

A P P E N D I X B

G E O L O G Y , S O I L S A N D S E I S M I C I T Y



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APPENDIX B.1 GEOLOGY, SOILS & SEISMICITY BACKGROUND

This appendix contains supplementary information about local geology, soils and faults within the 2020 LRDP area. Much of this information was previously published in the UC Berkeley *1990 Long Range Development Plan EIR*. Information has been updated where new information was available.

B.1.1 TOPOGRAPHY

UC Berkeley is located on the western slopes of the Berkeley Hills. Ground elevations in the 2020 LRDP area range from about 160 feet above mean sea level (+160 feet msl) in the west to about +1,200 feet msl at the Lawrence Hall of Science, and about +1,600 feet msl at Grizzly Peak Blvd. Elevations at the west end of the Campus Park are about +200 feet msl. Slopes in the Campus Park and adjacent areas are shallow, ranging from less than two percent west of Shattuck Avenue to about five percent west of Gayley Road. East of Gayley Road, slopes rise from about ten percent at the Greek Theatre to more than 50 percent in some areas at the heads of Strawberry and Claremont Creeks.¹

The Campus Park and Hill Campus can be defined by two distinct landforms: most of the Campus Park is on an alluvial plain, and the Hill Campus (plus a portion of Southside east of the Hayward fault) is in the Berkeley Hills.

B.1.2 BEDROCK

The UC Berkeley campus is divided by the Hayward fault. Bedrock of the Cretaceous Franciscan assemblage has been mapped on the west side of the Hayward fault. This assemblage consists of sandstones, shales, and blue schists. On the east side of the Hayward fault, the bedrock consists of micaceous claystones, shale, sandstones and siltstones ranging in age from late Cretaceous to Tertiary.² Most of the underlying geologic material in the LRDP Housing Zone is Temescal formation.³

B.1.3 SEDIMENTS

West of the Hayward fault and overlying the bedrock is the Quaternary Temescal formation, consisting of alluvial fan deposits that originate from the Berkeley Hills. Composition of this material varies greatly, but is predominantly clayey gravel containing rocks of the Franciscan assemblage and of igneous origin. The Franciscan rocks are greywacke, shale, chert, conglomerate, schist and limestone. Foundation conditions of the Temescal formation typically are excellent to fair, with good to fair earthquake stability.⁴

East of the fault, colluvium and small alluvial fan deposits dominate the surficial geologic materials in the Berkeley Hills. Colluvium is the debris that moves downslope as soil creep, soil flows, small landslides, and slope wash. Within the developed part of the Campus Park, much of the natural surficial geologic materials have been covered by artificial fill.⁵

B.1.4 SOILS

West of the Hayward fault, most of the native soil has been covered, graded, or otherwise modified by campus development. Native soils still existing, although not necessarily exposed, include the Xerorthent, Millsholm, Los Osos, and Tierra associations.⁶ A January 2000 geotechnical investigation of the Campus Park and its immediate area concluded that older alluvium overlies the Franciscan rocks across most of the Campus Park. The alluvium typically comprises very stiff sandy clay.⁷ Over most of the Campus Park, the depth to rock is less than 50 feet.⁸

East of the Hayward fault, three different soils dominate the Hill Campus. Maymen loam covers about one-third of the steep upland slopes. It is a shallow acidic soil (10 to 20 inches deep over shale) in which runoff is rapid to very rapid and the risk of erosion is high to very high. The Maymen-Los Gatos complex covers about one-quarter of the steep upland slopes. These loamy soils are shallow to moderately deep (10 to 40 inches over shale and sandstone) and some are highly acidic. Runoff and erosion hazards are identified with the Maymen loam.⁹

The Xerorthent-Millsholm complex covers about one-fifth of steep upland slopes. Soil depths vary from shallow to moderately deep. They are moderately acidic to slightly alkaline loams, clays and silty clay loams, developed on sandstone, siltstone or alluvium, and have runoff and erosion characteristics identical with the Maymen loam.¹⁰ Xerorthent-Millsholm and Maymen soils have a low shrink-swell potential.¹¹

Most of the LRDP Housing Zone consists of Tierra-Urban land soils. These soils consist of moderately well drained loams.¹² Tierra and Azule soils cover a large portion of the LRDP Housing Zone. Tierra soils have low to high shrink-swell potential, while Azule has a moderate to high shrink-swell potential.¹³

B.1.5 SEISMICITY

BACKGROUND

The strength of an earthquake is generally expressed in two ways: *magnitude* and *intensity*. Magnitude, which is expressed in whole numbers and decimals (e.g. 7.1), is a measure that depends on the seismic energy radiated by the earthquake as recorded on seismographs. The original magnitude scale is the Richter scale.¹⁴ Earthquakes with magnitude of about 2.0 or less on the Richter scale are usually called micro-earthquakes and are not commonly felt by people. Events with magnitudes of about 4 and up are felt by most people. The Richter Scale has no upper limit and is not used to express damage.¹⁵

The most commonly used magnitude scale today is the Moment Magnitude (M_w) scale, which is related to the physical size of fault rupture and the movement across a fault. M_w is based on the seismic moment at the source, or hypocenter, of the earthquake.¹⁶ The Moment Magnitude scale is a way of rating the seismic moment of an earthquake with a simple, logarithmic numerical scale similar to the original Richter magnitude scale. Because it does not "saturate" the way local

magnitude does, it is used for large earthquakes – those that would have a local magnitude of about 6 or larger.¹⁷

The force of an earthquake at a particular place is measured on the Modified Mercalli Intensity Scale, which is a subjective ranking of earthquakes’ effects on persons and structures. It is expressed in Roman numerals from I to XII. Lower numbers on the scale indicate less severe shaking. Table B.1-1 summarizes the Modified Mercalli Intensity Scale in relation to the Richter Scale.

TABLE B.1-1 MODIFIED MERCALLI AND RICHTER SCALES¹⁸

Richter Magnitude	Modified Mercalli Category	Expected Modified Mercalli Maximum Intensity at Epicenter
2	I-II	Usually detected only by instruments
3	III	Felt indoors
4	IV-V	Felt by most people Slight damage
5	VI-VII	Felt by all Many frightened and run outdoors Damage minor to moderate
6	VII-VIII	Everybody runs outdoors Damage moderate to major
7	IX-X	Major damage
8+	X-XII	Total and major damages

ACTIVE FAULTS

Active faults in the LRDP area are discussed in Chapter 4.5.

INACTIVE FAULTS

There are several inactive faults in the LRDP area. The Wildcat fault in the Hill Campus is a minor fault that cuts late Cenozoic strata, striking sub-parallel to the Hayward fault past the Botanical Garden and through the Field Station for Behavioral Research.¹⁹ There have been no studies indicating Holocene activity on the Wildcat fault.²⁰ The California Division of Mines and Geology (CDMG) does not designate Wildcat Fault as an Alquist-Priolo Earthquake Fault Zone.

The Strawberry Canyon fault is a buried, east-west trending linear feature in the Cretaceous bedrock. It is cut off by the Hayward and the Wildcat faults.²¹ It is unknown whether Holocene Activity studies have been done on the Strawberry Canyon Fault but, as it appears to be older than both the Wildcat and Hayward faults, it is not considered to be active.²²

From a probabilistic standpoint,²³ the slip rates of the Wildcat and Strawberry Canyon fault would be so low as to not impact seismic hazard at all even if both were active. The only potential seismic hazards they would pose is ground rupture along the surface trace. In other words, only structures built directly on these faults would be potentially endangered. This is because of the large extent of seismic activity from other faults in the region. Even if one uses a deterministic model,²⁴ the ground motions at any site along the Wildcat or Strawberry Canyon faults will be dominated by ground motions from characteristic earthquakes on the Hayward fault, because of its proximity and its characteristic earthquake magnitude, which would be much larger than that of the other faults discussed here.²⁵

The Lawrence Hall fault complex refers to a web of closely spaced, short, intersecting linear features northwest of the Lawrence Hall of Science. The area has been studied since the 1960s and 1970s, when the complex was originally postulated. Past investigation indicates the complex is a sheared contact zone between the Orinda and Moraga formations and is not a set of faults.²⁶

Other short, discontinuous faults mapped in the Hill Campus during the 1970s are identified as sheared contact zones in the ancient bedrock. These faults are not active and pose no threat of surface rupture to the area.

EARTHQUAKE PROBABILITY

As stated in Chapter 4.5, the San Andreas fault, the Hayward-Rodgers Creek fault, and the Calaveras fault pose the greatest threat because they have high quake odds and run through the Bay Area's urban core.²⁷ The Hayward fault and the Calaveras fault are each capable of generating a maximum credible earthquake (MCE)²⁸ of M7.5 on the Richter scale,²⁹ and of producing maximum earthquakes ranging from Mw 6.9 to 7.5 and Mw 6.8 respectively.³⁰ The northern section of the San Andreas fault could generate an MCE of M8.3³¹ and earthquakes of up to Mw 8.0.³² The Rogers Creek fault, located about 20 miles northwest of the Campus Park, also has the potential to generate seismic activity in the City of Berkeley.³³ It is considered capable of producing a maximum magnitude earthquake of Mw 7.0.³⁴ Earthquakes of these magnitudes are sufficient to create ground accelerations in bedrock and unconsolidated deposits, and severe enough to cause major damage to structures, foundations and underground utility lines.³⁵ Other faults that are sources for earthquakes that may result in strong ground shaking in the Bay Area include the Concord-Green Valley, Northern Calaveras, West Napa, and Clayton-Marsh Creek-Greenville faults.

The Hayward fault is of particular concern at UC Berkeley because it crosses the campus and because of the density of urban development along it and the major infrastructure lines that cross it. The seismicity on the Hayward fault has been relatively low in the past 45 years, with only four earthquakes of M4.0 or greater; however, the fault has an extensively documented history of higher activity. At least ten earthquakes of M6.0 or greater have occurred within 20 miles of this fault since 1836. In 1868, an earthquake estimated at about M7 ruptured about 30 miles of the Hayward fault with a maximum reported offset of about three feet.³⁶

B.1.6 REFERENCES

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- ⁶ U.S. Department of Agriculture (USDA), Natural Resources Conservation Service, *Soil Survey of Alameda County, Western Part*, March 1981.
- ⁷ Geomatrix Consultants, *Appendix One: Geologic Hazards Investigation Central Campus, University of California at Berkeley*, January 2000, page 13, prepared as part of *Economic Benefits of a Disaster Resistant University* by Dr. Mary Comerio, Institute of Urban and Regional Development, UC Berkeley, April 2000.
- ⁸ Geomatrix Consultants, *Appendix One: Geologic Hazards Investigation Central Campus, University of California at Berkeley*, January 2000, page 23, prepared as part of *Economic Benefits of a Disaster Resistant University* by Dr. Mary Comerio, Institute of Urban and Regional Development, UC Berkeley, April 2000.
- ⁹ U.S. Department of Agriculture (USDA), Natural Resources Conservation Service, *Soil Survey of Alameda County, Western Part*, 1981, page 18-19. Map Sheets No. 1,2,7.
- ¹⁰ U.S. Department of Agriculture (USDA), Natural Resources Conservation Service, *Soil Survey of Alameda County, Western Part*, 1981, page 29.
- ¹¹ U.S. Department of Agriculture (USDA), Natural Resources Conservation Service, *Soil Survey of Alameda County, Western Part*, 1981, page 99.
- ¹² U.S. Department of Agriculture (USDA), Natural Resources Conservation Service, *General Soils Map of Alameda County, Western Part*, 1981, General Soil Map, page 5.
- ¹³ U.S. Department of Agriculture (USDA), Natural Resources Conservation Service, *Soil Survey of Alameda County, Western Part*, 1981, pages 98.
- ¹⁴ California Geological Survey, *How Earthquakes and Their Effects are Measured*, Note 32, Revised April 2002, http://www.conservation.ca.gov/cgs/information/publications/cgs_notes/note_32/note_32.pdf, retrieved February 19, 2004.
- ¹⁵ California Geological Survey, *How Earthquakes and Their Effects are Measured*, Note 32, Revised April 2002.
- ¹⁶ The seismic moment of an earthquake is determined by the strength or resistance of rocks to faulting multiplied by the area of the fault that ruptures and by the average displacement that occurs across the fault during the earthquake. (Source: California Geological Survey, *How Earthquakes and Their Effects are Measured*, Note 32, Revised April 2002.)
- ¹⁷ Southern California Earthquake Data Center, *Investigating Earthquakes through Regional Seismicity*, page 19, <http://www.data.scec.org/Module/sec3pg19.html>, retrieved on February 18, 2004.

- ¹⁸ Association of Bay Area Governments (ABAG), “Modified Mercalli Intensity Scale”, <http://www.abag.ca.gov/bayarea/eqmaps/doc/mmi.html>, retrieved on April 2, 2004.
- ¹⁹ California Department of Conservation, Mines and Geology, *GIS Data for the Geologic Map of California*, DMG CD 2000-007, 2000; Wakabayashi, John, California Registered Geologist No. 5890. Personal communication with DC&E, November 22, 2003.
- ²⁰ Wakabayashi, John, California Registered Geologist No. 5890. Personal communication with DC&E, November 20, 2003.
- ²¹ California Department of Conservation, Mines and Geology, *GIS Data for the Geologic Map of California*, DMG CD 2000-007, 2000.
- ²² Wakabayashi, John, California Registered Geologist No. 5890. Personal communication with DC&E, November 22, 2003.
- ²³ A probabilistic model assumes that the hazard is dominated by the highest slip rate faults closest to the site of interest and those of such faults that produce the biggest earthquakes.
- ²⁴ A deterministic model assumes that all considered faults will rupture in characteristic earthquakes during the design lifetime, regardless of probability.
- ²⁵ Wakabayashi, John, California Registered Geologist No. 5890. Personal communication with DC&E, November 20, 2003.
- ²⁶ Converse Consultants, *Hill Area Dewatering and Stabilization Studies*, University of California Department of Facilities Management, October 31, 1984, pages 4-11 and 4-12.
- ²⁷ U.S. Geological Survey (USGS), Fact Sheet 039-03, “Is a Powerful Quake Likely to Strike in the Next 30 Years?”, 2003, <http://geopubs.wr.usgs.gov/fact-sheet/fs039-03/fs039-03.pdf>, retrieved April 4, 2004.
- ²⁸ The maximum credible earthquake is defined as the earthquake which produces the greatest levels of ground motion at the site as a result of the largest magnitude earthquake that could reasonably occur along the recognized faults or within a particular seismic source. (Source: <http://www.usace.army.mil/publications/eng-pamphlets/ep1110-2-12/c-4.pdf>, retrieved on February 18, 2004).
- ²⁹ UC Berkeley, *Long Range Development Plan Draft Environmental Impact Report*, January 1990, page 4.7-2.
- ³⁰ Geomatrix Consultants, *Appendix One: Geologic Hazards Investigation Central Campus, University of California at Berkeley*, January 2000, pages 7-8, prepared as part of *Economic Benefits of a Disaster Resistant University* by Dr. Mary Comerio, Institute of Urban and Regional Development, UC Berkeley, April 2000.
- ³¹ UC Berkeley, *Long Range Development Plan Draft Environmental Impact Report*, January 1990, page 4.7-2.
- ³² Geomatrix Consultants, *Appendix One: Geologic Hazards Investigation Central Campus, University of California at Berkeley*, January 2000, page 8, prepared as part of *Economic Benefits of a Disaster Resistant University* by Dr. Mary Comerio, Institute of Urban and Regional Development, UC Berkeley, April 2000.
- ³³ *City of Berkeley Draft General Plan EIR*, February 2001, page 197.
- ³⁴ Geomatrix Consultants, *Appendix One: Geologic Hazards Investigation Central Campus, University of California at Berkeley*, January 2000, page 7, prepared as part of *Economic Benefits of a Disaster Resistant University* by Dr. Mary Comerio, Institute of Urban and Regional Development, UC Berkeley, April 2000.
- ³⁵ UC Berkeley, *Long Range Development Plan Draft Environmental Impact Report*, January 1990, page 4.7-2.
- ³⁶ UC Berkeley, *Long Range Development Plan Draft Environmental Impact Report*, January 1990, page 4.7-11.

APPENDIX B.2

UNIVERSITY POLICY ON SEISMIC SAFETY

Original Issue/Approval Date: January 20, 1975

Latest Revision: January 17, 1995 [Editor's Revision: April 20, 2000]

B.2.1 POLICY

It is University policy – to the maximum extent feasible by present earthquake engineering practice – to acquire, build, maintain, and rehabilitate buildings and other facilities which provide an acceptable level of earthquake safety, as defined in this policy, for students, employees, and the public who occupy those buildings and other facilities at all locations where University operations and activities occur. It is also University policy to repair University buildings and other facilities damaged in an earthquake as set forth below in the section entitled Repair of Buildings and Other Facilities Damaged by Earthquakes. Feasibility is to be determined by weighing the practicability and cost of protective measures against the gravity and probability of injury resulting from a seismic occurrence.

- **Responsibility.** The President is responsible for overall administration of this policy and shall provide for (1) interpretation or clarification of the policy as may be required; (2) development of seismic safety criteria, standards, and guidelines supplementary to the policy; (3) evaluation of seismic safety programs and review of specific proposals for the abatement of seismic hazards; and (4) determination of University-wide priorities among seismic safety projects and other projects proposed for inclusion in the Capital Improvement Program.

The President shall assign specific duties and authority to individuals within the Office of the President who may engage professional consultants or other specialists to advise and assist them in matters involving seismic safety.

The Chancellors, Senior Vice President-Business and Finance, Vice President-Agriculture and Natural Resources, Director-Lawrence Berkeley Laboratory, Director-Lawrence Livermore Laboratory, and Director-Los Alamos Scientific Laboratory are the officials responsible for taking all reasonable steps to assure protection of persons under their respective jurisdictions against the effects of earthquakes which could result in the loss of life or injury to persons. Each responsible official shall assign specific duties and authority to individuals under his or her jurisdiction for the purpose of discharging this responsibility.

- **Program for Abatement of Seismic Hazards.** Each responsible official shall develop a program for abatement of seismic hazards in existing buildings and other facilities within their respective jurisdictions and shall establish priorities for seismic safety projects in accordance with this policy. Each responsible official shall coordinate proposed seismic correctional work with (1) proposed fire protection work (see University policy on fire protection, issued September 22, 1971) [Editor's Note: In place of the aforementioned policy on fire protection, the University currently follows, as policy, fire protection regulations of CCR, Title 24, Part 9.], (2) other proposed work involving environmental health and safety considerations, and (3) reasonable and prudent rehabilitation for functional and programmatic improvements.

The program for abatement of seismic hazards shall include identification and temporary and permanent correction of potential earthquake falling, sliding, or rupturing hazards such as, but not limited to, interior and exterior building elements, utilities, equipment, fixtures, furnishings, and other contents which could be dislodged, fall, overturn, slide, or rupture during seismic disturbances. Temporary measures to reduce the risks of injury pending permanent corrective action shall be considered and implemented if feasible.

- **The Consulting Structural Engineer.** Each responsible official shall secure the services of one or more consulting structural engineers experienced in field investigations and analyses of damage in earthquakes. The consulting structural engineer shall be required to examine existing buildings and other facilities as directed by the responsible official and to submit to the responsible official reports on the adequacy of the resistance of such campus buildings and other facilities to seismic forces based on (1) conformance to the current seismic provisions of California Code of Regulations (CCR), Title 24, California Building Standards Code, or local seismic requirements (e.g., city or county building regulations), whichever requirements are more stringent; and (2) the consulting structural engineer's professional evaluation of their anticipated seismic performance, expressed in terms of Good, Fair, Poor, or Very Poor, as defined in Appendix A, with respect to degree of risk of injury to persons but not necessarily in conformance with the above specific seismic provisions. For buildings and other facilities which are reported as Poor or Very Poor by the consulting structural engineer, the responsible official shall immediately consider alternatives to undiminished continued use and occupancy of the buildings and other facilities, including total or partial evacuation, temporary emergency measures, reductions in use, reconstruction, or combinations of these alternatives, and shall then take appropriate action.

The consulting structural engineer shall be required to include in all reports recommendations regarding priorities for abatement of seismic hazards and estimates of costs for correcting seismic deficiencies in accordance with this policy.

- **Standards for Seismic Rehabilitation Projects.** When evaluation by the consulting structural engineer of existing buildings or other facilities discloses conditions which do not afford an acceptable level of safety, proposed correctional work shall be incorporated in the program developed by the responsible official for abatement of seismic hazards and integrated in the University's proposed Capital Improvement Program. Seismic rehabilitation projects shall provide, as a minimum, an acceptable level of earthquake safety based on the sole consideration of the protection of life and prevention of personal injury, insofar as predictable, at a level of safety equivalent to that which would be established by compliance with the current seismic provisions of CCR, Title 24, California Building Standards Code, or local seismic requirements, whichever requirements are more stringent, disregarding, insofar as possible, potential building damage not jeopardizing life, which would be expected from one earthquake of the intensity of at least IX on the Modified Mercalli Intensity Scale (modified by Charles F. Richter in

1958, as shown in Appendix B), except that an intensity of VIII can be utilized for buildings on the Davis and San Diego Merced campuses. The intent of seismic rehabilitation shall be to reconstruct buildings and other structures so that they would have a Good seismic performance rating, as defined in Appendix A. based on the present state of the practice of earthquake engineering.

When funds for seismic rehabilitation are limited, the program developed by the responsible official may include a phased rehabilitation program for selected buildings. The first phase would have the goal of reducing the greatest life safety hazards of the structure such as reducing the potential of partial building collapse and/or reducing falling hazards at building entrances and along adjacent walkways. Later phases, to be performed when funds are available, would complete the seismic rehabilitation program of the structure. The consulting structural engineer shall assist the responsible official in establishing the scope of work in each phase of a phased rehabilitation program.

Preliminary plans for all seismic rehabilitation projects shall be reviewed by the consulting structural engineer, who shall verify the scope of the rehabilitation work and shall prepare any recommendations regarding any special criteria which should be considered in the project design. Upon completion of plans and specifications, the consulting structural engineer shall review the plans and structural calculations for completeness, general accuracy, appropriateness of details, and for compliance with any special criteria. The design structural engineer shall incorporate comments into the plans prior to bidding.

- **Repair of Buildings and Other Facilities Damaged by Earthquakes.** In addition to the requirements established elsewhere in the Policy pertaining to the construction, maintenance and rehabilitation of University buildings and facilities, the following standards shall apply to repair of University buildings and facilities which are damaged by earthquakes.
 1. Subject to the provisions of paragraph 2, below, when the lateral load resisting capacity for the building or facility as a whole is reduced by less than 10 percent, repairs shall be in conformity with the requirements of codes currently applicable to University construction. Related work required by currently applicable codes shall also be performed in areas affected by the repairs.
 2. When (i) the lateral load resisting capacity for the building or facility as a whole is reduced by 10 percent or more, or (ii) in the case of hospitals, skilled nursing facilities, intermediate-care facilities and essential service buildings as defined in Table 23-K of the 1991 California Code of Regulations, Title 24, California Building Standards Code, Part 2, California Building Code, the lateral load resisting capacity of the entire building or facility is reduced by 5 percent or more, or (iii) when the lateral load resisting capacity is reduced by less than 10 percent, but the estimated cost of repairs required to bring damaged elements into substantial compliance with the seismic performance objectives of current codes exceeds 10 percent of the replacement cost of the entire building or

facility, the entire building or facility shall be made to substantially comply with the seismic performance objectives of the codes currently applicable to University construction. Related work required by currently applicable codes shall also be performed in areas affected by the repairs. For purposes of this Policy, "replacement cost" is defined as construction cost of a like number of assignable square feet designed to house a like program on the same site and built in compliance with codes currently applicable to University construction.

3. When calculating the percentage reduction in total lateral load resisting capacity of any building or facility the construction of which was first completed prior to January 1, 1941, damage to all building or facility elements which served as lateral resisting elements shall be included, even if such elements were not originally designed or intended as lateral resisting elements, unless the building or facility possesses sufficient seismic resistance to substantially comply with the performance objectives of the codes currently applicable to University construction without these elements.

- **New Buildings and Other Facilities; Hospitals.** The design and construction of new buildings and other facilities on University premises shall, as a minimum, comply with the current seismic provisions of CCR, Title 24, California Building Standards Code, or local seismic requirements, whichever requirements are more stringent. In addition, provisions shall be made for adequate anchorage for seismic resistance of nonstructural building elements-including, but not limited to, glass, fixtures, furnishings, and other contents, equipment, material storage facilities, and utilities (gas, high-temperature water, steam, fire protection water, etc.) - with respect to potential hazards to persons in the event of seismic disturbances.

New University buildings shall not be constructed on the trace of an active geological fault.

Preliminary plans for new major capital improvement projects, except pre-engineered buildings, wood-framed buildings of less than 3,000 square feet, and buildings not intended for human occupancy other than hospitals proposed for construction shall be examined by the consulting structural engineer, who shall prepare recommendations regarding any special criteria that, in that engineer's opinion, should be recognized in providing adequate resistance to seismic forces to minimize the risk of injury to persons and damage to property. Upon completion of the final plans, the consulting structural engineer shall review the plans and structural calculations for completeness, general accuracy, structural details, and for compliance with any special criteria previously established. Should seismic design standards be revised during the period between completion of final plans and the date of advertisement for bids, the consulting structural engineer shall review again the plans and structural calculations before advertising for bids. The design structural engineer shall incorporate all comments into the plans prior to bidding.

Prior to the release of funds for structures other than hospital or for seismic rehabilitation projects, a letter or report from the campus consulting structural engineer shall be submitted, stating that the construction plans are in general conformance with the University policy on seismic safety.

The design and construction of new facilities or alterations for hospitals, skilled nursing facilities, and intermediate-care facilities as defined in Section 15001 of the California Health and Safety Code, on University premises or under University operation shall comply with CCR, Title 24, California Building Standards Code.

B.2.2 BACKGROUND

This policy was set forth in Vice President McCorkle's letter to the Chancellors et al., of January 20, 1975. It was reported and accepted by The Regents' Committee on Grounds and Buildings on January 16, 1975. The policy was revised by President Gardner in his letter to the Chancellors et al., of May 17, 1988 and it was revised by President Peltason in his letter to the Chancellors et al., of January 17, 1995.

B.2.3 GUIDELINES

The Senior Vice President Business and Finance is responsible for coordination of seismic safety programs and may issue appropriate administrative guidelines as necessary.

B.2.4 APPENDIX A

MEANING OF GOOD, FAIR, POOR, OR VERY POOR SEISMIC PERFORMANCE RATINGS

"**Good**" seismic performance rating would apply to buildings and other structures whose performance during a major seismic disturbance "is anticipated to result in some structural and/or nonstructural damage and/or falling hazards" that would not significantly jeopardize life. Buildings and other structures with a "Good " rating would have a level of seismic resistance such that funds need not be spent to improve their seismic resistance to gain greater life safety, and would represent an acceptable level of earthquake safety.

"**Fair**" seismic performance rating would apply to buildings and other structures whose performance during a major seismic disturbance is anticipated to result in structural and nonstructural damage and/or falling hazards that would represent low life hazards. Buildings and other structures with a "Fair" seismic performance rating would be given a low priority for expenditures to improve their seismic resistance and/or to reduce falling hazards so that the building could be reclassified "Good."

"Poor" seismic performance rating would apply to buildings and other structures whose performance during a major seismic disturbance is anticipated to result in significant structural and nonstructural damage and/or falling hazards that would represent appreciable life hazards. Such buildings or structures either would be given a high priority for expenditures to improve their seismic resistance and/or to reduce falling hazards so that the building could be reclassified as "Good," or would be considered for other abatement programs, such as reduction of occupancy.

"Very Poor" seismic performance rating would apply to buildings and other structures whose performance during a major seismic disturbance is anticipated to result in extensive structural and nonstructural damage, potential structural collapse, and/or falling hazards that would represent high life hazards. Such buildings or structures either would be given the highest priority for expenditures to improve their seismic resistance and/or to reduce falling hazards so that the building could be reclassified "Good," or would be considered for other abatement programs such as reduction of occupancy.

"Major seismic disturbance" is defined for the purposes of these seismic performance ratings as an earthquake at the site which would be given a Modified Mercalli Intensity Scale (modified by Charles F. Richter in 1958) rating of at least IX based on the description of the structural effects, except that an intensity of VIII can be utilized for buildings of the Davis and San Diego Merced campuses. It is assumed that the intensity of the ground shaking is not appreciably greater in areas rated MM X, MM XI, and MM XII than in areas rated MM IX. The damage descriptions in MM X, MM XI, and MM XII relate more to the geologic features and non-building structures.

"Falling Hazards" are defined for the purposes of these seismic performance ratings as potential falling or sliding hazards such as interior and exterior building elements including parapets, ornamentation, chimneys, walls, and partitions, but excluding equipment, fixtures, ceilings, furniture, furnishings, and other contents. The falling hazards in the excluded list above should not be used in the determination of the seismic performance rating of a building or structure but should be abated.

B.2.5 APPENDIX B

MODIFIED MERCALLI INTENSITY SCALE

- I Not felt. Marginal and long-period effects of large earthquakes.
- II Felt by persons at rest, on upper floors, or favorably placed.
- III Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.

- IV Hanging objects swing. Vibration like passing of heavy trucks, or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of [intensity] IV, wooden walls and frames creak.
- V Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small, unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.
- VI Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc. off shelves. Pictures off walls, Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle).
- VII Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments). Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.
- VIII Steering of motor cars affected. Damage to masonry C; partial collapse. Some to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.
- IX General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. (General damage to foundations.) Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas, sand and mud ejected, earthquake fountains, sand craters.
- X Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.
- XI Rails bent greatly. Underground pipelines completely out of service.
- XII Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

The version of the scale given above was published by Richter (1), and is a slight abridgment of the original scale. Richter also included the description of the types of construction included here. The original scale was published in 1931 by H.O. Wood and Frank Neumann (2).

B.2.6 DEFINITION OF MASONRY A, B, C, D

Masonry A. Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.

Masonry B. Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.

Masonry C. Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at the corners, but neither reinforced nor designed against horizontal forces.

Masonry D. Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

B.2.7 BIBLIOGRAPHY

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Source: The University Policy on Seismic Safety can be downloaded at <http://www.ucop.edu/facil/fmc/facilman/volume1/rpsafety.html>.