

SCHOOL FACILITIES MANUAL
Nonstructural Protection Guide

SECTION A

BACKGROUND INFORMATION
AND
LESSONS LEARNED BY
SEATTLE PUBLIC SCHOOLS

INTRODUCTION

Purpose

Strengthening the nonstructural elements of a school building to resist earthquake-induced damage is an important step toward improving the safety of the school community in regions with notable earthquake activity. Strengthening nonstructural elements also tends to reduce property damage and speed the restoration of school programs following an earthquake emergency.

The Nonstructural Protection Guide provides information on how to establish a district-wide program to identify and strengthen nonstructural elements commonly found in school buildings. The Nonstructural Protection Guide was prepared to accompany the Washington Office of the Superintendent of Public Instruction (OSPI) School Facilities Manual.

Nonstructural elements of a building

The nonstructural elements of a building include the decorative details and those functional building parts and contents which support the activities in, and the performance of, the building. Nonstructural elements make it possible to enjoy and use a building safely, comfortably, and efficiently as distinguished from the structural elements that maintain the physical integrity of the building.

Earthquake induced damage to the nonstructural elements of a building generally does not undermine the capability of the structural elements to support the building. Structural elements such as beams, columns, floors, walls, and foundation, are designed to resist the expected pushes and pulls of gravity, wind, earthquakes, and other types of loads in order to prevent structural collapse. Figure 1 shows examples of the nonstructural and structural elements of a building.

Typical nonstructural elements of a building include:

Architectural Elements

- Cladding
- Veneer
- Windows and partition walls
- Parapets and cornices
- Canopies and walkways
- Stairways
- Water towers

Mechanical Systems

- Heating, ventilation, and air-conditioning
- Fire protection
- Elevators
- Water and sewage

Electrical Systems

- Transformers
- Lighting
- Emergency power

Furnishings and Equipment

- Computers
- File cabinets
- Shelving
- Display cabinets
- Shop equipment
- Lab equipment
- Kitchen appliances
- Vending machines

Hazardous Materials

- Natural gas
- Chemicals
- Asbestos, lead

Benefits of strengthening nonstructural elements

Securing the nonstructural elements improves the safety and security of the school community during an earthquake emergency:

- Reduces casualties
- Helps maintain safe and clear exit ways for evacuation and to access the building
- Reduces dangerous chemical spills, fires, and gas leaks
- Improves the likelihood of using the building as a shelter following the earthquake

Securing the nonstructural elements also improves the safety and security of the school community during normal school operations:

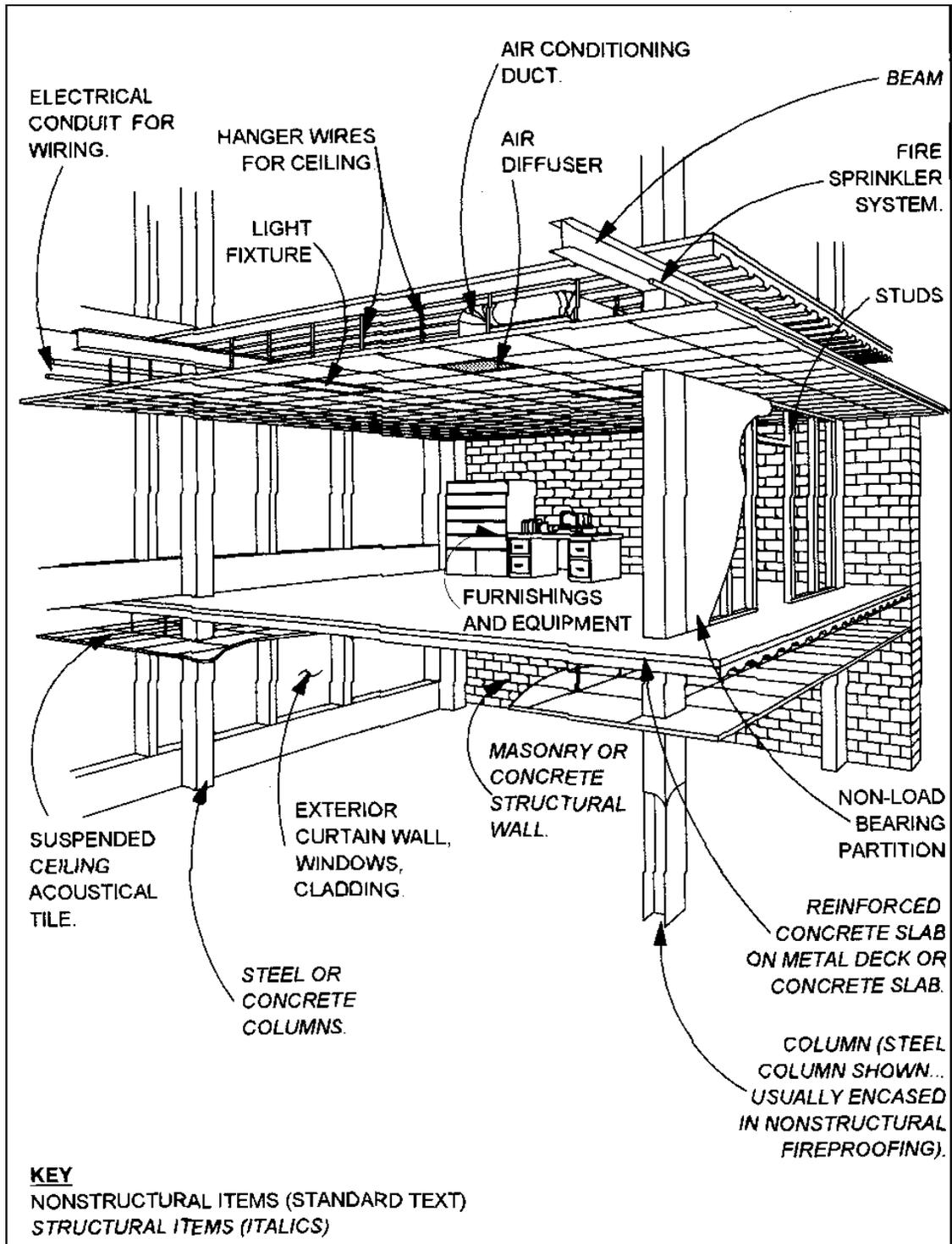
- Bookshelves and lockers attached to walls reduce vandalism and improve the safety of exit routes
- Locked storage rooms and secured equipment discourage theft
- Safety films on glass make access to the building by intruders more difficult

- Glass safety films may be tinted to improve energy conservation
- Anchored vending machines prevent casualties caused by overturning during an earthquake or if shaken by users
- Staff, parents, and students who inventory school areas for nonstructural earthquake hazards will also be learning skills that will enable them to make their homes and businesses safer
- The inventory promotes teamwork among the school community and helps team members become more familiar with building areas
- Secured and properly stored chemicals help reduce spills during normal classroom use

Securing nonstructural elements tends to foster recovery:

- Repair of earthquake induced damage to nonstructural elements can cost millions of dollars and keep schools closed even when no structural damage has occurred

Figure 1
Nonstructural And Structural Components of a
Typical Building (FEMA 1994).



Limitations of the Nonstructural Protection Guide

The many nonstructural elements in a building and our imperfect understanding of both regional earthquake hazards and their impacts on buildings make the elimination of all damage to nonstructural building elements an unrealistic and expensive goal.

Some of the nonstructural elements described in this Guide require specialized expertise to identify the specific earthquake hazard and to develop appropriate nonstructural protection measures. This expertise may not be available among school district personnel. Many of these elements are included in the Guide as a means of increasing awareness of the hazards they present and the types of outside services that may be needed to reduce that hazard.

Information in the Guide is based on current earthquake retrofit practice and standards for existing buildings. Practice and standard changes as new information is available. No building or its elements can be made “earthquake proof” due to the many variables involved in producing earthquake damage. However, the strengthening methods in this Guide can help make schools more resistant to earthquake induced damage and improve the safety of building occupants.

Implementation of the nonstructural protection measures in this Guide must be complete before the ground begins to shake. These measures, which reduce the severity of loss through strengthening the resistance of nonstructural elements to earthquake induced damage, are called mitigation measures. The earthquake is a test of the success of implemented mitigation measures to resist damage. Nonstructural protection is one element of a school facilities mitigation program.

School emergency preparedness

This Guide does not focus on emergency response actions taken after an earthquake to rescue victims, stabilize buildings, and salvage facilities. School staff, students, and visitors

must be ready to take immediate protective actions during the sudden on-set of earthquakes and other emergencies that may occur when schools are in session. A school emergency preparedness program to develop an effective emergency response capability is a necessary complement to a school facilities mitigation program.

The school emergency preparedness program should include a section that addresses the unique issues related to earthquakes:

- Earthquake-specific response procedures
- Earthquake drills and exercises
- Emergency supplies and equipment on site
- Information for staff and parents about home earthquake safety
- An educational program for staff and students and a psychological recovery plan

Getting help

City, county, or state emergency managers may be able to assist the school district in the development of a school nonstructural earthquake strengthening and preparedness program. Local emergency managers can help to: (1) identify planning and earthquake hazard reduction resources, (2) explain what local governments expect of schools during an emergency, and (3) assist with developing school emergency response drills and exercises. The coordination of school emergency plans with the city or county emergency plan is an important part of establishing an effective community response capability.

Nonstructural manual content

This Guide addresses:

- Washington Earthquake Hazards.
- Earthquake-Induced Damage to Washington Schools.
- Causes of Earthquake Damage.

- District Nonstructural Protection Program. Guidance is provided on developing and managing an on-going, Nonstructural Protection Program to reduce earthquake-induced hazards in school buildings.
- School Site Teams. Involvement of school site teams consisting of staff, parents, and students in inventorying nonstructural earthquake hazards and implementation of nonstructural protection measures.
- School Nonstructural Inventory (Section B) Directions and forms are provided to complete a comprehensive inventory of school nonstructural earthquake hazards.
- Nonstructural Protection Details (Section C) Drawings and implementation instructions show selected examples of methods and supplies needed to strengthen nonstructural elements to resist earthquake-induced damage.
- Appendices contain:
 - References Cited.
 - Lists of vendors selling nonstructural protection supplies.

WASHINGTON EARTHQUAKE HAZARDS

What is an earthquake?

An earthquake is the ground shaking caused by the sudden movement of rock along a fracture in the Earth's brittle outer layer. This sudden slip, referred to as faulting, releases waves of energy that radiate outward in all directions from the area of initial movement. Most faulting and associated earthquakes occur in response to temperature-driven movements of rock that is deep inside the Earth. This slow movement pushes and pulls against the Earth's outer layer.

Why, how big, and where do we have earthquakes in Washington?

Historically, earthquake activity has been most active and damaging west of the Cascade Range. However, all areas of the state are exposed to the threat of at least minor earthquake damage. The Washington Department of Natural Resources has a number of publications on Washington earthquakes. Washington Earthquake Hazards (Noson, et al 1988) provides a summary of state hazards and risks. A brief discussion of state hazards is provided below.

Washington is well known for its beautiful mountains, lakes, and forests. The same active geologic forces that shaped this landscape also generate earthquakes. The earthquake potential in Washington is largely determined by the interaction of three large, slowly moving slabs of rock, called tectonic plates. The relative movements of these plates generate Washington earthquakes in three source areas. Each of these source areas has unique earthquake characteristics:

- Deep earthquakes as strong as magnitude (M) of 7.5 (see paragraph titled How Is Earthquake Size Measured?) occur beneath Puget Sound in the Juan de Fuca Plate and are generated as the plate stretches and sinks northeastward below the North America Plate. Notable historic deep earthquakes include the 1949 Olympia (M = 7.1) and 1965 Seattle-Tacoma (M = 6.5) earthquakes.

- Shallow crustal earthquakes occur in Western and Eastern Washington in the North America Plate. Notable historic shallow earthquakes include the 1872 North Cascades (M = 7 to 7.5), the 1100 Seattle Fault (M = 7 to 7.5), and the 1936 Walla Walla (M = 6) earthquakes.
- Earthquakes of more than M = 8 in the inclined boundary where the North America Plate and the Juan de Fuca Plate overlap, called the Subduction Zone. Notable earthquakes along this boundary include the 18th Century Cascadia Earthquake (M = 8 to M = 9).

How often do Washington earthquakes occur?

Several thousand earthquakes occur in Washington each year. A dozen or more of these shake the Earth's surface hard enough for the vibrations to be felt by humans.

Deep Earthquakes: Every few decades, deep Puget Sound earthquakes rock local Washington communities hard enough to crumble older brick buildings, shift wood-frame buildings off their foundations, and disrupt utility and transportation systems. Every few hundred years larger deep earthquakes beneath Puget Sound cause significant damage to older buildings and more limited damage to modern buildings in communities throughout the state.

Subduction Zone Earthquakes: Every few hundred years huge subduction zone earthquakes along Washington's coastal margins permanently shift the land, dropping some areas by as much as 6 feet causing inundation of marsh grasses forests and shoreline communities, and elevating other areas potentially leaving marine facilities high and dry. These earthquakes can generate crushing water waves (tsunamis). Shaking caused by subduction zone earthquakes is expected to be strong enough to damage communities over the entire Cascadia Region from British Columbia to Northern California.

Shallow Earthquakes: Geologic studies show that 1,000 years ago a large, shallow western Washington earthquake much stronger than any we have experienced historically left evidence of intense shaking, dramatic movement of the Earth's surface, landslides, ground settlement, and tsunamis. A repeat of a major shallow earthquake on the Seattle Fault or other similar faults would cause extensive damage to Washington communities similar to the devastation caused in Kobe, Japan in 1994.

How is earthquake size measured?

Magnitude: Earthquake size or magnitude can be determined using an instrument called a seismograph. This instrument measures the movement of the Earth's surface by recording the radiating earthquake waves. Each whole-number magnitude increase represents a ten-fold increase in the up and down motion recorded by the seismograph. An $M = 6$ earthquake causes 10 times the recorded motion of an $M = 5$ and 100 times the motion of an $M = 4$ earthquake.

The magnitude may be used to calculate the amount of energy released by the earthquake. Each whole-number increase in magnitude corresponds to an energy increase of about 32 times the lower magnitude value. An $M = 6$ earthquake releases about 30 times the energy of a $M = 5$ and nearly 1,000 times the energy of a $M = 4$ earthquake

As earthquakes increase in size, the movement of the earth in response to the earthquake waves saturates. That is the ground motion no longer increases in a way directly related to the increased size of the earthquake. A different method of determining magnitude based on the number of factors, such as area of slip, is used to calculate the size of earthquakes generally greater than $M = 8$.

Intensity: Earthquake size may also be determined using a subjective scale of observed damage. This method was used before the installation of seismographs and before the

development of the Richter Magnitude Scale. An example is the Modified Mercalli Intensity (MMI) Scale (Table 1) first published in 1931. Defining the intensity of an earthquake is similar to describing the brightness of a light bulb at a particular location in a room. What is observed depends not only on the light bulb's "magnitude" as measured by the number of watts, but also on the characteristics at any particular location that might affect the light's brightness. Similarly, the intensity of damage observed at a specific building depends upon a number of factors, such as the earthquake's magnitude, distance from the fault generating the earthquake, type of geologic materials underneath the building, type of building construction, age of construction, and other attributes. Over time the MMI scale has been modified to address changes in building types.

All these possible variations in damage result in a single earthquake being capable of producing intensities ranging from *not felt at a particular location* (MMI = I) to *causing catastrophic damage* (MMI = XII) at another place. Historical records generally list an earthquake's maximum observed intensity and the size of the area in which the earthquake was felt.

The maximum reported intensity for the 1965 Seattle-Tacoma Earthquake was MMI = VII. The maximum intensity reported for the 1949 Olympia earthquake was MMI = VIII. Both earthquakes were felt widely from western Canada south to Western Oregon.

Historic earthquakes in eastern Washington have generally been less frequent, more localized and of smaller intensity than those observed west of the Cascades. The 1936 Walla Walla, Earthquake, however, had a maximum intensity of MMI = VII, indicating that significant earthquake hazards do occur in eastern Washington.

Table 1
Modified Mercalli Intensity Scale

Scale	Description
I.	Not felt except by a very few people under especially favorable circumstances.
II.	Felt only by a few people at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III.	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. The vibration is similar to that caused by the passing of a truck. People often estimate the duration.
IV.	Felt indoors by many and outdoors by a few. Some are awakened. Dishes, windows, and doors are disturbed; walls make cracking sound. The sensation is like a heavy truck striking a building. Standing motor cars rock noticeably.
V.	Felt by nearly everyone; many are awakened. Some dishes and windows are broken. Unstable objects may be overturned. Pendulum clocks may stop. <i>[MMI = V generally marks the beginning of damage to nonstructural elements.]</i>
VI.	Felt by all and many are frightened. Some heavy furniture is moved; there can be a few instances of fallen plaster. Damage is slight.
VII.	[Structural] damage is negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly built structures. Some chimneys can be broken. Motion is noticed by persons driving motor cars. <i>[MMI = VII generally marks the beginning of possible structural damage to modern buildings. This is the maximum intensity reported for the 1965 Seattle-Tacoma Earthquake.]</i>
VIII.	Structural damage is slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, and walls common. Heavy furniture is overturned. <i>[This is the maximum intensity noted for the 1949 Olympia Earthquake.]</i>
IX.	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings may be shifted off foundations.
X.	Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed along with their foundations. Rails are bent.
XI.	Few, if any (masonry) structures remain standing. Bridges are destroyed. Rails are bent greatly.
XII.	Damage total. Lines of sight and level are distorted. Objects are thrown into the air.

Taken from a pamphlet titled "The Severity of an Earthquake" prepared by the US Geological Survey in 1986. See Wood and Neumann (1931) for complete details. Comments in italics added by the authors.

EARTHQUAKE-INDUCED DAMAGE TO WASHINGTON SCHOOLS

Introduction

Substantial damage to public and private schools in the 1949 and 1965 earthquakes in western Washington heightened awareness of the vulnerability of state schools. The severe damage sustained by older, unreinforced masonry school buildings and the deaths of two students called attention to the need for structural strengthening or replacement of many older schools.

There is no state requirement that school districts identify structural and nonstructural earthquake hazards or implement programs to improve the earthquake safety of school buildings. But a number of school districts are strengthening their buildings to improve student safety in response to concerns expressed by district managers, teachers, and parents.

The Seattle Public School District completed a series of building evaluations, facility utilization studies, and seismic evaluations from the mid-60s to the mid-90s (Perbix and Noson, 1996). In 1998 the Seattle School District was in the final phase of implementing a multi-year capital improvement program addressing potential structural earthquake hazards in city school buildings. Seattle is now moving forward with a program to secure nonstructural elements.

1949 Earthquake Damage

The April 1949 Olympia earthquake ($M = 7.1$; $MMI = VIII$) resulted in the closure of 30 Washington schools normally serving more than 10,000 students (Table 2). Ten of these schools were condemned and permanently closed. Gonen and Hawkins (1974) report 1949 losses to Washington schools of \$10 million or about \$60 million using the Consumer Price Index to adjust to 1998 dollar values. Total estimated property losses for this earthquake ranged from

about \$100 to 165 million dollars (1998 dollars; \$15 to 25 million 1949 dollars).

Casualties related to the earthquake included the death of the student body president at Castle Rock High and a small child killed at Lowell Elementary School in Tacoma. Both were killed by bricks dislodged from the exterior of the building. The Seattle Public Schools were closed for spring holidays, which prevented loss of life to staff and students from the extensive fall of bricks, chimneys, and parapets on to many school walkways and playgrounds experienced in Seattle.

Costs to replace and repair 21 Seattle school buildings damaged in the 1949 earthquake represented nearly one half of the total damage reported for Washington State Schools. Three schools were condemned (Lafayette Elementary School, Central Grade School, and Cascade Grade School) and five temporarily closed for repairs (Lincoln High, Queen Anne High, Roosevelt High, West Seattle High, and Whitworth Grade School). Repair and replacement costs for these eight schools were over \$25 million (1998 dollars; \$4 million 1949 dollars). The remaining 14 schools required over \$3 million in repairs (1998 dollars; \$500,000 1949 dollars).

1965 Earthquake Damage

The April 1965 Seattle-Tacoma Earthquake, although a less powerful earthquake than the 1949 earthquake, had a similar damage pattern. Over \$60 million (1998 dollars; \$12 million 1965 dollars) in estimated property loss was reported for this earthquake (Gonen and Hawkins 1974). Table 3 lists damage to Seattle school buildings. Eight Seattle public schools were closed. Two schools in West Seattle, including West Alki School, sustained severe damage.

Table 2.
Selected Damage In Washington Communities
From 1949 Olympia Earthquake

Community	Impact
Auburn	Junior high school was condemned. Four blocks of downtown business district damaged severely. Fall of parapet walls and many chimneys. Small objects overturned. Books fell. Dishes broken.
Castle Rock	Castle Rock High School damaged severely, with brick and masonry falling on children (one fatality). Upper wall over entrance to school building fell. Considerable damage to brick masonry and concrete buildings. Chimneys fell. Dishes, windows, and furniture broken.
Centralia	Over 30 businesses and school buildings were very severely to moderately damaged. Collapse of building walls and many chimneys. Water mains broken. Two schools permanently closed. Water and sand spouted from the ground. Damage to water intake. Telephone lines twisted together for many miles.
Chehalis	Damage was considerable to wood, brick, masonry, and concrete buildings. Most downtown buildings, schools, and churches damaged. Brick damaged most severely. City library condemned.
Longview	High school water main broke and beams cracked in the cafeteria. Light damage to water main and electric transmission line. Several refrigerators overturned. Water and sand spouted from the ground and up into basements.
Olympia	Nearly all large buildings were damaged with cracked or fallen walls and cracked or fallen plaster; water and gas mains broken. All schools evacuated by fire marshal for inspection. Eight capitol buildings damaged; two closed. Fifty percent of chimneys down or severely damaged.
Puyallup	High school was damaged severely; stage collapsed in auditorium. Nearly every house chimney toppled at roofline; several houses jarred off foundations. Four buildings collapsed. Water mains were broken. Several basement floors were raised several feet. Basements filled with water and sand.
Seattle	Damage to 21 schools, with five closed temporarily and three condemned. Typical damage included failure of gables, parapet walls, and exterior ornamentation and collapsed chimneys. Many houses on filled ground demolished. Collapse of the top of a radio tower. Heavy damage to docks and stores waiting for shipment. Many water mains in soft ground broken, and many basements flooded. Telephone and power service temporarily interrupted. Bookcases overturned.
Tacoma	Three schools damaged and closed for repairs. Few homes escaped some damage. Several houses slid into Puget Sound. Railroad bridges south of Tacoma thrown out of line, and traffic held up for hours. Railroad tracks kinked, buckled, and sank 4 feet in one place. Tremendous rock slide followed earthquake.
Tenino	Every business and house suffered some damage. Grade school heavily damaged. Damage considerable to brick.

(Information from U.S. Department of Commerce, 1949)

Table 3.
Damage To Selected Seattle School Buildings
From The 1965 Seattle-Tacoma Earthquake

Name of School	Description of Damage
Ballard High School	Damage was confined to the auditorium where a ceiling arch was bent and a study wall twisted.
Broadview Elementary School	Part of an older exterior brick wall fell.
Colman Elementary School	A chimney was damaged; part of the masonry gables at the entrance fell; the front wall was damaged.
Franklin High School	Parts of cornices on four corners of the building fell; the lunchroom ceiling was cracked; hallway and stairwells were damaged. All fire alarms were short-circuited and activated.
Gatewood Elementary School	Gables fell.
Leshi Elementary School	Gables fell.
Madison Junior High School	A chimney collapsed, and masonry fell at the entrance; a water line broke.
Queen Anne High School	Walls were cracked.
St. Joseph's School	Pieces of cornices fell from the front of the building.
University of Washington	Minor damage occurred to the Mechanical Engineering Building, including a broken electric cable. Minor cracks were observed on the fourth floor of the new library.
West Alki Elementary School	The 60-foot brick chimney stack fell through the roof down into the boiler room; x-cracks were found in the unreinforced sand-lime mortar brickwork in the 1914 wing; stairs were shifted; the north wall of the new wing moved outward.
West Seattle High School	Walls throughout the school were severely cracked. Exterior and interior walls of the auditorium were cracked.

(Information from Thorsen, 1986)

CAUSES OF EARTHQUAKE DAMAGE

Introduction

Earthquakes shake the ground in all directions. Because of this multi-directional shaking, the structural and nonstructural elements of a building must be specially designed to resist earthquake forces in a variety of directions. Structural and nonstructural elements of a building that are not secured to resist expected up and down and side-to-side earthquake shaking pose a hazard to building occupants.

Structural damage

The structural elements of a building must be designed and constructed to support heavy weights under the force of gravity. Structural elements of Washington buildings generally have sufficient strength to prevent collapse due to vertical earthquake motions. However, special earthquake-resistant design is often needed to strengthen structural elements to resist lateral or side-to-side earthquake motions.

Earthquake-resistant design requirements were absent from local Washington building codes before 1952, limited and largely incomplete from 1952-1975, and generally not standard practice in all Washington communities until after 1980 (Seattle Department of Construction and Land Use, 1999). Therefore, the structural elements of Washington schools built prior to 1952 are particularly vulnerable to earthquake shaking. More modern Washington schools may still have earthquake design deficiencies that could result in severe damage to the structural system during an earthquake. Damage to structural elements may result in partial or complete building collapse.

School facility managers should note that a building that does successfully meet the building code objective to protect building occupants from partial or total building collapse may still need to be torn down after a major earthquake. A school building that does not collapse, may still sustain severe damage to structural and nonstructural elements. This damage may endanger lives, result in building closure, and generate repair costs equal to the cost of building replacement.

Nonstructural damage

Nonstructural elements can be vulnerable to damage from both vertical and lateral earthquake motions. When an earthquake shakes a building, the result can be:

- **Distortion and damage** to nonstructural elements, such as windows, partition walls, and elevators, caused as the shape of the surrounding building deforms in response to earthquake shaking (Figures 2 to 5).
- **Sliding and overturning** of book shelves, file cabinets, mechanical equipment and many other types of furnishings and equipment (Figures 6 to 9).
- **Falling of items** from counters, desks, and shelves (Figure 10).
- **Swaying and shaking** of suspended elements like piping and light fixtures resulting in breaks, leaks, and falls (Figure 11 and 12).

Earthquake-resistant design of nonstructural elements was generally not a major concern in local or national building codes before 1980. Even in the most recent building codes, only a few nonstructural elements must be designed to resist earthquake damage. Therefore, the nonstructural elements in most buildings in the United States remain vulnerable to damage during earthquake shaking.

Why be concerned about nonstructural damage?

Even minor to moderate earthquake shaking may damage nonstructural building elements, possibly resulting in injuries and loss of life. Such light shaking occurs much more frequently than the vigorous shaking that accompanies major earthquakes. The general lack of earthquake-resistant design requirements for nonstructural elements in today's building code further increases the potential for damage and injury. Consider the following effects of nonstructural earthquake damage:

- The Olive View Medical Center performed well structurally in the 1994 Northridge Earthquake (M = 6.7), but damage to equipment and sprinklers resulted in the evacuation of patients (Earthquake Engineering Research Institute, 1994).
- Differences in movement between rigid fire sprinkler systems and more flexible suspended ceilings damaged sprinkler heads resulted in extensive flooding during the 1989 Loma Prieta earthquake, even in structures with no structural damage (Dames & Moore 1989).
- Public school buildings generally performed well structurally in the Northridge earthquake, with no structural collapses. Most damage was nonstructural. Property loss to the Los Angeles Unified School District of \$700 million was reported (EERI 1994).
- Damage to nonstructural parts of a building may delay emergency response actions by blocking exits with debris, disrupting communications, and destroying the capacity to fight fires.
- Damage to electric power systems can cause loss of electrical service resulting in failure of lighting, communications, alarms, pumps, and other power dependent equipment. Fluctuations in power may damage equipment.
- After the earthquake, nonstructural damage may prevent building use even in the absence of structural damage. The costs to repair nonstructural earthquake damage can equal the cost of building replacement.



Figure 2. Imposed deformation diagram. Vertically oriented built-in nonstructural components, such as full-height partitions or windows, are vulnerable to deformation imposed by the drift of the structure as it undergoes lateral loads during the earthquake (Graphic credit: Earthquake Engineering Research Institute (EERI), Federal Emergency Management Agency).



Figure 3. Broken windows, close-up view. A graphic example of the result of severe drift experienced by a concrete structure in the 1964 Alaska earthquake and the resulting failure of the glass panes (photo credit: EERI, John F. Meehan).



Figure 4. Fallen light fixture. These light fixtures, which were supported by the hung ceiling, fell when the ceiling distorted in the 1971 San Fernando Earthquake. The typical safety measure for fluorescent fixtures such as these is to attach back-up safety wires to them and anchor these wires to the floor or roof structure above, so that even if the ceiling grid distorts or collapses, the light fixture will not fall (Photo credit: EERI James L. Stratta).



Figure 5. Escape hole made through partition and view of jammed door. In the 1979 Imperial County, California Earthquake, the door to this office in the imperial county services building was jammed shut by the distortion of the structure. The occupant was trapped until co-workers broke through the sheet-rock clad metal stud partition wall (Photo credit: EERI, Christopher Arnold).

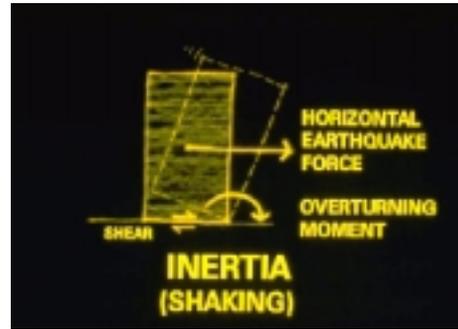


Figure 6. Diagram of shear and overturning. Inertial forces generated within unanchored nonstructural objects cause them to overturn if they are slender and to slide if they are stocky. This generalization is modified by the distribution of mass – some pieces of equipment are top-heavy and more prone to overturning under lateral loading than their proportions would indicate – and also by the amount of friction at the base – sliding is more likely as the friction decreases. Seismic codes specify seismic nonstructural component coefficients that are multiplied by the weight of the object to produce lateral design forces. Depending upon the applicable code or analysis method, factors are used in this calculation process to increase design forces for components that are especially hazardous or essential, located at an upper story level, or have flexible mountings rather than rigid bolted anchorage (Graphics credit: EERI, Federal Emergency Management Agency).



Figure 7. Overturned file cabinet. File cabinets are prone to overturning because of their slenderness, and they are even more vulnerable when unlatched drawers can slide out. This photo of the Santa Clara County Administration Building after the 1984 Morgan Hill Earthquake, shows that desks proportions make them unlikely to overturn and thus they provide good protection against nonstructural damage if occupants are trained to quickly take cover (Photo credit: EERI, Wesley Van Osdol).



Figure 8. Overturned file cabinet. The hazardous nonstructural damage pictured here occurred at Coalinga district hospital in the 1993 Coalinga, California Earthquake (Photo credit: EERI, Sawant Rinal).



Figure 9. Overturned bookshelves. These library shelves in Seattle, Washington, overturned during the magnitude 7.1, 1949 Olympia Earthquake. Return to normal required not only reinstalling the shelves, but also sorting and shelving the books (Photo credit: Steinbrugge Collection, Earthquake Engineering Research Center, University of California, Berkeley, Harlan Edwards).

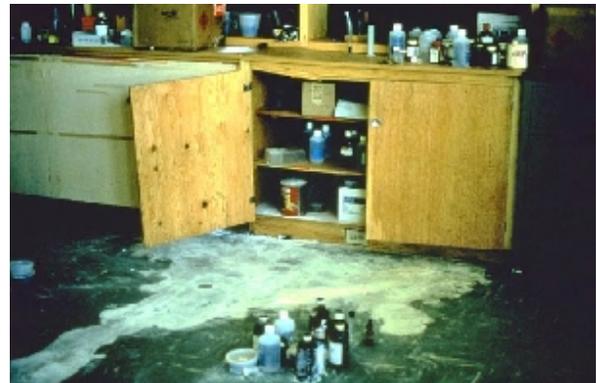


Figure 10. Spilled chemicals. Unrestrained chemicals can fall, their containers can break, and hazardous reactions can occur, even if the cabinetry itself is properly anchored, as shown here in an example from a high school's chemistry lab in the 1971 San Fernando Earthquake (Photo credit: EERI, Chuck Wilton).



Figure 11. Broken pipe. Earthquake damage to piping is most frequently observed at joints. Although damage to small-diameter piping has been observed in recent earthquakes, lack of bracing on larger diameter piping typically makes them more seriously vulnerable. The damage here occurred in the 1971 San Fernando Earthquake at the original Olive View Hospital (Photo credit: EERI, J. Marx Ayres).



Figure 12. Water pouring down the stairs. Broken piping leads not only to direct property loss – the cost of repairing the piping – but is also often the cause of leakage and resulting water damage that is more costly to repair. The cascade of water down these stairs in an industrial building occurred in the 1971 San Fernando Earthquake (Photo credit, EERI, J. Marx Ayres).

DISTRICT NONSTRUCTURAL PROTECTION PROGRAM

Introduction

This section provides detailed information for school district staff on how to initiate and manage a School Nonstructural Earthquake Protection Program. Securing nonstructural elements to reduce earthquake-induced damage and injury may best be seen as part of the school district's responsibility to improve school safety. The program includes the identification of nonstructural earthquake hazards in school building spaces and the implementation of protection measures. Program issues related to necessary skills, safety, budgets, consistency, and liability generally require that Washington school district staff manage the nonstructural protection program. However, as proposed in this manual, building site teams with district support and training may be able to help meet district and school earthquake safety goals.

The large number of potential nonstructural earthquake hazards in any building makes the implementation of nonstructural earthquake protection measures a long-term, on-going task. District leadership will be needed to track and monitor program activities over time and to ensure that nonstructural protection measures are properly implemented.

Guiding principles

The assumptions and philosophies behind the School Nonstructural Earthquake Protection Program are:

- Strong earthquake ground shaking will damage nonstructural elements in school buildings.
- School buildings in western Washington are at greater risk of being damaged by an earthquake than those in eastern Washington. However, all Washington schools are exposed to earthquake hazards capable of damaging nonstructural elements of the building.

- Older, unreinforced masonry (brick) schools are the most vulnerable to earthquake-induced partial or total collapse, but all schools are likely to sustain damage to nonstructural elements.
- Elimination of all nonstructural earthquake hazards is not practical because costs may exceed the benefits and because some protective measures may interfere with necessary school operations.

Summary of program steps

The School Nonstructural Earthquake Protection Program may be established by completing these steps:

1. Define the school district's nonstructural protection program goals and identify program responsibilities. What does the district want to accomplish? Who will manage the district's program?
2. Obtain district support and commitment
3. Identify, coordinate, and manage the expertise that will be needed to complete program activities.
4. Train district maintenance, facilities, safety and security staff on how to use the information in this manual.
5. Complete the inventory of school building spaces for nonstructural earthquake hazards
6. Use the completed inventory forms to prepare a work plan. What Work Needs To Be Done?
7. Select and implement nonstructural earthquake protection measures using the details provided in Section C as a guide. How Will the Work Be Done?
8. Monitor and track all program activities.

Step One: Define the School District's Program Goals and Identify Potential Program Responsibilities

Program Goal: The primary goal of the School Nonstructural Earthquake Protection Program should be the safety of students, staff, teachers, and school visitors. Protection of school property and a return to normal school operations are important, but are generally secondary concerns.

Responsibilities: District staff will need to be involved in developing and overseeing program activities. District involvement is essential to maintaining a safe, reliable, and consistent program. Program activities may be integrated into existing facilities, maintenance, safety, and security programs. Nonstructural protection program responsibilities may include some or all of the following personnel and tasks:

- District maintenance staff will normally be responsible for developing the program goals and scope of activities. Other district staff and/or a district committee may help in this process. A consultant specializing in nonstructural earthquake protection programs may be hired to help outline the scope of the program.
- District maintenance staff may be responsible for training district staff in how to use this manual, how to inventory school building spaces, and how to implement nonstructural earthquake protection measures. A consultant specializing in nonstructural earthquake protection programs may be hired to help in the development and delivery of training.
- District maintenance staff could track work completed and monitor the implementation of nonstructural protection measures by district staff, equipment installers, contractors, and school site teams.
- District volunteer coordinator(s) will normally work with safety and security to identify potential school site team members, including school staff, parents, students, and community volunteers.
- District safety and security staff will normally have responsibility for training site

team members, including school staff, parents, students, and community volunteers. District safety and security staff may help coordinate nonstructural program activities with district emergency response needs and priorities.

- School safety committees may coordinate the nonstructural program activities with school emergency response needs and priorities at the building level.
- School site teams may be responsible for inventorying and protecting selected nonstructural elements after receiving training from district staff. All school site team activities should be tracked and monitored by district staff and coordinated with school safety committees.

Step Two: Obtain District Management Support and Commitment

Support and commitment from district management will be necessary to implement the Nonstructural Earthquake Protection Plan consistently, systematically, and fairly in district school buildings. The district staff responsible for developing and overseeing the program should prepare a presentation for the District Budget Committee using the information in this manual to explain the following three elements:

- **Status:** What is the district's exposure to damaging earthquake activity? What are nonstructural earthquake hazards? How do these hazards threaten the staff, students, parents, and others working who may be studying, or visiting in school district buildings?
- **Target:** What is the level of protection that the district should establish for school building spaces?
- **Proposal:** How can the district achieve an acceptable level of protection? What activities and resources will be needed?

Step Three: Identify, Coordinate, And Manage the Expertise That Will Be Needed To Complete Program Activities

The large number and varying complexity of nonstructural elements in a school building call for an understanding of the type of training and expertise needed to:

- Identify and inventory potential nonstructural earthquake hazards.
- Select appropriate protective measures to reduce those hazards.
- Implement the selected measures.

Each school district will have staff with varying levels of engineering, architectural, and trade capability to perform the tasks called for to implement the different aspects of the nonstructural earthquake protection program.

District resources will normally determine which tasks will be carried out and by whom (see Financing). Tables 4a-4d list the advantages and challenges of the following four options for completing program tasks:

- **Option 1:** Use district staff
- **Option 2:** Use school site teams
- **Option 3:** Hire temporary district staff to be dedicated to the nonstructural program
- **Option 4:** Hire contractor(s)

Most districts will likely select a combination of the options presented above. Tables 4a-4d also include a list of tasks normally assigned for that option.

The services of a professional engineer may also be required to prepare appropriate construction drawings to guide the implementation of nonstructural earthquake protection measures for architectural, mechanical, and electrical systems and for heavy, expensive, or large furnishings and equipment. The construction drawings (details) included in Section C of this manual note when the services of a professional engineer may be needed. These details are provided to help district staff clarify the work that needs to be completed. Table 5 summarizes the nonstructural elements that may require the services of a professional engineer.

Table 4a
Option 1 — Use Regular District Staff To Manage the Nonstructural Earthquake Protection Program. Staff May Also Inventory Spaces and Implement These Protection Measures

Advantages	Challenges	Tasks Typically Assigned To District Staff
<p>District staff are normally familiar with the construction, location of plumbing and wiring systems, and work that has already been completed in school district buildings.</p> <p>District staff can integrate the implementation of nonstructural protection measures with the completion of routine maintenance work orders, facility remodel work, and new construction design.</p> <p>District staff acquires capabilities during implementation of the program that enhance district skills and expertise.</p> <p>District staff is in a position to provide long-term, on-going oversight to foster consistent program implementation.</p>	<p>District staff time may already be committed to other projects.</p> <p>Other district priorities or emergencies may take staff away from the nonstructural earthquake protection program and delay completion of tasks.</p> <p>District staff may not have the specific skills needed to develop and manage all program activities.</p> <p>The services of a professional engineer may be required to design appropriate protection for more complex nonstructural elements.</p>	<ul style="list-style-type: none"> ■ Obtain district management support and commitment by making a presentation to the School Budget Committee on the need for a nonstructural protection program. ■ Define the program purpose and scope using the information provided in this manual. A consultant may be needed to help with this task. ■ Provide training to district maintenance staff, safety and security staff, and to School Site Teams. ■ Maintain records of work completed at each school. ■ Manage contracts with contractors, consultants, and engineers. ■ Inventory spaces with complex nonstructural elements or elements located in restricted areas. ■ Inspect work completed before and after earthquake shaking. ■ Recommend improvements to the manual. ■ Identify nonstructural elements to be addressed when designing new facilities, remodeling building spaces, and when selecting, purchasing, and installing new furnishings and equipment. ■ Develop nonstructural earthquake protection standards such as construction standards to guide engineers and architects in the design of nonstructural elements in new school buildings

Table 4b
Option 2 — Use The School Site Team To Complete A Building Inventory and Implement Nonstructural Earthquake Protection Measures

Advantages	Challenges	Tasks That Might Be Assigned To School Site Teams
<p>School site teams can save the district money by reducing labor costs.</p> <p>School site teams may be especially motivated to try to improve the safety of the school in which team members work, have children enrolled, or visit on a regular basis.</p> <p>Community volunteers on the school site team may see safer schools as an integral part of improving community safety.</p> <p>School site teams may be especially successful in carrying out fund-raising activities when the money will be used to benefit the local neighborhood school. Funds can be used to cover expenses for school safety projects.</p> <p>School site teams can set a schedule for program activities that meet their particular concerns and priorities.</p>	<p>District resources will be needed to provide training and to manage school site team activities. District staff will need to track and monitor activities.</p> <p>School site teams may lack sufficient expertise to inventory all building spaces. Team expertise will vary from school to school.</p> <p>District staff and others will normally be needed to implement more complex nonstructural earthquake protection measures.</p> <p>Potential liability issues need to be carefully assessed when using non-district staff to complete work in spaces owned by the district. The district risk manager may suggest risk control measures to manage this potential liability. For example, team training should include safety topics such as the proper use of tools and equipment and how to prevent back injuries when moving heavy items.</p> <p>School site team members may be interested in only a small number of building spaces.</p> <p>District union representatives should be involved so as to prevent any conflicts with union requirements.</p>	<ul style="list-style-type: none"> ■ Complete program training. ■ Complete the inventory of nonstructural earthquake hazards in school building spaces according to team capabilities. ■ Prepare a request for self-help funding and assistance from the district to help complete program activities. ■ Carry out fund-raising activities to help complete program activities. ■ Maintain records of activities completed at the school and provide copies of records to district staff. ■ Implement nonstructural earthquake protection measures according to team capabilities. ■ Provide district staff with information to help improve manual guidance for other teams.

Table 4c
Option 3 — Hire Special District Staff To Complete Inventory And Implement
Nonstructural Earthquake Protection Measures

Advantages	Challenges	Tasks That Might Be Assigned To Specialty District Staff
<p>Hiring special district staff can accelerate the completion of program activities.</p> <p>If a large number of nonstructural elements are involved, a specialized district team may demonstrate cost savings over carrying out work in a piecemeal manner.</p> <p>Work will be carried out more consistently across the district if the same team is responsible.</p> <p>Specialized staff may be selected to complement existing staff and/or school site team capabilities.</p> <p>Temporary staff may be hired to add specialized skills to those of permanent district staff.</p>	<p>The normally heavy workload in most school districts will make it tempting to use the dedicated team for other projects.</p> <p>District hiring practice may not allow hiring temporary staff or staff that is dedicated to specific tasks.</p> <p>The district may still require the services of a professional engineer to design specialized nonstructural earthquake protection measures and to oversee implementation of design details.</p> <p>Implementation of some measures may require specific trade skills and permits. For example, a licensed contractor or plumber may be required.</p>	<ul style="list-style-type: none"> ■ Inventory building spaces or use inventories completed by school site teams. ■ Implement nonstructural earthquake protection measures according to methods outlined in the manual or prepared by engineers. ■ Provide district manager with records of actions completed and any problems encountered using manual details.

Table 4d
Option 4 — Hire Contractor(s) to Complete Inventory and Implement Nonstructural Earthquake Protection Measures.

Advantages	Challenges	Tasks Typically Completed By Contractors
<p>The district can hire the expertise needed to complete specific tasks.</p> <p>If a large number of nonstructural elements must be addressed, there may be cost savings in hiring a contractor versus doing the work in a piecemeal manner.</p> <p>Hiring a contractor can limit district staff time to project management.</p> <p>Nonstructural protective measures may be added to existing contracts with some contractors. For example, remodel projects could also address nonstructural earthquake protection.</p> <p>Upgrades of sprinkler systems provide an opportunity to secure ceiling systems.</p>	<p>Hiring a contractor may be more costly than using district staff or school site teams.</p> <p>More specific construction details may be required in order to prepare bid specification documents.</p> <p>District staff may need to manage a number of contracts with various contract specialists in order to complete the work.</p>	<ul style="list-style-type: none"> ■ Implement nonstructural earthquake protection measures according to district staff specifications. ■ Address special nonstructural elements that require a particular type of expertise, training, or licensing.

Step Four: Train District Staff in How to Use the Information in This Manual

Training district staff in how to identify nonstructural earthquake hazards, how to inventory school spaces, how to implement nonstructural earthquake protection measures, and how to work with school site teams is an important part in the School Nonstructural Earthquake Protection Program. Trained staff will be more alert to potential nonstructural earthquake hazards in school building spaces and better able to incorporate earthquake safety into routine maintenance operations than untrained staff. Some districts may need to hire a consultant to assist with the development and delivery of staff training.

Step Five: Complete the Inventory of School Building Spaces

Use the inventory forms provided in Section B to collect data regarding nonstructural earthquake hazards located in school building spaces. These inventory forms will cover the nonstructural elements in five types of building spaces:

- **Special Use Areas:** These spaces, such as chemistry laboratories, kitchens, and automobile and wood shops, commonly have a number of nonstructural elements that may pose a high life safety hazard if damaged during earthquake shaking.
- **Assembly Occupancies:** Hallways, stairwells, and all-purpose rooms have the potential to expose many people at one time to potential earthquake hazards and they are critical to safely exiting the building.
- **Normal Occupancies:** Classrooms, offices, and libraries support the school's educational program. Suspended ceiling systems, storage cabinets, library shelving, and countertop equipment normally account for most of the nonstructural earthquake hazards in these spaces.
- **Utility And Mechanical Rooms:** These spaces contain the nonstructural elements that support the operation of water, electrical, and heating systems. Damage to these elements impact building operations rather than safety. However, damage to gas-fueled equipment may result in fire

- **Exterior Spaces:** Many school buildings have exterior features that have the potential of causing severe injuries if damaged during earthquake shaking. Many of these features are located over exits and other places where staff and students gather.

Grouping the inventory forms according to the type of building space helps to identify nonstructural elements unique to specific spaces, integrate the protection of nonstructural elements against earthquake damage with space remodels and other room-by-room inspections, and provides one approach for organizing school nonstructural earthquake hazard inventories. School site teams can use the inventory forms to focus on those spaces of special interest or concern to building occupants.

Either district staff or school site teams can inventory most nonstructural elements located in these five types of building spaces after completing a district training class. However, some elements may require special inventory skills or the elements may be located in spaces that are not easily accessible to the school site teams. District staff may want to take the responsibility for completing inventories in spaces that are generally locked, such as utility and mechanical rooms, penthouses, and rooftops. District staff may also want to take the responsibility for hiring consultants to inventory more complex nonstructural elements, such as architectural elements.

The inventory forms are duplicated and included in a separate “Action Packet”. This packet makes copying inventory forms easier, prevents damage to the manual, and enables district staff to add information pertaining to their specific school district or program. Copies of blank inventory forms can be made for each of the spaces to be inventoried. A copy of the completed inventory form should be sent to the district program manager and a copy should be maintained by the school site team.

When completing the nonstructural earthquake hazards inventory, persons inventorying will need the following:

- A copy of the inventory form from the Action Pack for the space or spaces you will be inventorying.
- Clipboard
- Pen or pencil
- Flashlight
- Tape measure
- Room keys
- Camera
- Step ladder
- Video camera (optional)

Step Six: Use Completed Inventory Forms To Prepare A Work Plan

District staff may review the completed inventory forms and use Tables 4a-4d and 5 to determine which elements will be addressed in the nonstructural program and by whom. Work may be organized into the following categories:

- School site safety teams
- District maintenance staff
- Contractors
- Engineering services

Supplies will be provided to the school site teams for completing each nonstructural protection measure shown on the construction drawings (details), located in Section C of this manual. The school site team work plan needs to focus on what work will be done, where, by whom, and when. School site teams can use the work plan to develop a self-help proposal to submit to the district to obtain support.

Work plans for nonstructural protection measures that require district staff, contractors, or professional engineering services, need to consider a number of factors when estimating project costs:

- Who will do the work? Will all inventory and implementation work be completed by district staff? Will the volunteer school site teams help complete some tasks? How many elements will be done at one time?
- Is professional engineering design required?
- What performance goal is to be applied?
- Will work require relocation of building occupants?
- Can the implementation of nonstructural earthquake protection measures be combined with other building projects?

Step Seven: Identify and Select Nonstructural Earthquake Protection Measures

Nonstructural earthquake protection details are provided in Section C of this manual following the inventory forms. The services of a professional engineer may be required to develop construction drawings for some elements. “Engineering required” is marked on these details. These details are provided in this manual to give a general idea of the work that needs to be done. Table 5 lists the elements that normally require the services of a professional engineer to prepare an appropriate earthquake protection design. Table 5 also lists the type of skills required to install the protective measure according to the engineer’s design.

A shopping list of materials and equipment required to complete earthquake protection measures appropriate for the school site teams is provided on each detail.

Step Eight: Monitor and Track All Program Activities

Proper maintenance of nonstructural plan records will enable the district manager to better plan and coordinate district and school site team activities. Each inventory form should contain:

- The date the inventory was completed.
- The spaces that were inventoried.

- A measure of the number of nonstructural elements that need to be protected.
- The date that the nonstructural earthquake protection measure was installed.
- The cost to carry out the nonstructural earthquake protection measure.
- The date that a copy of the inventory form was sent to the school district manager.
- The skill that was needed to implement the selected measure.

Table 5
Nonstructural Elements For Which Engineering Services May Be Required To Design
Appropriate Earthquake Protection Measures

Nonstructural Category	Nonstructural Elements	Design Implementors
<ul style="list-style-type: none"> ■ Mechanical systems 	<ul style="list-style-type: none"> ■ Boilers ■ Water tanks ■ Condensate tanks ■ Flue pipes ■ Breechings ■ Compressors ■ Fan-coil units ■ Heat exchangers and heat pumps ■ Elevators 	<ul style="list-style-type: none"> ■ District maintenance staff ■ Contractors ■ Plumbers <p><i>Note: A plumbing permit may be required for some tasks.</i></p>
<ul style="list-style-type: none"> ■ Electrical system 	<ul style="list-style-type: none"> ■ Site transformer ■ Uninterrupted power system ■ Wire distribution system ■ Emergency power system 	<ul style="list-style-type: none"> ■ Service Provider ■ Maintenance Staff ■ Contractor <p><i>Note: An electrical permit may be required for some tasks.</i></p>
<ul style="list-style-type: none"> ■ Architectural elements – exterior 	<ul style="list-style-type: none"> ■ Masonry chimneys ■ Covered play areas ■ Canopies ■ Parapets ■ Cornices ■ Cap-Stones ■ Cladding 	<ul style="list-style-type: none"> ■ Contractor
<ul style="list-style-type: none"> ■ Architectural elements – interior 	<ul style="list-style-type: none"> ■ Walls acting as supports for heavy shelves or equipment ■ Special light fixtures 	<ul style="list-style-type: none"> ■ Contractor
<ul style="list-style-type: none"> ■ Furnishings and equipment 	<ul style="list-style-type: none"> ■ Equipment on vibration mounts ■ Unusually large and/or tall equipment ■ Heavy, wall-mounted shelving systems ■ Tall, heavy racking systems ■ Sensitive laboratory equipment ■ Equipment located above the third floor 	<ul style="list-style-type: none"> ■ District maintenance staff ■ Contractor

Financing

The option(s) selected in Step Three for managing and implementing a nonstructural protection program will depend to some extent upon the source and availability of financing. Public financing may have specific requirements for the type and training of personnel and the level of documentation required to identify and correct nonstructural earthquake hazards. Private financing may focus on specific elements or areas of interest to the donor. This section identifies some financing sources that might be available to support a nonstructural protection program.

School districts in Washington State may obtain funds for financing capital improvements from some or all of the following sources (see the OSPI School Facilities Manual for details):

- Sale of general obligation bonds authorized for school building construction purposes and currently collectible.
- Voter-authorized excess tax levies for capital purposes.
- Proceeds from investments of capital project fund moneys.
- Funds received from the state for assistance in the construction of school facilities
- Funds received from other sources (federal funds, insurance proceeds, property sales, etc.) and available for the construction of school facilities.
- Mitigation fees from environmental impacts by the State Environmental Protection Act (SEPA). SEPA mitigation fees are not part of local matching for school construction.
- Impact fees or charges for expanding school facilities to meet growth under the Growth Management Act (GMA). GMA impact fees are part of local funding for school construction. Refer to Growth Impact Fees WAC 180-27-032.

Some districts may be able to obtain funds for reducing nonstructural earthquake hazards from

- Federal or state hazard mitigation grants, such as the FEMA initiated Seattle Project Impact partnership that funded the revision of this manual and the implementation of nonstructural mitigation measures in Seattle School buildings.
- Private sector community partners, such as insurance companies, banks, local radio or television stations, or any of many private companies concerned about the safety of school children.
- School site teams may donate time and resources to address nonstructural earthquake hazards at their schools.
- Volunteer organizations like the American Red Cross, Habitat for Humanity, Christmas in April, and National Voluntary Organizations Active in Disaster may donate supplies or assist in implementation of nonstructural mitigation details.

SCHOOL SITE TEAMS

Introduction

School Site Teams can be a key part of a district nonstructural protection program. These teams may consist of teachers, parents, non-profit volunteer organizations, and other volunteers interested in helping improve school safety. The School Safety Committee may provide a nucleus for forming and overseeing activities of Site Teams.

Site teams can coordinate with district personnel in the completion of inventories of nonstructural elements in school building spaces. The extent of the team's participation in the inventory will depend upon the skills, training, and interests of the site team.

Site teams can implement some nonstructural protection measures. Table 6 shows tasks generally suitable for school Site Teams. Ideally, district staff will provide centralized coordination and management of nonstructural earthquake protection activities.

Initiation

Site Teams may be encouraged by the district or initiated by interested staff, parents, or students at the building level. Ideas for initiating a Site Team include:

- Develop a short presentation on the need to establish a nonstructural protection plan using the material in the guide.
- Deliver the presentation to the building administrator, Safety Committee, or other district group with the authority to support your program.
- Call districts in areas that have sustained earthquake damage to identify specific impacts on comparable school facilities.
- Use newspaper reports showing damage to schools.
- Identify school site team volunteers.
- Seek out training on nonstructural protection activities.
- Identify support needed by school site teams, including workspace, tools, and repair supply lists (Section C).

- Identify potential funding sources, including community partners.
- Package supplies individually for selected nonstructural elements to make implementation easier. For example, package the materials for securing desktop equipment.
- Consider storage location of nonstructural protection products and tools. The Seattle School District will be placing a storage container at each school site. Mitigation and preparedness materials will be stored inside.

Summary of site team activities

The Site Team should follow a process similar to the districts, but tailored to meet the interests and capabilities at the building level:

1. Define the building level nonstructural protection goals and objectives that the Site Team wants to accomplish. These may be more or less detailed than the district's goals. Generally the Site Team will focus on protecting nonstructural elements that do not require engineering or other building expertise to identify and implement.
2. Obtain support and commitment of the building administrator. Access to school spaces may require coordination with school custodial or maintenance staff.
3. Find out if there is a district nonstructural protection program that will provide training, supplies, guidance, etc.
4. Identify, coordinate, and manage the expertise that will be needed to complete program activities.
5. Request training from the district on how to use the information in this manual.
6. Complete the inventory of school building spaces for nonstructural earthquake hazards. The team may want to inventory all spaces, selected spaces, or implement mitigation of selected elements without completing an inventory.

7. Use the completed inventory forms to prepare a work plan (What Work Needs To Be Done?) Or list number and type of desktop equipment to be secured.
8. Select and implement nonstructural earthquake protection measures using the details provided in Section C as a guide. (How Will the Work Be Done?) If using pre-packaged kits, follow kit instructions.
9. Monitor and track all program activities.

Inventory Tools

When completing the nonstructural earthquake hazards inventory, persons inventorying will need the following:

- A copy of the inventory form from the Action Pack for the space or spaces you will be inventorying
- Clipboard
- Pen or pencil
- Flashlight
- Tape measure
- Room keys
- Camera
- Video camera (optional)
- Step ladder

Training

Participating school site teams should receive training on:

- Information on local earthquake hazards
- What causes nonstructural earthquake hazards.
- How to identify potential nonstructural earthquake hazards.
- How to fill out the inventory forms in Section B of this guide.
- How to prepare a work plan.
- What tools and materials are needed to complete the inventory and to correctly implement the nonstructural earthquake protection methods.
- Safe practices for completing an inventory of school building spaces, using tools, and moving and relocating furnishings and equipment.
- Record keeping tracking the completion of tasks.

Management

- Maintain school site team inventory data sheets.
- Monitor activities by recording activities completed and keeping records up-to-date. If there is a district program be sure to copy records to the district nonstructural protection manager.
- Remember to recognize and reward school Site Team volunteers to show appreciation for their activities.

Table 6
School Site Team Tasks
Nonstructural Earthquake Protection Tasks Suitable for School Site Teams

Task	Action
Inventory	Identify potential nonstructural earthquake hazards. Most site teams will focus on identifying nonstructural earthquake hazards in Normal Occupancy areas like classrooms, libraries, and offices.
Data management	Maintain school site inventory records. Send copies of records of work completed to district manager.
Implementation of nonstructural earthquake protection measures	<p>Secure desktop and counter-top equipment, such as computers, aquariums, and microwaves, weighing less than 40 pounds.</p> <p>Secure lightweight, overhead elements weighing less than 25 pounds (hanging plants, mobiles, and shelf contents) to ceiling structure.</p> <p>Secure equipment on audio-visual carts to the cart; tether the cart to the wall when not in use.</p> <p>Install shelf restraints to prevent hazardous materials, such as chemicals in science laboratories, from falling to the floor and breaking their containers. Make sure chemicals are labeled and stored appropriately.</p> <p>Locate bookshelves, storage cabinets, coat closets, and file cabinets in low occupancy areas if possible.</p> <hr/> <p>The following elements may require district assistance.</p> <p>Secure classroom bookshelves, storage cabinets, and coat closets more than 48 inches tall to the wall studs. The services of a professional engineer may be required to evaluate the capacity of the wall to support heavier shelves and cabinets.</p> <p>Secure objects, such as wall cabinets, pictures, televisions, and fire extinguishers weighing less than 50 pounds to the wall studs. Care should be given to the potential that electrical conduit may be present inside wall spaces.</p> <p>Secure floor-mounted equipment, such as drill presses, to the floor. Verify with district staff that floor is not made of prestressed concrete, which could be structurally damaged by installation of bolts. District staff or contractors should normally secure floor-mounted equipment over 250 pounds or containing electrical systems, such as transformers.</p>
Preparation of information sheets on reducing nonstructural earthquake hazards in the home	<p>Prepare information sheets on protecting nonstructural elements in the home using the information in this Guide.</p> <p>Provide assistance in identifying potential home nonstructural earthquake hazards and implementing home nonstructural earthquake protection measures.</p>

SCHOOL FACILITIES MANUAL
Nonstructural Protection Guide

SEATTLE PUBLIC SCHOOLS
LESSONS LEARNED

NOVEMBER 2000

SEATTLE PROJECT IMPACT

Seattle Public Schools Nonstructural Protection Program

INTRODUCTION

Seattle Project Impact is a public/private partnership initiated by the Federal Emergency Management Agency (FEMA). FEMA's Project Impact program seeks to improve the disaster resistance of communities by fostering the implementation of hazard reduction measures at the local level. With initial funding from FEMA, leadership by Seattle Emergency Management and extensive participation and in-kind contributions from many private and public organizations, Seattle Project Impact has generated a collaborative approach to managing the impacts of natural hazards buildings and systems in the Seattle area.

The Seattle Project Impact organizing committee identified four priority projects for improving community disaster resistance: earthquake Home Retrofit, School Retrofit for earthquake nonstructural safety, and the improved delineation and evaluation of seismic and landslide Hazard Mapping. Monthly committee meetings provide an opportunity to monitor progress, keep community partners informed, and identify new projects.

SEATTLE PUBLIC SCHOOLS

The Seattle Public Schools focused their effort on improving school earthquake safety by reducing the potential for earthquake-induced damage to the nonstructural elements of school buildings. This project is a natural continuation of the district's Capital Improvement Program to strengthen district buildings to resist earthquake-induced structural damage. Notable earthquakes in 1949 and 1965 caused a disproportionate amount of damage to Seattle school buildings. Extensive repairs and building replacements were required to fix the damage caused by these two events. Subsequent seismic evaluations and retrofit of Seattle schools began in 1977. Since the structural retrofit of school buildings is near completion, the district can not focus greater attention to the reduction of nonstructural earthquake hazards.

The Seattle Public Schools Project Impact program includes: (1) removing overhead safety hazards; (2) evaluating automatic seismic gas shut-off valves; and (3) updating the 1988 School Earthquake Hazard Reduction Manual and (4) implementing a District nonstructural mitigation program. Funding for these activities combined \$400,000 from FEMA through Seattle Project Impact, \$100,000 from the Seattle Public Schools and in-kind contributions by district staff, volunteers and Project Impact partners.

(1) Removing Overhead Hazards

Many Seattle schools have out-dated waste water systems. Heavy reservoirs of water located in school attics (Figure 1) and porcelain tanks of water located in boy's restrooms are part of these antiquated systems. These nonstructural elements are particularly vulnerable to earthquake-induced damage. The consequences of failure pose significant life safety hazards to building occupants. The water in five reservoir vats was drained. Porcelain tanks were removed and high-pressure flush systems were installed in 46 Seattle school buildings. Labor and materials required to remove these hazards amounted to nearly \$235,000. Two-thirds of this cost was for labor. The removal took approximately 4,000 hours.



Figure 1. Outdated water reservoir located in an attic.

(2) Evaluating the Advisability of Installing Automatic Gas Shut-Off Valves

Extensive discussions occurred between the District and the local gas service provider (Puget Sound Energy) concerning the advisability of installing earthquake activated automatic gas shut-off valves (Figure 2) on school gas lines. A survey of gas service providers in California (Pacific Gas & Electric and Southern California Gas Companies) and Idaho Power identified conflicting company policies. In Los Angeles, shut-off valves are required on new residential construction and on remodels that cost over \$10,000. However, in most areas the decision to install a gas

automatic shut-off valve is left up to the customer. The valves are installed on the customer's side of the gas meter and may require a plumbing permit. Valves must be firmly attached to the building or its foundation and located in a protected, secure area, away from foot or vehicle traffic. A school with a large distribution system may require a number of shut-off valves to



Figure 2. Automatic gas shut-off valve

adequately restrict potential gas leaks. Maintenance of the valves is the school district's responsibility.

Gas service providers stressed that there are more cost effective actions to improve gas safety, including bracing gas water heaters, installing flexible pipe connections to water heaters, stoves, furnaces, and other gas appliances, and reviewing the age, type and distribution of gas piping to identify potential hazards. The decision to install automatic gas shut-off valves must be made on a case by case basis.

The Seattle School District installed three valves, one at a high school and two at a middle school for a cost of \$9200 (Figure 2). A number of factors were considered in the initial decision to install the automatic gas shut-off valves. For example, high schools and middle schools have gas hazards in laboratories and shop areas; a number of school buildings have older, more vulnerable gas distribution systems; and, a leak could go unnoticed if an earthquake occurred when school was not occupied. However, valve installation was discontinued. The district decided that due to the high costs of installation nonstructural hazard reduction funds would be better applied to other protective measures. Seattle's frequent cool, damp weather also raised concern about the comfort and safety of students in classrooms if gas fueled heaters were shut off. Further,

recovery of the school education program might be delayed if classrooms were unheated. The installation of automatic gas shut-off valves is a low priority protective measure for the Seattle School District.

If gas service is shut off following a major earthquake, either automatically or manually, the service provider must be notified to restore service. The customer should not attempt to restore service before the system has been evaluated, including having the gas pipes pressurized to determine if leaks in the system do exist. Service restoration may take days to weeks. To avoid lengthy, unnecessary service outages, which may result in school closure, avoid shutting-off gas service unless there is evidence that a leak is present.

If the building lacks an automatic gas shut-off valve, a strong gas smell will alert building occupants to the presence of a pipe leak. Then the gas service should be turned-off and the building ventilated. If possible, a building that is unoccupied as a result of severe damage should have the utilities – gas, water, and electric – shut-off at the building to avoid damage that may occur when community systems are restored to the damaged area.

(3) Up Date of The Nonstructural Earthquake Hazard Reduction Manual

Updating the Nonstructural Guide

Background

The *Nonstructural Protection Guide* is an update of the School Earthquake Hazard Reduction Manual. The earthquake hazard reduction manual was published by the Office of the Superintendent of Public Instruction (OSPI) in 1988 and distributed to school districts in western Washington. This revised guide will be a part of the OSPI School Facilities Manual.

The title was revised to enable the information to be incorporated into a comprehensive nonstructural protection program. Protection of nonstructural elements from a variety of potential hazards will be part of the Seattle School District maintenance, risk management, and custodial programs.

Recommended Changes

The guide was updated to include the following sections: (a) past earthquake damage to Washington schools, (b) how to manage a school nonstructural protection program; (c) involving District staff; and (d) working with school site teams. In addition, the protective details in Section C were updated to include new strengthening solutions and installation cautions.

Pilot Test

A pilot test of the content and process contained in the guide was carried out to identify the capability of the manual to assist District staff and school site teams in the identification and protection of hazardous nonstructural elements. Based on the pilot

study the guide was further revised to include a simplified inventory checklist and process.

Revising the Inventory Forms

Inventory Form Complexity

School site teams helped assess the inventory process. These teams include teachers, custodians, maintenance, and PTSA members. A review of the forms completed in these trial inventories showed that the number of elements on the forms overwhelmed most site team members and with the responsibility of assessing the quality of existing attachments. For example, the forms in Section B ask if nonstructural elements are securely attached to a stud wall. The quality-of-attachment is difficult to evaluate unless one is familiar with construction practice and can determine what is a stud wall.

The forms were modified to include two levels of inventory based on skill and training. The revised forms are provided at the end of this appendix. Experience, training, and liability issues distinguish the two levels of inventory:

Level 1 – focuses the identification of the type and number of elements in a room. For safety and liability concerns, the Level 1 inventory does not include the use of a ladder, access to mechanical and electrical rooms, or roof areas.

Level 2 – focuses on the identification of the type and number of elements and an assessment of the quality of attachments, such as the attachment of lockers to the wall in hallways. Issues to be addressed include the selection of hardware, the proper installation of anchors and screws, and the quality of the element used for attachment (stud wall, file cabinet, etc.). This inventory may require a ladder, specialized construction skills, safety training, and coverage under worker's compensation. Inventories will normally be completed by maintenance or facility personnel or by district contractors. Site team members may complete Level 2 inventories if they meet qualification criteria defined by the district and are supervised by district personnel.

Inventory Order

The initial order of elements included on the inventory forms in the guide was revised to reflect the simplicity desired by site teams. Elements generally inventoried by Level 1 teams are now presented first. More complex elements generally inventoried by Level 2 teams are placed at the end of the form. The immediate occurrence of elements like overhead ceiling systems, which are not included in a Level 1 inventory, caused many site team members concern and reluctance to complete the form. Reversing the order of elements reduced this reluctance.

Identifying Protective Measures

Good Housekeeping

This option should be stressed more strongly in the guide. Often simple room rearrangement and proper storage will improve classroom safety. Moving heavy items to low shelves, moving file cabinets away from exit ways, and keeping hallways clear will reduce the risk of direct injury and injury related to blocked exit ways. While simple, these steps are a challenge to schools with limited storage. Reminders of the importance of good housekeeping in providing a safe environment are required to encourage and maintain good housekeeping behavior.

Restraints

Section C of the guide provides construction details for the installation of measures to restrain elements to reduce potential injury to building occupants. More complex elements addressed by these details require skilled personnel for implementation. A list of supplies for each protective measure is included in the details as a guide in the development of an appropriate design.

Commercial products may be substituted for some of the supplies recommended in the protective details provided the substitutions offer equivalent protection. In some instances, such as the restraint of refrigerators, commercial products are easier to install. Product companies may be willing to provide discounts on large orders or help complete a model school in the district.

(4) Implementation of the Seattle School District Classroom Mitigation Program: Lessons Learned

Identifying District Support

Program Management

To ensure program success sufficient management is required. This includes a District Manager, a Site Coordinator and a Building Coordinator. The District Manager schedules the implementation of nonstructural protective measures, monitors the program, trains employees, and prepares budget requests for over head hazards. This management position increases sustainability by integrating all program activities with normal maintenance or facilities operations.

A Site Coordinator is an essential part for increasing interest and involvement by school site teams (Figure 3). The Site Coordinator works with site teams to explain why the program is important and to encourage the implementation of nonstructural protection measures. The Site Coordinator works with site team members to identify protective measures that are most compatible with how building spaces are used. Site Teams may be made up of teachers, custodial staff, parents, community volunteers and others interested in improving school earthquake safety. Site Teams usually have a strong

vision of how classrooms and other building spaces should be organized to support their daily operations.

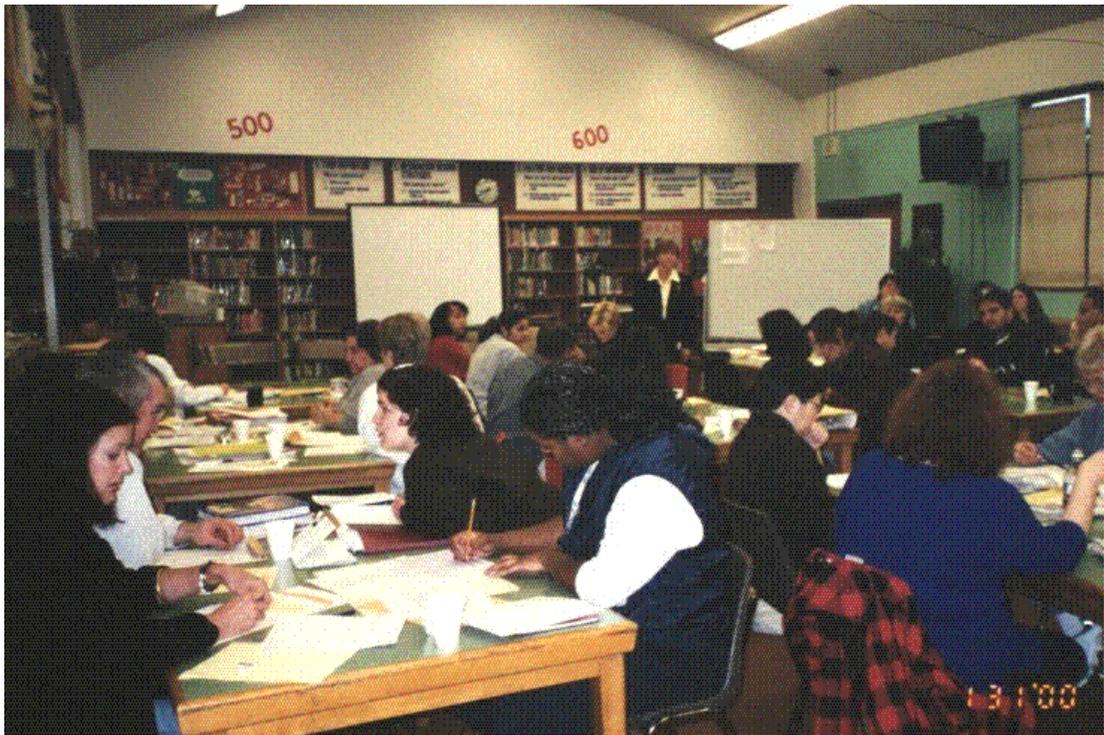
A Building Coordinator (often the Safety Committee Chair or School Nurse) keeps track of work completed at the school. Completed inventory forms are maintained in a binder for review by district safety staff. In Section B, it was originally suggested that these forms be copied and sent to the District Manager. The pilot test indicated it would be easier for the Site Coordinator to check the forms on site.

Training

Training is necessary to provide a consistent approach to the identification and mitigation of nonstructural earthquake hazards and to sustain the program. Maintenance and custodial staff learned how to identify nonstructural elements likely to injure building occupants and how to implement appropriate nonstructural protective measures. The information on protecting nonstructural elements from earthquake-induced damage can be combined with a comprehensive nonstructural protective program that addresses a variety of potential hazards.

District maintenance and custodial staff must be included because of their familiarity with the school buildings, comprehension of basic construction practices, and long term program involvement. Involvement of building staff in identifying and selecting protective measures ensures that solutions are acceptable to building occupants.

Figure 3. Introducing the Seattle School Nonstructural Protection program to teaching staff.



School Participation

Presentations on the program are given at school staff and PTSA meetings. An introductory presentation should be limited to 15 minutes. Brief follow-up meetings can be held to answer questions, identify problem areas, and keep the program moving along. This is also an opportunity to identify individuals willing to participate on the site teams.

Inventorying Building Spaces

District Inventory

A District Core Mitigation Team composed of the Site Coordinator, a Building Custodian, the Maintenance Supervisor, and selected volunteers inventoried a representative sample of school buildings using the revised inventory forms included in this appendix. From this inventory, a standard list of nonstructural items was developed for each building occupancy type. For example, in most Seattle Public Schools a classroom has 1-4 computers, one television set, one VCR, an audiovisual cart with an overhead projector, several bookshelves or wall cabinets, and a file cabinet. A representative inventory of labs, shops, and mechanical rooms in a district provided a common list of items for those spaces. These representative nonstructural elements were entered in an Excel database for each building space. This database was used to estimate type and costs of elements needed for implementing a protective action work plan.

This process provided a consistent approach to the inventory and to the estimation of costs. The Core Mitigation Team included experienced district personnel. District personnel are covered by workman's compensation and participate in district safety programs. In addition, the Core Mitigation Team is best suited to identifying the skills needed to implement protective measures.

The Core Mitigation Team enhances the awareness and participation of school staff at the building level.

Building Site Teams

Site teams, which can include teachers, parents, and other volunteers, may complete the inventory forms included in Section B of the guide or the less complex forms included in this appendix. They may use the inventory to determine the priority of elements that need protection and to estimate costs to implement nonstructural protective measures.

Most site teams will inventory a limited number of elements (Table 1) that are located in selected building spaces and they will implement a limited number of protective measures. A complete inventory and extensive implementation requires training and education in construction practice beyond what is present in most site teams. In addition, there may be legal or union restrictions on using site teams for more than a small part of the nonstructural protection program.

The site teams need to coordinate their nonstructural protection activities with the school district. The building administrator should contact the maintenance manager and, if one

is available, the Site Coordinator. Coordination is important to identify district resources that are available to help individual schools.

Table 1. Inventory tasks and protective actions generally taken by Site Team Members.

<p>Site Team Members: school staff, parents, volunteers, and custodians</p> <p>Occupancies: Normal, Assembly, and Special Occupancy</p> <p>Inventory Tasks: Identify the type and number of each element according to school goals and objectives</p> <p>Types of Nonstructural elements:</p> <ul style="list-style-type: none">■ Desktop/counter top equipment■ Furnishings and equipment■ Shelves■ Shelf storage■ Supplies and materials■ AV equipment■ Wall mounted objects■ Maps■ Display Cases■ Location of heavy storage <p>Protective Actions</p> <ul style="list-style-type: none">■ Store heavy objects on lower shelves■ Installation of restraints for desktop/counter-top equipment■ Installation of restraints for shelving under supervision
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Implementing Protective Measures

Work Parties

Site teams implemented many of the protective measures. The Core Mitigation Team was essential to the success of the work parties. The core team included a custodian, maintenance crew zone supervisor, and the district site coordinator. This team worked with school staff, parents, and non-profit volunteer agencies (e.g. Habitat for Humanity) to install protective measures appropriate to site team skills. Significant reduction of installation time can be achieved by having enough help to complete the work in one day.

Work Orders

The completed inventory forms are used to prepare work orders for the implementation of nonstructural protective measures that are too complex for work parties. Work orders can only be completed by District staff.

Tools

The District purchased tools and supplies to implement the protective measures (Table 2). Having a set of tools available for this project is essential. The information provided on Table 2 is not an endorsement of specific vendors. Comparison shopping will help identify the best price and quality. Prices are subject to change.

Storage

The Seattle schools initially intended to store the tools and supplies in out-door containers placed on school sites. However, the containers were very cold in the winter. The school buildings provided more comfortable locations from which to access materials. While finding space inside the school buildings was not a problem, the tools needed to be stored in a toolbox to keep them together and easily accessible for work parties.

Table 2 Tools used by the District to implement nonstructural protective measures.

Description	Qty	Stock No.	Vendor	Price Each	Price Ext.
Allen wrench set	3	757-497	Home Depot	\$11.97	\$35.91
Ballpein hammer	3	342-008	Home Depot	\$12.94	\$38.82
Claw hammer	3	310-925	Home Depot	\$9.47	\$28.41
Cord, ext. 25 ft x 12 GA	3	524-646	Home Depot	\$15.95	\$47.85
Cordless drill, 12Volt	3	190-948	Home Depot	\$99.95	\$299.85
Crow bar	3	451-010	Home Depot	\$5.93	\$17.79
Drill index	3	163-486	Home Depot	\$19.87	\$59.61
Knee pads	3	337-520	Home Depot	\$4.98	\$14.94
Level Pak	3		Home Depot	\$9.84	\$29.52
Lockable job box with padlock	3	4824 Knaack	Acme	\$265.11	\$795.33
Measuring tape; 25 ft	3	Y-125 Lufkin	Home Depot	\$6.97	\$20.91
Pliers set	3	600-148	Home Depot	\$29.96	\$89.88
Portable, small vacuum cleaner	3	335-204	Home Depot	\$29.96	\$89.88
Pry bar, flat	3	B-215 Vau	Home Depot	\$11.46	\$34.38
Rags	3	CUS63651652	C. Warehouse	\$21.71	\$65.13
Screw driver set with bits	3	360-658	Home Depot	\$5.97	\$17.91
SDS bit set	1	DW5347	Acme	\$38.21	\$38.21
SDS hammer drill (roto)	1	DW563K	Acme	\$199.05	\$199.05
Small sledge, 4 LB	3	30-570 Un	Acme	\$11.67	\$35.01
Socket set	3	880-974	Home Depot	\$37.02	\$111.06
Square, 12"	3	731-528	Home Depot	\$3.97	\$11.91
Step ladder, 6 ft.	3	718-908	Home Depot	\$39.02	\$117.06
Studfinder	3	214-671	Home Depot	\$29.94	\$89.82
Tool bucket buddy	3	721-631C	Home Depot	\$7.01	\$21.03
Vise grips	3	232-092	Home Depot	\$12.84	\$38.52
subtotal					\$2,247.79
Sales tax @8.6%					\$193.31
Total					\$2,441.10

Working with Volunteers

Identifying Volunteers

Volunteers may be business partners, parents, and members of church organizations, local business employees, community groups, Habitat for Humanity or other civic groups. Volunteers participating in the school program mainly included District staff

working after hours, the nonstructural materials vendor, parents, university students, and American Red Cross personnel.

Volunteer Tasks

The Seattle School District nonstructural protection program did not use volunteers to inventory school spaces. First, the District's Core Mitigation Inventory team enabled nonstructural hazards to be identified in a consistent manner and enabled the district to coordinate work orders and purchasing with site visits. Second, some building staff was not comfortable with volunteers assessing the safety in their classrooms. This is in part due to reluctance to having strangers on the school grounds and to a desire to control activities in their workspace.

The Seattle School District used volunteers mainly to help implement nonstructural protective measures during district supervised work parties.

Issues Concerning the Use of Volunteers

The District Site Coordinator identified tasks and scheduled volunteers. Ideally sufficient volunteers can be identified to enable protective measures to be implemented during a one-day work party.

Volunteers should receive basic safety training if they will be using tools or equipment. They should be supervised to ensure consistent installation of protective measures, to make technical advice readily available, and to oversee the presence of non-school employees on the school campus.

COSTS OF IMPLEMENTING PROTECTIVE MEASURES

The following table shows the implementation costs and installation times for two pilot schools. Types of nonstructural elements protected include computers (including server hubs), television sets, aquariums, bookshelves, file cabinets, microwaves, refrigerators and washers and dryers. District trades personnel will take care of larger elements, such as lighting systems and boilers. This is related to the complexity of the element and the need to use union trades.

The costs represent significant savings due to the generosity of a Project Impact partner WorkSafeTechnologies. For example, the material and installation cost for protective film to cover 34 windows was \$2000, or \$3.50 – \$4 per square foot. Districts may be able to negotiate savings due to bulk orders and for the completion of model school sites.

School Information	School Name	
	Lawton Elementary School	Mercer Middle School
Date Constructed	1991	1957
Student Enrollment	390	823
Gross square footage	54,986	123,182
Project Cost	\$3,800	\$11,184
	Labor	
Inventory Assessment District Staff (2 @ 8 Hrs)		16
Custodial	9	16
Administrative	14	21
Team Leaders (2 @ 16 hrs)		32
Volunteers	32 (8 @ 4 hrs)	36 (6 @ 6 hrs)
Total	55 hours	121 hours

SUSTAINING THE NONSTRUCTURAL PROTECTION PROGRAM

The Seattle Public Schools risk management, logistics (Site Coordination), custodial, and the maintenance departments will work together to continue the success of this pilot project. This includes providing additional staff time and training to assist schools with work parties. This project requires the community and district involvement for continued success.

The safety of the students and staff are of great importance to the Seattle Public Schools. A safe environment is a necessary part of a good learning environment. Sustaining the nonstructural protection program requires a conscious effort to make the school community aware and concerned about nonstructural earthquake-induced damage to school sites. Damage to nonstructural elements is capable of injuring building occupants and destroying school property.

Integrating nonstructural protection into existing safety, maintenance, construction, and building programs is necessary to sustain program activities. Opportunities to incorporate nonstructural protective measures include:

- Purchasing criteria that will provide solid furnishings and equipment to better resist earthquake-induced damage
- Installation requirements for new equipment, such as emergency generators, that secure equipment against earthquake forces
- New construction and remodeling designs, which often do not address the protection of nonstructural elements;

- Coordination with other upgrades to reduce costs, such as securing recessed lights when the sprinkler system is upgraded;
- Determination of risk retention and risk transfer mechanisms to estimate potential cash required to resume school operations following a major earthquake; and
- Preparation of emergency operations and recovery plans to include earthquake contingency and redevelopment plans.

