can be effectively applied in Oregon.

13. Implementation actions should be sufficiently flexible to accommodate the continuing evolution of nationally accepted practices and standards for seismic rehabilitation of older structures.

14. Many buildings that would be affected by seismic rehabilitation are historic buildings. Provisions that are adopted should have enough latitude so that the historic buildings can be preserved and life safety maintained.

15. Consistent qualification standards are needed for persons supplying structural engineering expertise relating to seismic design and rehabilitation.

16. Legislative changes will be required to implement many of the proposals in this study.

IV. RECOMMENDATIONS: A PROPOSED PROGRAM FOR THE SEISMIC REHABILITATION OF EXISTING BUILDINGS IN OREGON

A. Oregon should adopt the following long-term goals for its seismic rehabilitation program:

1. All unreinforced masonry (URM) buildings should be seismically rehabilitated within 30 years of the adoption of these recommendations.

2. All other buildings should be seismically rehabilitated within 70 years.

- **Definition of URM building:** A URM building is one constructed of masonry walls with little or no reinforcement. Common types of masonry are fired clay brick, hollow clay tile, unfired clay adobe, concrete block, and stone.

- **Why URM buildings are emphasized in these proposals:** URM buildings are the buildings that have historically posed the greatest life safety risk during earthquakes. Life-threatening URM building collapses or partial collapses have occurred in virtually every U.S. earthquake of magnitude 6 or greater as well as in earthquakes in other parts of the world (Figures 3 and 4). For this reason, URMs have been the focus of seismic rehabilitation actions in California for several years. The Klamath Falls and Scotts Mills earthquakes of 1993 demonstrated that URMs in Oregon are also a threat to life safety (Figure 5). URMs are hazardous for these reasons:

    1. **They have relatively low strength.** Unreinforced masonry is a strong material for compressive loads, such as those placed on it by floors and roofs; however, masonry is brittle and weak when under tension loads, such as those produced by an earthquake. When masonry walls are shaken or twisted during an earthquake, they develop tensile stresses that crack and weaken the masonry.

    2. **They are often inadequately tied together.** When a URM building is subjected to strong ground shaking, separate components such as walls that are not adequately tied to the rest of the structure can pull apart from the building, and the building can collapse.

    3. **URM buildings often have parapets and attachments such as signs that collapse onto streets below during earthquakes.** In many cases, the attachments holding parapets, signs, and other types of ornamentation are weak or have been weakened over time and during an earthquake can fail, creating a falling hazard.

- **Rationale for timeline:** The experiences of other jurisdictions with establishing timelines for seismic rehabilitation are described in Appendix D.

California, much of which is in Seismic Zone 4, has become increasingly aggressive in its seismic rehabilitation program, with most local jurisdictions mandating rehabilitation of URMs within 15 years. California has had sufficient experience with earthquakes to heighten public concerns and justify these actions.

Figure 3. This URM building was damaged in the Northridge, California, earthquake of January 17, 1994. This hotel was located 20 miles west of the epicenter of the earthquake. Only the first story of the hotel had been seismically rehabilitated, and during the earthquake, the upper walls fell outward. Photo by Richard Klingner, University of Texas, and made available to the Task Force courtesy of the Earthquake Engineering Research Institute (EERI).

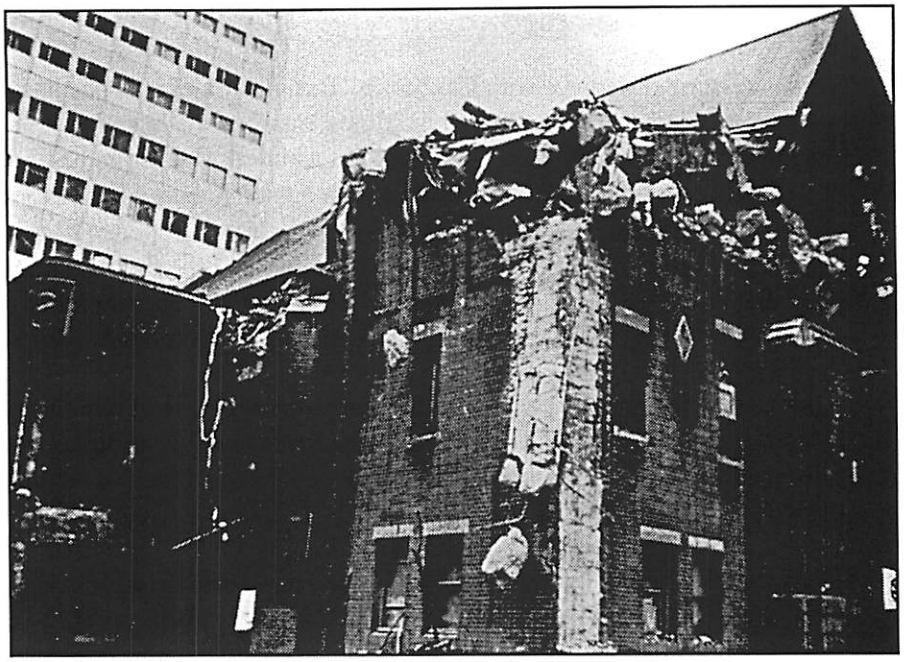

Figure 4. Damage to a URM church in the January 17, 1995, earthquake in Kobe, Japan. Photo courtesy Japan Society of Civil Engineers, from their collection entitled "Records of the 1995 Great Hanshin-Awaji Earthquake Disaster."

Figure 5. Photo of damage to Molalla High School, Oregon, from the Scotts Mills earthquake of 1993. Bricks from the URM gable over the doorway fell on the steps and sidewalk during the earthquake.

There is another difference with California. Because California has had large earthquakes which have damaged or collapsed buildings, many of the higher risk buildings in the existing stock have already been eliminated. In addition, California has been addressing seismic building design in new construction to a higher standard (Zones 3 and 4) for several years. Therefore, the existing building stock is already better equipped to withstand the forces of an earthquake. This, in part, accounts for the fact that only 57 lives were lost in the Northridge earthquake of 1994. By contrast, Kobe, Japan, experienced over 5,000 fatalities in its 1995 earthquake, indicating the possible risks when large failure potentials exist.

At the Federal level, a 35-year rehabilitation target for Federal buildings was considered during preparation of what eventually became Presidential Executive Order 12941 but was not adopted because of the lack of sufficiently reliable cost data of the program. In Salt Lake City, where the focus has been on public schools, the rehabilitation deadlines range from 5 to 20 years, depending on the perceived risk.

In general, prolonging the time frame heightens the seismic risk. Given this concern and drawing upon the experience noted above, the Task Force believes a 30-year rehabilitation target is appropriate for all URMs in Oregon. Not only is this consistent with the general time frames proposed or adopted elsewhere, it reflects the Task Force's belief that URMs clearly pose the greatest hazard. It is also consistent with the economic life of such buildings where, most generally, a 39-year depreciation schedule is used.

The Task Force is concerned that this time frame for URMs may not be achievable with the proposed program outlined in this report. However, the alternative would be a mandatory rehabilitation program, which was not proposed because of cost uncertainties and equity considerations (see further discussion in Section IV.D). Accordingly, the Task Force is recommending that a review of the progress being made toward these goals be completed and reported to the Legislature by January 1, 2005. This would give sufficient time to complete the inventory proposed in Section IV.C, establish better cost information, and gain experience with rehabilitation rates which would occur under the Task Force proposals. At that time, modifications can be recommended if they appear necessary to achieve the 30-year rehabilitation goal.

A longer goal, 70 years, has been proposed for all other buildings. This goal is based upon the perception that these involve lesser risks and the expectation that this is consistent with the rehabilitation rates that might occur with the proposals made by the Task Force. Progress toward this 70-year goal can also be assessed in the report to the Legislature in 2005.[1]

[1] A timeline for the actions proposed in this report is provided in Appendix E. All dates in this report were derived from that timeline.

B. The following types of buildings are exempt from the seismic rehabilitation program outlined in this report:

1. One- and two-family dwellings and their accessory structures.

2. Agricultural buildings as defined in ORS 455.315.

3. Buildings located on property that is exempt from regulation by the State Building Code such as Federal land and Native American Reservation and Trust Land.

- **Rationale for exemptions:** Mandatory seismic rehabilitation of one- and two-family dwellings was considered by the Task Force. Although social and economic impacts of damage to homes from earthquakes has been significant around the world, the Task Force believes that individual homeowners have the responsibility for protection and safety of their own homes. Homeowners' decisions on whether to rehabilitate or not affect primarily only their family members, whereas seismic rehabilitation of publicly owned buildings, multifamily dwellings, and other larger buildings has a much greater impact on society. For these reasons, the Task Force chose to exempt one- and two-family dwellings from these recommendations and focus instead on the types of buildings that affect a much broader segment of society.

  James E. Russell, Building Codes consultant from Concord, California, who presented information to the Task Force on the importance and cost effectiveness of seismic rehabilitation of homes, indicated a modest investment by homeowners in bolting and bracing will have enormous payback in preventing loss of life and damage to homes during an earthquake. The Task Force believes that a public education program will give homeowners the information they need to make informed decisions about the seismic rehabilitation of their own homes.

  Agricultural buildings and buildings on Federal land and on Native American tribal and treaty lands are exempt from regulation by State Building Codes. At this time, the Task Force recommends such buildings also be exempt from the provisions of the seismic rehabilitation program recommended in this report.

C. A statewide inventory of all nonexempt buildings should be completed by July 1, 2004.

- **Reasons for inventory:** The Task Force was constrained by a lack of information about the existing building stock in Oregon. The Task Force believes that the first step in developing an effective seismic rehabilitation program will require the development of a comprehensive inventory of the existing building stock identifying such things as building types, numbers of buildings that present a hazard, and their locations. Therefore the Task Force is proposing that an inventory be conducted which would:

  1. Determine the magnitude of the problem.
  2. Collect data that will make it possible to estimate the cost of seismic rehabilitation and do realistic cost/benefit analyses.
  3. Identify structures most in need of seismic rehabilitation.
  4. Establish a baseline against which progress in seismic rehabilitation can be measured through benchmarks.
  5. Provide sufficient information to better establish seismic policy for Oregon.

- **Method of conducting inventory:** The City of Portland has conducted a building inventory excluding one- and two-family dwellings, using methods presented in FEMA 154, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook.* The inventory program was expanded by Metro to include all buildings in the Portland metropolitan area and was conducted by Dr. Franz Rad of the Civil Engineering Department of Portland State University, with engineering students doing the actual rapid visual screening of buildings.

  The Task Force proposes that the statewide inventory be directed by the Building Codes Division and that the same technique used in Portland be used for inventorying the existing buildings in the rest of the state. Because the FEMA 154 methodology was used for the Portland building stock, a significant portion of the statewide inventory has already been completed. The inventory can be conducted throughout the state by trained students or other personnel who would travel to outlying communities to conduct the inventories, thereby assuring consistency of information.

  The inventory process should be designed to collect sufficient information to establish benchmarks and performance measures (see Section IV.K).

- **Inventory data storage and maintenance:** It is recommended the data be stored in a geographic information system (GIS) developed and maintained by the State GIS Service Center in the Department of Administrative Services.

- **Notification and appeals process:** The Task Force recommends that through appropriate rulemaking the Building Codes Division establish a notification procedure by which building owners are notified of buildings falling under the mandatory seismic rehabilitation requirements of the proposed program.

  The Task Force also recommends that the Building Codes Division establish an appeals process for situations in which (1) a building is incorrectly identified, (2) a seismic upgrade of a building has already been completed, or (3) for unusual circumstances where it may be appropriate to modify the requirements for evaluation and seismic upgrade of particular buildings. The appeals process should be part of the standards and rules adopted by the Building Codes Division. Information concerning these individual cases should be forwarded with other inventory reports to the State GIS Service Center.

- **Funding for inventory:** The Task Force has recommended the inventory be conducted through a statewide contract under the direction of the Building Codes Division. This reflects several concerns:
  - Requiring local municipalities and State agencies to perform the inventory would have constituted one more unfunded mandate;
  - Performing the inventory as a statewide program gives the greatest assurance that results will be consistent and accurate; and
  - Conducting the inventory through a statewide contract will most likely result in lowest total program costs.

A consequence of this approach is the need to identify a source of funding at the State level. The following options for funding were considered:

1. State General Fund.

2. FEMA hazard mitigation funds used to provide data for an "all hazards" building inventory in the state.
3. A 1.25% surcharge on building permits. The surcharge would be used to fund only the inventory and would end after six years.
4. Surcharge on insurance.

Ideally, State General Funds supplemented by FEMA grant monies could fund the project. Other options that do not distribute the costs as broadly are the 1.25% surcharge on permits for new building construction and the insurance surcharge that would be borne by building owners and those who carry insurance.

D. The Task Force proposes that a mandatory seismic strengthening program be adopted for:

1. Parapets, signages, and other types of building appendages.

2. All essential and hazardous URMs.

3. Hospitals.

4. Buildings damaged by a seismic event.

Legislation authorizing the Building Codes Division of the Department of Consumer and Business Services to develop rules to implement this seismic strengthening should be adopted.

1. **Parapets, signage, and other types of building appendages (M-1)[2]:** Many buildings have parapets, signage, marquees, and other appendages that are attached to the face of the building and not securely fastened to the structural frame. During an earthquake, the attachments can fail, causing the parapets or other appendages to fall, often with portions of walls, onto adjacent buildings or to the pavement below. In California, because parapet collapse has been a major cause of fatalities during earthquakes, special attention has been given to securing parapets. Klamath Falls and Scotts Mills also experienced such failures and damage during their 1993 earthquakes (Figure 6).

   The Task Force recommends that, because of the threat they pose to human life, parapets, signage, and other building appendages except for cornices should be evaluated and rehabilitated by building owners within 15 years of notification after the inventory or, in the case of parapets, when the buildings are being reroofed, whichever comes sooner. Cornices and nonstructural cladding were also considered but were excluded from coverage because reinforcing these structures would be structurally complex, and costs could be significant. See M-1, Table F-1.a, Appendix F, for summary of recommended mandatory standards for seismic evaluation and rehabilitation of parapets and other falling hazards. This is a partial rehabilitation program in that it affects only limited components of a building.

2. **Essential and hazardous URMs (M-2):** Facilities such as fire stations, police stations, and emergency communications centers will be needed immediately after a disaster to provide essential services. In addition, buildings housing hazardous or toxic materials that could spill during an earthquake pose a threat to the entire community. Immediate access to such buildings after an earthquake is essential. Therefore, the Task Force recommends both categories of buildings be evaluated and rehabilitated by July 1, 2019, fifteen years after completion of

[2] Numbers preceded by an "M" are numbers assigned to categories of structures or features that require mandatory seismic rehabilitation.

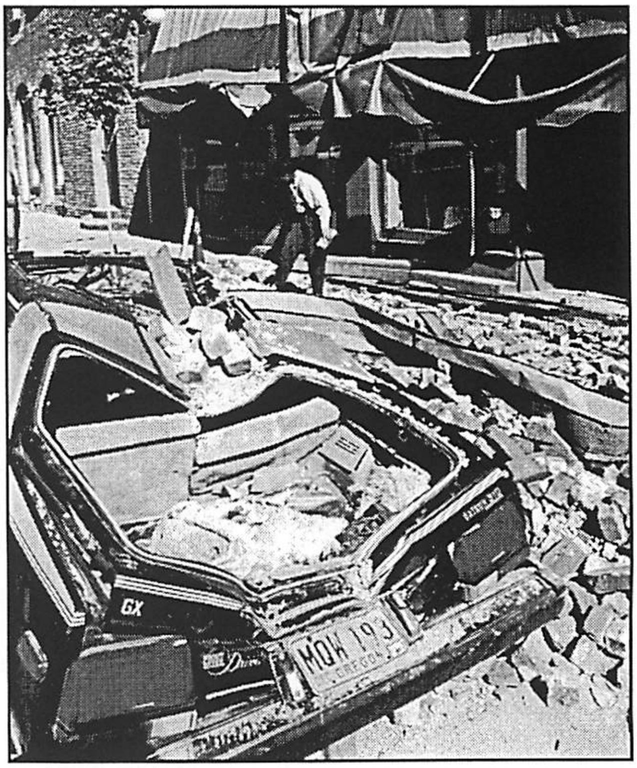

Figure 6. Parapet damage to a URM building in Klamath Falls, Oregon, after the 1993 earthquakes. This parapet fell on a car parked below, destroying it. Lower photo, courtesy Lou Sennick, Herald and News, Klamath Falls. This photo also appeared in Earthquakes and Volcanoes.

the inventory. See M-2, Table F-1.a, Appendix F, for a summary of recommended mandatory requirements for these types of buildings.

Since these requirements are intended to allow immediate access to facilities containing hazardous and toxic materials, the Building Codes Division should include consideration of the nonstructural elements that need to be secured as part of the rehabilitation program in rule development.

3. **Hospitals (M-3):** Hospitals represent a major class of essential facilities since they are needed for emergency treatment immediately after a major catastrophe. Special consideration should be given to any seismic rehabilitation program for hospitals because (1) the services must be provided routinely and without interruption, and (2) they are expensive to remodel and rehabilitate. Moreover, they are regularly upgraded at planned intervals to adapt to changing technology and operational needs. For these reasons, the Task Force consulted with the Hospital Coalition and the City of Portland Seismic Task Force, Seismic Code Subcommittee. Based upon their input, the Task Force recommends adoption of the program described below.

   All hospitals such as those defined by the State Building Code as Occupancy Group I, Division 1, containing surgery or emergency treatment facilities should inventory and conduct seismic evaluations of their buildings within three years of adoption of standards of inventory. The inventory and evaluation should be filed with the Oregon Department of Geology and Mineral Industries (DOGAMI). The necessary seismic rehabilitation should then be completed within 15 years of the date the inventory and evaluation are filed. Attention should also be given to utilities that supply the facilities.

   Under conditions where the time frame causes unworkable scheduling or cost impacts, it is suggested the hospital instead be allowed to file a detailed rehabilitation plan with the local building official and DOGAMI within three years of adoption of standards of the inventory, with phased upgrades over a 25-year period. The plan should demonstrate a committed continuous upgrade effort with early attention to buildings with the highest risk. Hospitals should work with local building jurisdictions to develop acceptable planning for upgrade efforts. See M-3, Table F-1.a, Appendix F, for summary of rehabilitation requirements.

4. **Buildings damaged by seismic events (M-4):** In the wake of the 1993 Klamath Falls and Scotts Mills earthquakes, current codes were applied to repair buildings damaged by earthquakes. It became apparent that the codes need clarification. The Task Force recommends the following revision to the State Building Code to make the seismic retrofit standards clearer and consistent with provisions which have been adopted in the state of California for dealing with buildings damaged by earthquakes:

   - Buildings that have been damaged by earthquakes so that their load resisting capacity in any one story has been reduced 20% or more should be retrofitted to the standard in effect at the time of the original construction or to current seismic rehabilitation standards, whichever is greater, in the time frame mandated by current rules.

   See M-4, Table F-1.a, Appendix F, for summary of rehabilitation requirements.

- **Exemptions:** It is recommended the following buildings be exempt from the mandatory rehabilitation requirements of M-1, M-2, and M-3:
  1. Buildings for which seismic rehabilitation plans have been submitted before April 1, 2000,[3] but not yet fully implemented may follow their approved plans and time schedules providing the time periods do not exceed those established by law.

  2. In Seismic Zone 3, all buildings built or rehabilitated under a permit in effect after January 1, 1993; in Seismic Zone 2B, all buildings built or rehabilitated to the Oregon Structural Specialty Code in effect after January 1, 1990.

- **Why not mandate rehabilitation of all URMs?**

The Task Force proposes that the State adopt as a long-term goal the rehabilitation of all URMs in 30 years because of the threat they pose to the life safety of Oregonians. In this section, the Task Force proposes to adopt a time scale for essential and hazardous URMs that would achieve complete rehabilitation in about 20 years. However, other URMs are not subject to mandatory rehabilitation and are covered by passive triggers (see Section IV.E).

Studies performed for the City of Portland demonstrated that rehabilitation of URMs would be cost beneficial. In their report to the Portland Seismic Task Force, Goettel and Horner (1995) concluded that the benefits of seismic rehabilitation of URMs outweigh the costs. For example, using values provided by FEMA, Goettel and Horner determined that URM masonry buildings require only about one occupant per 1,000 square feet for life safety benefits to equal typical rehabilitation costs. This occupancy level is equal to or lower than occupancy levels of most types of URM buildings, based on expected occupant density during business hours determined by Goettel and Horner (1995) in their earthquake risk analysis of Portland.

For this reason, the Task Force gave serious consideration to proposing mandatory rehabilitation of all URMs. Yet, following receipt of public comment, the Task Force chose not to adopt this proposal. First, while the financial burden on building owners may be significant, the rehabilitation adds little to the value of the building and offers primarily a societal benefit. Yet without broader awareness of seismic risks, the public is unlikely to fund these upgrades. Second, available information is not adequate at this time to make accurate assessments of the total cost of seismic rehabilitation for public policy decisions.

Instead, the Task Force proposes that URMs be upgraded through the passive triggers outlined in Section IV.E. Since these are typically older buildings, the pace of renovations would be expected to be higher, and it is possible that the 30-year goal for URMs could still be met. At the same time (see Section IV.A), many Task Force members have reservations that the existing proposals will be adequate. Accordingly, in Section IV.K, the Task Force proposes an interim assessment of progress toward goals be made once the inventory is completed and that adjustments be made at that time if necessary. This will not only allow time for the adequacy of the existing proposals to be assessed, it will allow for the completion of the statewide inventory, giving any such recommendations a better factual foundation.

[3] April 1, 2000, is the date when new seismic design standards are expected.

The Task Force remains hopeful that most Oregon building owners will implement seismic rehabilitation over a reasonable period of time once they understand the earthquake hazard, learn of incentives that will encourage them to seismically rehabilitate their buildings, or encounter passive triggers proposed later in this report that will require them to seismically rehabilitate their buildings as they remodel or upgrade them.

- **Enforcement:** A method of ensuring that property owners comply with the requirements for rehabilitating buildings that need seismic strengthening is needed. The Task Force recommends that existing laws regulating buildings damaged by earthquakes be expanded to include buildings required to be seismically rehabilitated. This would allow local building officials to require action by the property owner through application of a State dangerous building code.

E. The Task Force proposes that all other nonexempt buildings should be rehabilitated through a set of "passive triggers." Passive triggers are actions within the control of the owner that "trigger" a need to do seismic rehabilitation. The Building Codes Division under current authority should amend the State Building Code to implement these seismic strengthening requirements. The proposed passive triggers fall into three categories:

1. *Changes in use that increase the occupancy risk (Passive Triggers P-1.1, P-1.2, and P-2); or*
2. *Major renovations that are substantial relative to the market value of the building as reflected in the most recent property tax statement, which significantly increase loads on the structure or which weaken the existing structure (Passive Triggers P-3, P-3.1, and P-3.2); or*
3. *Major building additions that weaken the existing structure (Passive Trigger P-4).*

A detailed discussion of the recommended passive triggers is provided in Appendix G.

- **Use of term "passive triggers":** The State Building Code currently uses the concept of passive triggers when buildings are altered or used for a more hazardous occupancy. These provisions are frequently used for features such as exits, fire sprinklers, smoke detectors and alarms, mechanical systems, and other life safety features.

  The Task Force proposes that this concept of "passive triggers" be applied broadly to seismic rehabilitation. The passive triggers proposed in this report will assure that, in most cases, over a reasonable period of time building owners will include seismic improvements as they remodel and upgrade their buildings. The recommended passive triggers are tied to occupancies in the Oregon Structural Specialty Code and are explained in detail in Appendix G.

- **Recommended passive triggers:** Five categories were considered, and of these three are recommended.

  1. **Change of use:** When a change of occupancy use results in an increase to a higher relative seismic hazard (see Table G-1, Appendix G), the building should be evaluated and possibly rehabilitated. This change applies to Passive Triggers P-1.1, P-1.2, and P-2.

2. **Increased occupancy:** The number of occupants is used as a measure of risk. As the occupancy of the building increases, so does the relative hazard as more lives are put in potential danger. The Task Force proposes through Passive Triggers P-1.2 and P-2 to require rehabilitation if the building occupancy increases by more than 20%.

3. **Alterations and additions:** Buildings that will have substantial funds invested in them for nonstructural improvements such as electrical and mechanical systems or architectural appearance should also be as seismically safe as they appear to be to the tenants. Furthermore, significant remodels of buildings should require an evaluation of the structure and rehabilitation required if the proposed alteration weakens the building. Additions that add weight to an existing structure should also require the structure to be improved. These changes apply to Passive Triggers P-3, P-3.1, P-3.2, and P-4.

- **Passive triggers that were considered but not recommended:** The Task Force also considered triggers related to vacancies and sale of property and chose not to do them for the following reasons:

1. **Vacancy:** The Task Force felt this would not be a practical trigger due to the tremendous amount of record keeping that would be required as well as the difficulty in defining the level of vacancy that would be appropriate.

2. **Sale of property:** Because building officials are not notified when property changes owners, enforcement of sale of property as a trigger would not be feasible. Furthermore, due to requirements of current disclosure laws, any known building deficiencies that the Task Force believes would include seismic hazards must be disclosed prior to the completion of a sale. This market-driven approach may eventually help to instigate the abatement of these hazards, removing the need for sale of property to serve as a trigger.

F. The Task Force has identified the following categories of buildings which will require special attention: (1) Public and private schools and all other publicly owned buildings, and (2) historic buildings.

- **Public and private schools and all other publicly owned buildings:** The Task Force considered the approach that would be appropriate for schools, both public and private, as well as other publicly owned buildings. First, funding decisions are made differently for these structures and involve a process that allows policy trade-offs to be made in a more public forum. Second, the Task Force learned from several jurisdictions that programs are already underway to achieve significant rehabilitation through currently planned programs.

  Therefore, the Task Force proposes an approach for these buildings that would require an inventory and limited evaluations to be conducted by schools and public agencies for buildings within their control. This process by itself should result in responsible rehabilitation actions being taken and permit the State to better evaluate the adequacy of adopted strategies. This information would be reported to the State GIS Service Center and the Oregon Department of Geology and Mineral Industries and be included in a report to the Legislature on January 1, 2005. With this information, the State can then determine if any additional upgrading requirements should be adopted.

Therefore, public school districts, private school operators, the State of Oregon, local governments, and special districts should follow the steps listed below by January 1, 2004, to lay the groundwork for the seismic rehabilitation of their buildings:

1. Inventory all their buildings and report by January 1, 2004, to the State Service Center in the GIS format developed for doing the inventories.
2. Identify exempt and nonexempt buildings within the parameters suggested by the Task Force.
3. Classify buildings according to use.
4. Recommend seismic rehabilitation requirements based upon use, meaning that depending on the identified or proposed use of the building, buildings should be rehabilitated to a life safety standard, with special requirements for buildings requiring immediate occupancy or housing hazardous materials.
5. Select buildings to be evaluated, including all URMs.
6. Estimate engineering, evaluation, design, and rehabilitation costs.
7. Conduct seismic evaluations of selected buildings, including all URMs, and develop plans for seismic rehabilitation in cooperation with the local building official. It is the intention of the Task Force that efforts will be made by the local jurisdictions to make this information available to the public.
8. Report all of the above information including inventory results and rehabilitation plans to DOGAMI by January 1, 2004.

- **Historic buildings:** The Task Force believes the life safety standard should apply to historic buildings. At the same time, innovative mitigation methods that deviate from these standards should be permitted if necessary to preserve the historic character of the building, as long as life safety is attained. The Task Force understands that current building codes provide this flexibility.

  The Task Force recommends that tax rules be modified so that if seismic rehabilitation disqualifies a building for special tax benefits, the owner is not liable either for past tax benefits that he or she has already received or for interest on those past benefits.

G. The Task Force proposes that life safety should be the standard for rehabilitation of existing buildings unless a higher standard such as immediate occupancy is required to achieve other public safety goals. Legislation should be adopted giving Building Codes Division authority to adopt rules for seismic evaluation.

- **Life safety standard:** Structures should be rehabilitated to achieve a goal of life safety. This means the building or its rehabilitated components will not collapse on occupants during an earthquake or exits and entrances to the building will not be blocked. The Building Codes Division should adopt building design and rehabilitation standards under its current authority to adopt construction codes. In addition, these rules should be based upon nationally accepted standards for achieving this objective.

- **Higher than life safety is appropriate for some structures:** For facilities that are necessary for emergency management after an earthquake or that house materials whose release could create a life safety hazard, the structure or its rehabilitated components should be designed for immediate occupancy. These standards should be similarly adopted.

- **Standards for evaluation:** The Task Force recommends that legislation be adopted giving the Building Codes Division authority to adopt rules based upon nationally accepted practices for the seismic evaluation of buildings. For example, guidelines for seismic evaluation and rehabilitation are defined in FEMA 178, *NEHRP Handbook for the Seismic Evaluation of Existing Buildings*, which currently serves as the nationally accepted document.

  At the same time, new techniques are being developed, and it is expected that they will be made available in the near future in two new publications, FEMA 273, *NEHRP Guidelines for the Seismic Rehabilitation of Buildings*, and FEMA 274, *NEHRP Commentary on the Guidelines for the Seismic Rehabilitation of Buildings*, which will become the new standards for seismic rehabilitation upon their release.

  The Task Force anticipates that the Building Codes Division will monitor the evolving body of knowledge regarding earthquakes and building construction practices so it can modify its rules to incorporate better techniques for seismic strengthening as they are developed.

  Additional information on standards appears in Appendix F.

- **Evaluation of nonstructural elements:** Nonstructural elements, or those items which are necessary to preserve the function of essential and immediate occupancy facilities, should be properly braced and anchored for seismic loads. Such nonstructural items include, but are not limited to, electrical transformers, switchgear, motor control centers, generators, and life safety electrical, plumbing, and mechanical systems. In hazardous facilities, nonstructural items such as pipes, tanks, and storage cabinets that contain hazardous or toxic chemicals should also be properly braced and anchored for seismic loads.

  The Task Force recognizes the threat posed by failure of these nonstructural elements during an earthquake. Therefore, the Task Force encourages the Building Codes Division while adopting rules to implement the requirements of this proposed program to include consideration of the nonstructural elements that need to be secured in buildings during their construction and rehabilitation.

H. The Task Force proposes that the following incentives be adopted:

1. *Tax credits: A State income tax credit is proposed to offset investments which are exclusively for the purpose of seismic rehabilitation.*
2. *Property tax abatements: It is proposed that local jurisdictions be authorized to reduce the assessed value of eligible properties by an amount representing some fraction of investments made exclusively to achieve seismic rehabilitation.*

These incentives should be made retroactive to 1993, the year western Oregon was changed from Seismic Zone 2B to 3.

- **Rationale:** The Task Force believes incentives should be adopted for several reasons:

  1. In the absence of incentives, passive triggers act as a disincentive to make necessary investments for the growth and renewal of neighborhoods and business districts. The experience in Portland reinforces this concern, where in the Findings and Recommendations of the Infrastructure and Finance Committee to the Central City 2000 Task Force it was stated that:

     a) "Almost 40% (or about 6 million square feet) of downtown office space is in older and historic buildings (sometimes called Class B and Class C Buildings).
     b) "These buildings are averaging over 20% vacancy, and there are several significant buildings that are 80-100% vacant.
     c) "These buildings are prime opportunities to house new jobs requiring less expensive space, in particular those industries that require incubator space.
     d) "There are serious barriers to achieving the renovation of these buildings--in many cases, the cost of renovating B&C Buildings to meet code and market requirements exceeds the limits of financial feasibility.

        1) "The City has found that the typical seismic retrofit cost would be about $30 per square foot for commercial buildings.
        2) "In addition, there are (i) other code dictated renovation costs for fire/life safety and Americans with Disability Act (ADA) retrofits and (ii) "updating" costs, such as facade improvements, mechanical upgrades, painting, recarpeting, etc., that in total could add $20 per square foot (or more).
        3) "Thus, a total renovation project might add $5-$6.25 per square foot per year to the total carrying cost of the building. This amount exceeds the net cash flow of many B&C buildings."

  2. Public policy should encourage seismic rehabilitation by providing incentives to

owners who take action to rehabilitate their buildings, thereby protecting lives and property.

3. The Task Force further believes these incentives should be retroactive to 1993 to be equitable to building owners who voluntarily rehabilitated their buildings before being mandated to do so.

- **Explanation of proposed incentives:**

1. **Tax credits** are a form of financial incentive used to promote public policy in such areas as energy conservation, historic preservation, and affordable housing. Tax credits have the advantages of not requiring appropriation of government funds and being inexpensive to administer. To qualify for a tax credit, (1) the investment should be at least 20% of the value of the building, (2) the tax credit should apply only to seismic upgrade costs, and (3) the amount of the tax credit should be 35% of the investment. The credits should be retroactive to January 1993, should be allowed to carry forward for a maximum of 10 years, and should not apply to any costs incurred after July 1, 2019.

2. **Property tax abatement** is a financial incentive such as the Oregon Property Tax Law that has been extremely successful in stimulating restoration of historic buildings. The property tax abatement program would be locally adopted, with procedures and criteria established by the local municipality The tax abatement could continue for up to 10 years, as set by the local municipality. State legislative changes may be necessary to give appropriate authority to local jurisdictions to make these changes. Provisions similar to those of tax credits are suggested: (1) The investment should equal or exceed 20% of the value of the building, (2) the abatement should apply only to seismic upgrade costs, and (3) the amount of the abatement should be 35% of the investment.

3. **Urban renewal** should include seismic upgrades. The Task Force understands that the current urban renewal statutes would include seismic rehabilitation (see letter dated August 20, 1996, from Bob Hibschman to John Tess on file with the Oregon Department of Geology and Mineral Industries).

- **Other proposed incentives to be considered in the future after more information on the inventory and the effects of triggers and incentives on seismic rehabilitation is available:**

1. **Loan guarantees** were considered, but it was not apparent at this time to what extent such guarantees would be a motivating incentive. The Task Force was also concerned about (1) potential exposure of the State to liability for unsecured loans, and (2) uncertainty about costs for such a program. These incentives should be further evaluated.

2. **Grant programs** were also considered, but the cost of grants was believed to be

prohibitive. Nevertheless, after more experience is obtained with the current program, the Task Force believes grant programs should be reconsidered to determine if they are necessary and cost effective.

3. **Other local options** should also be evaluated and considered over the next few years. For example, the Task Force was informed that some jurisdictions in California have established special assessment districts in which tax exempt municipal bonds have been sold to create a fund for financing seismic rehabilitation of older buildings. These bonds are not secured by the full faith and credit of the municipality but by the properties that the funds are used to rehabilitate. Under a California statute passed in 1915, these funds can be placed as a lien against the property and take priority over all other security interests. They are attractive because they can provide funding for buildings that cannot otherwise obtain financing for rehabilitation. Because these jurisdictions often include seismic requirements in their zoning provisions, seismic rehabilitation often permits a higher use of the building. In this way, the rehabilitation adds value and provides some measure of security for the existing lienholders, even though they are subordinated by the seismic rehabilitation lien. The Task Force believes the Legislature should explore existing statutes to see if this can be made a local option.

I. Any legislation adopting these measures should provide protection from liability for parties adhering to the seismic rehabilitation program.

- **Building owners:** The Task Force is concerned that either private parties or public agencies may be exposed to civil or criminal liability once notice of a seismic risk is provided to them or as the result of the performance of a seismic evaluation of buildings or other facilities within their control. It is in the public interest to encourage these parties to perform seismic evaluations, and such evaluations should not be avoided for fear of liability exposure. Therefore, the Task Force proposes that any legislation adopting these provisions provide protection from liability that might arise due to notice of seismic risks contained in the inventory report or a seismic evaluation, as long as seismic rehabilitation is being pursued in a manner consistent with the seismic rehabilitation program that is ultimately adopted.

  The liability protection proposed by the Task Force should continue while appeals are pending before an administrative agency, since it is expected that appeal provisions would include specified time frames within which appeals must be resolved. Because the Task Force is concerned that judicial appeals might be used to frustrate the intention of this program, it proposes that liability protection not extend to judicial appeals that might be taken from a final agency determination. Under these circumstances, it would be appropriate for the appellant to bear the risk that the appeal is meritorious.

- **Municipalities and State agencies:** The Task Force recommends that municipalities and State agencies be protected from liability for errors and omissions during inventory, notification, and enforcement of the requirements of this law except for negligence.

- **Structural engineers:** The Task Force recommends that structural engineers be protected from liability for building failure due to unknown conditions in existing buildings they are evaluating or for which they are preparing rehabilitation plans, as long as the work they have performed is in compliance with the State-adopted seismic evaluation and rehabilitation design standards.

J. The Task Force proposes that the Oregon Department of Geology and Mineral Industries be charged with overall administrative responsibility for the seismic rehabilitation program. This should include a program for public education.

- **Administration:** Carrying out a program of seismic rehabilitation of existing buildings will require efforts and involvement of several Federal and State agencies, county and local governments, and owners and tenants of affected buildings. To assure that the program moves ahead, the Task Force recommends the Oregon Department of Geology and Mineral Industries (DOGAMI) be given the responsibility of overseeing and coordinating the program and related multiagency activities.

  DOGAMI should oversee the inventory, receive reports from agencies with defined roles in the inventory process and rehabilitation process, maintain a library of evaluation reports, and develop data on costs of seismic rehabilitation based on results of the inventory. As part of its responsibilities for oversight, DOGAMI in consultation with the affected agencies should prepare a report bi-annually for the Legislature on the progress that is being made on the program. On January 1, 2005, six months after completion of the inventory, DOGAMI will report to the Legislature on progress toward the long-term goals (see discussion on report, Section IV.K, below).

  DOGAMI should work with all affected agencies and governments to define their roles, see that the provisions of the seismic rehabilitation program are fulfilled, coordinate public education activities, and give guidance and advice in areas that are found to be inadequate. Finally, DOGAMI will stay informed on changes and developments in seismic risk and mitigation and see that continued review and adjustment of State policy occurs.

- **Public education:** A public education program is needed to build public awareness of Oregon's seismic risk and the benefits of the proposed seismic rehabilitation program. Various State agencies already provide information to a variety of audiences. The Task Force recommends that, when appropriate, their programs be expanded to reach wider audiences. The Task Force also recommends that progress toward the goal of a public that is well informed on earthquake hazards, preparedness, and mitigation be measured periodically by scientifically conducted public opinion polls. DOGAMI should coordinate these education efforts.

K. The Task Force proposes that the Oregon Department of Geology and Mineral Industries prepare and present a comprehensive report to the Legislature by January 1, 2005, on the progress made toward seismic rehabilitation of buildings, recommending program changes as appropriate.

- **Rationale for report:** The Task Force is concerned that progress toward the long-term goals, especially rehabilitation of URMs, may not be adequate under the current proposals.

Therefore, the Task Force proposes that progress toward the State's seismic rehabilitation goals be reviewed once the inventory has been completed and enough information has been gathered to assess the adequacy of the approaches proposed in this report. This review should be conducted by the Oregon Department of Geology and Mineral Industries (DOGAMI), acting as oversight and coordinating agency for seismic rehabilitation during the year after the inventory is completed. A report of this review should be prepared in partnership with the Building Codes Division and other affected agencies and should be presented as a progress report to the Legislature by January 1, 2005, eight years after the adoption of these recommendations.

- **Proposed timeline:** A detailed timeline for the program proposed by the Task Force is provided in Appendix E. In general, the January 1, 2005, date was adopted assuming the legislation initiating this program would be effective in September 1997. Building Codes Division has estimated that it would then require until April 1, 1999, to adopt rules for inventories and initiate the process of conducting inventories throughout the state. The Task Force proposals assume about five years would then be required to complete the inventories, thus having them completed in July 1, 2004. The January 1, 2005, date is, therefore, consistent both with the time frame required to complete the statewide building inventory and the schedule for the Legislative Session in 2005.

- **Information to be reported:** The report should contain the following information:
    1. Results of building inventory.
    2. A baseline based on inventory results for benchmarking and policy making.
    3. Benchmarks for adoption based on results of the inventory.
    4. Assessment of the overall costs required to complete the seismic rehabilitation of all buildings in Oregon.
    5. Report on the number of buildings that have been rehabilitated during the period since passage of legislation.
    6. Assessment of the rate of progress being made toward long-term goals.
    7. Recommendations for any revisions to current policy that might be required to meet the long-term goals.

- **Proposal for performance measures:** The Task Force was charged by SB 1057 with addressing the issue of "benchmark tracking of structural seismic rehabilitation programs" in order to establish long-term goals and measure progress toward them. The Task Force has recommended benchmarks of seismic rehabilitation of all URM buildings within 30 years and seismic rehabilitation of all other buildings within 70 years. The Task Force recommends establishment of the following performance measures that would serve to monitor annual and long-term progress in achieving the seismic rehabilitation of the building stock in Oregon:
    1. The number of buildings in various categories that have been rehabilitated.
    2. The number of occupants in the buildings rehabilitated.
    3. The square footage of building space that has been rehabilitated.
    4. The cost investment in rehabilitated buildings.

  The information required to adopt these performance measures should be developed by the inventory process (see discussion on inventory, Section IV.C, above). DOGAMI should propose specific baselines in the above categories to the Oregon Progress Board within one year of the completion of the required inventory. DOGAMI should also report annually to the Oregon Progress Board on the performance measures.

L. The Task Force proposes that a Structural Engineering Specialty License be established to assure the competency of persons providing design and rehabilitation services. Legislation should be adopted to direct the State Board of Examiners for Engineering and Land Surveying to implement this recommendation.

The Task Force believes that consistent qualification standards are needed for professional engineers who provide services related to seismic design and rehabilitation of significant structures. Significant structures are buildings that are more subject to seismic damage or that contain occupancies at greater risk. Significant structures are defined as:

1. Essential facilities, hazardous facilities, or special occupancy structures as defined by the State Building Code.
2. Structures having irregular features as defined in the State Building Code.
3. Buildings four or more stories tall or greater than 45 feet tall, whichever is less.

Seismic evaluation of existing structures requires a knowledge of structural dynamics, structural analysis and design, geotechnical engineering, construction methods, and the exercise of considerable judgment. The knowledge that persons providing these services are qualified is necessary (1) to assure that rehabilitative actions will achieve a life safety objective, and (2) to assure building owners that unnecessary building alterations are not performed.

Legislation should be adopted to direct the State Board of Examiners for Engineering and Land Surveying to establish competency in seismic issues related to structural engineering by creating the title "professional structural engineer" and by stipulating requirements in the qualifying examination for professional engineers who wish to become qualified in structural engineering. Legislation should also require significant structures be designed and constructed under the oversight of structural engineers. Consideration should be given to prior engineering experience in adopting these requirements.

The Task Force further recommends that continuing education in areas related to earthquake hazard evaluation and design of buildings be a requirement for renewing a professional structural engineer certificate of registration.

M. The Task Force recommends that the Oregon Department of Geology and Mineral Industries and Building Codes Division provide quality control standards and oversight of seismic site hazard investigation reports as noted herein.

The Task Force recommends that the Oregon Department of Geology and Mineral Industries (DOGAMI) assist the Building Codes Division in developing standards, making training available for engineers and plans examiners, and amending the State Building Code to address quality control in seismic site hazard investigation reports.

DOGAMI should develop guidelines and standards for evaluating site conditions including soil and ground response; Building Codes Division (BCD) should develop related standards for the resulting structural analysis and design.

The following actions are recommended:

1. Ensure structural design of the building takes into consideration the findings of the seismic site hazard investigation report. (BCD)
2. Require engineering design calculations to include a discussion of the applicability and/or any pertinent items of the report. (BCD)
3. Provide technical peer reviews of seismic site hazard investigation reports (DOGAMI). This may be accomplished either (a) by professional staff within DOGAMI, or (b) by the local jurisdiction with advice and counsel from DOGAMI. Costs for these reviews may be recovered through fees.
4. Reference the newly developed Board of Geologists Examiners' seismic site hazard investigation report guidelines and include them as an appendix in the building code. (BCD)
5. Review and amend as necessary the code language in Section 1804 of the Oregon Structural Specialty Code taking into consideration the Board of Geologist Examiners' guidelines. (BCD)

N. Additional topics, not covered above, are related to the issues addressed by the Task Force: (1) Seismic rehabilitation should not trigger upgrades for nonseismic purposes. (2) Tsunamis. (3) The Task Force recommendations do not address infrastructure.

1. **Seismic rehabilitation should not trigger upgrades for nonseismic purposes:** In order to encourage the voluntary rehabilitation of buildings and limit the cost impacts of mandatory seismic rehabilitation requirements, State statutes (ORS 447.241) and the State Building Code should be amended to exempt seismic rehabilitation from the requirements for disabled access and energy upgrades except for new work performed. Any seismic rehabilitation should neither create architectural barriers nor reduce the energy efficiency of the existing building. New work should comply with the State Building Code requirements for accessibility and energy conservation.

2. **Tsunamis:** The Task Force discussed tsunamis and concluded the following:
   a. The Task Force charge was to focus on rehabilitation required to protect the pub-

lic from seismic events. Therefore, it did not conduct an in-depth review of tsunami risks or develop comprehensive recommendations concerning steps that should be taken to address the risk of tsunamis.

b. To the extent that buildings are upgraded to accommodate seismic events, some measure of improved ability to withstand tsunamis will be accomplished.

c. The primary risk prevention issues related to tsunamis will involve
   - Public education.
   - Locating structures in such a way that the exposure to tsunami risks is minimized (i.e., locating major structures farther away from the ocean and on higher ground).
   - Assuring the availability of emergency response capabilities and post-incident mitigation measures in the event a major tsunami occurs.

d. The Task Force encourages the Oregon Department of Transportation to improve coastal highways so that evacuation of coastal residents and visitors is possible in the event of a subduction zone earthquake and accompanying tsunami.

e. The Task Force believes these are appropriate issues to be addressed and would request consideration by the Legislature for appropriate processes for dealing with them. A suggestion would be to assign this issue to either the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) and/or Oregon Emergency Management and request recommendations from them for further action.

3. **The Task Force recommendations do not address infrastructure:** The Task Force recognizes the vulnerability of elements of the infrastructure such as roads, bridges, dams, communications systems, power lines, and other lifelines to damage from earthquakes. However, as seismic rehabilitation of the infrastructure is outside of the mandate given through SB 1057 to the Task Force, it recommends the Legislature satisfy itself that this issue is being addressed though the Seismic Safety Policy Advisory Commission and State agencies such as the Oregon Department of Transportation. The Task Force suggests the Legislature ask appropriate groups and agencies to come before it and comment on their plans for seismic strengthening of the portions of the infrastructure for which they are responsible.

V. COST IMPACT OF SEISMIC REHABILITATION TASK FORCE RECOMMENDATIONS

The following categories of costs resulting from the impact of these recommendations have been identified:

1. Conduct of inventory
2. Building evaluations
3. Building rehabilitation
4. State and local tax incentives
5. State agency costs
   a. Administration
   b. Rulemaking
   c. Public education

1. Inventory

The inventory of buildings in the Portland metropolitan area cost approximately $15 per building. Oregon is estimated to have 97,000 buildings that are not "single-family" dwellings. Approximately 27,000 of these buildings are in the Portland metropolitan area and will be inventoried in the Metro project. The cost of the five-year inventory of the remaining 70,000 buildings in the rest of the state is estimated at approximately $1.7 million, or about $340,000 per year over the recommended five-year period. This figure includes data storage costs of $300,000 at the State GIS Service Center and $1.4 million for inventory at $15 per building. The $1.4 million includes approximately $350,000 for expenses such as travel. Details of costs of the inventory are presented in Appendix H.

2. Building evaluations

The Task Force recommends that seismic evaluations of buildings be conducted. The estimate of cost of evaluation if it is done in accordance with the provisions of FEMA 178 ranges from $2,000 to $10,000 per building, depending on size and complexity of the building.

3. Building rehabilitation

The estimated costs of seismic rehabilitation can range from $10 to $50 per square foot depending on the building, type of rehabilitation, and what is included in the costs of the seismic portion of a project. According to Goettel and Horner, the typical rehabilitation cost for average or commercial URMs is approximately $35 per square foot. This cost, however, does not include other costs such as relocation costs that may be incurred during seismic rehabilitation.

Preliminary estimates of the total cost of seismic rehabilitation of buildings in Oregon can be made in three different ways:

a. Oregon has approximately 97,000 buildings, excluding single-family dwellings but including two-family dwellings. The square footage of these existing buildings is about 923 million square feet. Approximately 11% of this total footage may be in URM buildings, based on percentages in the Portland building inventory. At the Goettel and Horner cost of

$35 per square foot, rehabilitation of the 11% of the total footage would cost approximately $3.6 billion.

b. The average size of a building is calculated to be 17,000 square feet, based on inventory figures for the City of Portland, information on publicly owned buildings in several Oregon counties, and the footprint of a three-story building based on average block sizes in various Oregon cities (personal communication, Matthew Mabey, 1996). Using 11% of 97,000 buildings and this average size of 17,000 square feet per building gives an estimated rehabilitation cost of $6.3 billion.

c. Because the city of Portland has 1,373 URM buildings, a sixth of the population of the state, and probably a sixth of the total number of URM buildings, if those buildings have an average size of 17,000 square feet per building, then the cost of seismic rehabilitation for the entire state could be estimated at $4.9 billion.

Based on the above methods of estimating costs of rehabilitation, the cost of seismic rehabilitation of all the URM buildings in the state, which are believed to make up 11% of the building stock, can be estimated at between $3.6 and $6.3 billion, with $5 billion as a "reasonable estimate." When the cost is spread over 30 years, the cost per year is $167 million, or about $55 per Oregonian per year. Additional details on the costs of seismic rehabilitation are presented in Appendix H.

The Task Force was unable to estimate further rehabilitation costs because of inadequate information about the existing building stock. Once this information is gained through the inventory, better cost estimates can be made.

4. State and local tax incentives

The Task Force recognizes that the incentives proposed in Section IV.H will have cost impacts but has not estimated those impacts. The Task Force anticipates that an evaluation of the cost impacts will be part of the legislative process.

5. State Agency costs

a. **Building Codes Division:** The Building Codes Division will require four staff positions for rule development, contract development and administration for the inventory, and technical assistance. The total cost (for the 1997-1999 biennium) is estimated at $445,000.

b. **Oregon Department of Geology and Mineral Industries (DOGAMI):** Three DOGAMI roles that will require budget and staffing are (1) public education, (2) review of seismic site hazard investigation report, and (3) oversight and periodic reporting. Three positions will be needed. The total cost for 1997-1999 biennium is calculated to be $370,290, or $1.1 million for the six years covering the inventory and report to the Legislature.

VI. PROPOSED LEGISLATION: SUMMARY OF LEGISLATIVE CONCEPTS

A. Establish a program to achieve seismic rehabilitation of existing buildings.

1. **Establish program:** The Task Force recommends the State of Oregon establish a program that achieves seismic rehabilitation or mitigation of existing unreinforced masonry buildings within 30 years and other types of existing buildings within 70 years. The Task Force recommends that all buildings, except one- and two-family dwellings, agricultural buildings, and buildings on property exempt from State regulation, be inventoried by the State in order to identify the extent of potential risks from buildings damaged by earthquakes. The Task Force recommends that certain buildings be evaluated for structural safety and seismically strengthened or abated by property owners to protect building occupants, to preserve essential facilities such as hospitals, and to protect the public from hazardous conditions. The Task Force also recommends the establishment of long-term goals and incremental steps that will improve the level of seismic safety in all existing buildings. Legislation should include the following:

    a. **Inventory of buildings:** Authorize the State Department of Consumer and Business Services (DCBS) to inventory all buildings within the state according to statewide standards, report the findings to the Department of Administrative Services, GIS Service Center, and notify property owners of inventory findings.

        1) **Exemptions:**
            a) One- and two-family dwellings and their accessory buildings.
            b) Agricultural buildings defined in ORS 455.315.
            c) Buildings located on property exempt from regulation by the State Building Code such as Federal lands and Native American Reservation and Trust Land.

    b. **Seismic rehabilitation requirements:** Require building owners of the following types of buildings to have an engineering evaluation of their building or applicable portions thereof and to abate the identified hazards to the standard necessary to provide the desired performance level:

        1) **Falling hazards:** Buildings throughout Oregon having parapets, signage, marquees, and other appendages, excluding cornices, shall have the appendages evaluated and repaired to eliminate falling hazards and protect life safety.

        2) **Essential and hazardous facilities except hospitals:** Unreinforced masonry buildings housing essential and hazardous facilities such as police

and fire stations and emergency centers, as defined in ORS 455.447 and the State Building Code, and facilities containing hazardous or toxic chemicals shall be evaluated and rehabilitated to a standard protecting life safety. In this case, because of the critical need to use essential facilities following an earthquake and the potential hazard to the public, it is appropriate to adopt standards that also provide immediate occupancy of the buildings following an earthquake. Immediate occupancy shall be defined as a condition where only limited structural and nonstructural damage to the structure has occurred. The basic vertical and lateral force-resisting systems of the building retain most of their pre-earthquake capacities, and nonstructural damage is minimized. In general, mechanical, plumbing, and electrical systems are structurally secure and able to function, although public utilities may not be immediately available. Evaluation of essential and hazardous facilities shall include a site-specific seismic hazard survey as required by the State Building Code.

3) **Hospitals:** All hospital buildings having surgery and emergency treatment facilities, and their support services essential for continuing emergency operation, shall conduct an inventory and seismic evaluations within three years of adoption of standards for inventory, and necessary rehabilitation within 15 years of the date the inventory and evaluations are completed and filed with DOGAMI. Under conditions where the time frame causes unworkable scheduling or cost impacts, the hospital may file a detailed rehabilitation plan with the local building official and DOGAMI within the three years after adoption of the standards of inventory and phase rehabilitation of their buildings over a 25-year period. The plan must demonstrate a committed rehabilitation effort with early attention to buildings with the highest risk and be approved by the building official. Hospitals shall be rehabilitated to a standard that provides immediate occupancy following an earthquake.

4) **Exemptions:** Exemptions to the requirements of b.1), b.2) and b.3), above, for evaluation and rehabilitation are established as follows:

   a) One- and two-family dwellings and their accessory buildings.

   b) Buildings for which seismic rehabilitation plans have been submitted before April 1, 2000,[4] but not yet fully implemented may follow their approved plans and time schedules providing the time periods do not exceed those established by this law. This exception does not apply to buildings damaged by earthquakes or otherwise required to be strengthened by the State Building Code.

   c) Buildings built or rehabilitated in Seismic Zone 3 under permits issued under the State Building Code in effect after January 1,

[4] April 1, 2000, is the date when new seismic design standards are expected.

1993, and in Zone 2B under the code in effect after January 1, 1990.

d) Agricultural buildings as defined in ORS 455.315.

e) Buildings located on property that is exempt from regulation by the State Building Code such as Federal land and Native American Reservation and Trust Land.

c. **Requirements for public and private schools and all other publicly owned buildings:** In order to identify the potential risks and costs to the public, require State and municipal governments, public and private schools, and fire and utility districts to inventory and screen all of their buildings to determine the relative levels of hazards that exist and develop and make public a plan for evaluation and rehabilitation for all of their buildings as required to protect life safety. Inventory information shall be reported to the Department of Administrative Services State GIS Service Center and DOGAMI within four and a half years of adoption of standards for the inventory. Essential and hazardous unreinforced masonry buildings shall be evaluated and rehabilitated as required for other property owners.

d. **State Building Code:** Amend the State Building Code to include standards for the evaluation and strengthening of existing buildings that undergo alterations and additions, including but not limited to, change in use, an increase in occupant load or alterations or additions that add weight to, or reduce the strength of, the existing structure. Building evaluations performed prior to adoption of standards under this law may be submitted to help determine compliance with code requirements. The building official may require additional information necessary to determine compliance with the adopted standards. Draft rules shall be prepared based on the recommendations of the SB 1057 Task Force and submitted for public hearing as required for rulemaking under ORS Chapter 183.

B. Establish responsibility and authority for programs.

1. **Oregon Department of Geology and Mineral Industries (DOGAMI):** Establish responsibilities and authority for DOGAMI as follows:

a. Oversee and coordinate the various State agency and local municipality responsibilities in partnership with the Department of Consumer and Business Services, Building Codes Division (BCD).

b. Recommend appropriate benchmarks and performance measures to Oregon Progress Board and monitor progress. Report progress annually to the Oregon Progress Board.

c. In cooperation with other agencies, provide training and public education to the citizens of Oregon and particular affected groups including a program relating to the rehabilitation of existing one- and two-family dwellings.

d. Provide technical assistance relating to geotechnical reports (seismic site hazard investigation reports), reviewing them for local building departments where they do not have the technical expertise to do so. Costs of the review may be recovered through fees.

e. Prepare and present legislative reports in partnership with the DCBS/BCD and other State agencies.

f. Make recommendations for program changes and future actions to the Legislature by January 1, 2005.

g. Maintain a library of seismic evaluation reports.

2. **Department of Consumer and Business Services and Building Codes Division (DCBS/BCD):** Establish responsibilities and authority for DCBS/BCD as follows:

   a. Notify local municipalities of requirements of this law, providing necessary information and training to carry out their responsibilities.

   b. Grant rulemaking authority for establishing the following:

      1) Inventory and waiver/appeal procedures based on nationally recognized standards. The appeals process should include provisions for situations in which a building is incorrectly identified, a seismic upgrade of a building has already been completed, or it may be appropriate to modify the requirements for further evaluation and seismic upgrade of particular buildings.

      2) Building evaluation standards based on nationally recognized standards.

      3) Design standards for seismic strengthening of existing buildings based on nationally recognized standards.

      4) Enforcement procedures, through adoption of dangerous building codes, for existing buildings found to require seismic strengthening under this law.

   c. Amend the State Building Code under current authority to:

      1) Create standards for seismic rehabilitation and criteria for alteration of existing buildings including one- and two-family dwellings.

      2) Create standards for when evaluation and seismic strengthening of existing buildings undergoing alterations or additions are required.

      3) Require that the structural design and calculations of buildings take into consideration the findings of the seismic site hazard investigation report when applicable.

4) Reference the Board of Geologists Examiners' guidelines for seismic site hazard investigation reports, including them as an Appendix to the Code, and make the Code requirements for seismic site hazard investigation reports consistent with their intent.

d. Periodically ascertain status of municipality compliance with requirements of this law and report to DOGAMI.

e. Prepare and present reports to DOGAMI and the Legislature.

3. **Local municipalities:** Establish responsibilities and authority for local municipalities as follows:

a. Annually report changes to the inventory to the Department of Administrative Service GIS Service Center.

b. Monitor and enforce property owner compliance with requirements of law.

c. Implement requirements of the adopted statewide Dangerous Building Code abating properties that do not comply within the specified effective dates of this law.

4. **Other State agencies:** Establish responsibilities and authority for various State agencies as follows:

a. **All State agencies that own buildings** shall inventory their buildings, prepare a plan for mitigation of hazards, and assess and report the cost impacts on their particular department to the Legislature.

b. **All State agencies that own essential or hazardous buildings** shall have required engineering evaluations performed by qualified persons, report the costs to the Legislature as part of the budget process, and proceed to implement rehabilitation plans by July 1, 2019.

c. **State agencies** (below) shall provide education and training as part of regular agency activities:
   1) Department of Geology and Mineral Industries
   2) Department of Consumer and Business Services
   3) State Historic Preservation Office
   4) Oregon Emergency Management
   5) Department of Administrative Services
   6) Department of Revenue

d. **Department of Administrative Services/GIS Service Center** create and distribute to DCBS, State and local government agencies, schools, hospitals, and fire and utility districts a copy of a statewide database for inventory and record keeping of affected existing buildings. Report to DOGAMI and the Legislature and provide access to database as appropriate. If not already existing, a method of charging users for copies of the data should be provided. There should be no charge to DOGAMI, other State agencies, schools, hospitals, local municipalities, and special districts.

C. Establish timelines and effective dates.

1. **Adopt standards:** Require Department of Consumer and Business Services, Buildings Codes Division, to adopt procedures and standards for inventory by April 1, 1999, and standards for building evaluation and design by April 1, 2000.

2. **Inventory:** Require inventory to be completed by the State with notification of property owners given by July 1, 2004.

3. **Public agency plans:** Require State and local governments, public schools, and fire and utility districts to inventory and screen their buildings and prepare and make public a plan for rehabilitation by January 1, 2004.

4. **Engineering evaluation:** Require property owners of unreinforced masonry essential and hazardous facilities and buildings with falling hazards such as parapets found during the inventory to evaluate them according to adopted standards by July 1, 2009.

5. **Seismic rehabilitation:** Require property owners to rehabilitate or mitigate subject buildings found to be dangerous by July 1, 2019.

6. **Hospital rehabilitation:**
   a. Inventory and evaluation completed by July 1, 2002.
   b. Rehabilitation shall be completed by July 1, 2017. This may be extended with approval of plans to July 1, 2027.

D. Establish incentive programs to encourage voluntary compliance.

1. **Tax incentives.** Establish tax incentive programs.

   a. Create a tax program similar to proposed 1995 Senate Bill 703 retroactive to January 1, 1993, the implementation date of Seismic Zone 3 in western Oregon.

      1) Credits applicable only to costs of seismic rehabilitation.

      2) Eligible buildings include all buildings required to be seismically upgraded.

      3) The investment must be at least 20% of the value of the building.

4) The amount of tax credit equals 35% of the actual direct seismic rehabilitation construction costs.

5) The credit does not apply to any costs incurred after July 1, 2019.

6) The credits are allowed to be carried forward for a maximum of 10 years from the date the investment is made.

7) Tax credits should be retroactive to January 1993.

b. Establish a statewide property tax abatement program similar to proposed 1995 Senate Bill 688 retroactive to January 1, 1993, the implementation date of Seismic Zone 3 in western Oregon.

1) The program is to be discretionary, subject to approval on a case-by-case basis by a particular municipality.

2) The tax abatement incentive is applicable only to buildings required to be seismically rehabilitated with costs which equal or exceed 20% of the building value.

3) The amount of tax abatement equals 35% of the actual direct seismic rehabilitation construction costs.

4) The value of the building is based on the real market value as determined by the latest assessment for property tax purposes.

5) The tax abatement may continue for a period up to 10 years as set by local municipality.

6) The municipality establishes local procedures and criteria for approving property tax abatements.

c. Properties that have received tax incentives for renovation of historic buildings and are required to be seismically rehabilitated by this legislation shall not be penalized by requiring back payment of taxes and accrued interest if the seismic upgrade causes the building to be taken off the National Register of Historic Buildings.

2. **Urban renewal.** Ensure that the urban renewal definition of "blighted area" includes buildings required to be seismically rehabilitated, thereby qualifying them for funding.

3. **Exclusion from accessibility and energy upgrades beyond the requirements of Federal law.** In order to encourage the voluntary rehabilitation of buildings and limit the cost impacts of mandatory seismic rehabilitation requirements, amend ORS 447.241 and the State

Building Code to exempt seismic rehabilitation from the requirements for disabled access and energy upgrades except for the new work performed. Any seismic rehabilitation shall not create architectural barriers nor reduce the energy efficiency of the existing building. New work shall comply with the State Building Code requirements for accessibility and energy conservation.

E. Establish liability protection for property owners and municipalities.

1. **Building owners:** Protect building owners from liability in case of an earthquake when they have received an inventory notice or have had a seismic evaluation performed but have not completed the necessary rehabilitation design, as long as seismic rehabilitation is being pursued in a manner consistent with the seismic rehabilitation program which is ultimately adopted. The liability protection should extend while appeals are pending before an administrative agency and not extend to judicial appeals which might be taken from a final agency determination.

2. **Municipalities and State agencies:** Protect municipalities and the Department of Consumer and Business Services from errors and omissions during inventory, notification, and enforcement of the requirements of this law except for negligence.

3. **Structural engineers:** Protect structural engineers from liability for building failure due to unknown conditions in existing buildings they are evaluating, or for which they are preparing rehabilitation plans, when the work they have performed is in compliance with the state adopted seismic evaluation and rehabilitation design standards.

F. Amend ORS 455.020 in deference to the requirements of a statewide program under this law.

1. **Establish statewide standards:** Remove the allowance for local adoption of seismic rehabilitation standards in ORS 455.020.

2. **Local amendments:** Allow local amendments to the adopted statewide standards through current process for amending the State Building Code in ORS 455.040.

G. Direct the Board of Examiners for Engineering and Land Surveying to create new requirements.

1. **Structural Engineering Certification.** Establish engineering certification requirements for structural engineering and the design of significant structures.

a. Only a professional engineer qualified in structural engineering with competency in seismic issues shall provide engineering services related to "significant structures". Significant structures shall be defined as:

   1) Essential facilities, hazardous facilities, or special occupancy structures as defined by the State Building Code.

   2) Structures having irregular features as defined in the State Building Code.

   3) Buildings four or more stories tall or greater than 45 feet tall, whichever is less.

   "Professional structural engineer" means a person who has knowledge of the discipline of structural engineering and of the principles and methods of structural engineering analysis and design acquired by engineering education and experience. Such a person shall be designated as the "Professional Structural Engineer of Record" on each significant structure for which structural engineering services are provided.

b. The Board of Examiners for Engineering and Land Surveying shall adopt rules, including but not limited to requirements for supervision of structural design, testing, observation and inspection programs to be used by structural engineers during construction of significant structures.

c. A professional engineer registered by the Board of Examiners for Engineering and Land Surveying on the effective date of this legislation may continue to practice structural engineering and be registered as a professional structural engineer if, within two years of the effective date of this legislation, he or she demonstrates to the satisfaction of the Board by oral or written review that the structural engineer has 10 years of experience in Oregon as a structural engineer. The Board of Examiners for Engineering and Land Surveying shall adopt guidelines for evaluating the competency of professional engineers practicing structural engineering by reviewing previous work done on significant structures in areas of comparable seismicity.

d. A professional engineer registered by the Board of Examiners for Engineering and Land Surveying on the effective date of this legislation may continue to practice structural engineering for three years from the effective date of this legislation, if the structural engineer takes the first examination related to structural engineering offered by the Board after the effective date of this legislation.

e. Require continuing education for renewing professional engineer certificates of registration in structural engineering in areas related to evaluating and designing earthquake hazard mitigation for significant structures.

APPENDICES

APPENDIX A. TASK FORCE PROCESS

I. EARTHQUAKE LEGISLATION IN OREGON

As realization of Oregon's seismic risk has grown in recent years, building codes and practices in the state since 1974 have addressed earthquakes in some form. It should be noted, however, that even before that time, some structural engineers in this area utilized the seismic design requirements of the Uniform Building Code (UBC). More recently, concern for public safety has led to revisions of building codes and passage of new laws related to earthquake mitigation.

In 1988, the entire state was reclassified Uniform Building Code Seismic Zone 2B. In 1989, the Legislature passed Senate Bill 955, which instructed the Oregon Department of Geology and Mineral Industries (DOGAMI) to improve the State's understanding of earthquake and other geologic hazards and to use this knowledge to reduce the loss of life and property due to these hazards.

After Senate Bill 96 was passed in 1991, schools were required to hold "duck and cover" earthquake drills, and developers of new essential and special occupancy structures were required to investigate their building sites and to file their investigation reports with DOGAMI. This same bill also created the Oregon Seismic Safety Policy Advisory Commission (OSSPAC), which was charged with reducing exposure to earthquake hazards in Oregon by developing and influencing seismic-related policy at Federal, State, and local levels; facilitating improved public understanding and encouraging identification of risk from earthquakes; supporting research and special studies about earthquakes; implementing appropriate earthquake hazard mitigation; and preparing for response and recovery from earthquakes.

In 1993, the Oregon Building Codes agency upgraded the Oregon Structural Specialty Code Seismic Zone 2B to Seismic Zone 3 in western Oregon including Hood River and Klamath counties.

To further address Oregon's vulnerability to earthquakes, in 1995, 14 bills dealing with earthquakes and earthquake-generated tsunamis were introduced in the Legislature. One bill that became law was concerned with tsunami drills and education, another affected construction of essential and special occupancy buildings in the tsunami inundation zone, another added four new members to OSSPAC, another provided tax credits for seismic rehabilitation expenditures in historic properties, and finally, Senate Bill 1057 created this Seismic Rehabilitation Task Force. That bill was designed to provide recommendations and guidance to the 1997 Legislature as it would consider seismic rehabilitation of existing buildings--a new, complex, and potentially costly issue.

II. GATHERING OF INFORMATION

The Task Force drew on both printed material and presentations by people with direct experience with various aspects of the existing building seismic hazard.

Printed resources that the Task Force used included a large array of publications from the Federal Emergency Management (FEMA), various California organizations, National Institute of Standards and Technology (NIST), the City of Portland, the City of Seattle, the Earthquake Engineering Research Institute (EERI), and the Task Force members' own libraries, knowledge, and experience. A complete list of the materials collected and considered is found in Appendix K. All minutes of meetings, correspondence, and materials gathered by the Task Force are on file with the Oregon Department of Geology and Mineral Industries.

The following invited speakers made presentations to the Task Force:

1. Franz Rad, Department of Civil Engineering, Portland State University
Inventorying Existing Buildings in the Portland Metropolitan Area.
Rehabilitation of Existing Buildings: Cost-Benefit Analysis
2. Ugo Morelli, FEMA, and Diana Todd, National Institute of Standards and Technology
Review of Federal and State Seismic Retrofit Programs, Seismic Rehabilitation of Federal Buildings, and the FEMA Seismic Rehabilitation Program
3. Cynthia Hoover, City of Seattle, author of a comprehensive review of California seismic retrofit policies
Discussion of Incentives/Measures for Seismic Retrofit in Zone 3
4. Ed Graham, Board of Geologist Examiners and Board of Engineering Examiners
Guidelines for Submittal of Geotechnical Reports; Status of Professional Engineering Licensing
5. Donald A. Hull, Oregon Department of Geology and Mineral Industries and Board of Geologist Examiners
Guidelines for Submittal of Geotechnical Reports
6. Kenneth Goettel, Goettel and Associates, Inc., and James Russell, Consulting Engineer
Seismic Risk Assessment, City of Portland
7. Margaret Mahoney, Portland Bureau of Buildings
Review of Progress of the Portland Seismic Task Force
8. Don Eggleston, Portland Seismic Task Force
Review of Progress of the Portland Seismic Task Force
9. Ken Zinsli, Providence Hospital
Seismic Rehabilitation as It Relates to Hospitals
10. John Beaulieu, Oregon Department of Geology and Mineral Industries
Legislative History of Senate Bill 1057
11. Joe Brewer, Building Codes Division
Building Code Division's Position on Building Permit Surcharge and Active Triggers
12. Tom McCormack, Department of Civil Engineering, Portland State University
Rehabilitation of Existing Buildings: Cost-Benefit Analysis
13. Howard Kieffer, District Counsel, Santa Ana, CA
Benefit Assessment District Experiences of Long Beach, California
14. Chris Crean, Legislative Counsel
Legislation Related to Seismic Rehabilitation Recommendations

Meetings or hearings were held on the following dates at the following locations:

Meeting Date	Location
October 31, 1995	Portland
November 15, 1995	Salem
November 29, 1995	Salem
December 21, 1995	Salem
January 18, 1996	Salem
February 2, 1996	Salem
February 15, 1996	Salem
February 22, 1996	Salem
March 7, 1996	Salem
March 14, 1996	Salem
March 28, 1996	Salem
April 4, 1996	Salem
April 25, 1996	Salem
May 15, 1996	Portland
May 21, 1996	Portland
May 30, 1996	Klamath Falls (Town Hall Meeting)
June 5, 1996	Eugene (Town Hall Meeting)
June 6, 1996	Newport (Town Hall Meeting)
June 12, 1996	Salem
June 13, 1996	Portland
June 14, 1996	Salem
June 18, 1996	Salem
June 27, 1996	Salem
July 10, 1996	Portland
August 1, 1996	Salem
August 8, 1996	Salem
August 21, 1996	Salem

III. INPUT FROM THE PUBLIC

All meetings of the Task Force were open to the public. As the report was being written, draft documents were made available to the public, the private sector, members of the professional engineering community, and government agencies. Input from these sources was noted and incorporated into succeeding drafts.

Spoken and written comment was received at Task Force meetings from the following people: James Bela, Oregon Earthquake Awareness; Gerry Uba, Metro, Natural Hazard Program; Evan Kennedy, Kennedy Associates, Inc.; Sherry Patterson, Oregon Earthquake Preparedness Network; Grant Davis, KPFF and Portland Seismic Task Force; Mike Hagerty, City of Portland; Randy Prince, Lane County resident; John McDonald, geotechnical engineer; Henry Kunowski, Oregon State Historic Preservation Office; Greg Shea, Structural Engineering Association of Oregon; Ron McMillan, Bank of America; Gregory Shea, Structural Engineers of Oregon; Jane Cummins, League of Oregon Cities; Bill Elliott, Portland Water Bureau and Oregon Seismic Safety Policy Advisory Commission; Lisa Burchen, Historic Preservation League of Oregon; Dennis Sigrist, Oregon Emergency Management.

Following is a list of persons or groups who commented in writing on the draft report:

Martha Peck Andrews, Architects Council of Oregon, American Institute of Architects; James Andrews, Architect, Portland; Association of Oregon Cities (AOC); League of Oregon Cities (LOC); Special Districts Association of Oregon (SDAO); Oregon Association of Water Utilities (OAWU); Oregon School Boards Association (OSBA); Carole Atherton, Property Owner, Lake Oswego; James Lynch, Beaverton Schools; Don Bloom, Portland Office of Emergency Management; Robert Butler, Portland; Tim Lindsey, City of Cannon Beach; Ian McKechnic, Director of Housing Development, Portland Central City Concern (CCC); Bill Foster, Oregon Department of Administrative Services (DAS); Edwin Dean, Structural Engineer, Portland; Sue Frey, Engineer, CH2MHill, Corvallis; Lee Hodges, General Manager, Corporate Real Estate, PGE, and member of OSSPAC and Portland Seismic Task Force; Hood River Board of Commissioners; Cynthia Hoover, Structural Building Inspector for Seattle; Thomasina Gabriele, Institutional Facilities Coalition (IFC); Arthur James, Engineer, Arthur James Engineers, Portland; Thomas Kammerer, Professional Engineer, Salem; Evan Kennedy, Engineer, Portland; Dan Kovtynovich, Engineer, Eugene; Donald Little, Task Force and City of Salem; Jane Cummins, League of Oregon Cities (LOC); Richard Maris, Architect, Eugene; Patrick McCluskey, IDC/Structural Department Manager; Roger McGarrigle, PE, Portland; Doug Meltzer, PE, BMGP Engineers, Inc.; Raymond Miller, PE; Craig McConachie, Metro Multifamily Housing Association (MMHA); Ugo Morelli, Policy Manager, FEMA; Richard Nored, President, HGE Inc. Architects, Engineers, Surveyors, and Planners; Frank Brawner, Oregon Bankers Association; Bob Moore, Oregon Building Officials Association (OBOA); Vickie Totten, Oregon Community College Association (OCCA); Gary Pope, Oregon Episcopal School; Oregon Seismic Safety Policy Advisory Commission (OSSPAC); William Bennett, Pacific Northwest Association of Independent Schools (PNAIS); Jay Buechler, Portland General Electric (PGE); Portland Metropolitan Association of Building Owners and Managers (BOMA); Portland Seismic Rehabilitation Task Force; Michael Powell, Powells Books; Frank Summerton, Vice President, RiverPlace; J.E. Russell, Building Codes, Concord, CA; Greg Shea, President, Structural Engineers of Oregon; Alfred Staehli, Architect, Portland; Steve Huskins, Standard Insurance Co.; John Stirek and Dave Hewett, Trammel Crow Company; J.A. Talbott, Talbott Engineers; Gerry Uba, Metro; Joseph Weston, Weston Investment Co., Portland; and Wade Younie, PE.

Following is a list of individuals or groups who commented in person on June 12, 13, or 14, 1996, on the draft report.

William Elliott, Vice-Chair of the Oregon Seismic Safety Policy Advisory Committee (OSSPAC); Allan Contreras, Oregon Community College Association (OCCA); Jane Cummins, League of Oregon Cities (LOC); Bob Moore, Oregon Building Officials Association (OBOA); Jim Green, Oregon School Board Association (OSBA); James Bela, Oregon Earthquake Awareness; Chuck Fetig, President, Building Owners and Managers Association (BOMA); John Russell, Russell Development Company and BOMA; Carole Atherton, Building Owner; Steve Kuskins, Standard Insurance; Dan Goodrich, Washington Mutual and BOMA; Steve Rose, Bristol Equities, Inc., and BOMA; Robin White, BOMA; Greg Shea, President, Structural Engineers of Oregon; Wade Younie, P.E.; Carol Hasenberg, P.E.; Don Eggleston, Chair, City of Portland Seismic Task Force; Margaret Mahoney, Director, City of Portland Bureau of Buildings; Thomasina Gabrielle, Institutional Facilities Coalition; Michael Hagerty, City of Portland Bureau of Buildings; Jim Russell, California engineer; William Bennett, Pacific Northwest Association of Independent Schools; Andrew Beyer, Catlin Gabel School; Gary Pope, Oregon Episcopal School; Ruth Gavish, Portland Jewish Academy; Martha Andrews, Architects Council of Oregon; Lee Row, State Service Center for GIS; Michael Powell, Powells Books; and Ray Lindley, State Department of Education.

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September 25, 1996

Seismic Rehabilitation Task Force
Oregon Dept. of Geology and Mineral Industries
800 NE Oregon Street, Suite 965
Portland, Oregon 97232

Seismic Rehabilitation Task Force Chair, Paul Lorenzini, has been gracious enough to allow each individual member of the task force to make a statement regarding their "sign-off" of the report. I, therefore, am taking advantage of this opportunity.

My signature to this report is to indicate that I have participated with the task force and I find the document to be a complete and accurate portrayal of our committee process and resultant findings, recommendations, and proposed legislation.

It should be clear, however, that the task force report was arrived at by consensus. "Consensus" does not mean total agreement. I fully support the thrust of the report, but may reserve the right to differ on some details.

Having been a participant on many other task forces, I believe we have produced a fine document considering the limited time and resources at our disposal. The legislature should take these recommendations seriously in order to protect the public health, safety and welfare.

I also thank the chair for succeeding in the difficult task of bringing us together to produce this important document.

Sincerely,

Dell Isham

Dell Isham
Public Member

APPENDIX B. SENATE BILL 1057

68th OREGON LEGISLATIVE ASSEMBLY–1995 Regular Session

B-Engrossed

Senate Bill 1057

Ordered by the House May 18
Including Senate Amendments dated April 26 and
House Amendments dated May 18

Sponsored by COMMITTEE ON GOVERNMENT FINANCE AND TAX POLICY (at the request of City of Portland)

SUMMARY

The following summary is not prepared by the sponsors of the measure and is not a part of the body thereof subject to consideration by the Legislative Assembly. It is an editor's brief statement of the essential features of the measure.

Allows municipality to adopt specified seismic rehabilitation plans. Establishes Seismic Rehabilitation Task Force. Defines terms. Limits admissibility of certain data as evidence in action for damages arising from building failure due to seismic activity.

A BILL FOR AN ACT

Relating to buildings; creating new provisions; and amending ORS 455.020.

Be It Enacted by the People of the State of Oregon:

SECTION 1. As used in this Act:

(1) "Seismic rehabilitation" means construction of structural improvements to a building that result in the increased capability of the building to resist earthquake forces and that are based on standards adopted by the State of Oregon or by local governments.

(2) "Seismic rehabilitation agreement" means an agreement between a local government entity and a building owner pursuant to a seismic rehabilitation program for the phased completion of structural improvements to the owner's building.

(3) "Seismic rehabilitation data" means data contained in any documents, reports, studies, test results, papers, files or other records that result from a seismic rehabilitation survey or are contained in a seismic rehabilitation agreement. "Seismic rehabilitation data" does not include data or reports required by ORS 455.447 or rules adopted pursuant thereto.

(4) "Seismic rehabilitation program" means any program enacted under an ordinance of a local government entity that provides for the seismic rehabilitation of buildings within the jurisdiction of the entity and authorizes the rehabilitation to be phased over a period of time not to exceed 10 years.

(5) "Seismic rehabilitation survey" means any investigation, survey, audit or other process for generating data from which the local government entity and the building owner may determine and agree upon the deficiencies that need to be addressed in a plan for the seismic rehabilitation of the owner's building.

SECTION 2. (1) No seismic rehabilitation data or seismic rehabilitation agreement is admissible in evidence to prove negligence or culpable acts or omissions in connection with injury, death or loss that occurs in an owner's building as a result of the failure of the building to adequately withstand a seismic event. Such data or agreements are considered privileged and are excluded from evidence admitted in any legal action for the recovery of

NOTE: Matter in **boldfaced** type in an amended section is new; matter [*italic and bracketed*] is existing law to be omitted. New sections are in **boldfaced** type.

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damages arising from the building's failure due to seismic activity.

(2) A person may not maintain a cause of action against a building owner for injury, death or loss that occurs in the owner's building as a result of a failure of the building to adequately withstand a seismic event, provided the owner was in substantial compliance with the terms and conditions of a seismic rehabilitation agreement on the date of the seismic event.

(3) The provisions of subsection (2) of this section shall apply only for the period during which the seismic rehabilitation agreement is in effect.

SECTION 3. Section 2 of this Act applies to injuries, deaths or losses occurring on or after the effective date of this Act.

SECTION 4. (1) There is established a Seismic Rehabilitation Task Force consisting of 13 members. The task force shall make recommendations to the Sixty-ninth Legislative Assembly regarding provisions of law that will lead to effective seismic rehabilitation of existing structures in the State of Oregon.

(2) Members of the task force shall be appointed by the State Geologist, in conjunction with the Governor, by September 1, 1995, and shall include representatives of the following:

(a) The three largest cities in this state.

(b) A building owners and managers association.

(c) The State Department of Geology and Mineral Industries.

(d) An association representing the interests of cities.

(e) An association representing the interests of counties.

(f) The Department of Consumer and Business Services.

(g) The general public, to be represented by two members.

(h) The financial industry.

(i) The insurance industry.

(j) An organization of structural engineers.

(3) The task force shall consider and make recommendations on seismic rehabilitation issues, including but not limited to:

(a) Incentives.

(b) Long term goals.

(c) Liability.

(d) Review of existing structures.

(e) Reasonable standards for structural rehabilitation.

(f) Cost and public safety considerations.

(g) Administration of structural rehabilitation programs.

(h) Geotechnical reports.

(i) Benchmark tracking of structural rehabilitation programs.

(4) The task force shall prepare and deliver to the Legislative Assembly a report of its findings and recommendations by September 30, 1996.

SECTION 5. ORS 455.020 is amended to read:

455.020. (1) This chapter is enacted to enable the Director of the Department of Consumer and Business Services to promulgate a state building code to govern the construction, reconstruction, alteration and repair of buildings and other structures and the installation of mechanical devices and equipment therein, and to require the correction of unsafe conditions caused by earthquakes in existing buildings. The state building code shall establish uniform performance standards providing reasonable safeguards for health, safety, welfare, comfort and security of the residents of this state who are occupants and users of buildings, and will provide for the use of modern methods, devices, materials, techniques and practicable maximum energy conservation.

(2) The regulations adopted pursuant to this chapter shall include structural standards; standards for the installation and use of mechanical, heating and ventilating devices and equipment; and standards for prefabricated structures; and shall, subject to ORS 455.210 (1) to (5), prescribe reasonable fees for the issuance of building permits and similar documents, inspections and plan review services by the Department of Consumer and Business Services.

(3) This chapter does not affect the statutory jurisdiction and authority of the Workers' Compensation Board, under ORS chapter 654, to promulgate occupational safety and health standards relating to places of employment, and to administer and enforce all state laws, regulations, rules, standards and lawful orders requiring places of employment to be safe and healthful.

(4) This chapter and any specialty code does not limit the authority of a municipality to enact regulations providing for local administration of the state building code; local appeal boards; fees and other charges; abatement of nuisances and dangerous buildings; enforcement through penalties, stop-work orders or other means; or minimum health, sanitation and safety standards for governing the use of structures for housing, except where the power of municipalities to enact any such regulations is expressly withheld by statute. **Pursuant to the regulation of dangerous buildings, a municipality may adopt seismic rehabilitation plans that provide for phased completion of repairs that are designed to provide improved life safety but that may be less than the standards for new buildings.**

(5) No person shall rent, lease, sell, exchange or offer for rent, lease, sale or exchange within this state a prefabricated structure constructed on or after July 1, 1991, unless it bears an insignia of compliance or certification stamp indicating compliance with the state's building regulations and standards for prefabricated structures. A prefabricated structure assembled or installed on or after July 1, 1991, shall bear one data plate describing the characteristics of the structure as required by the department. A prefabricated structure with an insignia of compliance or certification stamp shall be acceptable to municipalities as meeting the state building code regulations. Prefabricated structures constructed prior to July 1, 1991, are subject to the building code regulations in effect at the time of original construction.

SECTION 6. Nothing in this Act shall be construed as expanding or limiting the exclusive means by which subject workers and their beneficiaries are compensated for injury, death or disease arising out of and in the course of employment as provided in ORS chapter 656.

APPENDIX C. EARTHQUAKES IN OREGON

Earthquakes occur in Oregon because of plate tectonics. The earth is covered by rigid plates that are all moving relative to each other. Most earthquakes in the world occur at plate boundaries, where the plates interact with each other. California has very complex geology with frequent earthquakes because it is located where two plates, the Pacific Plate and the North American Plate, are sliding past each other. In the Pacific Northwest, however, the plates run headlong into each other, forcing one plate, the Juan de Fuca Plate, to dive under the overriding plate, the North American Plate in which Oregon is embedded, along a huge fault called the Cascadia Subduction Zone that parallels the Oregon and Washington coasts. Because the nature of the contact between the plates is different in Oregon than it is in California, earthquakes happen less frequently in Oregon.

Oregon earthquakes can originate in one of three source areas: (1) Relatively shallow **crustal earthquakes** occur along faults that can extend to as deep as 20 miles below the surface in the overriding North American Plate as it crumples against the Juan de Fuca Plate. (2) **Intraplate earthquakes** occur at greater depths (about 20 to 40 miles beneath the surface) within the subducting Juan de Fuca Plate. (3) **Subduction zone earthquakes** occur when the plates, which are locked against each other along the Cascadia Subduction Zone, break free, releasing stored-up energy in a great regional earthquake.

Crustal earthquakes, while smaller in magnitude than subduction zone earthquakes, are the most frequent earthquakes to occur in Oregon. The Scotts Mills (magnitude 5.5) and Klamath Falls earthquakes (magnitudes 5.9 and 6.0) in 1993 were both shallow crustal earthquakes. The most recent deep, intraplate earthquakes occurred in Washington in 1949 (magnitude 7.1) and again in 1965 (magnitude 6.5). The subduction zone earthquakes occur less frequently, on average between 350 to 500 years apart. The last subduction zone earthquake occurred about 300 years ago. Although they happen infrequently, subduction zone earthquakes affect large geographic areas and can be quite powerful, ranging generally between magnitude 8 and 9, with one in Chile in 1960 reaching magnitude 9.5.

Because California has had frequent but smaller earthquakes, Californians have learned to prepare for them, and California has done much to develop and implement earthquake mitigation measures such as building codes, building practices, and emergency procedures. In Oregon, however, because our geology is different and earthquakes happen less frequently here, we have only recently become aware of the seismic threat, and a great subduction zone earthquake, though rare, has the potential to do much damage. Because our buildings and people are not adequately prepared, steps need to be taken to mitigate the potentially devastating effects of earthquakes.

For more detailed technical information about earthquakes in Oregon, see "Technical Explanation of Earthquake Hazard in Oregon" (below).

Technical Explanation of Earthquake Hazard in Oregon

Oregon has earthquakes because of plate tectonics. Scientists know that the surface of the earth is covered by several large rigid plates all moving relative to each other. Oregon lies where a continental plate called the North American Plate and an oceanic plate called the Juan de Fuca Plate are running headlong into each other. Because the Juan de Fuca Plate is denser than the North American Plate, it is diving beneath the North American Plate, along a fault called the Cascadia Subduction Zone. Earthquakes in Oregon originate from one of three different source areas: (1) Relatively shallow **crustal**

earthquakes occur in the North American Plate along faults that can be as much as 20 miles below the surface. (2) **Intraplate earthquakes**, known also as Wadati-Benioff earthquakes, occur at greater depths (about 20 to 40 miles beneath the surface) in the subducting Juan de Fuca Plate. (3) **Subduction zone earthquakes** occur where the plates are believed to be locked against each other along an offshore fault called the Cascadia Subduction Zone that parallels the Oregon and Washington coasts.

Crustal earthquakes are the most common in Oregon and include both of the 1993 events. They occur along relatively short and shallow faults that may or may not be visible at the surface of the earth. Although historically such earthquakes have not exceeded magnitude 6, geoscientists conclude that many faults in Oregon are capable of producing occasional earthquakes as large as magnitude 6.0 to 6.5, with a few reaching close to magnitude 7. The magnitude 5.6 Scotts Mills earthquake of March 25, 1993 (Madin and others, 1993), and the magnitude 5.9 and 6.0 Klamath Falls earthquakes of September 20, 1993 (Wiley and others, 1993), were all shallow crustal earthquakes. Crustal earthquakes are relatively common in the Portland area and northern Willamette Valley, off the southern coast of Oregon, in northeastern Oregon, and in scattered areas throughout southeast Oregon. For most areas east of the Cascades, the majority of the bedrock earthquake shaking hazard comes from crustal faults. Both the Northridge, California, earthquake of January 17, 1994, and the Kobe, Japan, earthquake of January 17, 1995, were crustal earthquakes with magnitudes less than 7. In the Northridge earthquake, more than $30 billion dollars in damage was done, $336 million to schools alone. Due to California's long history of earthquake-resistant building requirements combined with seismic rehabilitation programs, only 57 lives were lost. Damage from the Kobe earthquake is estimated to have been over $100 billion. Furthermore, over 5,000 people lost their lives in the Kobe earthquake. Figure C-1 shows that the damage was concentrated in the older structures built in Kobe before Japan's stringent modern building codes were in place.

Intraplate earthquakes are the type that rocked the Puget Sound region in 1949 (magnitude 7.1) and again in 1965 (magnitude 6.5). Those who lived in Portland in 1949 will recall that the Portland area also had damage from that earthquake. Intraplate earthquakes occur within the remains of the ocean floor that has been shoved (subducted) beneath North America. It is now believed that this type of earthquake could occur anywhere beneath the Coast Ranges or western Willamette Valley, with 7 to 7.5 being the maximum magnitude.

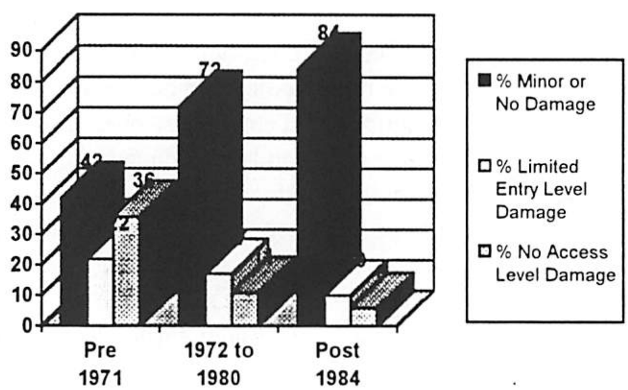


Figure C-1. Comparison of damage vs. date of construction in Kobe earthquake.

Subduction zone earthquakes occur around the world in subduction zones, where continent-sized pieces of the earth's crust are shoved deep into the body of the earth. These earthquakes consistently are among the most powerful recorded, often having magnitudes of 8 to 9 on the moment magnitude scale. The Cascadia Subduction Zone, which has long been recognized off the coast of Oregon and

Washington, has had no earthquakes during our short 200-year historical record. However, in the past five years, studies by numerous Pacific Northwest geologists from the US Geological Survey and various universities, including University of Washington, Portland State University, and Humboldt State University have found evidence of past earthquakes causing tsunamis that left sand deposits in low-lying areas, coastal subsidence that buried low-lying forests and marshes, turbidites in the ocean, liquefaction resulting from strong ground shaking, and Native American legends of inundation of villages along the coast, over an area extending from Cape Mendocino, California, to British Columbia. This research has been summarized by Atwater and others (1995). Other research on the same subject is summarized in a variety of papers, including those by Atwater (1987, 1992), Madin (1992), Peterson and others (1993), Mitchell and others (1994), Darienzo and Peterson (1995), Nelson and others (1995), Priest (1995), and Toppozada and others (1995). Repeated sequences of buried marsh deposits indicate that subduction zone earthquakes occurred at intervals of about 350 to 500 years. Radiocarbon dating and tree-ring chronology studies of vegetation taken from a variety of sites along the coast show that the most recent earthquake occurred about 300 years ago. The damage potential of subduction zone earthquakes stems from the combination of strong ground shaking combined with long duration of shaking--all taking place over a broad area. A subduction zone earthquake is capable of damaging buildings in western Oregon from the California border to the Washington border.

Figure C-2 shows all faults in Oregon known or suspected to be capable of producing earthquakes. The faults are divided into three categories based on the age of the evidence of the most recent activity. The age is determined by estimating the age of the youngest geologic material cut by the fault. As such, it provides a maximum estimate for the age of activity. It is possible that significant earthquakes might occur along a fault and not break the surface, as was the case with both the Scotts Mills and Klamath Falls earthquakes of 1993. It is also possible that recent faulting may have occurred in an area where only old rocks are exposed, so that the age estimate would be too old.

In many parts of Oregon, particularly western Oregon, which is heavily vegetated, it is difficult to locate faults at the surface and therefore difficult to determine where a fault is with respect to a given site. This fault map should not be used to determine the presence or absence of faulting for specific sites. It is also important to note that there is no historical record of an earthquake in the Pacific Northwest that caused visible fault rupture at the ground surface. This includes the North Cascades event in 1872 (magnitude 7.4); Port Orford earthquake in 1873 (magnitude 6.8); Portland earthquakes of 1877 (magnitude 5.5) and 1961 (magnitude 5.2); Milton-Freewater earthquake of 1936 (magnitude 6.1); Olympia, Washington, earthquake of 1949 (magnitude 7.1); Seattle, Washington, earthquake of 1965 (magnitude 6.5); Klamath Falls earthquake of 1993 (magnitude 6.0); and Scotts Mills earthquake of 1993 (magnitude 5.6). Clearly the presence of faults does not necessarily indicate a high degree of hazard, nor does the absence of faults mapped as being active indicate an absence of hazard.

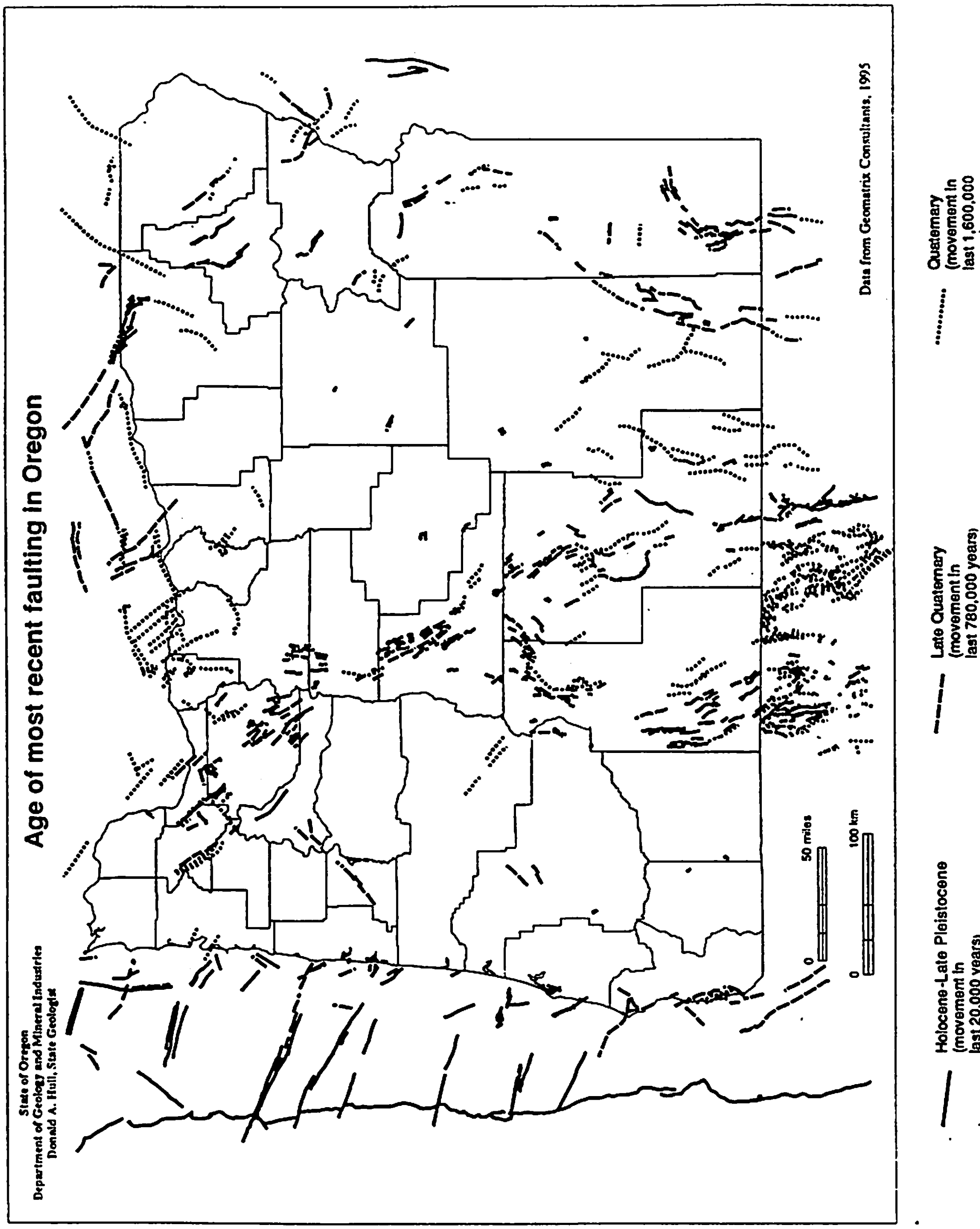


Figure C-2. Age of most recent faulting in Oregon.

The probabilistic hazard maps in Figures C-3, -4, and -5 are from a series of maps produced by Geomatrix Consultants for the Oregon Department of Transportation in 1994 and 1995. The purpose of the maps is to provide the most up-to-date possible estimate of the likely strength of bedrock earthquake shaking throughout Oregon. The maps were produced by assembling all known information about faults, earthquakes, and rates of earth movement and using this information to estimate how often, how large, and where future earthquakes would strike. All of the information collected by Geomatrix Consultants was reviewed by a panel of geoscientists who are experts in Oregon geology and seismology. This information and other information describing how earthquake shaking travels and diminishes with distance were modeled by computer to calculate the probable strength of shaking at any site in Oregon from all earthquake sources combined.

The maps include information about how often an earthquake occurs, because over time, the damage caused by frequent small events may be similar to that caused by much larger but much rarer events. In simple terms, the map shows a level of ground shaking that has a 90% chance of not being exceeded in the selected time period (500, 1,000, or 2,500 years, in this case). Another way to look at this is that if a building is designed for the level shown on the map, there is only a 10% chance that that level will be exceeded during the time period of the map.

Clearly, the level of hazard changes significantly from the 500-year map to the 1,000-year map to the 2,500-year map. The time window appropriate for a given objective is discussed in the section on seismic rehabilitation standards. One should note the difference between the rare but foreseeable and expected ground motions in the 2,500-year map and the ground motions in the 500-year map.

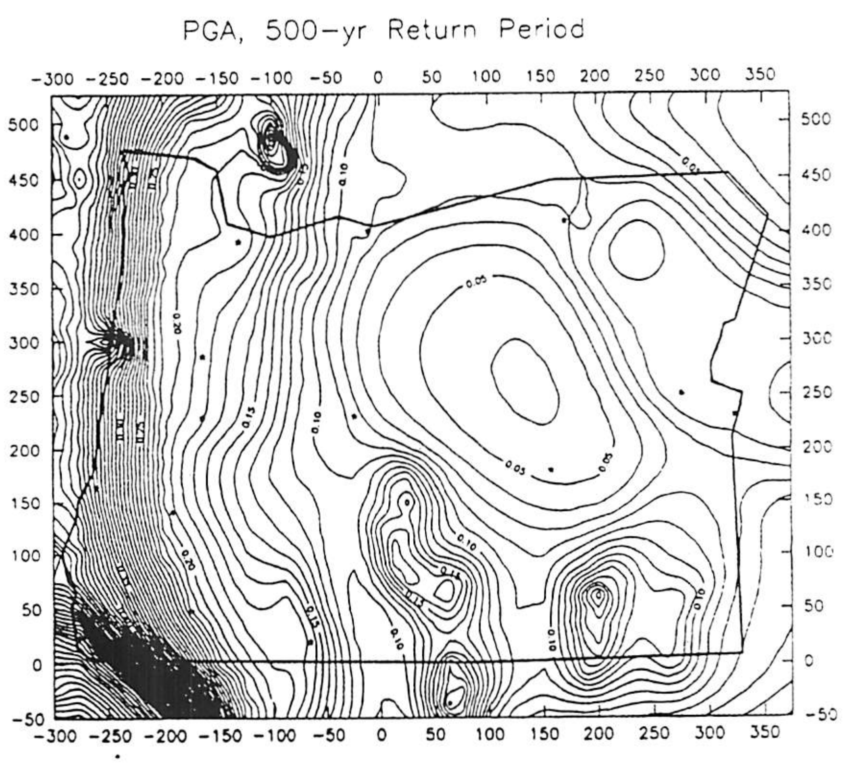


Figure C-3. Contours of peak ground acceleration levels (g) with a return period of 500 years.

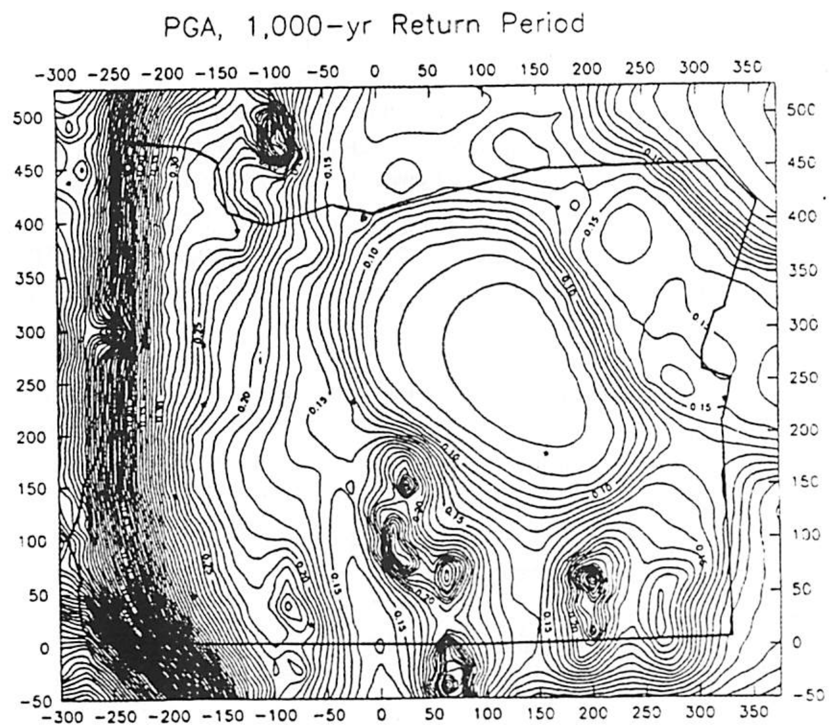


Figure C-4. Contours of peak ground acceleration levels (g) with a return period of 1,000 years.

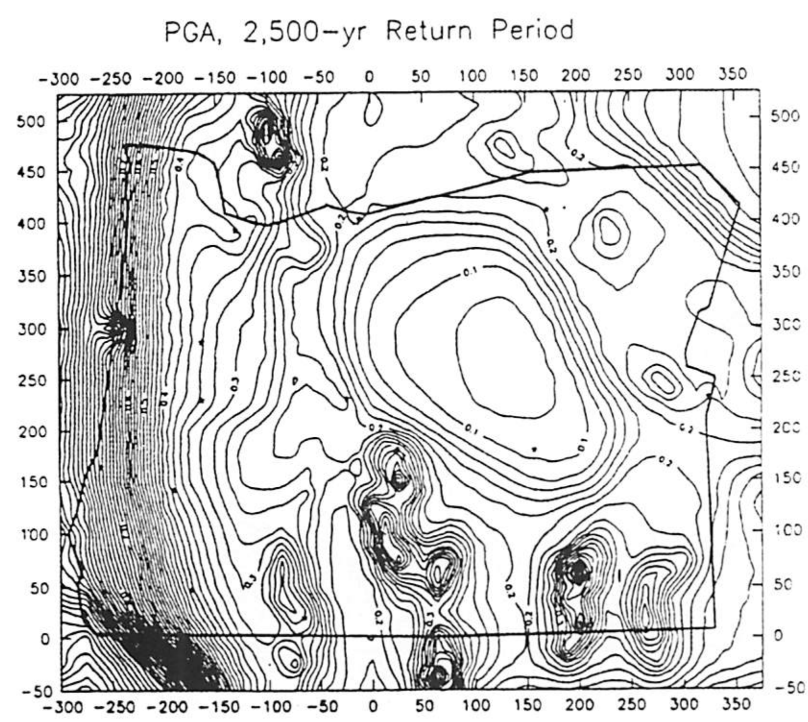


Figure C-5. Contours of peak ground acceleration levels (g) with a return period of 2,500 years.

APPENDIX D. TIME FRAMES IN OTHER JURISDICTIONS

At this time, only a few government agencies in other parts of the country have defined time frames for seismic rehabilitation work.

1. The Federal government under Executive Order 12941 directed the Interagency Committee on Seismic Safety in Construction (ICSSC) to develop an inventory of federally owned and leased buildings within four years of issuance of the order, which was signed on December 1, 1994. The ICSSC arrived at a seismic rehabilitation deadline of 35 years from the completion of the inventory. This number was based upon the average lease length of a typical government building. Due to the lack of comprehensive cost data, however, this additional timeline has not been mandated.

2. California Senate Bill 1953 regarding seismic safety in hospitals has mandated the following timelines:
   - After January 1, 2008, any acute care hospital building that is determined to be at potential risk of collapse or which poses significant loss of life during an earthquake shall be used only for nonacute care hospital purposes.
   - No later than January 1, 2030, owners of all acute care inpatient hospitals shall either:
     - Demolish, replace, or change to nonacute care use all hospital buildings not in substantial compliance, or
     - Seismically retrofit all acute care inpatient hospital buildings so that they are in substantial compliance with the regulations.

3. The City of Los Angeles' proposed Division 95 regulations concerning earthquake hazard reduction in existing reinforced concrete buildings and concrete frame buildings with masonry infills mandate the following compliance schedule once the regulations have been adopted:
   - Submit plans within one year.
   - Obtain building permit within two years.
   - Commence construction within two and one-half years.
   - Complete construction within four years.

4. According to the Hoover report, as of 1992, the following cities within California had mandatory URM active trigger ordinances and stipulated deadlines for mitigation:
   - Berkeley has a three- to ten-year deadline, depending upon occupant load.
   - Daly City has a five-year deadline.
   - Hayward has a five-year deadline.

5. Fred Turner of the Seismic Safety Commission of the State of California stated in a phone conversation that the State of California is currently requiring all jurisdictions that do not have a timeline to adopt one with a range of between three and seven years. The range is to accommodate varying levels of hazard. This timeline starts from the date an owner is notified of the required upgrade to the time of issuance of the building seismic rehabilitation permit.

6. Salt Lake City seismic rehabilitation requirements for schools are as follows:
    - Three-story, high hazard schools have a five-year deadline.
    - Other high-hazard schools have a ten-year deadline.
    - Two-story, appreciable hazard schools have a 15-year deadline.
    - Other appreciable-hazard schools have a 20-year deadline.

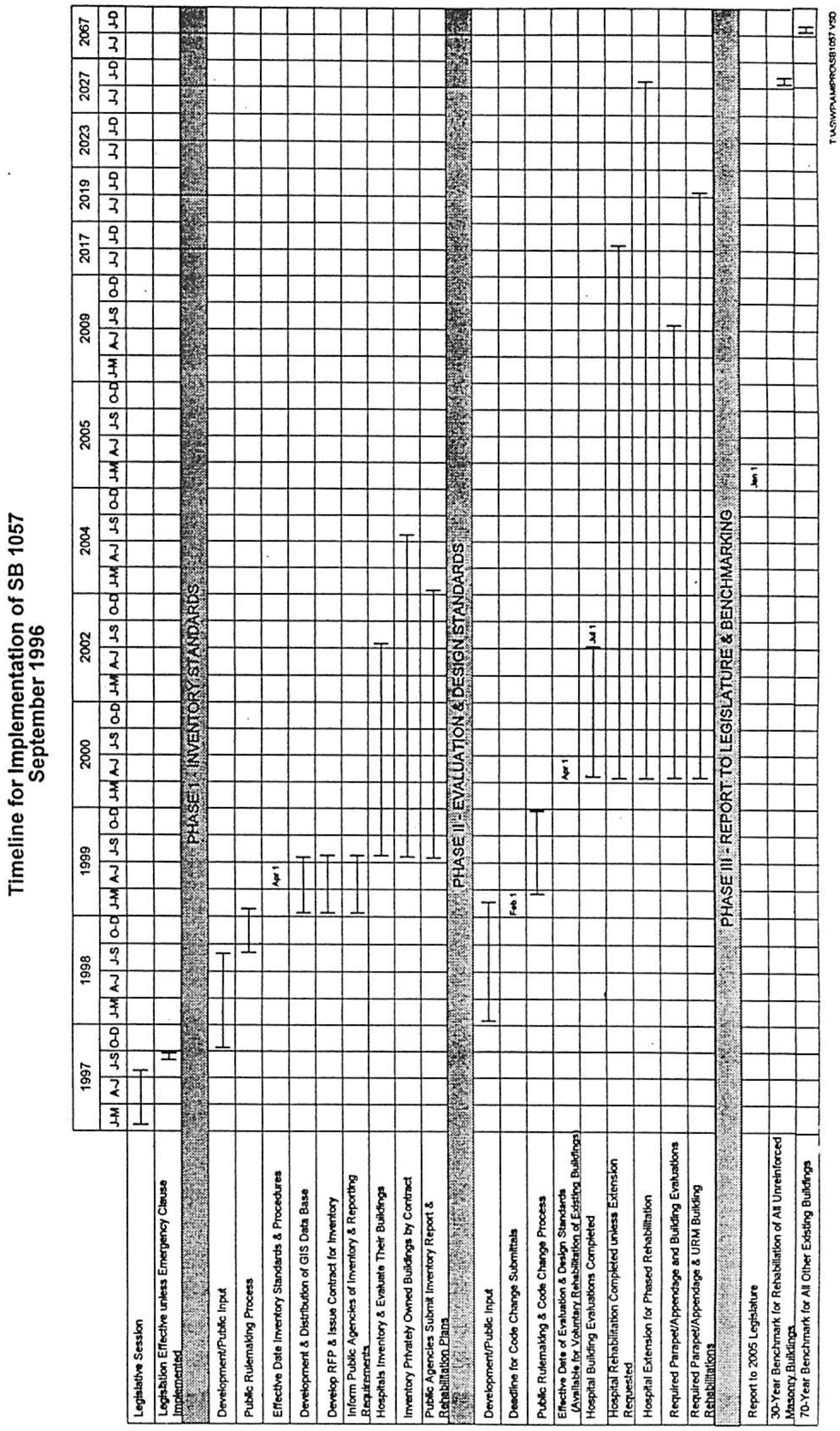
7. Various California jurisdictions have the following requirements for seismic rehabilitation (Table D-1):

Table D-1. *Seismic Rehabilitation Requirements for Some California Jurisdictions**

City	Priority classification	Submit plans	Permit	Complete within	Comments/ definitions
Fullerton	All pre-1934 bldgs.				Mandatory retrofitting: must comply with ordinance within two years.
	Essential	--	--	--	
	High risk	--	--	--	
	Medium risk	--	--	--	
	Low risk	--	--	--	
	All pre-1974 concrete tilt-up bldgs.	--	--	--	Mandatory retrofitting: must comply with ordinance within two years.
Long Beach	Most dangerous	--	--	Immed.	
	More dangerous	--	--	Six years	
	Least dangerous	--	--	11 years	
Palo Alto	All URMs	1.5 yrs.	--	--	No set deadline for completion.
	All pre-1935 non-URM with 100 or more occupants	2 yrs	--	--	
	All with 300 or more occupants built between 1/1/35 and 8/31/76	2.5 yrs.	--	--	
Sonoma	Unsafe and masonry concrete buildings				--
	High priority	2 yrs.	2.5 yrs.	4.5 yrs.	--
	Moderate priority	3 yrs.	5 yrs.	7 yrs.	--
	Low priority	4 yrs.	10 yrs.	12 yrs.	--
West Hollywood	URMs	--	--	12-18 mo.	Installation of wall anchors.
		--	--	4-7 yrs. (depending on const. type)	Complete retrofit.
San Mateo (based on L.A. ordinance)	URMs	--	--	8 yrs.	If owner installs anchors.
		--	--	3 yrs.	If owner doesn't install anchors.

*According to "Seismic Retrofit Incentive Programs" published by the California Office of Emergency Services and the Association of Bay Area Governments, 1992. Timelines are from date of notification.

APPENDIX E. OREGON TIMELINE FOR SEISMIC REHABILITATION PROGRAM



APPENDIX F. STANDARDS

COMMENTARY

Tables F-1.a and F-1.b describe the intent of the recommended seismic rehabilitation design standards with regard to triggering mechanism, occupancy type, seismic rehabilitation standard (present and future) to be used, time frame for work to be performed, applicable Uniform Building Code Seismic Zone, and seismic performance objective.

A. Basis of Triggering Mechanisms

There are two recommended approaches to seismic rehabilitation. The most hazardous types of buildings and portions of buildings are to be evaluated and rehabilitated as soon as possible. These types of buildings are covered by the mandatory seismic requirements. Passive triggers are used to address other construction types that pose less risk than those buildings included in the mandatory triggers. Due to economic considerations, passive triggers may minimize the initial cost impact to the community.

Initial emphasis is on only one construction type: unreinforced masonry buildings (URMs). These structures have historically proven to be the most hazardous due to their lack of ductility, unbraced parapets, and lack of adequate wall-to-diaphragm connections. A few communities in California have adopted more aggressive approaches to seismic rehabilitation, which are intended to address other hazardous building types such as nonductile reinforced concrete or older tilt-up wall structures. The State of California as a whole has less stringent standards than do these few communities. Therefore, it is the consensus of this Task Force that to adopt a more encompassing plan than California has was not feasible at this time. The Task Force recognizes that other potentially hazardous structures exist that are not covered by the initial proposed program of seismic rehabilitation.

It is possible to develop a more elaborate seismic rehabilitation policy, recognizing that seismic risk is not strictly dependent upon building construction type alone. Other factors such as local soil conditions and building geometry (height, structural irregularities, building adjacencies, and lateral force resisting system redundancies) greatly affect the behavior of a structure. Additionally, the type or density of occupancy is another variable that could be used to better characterize the risk. For example, structural engineers have identified nonductile reinforced concrete frames as being another hazardous construction type. Buildings of this type are most prevalent in the larger metropolitan areas and were constructed beginning in the early 1900s until the 1970s. In its inventory of buildings, the City of Portland has identified 200 of these structures so far (see Table F-2, type C1). A 10-story building of this type of construction, founded on a deep soft soil, may have more seismic risk than a short unreinforced masonry building founded on rock because of the increased number of occupants, lack of adequate ductility, and increased dynamic effects due to the soil-structure interaction.

Table F-1.a. Seismic Rehabilitation Standards for Mandatory Seismic Rehabilitation

		REHABILITATION STANDARD											
		PRESENT PRACTICE					FUTURE PRACTICE						
		Force level applied to:		Detailing			Force level applied to:		Detailing			Time frame (years)	
Category	Occ. type (Table 16-K, UBC)	Exist. construction	New work	Evaluation of exist. construction	Design of new work	Seismic performance objective**	Exist. const.	New work	Eval. of existing construction	Design of new work	Seismic performance objective***	Evaluation and analysis	Rehab.
M-1	All	FEMA 178	FEMA 178	FEMA 178	UBC	Subst. life safety	FEMA 273 (see seismic performance objective for minimum force level)	FEMA 273	FEMA 273	IBC (FEMA 222A)	Life safety/ collapse prevention	5	10 TOTAL 15
M-2	Essential	UBC I=1.25*#	UBC I=1.25*	UBC I=1.25*	UBC I=1.25*	Immed. occupancy	FEMA 273 (see seis. perf. obj. for min. force level)	FEMA 273	FEMA 273	IBC (FEMA 222A)	Immed. occ./ life safety	5	10 TOTAL 15
	Hazardous	UBC I=1.25*#	UBC I=1.25*	UBC I=1.25*	UBC I=1.25*	Immed. occupancy							
M-3	Hospital	UBC I=1.25*	UBC I=1.25*	UBC I=1.25*	UBC I=1.25*	Immed. occupancy	FEMA 273 (see seismic perf. objective for minimum force level)	FEMA 273	FEMA 273	IBC (FEMA 222)	Immed. occ./ life safety	3	15 TOTAL 18
M-4	All	Code at time of design or FEMA 178, whichever is greater				Subst. life safety	Code at time of design or FEMA 273, whichever is greater				Life safety/ collapse prev.	As mandated by current law (918-470-010-110)	
	Essential/ hazardous	UBC I = 1.25#				Immed. occupancy	Code at time of design or FEMA 273, whichever is greater				Immed. occ./life safety		

Table F-1.b. Seismic Rehabilitation Standards for Passive Triggers

		REHABILITATION STANDARD											
		PRESENT PRACTICE					FUTURE PRACTICE						
		Force level applied to:		Detailing			Force level applied to:		Detailing			Time frame (years)	
Trigger	Occ. type (Tbl 16-K,UBC)	Exist. const.	New work	Eval. of exist. const.	Design of new work	Seismic performance objective**	Existing construction	New work	Eval. of existing construction	Design of new work	Seismic performance objective***	Eval. and analysis	Retrofit
P-1 1	All changes to ess./haz. (cat 5)	UBC I=1.25*#	UBC I=1.25*	UBC I=1.25*	UBC I=1.25*	Immed. occupancy (I=1.25)	FEMA 273 (see seismic perf. objective for minimum force level)	IBC (FEMA 222A)	FEMA 273	IBC (FEMA 222A)	Immed. occupancy/ life safety	N/A	N/A
	Spec. (cat 5)	UBC I=1.0#	UBC I=1.0	UBC I=1.0	UBC I=1.0	Life safety (I=1.0)					Life safety/collapse prevention		
P-1 2	Essential/ hazardous	UBC I=1.25*	UBC I=1.25*	UBC I=1.25*	UBC I=1.25*	Immed. occupancy (I=1.25)	FEMA 273 (see seismic perf. objective for minimum force level)	IBC (FEMA 222A)	FEMA 273	IBC (FEMA 222A)	Immed occupancy/ life safety	N/A	N/A
	All other	UBC I=1.0#	UBC I=1.0	UBC I=1.0	UBC I=1.0	Life safety (I=1.0)					Life safety/collapse prevention		
P-2	Essential/ hazardous	UBC I=1.25*#	UBC I=1.25*	UBC I=1.25*	UBC I=1.25*	Immed. occupancy	FEMA 273 (see seismic perf. objective for minimum force level)	IBC (FEMA 222A)	FEMA 273	IBC (FEMA 222A)	Immed. occupancy/life safety	N/A	N/A
	All other	UBC I=1.0#	UBC I=1.0	UBC I=1.0	UBC I=1.0	Life safety. (I=1.0)					Life safety/collapse prev.		
P-3	All	FEMA 178 study	N/A	FEMA 178 study	N/A	Subst. life safety	FEMA 273 (see seismic perf. objective for minimum force level)	N/A	FEMA 273	N/A	Life safety/ collapse prevention	N/A	N/A
P-3.1 P-3.2	Essential/ hazardous	UBC I=1.25*#	UBC I=1.25*	UBC I=1.25*	UBC I=1.25*	Immed. occupancy	FEMA 273	IBC (FEMA 222A)	FEMA 273	IBC (FEMA 222A)	Immed. occ./life safety	N/A	N/A
	All other	UBC I=1.0#	UBC I=1.0	UBC I=1.0	UBC I=1.0	Life safety					Life safety/ collapse prevention		
P-4	Essential/haz.	UBC I=1.25*#	UBC I = 1.25#	UBC I = 1.25#	UBC I = 1.25#	Immed. occupancy	FEMA 273 (see seismic perf. objective for minimim force level)	IBC (FEMA 222A)	FEMA 273	IBC (FEMA 222A)	Immed. occupancy/life safety	N/A	N/A
	All other	UBC I=1.0#	UBC I=1.0#	UBC I=1.0#	UBC I=1.0#	Life safety					Life safety/collapse prevention		

* Site-specific seismic hazard study required according to the Oregon Structural Specialty Code.
\# For URMs, use UBC force levels with FEMA 178, Appendix C, lateral force distribution; otherwise, for other construction types, use UBC.
** As defined by FEMA 273.
*** As defined by FEMA 273 for 475-year and 2,500-year events.

Table F-2. *Distribution of Portland Buildings by Structure Category. Listed from Most Hazardous Type to Least Hazardous Type*

CITY OF PORTLAND SURVEY (as of 3/1/96)		
Building type	**G and H Code***	**Percentage**
Unreinforced masonry bearing walls	URM	8.9
Precast concrete frame with concrete shear walls	PC2	0.3
Concrete/steel frames with unreinforced masonry infill walls	C3/S5	0.7
Reinforced masonry bearing walls with concrete or wood diaphragms	RM	12.7
Concrete moment resisting frame	C1	1.5
Precast concrete tilt-up walls	PC1	5.8
Concrete shear walls	C2	16.6
Steel moment frame	S1	0.5
Steel-braced frame	S2	0.3
Steel-light frame	S3	3.6
Steel frame with cast-in-place concrete shear walls	S4	0.7
Wood structures	W	48.4

* Code used within Goettel and Horner report.

Because of the number of variables involved, it is the recommendation of the Task Force to implement the triggers as currently written and to let each building, on a case-by-case basis, be evaluated to determine if the other variables demand more or less rehabilitative work.

A more in-depth analysis of hazardous construction types and their associated seismic risks may be found in the Goettel and Horner report. Table F-3 taken from their report presents estimated long-term average deaths per year as a function of building type and soil profile (site characteristics). This table indicates how soil profile and building type can greatly affect the seismic risk. It is the consensus of the Task Force that to incorporate this additional level of complexity into the mandatory requirement mechanism is not appropriate at this time. This information should be considered by the structural engineer performing the evaluation.

Mandatory requirement M-4 deals with earthquake damaged buildings. Currently, building codes for earthquake damage are limited in content and are not uniformly applied between jurisdictions. The cities of San Francisco, Los Angeles, and a few others adopted emergency ordinances to address repairs following the Loma Prieta and Northridge earthquakes. In many instances, the retroactive adoption of these provisions was not enough to satisfy the public agencies and insurance companies providing funds for repairs. In response to this, the International Conference of Building Officials adopted a revision to the 1994 UBC, "Repairs to Buildings and Structures Damaged by Occurrence of a Natural Disaster." While this appears to be a step in the right direction by providing regional consistency in earthquake repair standards, this code revision does not necessarily require an evaluation of the vulnerability of a repaired structure to future earthquakes.

A study by Maffei and Cocke (1995) reviewed codes that address earthquake repair/retrofit standards. Their study found no standard that addresses all concerns on this issue. The approach followed by the cities of San Francisco and Los Angeles appears to be the most practicable to apply on a statewide basis. Mandatory requirement M-4 utilizes similar provisions as those of the City of San Francisco by requiring repairs be made if the lateral load resisting system is damaged by more than 20% from its predamaged condition. However, the utilization of the percentage of damage to the lateral load resisting system has some limitations. The actual intensity of shaking experienced by different buildings is ignored. For example, buildings that experience a greater intensity of shaking and sustain damage to 20% of their lateral load resisting system probably have a greater capacity than a building that experienced a low intensity of shaking and sustained the same amount of damage. Therefore, linking repair standards to a percentage loss of pre-earthquake capacity has little to do with how the building's capacity compares to that required by law. It is often difficult to determine precisely what the lateral load resisting system is. Is the lateral load resisting system of the building the assemblage of structural elements the engineer defines as load resisting, or is it the elements that the earthquake found were load resisting? Many nonstructural elements of a building serve as lateral load resisting elements. Despite these complexities, there does not appear to be a more uniform way to deal with this issue that allows for expedient analyses, often times based upon limited data, after a disaster.

The remainder of the building construction types were addressed in the passive trigger category.

Table F-3. *Estimated Long-Term Average Deaths per Year per 100,000 Occupants by Building Class and Site Characteristics*

Building class	Rock sites *	Firm soil sites	Soft soil sites
Unreinforced masonry bearing walls (URM)	0.82	36.5	91.0
Precast concrete frame with concrete shear walls (PC2)	0.80	18.4	51.0
Concrete frame with unreinforced masonry infill walls (C3)	0.17	10.1	37.3
Steel frame with unreinforced masonry infill walls (S5)	0.16	10.1	36.0
Reinforced masonry bearing wall with precast concrete diaphragms (RM2)	0.12	6.7	24.5
Concrete moment resisting frame (C1)	0.04	3.3	13.5
Precast concrete tilt-up walls (PC1)	0.07	3.7	11.1
Reinforced masonry bearing walls with wood or metal deck diaphragms (RM1)	0.04	1.7	7.4
Steel frame with cast-in-place concrete shear walls (S4)	0.02	0.66	3.6
Concrete shear walls (C2)	0.04	0.74	3.4

*Little construction has been or is done on "rock sites," as defined for this table, in Oregon.
Taken from the Goettel and Horner report to the City of Portland.

B. Basis of Force Levels, Detailing Requirements, and Seismic Rehabilitation Standards

Once a building has been identified as in need of seismic rehabilitation, a structural retrofit scheme is one way of achieving this end. At this point, it must be determined what structural standard will be applied to this rehabilitation. Because an appropriate retrofit standard or code is unavailable at this time, jurisdictions require compliance to the current building code required for the construction of new buildings or a fraction of the current building code's force requirements. Additionally, FEMA 178, *NEHRP Handbook for the Seismic Evaluation of Existing Buildings*, is frequently being used in conjunction with the current code. Existing structures may possess different response characteristics as compared to new ones due to the building's materials and methods of construction.

Current structural engineering practice in this area is to use the FEMA 178 document as a guideline to evaluate existing buildings and the current edition of the Oregon Structural Specialty Code (OSSC) for other work stated in Tables F-1.a and F-1.b. The limitation of this approach is that FEMA 178 is not a code or standard but merely a guideline frequently utilized because of the limited availability of appropriate documents of this type. Furthermore, FEMA 178 is a strength design-based document, and the OSSC is a working stress-based code. Additionally, FEMA 178 is an incomplete document regarding appropriate strength-based evaluation guidelines for all existing material and construction types. However, FEMA 178 has gained nationwide acceptance as an evaluation guideline and will continue to be used, at least in the near term.

As a result of this lack of codified comprehensive guidelines, it is not readily known where the current Oregon Structural Specialty Code (currently the working stress-based Uniform Building Code) is appropriate with respect to its application to the evaluation of existing structures. This is due, in part, to the fact that FEMA 178 is incomplete and also because the more comprehensive guideline for seismic rehabilitation of existing buildings is under development. FEMA 273, *NEHRP Guidelines for the Seismic Rehabilitation of Buildings*, and FEMA 274, *NEHRP Commentary on the Guidelines for the Seismic Rehabilitation of Buildings*, are expected to be the most appropriate documents that can be incorporated into a formal codified design standard for existing buildings. They are scheduled to be adopted by FEMA in the fall of 1997. They are a major step forward from the FEMA 178 guidelines but in their final form may rely somewhat on the continued use of FEMA 178. The next step would be for the model building codes to adopt and appropriately modify them into an existing building seismic rehabilitation standard. As previously stated, until this adoption takes place, it is recommended that the FEMA 178 document be utilized in combination with the Oregon Structural Specialty Code, as noted in Tables F-1.a and F-1.b.

To properly undertake an evaluation of an existing structure, two areas need to be examined: the appropriate force level to be applied to the building and the evaluation of the building's ductility. Ductility is the ability of structural members to yield and to make significant excursions beyond the elastic range, while structural damage is controlled and the structural integrity preserved, so that the structure does not pose a life safety hazard. To design for limited damage is a more difficult problem than designing for purely an elastic response. Ductility is normally measured by the ratio of the overall displacement, curvature, or strain of a structure (or element) to the elastic limit. The amount of ductility permitted in the design should be determined by the need to preserve the basic safety of the occupants and by the costs of the damage implied by the ductile response.

Ductility varies from building to building, even within the same construction type. At this time, structural engineers have assigned levels of ductility only to a relatively small group of different structural framing systems. Furthermore, these systems are typically for new construction. To apply these values to systems of existing construction is difficult and often requires evaluation by professionals using professional judgment. Older structures typically possess less ductility than those designed today. In order to compensate for this and comply with the intent of the current building code, the force levels may be increased so the ductility requirements would not be as great or to reduce the assigned level of ductility (decrease the "R" value). This method, however, may lead to excessive costs due to the force levels required.

As a result of this inconsistency, a code for the evaluation of existing structures is needed to address the issue of force levels and required levels of ductility. The FEMA 178 *Handbook* is the first step in this direction, to eventually be followed by the provisions contained within FEMA 273. In the interim, current practice in areas such as California and Oregon is to design to either 100% of the forces required for new structures or a fraction of it (usually between 67% and 85%) and to use engineering judgment to assess the existing structure's ability to achieve the ductility demands that are associated with these current code forces. This approach may seem at odds with the philosophy of current building codes for new construction, the sole purpose of which is to provide a minimum level of life safety. The use of forces less than current code applied to existing buildings is felt by some to be a compromise measure since to use full code forces may not be economical and to partially rehabilitate a building to some standard less than current code is better than no seismic rehabilitation at all. The FEMA 178 forces are approximately 67% to 85% of the current code for new building construction. This reduced force methodology for a comprehensive retrofit will probably be eliminated from the FEMA document when FEMA 273 is adopted.

The Task Force believes that once a building has been evaluated, the analysis and detailing of any new work required to accomplish the retrofit must be designed to current code. Under some circumstances, however, force levels less than current code may be applied within the FEMA 178 framework. For example, new work where there is no need to be stronger than the existing work upon which it rests may be designed with lesser force levels. In any case, the design provisions for materials and detailing must comply with the current code for new structures.

C. Seismic Zone

Building codes for new construction typically measure the seismicity of an area in one of two ways: (1) by seismic zone, which is done in the Uniform Building Code, and (2) by effective peak ground acceleration and velocity related acceleration values, which is done in the NEHRP/FEMA 222-based codes, such as the BOCA code. Currently, Oregon has adopted the Uniform Building Code with Oregon amendments as the Oregon Structural Specialty Code. This code divides the state into two seismic zones: 2B and 3. FEMA 178 and all other Federal documents use the NEHRP effective peak ground acceleration contour maps. Due to relatively recent work performed in this area, these maps have been modified, with the effective peak ground accelerations adjusted up to 0.3 *g* for western Oregon and 0.2 *g* for eastern Oregon. It is expected the NEHRP maps will ultimately be used in all future building codes.

At this time, both methods used to measure seismicity define ground accelerations based upon a probabilistic seismic event with a 10% chance of exceedance in 50 years. This level is assumed to be the minimum ground motion for life safety. It is considered by many that, in areas of less frequent seismicity than the San Andreas region of California, a lesser probability is required to assure life safety in foreseeable earthquakes. Evidence of this is the inclusion of all of California in at least Seismic Zone 3 regardless of 10 percent in 50-year probability ground motion values.

D. Seismic Performance Objectives

Seismic performance objectives are statements of the desired building performance given that the building is subjected to earthquake demands with specified probabilities of exceedance (or return period). The goal is to describe these performance objectives in terms meaningful to the building community, including building owners, users, and occupants. Building performance is characterized in terms of performance level or range. It can be described qualitatively in terms of the safety afforded building occupants during and after an event, the cost and feasibility of restoring the building, the length of time the building is removed from service to effect repairs, and similar user impacts. These performance characteristics are directly related to the extent of damage experienced by the building.

Currently, building codes are centered around only one seismic performance objective, that of life safety. Indirectly, in many circumstances, the building code has incorporated a higher seismic performance objective, that of repairable damage, due to such items as drift limit requirements. For many structures this increases the sizes of structural members, which may provide a slightly higher performance. In general, however, a building code's main objective is to provide only for life safety. For example, the Uniform Building Code addresses life safety by applying 84-percentile spectral amplification factors to the 10% probability of exceedance in 50-year ground motions. FEMA 178, on the other hand, attempts to achieve life safety by applying median spectral amplification factors to the same ground motions as the UBC. This FEMA 178 methodology results in lower forces being applied to the building. As previously stated, jurisdictions in the past have used forces less than code, merely based on a percentage of the code forces. The philosophy of reduced forces has been a topic of much debate. Many structural engineers feel that the design force level, by itself, is a poor indicator of performance, and that the detailing requirements will still be required and are a large proportion of the cost. However, most concede that a reduction in lateral design force for retrofit purposes may result in reduced construction costs. Current trends indicate that the FEMA 273 document will try to achieve current code force levels as a basis for comprehensive retrofit design and that the lower force levels previously described may be relegated to partial seismic rehabilitation programs only.

In the near future, model codes will greatly expand the number of levels of seismic performance objectives. Documents such as FEMA 273 and the Structural Engineers Association of California "Performance Based Seismic Engineering of Buildings" (SEAOC Vision 2000) have recommended five to six levels. Refer to Table F-4 for a comparison of these levels along with a comparison with what is done by the California Seismic Safety Commission (CSSC) and the Federal government (ICSSC RP4). As can be seen, terminology varies between methodologies, but the concept is approximately the same. Existing seismic rehabilitation programs (CSSC and ICSSC) utilize the lower force levels of FEMA 178, but, as previously mentioned, this may be eliminated in the future for comprehensive retrofits. Since this task force is concerned with existing buildings, FEMA 273 methodology is described. The following are the definitions of the objectives proposed in FEMA 273.

Collapse Prevention Level: The building is on the verge of experiencing partial or total collapse. Substantial damage to the structure has occurred, potentially including significant degradation in the stiffness and strength of the lateral force-resisting system. However, all significant components of the gravity load resisting system must continue to carry their demands. Although the building retains its overall stability, significant risk of injury due to falling hazards and similar damage may exist. Aftershock activity may induce a total collapse.

Life Safety Level: Significant damage to the structure has occurred, but some margin against either total or partial collapse remains. Major structural and nonstructural components have not become dislodged and fallen. Egress routes within the building are not blocked. It should be possible to repair the structure; however, for economic reasons this may not be practical.

Immediate Occupancy Level: Only limited structural and nonstructural damage has occurred. The basic vertical and lateral force-resisting systems of the building retain nearly all their pre-earthquake capacities. Nonstructural damage is minimized. In general, components of mechanical and electrical systems in the building are structurally secured and should be able to function. Power, water, natural gas, communication lines, and other utilities may not be available.

Operational Level: The building is suitable for its normal occupancy and use, albeit possibly in a slightly impaired mode. Most nonstructural systems required for normal use of the building, including lighting, heating, ventilation, and air conditioning, are functional.

FEMA 273 has also defined two ranges that exist between performance levels:

The **Limited Safety** range defines damage states that occur at response levels larger than those defined for the Life Safety level and that can be obtained by interpolating between the values provided for the Life Safety and Collapse Prevention levels. Partial seismic rehabilitation programs that address the anchoring of walls to diaphragms or the bracing of parapets without the consideration of overall structural stability often times represent design for performance within this range. Due to considerations for life safety, however, the Task Force is recommending for mandatory requirement M-1, which is partial rehabilitation, that life safety force levels be used.

Table F-4. *Comparison of Seismic Performance Objectives*

	SEAOC VISION 2000		FEMA 273/ATC 33		CALIF. SEISMIC SAFETY COMM.			ICSSC RP4, NISTIR 5382		
POST EQ. FUNCTIONS WITHIN	SPO	OVERALL DAMAGE	SPO	OVERALL DAMAGE	SPO	OVERALL DAMAGE	BLDG STAN-DARDS	SPO	OVERALL DAMAGE	BLDG. STAN-DARDS
Immediate (nuclear plants)	Fully opera-tional	Negligible	Operational	Light damage	Fully functional	No significant damage	Nuclear Reg. Comm.	Fully functional	--	--
Hours (hospitals)	Operational	Light	Immediate oc-cupancy	Light damage	Immediate oc-cupancy	Minimal	Calif. Title 24, I = 1.25, 1.50	Immediate oc-cupancy	Minor damage	Calif. Title 24 (hospitals)
			Damage control							
Days to months (new, regular, bldgs.)	Life safety	Moderate	Life safety	Moderate	Repairable damage	Some, no signif-icant jeopardy to life	UBC	Damage control	Some	UBC, FEMA 222
Years	--	--	Limited safety range	--	Substantial life safety	Significant damage	FEMA 178	Substantial life safety	Significant damage	FEMA 178, ATC-14
No limit	Near collapse	Severe, egress may be ob-structed	Collapse pre-vention	Severe	Life hazards re-duced	Unrepairable very likely, falling hazards	UCBC	Risk reduction	Depends upon improvements made	
No limit	Collapse	Complete, egress ob-structed	--	--	Very poor life safety	Collapse likely	--	--	--	--

Note: SPO = Seismic Performance Objective

The **Damage Control** range defines damage states that occur at lower response levels than that defined for Life Safety and that can be obtained by interpolating between the values provided for the Life Safety and Immediate Occupancy levels. Damage control may cover contents, structural and nonstructural elements, minimization of repair time, and operation interruption.

FEMA 273 is recommending a two-tier design approach, defined as the Basic Safety Objective. In order to achieve this objective, building rehabilitation shall be designed to achieve the Life Safety performance level for earthquake demands with a 10% chance of exceedance in 50 years and the Collapse Prevention level for earthquake demands with a 2% chance of exceedance in 50 years. The method utilized by FEMA 273 in deriving spectral amplification factors to be applied to these ground motions appears close to the 84-percentile values used by the OSSC and is therefore higher than the values used in FEMA 178. Building seismic rehabilitation programs designed to this objective are intended to provide a low risk of life endangerment for any earthquake likely to affect the site. This approximately represents the risk to life safety associated with buildings traditionally considered acceptable in this country. Ivan Wong of Woodward-Clyde Associates and C.B. Crouse of Dames & Moore indicate that in their opinion these two recurrence levels are appropriate for Oregon. Refer to Tables F-5 and F-6 for various performance levels for the building types considered.

To reiterate, this Basic Safety Objective of FEMA 273 is higher than that which is recommended in FEMA 178 and tries to achieve the level of performance as the current building codes, such as the UBC, for new buildings.

Table F-5. *Essential/Hazardous Facilities*
Recommended Performance Objectives for Essential/Hazardous Facilities

Earthquake Design Level	Recurrence Interval	Probability of Exceedance	Minimum Performance Level
Frequent	43 years	50% in 30 years	Operational
Occasional	72 years	50% in 50 years	Operational
Rare	475 years	10% in 50 years	Immediate Occupancy
Very Rare	2,500 years	2% in 50 years	Life safety

Table F-6. *Basic Facilities*
Recommended Performance Objectives for Basic Facilities

Earthquake Design Level	Recurrence Interval	Probability of Exceedance	Minimum Performance Level
Frequent	43 years	50% in 30 years	Operational
Occasional	72 years	50% in 50 years	Immediate Occupancy
Rare	475 years	10% in 50 years	Life safety
Very Rare	2,500 years	2% in 50 years	Collapse Prevention

E. Application to Current Practice

It is the intent of the Task Force to have all buildings that require improvement to the seismic performance objective of "Life Safety" meet the force levels of FEMA 178 (see Tables F-1.a and F-1.b). This force level, however, is defined in FEMA 178 as "Substantial Life Safety." Refer to Table F-4 for a comparison between FEMA 178 "Substantial Life Safety" and FEMA 273 "Life Safety." Due to the lower force levels prescribed by FEMA 178, the building performance may be less than that of the life safety force levels of FEMA 273. Those buildings that must meet the seismic performance objectives of "Immediate Occupancy" must also meet the requirements of the current OSSC.

Given the above philosophy, the current practice is to intend that buildings that are required to be evaluated due to mandatory requirement mechanisms be done so to satisfy only basic substantial life safety provisions as defined in FEMA 178. At this time, these may be less than the current code for new structures. This may be appropriate, except for essential or hazardous facilities, due to the proactive nature of this requirement upon a building owner and because the useful life of the building may not have been intended to have been extended in the first place.

Buildings that fall under a passive trigger do so because of the building owner's desire to change the current use of the building in such a manner as to increase its seismic risk. The building owner increases the seismic risk of this existing structure by either extending its useful life due to a remodel or alteration or by increasing the number of occupants at risk by increasing occupant density, or by exposing an unchanging occupant load to a higher hazard such as flammable or toxic substances.

For the above types of changes, it is the consensus of the Task Force that a higher level of structural performance is required. This is typically accomplished by trying to achieve the intent of what is required for new buildings. Regardless of whether 67% or 100% of the current OSSC forces are used, the difficult task still remaining is to make the existing portion of this structure achieve appropriate and consistent levels of ductility, recognizing that to achieve the intent of the code for new buildings may not be practicable.

The application of increased seismic force of 25% to essential or hazardous structures is typically done in codes for new construction. This is done to raise the required level of elastic response, which may reduce the required ductility demand on the building and hence allow its reoccupancy much sooner. Application of this philosophy to existing structures may not be appropriate if they are to continue operating following a seismic event. This level may need to be increased due to the potential lack of ductility within the existing portion of the building.

F. Application to Future Practice

Codified structural engineering design requirements are anticipated to become consistent and uniform nationwide by 1997, at the latest by the year 2000. This will occur as the result of the adoption of a uniform national code, known as the International Building Code (IBC). This code will be based on strength design as the design philosophy to be used for all materials. Strength design is currently used within all FEMA, NEHRP, BOCA, and Southern Building Code (SBC) documents.

As the FEMA 273 and SEAOC Vision 2000 documents become utilized, the two-level design approach will be used on many designs. A single-level design approach will also be provided for simplified designs. The seismic event currently considered for this single-level design approach is approximately 5% of exceedance in 50 years. The force levels for comprehensive building seismic rehabilitation utilizing these new approaches, however, will be larger than those used at this time with the FEMA 178 approach. Additionally, the portions of the OSSC now utilized in existing building evaluations will be replaced by the FEMA 273 methodology, and the OSSC will be required only for new work added to the structure.

APPENDIX G. PASSIVE TRIGGERS

Table G-1 classifies the relative seismic hazard of all building occupancies for Passive Triggers P-1.1, P-1.2, and P-2:

Table G-1. *Relative Seismic Hazard Ratings for Occupancy Classifications*

Relative seismic hazard	Occupancy classifications
5 (highest)	A, E, I except 1.2 and 1.3, H-1, H-2, H-3, H-6, H-7
4	R-1, SR (large)
3	B, M, I-1.2, I-1.3
2	F, S, H-4, H-5
1 (lowest)	R-3, U, SR (small and home)

The following passive triggers are recommended:

P-1.1 All buildings that have a change of use from categories 1 through 4 to a category 5 within the relative seismic hazard occupancy classifications table (Table G-1) shall have an evaluation performed and any necessary seismic improvements made as a result of this evaluation to a life safety standard.

P-1.2 All buildings having a change of use where there is an increase in relative hazard occupancy classification and the affected area exceeds 15% of the gross floor area of the building and the occupant load increases by more than 50 persons as defined by the State Building Code shall have an evaluation performed and any necessary seismic improvements made as a result of this evaluation to a life safety standard.

P-2 All buildings that through a change of use have an increase of at least 20% in building occupant load as defined by the State Building Code shall have an evaluation performed and any necessary seismic improvements made as a result of this evaluation to a life safety standard.

P-3 For all renovations requiring a building permit, a seismic evaluation of the structure shall be performed.

Notwithstanding the above requirement, if the value of the building alterations is less than 25% of the real market value, the seismic evaluation requirement can be met in either of the following ways:

a) A letter of intent to have a seismic evaluation performed may be submitted in lieu of an actual seismic evaluation with the permit application. The evaluation shall be completed before any future permits will be issued.

b) A previously prepared seismic study may be submitted for consideration by the building department as meeting the requirements of the seismic evaluation study.

P-3.1 When the total value of the renovations within a 12-month period is 50% or more of the real market value as reflected in the most recent property tax statement, any necessary seismic improvements required by this evaluation will be made to meet the requirements of a life safety standard.

P-3.2 For all renovations, if the seismic evaluation indicates that the alteration weakens the lateral force resisting system of the building at any floor below that required for new buildings, the entire building shall be required to conform to the seismic requirements of a life safety standard.

Exceptions to P-3, P-3.1, and P-3.2:

a) Single-story, light metal buildings less than 4,000 square feet in area.

b) Wood-framed buildings less than 4,000 square feet in area.

c) If after a seismic evaluation has been performed, the alteration is determined by the building official to be minor in its effect on the structure, then only that area of the affected lateral load resisting system needs to be rehabilitated to possess the same seismic resistance as prior to the alteration.

P-4 An addition that is not structurally independent from an existing building shall be designed and constructed in such a way that the entire building conforms to the seismic resistance requirements for new buildings, unless the following three conditions are met:

a) The addition complies with the requirements for new buildings.
b) The addition does not increase the seismic force in any existing structural element of the building by more than 5% unless the force and deformation capacities of the element subject to the increased demand are equal to or greater than those required for new buildings.
c) The addition does not decrease the seismic force and deformation capacities of any structural element of the existing building unless the reduced seismic capacity of the element is equal to or greater than that required for new buildings.

See Table G-2 for a list of passive triggers categorized by seismic performance objectives.

Table G-2. *Passive Triggers Categorized by Seismic Performance Objective (Current Design Philosophy)*

No.	Description	Seismic performance objective	Force level for evaluation	Force level for design	Other reqmt.	Seismic zone
P-1.1	All changes of use to ess./haz. (Cat. 5)	Immediate occupancy	UBC I=1.25	UBC I=1.25	SSHS	3, 2B
P-1.2	Changes of use to ess./haz.	Immediate occupancy	UBC I=1.25	UBC I=1.25	SSHS	3, 2B
P-2	Changes of use to ess./haz.	Immediate occupancy	UBC I=1.25	UBC I=1.25	SSHS	3, 2B
P-3.1 P-3.2	Structural alterations to ess./haz.	Immediate occupancy	UBC I=1.25	UBC I=1.25	SSHS	3, 2B
P-4	Ess./haz. building additions	Immediate occupancy	UBC I=1.25	UBC I=1.25	SSHS	3, 2B
P-1.1	All changes of use to special (Cat. 5)	Life safety	UBC I=1.0	UBC I=1.0	—	3, 2B
P-1.2	Changes of use to all other buildings	Life safety	UBC I=1.0	UBC I=1.0	—	3, 2B
P-2	Changes of use to all other buildings	Life safety	UBC I=1.0	UBC I=1.0	—	3, 2B
P-3.1 P-3.2	Structural alterations to all other buildings	Life safety	UBC I=1.0	UBC I=1.0	—	3, 2B
P-4	All other building additions	Life safety	UBC I=1.0	UBC I=1.0	—	3, 2B
P-3	Building alterations	Substantial life safety	FEMA 178 study	FEMA 178 study	—	3, 2B

SSHS = Site-Specific Hazard Study required according to Oregon Structural Specialty Code
UBC=Uniform Building Code
FEMA 178=Federal Emergency Management Agency publication, *NEHRP Handbook for the Seismic Evaluation of Existing Buildings*
I=Importance factor according to the Oregon Structural Specialty Code

APPENDIX H. COSTS OF SEISMIC REHABILITATION

The data sources used for these estimates include the following:

1. F.W. Dodge construction data for the state of Oregon.
2. DOGAMI's economic model for aggregate demand
3. The Metro Earthquake Hazards Project's interim results
4. Estimates of permit issuance rates by Michael Haggerty of the Portland Bureau of Buildings
5. Comments from the public on the draft report

Inventory:

Approximately 97,000 buildings in Oregon are not "single-family dwellings." Of these, approximately 70,000 will not be inventoried by the Metro Earthquake Hazards project. This number likely includes two-family and agricultural buildings, which are to be excluded from the inventory. Data from FEMA, Metro, Portland Bureau of Buildings, and Portland State University indicate that the average cost of completing a FEMA 154 type inventory data sheet for a building ranges from $12 to $20, with the average for the Metro project being close to $15 per building. Assuming that inventorying buildings outside the Portland metropolitan area will be slightly more expensive due to additional expenses such as travel, a cost of $20 per building is assumed. The cost for completing an inventory of all the state outside the Metro region would be approximately $1.4 million, with the possible range being $1 million to $2 million. Ideally these costs would be covered by State General Fund and supplemented by FEMA disaster mitigation funds. This allows those who benefit to pay the costs of the program. An alternative plan is to create a State surcharge on building permits to cover the costs of completing the inventory.

Expected rehabilitation rates:

BOMA suggested to OSSPAC that nearly all of the building stock would turn over in a 70-year time span. Based on this estimate, a preliminary 70-year benchmark for the rehabilitation of the general building stock was proposed. The City of Portland estimates that, out of a building inventory of 17,984 buildings, approximately 24 undergo seismic rehabilitation each year under the status quo. The City further estimates that approximately 120 buildings per year would be rehabilitated under the passive triggers in the Draft Seismic Rehabilitation Report.

At 24 buildings per year, it would theoretically take 750 years for all 17,984 buildings to be rehabilitated. At 24 buildings per year, it would take 100 years for all the mandatory requirement candidates to be rehabilitated. If all 24 building were URMs (this is not the case), then it would take 57 years to rehabilitate just the URMs.

At 120 buildings per year, it would theoretically take 150 years for all 17,984 buildings to be rehabilitated. If 40% of the buildings are nonexempt (a reasonable and reasoned estimate), then it would take 60 years to rehabilitate all the nonexempt buildings. If all 120 buildings per year were URMs (very unreasonable and unrealistic), then it would take 11 years to rehabilitate all the URMs. If 30% of the 120 per year were URMs, then the time to rehabilitate all URMs would be approximately 38 years. In many parts of the state, the nonexempt buildings will constitute more than 40% of the building stock. Given these estimates, the conclusion is that the passive triggers proposed by the Task Force will achieve about the rate of rehabilitation that is desired. To make the passive trigger net a looser mesh would almost certainly result in missing the objective rates of rehabilitation.

Cost of rehabilitation:

The construction costs of seismically rehabilitating a building can range from $10 to $50 per square foot, depending on the building and exactly what is included in the costs of the seismic portion of a project. Goettel and Horner used $35 per square foot, and since this is in good agreement with data from FEMA as well as local engineers and contractors, this amount will be used here as well.

There are approximately 923 million square feet of existing buildings (excluding single-family dwellings but including two-family and agricultural buildings) in Oregon. To rehabilitate <u>all</u> of these buildings is being proposed by no one. Approximately 11% of this total may be URM construction, based on the Portland building inventory, which at this time has identified 9% of its inventory as URMs (see Table F-2, Appendix F), and expert opinion on how the rest of the state differs from Portland.

Costs can be estimated in three ways: (1) Using square footage, $35 per square foot, and the 11% gives a total URM rehabilitation cost of $3.6 billion. (2) Using 11% of 97,000 buildings and an average size of 17,000 square feet per building gives a cost of $6.3 billion. (3) Extrapolating the City of Portland's 1,373 URM buildings to the entire state by population (one-sixth the population) and using 17,000 square feet per building gives a cost of $4.9 billion.

It can be therefore be concluded that the cost of rehabilitating all the URM buildings in the state lies within the range of $3.6 billion to $6.3 billion, with $5 billion being a "best estimate". If we assume that the this cost will be uniformly spread out over 30 years, the cost per year is $167 million. This is about $55 per Oregonian per year.

For comparison purposes, the average annual construction expenditure in Oregon over the period 1990 to 1994 was $2.3 billion per year. Of this, the approximate average expenditure on buildings (as opposed to highways and bridges, etc.) was $1.8 billion per year. Of this, $120 million per year was for additions, and $125 million per year was for alterations (as defined by F.W. Dodge). The average driver spends approximately $200 per year on the State gasoline tax (15,000 miles @ 18 mpg x $0.24/gallon).

Cost for schools:

Aggressive seismic rehabilitation plans would result in approximately 20 million square feet of school space in Oregon being rehabilitated for a cost of $700 million. This would be $35 million per year if spread over 20 years. If the seismic rehabilitation plans which are ultimately drafted propose to rehabilitate just URMs, the cost can be grossly estimated at $262 million, or $13 million per year over 20 years. There are approximately 1,200 school buildings in Oregon that would cost $6 to $12 million to evaluate. If some recently built schools are exempted, then the cost could drop to as low as $2.4 million to $4.8 million. Using the latter numbers would give a cost of less than $1 million per year. In the period 1990 through 1994, an average of $115 million was spent per year on school construction in Oregon, $52 million of which was for additions and alterations.

APPENDIX I. INCENTIVES

A. Introduction and overview:

The Task Force has recommended that several requirements be adopted by the State of Oregon to achieve the rehabilitation of existing buildings. The purpose of imposing these requirements is to serve a public policy objective of reducing life safety risk for its citizens. But these improvements will be expensive. Therefore, the Task Force has determined that economic incentives are necessary to accomplish this task. This conclusion is based on the following premises:

1. Public policy should encourage the rehabilitation of existing buildings that are seismically unsafe.

2. Seismic upgrades do not add to the value of buildings. They may in fact mean a loss of value.

   The Goettel and Horner report estimates that the total life safety rehabilitation cost per square foot for buildings of various construction and 10,000 to 50,000 square feet in size may run anywhere from $15 to $40.

   In general, the cost of seismic rehabilitation is not recoverable in rents or income. Thus, when owners are mandated to upgrade their buildings, they are in fact being asked to make sizable unrecoverable capital expenditures. These expenditures may actually cause the income of a building to be reduced, depending on the construction, design, and occupancy of the building, as well as the fact that owners will be required to absorb indirect costs such as interruption to business and relocation during construction.

   Since public policy should be to encourage seismic rehabilitation of older buildings, these factors all indicate that supporting such a public policy will require some form of financial incentive for building owners.

3. Seismic upgrades required by passive triggers are often barriers to making building improvements. When building owners know they will face the cost of seismic improvements, they will often allow buildings to stand idle rather than making the upgrades because the upgrades are not economic. This is not in the public interest because it results in unused buildings and deters modernization.

The Task Force reviewed the experience of California and other states, as well as proposals that have been made by the City of Portland and FEMA. Incentives that are most attractive are those which minimize the impacts on revenues and create genuine incentives to take action. In general, incentives can be implemented at the state or local levels. They may also seek to utilize sources of funds which are available at the federal level.

Based on these reviews, the Task Force makes the recommendations listed below and in the report.

B. Proposed incentives to be enacted immediately:

Since the enactment of the Tax Reform Act of 1976 and its subsequent modifications and Oregon's Special Assessment for Historic Property Tax Law in 1975, tax incentives have been successfully used to rehabilitate thousands of properties throughout the state of Oregon. Currently, Oregon's Special Assessment Tax Law provides property tax relief for owners of income-producing historic buildings who are planning to engage in seismic rehabilitation.

As an added incentive for the rehabilitation of historic buildings and older buildings, the Task Force recommends that a tax credit program and a tax abatement program be put in place. Both of the proposed pieces of legislation are based upon legislation proposed during the 1995 Legislative Session. Both pieces of legislation also incorporate proposed changes to the legislation in the Findings and Recommendations of the Infrastructure and Finance Committee of the Central City 2000 Task Force.

1. **Tax credits:** Tax credits are a form of financial incentive that has been used frequently and effectively over the past several decades to encourage private participation in governmental policies. Examples of areas in which tax credits have been used to promote policy include energy conservation, older building rehabilitation including historic preservation, and affordable housing.

   Tax credits have distinct advantages over other types of incentives in that they do not require an appropriation of government funds and can cost very little to administer. Tax credits also direct benefits to persons who are able to fund or finance the cost of rehabilitation.

   During the last legislative session, Senate Bill 703 was introduced but died in committee. Senate Bill 703 specifically provided an income tax credit for direct costs incurred in seismic rehabilitation of qualified property at risk for earthquake damage. The bill was to set a cap for the total amount of cost eligible for credit but did not state the cap amount. The bill also pertained only to unreinforced masonry buildings.

   During the 1997 Legislative Session, the Task Force recommends introduction of legislation based upon Senate Bill 703 and described in Section IV.H of the report.

2. **Property tax abatements:** ORS 358.505, Oregon's Historic Property Tax Law, has been one of the most successful tax laws to stimulate the rehabilitation of historic structures in the State of Oregon. The program in fact has gained national acclaim. Tax abatement has also been used as a successful incentive to stimulate the construction of low-income housing. Based upon the success of these two programs, Senate Bill 688 was introduced in the last legislative session. Like Senate Bill 703, the bill died in committee. Senate Bill 688 specifically reduced the assessed value for property tax purposes by certain costs incurred in seismic rehabilitation for qualified property. During the 1997 Legislative Session, the Task Force would introduce legislation based on Senate Bill 688, with minor modifications. The proposed legislation is discussed in Section IV.H of the report.

3. **Urban renewal** is a well-established program controlled at the local level to remove blighted areas in order to make them economically viable. "Blighted areas" are defined under ORS 457.010. The definition is very broad, and the Task Force believes current statutes include seismic upgrades

   However, if necessary, the Task Force suggests the definition of "blighted areas" be changed to allow seismic rehabilitation to qualify for urban renewal funding. The addition to the definition (in capital letters) could read as follows:

   ORS 457.010. As used in this chapter, unless the context requires otherwise:

   (1) "Blighted areas" means areas which by reason of deterioration, faulty planning, inadequate or improper facilities, deleterious land use of the existence of unsafe structures, or any combination of these factors, are detrimental to the safety, health, or welfare of the community. A blighted area is characterized by the existence of one or more of the following conditions....

   (j) PUBLIC, EMERGENCY, OR MEDICAL FACILITIES, OR COMMERCIAL BUILDINGS IN NEED OF REHABILITATION, RETROFITTING, OR REPAIR TO IMPROVE THEIR SEISMIC RESISTANCE.

C. Proposed incentives to be considered in six years after more information on the inventory and the effects of triggers and incentives on seismic rehabilitation is available:

1. **Loan guarantees:** The Task Force was informed that conventional financing is all that is available for projects involving seismic rehabilitation. Given the additional fact that seismic upgrades are not viewed as adding significant value to buildings, the availability of financing may be a significant barrier to seismic rehabilitation. Loan guarantees can offer a significant incentive to overcome this barrier.

   Some of these loans will involve facilities where value is not being added, and the financial community may be reluctant to provide the loans. To facilitate the lending process so that these upgrades can actually take place, it may be necessary to provide loan guarantees.

   Loan guarantees are programs where the government assures conventional loan repayment on behalf of the borrower. Examples are HUD and VHA housing loans. In the case of HUD and VHA loans, a specific public benefit is addressed, namely housing.

   Advantages of loan guarantee programs include (1) making credit available to borrowers who are less creditworthy than required by commercial lenders and (2) shortening of the waiting period for loans. In addition, other than staffing requirements, up-front costs to government agencies are minimal.

   The Task Force suggests that the State consider guaranteeing seismic rehabilitation loans each year for 20 years in order to facilitate the seismic rehabilitation of existing buildings. Local jurisdictions should also be directed to seek other sources of loan guarantees. The amount of loans to be guaranteed each year still needs to be established.

2. **Grant programs:** The Task Force suggests that consideration be given to expansion of existing grant programs to make seismic rehabilitation an eligible cost. One example would be making Historic Preservation Grant-in-Aid Funds administered by the State Historic Preservation Office available for seismic studies of existing buildings. Another example would be using Community Development Block Grants for the same purpose.

3. **Other local options:** Local programs such as special assessment districts have been established in California to help finance rehabilitation of older buildings. Such programs may be examined in the future to see if they are useful or needed in Oregon.

APPENDIX J. ACRONYMS AND DEFINITIONS OF TERMS

ACRONYMS USED IN THIS REPORT

ABAG--Association of Bay Area Governments
ADA--Americans with Disabilities Act
ATC--Applied Technology Council
BCD--Building Codes Division
BOCA--Building Officials and Code Administration
BOMA--Portland Metropolitan Association of Building Owners and Managers
CDBG--Community Development Block Grants
CHAS--Comprehensive Affordability Strategy
CRA--Community Reinvestment Act
CSSC--California Seismic Safety Commission
DAS--State of Oregon Department of Administrative Services
DOGAMI--State of Oregon Department of Geology and Mineral Industries
FEMA--Federal Emergency Management Agency
GIS--Geographic Information System
HVAC--Heating, ventilation, and air conditioning systems
IBC--International Building Code
ICBO--International Conference of Building Officials
ICSSC--Interagency Committee on Seismic Safety in Construction
NEHRP--National Earthquake Hazard Reduction Program
ODOT--State of Oregon Department of Transportation
ORS--Oregon Revised Statutes
OSSC--Oregon Structural Specialty Code
OSSPAC--Oregon Seismic Safety Policy Advisory Commission
SBA--Small Business Administration
SBC--Southern Building Code
SEAOC--Structural Engineers Association of California
SSSH--Site Specific Hazard Study (required according to OSSC)
UBC--Uniform Building Code
UCBC--Uniform Code for Building Conservation
URM--Unreinforced masonry
USGS--US Geological Survey

DEFINITIONS OF TERMS AS THEY ARE USED IN THIS REPORT

Acceleration: The rate of change of velocity with respect to time. Specifically, a measure of the intensity of seismic shaking at a particular site.

Applied Technology Council: A nonprofit, tax-exempt, information transfer corporation established through the efforts of the Structural Engineers Association of California to assist design practitioners in structural engineering and related design specialty fields such as soils, wind, and earthquakes in the task of keeping abreast of and effectively using technological developments. ATC identifies and encourages needed research and develops consensus opinions on structural engineering issues.

Appendage: An architectural component such as a canopy, marquee, ornamental balcony, or statuary.

Average return period: The arithmetic average of times between events of some like attribute.
Beam: A horizontal structural member.
Bearing wall: A wall providing support for vertical loads. It may be exterior or interior.
Benchmark: Goal against which progress is measured.
Building function: The predominant use of a building, defined by the activities of its occupants.
Building type: A building defined by its occupancy, such as residential or industrial.
Coastal subsidence: Drop in elevation of area along the coast. Generally caused when built-up stress in a tectonic plate is released by an earthquake, causing the overriding plate to move freely and drop in elevation.
Column: A vertical structural member.
Connection: A location at which different structural members are joined to each other or to the ground.
Cornice: Any molded projection which crowns or finishes the part to which it is affixed. The exterior trim of a structure at the meeting of the roof and wall; usually consists of bed molding, soffit, fascia and crown molding.
Crustal earthquakes: Shallow earthquakes originating between ground surface and 20 miles deep, in this case originating in the North American Plate.
Dangerous Building Code: A code that can be used by local authorities to identify a building as dangerous and that can be used to require the building owner to repair or demolish the dangerous building.
Detailing requirements: Those requirements utilized by a structural engineer in order to connect a structure together.
Diaphragm: A horizontal or nearly horizontal structural element, designed to transmit lateral forces to the vertical elements of the earthquake resisting system. A floor is a diaphragm.
Drift-limit requirements: Those requirements stipulated in a building code which limit the amount of horizontal movement of a building. Typically applied to seismic and wind loads.
Ductility: Capability of being deformed or distorted before breaking or fracturing.
Earthquake: A shaking or trembling of the earth's crust caused by underground volcanic forces or by breaking and shifting of rock beneath the surface.
Elastic range: That portion of a material's stress-strain diagram that remains elastic during loading and unloading. If a material is stretched within this range, it will return to its original shape without permanent deformation.
Force: That which tends to put a stationary body in motion or to change the direction or speed of motion of a moving body.
Force levels for design: Numbers put into an equation used by an engineer or architect to design a structure to withstand an earthquake.
Force levels for evaluation: Numbers put into an equation used to evaluate the ability of a structure to withstand an earthquake.
Frame: A structural system composed of interconnecting beams and columns that provide support for vertical loads. It may also provide lateral load resistance. If not, it must be accompanied by walls or braces.
Hazard: A source of danger with potential to cause illness, injury, or death to people or damage to a facility or the environment. In insurance terminology, it is the existence of a condition that increases the chance of loss.
Holocene: The 10,000- to 12,000-year time period extending from the end of the last glaciation to the present.
Horizontal irregularity: A type of structural irregularity considered to exist if a particular floor level is unusual in shape, or the bracing systems within the building are offset between floors, or there

is a marked difference between the locations of the centers of the mass and rigidity of the floor. If this difference is excessive, *torsion* may exist, which may cause significant problems.

Infill: Material, generally masonry, that is inserted within a surrounding structural frame to create a wall.

Intraplate earthquakes: Deep earthquakes originating between 20 and 40 miles deep, in this case originating in the subducting Juan de Fuca Plate.

Lateral force-resisting system: That portion of a structure that resists the lateral loads, typically wind or seismic. This system may be comprised of walls, braces, or moment frames, either singly or in combination.

Liquefaction: The process whereby soil and/or sand behave like a dense fluid rather than a wet solid mass during an earthquake.

Mandatory seismic rehabilitation requirements: The criteria used to identify and upgrade the most seismically hazardous buildings or portions of buildings that need to be rehabilitated within a specific time frame.

Mitigation: Any action taken before an earthquake that has the potential to reduce the consequences of an earthquake.

Moment resisting frame (MRF): A type of structural frame that is stable without the need of walls or braces. Connections between beams and columns are made in such a way that rotation, and hence progressive collapse, is restrained.

Municipality: An urban political unit with corporate status and powers of self government.

Nonductile or brittle modes of failure: Breaking or fracturing of materials rather than deforming or distorting. Contrasts with *ductile*.

Nonstructural: Material or structural member not designed to contribute to the vertical or lateral support of a building.

Nonstructural hazards: Parts of a structure, other than the gravity or lateral-load carrying systems, that could fail and injure people during an earthquake. Included parapets, exterior cladding or cornices, major mechanical equipment, tall hollow clay tile partitions, etc.

Oregon Structural Specialty Code: The body of Oregon regulations related to buildings and structures designed to provide uniform performance standards providing reasonable safeguards for health, safety, welfare, comfort, and security for residents of the state who are occupants and users of buildings.

Parapet: Rampart, low wall, or railing that is not part of the lateral-load carrying system of a building and is entirely above the roof.

Passive triggers: The criteria used to identify structures that pose life-safety hazards that will require eventual seismic rehabilitation. They are "passive" in that the building owner decides to do something that makes the building or its inhabitants more vulnerable to seismic risk.

Peak ground acceleration levels: The maximum ground acceleration expected during an earthquake.

Precast: Concrete components of structures that are cast away from the building site and assembled when set to form structural or nonstructural building systems.

Probabilistic: Based on probability calculations.

Probabilistic seismic event: A seismic event (earthquake) whose size and/or frequency of occurrence is based on probability calculations.

Professional structural engineer: A person who has knowledge of the discipline of structural engineering and design acquired by engineering education and experience.

Quaternary: The period of time covering the last 1.6 million years.

Redundancy: The presence of multiple lateral-force-resisting elements that comprise a system in such a way that if one or several elements have substantial strength or stiffness loss, continuing lateral displacement will be resisted by other elements of the system.

Rehabilitation: Construction actions taken before an earthquake to improve the ability of a structure to withstand an earthquake beyond its original capacity. Same as *seismic rehabilitation.*

Reinforced: Concrete or masonry construction in which steel bars are embedded to increase its strength.

Retrofit: Improvement of the seismic resistance of a structure after an earthquake, including repair of damage and upgrading of structural and/or nonstructural systems to provide a higher level of resistance than existed before the earthquake.

Risk: In insurance terminology, this is the "chance" of loss or damage occurring.

Seismic: Related to, resembling, or caused by an earthquake.

Seismic event: Earthquake.

Seismic force: The force generated by an earthquake equal to the vibrating mass of the building multiplied by the acceleration produced by the earthquake.

Seismic hazard: Probability of earthquake ground motion at a given location

Seismic performance objectives: Statements of the desired building performance when the building is subjected to earthquake. Performance objectives presented in this report include substantial life safety, life safety, immediate occupancy, and repairable damage.

Seismic rehabilitation: Construction actions taken before an earthquake to improve the ability of a structure to withstand an earthquake beyond its original capacity.

Seismic rehabilitation design standard: The standard to which structures must be rehabilitated to meet the objective of substantial life safety, life safety, or immediate occupancy for structures that would be needed after an earthquake. The Task Force recommends the guidelines presented in FEMA 178 be used until more detailed and better defined nationally recognized design standards are available.

Seismic resistance requirements: Those requirements, typically stipulated in a building code, that must be utilized when designing buildings to resist forces due to earthquake motions.

Seismic risk: The potential for damage and casualties from earthquakes to the "built" environment.

Seismic strengthening: Construction actions that improve the ability of a structure to withstand an earthquake by increasing the strength or stiffness.

Seismic upgrading: Same as seismic strengthening.

Seismic zone: A generally large geographic area within which the seismic design requirements for structures are the same.

Shear wall: A wall designed to resist earthquake force activity in the plane of the wall.

Significant structures: (1) Essential facilities, hazardous facilities, or special occupancy structures; (2) structures having irregular features as defined in the state building code; or (3) buildings four or more stories tall or greater than 45 feet tall, whichever is less. The Task Force is recommending that only a professional engineer qualified in structural engineering with competency in seismic issues related to structural engineering should be allowed to provide services related to these types of structures.

Site specific seismic hazard survey: An investigation of specific seismic hazards occurring at a specific location.

Soft story: In a building, a soft story is one in which the lateral stiffness is less that 70% of that in the story above or less that 80% of the average stiffness of the three stories above. It is a particular type of *vertical irregularity.*

Spectral amplification factors: Those factors which are to be applied to the seismic ground motion spectra to determine the force, velocity, and displacement of a single degree of freedom structure (a structure which translates in only one direction) due to that ground motion.

State Building Code: The complete body of all codes used in Oregon for construction of buildings.

Structural hazards: Structural elements of a building's vertical and lateral load-carrying systems that could be damaged or fail during an earthquake.

Strength design based document: A document which uses as its structural design philosophy a method based on the strength of a structure's material (modified slightly to account for variations in material strengths as well as construction workmanship). Defined loads used in the analysis are increased depending upon the probability of exceedance of a particular load.

Subduction zone earthquakes: Regional earthquakes of great magnitude, in this case caused by movement between the Juan de Fuca and North American Plates, which are believed to be currently locked against each other.

Tilt-up construction system: A construction system that used reinforced concrete walls cast flat on the ground adjoining their final building location. After setting, they are tilted up into place and connected together.

Torsion: A twisting about an axis; a wrenching in which one part of a structure is under pressure to turn about a longitudinal axis, while the other part is held fast or is under pressure to turn in the opposite direction.

Tsunami: A sea wave generated by sudden movement of the sea floor, usually by a submarine earthquake, but also caused by submarine landslide or undersea volcanic eruption. Tsunamis travel rapidly and generally unnoticed in the open sea, but as they approach shore and slow down, they grow in height and are capable of causing great damage when they come ashore.

Turbidite: Sediments deposited after sudden movement of accumulated sediments down the continental slope. Often triggered by earthquakes.

Uniform Building Code: The recognized model for building codes used with Oregon amendments to be the Oregon Structural Specialty Code. The Uniform Building Code was first enacted by the International Conference of Building Officials at the Sixth Annual Business Meeting in Phoenix, Arizona, October 18-21, 1927, and has been revised and amended since that time. Revised versions of the code are published approximately every three years.

URM: Unreinforced masonry.

Vertical irregularity: A type of structural irregularity in which the weight, strength, or stiffness of the building changes dramatically with each story, as defined in the State Building Code.

Working stress-based code: A code which uses as its structural design philosophy a method based upon factors of safety being applied to the structure's material. Defined loads used in the analysis are not modified.

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