In-Depth Treatment Recommendations for the Remaining Character-Defining Features of Building 100 in the Date Street Complex, Bureau of Reclamation, Lower Colorado Region, Boulder City, Nevada

Carrie J. Gregory, Melvyn Green, and Scott Thompson

Submitted to

U.S. Department of the Interior
Bureau of Reclamation
Lower Colorado Region
Boulder City, Nevada

Melvyn Green & Associates, Inc.
Torrance, California

Technical Report 09-15
Statistical Research, Inc.
Tucson, Arizona

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Introduction

Building 100 is part of the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), Lower Colorado Regional Office's Date Street Complex in Boulder City, Nevada (Figure 1). Building 100 is a contributing element of the Boulder City Historic District, a property listed in the National Register of Historic Places (Woodward et al. 1983). In 2001, Reclamation initiated a project to demolish several abandoned buildings in the complex—as part of a plan to expand facilities at the Lower Colorado Regional Office—and provided for Historic American Buildings Survey (HABS) documentation of those buildings. Building 100 was among several buildings not scheduled for demolition but recorded in the HABS. (A detailed historical overview of the Date Street Complex and Building 100 may be found in HABS No. NV-35 and HABS No. NV-35-A, respectively; an Addendum to NV-35-A [Thompson 2007] addresses the elements and construction characteristics of the building's entrances, windows, and interior.)

In February 2007, Reclamation initiated construction activities to repair problems with the roof, retrofit the building to withstand seismic occurrences, and renovate the interior for energy efficiency. This began with removing the roof, gutting the interior, and pouring a continuous concrete slab on grade. In December 2007, Reclamation tasked Statistical Research, Inc. (SRI), with preparing historic-preservation plans for the exterior of the building. The subsequent report (Green 2008a) identified character-defining features to be considered in the rehabilitation project, reviewed previous seismic evaluation reports, and provided recommendations for remediation, construction, and preservation of the building's exterior.

Wanting to maintain the structural and historical integrity of the building, Reclamation again contracted with SRI in 2008 to provide recommendations for the structural stabilization of the existing walls and protection of the building's remaining features from the elements. Mr. Melvyn Green, Structural Engineer, of Melvyn Green and Associates, Inc., (under contract to SRI) conducted an examination of the existing conditions of Building 100 and recommended interim stabilization and protective measures (Green 2008b).

At present, Reclamation is seeking additional information on historic-preservation methods to supplement Mr. Green's 2008 report (2008b) and has contracted with SRI to provide treatment recommendations. On February 9, 2009, Mr. Green (under contract to SRI) and SRI staff, Ms. Carrie Gregory and Mr. Scott Thompson, conducted an examination of Building 100. This report provides Reclamation with in-depth treatment recommendations for the building's remaining primary character-defining features—steel-sash casement and pivot windows, walkway covering, faux rafter tails, gable ends of the building, and exterior masonry walls—and measures to abate the associated hazardous materials.

Building Description

Constructed in 1941, Building 100 served as an administrative office and analytical laboratory for the U.S. Bureau of Mines. In 1945, a wing was added on the west side of the building to provide rooms for a library and additional support facilities (Figure 2). The T-shaped building is one story, with the east and south wings constituting the oldest portion. The building was constructed with a concrete perimeter foundation, and the basement of the 1945 addition was constructed with concrete walls and a dirt floor.

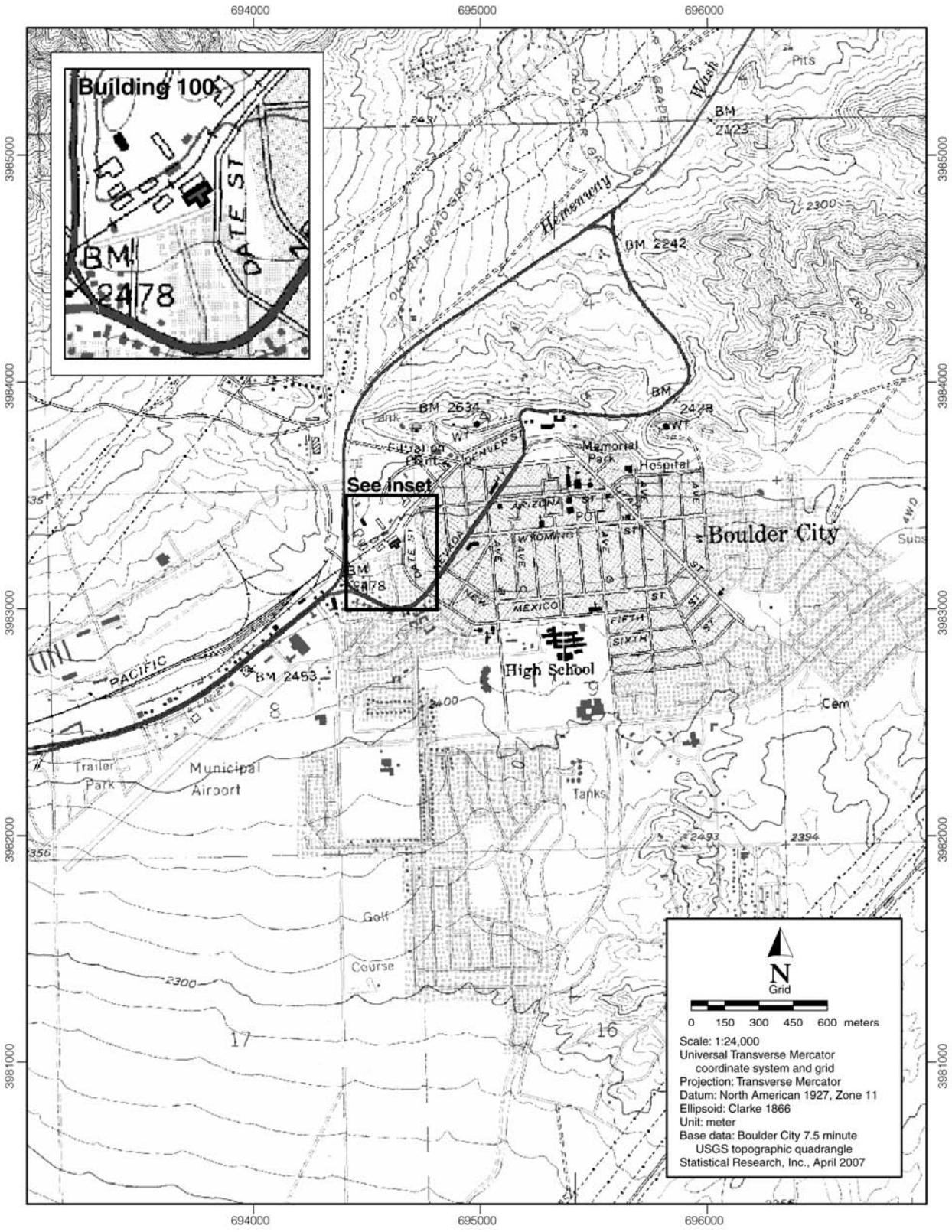

Figure 1. Project location (1958 Boulder City, Nevada, U.S. Geological Survey 7.5-minute quadrangle [photorevised 1983]).

Figure 2. Western end of Building 100, ca. 2001 (photograph courtesy of the Library of Congress, Historic American Buildings Survey).

The floor above the basement was supported by light steel columns and steel beams. The original floors were wood, with wood joists supported by concrete piers. The building has unreinforced, concrete masonry walls built of units measuring 4 inches high by 8 inches thick by 12 inches long laid in a running-bond pattern. There is a continuous, concrete bond beam on top of the exterior walls. As originally designed, fenestration included four styles of steel-sash casement and pivot windows.

A wood-framed covered walkway extends along the east facade of the south wing and along much of the south facade of the east wing (Figure 3). The covering consists of 6-by-6-inch wood posts supporting 6-by-8-inch-deep beams. Posts are spaced at 8 feet on center. Walkway roof framing consists of 4-by-6-inch rafters spaced at 24 inches on center. Solid board wood sheathing on top of the rafters completes the framing. The end of each rafter is cut and detailed in a bird's-mouth style, and the gable ends of the walkway roof have solid, vertical sheathing boards that are scalloped at the end.

In 2007, construction workers removed the roof, the louvered vent on the east facade, all of the interior fixed thermal windows, and the floor. The roof framing consisted of rafters spanning from the exterior wall to the ridge. Braces at the midpoint of the rafter span carried the roof load down to the interior corridor walls, which served as interior bearing walls. The interior ceiling height was 10 feet 6 inches. The gable ends (east, south, and west facades) of the roof consisted of vertical solid sheathing with scalloped edges that extended to cover the top plate on the masonry walls. The gabled roof was covered with flat tiles that were later replaced with asphalt shingles. In 2007, construction workers also permanently closed the previously blocked entrance on the east end of the east wing with concrete block and mortar, gutted the interior, and constructed a continuous concrete slab on grade, including the basement floor.

Figure 3. Eastern side of Building 100, ca. 2001 (photograph courtesy of the Library of Congress, Historic American Buildings Survey).

Current Building Status

At the time of inspection, February 9, 2009, the exterior walls remained in place, there was a new concrete floor at an elevation approximately 2 feet below that of the original wood floor, and the partial basement had some new steel framing and metal decking in place. Access to the building is limited by a fence along the public streets and fencing around the Reclamation yard. In its present state, Building 100 could possibly be vulnerable to loads from earthquakes and extreme winds. Potential environmental hazards are present in the building, including lead-based products (paint and glazing compound).

Exterior Walls

The exterior walls of Building 100 are unreinforced concrete masonry units. They are 8 inches thick, and the wall height is 12 feet 8 inches. The walls are not solid grouted, and they may have reinforcing only at jambs and corners. With the roof having been removed, the walls are no longer attached to the roof diaphragm. The walls bear on the continuous concrete foundation, and they are topped by a continuous concrete bond beam. Currently, temporary steel support beams brace the walls from the slab to points near the tops of the walls along the bond beam (Figure 4), following Mr. Green's recommendations (2008b). The exterior surfaces of the walls are in good condition and painted with lead-based paint. The interior sides of the walls are in fair condition. There are large sections of plaster still adhering to the walls, and lead paint coats both the plaster sections and the walls. The walls have been cut at several locations for chases, an alteration that affects the walls' stability.

Figure 4. Interior of east wing showing steel support beams bracing the walls, February 2009.

Windows

Building 100 has 46 metal-frame windows (casement and pivot), of which 45 remain in place. More than half of the windows are missing all or some glass panes. Window 43 has been removed and is in storage. For purposes of clarity, the window openings referred to in this section are numbered 1–46, as shown in Figure 5. There are five different window styles in use (Table 1). Twenty windows (Windows 1–16 and 43–46) are original, thirty-light, steel-sash casement windows (Figure 6). Each window has six fixed lights along the top. Below are paired, eight-light casement windows flanked by four fixed lights. Eleven windows (Windows 17–20 and 24–30) are original, fifteen-light, steel-sash casement windows (Figure 7). Paired, five-light casement windows flank five fixed lights. Six windows (Windows 31 and 36–40) are six-light, steel-sash pivot windows that rotated on a horizontal axis (Figure 8). Two windows (Windows 41 and 42) are four-light, steel-sash pivot windows that rotate on a horizontal axis (Figure 9). The remaining 7 windows (Windows 21–23 and 32–35) are fifteen-light, aluminum-sash, dual-pane casement windows that were installed around 1990 (Thompson 2007:11) (Figure 10). Although the same layout design as Windows 17–20, the replacement windows are noticeably different in profile.

Overall, all windows—consisting of the rails, stiles, and muntins—are in good condition and show minimal signs of, or light, surface corrosion (Figure 11). The cranks, stays, and interior latches on all casement windows have been removed; only the hinges remain in place. The latches and lifts on all pivot windows have been removed. All windows have been sealed shut using caulk, screws, or solder. The windows have been painted with lead-based paint, and the remaining glazing compound contains lead. The exterior concrete sills are in good to very good condition. The interior concrete sills are in poor to very good condition. Many have patchable voids and/or wood nailing strips (Figure 12).

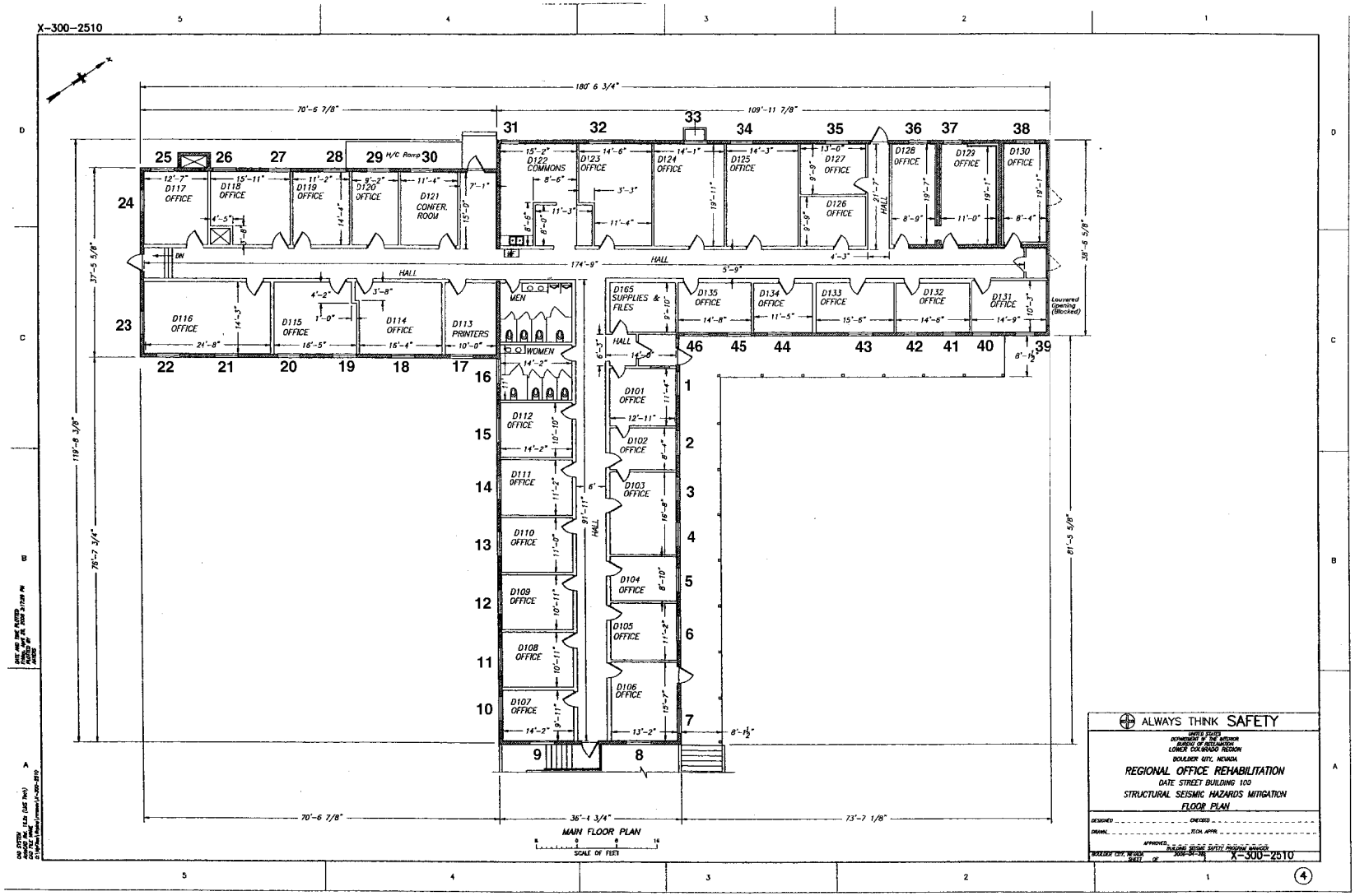

Figure 5. Plan drawing of Building 100 showing the locations of Windows 1–46 (after Bureau of Reclamation 2006a).

Table 1. Window Details of Building 100

Quantity	Style	Opening Size (height × width)[a]	Detail[b]	Window Number
20	30-light, steel-sash paired casement	57–57 7/8 × 55–56 7/16	6 / 24: 6 top-row lights (7 1/4 × 9 1/2); 24 lights (7 1/4 × 10 3/4)	1–16 and 43–46
11	15-light, steel-sash paired casement	59 3/4–60 3/4 × 54 1/4–54 7/8	5 h × 3 w: 15 lights (10 1/4 × 15)	17–20 and 24–30
7	15-light, aluminum-sash paired casement	57 1/2–60 1/2 × 53 1/2–56	5 h × 3 w: 15 lights (9 1/2 × 13 1/2)	21–23 and 32–35
6	6-light, steel-sash pivot	39 1/2–44 1/4 × 41 3/4–45 1/4	3 / 3: 6 lights (12 1/2 × 18 1/4)	31 and 36–40
2	4-light, steel-sash pivot	38 5/8 × 27	2 / 2: 4 lights (12 1/2 × 18 1/2)	41 and 42

[a] Measurements given are in inches.

[b] Measurements in inches given in parentheses.

Figure 6. Thirty-light, paired steel-sash casement window (interior of Window 7), August 2007.

Figure 7. Fifteen-light, paired steel-sash casement window (exterior of Window 17), August 2007.

Figure 8. Six-light, steel-sash pivot window (exterior of Window 31), August 2007.

Figure 9. Four-light, steel-sash pivot window (interior of Window 41), August 2007.

Figure 10. Fifteen-light, paired aluminum-sash casement window (interior of Window 23), August 2007.

Figure 11. Example of minimal corrosion (interior of Window 2), February 2009.

Figure 12. Example of interior sill condition (Window 9), February 2009.

Wood Features

The remaining wood features consist of the walkway covering and faux rafter tails with associated blocking cross members. Overall, the walkway covering is in good condition. Painted with a lead-based paint, some areas show signs of paint cracking and peeling (Figure 13). There is also an accumulation of mildew on some of the rafter tails (Figure 14). With respect to the structural elements, one post is temporary (Figure 15) and two are bowed. The stored faux rafter tails with associated blocking cross members are in good condition (Figure 16). They, too, are painted with a lead-based paint.

The three gable ends have been disposed of and will not be discussed beyond this section. SRI recommends that the three gable ends be reconstructed for Building 100 concurrently with the roof replacement project. They should be fashioned after the originals, with scalloped ends and louvered vents. Fortunately, two of the gable ends were photographed during a recent HABS documentation effort (Kautz Environmental 2001). Two of the gable ends date to 1941 and are presumed to match (see Figure 3); the third, which dates to 1945, is slightly different (see Figure 2). In addition to a 2006 drawing (Figure 17), Reclamation may have additional photographs or drawings of the gable ends that would aid in the reconstruction of these features.

Treatment Recommendations and Costs

The following treatment recommendations for Building 100 provide options for structurally and seismically sound walls and foundations, the repair and thermal upgrade of windows, the placement of a window in a previously blocked space, and the repair of wood features. The treatment recommendations strive to preserve the character-defining features of the building while providing life safety and protection of the resource, improving energy efficiency, and abating hazards posed by lead-based products. The recommendations follow treatments advocated by the National Park Service (NPS) in the following technical guidance documents:

- *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring and Reconstructing Historic Buildings* (Weeks and Grimmer 1995)
- Preservation Brief 3: *Conserving Energy in Historic Buildings* (Smith 1978)
- Preservation Brief 10: *Exterior Paint Problems on Historic Woodwork* (Weeks and Look 1982)
- Preservation Brief 13: *The Repair and Thermal Upgrading of Historic Steel Windows* (Park 1984)
- Preservation Brief 37: *Appropriate Methods for Reducing Lead-Paint Hazards in Historic Housing* (Park and Hicks 1995)
- Preservation Brief 41: *The Seismic Retrofit of Historic Buildings: Keeping Preservation in the Forefront* (Look et al. 1997)

Lead-Based Hazardous Materials

The exterior walls, windows, and wood features of Building 100 have been coated with lead-based paints, and the windows include a lead-based glazing compound. Lead-based products are considered toxic materials, and the hazard of lead poisoning is associated with ingesting and inhaling. In this project, a lead

Figure 13. Example of peeling and cracking paint on underside of walkway covering, February 2009.

Figure 14. Example of mildew on rafter tail of walkway covering, February 2009.

Figure 15. Temporary post in walkway covering, February 2009.

Figure 16. Faux rafter tails and associated blocking in storage, February 2009.

Figure 17. Elevations showing all gable ends (Bureau of Reclamation 2006b).

hazard may exist in the dust generated during construction, at times of drilling, sanding, and cleaning surfaces. The preferred approach to dealing with lead-based products in historic buildings is removing, controlling, and managing the hazard, rather than removing historic features and finishes. This is accomplished through the removal of deteriorating paint and the stabilization of lead-based products (Park and Hicks 1995:3).

Lead-based-paint handling, removal, and disposal are regulated by Code of Federal Regulations Title 29 (29 CFR), Section 1926.62. In September 2007, Zenitech Environmental submitted a lead-assessment report to Reclamation (Zenitech Environmental 2007). This report assumed the building was to be demolished but provided guidance for any future work dealing with lead-based paints. Paints on the exterior block walls of the east and south wings, exterior metal window frames, and all elements of the walkway covering exceed the Environmental Protection Agency's limit of 5,000 mg/kg total lead.

All recommended treatments will require workers to follow health and safety practices and employ the appropriate equipment to deal with the removal, encapsulation, and disposal of lead-based products. For on-site work, "environmental regulations must be checked prior to work, particularly if a large amount of lead waste will be generated or public water systems affected" (Park and Hicks 1995:11). The contractor performing the work must comply with the Occupational Safety and Health Administration's (OSHA's) standard for Lead in Construction (OSHA 2003) and must be licensed for lead abatement by the State of Nevada. The standard for Lead in Construction is provided in Appendix A. Lead-based-paint debris management in Nevada is overseen by the Division of Environmental Protection, Solid Waste Branch, and their information is attached in Appendix B.

Lead-hazard training and protection is recommended for all Reclamation staff and contractors working on this project. Reclamation must ensure that all individuals are trained regarding the potential hazards of lead exposure according to OSHA and State of Nevada standards, which may involve a medical surveillance program. Reclamation must ensure that all workers have the proper protective equipment. Requirements for air quality due to lead-laden dust should be followed. Dust may be generated by drilling into the masonry and sanding painted surfaces. Enclosure of the porch, as well as appropriate methods for limiting dust in the air from work on the masonry walls and windows, may have to be instituted. At grade level, the dust and debris should be collected as required.

Any masonry to be disposed of is treated as nonhazardous waste and may be legally disposed of in any Nevada or Arizona municipal landfill as nonhazardous waste. Any wood that is removed is considered hazardous waste and will have to be disposed of in an approved manner. Lead-based product removal must be performed by a licensed lead-abatement contractor and must be disposed of at an approved site, such as US Ecology's facility at Beatty, Nevada.

Paint Removal and Encapsulation

In terms of historic-preservation treatments, the most appropriate method is the least invasive. For Building 100, lead-hazard abatement includes paint removal and a combination of paint removal and encapsulation, not feature removal or replacement. Paint removal is the elimination of all paint from a surface without damaging the substrate. The combination of paint removal and encapsulation involves removing deteriorated paint to a sound layer using the gentlest means possible, to avoid damage to the substrate, and encapsulating remaining paint by repainting. Table 2 provides specific removal methods based on those established by Park and Hicks (1995:9). Once the lead-based paints have been abated, the encapsulation coats may be painted by any painter, without special equipment. Options for paint removal and encapsulation need to be compatible with the material, as one method may work better on the wood than on the brick. The use of specialized encapsulant paint is discouraged because it impedes the movement of moisture out of the material, potentially causing decay. Instead, an exterior-paint system (either oil/alkyd or latex) should be carefully applied and the surface repainted every 5–10 years.

Table 2. Lead-Based-Paint Removal Methods and Associated Impacts

Removal Method	Location	Material	Impact on Materials	Lead Dust Generated	Impact on Worker	Impact on Environment
Wet scraping; wet sanding.	on site	Wood, steel, and masonry	LOW: gentle to substrate; feather edges to obtain smooth paint surface.	LOW: misting surfaces reduces lead dust.	LOW: no special protection for respiration, but wash before eating or drinking.	LOW TO MEDIUM: debris often general waste, but check local disposal requirements.
Heat gun; paint removal with scrapers.	on site	Wood, steel, and masonry	LOW: gentle to substrate.	MEDIUM: flicking softened paint does create airborne lead dust.	MEDIUM: respirator with HEPA filters usually required.	MEDIUM: lead-paint sludge is hazardous waste.
Chemical stripping; use liquid or poultice; avoid methylene chloride.	on site	Steel	LOW to MEDIUM: avoid damage to wood texture/grain with long dwell time.	LOW: chemicals are moist and reduce lead dust.	LOW: for lead dust; for volatile chemicals, may require solvent filter mask.	MEDIUM: lead residue is hazardous; off/rinse must be filtered or contained.
Controlled HEPA sanding; primarily for wooden surfaces; sanders use HEPA vacuum shroud.	on site	Wood and steel	LOW to MEDIUM: avoid gouging wooden surfaces; good for feathering edges.	MEDIUM to HIGH: worker must know how to use equipment.	MEDIUM to HIGH: requires respirator with HEPA filter and possibly containment of area.	MEDIUM to HIGH: paint debris is hazardous and must be contained in drums for disposal.
Dry abrasives for durable metals; carbon dioxide, walnut shells, needle-gun removal; can use vacuum shrouds.	on site	Steel	LOW to MEDIUM: substrate must be durable and in good condition; not for soft or porous materials.	Generally HIGH: large volume of paint chips fall freely unless there is a vacuum shroud.	HIGH: generally requires full suiting, respirators, and containment, even if vacuum shroud used.	MEDIUM to HIGH: increased volume of hazardous waste if abrasive is added to lead debris.
Waterblasting; vacuum and collect lead chips and water.	on site	Masonry (large areas)	LOW to MEDIUM: substrate must be durable and in good condition; not for wood.	LOW to MEDIUM: large volume of paint chips fall freely and are collected.	MEDIUM to HIGH: requires respirator with HEPA filter and containment of area.	MEDIUM to HIGH: paint debris is hazardous and must be contained in drums for disposal.
Chemical stripping; cold tank reduces ungluing caused by hot tank.	off site	Steel	MEDIUM to HIGH: elements can be damaged during removal or in tank.	Usually LOW: take care when removing elements to minimize lead-laden dust.	LOW: take care when washing up to remove dust; wash clothes separately.	LOW to MEDIUM: stripping contractor responsible for disposal.

Note: Adapted from Park and Hicks (1995:9).
Key: HEPA = high-efficiency particulate air

Exterior Walls

Building 100 was constructed prior to the adoption of earthquake-resistant design standards in the Las Vegas region. Modern codes place the Las Vegas area in a high zone for potential earthquake shaking (American Society of Civil Engineers 2006:210). As an element of any rehabilitation of the building, it is necessary to identify the methods for resolving the possible risk created by the unreinforced-masonry walls of this building.

Building codes today have incorporated provisions for strengthening unreinforced-masonry buildings. Research, funded by the National Science Foundation after the 1971 Sylmar Earthquake, permitted the engineering community to develop methods for analyzing walls for stability and horizontal diaphragms, such as the roof and floors, for deflection and load capacity. The primary examples are the provisions (see Appendix A-1) of the Uniform Code for Building Conservation (International Conference of Building Officials 1991). These provisions have been updated and incorporated into the 2006 edition of the International Existing Building Code (International Code Council 2006).

The findings of importance to this study, based on the code provisions, are that the walls are stable if they are attached or braced at the tops and bottoms and are within a specified height-to-thickness (h/t) ratio. This measure of stability varies by site seismicity and the number of stories. In addition, the wind speeds for Boulder City, included in the International Existing Building Code (International Code Council 2006), need to be considered. The exterior masonry walls of the building area are 8 inches thick, and the wall height is 12 feet 8 inches. The walls are not solid grouted and may have reinforcing only at jambs and corners (this is not important when considering lateral stability). The walls bear on a continuous concrete foundation, and a continuous concrete bond beam tops the walls.

Seismic Retrofit

Site Seismicity

In 2002, the Interagency Committee on Seismic Safety in Construction issued Recommended Practice 6 (RP-6), *Standards of Seismic Safety for Existing Federally Owned or Leased Buildings* (Cauffman and Lew 2002). RP-6 requires evaluations of buildings in a seismic zone where the design short-period spectral response acceleration parameter, or S_{DS}, is more than 0.167 g (where g equals the force of gravity) and the design spectral response acceleration parameter at a 1-second period, or S_{D1}, is less than 0.0067 g. Site seismicity for Building 100 was determined from the U. S. Geological Survey web site, which gives site-specific seismic potential based on latitude and longitude. The values at the Building 100 site are 0.542 g for S_{DS} and 0.257 g for S_{D1}.

Findings

The goals for treating the exterior walls are life safety (i.e., that the building should not collapse and occupants are able to evacuate the structure) and protection of the resource (i.e., the building should be repairable after a seismic event). This section discusses three alternatives for ensuring the seismic stability of the exterior walls: (1) no-work option, (2) shotcrete option, and (3) wall-bracing option. Implementation of alternatives 2 or 3 would occur after mitigation of the hazardous materials and surface preparation. Each option is supported by seismic calculations that are based on field investigation and collected data. The calculations, presented in Appendix C, found that the existing walls are stable if adequately attached at the roof/ceiling line. The rest of the required seismic work, anchorage, roof diaphragm, and collectors will still require design. Shear in the plane of the wall, or in-plane shear, should be checked but is usually not a factor. The in-plane shear is transferred to the foundation by the bond between the cement mortar and the foundation concrete. Typically, no physical connection is necessary.

No-Work Option. New roof construction will include a roof diaphragm that is connected to the walls using anchors and drag-and-collector elements at the reentrant corners. Thus, there is a "no-work" option to the wall strengthening. This option has both advantages and disadvantages to consider. The advantage this option offers is reduced construction costs. A disadvantage to consider is the possibility of horizontal cracking in the walls from an earthquake. Although the walls would remain stable after cracking, they would require repair in a postearthquake situation. As part of any work with this option, the internal chases or other wall damage will need repair.

Shotcrete Option. This option involves creating new reinforced concrete walls by applying shotcrete to the interior surfaces of the existing masonry walls. In this case, reinforcing steel is placed on the interior sides of the masonry walls, and a layer of concrete is applied over the steel. Anchor bolts are attached to the existing masonry so the new concrete (shotcrete) and the masonry stay together.

Implementing this option would require approximately a 3-inch-thick layer of shotcrete with No. 5 reinforcing steel placed horizontally and vertically at 12 inches on center. The masonry would be anchored to this wall with ½-inch-diameter anchor bolts placed horizontally and vertically at 16 inches on center. These anchors would also be attached to the bond beam at the top of the wall and the foundation at the base. The wall acts as a vertical beam, spanning from the foundation to the bond beam. The bond beam is braced by the roof diaphragm and the base of the wall by the floor slab. Codes permit the shotcrete to be applied without upgrading the foundation, depending on the actual load and soil-bearing pressure. However, Reclamation would have to verify the foundation bearing capacity with the existing and new loads.

This method creates a building with reinforced concrete walls complying with current building code requirements. The existing masonry is attached to the new concrete and treated as an exterior veneer. Damaged areas and chases would be filled with concrete. This addition of concrete will increase the thermal resistance of the walls, allowing less heat to pass through them, thereby reducing the amount of air conditioning required to cool the building.

Wall-Bracing Option. The walls could be braced by vertical bracing elements to limit deflection and potential cracking. This would involve the installation of vertical steel tubes from the foundation or slab on grade elevation to the bond beam that is on top of the wall. The 3-inch-by-3-inch-by-$^{3}/_{16}$-inch hollow steel tubes should be spaced at a maximum of 10 feet on center. The tubes would be anchored to the wall with bolts in an epoxy, similar to the anchor bolts in the shotcrete option. Bolt spacing would be from 24 to 32 inches on center. This may vary with the value for epoxy adhesive in masonry. The steel tubes would be attached to the bond beam at the top and the concrete foundation at the bottom, with bolts adequate to resist the out-of-plane loads. Finishing of the space would be accomplished by the installation of steel studs between the braces. The electrical wiring would be in the space between the masonry and the interior wall finish, probably drywall. This option is more expensive than the no-work option. Although it is doubtful, the walls could crack in a major earthquake. However, they would not collapse.

Repair and Weatherize

We recommend that Reclamation repair and weatherize the exterior walls as part of the Building 100 rehabilitation. All lead-based paint should be removed from the masonry on the interior surfaces of the exterior walls and all surfaces of the interior walls (between the east and west wings). Lead-based paint should be encapsulated on the exterior surfaces of the existing walls prior to implementing any of the aforementioned options. The intent is to eliminate any concerns regarding lead-based paint by the general contractor and future staff occupying the building. Furthermore, with the shotcrete option, the removal of paint and plaster is recommended, to obtain an adequate bond and bearing between the masonry and the new concrete.

Windows

The following treatment recommendations provide options for the repair and thermal upgrade of the windows in Building 100 and an option for placing a window in a previously blocked space. The recommendations strive to preserve the historic character of the building's windows while improving energy efficiency through repair and weatherization and abating lead-based products. Recommended treatments for the windows of Building 100 are prioritized as follows:

- Repair and weatherize the existing 39 steel-sash windows.
  - Repair steel-sash windows.
  - Abate lead paint.
  - Seal windows as inoperable or repair to make operable.
  - Install interior thermal barriers or storm windows.

- Manufacture compatible windows: 1 for the opening previously filled with louvered vents and 7 for the existing aluminum-sash windows.
  - Manufacture replacement windows.
  - Seal windows as inoperable or leave as operable.
  - Install interior thermal barriers or storm windows.

- Repair the interior sills.

Repair

Repairing the existing 39 steel-sash windows includes removing the lead-based glazing compound and existing glazing, removing the lead-based paint and corrosion, reglazing, and finish-painting. Because the corrosion is light and no warping or broken elements were noted, the repair effort may be conducted on-site or off-site. Re-View, a window restoration firm, provides a systematic process, which is adapted below in concert with NPS recommendations (Re-View 2004). The choice of on-site or off-site repair can depend on cost estimates, the economies of scale, and the ability to work with and dispose of lead-based products.

Repair On-Site

1. Remove existing glazing, glazing compound, lead paint, and any corrosion (see Table 2).
2. Fill cavities with epoxy fillers.
3. Sand substrate to a smooth finish.
4. Prime metal with rust-inhibiting/anticorrosive primer (e.g., zinc-rich or fluoropolymer).
5. Glaze sash and use a double seal.
6. Finish paint with at least two coats of compatible paint.

Repair in Workshop

1. Make a detailed window schedule.
2. Remove windows.
3. Ship windows to factory.
4. Remove existing glazing, glazing compound, lead paint, and any corrosion (see Table 2).
5. Fill cavities with epoxy fillers.
6. Sand substrate to a smooth finish.
7. Prime metal with rust-inhibiting/anticorrosive primer (e.g., zinc-rich or fluoropolymer).
8. Glaze sash and use a double seal.
9. Finish-paint with at least two coats of compatible paint.

10. Ship units back.
11. Install windows.

Weatherize

Moisture is the primary cause of corrosion in steel windows. Therefore, it is necessary to remove excess moisture. For Building 100, it is recommended that the building is made weather tight before the window repairs and weatherization begin. Weatherization for the existing windows of Building 100 includes new glazing, weather stripping, and the addition of interior thermal barriers (or storm windows). Interior thermal barriers can be manufactured to size and of low-profile aluminum sashes.

Recommendations vary depending on Reclamation's preference for the operability of the windows. Additionally, upon the completion of installation of the repaired and replacement windows, the masonry surrounds should be caulked with an elastomeric compound (such as polyurethane, vinyl acrylic, or butyl rubber).

Inoperable Windows

Weatherization of inoperable windows begins with the new glazing of hardcoat Low-E or laminated glass and using a double seal when glazing. Windows should be sealed closed with an acrylic sealant. A single-pane thermal barrier should be installed on the interior side of each window.

Operable Windows

This option requires more window repair and may achieve less thermal resistance, as dual-pane glass has a slightly less thermal resistance, or R factor, than interior or exterior thermal barriers. If Reclamation wants the windows operable and energy efficient, there are some alternatives. Existing windows will need to be repaired to an operable state, with the removal of the sealing solder, caulking, or screws and the addition of new hardware (i.e., latches, cranks, stays, and lifts). Thermal glass, or dual-pane glass, and weather stripping will need to be installed. Typically, steel-sash windows and hardware of that era can support the weight of dual-pane glazing. The compromise is that the panes cannot be separated enough to maximize the thermal resistance. Weather stripping should be the thinnest material adequate to eliminate air infiltration. The NPS advocates spring metal, vinyl strips, foam tape, and sealant bead. See *The Repair and Thermal Upgrading of Historic Steel Windows* (Park 1984) for application details and an educational graphic, reproduced in Figure 18. Additionally, removable or sliding thermal barriers can be installed on the interior side of each window to improve thermal resistance.

Manufacture Windows

Eight windows should be manufactured for Building 100: one for the opening on the east facade of the east wing previously filled with louvered vents and seven to replace the existing aluminum-sash windows. Preferably, these windows will be manufactured of steel, but they can be manufactured of aluminum by specialists in historic-window replication. The goal for these manufactured windows is that they are similar in style and profile to the existing steel-sash casement windows, as insensitively designed replacement windows would diminish the building's historic character. The manufacture of new windows should be done in concert with the repair of the existing steel-sash windows and the manufacture of interior thermal barriers.

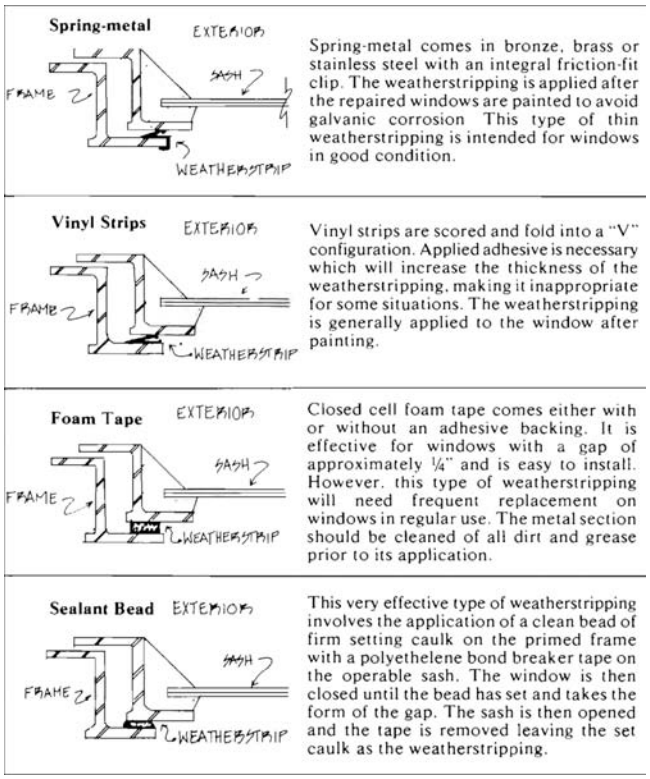

Figure 18. Weather-stripping options advocated by the National Park Service (drawing by Sharon C. Park [Park 1984:10]).

Repair Interior Sills

Once the repaired and replacement windows are installed, repairs should commence on the interior concrete sills. Many of the sills have embedded wood nailing strips. These strips have expanded with moisture and should be removed. These nailing-strip voids, along with other dimples and pocking, should be patched with a durable and nonshrinking concrete patch.

Wood Features

The following treatment recommendations provide options for the treatment of the walkway covering, faux rafter tails, and blocking cross members and the replacement of the wood gable ends for Building 100. The recommendations strive to preserve the historic character of the building's wood features through weatherization, lead-paint abatement, and element reconstruction. Recommended treatments for the wood features of Building 100 are prioritized as follows:

- Repair and weatherize wood features.
    - Abate lead paint.
    - Finish-paint.

- Manufacture missing components:
    - permanent post of walkway covering
    - three gable ends
    - any other missing elements

Repair

Repairing the walkway covering, faux rafter tails, and blocking cross members includes removing the failed lead-based paint, cleaning all surfaces, encapsulating the remaining lead-based paint, and replacing a temporary post of the walkway covering. Because the required repairs are minimal, the repair effort can be conducted on-site, as long as Reclamation has the ability to work with and dispose of lead-based paint (see Appendix A).

Abate Lead Paint

Abating lead paint includes removing failed paint and encapsulating adhered paint. Paint that is cracking, peeling, crazing, and blistering is considered to be failing. Paint can fail because of improper application or product and/or moisture collecting in the wood behind the paint. Using Table 2 as a guide to reduce lead-paint hazards, failing paint should be removed through an abrasive or thermal method. Once failing paint has been removed, transitional areas of removed paint and existing paint should be smoothed through sanding and edge feathering. Remaining lead-based paint will be encapsulated through the applications of exterior paint (see the Weatherize section, below). Bare wood that is exposed through the paint-removal process should be primed within 48 hours.

Clean Surfaces

Cleaning the surfaces to be painted improves paint adhesion. Cleaning includes first removing the mildew and then removing the dirt, soot, pollution, cobwebs, insect cocoons, etc. Mildew can be removed by scrubbing with a soft brush and a solution (1 cup of nonammoniated detergent, 1 quart of household bleach, and 1 gallon of water). For stubborn spots of mildew, an additional quart of bleach can be added to the solution. Once the area is mildew free, the treated areas should be sprayed with water. Removal of dirt, etc., can be accomplished by applying sprayed water or scrubbing with a bristle brush and a mild detergent ($^1/_2$ cup of household detergent in 1 gallon of water). In any of these applications, the wood should not be subjected to water blasting (above 600 pounds per square inch). Additionally, the water, which may have lead-paint dust and chips, may need to be disposed of using lead-paint disposal procedures (Weeks and Look 1982).

Weatherize

Weatherization treatments are the same for all existing wood features and consist of applying exterior paint. One of the main causes of wood deterioration is moisture penetration. Paint provides a shield between wood and excess moisture. Paint also insulates the wood from damaging particles in the wind and fluctuating temperatures. The primer and final-coat paint should be oil based, as oil paints shrink less than latex paints. If a latex paint is chosen as the final coat, an oil-based primer should be used.

Manufacture

A temporary post on the southeast corner of the building should be replaced with a permanent post that measures 6 by 6 inches and matches the length of the existing posts. This replacement post should be painted with the rest of the walkway covering.

As the building is rehabilitated, any additional elements found to be missing (e.g., faux rafter tail) should be replicated. This can be accomplished by using an existing element as a pattern or using photographs and drawings.

Costs

Order-of-magnitude costs have been developed for the in-depth treatment recommendations. Table 3 provides *ballpark* cost estimates for completing the seismic- and structural-stabilization repairs and the repair and rehabilitation of windows and wood features. They do not take into account "soft" costs, such as project management, overhead and profit, site inspection, and reporting. The costs are based on work provided by individual trades and do not reflect the costs of work provided by a combination of trades under a general contractor.

For the construction estimates, SRI contracted with ESG Construction Consultants (ESG), a Las Vegas–based construction-cost estimator. ESG's submittal is provided in Appendix D. SRI conducted the research and collected estimates for manufactured elements and off-site repairs. A summary of costs and a list of companies that provided estimates are presented in Appendix E. The data in the appendixes function as a tool that provides options and associated costs in the context of work items.

The construction estimates are based on the Davis-Bacon Wage Act. Davis-Bacon wage determinations are issued by the U.S. Department of Labor under the Davis-Bacon Wage Act and related acts. "The Wage and Hour Division of the U.S. Department of Labor determines prevailing wage rates to be paid on federally funded or assisted construction projects. It is the responsibility of the federal agency that funds or financially assists Davis-Bacon covered construction projects to ensure that the proper Davis-Bacon wage determination(s) is/are applied to such construction contracts(s). (See 29 CFR 1.5 and 1.6[b])" (Government Printing Office 2009).

Recommended Continuing Maintenance

The following list of recommendations continues Reclamation's management of a building with encapsulated lead-based paint.

- Control leaks.
- Maintain exterior roofs, siding, etc., to keep moisture out of the building.
- Perform emergency repairs quickly if lead-based paint is exposed.
- Keep topcoats of paint in good condition.
- Notify tenants and workers as to the location of encapsulated lead-based paints.
- Maintain a building file with lead-test data and reports and receipts or invoices on completed lead-mitigation work.

Table 3. Costs Associated with Treatment Recommendations

Task by Feature	Cost Option A	Cost Option B
Windows		
Repair and weatherize 39 existing steel-sash windows.	On-site: $52,002–$77,607 [a]	Off-site: $96,620–$98,220 [a]
Manufacture and install 8 windows.	Steel: $25,945–$32,416 [b]	Aluminum; $47,697 [c]
Manufacture and install 47 thermal barriers.	$20,601 [c]	
Finish all windows.	$10,260 [d]	
Wood Features		
Repair and weatherize walkway covering.	$49,600 [d]	
Repair and weatherize faux rafter tails and blocking.	$8,250 [d]	
Exterior Walls		
Stabilize walls.	Shotcrete: $231,992 [d]	Steel Tubes: $121,790 [d]
Weatherize exterior wall surfaces.	$43,897 [d]	

[a]Range includes options for operability and inoperability, five methods of lead-paint abatement, four types of weather stripping, and three types of glazing.
[b]Range includes options for three types of glazing.
[c]Range is not provided, as only one manufacturer responded to SRI's request.
[d]Range is not provided, as it is built into the construction estimates (see Appendix D).

APPENDIX A

Lead in Construction (OSHA 2003)

OSHA
Occupational
Safety and Health
Administration

www.osha.gov

Lead in Construction

OSHA 3142-09R 2003

This informational booklet provides a general overview of a particular topic related to OSHA standards. It does not alter or determine compliance responsibilities in OSHA standards or the *Occupational Safety and Health Act of 1970*. Because interpretations and enforcement policy may change over time, you should consult current OSHA administrative interpretations and decisions by the Occupational Safety and Health Review Commission and the Courts for additional guidance on OSHA compliance requirements.

This information is available to sensory impaired individuals upon request.
Voice phone: (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.

Lead in Construction

U.S. Department of Labor

Occupational Safety and Health Administration

OSHA 3142-09R
2003

Contents

Health Hazards of Lead Exposure

Pure lead (Pb) is a heavy metal at room temperature and pressure. A basic chemical element, it can combine with various other substances to form numerous lead compounds.

Lead has been poisoning workers for thousands of years. Lead can damage the central nervous system, cardiovascular system, reproductive system, hematological system, and kidneys. When absorbed into the body in high enough doses, lead can be toxic.

In addition, workers' lead exposure can harm their children's development.

Short-term (acute) overexposure–as short as days--can cause acute encephalopathy, a condition affecting the brain that develops quickly into seizures, coma, and death from cardiorespiratory arrest. Short-term occupational exposures of this type are highly unusual but not impossible.

Extended, long-term (chronic) overexposure can result in severe damage to the central nervous system, particularly the brain. It can also damage the blood-forming, urinary, and reproductive systems. There is no sharp dividing line between rapidly developing acute effects of lead and chronic effects that take longer to develop.

SYMPTOMS OF CHRONIC OVEREXPOSURE

Some of the common symptoms include:

- Loss of appetite;
- Constipation;
- Nausea;
- Excessive tiredness;
- Headache;
- Fine tremors;
- Colic with severe abdominal pain;
- Metallic taste in the mouth;
- Weakness;
- Nervous irritability;
- Hyperactivity;

- Muscle and joint pain or soreness;
- Anxiety;
- Pallor;
- Insomnia;
- Numbness; and
- Dizziness.

REPRODUCTIVE RISKS

Lead is toxic to both male and female reproductive systems. Lead can alter the structure of sperm cells and there is evidence of miscarriage and stillbirth in women exposed to lead or whose partners have been exposed. Children born to parents who were exposed to excess lead levels are more likely to have birth defects, mental retardation, or behavioral disorders or to die during the first year of childhood.

Workers who desire medical advice about reproductive issues related to lead should contact qualified medical personnel to arrange for a job evaluation and medical followup--particularly if they are pregnant or actively seeking to have a child. Employers whose employees may be exposed to lead and who have been contacted by employees with concerns about reproductive issues must make medical examinations and consultations available.

CHELATING AGENTS

Under certain limited circumstances, a physician may prescribe special drugs called chelating agents to reduce the amount of lead absorbed in body tissues. Using chelation as a preventive measure--that is, to lower blood level but continue to expose a worker--is prohibited and therapeutic or diagnostic chelations of lead that are required must be done under the supervision of a licensed physician in a clinical setting, with thorough and appropriate medical monitoring. The employee must be notified in writing before treatment of potential consequences and allowed to obtain a second opinion.

Worker Exposure

Lead is most commonly absorbed into the body by inhalation. When workers breathe in lead as a dust, fume, or mist, their lungs and upper respiratory tract absorb it into the body. They can also absorb lead through the digestive system if it enters the mouth and is ingested.

A significant portion of the lead inhaled or ingested gets into the bloodstream. Once in the bloodstream, lead circulates through the body and is stored in various organs and body tissues. Some of this lead is filtered out of the body quickly and excreted, but some remains in the blood and tissues. As exposure continues, the amount stored will increase if the body absorbs more lead than it excretes. The lead stored in the tissue can slowly cause irreversible damage, first to individual cells, then to organs and whole body systems.

Construction Workers and Lead Exposure

HOW LEAD IS USED

In construction, lead is used frequently for roofs, cornices, tank linings, and electrical conduits. In plumbing, soft solder, used chiefly for soldering tinplate and copper pipe joints, is an alloy of lead and tin. Soft solder has been banned for many uses in the United States. In addition, the Consumer Product Safety Commission bans the use of lead-based paint in residences. Because lead-based paint inhibits the rusting and corrosion of iron and steel, however, lead continues to be used on bridges, railways, ships, lighthouses, and other steel structures, although substitute coatings are available.

Construction projects vary in their scope and potential for exposing workers to lead and other hazards. Projects such as removing paint from a few interior residential doors may involve limited exposure. Others projects, however, may involve removing or stripping substantial quantities of lead-based paints on large bridges and other structures.

MOST VULNERABLE WORKERS

Workers potentially at risk for lead exposure include those involved in iron work; demolition work; painting; lead-based paint

abatement; plumbing; heating and air conditioning maintenance and repair; electrical work; and carpentry, renovation, and remodeling work. Plumbers, welders, and painters are among those workers most exposed to lead. Significant lead exposures also can arise from removing paint from surfaces previously coated with lead-based paint such as bridges, residences being renovated, and structures being demolished or salvaged. With the increase in highway work, bridge repair, residential lead abatement, and residential remodeling, the potential for exposure to lead-based paint has become more common.

Workers at the highest risk of lead exposure are those involved in:

- Abrasive blasting and
- Welding, cutting, and burning on steel structures.

Other operations with the potential to expose workers to lead include:

- Lead burning;
- Using lead-containing mortar;
- Power tool cleaning without dust collection systems;
- Rivet busting;
- Cleanup activities where dry expendable abrasives are used;
- Movement and removal of abrasive blasting enclosures;
- Manual dry scraping and sanding;
- Manual demolition of structures;
- Heat-gun applications;
- Power tool cleaning with dust collection systems; and
- Spray painting with lead-based paint.

OSHA's Lead Standard

OSHA's Lead Standard for the Construction Industry, Title 29 Code of Federal Regulations 1926.62, covers lead in a variety of forms, including metallic lead, all inorganic lead compounds, and organic lead soaps.

EXPOSURE LIMITS

The standard establishes maximum limits of exposure to lead for all workers covered, including a permissible exposure limit (PEL) and action level (AL).

The PEL sets the maximum worker exposure to lead: 50 micrograms of lead per cubic meter of air (50µg/m3) averaged over an eight-hour period. If employees are exposed to lead for more than eight hours in a workday, their allowable exposure as a TWA for that day must be reduced according to this formula:

Employee exposure (in µg/m3) = 400 divided by the hours worked in the day.

The AL, regardless of respirator use, is an airborne concentration of 30µg/m3, averaged over an eight-hour period. The AL is the level at which an employer must begin specific compliance activities outlined in the standard.

APPLICABILITY TO CONSTRUCTION

OSHA's lead in construction standard applies to all construction work where an employee may be exposed to lead. All work related to construction, alteration, or repair, including painting and decorating, is included. Under this standard, construction includes, but is not limited to:

- Demolition or salvage of structures where lead or materials containing lead are present;
- Removal or encapsulation of materials containing lead;
- New construction, alteration, repair, or renovation of structures, substrates, or portions or materials containing lead;
- Installation of products containing lead;
- Lead contamination from emergency cleanup;
- Transportation, disposal, storage, or containment of lead or materials containing lead where construction activities are performed; and
- Maintenance operations associated with these construction activities.

Employer Responsibilities

WORKER PROTECTIONS

Employers of construction workers are responsible for developing and implementing a worker protection program. At a minimum, the employer's worker protection program for employees exposed to lead above the PEL should include:

- Hazard determination, including exposure assessment;
- Medical surveillance and provisions for medical removal;
- Job-specific compliance programs;
- Engineering and work practice controls;
- Respiratory protection;
- Protective clothing and equipment;
- Housekeeping;
- Hygiene facilities and practices;
- Signs;
- Employee information and training; and
- Recordkeeping.

Because lead is a cumulative and persistent toxic substance and health effects may result from exposure over prolonged periods, employers must use these precautions where feasible to minimize employee exposure to lead.

The employer should, as needed, consult a qualified safety and health professional to develop and implement an effective, site-specific worker protection program. These professionals may work independently or may be associated with an insurance carrier, trade organization, or onsite consultation program.

ELEMENTS OF A COMPLIANCE PROGRAM

For each job where employee exposure exceeds the PEL, the employer must establish and implement a written compliance program to reduce employee exposure to the PEL or below. The compliance program must provide for frequent and regular inspections of job sites, materials, and equipment by a competent person. Written programs, which must be reviewed and updated at least every six months, must include:

- A description of each activity in which lead is emitted (such as equipment used, material involved, controls in place, crew size, employee job responsibilities, operating procedures, and maintenance practices);
- The means to be used to achieve compliance and engineering plans and studies used to determine the engineering controls selected where they are required;
- Information on the technology considered to meet the PEL;
- Air monitoring data that document the source of lead emissions;
- A detailed schedule for implementing the program, including copies of documentation (such as purchase orders for equipment, construction contracts);
- A work practice program;
- An administrative control schedule, if applicable; and
- Arrangements made among contractors on multi-contractor sites to inform employees of potential lead exposure.

Hazard Assessment

An employer is required to conduct an initial employee exposure assessment of whether employees are exposed to lead at or above the AL based on:

- Any information, observation, or calculation that indicates employee exposure to lead;
- Any previous measurements of airborne lead; and
- Any employee complaints of symptoms attributable to lead exposure.

Objective data and historical measurements of lead may be used to satisfy the standard's initial monitoring requirements.

INITIAL EMPLOYEE EXPOSURE ASSESSMENT

Initial monitoring may be limited to a representative sample of those employees exposed to the greatest concentrations of airborne lead. Representative exposure sampling is permitted when there are a number of employees performing the same job, with

lead exposure of similar duration and level, under essentially the same conditions. For employees engaged in similar work, the standard requires that the members of the group reasonably expected to have the highest exposure levels be monitored. This result is then attributed to the other employees of the group.

The employer must establish and maintain an accurate record documenting the nature and relevancy of previous exposure data. Instead of performing initial monitoring, the employer may in some cases rely on objective data that demonstrate that a particular lead-containing material or product cannot result in employee exposure at or above the action level when it is processed, used, or handled.

BIOLOGICAL MONITORING TESTS

Analysis of blood lead samples must be conducted by an OSHA-approved lab and be accurate (to a confidence level of 95 percent) within plus or minus 15 percent, or 6 µg/dl, whichever is greater. If an employee's airborne lead level is at or above the AL for more than 30 days in any consecutive 12 months, the employer must make biological monitoring available on the following schedule:

- At least every two months for the first six months and every six months thereafter for employees exposed at or above the action level for more than 30 days annually;
- At least every two months for employees whose last blood sampling and analysis indicated a blood lead level at or above 40 µg/dl; and
- At least monthly while an employee is removed from exposure due an elevated blood lead level.

PENDING EMPLOYEE EXPOSURE ASSESSMENT

Until the employer performs an exposure assessment and documents that employees are not exposed above the PEL, OSHA requires some degree of interim protection for employees. This means providing respiratory protection, protective work clothing and equipment, hygiene facilities, biological monitoring, and training—as specified by the standards—for certain tasks prone to produce high exposure. These include:

- Manual demolition of structures such as dry wall, manual scraping, manual sanding, and use of a heat gun where lead-containing coatings or paints are present;
- Power tool cleaning with or without local exhaust ventilation;
- Spray painting with lead-containing paint;
- Lead burning;
- Use of lead-containing mortar;
- Abrasive blasting, rivet busting, welding, cutting, or torch-burning on any structure where lead-containing coatings or paint are present;
- Abrasive blasting enclosure movement and removal;
- Cleanup of activities where dry expendable abrasives are used; and
- Any other task the employer believes may cause exposures in excess of the PEL.

TEST RESULTS SHOWING NO OVEREXPOSURES

If the initial assessment indicates that no employee is exposed above the AL, the employer may discontinue monitoring. Further exposure testing is not required unless there is a change in processes or controls that may result in additional employees being exposed to lead at or above the AL, or may result in employees already exposed at or above the AL being exposed above the PEL. The employer must keep a written record of the determination, including the date, location within the work site, and the name and social security number of each monitored employee.

EMPLOYEE NOTIFICATION OF MONITORING RESULTS

The employer must notify each employee in writing of employee exposure assessment results within five working days of receiving them. Whenever the results indicate that the representative employee exposure, without the use of respirators, is above the PEL, the employer must include a written notice stating that the employee's exposure exceeded the PEL and describing corrective action taken or to be taken to reduce exposure to or below the PEL.

Medical Surveillance

When an employee's airborne exposure is at or above the AL for more than 30 days in any consecutive 12 months, an immediate medical consultation is required when the employee notifies the employer that he or she:

- Has developed signs or symptoms commonly associated with lead-related disease;
- Has demonstrated difficulty in breathing during respirator use or a fit test;
- Desires medical advice concerning the effects of past or current lead exposure on the employee's ability to have a healthy child; and
- Is under medical removal and has a medically appropriate need.

MEDICAL EXAMS

The best indicator of personal lead exposure is through a blood test to indicate elevated blood lead levels. A medical exam must also include:

- Detailed work and medical histories, with particular attention to past lead exposure (occupational and nonoccupational), personal habits (smoking and hygiene), and past gastro-intestinal, hematologic, renal, cardiovascular, reproductive, and neurological problems;
- A thorough physical exam, with particular attention to gums, teeth, hematologic, gastrointestinal, renal, cardiovascular, and neurological systems; evaluation of lung function if respirators are used;
- A blood pressure measurement;
- A blood sample and analysis to determine blood lead level;

  • Hemoglobin and hematocrit determinations, red cell indices, and an exam of peripheral smear morphology; and

  • Zinc protopor-phyrin; blood urea nitrogen; and serum creatinine;
- A routine urinalysis with microscopic exam; and
- Any lab or other test the examining physician deems necessary.

INFORMATION FOR THE EXAMINING PHYSICIAN

The employer must provide all examining physicians with a copy of the lead in construction standard, including all appendices, a description of the affected employee's duties as they relate to the employee's exposure, the employee's lead exposure level or anticipated exposure level, a description of personal protective equipment used or to be used, prior blood lead determinations, and all prior written medical opinions for the employee.

WHEN MONITORING SHOWS NO EMPLOYEE EXPOSURES ABOVE THE AL

Employers must make available, at no cost to the employee, initial medical surveillance for employees exposed to lead on the job at or above the action level on any one day per year. This initial medical surveillance consists of biological monitoring in the form of blood sampling and analysis for lead and zinc protoporyrin (ZPP) levels. In addition, a medical surveillance program with biological monitoring must be made available to any employee exposed at or above the action level for more than 30 days in any consecutive 12 months.

AFTER THE MEDICAL EXAMINATION

Employers must obtain and provide the employee a copy of a written opinion from each examining or consulting physician that contains only information related to occupational exposure to lead and must include:

- Whether the employee has any detected medical condition that would increase the health risk from lead exposure;
- Any special protective measures or limitations on the worker's exposure to lead,
- Any limitation on respirator use; and
- Results of the blood lead determinations.

In addition, the written statement may include a statement that the physician has informed the employee of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

The employer must instruct the physician that findings, including lab results or diagnoses unrelated to the worker's lead exposure, must not be revealed to the employer or included in the written opinion to the employer. The employer must also instruct the physician to advise employees of any medical condition, occupational or non-occupational, that necessitates further evaluation or treatment. In addition, some states also require laboratories and health care providers to report cases of elevated blood lead concentrations to their state health departments.

Medical Removal Provisions

Temporary medical removal can result from an elevated blood level or a written medical opinion. More specifically, the employer is required to remove from work an employee with a lead exposure at or above the AL each time periodic and follow-up (within two weeks of the periodic test) blood sampling tests indicate that the employee's blood level is at or above 50 µg /dl. The employer also must remove from work an employee with lead exposure at or above the AL each time a final medical determination indicates that the employee needs reduced lead exposure for medical reasons. If the physician who is implementing the employer's medical program makes a final written opinion recommending the employee's removal or other special protective measures, the employer must implement the physician's recommendation.

For an employee removed from exposure to lead at or above the AL due to a blood lead level at or above 50 µg/dl, the employer may return that employee to former job status when two consecutive blood sampling tests indicate that the employee's blood lead level is below 40 µg /dl. For an employee removed from exposure to lead due to a final medical determination, the employee must be returned when a subsequent final medical determination results in a medical finding, determination, or opinion that the employee no longer has a detected medical condition that places the employee at increased risk of lead exposure.

The employer must remove any limitations placed on employees or end any special protective measures when a subse-

quent final medical determination indicates they are no longer necessary. If the former position no longer exists, the employee is returned consistent with whatever job assignment discretion the employer would have had if no removal occurred.

WORKER PROTECTIONS AND BENEFITS

The employer must provide up to 18 months of medical removal protection (MRP) benefits each time an employee is removed from lead exposure or medically limited. As long as the position/job exists, the employer must maintain the earnings, seniority, and other employment rights and benefits as though the employee had not been removed from the job or otherwise medically limited. The employer may condition medical removal protection benefits on the employee's participation in followup medical surveillance.

If a removed employee files a worker's compensation claim or other compensation for lost wages due to a lead-related disability, the employer must continue medical removal protection benefits until the claim is resolved. However, the employer's MRP benefits obligation will be reduced by the amount that the employee receives from these sources. Also, the employer's MRP benefits obligation will be reduced by any income the employee receives from employment with another employer made possible by virtue of the employee's removal.

RECORDS REQUIREMENTS INVOLVING MEDICAL REMOVAL

In the case of medical removal, the employer's records must include:

- The worker's name and social security number,
- The date of each occasion that the worker was removed from current exposure to lead,
- The date when the worker was returned to the former job status,
- A brief explanation of how each removal was or is being accomplished, and
- A statement indicating whether the reason for the removal was an elevated blood lead level.

Recordkeeping

EMPLOYER REQUIREMENTS

The employer must maintain any employee exposure and medical records to document ongoing employee exposure, medical monitoring, and medical removal of workers. This data provides a baseline to evaluate the employee's health properly. Employees or former employees, their designated representatives, and OSHA must have access to exposure and medical records in accordance with 29 CFR 1910.1020. Rules of agency practice and procedure governing OSHA access to employee medical records are found in 29 CFR 1913.10.

EXPOSURE ASSESSMENT RECORDS

The employer must establish and maintain an accurate record of all monitoring and other data used to conduct employee exposure assessments as required by this standard and in accordance with 29 CFR 1910.1020. The exposure assessment records must include:

- The dates, number, duration, location, and results of each sample taken, including a description of the sampling proce-dure used to determine representative employee exposure;
- A description of the sampling and analytical methods used and evidence of their accuracy;
- The type of respiratory protection worn, if any;
- The name, social security number, and job classification of the monitored employee and all others whose exposure the mea-surement represents; and
- Environmental variables that could affect the measurement of employee exposure.

MEDICAL SURVEILLANCE RECORDS

The employer must maintain an accurate record for each employee subject to medical surveillance, including:

- The name, social security number, and description of the employee's duties;
- A copy of the physician's written opinions;

- The results of any airborne exposure monitoring done for the employee and provided to the physician; and
- Any employee medical complaints related to lead exposure.

In addition, the employer must keep or ensure that the examining physician keeps the following medical records:

- A copy of the medical examination results including medical and work history;
- A description of the laboratory procedures and a copy of any guidelines used to interpret the test results; and
- A copy of the results of biological monitoring.

The employer or physician or both must maintain medical records in accordance with 29 CFR 1910.1020.

DOCUMENTS FOR EMPLOYEES SUBJECT TO MEDICAL REMOVAL

The employer must maintain--for at least the duration of employ-ment–an accurate record for each employee subject to medical removal, including:

- The name and social security number of the employee;
- The date on each occasion that the employee was removed from current exposure to lead and the corresponding date which the employee was returned to former job status;
- A brief explanation of how each removal was or is being accomplished; and
- A statement about each removal indicating whether the reason for removal was an elevated blood level.

EMPLOYER REQUIREMENTS RELATED TO OBJECTIVE DATA

The employer must establish and maintain an accurate record documenting the nature and relevancy of objective data relied on to assess initial employee exposure in lieu of exposure monitoring. The employer must maintain the record of objective data relied on for at least 30 years.

DOCUMENTS FOR OSHA AND NIOSH REVIEW

The employer must make all records--including exposure monitor-ing, objective data, medical removal, and medical records--

available upon request to affected employees, former employees, and their designated representatives and to the OSHA Assistant Secretary and the Director of the National Institute for Occupational Safety and Health (NIOSH) for examination and copying in accordance with 29 CFR 1910.1020.

WHEN CLOSING A BUSINESS

When an employer ceases to do business, the successor employer must receive and retain all required records. If no successor is available, these records must be sent to the Director of NIOSH.

Exposure Reduction and Employee Protection

The most effective way to protect workers is to minimize their exposure through engineering controls, good work practices and training, and use of personal protective clothing and equipment, including respirators, where required. The employer needs to designate a competent person capable of identifying existing and predictable lead hazards and who is authorized to take prompt corrective measures to eliminate such problems. The employer should, as needed, consult a qualified safety and health professional to develop and implement an effective worker protection program. These professionals may work independently or may be associated with an insurance carrier, trade organization, or onsite consultation program.

Engineering Controls

Engineering measures include local and general exhaust ventilation, process and equipment modification, material substitution, component replacement, and isolation or automation. Examples of recommended engineering controls that can help reduce worker exposure to lead are described as follows.

EXHAUST VENTILATION

Equip power tools used to remove lead-based paint with dust collection shrouds or other attachments so that paint is exhausted

through a high-efficiency particulate air (HEPA) vacuum system. For operations such as welding, cutting/burning, or heating, use local exhaust ventilation. Use HEPA vacuums during cleanup operations.

For abrasive blasting operations, build a containment structure that is designed to optimize the flow of clean ventilation air past the workers' breathing zones. This will help reduce the exposure to airborne lead and increase visibility. Maintain the affected area under negative pressure to reduce the chances that lead dust will contaminate areas outside the enclosure. Equip the containment structure with an adequately sized dust collector to control emissions of particulate matter into the environment.

ENCLOSURE OR ENCAPSULATION

One way to reduce the lead inhalation or ingestion hazard posed by lead-based paint is to encapsulate it with a material that bonds to the surface, such as acrylic or epoxy coating or flexible wall coverings. Another option is to enclose it using systems such as gypsum wallboard, plywood paneling, and aluminum, vinyl, or wood exterior siding. Floors coated with lead-based paint can be covered using vinyl tile or linoleum.

The building owner or other responsible person should oversee the custodial and maintenance staffs and contractors during all activities involving enclosed or encapsulated lead-based paint. This will minimize the potential for an inadvertent lead release during maintenance, renovation, or demolition.

SUBSTITUTION

Choose materials and chemicals that do not contain lead for construction projects. Among the options are:

- Use zinc-containing primers covered by an epoxy intermediate coat and polyurethane topcoat instead of lead-containing coatings.
- Substitute mobile hydraulic shears for torch cutting under certain circumstances.
- Consider surface preparation equipment such as needle guns with multiple reciprocating needles completely enclosed within an adjustable shroud, instead of abrasive blasting under certain

conditions. The shroud captures dust and debris at the cutting edge and can be equipped with a HEPA vacuum filtration with a self-drumming feature. One such commercial unit can remove lead-based paint from flat steel and concrete surfaces, outside edges, inside corners, and pipes.

- Choose chemical strippers in lieu of hand scraping with a heat gun for work on building exteriors, surfaces involving carvings or molding, or intricate iron work. Chemical removal generates less airborne lead dust. (Be aware, however, that these strippers themselves can be hazardous and that the employer must review the material safety data sheets (MSDSs) for these stripping agents to obtain information on their hazards.)

COMPONENT REPLACEMENT

Replace lead-based painted building components such as windows, doors, and trim with new components free of lead-containing paint. Another option is to remove the paint offsite and then repaint the components with zinc-based paint before replacing them.

PROCESS OR EQUIPMENT MODIFICATION

When applying lead paints or other lead-containing coatings, use a brush or roller rather than a sprayer. This application method introduces little or no paint mist into the air to present a lead inhalation hazard. (Note that there is a ban on the use of lead-based paint in residential housing.)

Use non-silica-containing abrasives such as steel or iron shot/grit sand instead of sand in abrasive blasting operations when practical. The free silica portion of the dust presents a respiratory health hazard.

When appropriate for the conditions, choose blasting techniques that are less dusty than open-air abrasive blasting. These include hydro- or wet-blasting using high-pressure water with or without an abrasive or surrounding the blast nozzle with a ring of water, and vacuum blasting where a vacuum hood for material removal is positioned around the exterior of the blasting nozzle.

When using a heat gun to remove lead-based paints in residential housing units, be sure it is of the flameless electrical softener

type. Heat guns should have electronically controlled temperature settings to allow usage below 700 degrees F. Equip heat guns with various nozzles to cover all common applications and to limit the size of the heated work area.

When using abrasive blasting with a vacuum hood on exterior building surfaces, ensure that the configuration of the heads on the blasting nozzle match the configuration of the substrate so that the vacuum is effective in containing debris.

Ensure that HEPA vacuum cleaners have the appropriate attachments for use on unusual surfaces. Proper use of brushes of various sizes, crevice and angular tools, when needed, will enhance the quality of the HEPA-vacuuming process and help reduce the amount of lead dust released into the air.

ISOLATION

Although it is not feasible to enclose and ventilate some abrasive blasting operations completely, it is possible to isolate many operations to help reduce the potential for lead exposure. Isolation consists of keeping employees not involved in the blasting operations as far away from the work area as possible, reducing the risk of exposure.

Housekeeping and Personal Hygiene

Lead is a cumulative and persistent toxic substance that poses a serious health risk. A rigorous housekeeping program and the observance of basic personal hygiene practices will minimize employee exposure to lead. In addition, these two elements of the worker protection program help prevent workers from taking lead-contaminated dust out of the worksite and into their homes where it can extend the workers' exposures and potentially affect their families' health.

HOUSEKEEPING PRACTICES

An effective housekeeping program involves a regular schedule to remove accumulations of lead dust and lead-containing debris. The schedule should be adapted to exposure conditions at a particular worksite. OSHA's Lead Standard for Construction requires

employers to maintain all surfaces as free of lead contamination as practicable. Vacuuming lead dust with HEPA-filtered equipment or wetting the dust with water before sweeping are effective control measures. Compressed air may not be used to remove lead from contaminated surfaces unless a ventilation system is in place to capture the dust generated by the compressed air.

In addition, put all lead-containing debris and contaminated items accumulated for disposal into sealed, impermeable bags or other closed impermeable containers. Label bags and containers as lead-containing waste. These measures provide additional help in controlling exposure.

PERSONAL HYGIENE PRACTICES

Emphasize workers' personal hygiene such as washing their hands and face after work and before eating to minimize their exposure to lead. Provide and ensure that workers use washing facilities. Provide clean change areas and readily accessible eating areas. If possible, provide a parking area where cars will not be contaminated with lead. These measures:

- Reduce workers' exposure to lead and the likelihood that they will ingest lead,
- Ensure that the exposure does not extend beyond the worksite,
- Reduce the movement of lead from the worksite, and
- Provide added protection to employees and their families.

CHANGE AREAS

The employer must provide a clean change area for employees whose airborne exposure to lead is above the PEL. The area must be equipped with storage facilities for street clothes and a separate area with facilities for the removal and storage of lead-contaminated protective work clothing and equipment. This separation prevents cross contamination of the employee's street and work clothing.

Employees must use a clean change area for taking off street clothes, suiting up in clean protective work clothing, donning respirators before beginning work, and dressing in street clothes after work. No lead-contaminated items should enter this area.

Work clothing must not be worn away from the jobsite. Under no circumstances should lead-contaminated work clothes be laundered at home or taken from the worksite, except to be laundered professionally or for disposal following applicable federal, state, and local regulations.

SHOWERS AND WASHING FACILITIES

When feasible, showers must be provided for use by employees whose airborne exposure to lead is above the permissible exposure limit so they can shower before leaving the worksite. Where showers are provided, employees must change out of their work clothes and shower before changing into their street clothes and leaving the worksite. If employees do not change into clean clothing before leaving the worksite, they may contaminate their homes and automobiles with lead dust, extending their exposure and exposing other members of their household to lead.

In addition, employers must provide adequate washing facilities for their workers. These facilities must be close to the worksite and furnished with water, soap, and clean towels so employees can remove lead contamination from their skin.

Contaminated water from washing facilities and showers must be disposed of in accordance with applicable local, state, or federal regulations.

PERSONAL PRACTICES

The employer must ensure that employees do not enter lunchroom facilities or eating areas with protective work clothing or equipment unless surface lead dust has been removed. HEPA vacuuming and use of a downdraft booth are examples of cleaning methods that limit the dispersion of lead dust from contaminated work clothing.

In all areas where employees are exposed to lead above the PEL, employees must observe the prohibition on the presence and consumption or use of food, beverages, tobacco products, and cosmetics. Employees whose airborne exposure to lead is above the PEL must wash their hands and face before eating, drinking, smoking, or applying cosmetics.

END-OF-DAY PROCEDURES

Employers must ensure that workers who are exposed to lead above the permissible exposure limit follow these procedures at the end of their workday:

- Place contaminated clothes, including work shoes and personal protective equipment to be cleaned, laundered, or disposed of, in a properly labeled closed container.
- Take a shower and wash their hair. Where showers are not provided, employees must wash their hands and face at the end of the workshift.
- Change into street clothes in clean change areas.

Protective Clothing and Equipment

EMPLOYER REQUIREMENTS

Employers must provide workers who are exposed to lead above the PEL or for whom the possibility of skin or eye irritation exists with clean, dry protective work clothing and equipment that are appropriate for the hazard. Employers must provide these items at no cost to employees. Appropriate protective work clothing and equipment used on construction sites includes:

- Coveralls or other full-body work clothing;
- Gloves, hats, and shoes or disposable shoe coverlets;
- Vented goggles or face shields with protective spectacles or goggles;
- Welding or abrasive blasting helmets; and
- Respirators.

Clean work clothing must be issued daily for employees whose exposure levels to lead are above 200 µg/m3, weekly if exposures are above the PEL but at or below 200 µg/m3 or where the possibility of skin or eye irritation exists.

HANDLING CONTAMINATED PROTECTIVE CLOTHING

Workers must not be allowed to leave the worksite wearing lead-contaminated protective clothing or equipment. This is an essential

step in reducing the movement of lead contamination from the workplace into the worker's home and provides added protection for employees and their families.

Disposable coveralls and separate shoe covers may be used, if appropriate, to avoid the need for laundering. Workers must remove protective clothing in change rooms provided for that purpose.

Employers must ensure that employees leave the respirator use area to wash their faces and respirator facepieces as necessary. In addition, employers may require their employees to use HEPA vacuuming, damp wiping, or another suitable cleaning method before removing a respirator to clear loose particle contamination on the respirator and at the face-mask seal.

Place contaminated clothing that is to be cleaned, laundered, or disposed of by the employer in closed containers. Label containers with the warning: "Caution: Clothing contaminated with lead. Do not remove dust by blowing or shaking. Dispose of lead-contaminated wash water in accordance with applicable local, state, or federal regulations."

Workers responsible for handling contaminated clothing, including those in laundry services or subcontractors, must be informed in writing of the potential health hazard of lead exposure. At no time shall lead be removed from protective clothing or equipment by brushing, shaking, or blowing. These actions disperse the lead into the work area.

PREVENTING HEAT STRESS

Workers wearing protective clothing, particularly in hot environments or within containment structures, can face a risk from heat stress if proper control measures are not used.

Heat stress is caused by several interacting factors, including environmental conditions, type of protective clothing worn, the work activity required and anticipated work rate, and individual employee characteristics such as age, weight, and fitness level. When heat stress is a concern, the employer should choose lighter, less insulating protective clothing over heavier clothing, as long as

it provides adequate protection. Other measures the employer can take include: discussing the possibility of heat stress and its signs and symptoms with all workers; using appropriate work/rest regimens; and providing heat stress monitoring that includes measuring employees' heart rates, body temperatures, and weight loss. Employers must provide a source of water or electrolyte drink in a non-contaminated eating and drinking area close to the work area so workers can drink often throughout the day. Workers must wash their hands and face before drinking any fluid if their airborne exposure is above the PEL.

Respiratory Protection

Although engineering and work practice controls are the primary means of protecting workers from exposure to lead, source control at construction sites sometimes is insufficient to control exposure. In these cases, airborne lead concentrations may be high or may vary widely. Respirators often must be used to supplement engineering controls and work practices to reduce worker lead exposures below the PEL. When respirators are required, employers must provide them at no cost to workers.

The standard requires that respirators be used during periods when an employee's exposure to lead exceeds the PEL, including

- Periods necessary to install or implement engineering or work practice controls, and
- Work operations for which engineering and work practice controls are insufficient to reduce employee exposures to or below the PEL.

Respirators also must be provided upon employee request. A requested respirator is included as a requirement to provide increased protection for those employees who wish to reduce their lead burden below what is required by the standard, particularly if they intend to have children in the near future. In addition, respirators must be used when performing previously indicated high exposure or "trigger" tasks, before completion of the initial assessment.

PROVIDING ADEQUATE RESPIRATORY PROTECTION

Before any employee first starts wearing a respirator in the work environment, the employer must perform a fit test. For all employees wearing negative or positive pressure tight-fitting facepiece respirators, the employer must perform either qualitative or quantitative fit tests using an OSHA-accepted fit testing protocol. In addition, employees must be fit tested whenever a different respirator facepiece is used, and at least annually thereafter.

Where daily airborne exposure to lead exceeds 50 µg/m3, affected workers must don respirators before entering the work area and should not remove them until they leave the high-exposure area or have completed a decontamination procedure. Employers must assure that the respirator issued to the employee is selected and fitted properly to ensure minimum leakage through the facepiece-to-face seal.

RESPIRATORY PROTECTION PROGRAMS

When respirators are required at a worksite, the employer must establish a respiratory protection program in accordance with the OSHA standard on respiratory protection, 29 CFR 1910.134. At a minimum, an acceptable respirator program for lead must include:

- Procedures for selecting respirators appropriate to the hazard;
- Fit testing procedures;
- Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations, including cartridge change schedules;
- Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators;
- Training of employees in the respiratory hazard to which they are potentially exposed during routine and emergency situations;
- Training of employees in the proper use of respirators, including putting on and removing them, any limitations of their use, and their maintenance;

- Procedures for regularly evaluating the effectiveness of the program;
- Procedures to ensure air quality when supplied air is used;
- A written program and designation of a program administrator; and
- Recordkeeping procedures.

In addition, the construction industry lead standard stipulates medical evaluations of employees required to use respirators.

If an employee has difficulty in breathing during a fit test or while using a respirator, the employer must make a medical examination available to that employee to determine whether he or she can wear a respirator safely.

SELECTING A RESPIRATOR

The employer must select the appropriate respirator from Table 1 of the lead standard, 29 CFR 1926.62(f)(3)(i). The employer must provide a powered air-purifying respirator when an employee chooses to use this respirator and it will provide the employee adequate protection. A NIOSH-certified respirator must be selected and used in compliance with the conditions of its certification. In addition, if exposure monitoring or experience indicates airborne exposures to contaminants other than lead such as silica, solvents, or polyurethane coatings, these exposures must be considered when selecting respiratory protection.

Select type CE respirators approved by NIOSH for abrasive blasting operations. Currently, there are two kinds of CE respirators with the following assigned protection factors (APFs): a continuous-flow respirator with a loose-fitting hood, APF 25; and a full facepiece supplied-air respirator operated in a positive-pressure mode, APF 2,000. (Note: OSHA recognizes Bullard Helmets, Models 77 and 88 (1995); Clemco Appollo, Models 20 and 60 (1997); and 3M Model 8100 (1998) as having APFs of 1,000.)

For any airline respirator, it is important to follow the manufacturer's instructions regarding air quality, air pressure, and inside diameter and length of hoses. Be aware that using longer hoses or smaller inside diameter hoses than the manufacturer specifies or

hoses with bends or kinks may reduce or restrict the airflow to a respirator.

Employee Information and Training

The employer must inform employees about lead hazards according to the requirement of OSHA's Hazard Communication standard for the construction industry, 29 CFR 1926.59, including--but not limited to--the requirements for warning signs and labels, material safety data sheets (MSDSs), and employee information and training. (Refer to 29 CFR 1910.1200.)

PROGRAM REQUIREMENTS

Employers must institute an information and training program and ensure that all employees subject to exposure to lead or lead compounds at or above the action level on any day participate. Also covered under information and training are employees who may suffer skin or eye irritation from lead compounds. Initial training must be provided before the initial job assignment. Training must be repeated at least annually and, in brief summary, must include:

- The content of the OSHA lead standard and its appendices;
- The specific nature of operations that could lead to lead expo-sure above the action level;
- The purpose, proper selection, fit, use, and limitations of respirators;
- The purpose and a description of the medical surveillance program, and the medical removal protection program;
- Information concerning the adverse health effects associated with excessive lead exposure;
- The engineering and work practice controls associated with employees' job assignments;
- The contents of any lead-related compliance plan in effect;
- Instructions to employees that chelating agents must not be used routinely to remove lead from their bodies and when necessary only under medical supervision and at the direction of a licensed physician; and

- The right to access records under "Access to Employee Exposure and Medical Records," 29 CFR 1910.1020.

All materials relating to the training program and a copy of the standard and its appendices must be made readily available to all affected employees.

WARNING SIGNS

Employers are required to post these warning signs in each work area where employee exposure to lead is above the PEL:

- WARNING
- LEAD WORK AREA
- POISON
- NO SMOKING OR EATING

All signs must be well lit and kept clean so that they are easily visible. Statements that contradict or detract from the signs' meaning are prohibited. Signs required by other statutes, regulations, or ordinances, however, may be posted in addition to, or in combination with, this sign.

OSHA Assistance, Services, and Products

OSHA can provide extensive help through a variety of programs, including assistance about safety and health programs, state plans, workplace consultations, voluntary protection programs, strategic partnerships, alliances, and training and education. An overall commitment to workplace safety and health can add value to your business, to your workplace, and to your life.

How does safety and health management system assistance help employers and employees?

Working in a safe and healthful environment can stimulate innovation and creativity and result in increased performance and higher productivity. The key to a safe and healthful work environment is a comprehensive safety and health management system.

OSHA has electronic compliance assistance tools, or eTools, on its website that walks users through the steps required to develop a

comprehensive safety and health program. The eTools are posted at www.osha.gov, and are based on guidelines that identify four general elements critical to a successful safety and health management system:

- Management leadership and employee involvement,
- Worksite analysis,
- Hazard prevention and control, and
- Safety and health training.

STATE PROGRAMS

The Occupational Safety and Health Act of 1970 (OSH Act) encourages states to develop and operate their own job safety and health plans. OSHA approves and monitors these plans and funds up to 50 percent of each program's operating costs. State plans must provide standards and enforcement programs, as well as voluntary compliance activities, that are at least as effective as federal OSHA's.

Currently, 26 states and territories have their own plans. Twenty-three cover both private and public (state and local government) employees and three states, Connecticut, New Jersey, and New York, cover only the public sector. For more information on state plans, see the list at the end of this publication, or visit OSHA's website at www.osha.gov.

CONSULTATION ASSISTANCE

Consultation assistance is available on request to employers who want help establishing and maintaining a safe and healthful workplace. Funded largely by OSHA, the service is provided at no cost to small employers and is delivered by state authorities through professional safety and health consultants.

SAFETY AND HEALTH ACHIEVEMENT RECOGNITION PROGRAM

Under the consultation program, certain exemplary employers may request participation in OSHA's Safety and Health Achievement Recognition Program (SHARP). Eligibility for participation includes, but is not limited to, receiving a full-service, compre-

hensive consultation visit, correcting all identified hazards, and developing an effective safety and health management system.

Employers accepted into SHARP may receive an exemption from programmed inspections (not complaint or accident investigation inspections) for 1 year initially, or 2 years upon renewal. For more information about consultation assistance, see the list of consultation projects at the end of this publication.

VOLUNTARY PROTECTION PROGRAMS

Voluntary Protection Programs (VPP) are designed to recognize outstanding achievements by companies that have developed and implemented effective safety and health management programs. There are three VPP programs: Star, Merit, and Demonstration. All are designed to

- Recognize who that have successfully developed and implemented effective and comprehensive safety and health management programs;
- Encourage these employers to continuously improve their safety and health management programs;
- Motivate other employers to achieve excellent safety and health results in the same outstanding way; and
- Establish a cooperative relationship between employers, employees, and OSHA.

VPP participation can bring many benefits to employers and employees, including fewer worker fatalities, injuries, and illnesses; lost-workday case rates generally 50 percent below industry averages; and lower workers' compensation and other injury- and illness-related costs. In addition, many VPP sites report improved employee motivation to work safely, leading to a better quality of life at work; positive community recognition and interaction; further improvement and revitalization of already-good safety and health programs; and a positive relationship with OSHA.

After a site applies for the program, OSHA reviews an employer's VPP application and conducts a VPP onsite evaluation to verify that the site’s safety and health management programs are

operating effectively. OSHA conducts onsite evaluations on a regular basis.

Sites participating in VPP are not scheduled for regular, programmed inspections. OSHA does, however, handle any employee complaints, serious accidents, or significant chemical releases that may occur at VPP sites according to routine enforcement procedures.

Additional information on VPP is available from OSHA regional offices listed at the end of this booklet. Also, see "Cooperative Programs" on OSHA's website.

COOPERATIVE PARTNERSHIPS

OSHA has learned firsthand that voluntary, cooperative partnerships with employers, employees, and unions can be a useful alternative to traditional enforcement and an effective way to reduce worker deaths, injuries, and illnesses. This is especially true when a partnership leads to the development and implementation of a comprehensive workplace safety and health management system.

ALLIANCE PROGRAM

Alliances enable organizations committed to workplace safety and health to collaborate with OSHA to prevent injuries and illnesses in the workplace. OSHA and its allies work together to reach out to, educate, and lead the nation's employers and their employees in improving and advancing workplace safety and health.

Alliances are open to all, including trade or professional organizations, businesses, labor organizations, educational institutions, and government agencies. In some cases, organizations may be building on existing relationships with OSHA through other cooperative programs.

There are few formal program requirements for alliances, which are less structured than other cooperative agreements, and the agreements do not include an enforcement component. However, OSHA and the participating organizations must define, implement, and meet a set of short- and long-term goals that fall into three cat-

egories: training and education; outreach and communication; and promotion of the national dialogue on workplace safety and health.

STRATEGIC PARTNERSHIP PROGRAM

OSHA Strategic Partnerships are agreements among labor, management, and government to improve workplace safety and health. These partnerships encourage, assist, and recognize the efforts of the partners to eliminate serious workplace hazards and achieve a high level of worker safety and health. Whereas OSHA's Consultation Program and VPP entail one-on-one relationships between OSHA and individual worksites, most strategic partnerships build cooperative relationships with groups of employers and employees.

For more information about this program, contact your nearest OSHA office or visit our website.

OCCUPATIONAL SAFETY AND HEALTH TRAINING

The OSHA Training Institute in Arlington Heights, Ill., provides basic and advanced training and education in safety and health for federal and state compliance officers, state consultants, other federal agency personnel, and private-sector employers, employees, and their representatives.

TRAINING GRANTS

OSHA awards grants to nonprofit organizations to provide safety and health training and education to employers and workers in the workplace. Grants often focus on high-risk activities or hazards or may help nonprofit organizations in training, education, and outreach.

OSHA expects each grantee to develop a program that addresses a safety and health topic named by OSHA, recruit workers and employers for the training, and conduct the training. Grantees are also expected to follow up with students to find out how they applied the training in their workplaces.

For more information contact OSHA Office of Training and Education, 2020 Arlington Heights Rd., Arlington Heights, IL 60005; or call (847) 297-4810.

OTHER ASSISTANCE MATERIALS

OSHA has a variety of materials and tools on its website at www.osha.gov. These include eTools such as Expert Advisors and Electronic Compliance Assistance Tools, information on specific health and safety topics, regulations, directives, publications, videos, and other information for employers and employees.

OSHA also has an extensive publications program. For a list of items, visit OSHA's website at www.osha.gov or contact the OSHA Publications Office, U.S. Department of Labor, 200 Constitution Avenue, NW, N-3101, Washington, DC 20210. Telephone (202) 693-1888 or fax to (202) 693-2498.

In addition, OSHA's CD-ROM includes standards, interpretations, directives, and more. It is available for sale from the U.S. Government Printing Office. To order, write to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, or phone (202) 512-1800.

IN CASE OF AN EMERGENCY OR TO FILE A COMPLAINT

To report an emergency, file a complaint, or seek OSHA advice, assistance, or products, call (800) 321-OSHA or contact your nearest OSHA regional office listed at the end of this publication. The teletypewriter (TTY) number is (877) 889-5627.

Employees can also file a complaint online and get more information on OSHA federal and state programs by visiting OSHA's website at www.osha.gov.

OSHA Regional Offices

Region I
(CT,* ME, MA, NH, RI, VT*)
Boston, MA 02203
(617) 565-9860

Region II
(NJ,* NY,* PR,* VI*)
201 Varick Street, Room 670
New York, NY 10014
(212) 337-2378

Region III
(DE, DC, MD,* PA,* VA,* WV)
The Curtis Center
170 S. Independence Mall West
Suite 740 West
Philadelphia, PA 19106-3309
(215) 861-4900

Region IV
(AL, FL, GA, KY,* MS, NC,* SC,* TN*)
Atlanta Federal Center
61 Forsyth Street SW, Room 6T50
Atlanta, GA 30303
(404) 562-2300

Region V
(IL, IN,* MI,* MN,* OH, WI)
230 South Dearborn Street,
Room 3244
Chicago, IL 60604
(312) 353-2220

Region VI
(AR, LA, NM,* OK, TX)
525 Griffin Street, Room 602
Dallas, TX 75202
(214) 767-4731 or 4736 x224

Region VII
(IA,* KS, MO, NE)
City Center Square
1100 Main Street, Suite 800
Kansas City, MO 64105
(816) 426-5861

Region VIII
(CO, MT, ND, SD, UT,* WY*)
1999 Broadway, Suite 1690
PO Box 46550
Denver, CO 80202-5716
(303) 844-1600

Region IX
(American Samoa, AZ,* CA,* HI, NV,* Northern Mariana Islands)
71 Stevenson Street, Room 420
San Francisco, CA 94105
(415) 975-4310

Region X
(AK,* ID, OR,* WA*)
1111 Third Avenue, Suite 715
Seattle, WA 98101-3212
(206) 553-5930

*These states and territories operate their own OSHA-approved job safety and health programs (Connecticut, New Jersey, and New York plans cover public employees only). States with approved programs must have a standard that is identical to, or at least as effective as, the federal standard.

Note: To get contact information for OSHA Area Offices, OSHA-approved state plans, and OSHA Consultation Projects, please visit us online at www.osha.gov or call us at (800) 321-OSHA.

Fact Sheet: Disposal of Lead-Based-Paint Contaminated Demolition Debris (in Nevada)

FACT SHEET – Disposal of Lead-Based Paint Contaminated Demolition Debris

Lead-based paint (LBP) was widely used on buildings until 1978, when it was banned on residential structures by the Consumer Products Safety Commission. Prior to the 1950s, paints for residential uses may have contained up to 50% lead by weight. Today, some commercial and military paints still contain lead and are used on non-residential structures.

Renovation, remodeling, demolition, and surface preparation for painting, in addition to specified lead abatement, are all activities that have the potential to produce hazardous wastes if the property involved was painted with LBP. The only sure way to tell if a property was painted with LBP is to test the paint for lead. The hazardous waste criterion for lead wastes is established under the federal Resource Conservation and Recovery Act (RCRA), Subtitle C, as 5.0 mg/L measured with the Toxicity Characteristic Leaching Procedure (TCLP).

Disposal of LBP-containing construction debris is very costly if it must be managed as a regulated hazardous waste. This fact sheet provides guidance on how waste generators can determine whether hazardous waste rules apply, and how to reduce the volume, and thereby the cost, of the hazardous waste component of the debris.

Residential Structures - Household Hazardous Waste Exemption

In order to facilitate the removal of LBP from residential structures, where it may pose a significant health threat to children, on June 18, 2003 the USEPA published a rule under solid waste regulations that streamlines disposal of LBP debris from residential structures. Under the new rule LBP debris from households, whether generated by a do-it-yourselfer or a contractor, may be disposed of at a municipal waste landfill or a construction & demolition (C&D) waste landfill, as defined in 40 CFR §257.2.

Non-residential Structures - Waste Determination & Management

LBP debris that comes from commercial or industrial sources, as opposed to households, may be subject to state and federal hazardous waste rules. In this case the generator must determine whether the debris fails, or is likely to fail, the toxicity characteristic for lead. Two scenarios are outlined below for making the waste determination and then managing the LBP debris in accordance with applicable standards: 1) whole-building demolition, and 2) renovation/abatement.

Whole-Building Demolition

The US EPA has stated that solid architectural components coated with LBP are less likely to be hazardous because of the small ratio of lead paint to total waste mass[1]. The US Army conducted a study which concluded that whole-building demolition debris is not likely to exceed the toxicity characteristic standard for lead if it is handled as a single, whole waste stream and disposed of all together[2]. Whole-building demolition debris is therefore considered a non-hazardous waste with regard to lead. No sampling/analysis of painted

components for lead is required for disposal as non-hazardous waste.

Note: Constituents other than LBP, i.e. PCBs from light ballasts or asbestos containing materials, may require special handling, and these should be removed before demolition.

Renovation/Abatement

Small-scale debris that is generated during renovation, maintenance, or abatement activities such as paint chips, vacuum debris and dust, waste wash water and sludge from chemical paint stripping is more likely to exceed the lead toxicity characteristic. Sampling may also be appropriate for intermediate-volume renovation wastes such as window moldings, doors, etc. Core or sectional samples can be taken of representative waste items to determine whether each type (eg. doors) is hazardous. Alternatively, the number of samples needed could be reduced by taking one or more core samples, compiling ratios of waste material surface area to mass for each type, and then comparing these to the surface area/mass ratio of the sample(s). A sampling protocol should be used for each site. Individual waste materials such as those described above should either be sampled/analyzed by TCLP and then handled/disposed accordingly, or segregated from other large-scale debris and then managed as hazardous waste. Records of sampling procedures and analytical results must be kept for at least 3 years.

1 US EPA. 1993. Applicability of RCRA disposal requirements to lead-based paint abatement wastes. Final Report.
EPA 747-R-93-006 Technical Programs Branch, Office of Pollution Prevention and Toxics. March 1993.
2 US Dept. of the Army. US Army Environmental Hygiene Agency. Interim Final Report. Lead-based paint contaminated debris waste characterization study No. 27-26-JK44-92. May 1993.

Contact

For more information on the EPA lead paint rule visit:
http://www.epa.gov/epaoswer/non-hw/muncpl/landfill/pb-paint.htm

For information on LBP debris management in Nevada call the:
Nevada Division of Environmental Protection, Solid Waste Branch at (775) 687-9462
In Clark and Washoe Counties contact:

- Southern Nevada Health District at (702) 759-0600
- Washoe County District Health Department at (775) 328-2434

APPENDIX C

Unreinforced-Masonry-Wall Analysis

MELVYN GREEN
& ASSOCIATES, INC.
21311 Hawthorne Blvd. Suite 220
TORRANCE, CALIFORNIA 90503
1-310-792-9252

JOB 2009106
SHEET NO. 1 OF
CALCULATED BY RCM DATE
CHECKED BY DATE
SCALE

BLDG 100 DATE STREET COMPLEX, BOULDER CITY
URM WALL STRENGTHENING

OPTION 1 - Do Nothing

Wall is currently stable. During seismic event, wall will buckle and crack. Refer to IEBC 2006 TABLE A1-A and A1- B.

OPTION 2 - Reinforce w/ Shotcrete

Reinforcing requires 3" of shotcrete (f_c' = 3000psi) w/ #5 bars @ 12" O.C. vertical. Attachment to URM wall requires ½" ϕ threaded rods spaced @ 16" in each direction. #5 Reinf @ 12" O.C. HORIZ.

OPTION 3 - Reinforce w/ TS

Reinforcing requires HSS 3x3x3/16 placed @ 10'-0" O.C. max. Attachment to URM Wall requires 2-½" ϕ threaded rods spaced @ 32" O.C. max, installed w/ HILTI HIT HY 150 MAX adhesive.

D PRODUCT 207

MELVYN GREEN
& ASSOCIATES, INC.
21311 Hawthorne Blvd. Suite 220
TORRANCE, CALIFORNIA 90503
1-310-792-9252

JOB 2009106
SHEET NO. 2 OF
CALCULATED BY RCM DATE 03/03/09
CHECKED BY DATE
SCALE

BLDG 100 DATE STREET COMPLEX, BOULDER CITY
URM WALL STRENGTHENING, CONT'D

DESIGN CRITERIA

WIND - BASIC SPEED = 90mph

SEISMIC - $S_{DS} = 0.542$
$S_{D1} = 0.257$

MATERIALS

URM Unit Weight = 50psf
CONCRETE $f_c' = 3{,}000$psi

OPTION 1

$h/t \approx$ stable ?

$h/t = \frac{12.67' \times 12 \text{ in/ft}}{8 \text{ in}} = 19.005$

$S_{D1} = 0.257 \Rightarrow (h/t)_{req'd} = 20.0$ [2006 IEBC, TABLE A1-B]

∴ WALLS ARE STABLE

SEISMIC CALCULATION

$V = C_s W$ [12.8-1]

$C_s = \frac{S_{DS}}{(R/I)}$ $R = 1.5$, $I = 1.0$

$C_s = \frac{0.542}{(1.5/1.0)} = 0.361$

$V = 0.362\,W$

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& ASSOCIATES, INC.
21311 Hawthorne Blvd. Suite 220
TORRANCE, CALIFORNIA 90503
1-310-792-9252

JOB 2009106
SHEET NO. 3 OF
CALCULATED BY RCM DATE 03/03/09
CHECKED BY DATE
SCALE

$h = 12.67'$

$V = 0.362(50psf)$

$\underline{V = 18.1psf}$

WIND CALCULATION

$\underline{p_{net} = -17.55psf}$

$V > p_{net}$ ∴ Seismic governs

OPTION 2 - Convert to R/C Wall
Assume 3" Shotcrete Wall ($f_c' = 3000psi$) w/ #5 @ 12" O.C.

$V = 0.362(87.5psf) = 31.7psf$

$M_u = \frac{31.7psf \times (12.67ft)^2}{8}$

$\underline{M_u = 636 \ lb\text{-}ft/ft}$

$\phi M_n = \phi A_s f_y (d - \frac{a}{2})$

$a = \frac{A_s f_y}{0.85 f_c' b} = \frac{0.31in^2(60ksi)}{0.85(3ksi)(12in)}$

$a = 0.608$

$\phi M_n = 0.9(0.31in^2)(60ksi)(1.5in - \frac{0.608}{2})$

$\phi M_n = 20.0 \ k\text{-}in \times \frac{1000 \ lb/k}{12 \ in/ft}$

$\underline{\phi M_n = 1,668 \ lb\text{-}ft/ft > M_u}$

∴ USE 3" SHOTCRETE WALL w/ #5 @ 12" O.C.

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& ASSOCIATES, INC.
21311 Hawthorne Blvd. Suite 220
TORRANCE, CALIFORNIA 90503
1-310-792-9252

JOB

SHEET NO. 4 OF

CALCULATED BY RCM DATE 03/03/08

CHECKED BY DATE

SCALE

OPTION 3 - TS BRACING (f_y = 46 ksi)

TRY 10' O.C. SPACING

$V = 0.362(50psf) = 18.1psf$

$w_{TS} = 18.1psf \times 10ft = 181 lb/ft$

$M_u = \frac{181 lb/ft \cdot (12.67ft)^2}{8} = 3.63^{k-ft}$

TRY HSS 3×3×3/16

$F_y = 46 ksi$

$Z = 1.97in^3$

$\phi M_n = \phi F_y Z$

$\phi M_n = 0.90(46ksi)(1.97 in^3)/12$

$\phi M_n = 6.80^{k-ft} > M_u$

∴ USE HSS 3×3×3/16 @ 10' O.C.

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& ASSOCIATES, INC.
21311 Hawthorne Blvd. Suite 220
TORRANCE, CALIFORNIA 90503
1-310-792-9252

JOB 2009106
SHEET NO. 5 OF
CALCULATED BY RCM DATE
CHECKED BY DATE
SCALE

CONNECTIONS

SHOTCRETE WALL

Try ½" threaded rod attachment to URM wall using HILTI HIT HY 150 MAX adhesive

$V = 18.1$ psf

$T_{allow/rod} = 1{,}265\ lb \times \frac{1.25''}{4.5''} \times \frac{4}{3} = 469\ lb/rod$

∴ SPACE RODS @ 16" O.C. EACH WAY

IS REINFORCED WALL

$T_{allow/rod} = 469\ lb/rod$

$T_{actual} = 181\ lb/ft$

$S_{req'd} = \frac{469\ lb/rod}{181\ lb/ft} \approx 2.5\ ft/rod$

∴ SPACE RODS @ 32" O.C.

D PRODUCT 207

MELVYN GREEN & ASSOCIATES, INC.
21311 Hawthorne Blvd. Suite 220
TORRANCE, CALIFORNIA 90503
1-310-792-9252

JOB 2009106
SHEET NO. 6 OF
CALCULATED BY RCM DATE 5/6/09
CHECKED BY DATE
SCALE

Supplemental Calculations

URM 8" block grouted @ 48" O.C. (Assumed)
Unit Wt. = 55 psf (REDUCED FROM 87.5 psf) (SEE SH 3)

Option 2 Try 3" shotcrete wall (f'_c = 3000 psi) w/ #5 @ 12" O.C.

$W_{shotcrete} = \frac{3}{12}(150 pcf) = 37.5 psf$

$w = 55 + 37.5 = 92.5 psf$

$V = 0.362(92.5 psf) = 33.5 psf$

$M_u = \frac{33.5(12.67)^2}{8} = 665^{lb\text{-}ft}/_{ft}$

$\phi M_n = \phi A_s f_y (d - a/2)$

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.31 in^2 (60 ksi)}{0.85(3)(12)} = 0.608"$

$\phi M_n = 0.9(0.31)(60)(1.5 - \frac{0.608}{2})/12$

$\phi M_n = 1{,}668^{lb\text{-}ft}/_{ft} > M_u$ OK

∴ USE 3" SHOTCRETE WALL w/ #5 @ 12" O.C.

Option 3 - TS Bracing

Try 10' O.C. Spacing (HSS 3x3x3/16)

$V = 0.362(55 psf) = 19.9 psf$

$w_{TS} = 10^{ft} \times 19.9 psf = 199^{lb}/_{ft}$

$M_u = \frac{199(12.67)^2}{8} = 3993^{lb\text{-}ft} < \phi M_n$

∴ USE HSS 3x3x3/16 @ 10'-0" O.C. ($\phi M_n = 6.8^{k\text{-}ft}$)

NO CHANGE TO DESIGN

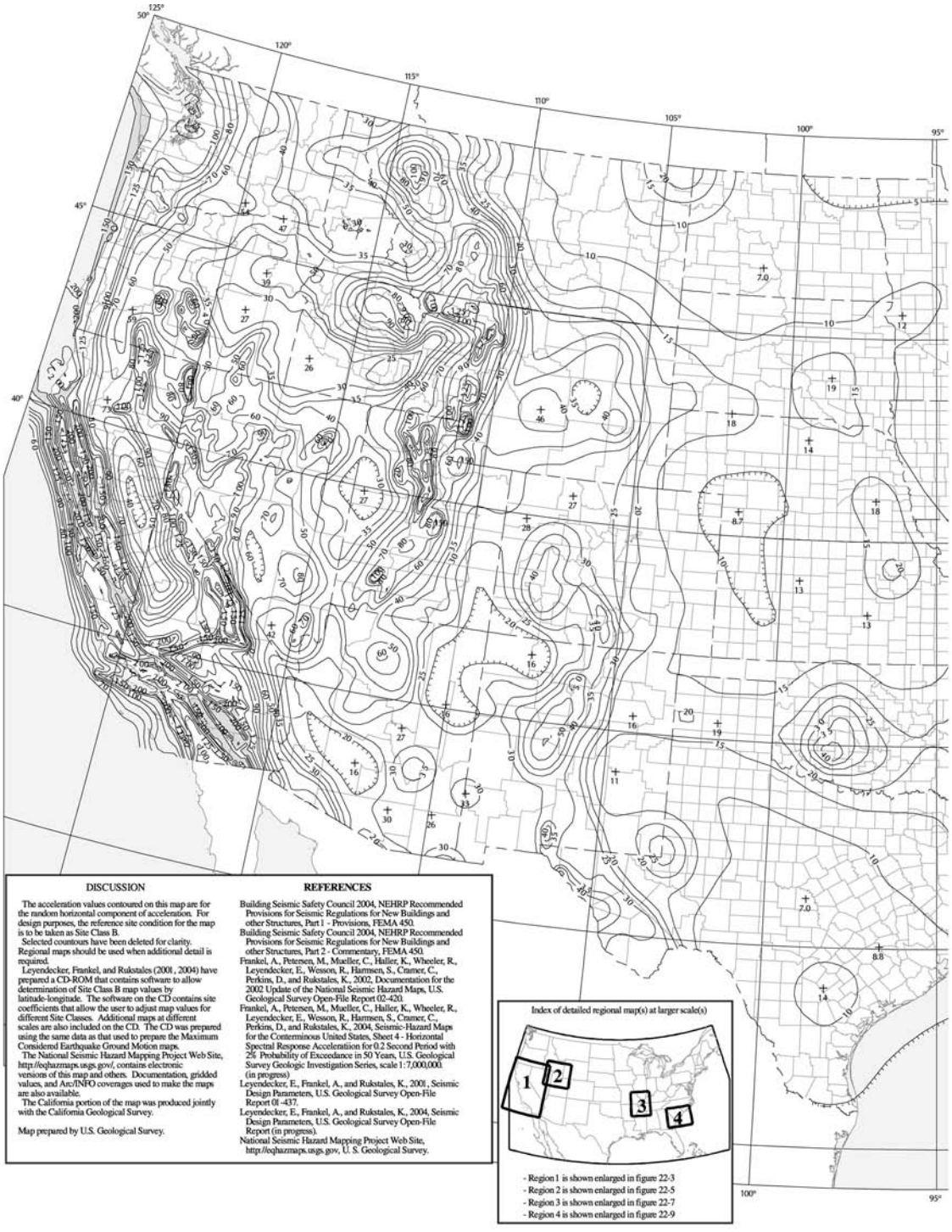

FIGURE 22-1 MAXIMUM CONSIDERED EARTHQUAKE GROUND MOTION FOR THE CONTERMINOUS UNITED STATES OF 0.2 SEC SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B

A113.8 Nonstructural masonry walls. Unreinforced masonry walls that carry no design vertical or lateral loads and that are not required by the design to be part of the lateral-force resisting system shall be adequately anchored to new or existing supporting elements. The anchors and elements shall be designed for the out-of-plane forces specified in the building code. The height- or length-to-thickness ratio between such supporting elements for such walls shall not exceed nine.

A113.9 Truss and beam supports. Where trusses and beams other than rafters or joists are supported on masonry, independent secondary columns shall be installed to support vertical loads of the roof or floor members.

Exception: Secondary supports are not required where S_{D1} is less than 0.3g.

A113.10 Adjacent buildings. Where elements of adjacent buildings do not have a separation of at least 5 inches (127 mm), the allowable height-to-thickness ratios for "all other buildings" per Table A1-B shall be used in the direction of consideration.

SECTION A114
WALLS OF UNBURNED CLAY, ADOBE OR STONE MASONRY

A114.1 General. Walls of unburned clay, adobe masonry construction shall conform to the following

1. Walls of unburned clay, adobe or stone maso not exceed a height- or length-to-thickness ra fied in Table A1-G.
2. Adobe may be allowed a maximum value of per square inch (62.1 kPa) for shear unless high are justified by test.
3. Mortar for repointing may be of the same soil tion and stabilization as the brick, in lieu of cem tar.

TABLE A1-A—ELEMENTS REGULATED BY THIS CHAPTER

BUILDING ELEMENTS	S_{D1} ≥ 0.067$_g$ < 0.133$_g$	≥ 0.133$_g$ < 0.20$_g$	≥ 0.20$_g$ < 0.30$_g$	>
Parapets	X	X	X	
Walls, anchorage	X	X	X	
Walls, *h/t* ratios		X	X	
Walls, in-plane shear		X	X	
Diaphragms[a]			X	
Diaphragms, shear transfer[b]		X	X	
Diaphragms, demand-capacity ratios[b]			X	

a. Applies only to buildings designed according to the general procedures of Section A110.
b. Applies only to buildings designed according to the special procedures of Section A111.

TABLE A1-B—ALLOWABLE VALUE OF HEIGHT-TO-THICKNESS RATIO OF UNREINFORCED MASONRY WALLS

WALL TYPES	0.13$_g$ ≤ S_{D1} < 0.25$_g$	0.25$_g$ ≤ S_{D1} < 0.4$_g$	S_{D1} ≥ 0.4$_g$ BUILDINGS WITH CROSSWALLS[a]	S_{D1} > 0.4 ALL OTHER BU
Walls of one-story buildings	20	16	16[b,c]	13
First-story wall of multistory building	20	18	16	15
Walls in top story of multistory building	14	14	14[b,c]	9
All other walls	20	16	16	13

a. Applies to the special procedures of Section A111 only. See Section A111.7 for other restrictions.
b. This value of height-to-thickness ratio may be used only where mortar shear tests establish a tested mortar shear strength, v_t, of not less than 100 pound inch (690 kPa). This value may also be used where the tested mortar shear strength is not less than 60 pounds per square inch (414 kPa), and where a vi nation of the collar joint indicates not less than 50-percent mortar coverage.
c. Where a visual examination of the collar joint indicates not less than 50-percent mortar coverage, and the tested mortar shear strength, v_t, is greater tha per square inch (207 kPa) but less than 60 pounds per square inch (414 kPa), the allowable height-to-thickness ratio may be determined by linear i between the larger and smaller ratios in direct proportion to the tested mortar shear strength.

Order-of-Magnitude Construction Cost Estimates

ESG Construction Consultants

June 8, 2009

Statistical Research, Inc.
Scott Thompson, M.A., C.A.
6099 E. Speedway Blvd.
Tucson, AZ 85712

Re: In-Depth Treatment Recommendations for the Remaining Character-Defining Features of Building 100 in the Date Street Complex
Bureau of Reclamation, Lower Colorado Region, Boulder City, Nevada
Order-of-Magnitude Cost Estimates
ESG Construction Consultant Project Number: 2009-10

Dear Mr. Thompson,

The following comments are reflected in the attached Order-of-Magnitude Cost Budgets:

1. ORDER OF MAGNITUDE COST BUDGET FORMAT
The Order-of-Magnitude Cost Budget is based on a Systems-Unit Cost Basis reflecting the analysis and assumptions presented herein. (General Conditions and Overhead-Profit Fees for the Prime Contractor are not referenced.)

2. PROJECT DETAILS
Historical Preservation Analysis procedures are outlined in the Historical Preservation Analysis; Report 07-55, prepared by Statistical Research date stamped 3/13/09 along with the reference document, Interim Protective Measures for the Stabilization and Environmental Control prepared by Melvyn Green & Associates, Inc.

3. STATEMENT OF ORDER-OF-MAGNITUDE COST BUDGETS
The Order-of-Magnitude Cost Budgets are construed as an evaluation of costs based upon cost data for similar projects. Actual costs will depend on a variety of factors as final selection of materials, perceived means and methods of construction, expertise of contractor's abilities and expertise, etc. Under current market conditions at the day of this writing, a cost variance of +/- 5% is anticipated; however, these Order-of-Magnitude Cost Budgets should be revisited as the design process continues due to unknown future market conditions.

11549 Snow Creek Ave.
Las Vegas, Nevada 89135
702-889-4033
Fax 702-889-4035

4. INTENT OF THE ORDER OF MAGNITUDE COST BUDGET

The Order-of-Magnitude Cost Budgets are based on a competitive bid environment by a minimum of three responsible subcontractors in each trade for a Davis-Bacon type project. Work is intended to be performed continuously during normal work hours and on normal work days.

5. OBSERVATIONS/CLARIFICATIONS:

A) Mid-Point-Of-Construction is anticipated to be within the third quarter of 2009. (Escalation beyond this time period is not included.)

B) Exclusions:

- Contractor's Overhead-Profit Fees, generally understood to be approximately Twenty-Five to Thirty–Five Percent of direct costs. (This cost should be added to reflect the current market conditions through the design process and adjusted as necessary.)
- Contractor's General Conditions Costs are generally understood to be approximately Twenty-Five to Thirty Percent of all direct costs. (These costs should be added to reflect the current market conditions through the design process and adjusted as necessary.)
- Permits, Testing and Inspection Fees, A/E Fees, etc.
- Unforeseen hazardous materials abatement and proper disposal, if encountered.

Please feel free to contact me at (702) 889-4033 should there be any questions or comments.

Sincerely,

Ed Golembiewski, CPE

In-Depth Treatment Recommendations for the Remaining Character-Defining Features of Building 100 in the Date St. Complex

Bureau of Reclamation, Lower Colorado Region
Boulder City, Nevada
Unreinforced Masonry (URM) Wall Stabilization Work 6/8/2009
Order-of-Magnitude Cost Estimate

Item	Description of Work	QTY.	UNIT	UNIT COST	COST	ITEM SUBTOTAL
	URM Wall Stabilization (Shotcrete Option)					
a	Remove Lead Based Paint (Protect Window Openings)	47	EA	155.75	7,320	
	(Protect Roof Line)	700	LF	3.55	2,485	
	(Protect Misc. Wall Openings)	22	EA	193.18	4,250	
	(Light Waterblast Wall Removal)	7,200	SF	2.15	15,480	
	(Collect and Remove Lead Chips, etc.)	1	LS	10,000.00	10,000	
b	Surface Preparation (Remove Plaster Substrate)	7,200	SF	2.35	16,920	
c	Shotcrete Operation (Frame Windows,& Openings, Screeds, etc.)	47	EA	119.50	5,617	
	(Anchors, Reinforcing, Chairs, etc.)	7,200	SF	13.65	98,280	
	(Shotcrete Installation)	7,200	SF	9.95	71,640	
	Subtotal					231,992
	URM Wall Stabilization (Wall Braced Option)					
a	Remove Lead Based Paint (Protect Window Openings)	47	EA	155.75	7,320	
	(Protect Roof Line)	700	LF	3.55	2,485	
	(Protect Misc. Wall Openings)	22	EA	193.18	4,250	
	(Light Waterblast Wall Removal)	7,200	SF	2.15	15,480	
	(Collect and Remove Lead Chips, etc.)	1	LS	10,000.00	10,000	
b	Surface Preparation (Remove Plaster Substrate)	7,200	SF	1.85	13,320	
c	Wall-Bracing Work (Install Steel Tube Members, etc.)	8,500	LBS	8.11	68,935	
	Subtotal					121,790

Clarifications:

See ESG Construction Consultants letter of 6/8/09.

In-Depth Treatment Recommendations for the Remaining Character-Defining Features of Building 100 in the Date St. Complex

Bureau of Reclamation, Lower Colorado Region
Boulder City, Nevada

Unreinforced Masonry (URM) Wall Stabilization Work 6/8/2009
Order-of-Magnitude Cost Estimate

Item	Description of Work	QTY.	UNIT	UNIT COST	COST	ITEM SUBTOTAL
	URM Wall Stabilization Repair Exterior Walls					
a	Remove Failed Paint (Containment Shroud, Removal, Disposal	1	LS	17,500.00	17,500	
	(Protect Openings and Adjacent Areas)	53	EA	49.75	2,637	
b	Painting-Exterior (Pre-Painting/Light Water Blast, etc.)	7,200	SF	0.55	3,960	
	(Primer Coat)	7,200	SF	0.55	3,960	
	(Finish Coat)	7,200	SF	0.55	3,960	
c	Painting-Interior (Pre-Painting/Light Water Blast, etc.)	7,200	SF	0.55	3,960	
	(Primer Coat)	7,200	SF	0.55	3,960	
	(Finish Coat)	7,200	SF	0.55	3,960	
	Subtotal					43,897

Clarifications:

See ESG Construction Consultants letter of 6/8/09.

In-Depth Treatment Recommendations for the Remaining Character-Defining Features of Building 100 in the Date St. Complex

Bureau of Reclamation, Lower Colorado Region
Boulder City, Nevada
Window Repair/Replicate Windows, etc. 6/8/2009
Order-of-Magnitude Cost Estimate

Item	Description of Work	QtTY.	UNIT	UNIT COST	COST	ITEM SUBTOTAL
	On-Site Repair (Existing Steel Sash Windows					
a	Remove Glazing and Glazing Compound	39	EA	128.25	5,002	
b	Remove lead paint and Corrosion (Wet Scraping, Wet Sanding)	39	EA	230.77	9,000	
	(Heat Gun, Scraping)	39	EA	164.10	6,400	
	(Chemical Stripping)	39	EA	205.13	8,000	
	(Controlled HEPA Sanding)	39	EA	287.18	11,200	
	(Sandblasting/Dry Abrasives)	39	EA	307.69	12,000	
c	Fill Cavities with Epoxy Fillers	39	EA	101.28	3,950	
d	Sand Substrate	39	EA	138.97	5,420	
	Operable Windows (Remove Seals)	1	LS	1,440.00	1,440	
	(Install Hardware)	1	LS	9,600.00	9,600	
	(Weatherstrip, Spring Metal)	1	LS	4,095.00	4,095	
	(Weatherstrip, Vinyl Strips)	1	LS	3,500.00	3,500	
	(Weatherstrip, Foam Tape)	1	LS	2,400.00	2,400	
	(Weatherstrip, Sealant Bead)	1	LS	1,900.00	1,900	
e	Inoperable Windows (Seal Windows)	1	LS	5,130.00	5,130	
f	Prime Metal	39	EA	107.69	4,200	
g	Glaze Sash and Double Seal (Low-E Glass)	39	EA	448.72	17,500	
	(Laminated Glass)	39	EA	551.28	21,500	
	(Dual Pane Glass)	39	EA	705.13	27,500	
h	Finish Paint	39	EA	112.82	4,400	
	Mean/Average Subtotal (Reflects 75 various options)					61,897
	Off-Site Repair Existing Steel Sash Windows)					
a	Make a Window Schedule	39	EA	19.23	750	
b	Remove Windows	39	EA	120.00	4,680	
c	Ship Windows to Factory	1	LS	1,000.00	1,000	
d	Ship Windows Back to Site	1	LS	1,000.00	1,000	
e	Off-Site Repair of Existing Steel-Sash Windows	39	EA	1,945.00	75,855	
f	Install Windows	39	EA	363.85	14,190	
	Subtotal					97,475
	Manufacture Replacement Windows (Glaze Sash and Double Seal)					
a	Manufacture (7) Replicate and (1) New Aluminum Sash Window Units	8	EA	4,297.13	34,377	
b	Low E-Glass	8	EA	328.12	2,625	
c	Laminated Glass	8	EA	376.88	3,015	
d	Dual-Pane Glass	8	EA	525.00	4,200	
e	Finish Paint	8	EA	105.00	840	
f	Install Windows	8	EA	1,560.00	12,480	
	Mean/Average Subtotal (Reflects 3 various options)					50,977
	Manufacture Replacement Windows (Glaze Sash and Double Seal)					
a	Manufacture (7) Replicate and (1) New Steel Sash Window Units	8	EA	1,625.00	13,000	
b	Low E-Glass	8	EA	328.13	2,625	
c	Laminated Glass	8	EA	376.88	3,015	
d	Dual-Pane Glass	8	EA	525.00	4,200	
e	Finish Paint	8	EA	105.00	840	
f	Install Windows	8	EA	1,560.00	12,480	
	Mean/Average Subtotal (Reflects 3 various options)					29,600
	Manufacture Interior Thermal Barriers					
a	Manufacture Aluminum -Sash Interior Barriers	47	EA	301.62	14,176	
b	Install Barriers	47	EA	136.70	6,425	
	Subtotal					20,601
	Finish all Windows					
a	Remove Nailing Strips	47	EA	30.64	1,440	
b	Patch	47	EA	106.38	5,000	
c	Caulk Surrounds	47	EA	81.28	3,820	
	Subtotal					10,260

Clarifications:

See ESG Construction Consultants letter of 6/8/09.

In-Depth Treatment Recommendations for the Remaining Character-Defining Features of Building 100 in the Date St. Complex

Bureau of Reclamation, Lower Colorado Region
Boulder City, Nevada
Wood Features (Repair, Replacement, Weatherization) 6/8/2009
Order-of-Magnitude Cost Estimate

Item	Description of Work	QTY.	UNIT	UNIT COST	COST	ITEM SUBTOTAL
	Repair Wood Features					
a	Remove Failed Lead Based Paint (Walkway Covering)	1	LS	23,775.00	23,775	
	(Faux Rafter Tails & Blocking)	1	LS	3,750.00	3,750	
b	Clean Surfaces: Dirt Pollution, Mildew (Walkway Covering)	1	LS	1,500.00	1,500	
	(Faux Rafter Tails & Blocking)	1	LS	500.00	500	
c	Prepare Surfaces (Walkway Covering)	1	LS	17,500.00	17,500	
	(Faux Rafter Tails & Blocking)	1	LS	500.00	500	
d	Manufacture Wood Features (Column Support 6 by 6 @ 8.0')	1	LS	750.00	750	
e	Install Wood Features (Column Support 6 by 6 by 8.0')	1	LS	750.00	750	
f	Paint Wood Features (Prime Coat/Walkway Covering)	1	LS	2,575.00	2,575	
	(Prime Coat/Faux Rafter Tails & Blocking)	1	LS	1,750.00	1,750	
	(Finish Coat/Walkway Covering)	1	LS	2,750.00	2,750	
	(Finish Coat/Faux Rafter Tails & Blocking)	1	LS	1,750.00	1,750	
	Subtotal					57,850

Clarifications:

See ESG Construction Consultants letter of 6/8/09.

Summary of Costs for Manufactured Elements and Off-Site Repairs and a Contact List of Companies

Summary of Costs for Manufactured Elements and Off-Site Repairs

Element or Repair	Cost	Not Included
Manufacture 7 replicate and 1 new steel-sash window units	$10,000–14,896	shipping, glazing, installation, final paint coat
Manufacture 7 replicate and 1 new aluminum-sash window units	$34,377	installation
Manufacture 47 aluminum-sash interior thermal barriers	$14,176	installation
Off-site repair of 39 existing steel-sash windows	$75,000–76,600	shipping, installation

Contact List of Companies

Restoration of Steel-Sash Windows

Re-View
Brooks Gentleman
1235 Saline Street
North Kansas City, Missouri 64116
(816) 741-2876 phone
(816) 746-9331 fax
http://www.re-view.biz/

Seekircher Steel Window Repair
John Seekircher
423 Central Avenue
Peekskill, New York 10566
(914) 734-8004 phone
(914) 734-8009 fax
http://www.seekirchersteelwindow.com/

Manufacturer of Replicate Steel-Sash Windows

A&S Window Associates, Inc.
Alan Herman
88-19 76th Avenue
Glendale, New York 11385
(718) 275-7900 phone
(718) 997-7683 fax
http://www.aswindowassociates.com/

Seekircher Steel Window Repair
John Seekircher
423 Central Avenue
Peekskill, New York 10566
(914) 734-8004 phone
(914) 734-8009 fax
http://www.seekirchersteelwindow.com/

Torrance Steel Window Co., Inc.
Gabriel Mena
1819 Abalone Avenue
Torrance, California 90501
(310) 328-9181 phone
(310) 328-7485 fax
http://www.torrancesteelwindow.com/

Manufacturer of Replicate Aluminum-Sash Windows

Custom Window Company
Peter Dean/Cal Hogan
2727 South Santa Fe Drive
Englewood, Colorado 80110
(303) 722-0822 phone
(303) 722-1993 fax
http://www.customwindow.com/

Manufacturer of Interior Thermal Barriers

Allied Window, Inc.
Dave Martin
11111 Canal Road
Cincinnati, Ohio 45241
(513) 559-1212 phone
(513) 559-1883 fax
http://www.alliedwindow.com/

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