Expected Performance Rating System

In researching seismic rating systems to determine how to best classify the facilities within the Portland Public School system, we searched out what was used by other school districts, federal agencies, and larger cities. Modeled after a system used by the University of California at Berkeley that created performance classifications to group their inventory into a few categories, the same system is being used here. Performance ratings were assigned to classifications of GOOD, FAIR, or POOR

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

- A **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 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.

- A **POOR** seismic performance rating would apply to buildings and other structures expected to sustain significant structural and non structural damage and/or result in falling hazards in a major seismic disturbance, representing 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 GOOD, or would be considered for other abatement programs, such as reduction of occupancy.

To determine which schools belong in the various performance rating categories, structural data from each school was reviewed. The seismic risk score developed for PPS over the years to help determine which schools have the higher seismic risk was used as the main factor in determining the performance rating. The performance rating system also takes into account previous seismic upgrade work, the building class, age of construction, vertical and horizontal irregularities, building site, number of stories, and condition of the structural materials. Using these factors, the schools were placed in one of the three Expected Performance classes.

Building Classes

Seismic "risk" (i.e., the potential for earthquake casualties and damages) results from the combination of seismic "hazard" (i.e., the probabilities of damaging ground motions) and the vulnerability of the existing building inventory to earthquake damage. Thus, building seismic vulnerability is a major determinant of the degree of seismic risk which Portland Public School facilities face.

A building's seismic vulnerability depends on the ability of its structural systems (i.e., walls, columns, beams, floors and roofs) to withstand seismic forces. Therefore, an individual building's seismic vulnerability depends on the materials used in its construction, on its age and condition and on the construction details connecting parts of the building together.

To compare seismic vulnerabilities, buildings are commonly grouped into "classes" of buildings with common construction materials, details and seismic performance. Seismic vulnerability varies markedly from building class to building class. We have evaluated and classified the seismic vulnerability of existing school buildings in Portland using the 16 building class list used by the National Institute of Building Sciences (NIBS). Definitions for these building classes are given in Table 1 on the following page.

The school facilities are often a combination of many additions and building types that have been built over the years. For the purpose of the charts and rating system, the original or main school was used to identify the building class. Most schools have more than one building class associated with the facility. The building class also is based on the main structural system of the school and not other elements. Many of the schools that have concrete exterior walls for the main structural system were found to contain URM partition walls (clay tile) which pose a high seismic risk for collapse. The URM partition walls are factored into the seismic risk score but would not be identified by the building class.

There are several published compilations of building seismic vulnerability vs. building class. For the reasons discussed in Technical Appendix, we have adjusted these existing compilations in order to account for the Portland-specific building stock. We have made Portland-specific estimates of the vulnerability of these building classes to seismic damage

Vertical and Horizontal Irregularities

Buildings' seismic vulnerability also depends on the design of individual buildings within a class. Buildings with configurational irregularities, soft stories and other less than optimum design characteristics may be more vulnerable than the typical building in a given class. "Configurational irregularities" means buildings with irregular shapes in plan (e.g., U-shaped instead of square) or changes in size between stories. "Soft stories", which are common in buildings with large open spaces on the ground floor, are weaker than the other stories in a building because they may have structurally weak elements instead of solid walls that typically occur in the floors above the ground floor.

All building classes located on rock or firm soil sites are generally much less vulnerable to seismic damage than are similar buildings located on soft soil sites. Soft soil sites are prone to amplification of ground motions, longer duration shaking and other effects that substantially increase building damages and thus the potential for injuries and deaths.

All of these factors were used in determining expected performance rating in conjunction with the PPS Risk Score that incorporates work done to date. Some buildings that have been recently substantially seismic upgraded may still be classified as "poor" or "fair" but have a lower risk score than other schools which is based on the structural system and location.

Table 1 Building Classification

LABEL	STRUCTURAL SYSTEM DESCRIPTION
W1	Wood, Light Frame
W2	Wood, Commercial and Industrial
S1	Steel Moment Frame
S2	Steel Braced Frame
S3	Steel Light Frame
S4	Steel Frame with Cast-In-Place Concrete Shear Walls
S5	Steel Frame with Unreinforced Masonry Infill Walls
C1	Concrete Moment Resisting Frame
C2	Concrete Shear Walls
C3	Concrete Frame with Unreinforced Masonry Infill Walls
PC1	Precast Concrete Tilt-Up Walls
PC2	Precast Concrete Frame with Concrete Shear Walls
RM1	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms
RM2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms
URM	Unreinforced Masonry Bearing Walls
MH	Mobile Homes

Buildings' seismic vulnerability - that is, their potential for damage and casualties in earthquakes - varies significantly with building class. See next page for chart.

Relative Life Safety Risk by Building Class

LIFE SAFETY RISK	BUILDING CLASS
HIGHEST RISK	Unreinforced Masonry Bearing Walls (URM)
	Precast Concrete Frame with Concrete Shear Walls (PC2)
	Concrete Frame with Unreinforced Masonry Infill Walls (C3)
	Steel Frame with Unreinforced Masonry Infill Walls (S5)
	Reinforced Masonry Bearing Wall with Precast Concrete Diaphragms (RM2)
	Concrete Moment Resisting Frame (C1)
	Precast Concrete Tilt-Up Walls (PC1)
	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms (RM1)
	Steel Frame with Cast-In-Place Concrete Shear Walls (S4)
LOWEST RISK	Concrete Shear Walls (C2)
	Wood Shear Walls (W2)

These relative life safety risk rankings are based on the estimated probabilities of death due to earthquake damages.

TECHNICAL APPENDIX

BUILDING CLASS AND DAMAGE STATE DESCRIPTIONS

This appendix contains a more detailed description of the 16 main building classes and descriptions of the damage states by building class. These descriptions are closely based on those in the NIBS report[1]• The alphanumeric symbols for each building class (e.g .• W1) are the same as given previously The suffices, L. M and H, refer to low-, mid- and high-rise buildings, respectively and not every classification applies to the Portland Public School inventory.

Building Class Descriptions

Wood Light Frame (W1)

These are typically single- or multiple-family dwellings. The essential structural feature of these buildings is repetitive framing by wood rafters or joists on wood stud walls. Loads are light and spans are small. These buildings may have relatively heavy masonry chimneys and may be partially or fully covered with masonry veneer. Most of these buildings, especially the single-family residences, are not engineered but constructed in accordance with conventional construction provisions of building codes (e.g., Sections 2516 and 2517 of the UBC). Hence. they usually have the components of a lateral-force-resisting system even though it may be incomplete. Lateral loads are transferred by diaphragms to shear walls. The diaphragms are roof panels and floors which may be sheathed with wood, plywood or fiberboard sheathing. Shear walls are exterior walls sheathed with wood siding, stucco. plaster. plywood. gypsum board, particle board or fiberboard. Interior partition walls are commonly sheathed with plaster or gypsum board.

Wood Commercial and Industrial (W2)

These buildings usually are commercial or industrial buildings with a floor area of 5.000 square feet or more and with few if any interior walls. The essential structural character of these buildings is framing by beams over columns. The beams may be glued-laminated (glu-lam) wood or steel beams or trusses. Lateral loads usually are resisted by wood diaphragms and exterior walls sheathed with plywood, stucco, plaster, or other paneling. The walls may have diagonal rod bracing. Large openings for stores and garages often require post-and-beam framing. Lateral load resistance on those lines may be achieved with steel rigid frames or diagonal bracing.

Steel Moment Frame (S1 L, S1 M, S1 H)

These buildings have a frame of steel columns and beams. In some cases, the beam column connections have very small moment resisting capacity but, in other cases, some of the beams and columns are fully developed as moment frames to resist lateral forces.
structure is concealed on the outside by exterior walls, which can be of almost any material (curtain walls, brick masonry, or precast concrete panels) and on the inside by ceilings and column furring. Lateral loads are transferred by diaphragms to moment resisting frames. The diaphragms can be

almost any material. The frames develop their stiffness by full or partial moment connections. The frames can be located almost anywhere in the building. Usually the columns have their strong directions oriented so that some columns act primarily in one direction while the others act in the other direction and the frames consist of lines of strong columns and their intervening beams. Steel moment frame buildings are typically more flexible than shear wall buildings. This low stiffness can result in large interstory drifts that may lead to relatively greater nonstructural damage.

Steel Braced Frame (S2L, S2M, S2H)

These buildings are similar to steel moment frame buildings except that the vertical components of the lateral-force-resisting system are braced frames rather than moment frames.

Steel Light Frame (S3)

These buildings are pre-engineered and prefabricated with transverse rigid frames. The roof and walls consist of lightweight panels. The frames are designed for maximum efficiency often with tapered beam and column sections built up of light steel plates. The frames are built in segments and assembled in the field with bolted joints. Lateral loads in the transverse direction are resisted by the rigid frames with loads distributed to them by shear elements. Loads in the longitudinal direction are resisted entirely by shear elements which can be either the roof and wall sheathing panels, an independent system of tension-only rod bracing, or a combination of panels and bracing.

Steel Frame with Cast-In-Place Concrete Shear Walls (S4L, S4M, S4H)

The shear walls in these buildings are cast-in-place concrete and may be bearing walls. The steel frame is designed for vertical loads only. Lateral loads are transferred by diaphragms of almost any material to the shear walls. The steel frame may provide a secondary lateral-force resisting system depending on the stiffness of the frame and the moment capacity of the beam-column connections. In modem dual systems, the steel moment frames are designed to work together with the concrete shear walls in proportion to their relative rigidities.

Steel Frame with Unreinforced Masonry Infill Walls (S5L, SSM, S5H)

This is one of the older types of buildings. The infill walls usually are offset from the exterior frame members, wrap around them and present a smooth masonry exterior with no indication of the frame. Solidly-infilled masonry panels, when they fully engage the surrounding frame members (Le., lie in the same plane), provide stiffness and lateral load resistance to the structure.

Reinforced Concrete Moment Resisting Frames (C1 L, C1 M, C1 H)

These buildings are similar to steel moment frame buildings except that the frames are reinforced concrete. There is a large variety of frame systems. Some older concrete frames may be proportioned and detailed such that brittle failure of the frame members can occur in earthquakes leading partial or full collapse of the buildings. Modem frames in zones of high seismicity are proportioned and detailed for ductile behavior and are likely to undergo large deformations during an earthquake without brittle failure of frame members or collapse.

Concrete Shear Walls (C2L, C2M, C2H)

The vertical components of the lateral-force-resisting system in these buildings are concrete shear walls that are usually bearing walls. In older buildings, the walls often are quite extensive and the wall stresses are low, but reinforcing is light. In newer buildings, the shear walls often are limited in extent, generating concerns about boundary members and overturning forces.

Concrete Frame Buildings with Unrelnforced Masonry Inflll Walls (C3L, C3M, C3H)

These buildings are similar to steel frame buildings with unreinforced masonry infill walls except that the frame is of reinforced concrete. In these buildings, the shear strength of the columns after cracking of the infill may limit the semi-ductile behavior of the system.

Precast Concrete Tilt-Up Walls (PC1)

These buildings have a wood or metal deck roof diaphragm, which often is very large, that distributes lateral forces to precast concrete shear walls. The walls are thin but relatively heavy, while the roofs are relatively light. Older buildings often have inadequate connections for anchorage of the walls to the roof for out-of-plane forces and the panel connections often are brittle. Tilt-up buildings often have more than one story. Walls can have numerous openings for doors and windows of such size that the wall looks more like a frame than a shear wall.

Precast Concrete Frames with Concrete Shear Walls (PC1 L, PC2M, PC2H)

These buildings contain floor and roof diaphragms typically composed of precast concrete elements with or without cast-in-place concrete topping slabs. The diaphragms are supported by precast concrete girders and columns. The girders often bear on column corbels. Closure strips between precast floor elements and beam-column joints usually are cast-in-place concrete. Welded steel inserts often are used to interconnect precast elements. Lateral loads are resisted by precast or cast-in-place concrete shear walls. Buildings with precast frames and concrete shear walls should perform well if the details used to connect the structural elements have sufficient strength and displacement capacity. However, in some cases, the connection details between the precast elements have negligible ductility

Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms (RM1 L, RM1M)

These buildings have perimeter bearing walls of reinforced brick or concrete..block masonry. These walls are the vertical elements in the lateral-force-resisting system. The floors and roofs are framed either with wood joists and beams with plywood or straight or diagonal sheathing or with steel beams with metal deck with or without a concrete fill. Wood floor framing is supported by interior wood posts or steel columns. Steel beams are supported by steel columns.

Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms (RM2L, RM2M, RM2H)

These buildings have bearing walls similar to those of reinforced masonry bearing wall structures with wood or metal deck diaphragms, but the roof and floors are composed of precast concrete elements such as planks or tee-beams and the precast roof and floor elements are supported on interior beams and columns of steel or concrete (cast-in-place or precast). The precast horizontal elements often have a cast-in-place topping.

UnreInforced Masonry Bearing Walls (URML, URMM)

These buildings include structural elements that vary depending on the building's age and to a lesser extent its geographic location. In buildings built before 1900, the majority of floor and roof construction consists of wood sheathing supported by wood subframing. In large multistory buildings, the floors are cast-in-place concrete supported by the unreinforced masonry walls and/or steel or concrete interior framing. In unreinforced masonry constructed after 1950, wood floors usually have plywood rather than board sheathing. In regions of lower seismicity, buildings of this type constructed more recently can include floor and roof framing that consists of metal deck and concrete fill supported by steel framing elements. The perimeter walls and possibly some interior walls, are unreinforced masonry. The walls mayor may not be anchored to the diaphragms. Ties between the walls and diaphragms are more common for the bearing walls than for walls that are parallel to the floor framing. Roof ties usually are less common and more erratically spaced than those at the floor levels. Interior partitions that interconnect the floors and roof can have the effect of reducing diaphragm displacements.

Mobile Homes (MH)

These are prefabricated housing units that are transported to location on wheels or moving platforms. At the site, the units are placed on isolated piers or masonry block foundations usually without any positive anchorage. Floors and roofs of mobile homes usually constructed with plywood and outside surfaces are covered with sheet metal.

Risk Scores as of December 31, 2011
Portland Public Schools Facility Improvement Program
The facility risk ratings have been updated to include all known lateral upgrades as of 12/31/11.

EAST SYLVAN MIDDLE SCHOOL

2003 Lateral Upgrade
-Reduce height of existing URM chimney to level of ceiling below attic and replaced by metal stack.
-New plywood roof diaphragm over original spaced sheathing of 1933 and 1947 wings.
-New blocking to transfer roof shears to shearwalls below.
-Removed orignal bus shed.

12/31/2011 No additional lateral improvements are known to have been undertaken at this facility beyond the above.

Remaining Lateral Upgrades Recommended	DCR	Occupancy x Hrs/Wk	Area Ft^2	Occup Hrs/Wk / Ft2	1/ X	HI Hazard Index	HI (1) Baseline Hazard Index	SHS Seismic Hazard Score
1)Strengthen load path of unsheathed shearwalls through attic zone	1.5	10,169	25,501	0.399	0.6	36	24	12
2)								
3)								
4)								
5)								
6)								
7)								
8)								
9)								
10)								

HAZARD INDEX TOTAL 36
HAZARD INDEX AVERAGE 36
SEISMIC HAZARD SCORE TOTAL Sum of HI-HI(1) 12

Scoring based upon: Building Area = 25,501 Ft^2

See next page for Occupancy Hrs data

James G. Pierson Inc. Consulting Structural Engineers

EAST SYLVAN MIDDLE SCHOOL

OCCUPANCY HOURS

Employees during Academic Months

Number of months for Academic Period	9				
Employee Type	Attendance Number Inside Building	Avg Hrs Per Wk During Academic Period	Ratio of Number of Months to 9 Month Base	Occupancy x Hrs/Wk	24/7/365 Occupancy
Typical School Staff	16.54	35	1.00	578.90	2.584
Janitorial	0	40	1.00	0.00	0.000
Other	0	0	1.00	0.00	0.000
Subtotals	16.54			578.90	2.584

Employees during Summer Months

Number of months for Summer Schedule	3				
Employee Type	Attendance Number Inside Building	Avg Hrs Per Wk During Summer Months	Ratio of Number of Months to 9 Month Base	Occupancy x Hrs/Wk	24/7/365 Occupancy
Typical School Staff	0	35	0.33	0.00	0.000
Janitorial	0	40	0.33	0.00	0.000
Other	0	0	0.33	0.00	0.000
Subtotals	0			0.00	0.000

Students during Academic Months

Number of months for Academic Period	9				
Student Type	Attendance Number Inside Building	Avg Hrs Per Wk During Academic Period	Ratio of Number of Months to 9 Month Base	Occupancy x Hrs/Wk	24/7/365 Occupancy
Typ Student Attendance	274	35	1.00	9,590.00	42.813
Other	0	40	1.00	0.00	0.000
Other	0	0	1.00	0.00	0.000
Subtotals	274			9,590.00	42.813

Students during Summer Months

Number of months for Summer Schedule	3				
Student Type	Attendance Number Inside Building	Avg Hrs Per Wk During Summer Months	Ratio of Number of Months to 9 Month Base	Occupancy x Hrs/Wk	24/7/365 Occupancy
Typ Student Attendance	0	10	0.33	0.00	0.000
Other	0	0	0.33	0.00	0.000
Other	0	0	0.33	0.00	0.000
Subtotals	0			0.00	0.000

Summary Occupancy Data

Occupancy Category	Attendance Number Inside Bldg	Occupancy Percentage	Occupancy x Hrs/Wk	24/7/365 Occupancy
Employees during Academic Months	16.54	5.69	578.90	2.584
Employees during Summer Months	0	0.00	0.00	0.000
Students during Academic Months	274	94.31	9,590.00	42.813
Students during Summer Months	0	0.00	0.00	0.000
Totals		100.00	10,168.90	45.397

The "Ratio of Number of Months to 9 Month Base" keeps the numbers at the same level as risk score data from previous years.

The occupancy on a 24/7/365 basis is used by the State of Oregon in their benefit to cost analysis.

2012 EXPECTED SEISMIC PERFORMANCE RATINGS AND SEISMIC HAZARD RISK SCORES -BASED ON STRUCTURAL DEFICIANCY-

Facility	Risk Score	Building Class [1]	Expected Performance Rating [2]
Abernethy	2.09	C2	Poor
Ainsworth	2.25	URM	Poor
Ainsworth Annex	0.00	W2	Good
Alameda	1.66	W2	Poor
Applegate	0.00	W2	Good
Arleta	2.37	C2	Poor
Astor	0.00	W2	Good
Atkinson	0.00	W2	Good
Beach	1.77	C2	Poor
Beaumont	2.26	C2	Poor
Benson	1.16	URM	Poor
Boise-Eliot	0.96	C2	Poor
Bridger	0.00	W2	Good
Bridlemile	0.95	W2	Fair
Buckman	0.55	URM	Poor
Capitol Hill	1.48	W2	Fair
Cesar Chavez	0.48	C2	Fair
Chapman	0.56	C2	Fair
Chief Joseph	1.73	W2	Poor
Clarendon	0.62	W2	Good
Cleveland	1.52	C2	Poor
Columbia T.C. (Pioneer)	0.63	W2	Fair
Creative Science	1.05	URM	Poor
Creston	1.73	C2/W2	Poor
Creston Annex	0.18	W2	Good
Davinci	0.62	C2	Fair
Duniway	2.93	C2	Poor
East Sylvan	0.26	W2	Fair
Edwards	0.00	W2	Good
Faubion	0.80	W2	Good
Fernwood (Beverly Cleary)	3.48	URM	Poor
Forest Park	0.00	C2	Good
Franklin	1.00	URM	Poor
George	1.74	W2	Fair
Glencoe	1.37	C2	Fair
Grant	2.79	URM	Poor
Gray	0.90	W2	Good
Grout	1.94	C2	Poor
Harrison Park	0.48	W2	Good
Hayhurst	2.38	W2	Poor
Holladay Center	0.48	PC1	Fair
Hollyrood (Beverly Cleary)	0.00	W2	Good
Hosford	1.88	C2	Poor

2012 EXPECTED SEISMIC PERFORMANCE RATINGS AND SEISMIC HAZARD RISK SCORES -BASED ON STRUCTURAL DEFICIANCY-

Facility	Risk Score	Building Class [1]	Expected Performance Rating [2]
Humbolt	0.44	W2	Good
Irvington	0.00	C2	Fair
Jackson	3.58	C1	Poor
James John	1.85	URM	Poor
Jefferson	3.25	URM	Poor
Kellogg	2.05	C2	Poor
Kelly	0.63	W2	Good
Kenton (Lasalle)	1.07	C2	Fair
King	0.26	C2	Fair
Lane	1.66	C2	Poor
Laurelhurst	0.92	C2	Fair
Lee	0.89	W2	Good
Lent	0.49	W2	Good
Lewis	1.42	W2	Fair
Lincoln	0.84	C2	Fair
Llewellyn	1.85	C2	Poor
Madison	1.09	C2	Fair
Maplewood	0.70	W2	Good
Markham	0.98	W2	Good
Marshall	1.01	C2	Fair
Marysville	2.78	W2	Poor
Meek	0.83	W2/C2	Fair
Metro Learning Center	1.37	C2	Poor
Mt. Tabor	1.35	W2	Fair
Ockley Green	1.55	C2	Fair
Peninsula	1.71	W2	Fair
Rice	0.48	W2	Good
Richmond	0.77	W2	Fair
Rieke	0.94	W2	Good
Rigler	1.07	C2	Fair
Roosevelt	2.57	URM	Poor
Rosa Parks	0.00	S2	Good
Rose City Park	2.15	URM	Poor
Roseway Heights	0.64	C2	Fair
Sabin	1.75	C2	Poor
Sacajawea	0.43	W2	Good
Scott	0.63	W2	Fair
Sellwood	0.35	C2	Fair
Sitton	0.79	W2	Good
Skyline	1.72	W2	Fair
Smith	0.00	RM1	Good
Stephenson	0.48	W2	Good
Sunnyside	1.38	C2	Fair

2012 EXPECTED SEISMIC PERFORMANCE RATINGS AND SEISMIC HAZARD RISK SCORES -BASED ON STRUCTURAL DEFICIANCY-

Facility	Risk Score	Building Class (1)	Expected Performance Rating (2)
Terwilliger	0.83	W2	Fair
Tubman	1.07	C2	Fair
Vernon	0.00	C2	Fair
Vestal	0.80	C2	Fair
West Sylvan	0.80	W2	Good
Whitman	0.56	W2	Good
Wilcox	0.00	RM1	Good
Wilson	0.76	C2	Fair
Winterhaven	0.80	C2	Fair
Woodlawn	2.63	C2	Poor
Woodmere	0.59	W2	Good
Woodstock	0.39	W2	Fair
Youngson (Pioneer)	1.52	W2	Fair

Key to Column Headings:

Risk Score — The total facility's final risk score. Calculated by the % of maximums (HI) + (HI Ave.) + 2x (SHS). The "SHS" value is double to give higher weighting for a better indication of true risk.

Facilities with a "0" risk score do not have any outstanding or remaining seismic upgrade work recommended by the FEMA-178 reports. A "0" does not indicate that that the school has no risk, just a low risk.

(1) Building Class — Based on original construction/highest risk construction type. Building class is not necessarily representative of the entire or majority of the school property (many schools have multiple building classes and additions. See attachment for more information

(2) Expected Performance — Expected performance ratings were determined using seismic risk score, building class, age of construction, presence of vertical and horizontal irregularities, building site, number of stories, and condition of the structural materials. See attachment for more information