Fire Station
Green Building Measures Report

Foundational Analysis for Integrating Sustainable Design Methods into City of Los Angeles Facilities

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Prepared for
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Brownfield development
Reduce footprint, limit site disturbance
Locate close to public transportation
Daylighting
Bamboo floor, wheat board, possibly engineered lumber from fast growing poplar or Monterey pine
Other Potential Measures That Do Not Earn LEED Credit
Minimize use of materials
Efficient washing machines
Energy star appliances
Efficient refrigerators
Insulated coffee maker
Eliminate vending machines
Diesel engine heater control
Efficient ice maker
Introduction

This document is prepared for the Architectural Division of the City of Los Angeles and the Southern California Gas Company by Eley Associates. Its purpose is to describe design measures applicable to a fire station that allow the new building to achieve a LEED green building certification. The City plans to build 19 new fire stations in the near future and aims to make these facilities as energy efficient, productive and environmentally sensitive as is feasible.

Typical Fire Station

Fire Station No. 3 (108 North Fremont Ave) was selected to be representative of future fire stations in terms of space usage and function. This station was identified as a good candidate by Chief Prince of the LAFD. In addition to Fire Station No. 3, two other stations, 27 (1333 Cole Ave) and 88 (5101 Sepulveda Blvd), were surveyed as part of this project. The information gathered during the survey has been used to help develop a baseline fire station description for the measures described in this report. Since each of these stations was constructed between 10 and 20 years ago, many features, such as lighting systems, differ from today’s standard new construction practice. The baseline station takes the basic form of Fire Station No. 3, but the energy consuming systems are upgraded to comply with the 2001 version of the Title 24 energy code.

The prominent feature of the station is the “apparatus bay” where the engines are garaged. The bay is a single story structure with high ceiling and doors at either end that allow engines to enter at the rear and leave through the front. The bays are sometimes also used for storage of miscellaneous gear, depending on availability of other storage space. New stations will have overhead exhaust removal systems with flexible ducts that connect directly to the engines’ exhaust pipes. The bays also have overhead electrical distribution to power diesel engine heaters that are necessary to allow instant starting.
Exterior walls are concrete masonry in most cases. Roof framing is primarily wood except in some apparatus bays where steel beams are used to span the open space.

Other space types within the fire station include:

- Dormitories. Typically several rooms with several beds each. May also contain lockers.
- Kitchen and dining room. Contains a commercial range with hood and two to three residential-style refrigerators in addition to other standard kitchen equipment.
- Offices and conference room.
- Exercise room and handball court.
- Training room and TV lounge
- Bathroom with showers.
- Storage areas.

**Green Building Measures**

The measures described in this report are a subset of potential green building design and construction practices that could be applicable to LAFD fire stations. This specific group of measures is chosen to be reasonably attainable and to illustrate the costs and benefits to achieving LEED certification. There may be additional measures that are feasible or even more desirable at specific sites.

Table 1 summarizes the impact of each measure on the project cost and the LEED score. With this set of design measures, the score is 31 points, 5 more than necessary for LEED certification. The total additional construction cost is about $123,080. Compared to a typical project budget of $3,180,000 ($212 per square foot for a 15,000 ft² fire station), these measures add about 4%.

Additional design costs increase by about $31,300, equal to a 1% increase over the typical budget. The largest cost items are energy modeling and general LEED documentation.

Commissioning cost is about $15,000, which increases the typical budget by an additional 0.5%.

Several “General” items listed at the top of Table 1 account for some of the additional costs to LEED certification. First is the application cost of $1,500. Second is the cost of completing the documentation required for the certification process, estimated to be roughly $10,000. The third item is a cost allowance of $7,500 for the energy modeling necessary to show how the building performs compared to the Title 24 energy standard baseline. Table 1 includes an assumption that savings will be at least 20%, for a LEED credit of 2 points. The specific measures to achieve these savings are listed throughout the table.

The scale for LEED certification is as follows:

1. Certified 26 points
2. Silver 33 points
3. Gold 39 points
4. Platinum 52 points
### Table 1 Summary of Green Building Measures, with LEED Impact and Incremental Project Cost

<table>
<thead>
<tr>
<th>LEED Points</th>
<th>Extra Design Cost**</th>
<th>Extra Construction Cost</th>
<th>Commissioning Cost***</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEED application fee</td>
<td>$1,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEED documentation</td>
<td>$10,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy modeling (required for documentation of LEED points)</td>
<td>$7,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy consumption 20% below Title 24 (specific energy measures listed below)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Demolition Phase Green Building Measures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycle concrete and asphalt demolition waste</td>
<td>1</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Separate and recycle all wood, metal and gypsum board demolition waste</td>
<td>1</td>
<td>$400 $15,000</td>
<td></td>
</tr>
<tr>
<td><strong>Design Phase – Site Planning</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appropriate site selection</td>
<td>1</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Highly reflective concrete paving</td>
<td>1</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Storm water dry well</td>
<td>1 $1,000 $10,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drip irrigation with local drought resistant landscaping</td>
<td>1</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Bike rack</td>
<td>1</td>
<td>$1,000</td>
<td></td>
</tr>
<tr>
<td><strong>Design Phase - Lighting and Daylighting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lighting power at least 20% under Title 24.</td>
<td>energy*</td>
<td>$15,000</td>
<td></td>
</tr>
<tr>
<td>Motion sensor lighting control</td>
<td>energy*</td>
<td>$2,000</td>
<td></td>
</tr>
<tr>
<td>Daylighting in apparatus bay</td>
<td>energy*</td>
<td>$800 $15,000</td>
<td></td>
</tr>
<tr>
<td>View access from 90% of high occupancy areas</td>
<td>1</td>
<td>$15,000</td>
<td></td>
</tr>
<tr>
<td>Full Cutoff Luminaries on Exterior lighting fixtures</td>
<td>1</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td><strong>Design Phase - Building Envelope</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Photovoltaic system</td>
<td>2 $2,500 $0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cool roof</td>
<td>1</td>
<td>$5,000</td>
<td></td>
</tr>
<tr>
<td>White exterior wall surface</td>
<td>energy*</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Operable windows</td>
<td>1</td>
<td>$7,500</td>
<td></td>
</tr>
<tr>
<td>Certified wood</td>
<td>1</td>
<td>$1,600</td>
<td></td>
</tr>
<tr>
<td>Local materials</td>
<td>2</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Recycled Content</td>
<td>1 $800 $9,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Design Phase – Mechanical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High efficiency split system with HFC refrigerant</td>
<td>1</td>
<td>$15,000</td>
<td></td>
</tr>
<tr>
<td>Improved air distribution performance</td>
<td>1 $800 $2,350</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal Comfort</td>
<td>1</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>High efficiency shower, toilet, and lavatory fixtures</td>
<td>1</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Spot radiant heating in apparatus bay</td>
<td>energy*</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Commissioning plan</td>
<td>1 $4,000 $15,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase Green Power</td>
<td>1</td>
<td>$5,000****</td>
<td></td>
</tr>
<tr>
<td>Negative pressure in chemical use and storage areas</td>
<td>0.50</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td><strong>Design Phase - Interior Design</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adhesives and sealants</td>
<td>1</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Paint</td>
<td>1</td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td>Carpet systems</td>
<td>1 $400 $1,430</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entry way systems to capture dirt and particulates</td>
<td>0.5 $1,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salvaged materials</td>
<td>1 $400 $0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Construction Phase</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction waste management plan</td>
<td>-- $400 $0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storm water management during construction</td>
<td>-- $400 $0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction indoor air quality plan</td>
<td>1 $400 $2,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>31 $31,300 $123,080 $15,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These energy measures contribute to the two points received for energy efficiency

** Additional design costs are based on an average rate of $100 per hour. Where no design cost is listed, the measure is not expected to increase the design effort compared to the baseline.

*** Commissioning costs are total for the whole building and not broken down by measure.

**** Annual increase in cost is $2,500/year. A two year contract to purchase green power is required to gain this LEED point.
Demolition Phase Green Building Measures

These demolition phase measures apply when an existing building is to be demolished on the proposed site. The primary goals are to reduce waste from being landfilled and reduce demand for natural resources.

One LEED point is awarded if at least 50% of demolition and construction waste (by weight) is recycled or salvaged. If 75% is achieved, then 2 points are awarded. For a typical project, the 50% level can be achieved through recycling of concrete and asphalt. To achieve the 75% level and earn an extra point, reuse or recycling of wood, metal, and gypsum board is required. These measures are selected as being the most effective for a typical site. However, other measures could be more beneficial and/or cost effective depending on specific site conditions and location.

For the LEED credit to apply, the same fraction of Construction Phase waste must also be salvaged or recycled.

For sites without any existing construction (green field sites), similar measures would apply. In these empty sites, recycling or reuse of at least 50% or 75% of any debris or plant waste is required to earn the LEED points.

Recycle concrete and asphalt demolition waste

Description
Crush concrete and asphalt waste for use as fill on site, for recycling into aggregate, or for similar uses. This measure assumes that concrete and asphalt will account for at least 50% by weight of demolition waste.

Baseline Condition
The City requires the submittal of a Solid Resources Management Plan. This plan consists of documenting the following.

1) Before beginning a project, the contractor must estimate the different types and quantities of waste that will be produced.

2) During the project, incremental progress reports must indicate the actual amount of waste materials produced and fate of those materials.

Demolition/construction recycling is encouraged, but not required by the City.

LEED Impact
One LEED point is available for this measure, as long as at least 50% (by weight) of construction phase waste is also reused or recycled.

Costs
There is typically no net cost for this measure. Additional costs for processing are offset by avoided landfill and transportation costs. Actual costs will vary depending on location, the condition of the material, and quantity of material.

Benefits
Reduced landfill waste helps the City meet overall waste reduction goals.

Gravel mining impact is reduced.

Important Issues
May add extra time to the demolition and construction schedule.
Temporary space may be required on the site for waste processing.
Project specifications must include a demolition waste management plan that lists the contractor responsibilities.
Documenting the weight of all debris leaving the site is necessary for LEED credit. This also fulfills city requirements.

1 Source: Carol Parker, Construction and Demolition Waste Coordinator, Los Angeles Bureau of Sanitation, 213 473 8162.

2 1989 Waste Management Act to reduce landfill disposal by 75% by 2020.
Examples

Staples Center. Most of the concrete and asphalt from the demolished Convention Center building was processed on site and used for grading and backfill. The owner reported “considerable” cost savings.³

References

Construction and Demolition Building Industry Recycling Toolkit.

Separate and recycle all wood, metal and gypsum board demolition waste

Description

In order to increase the amount of demolition waste reuse or recycling from 50% to 75% by weight, this additional separation of building materials is most likely necessary. This measure requires the separation of wood, metal, and gypsum board from other demolition debris.

Baseline Condition

The City requires the submittal of a Solid Resources Management Plan. This plan consists of documenting the following.

3) Before beginning a project, the contractor must estimate the different types and quantities of waste that will be produced.

4) During the project, incremental progress reports must indicate the actual amount of waste materials produced and fate of those materials.

Demolition/construction recycling is encouraged, but not required by the City.

LEED Impact

One point is awarded as long as this measure increases the recycling or reuse of demolition waste from 50% to 75% (by weight). To earn this point, construction phase waste reuse or recycling must also increase to 75%.

Costs

Depending on the characteristics, this measure adds a varying amount of cost to baseline project. The additional cost for deconstruction and separation of building materials ranges from $0.00 to $1.00 per square foot of existing building area.⁴ Total cost might be roughly $15,000.

Benefits

Reduced landfill waste helps the City meet overall waste reduction goals.⁵
Gravel mining impact is reduced.
Provides relatively low skill jobs.

Important Issues

Deconstruction is required for high levels of waste recycling. Deconstruction is labor intensive and can add time to the construction schedule.

Need area on construction site for material separation.

May require special contractor expertise.

Documenting the weight of all debris leaving the site is necessary for LEED credit. This documentation also fulfills city requirements for a Solid Resources Management Plan.

For the LEED point to apply, a Construction Phase waste management plan must also be developed in addition to the Demolition Phase plan.

Examples

EPA Region 10 Building Renovation, Seattle WA. This building reused, recycled, or salvaged over 95% of the material that were generated. The cost for demolition on this site was approximately $0.64/ft² more than standard demolition and waste


⁴ EPA Region 10 Renovation in Seattle reused or recycled 95% of waste at a cost of $0.64 per square foot.

⁵ 1989 Waste Management Act to reduce landfill disposal by 75% by 2020.
disposal practices. Overall project costs, however, were about average after accounting for saved landfill fees ($80/ton in Seattle) and avoided costs to purchase new materials where old materials were reused.

Table 2 – Materials salvaged, recycled, and landfilled at the EPA Region 10 Building

<table>
<thead>
<tr>
<th>Materials Salvaged</th>
<th>Materials Recycled</th>
<th>Materials Landfilled</th>
</tr>
</thead>
<tbody>
<tr>
<td>wood doors (60%)</td>
<td>Drywall (100%)</td>
<td>Rubber base cove</td>
</tr>
<tr>
<td>wood door frames (40%)</td>
<td>Metal framing (100%)</td>
<td>Vinyl floor tile</td>
</tr>
<tr>
<td>finish hardware (100%)</td>
<td>Carpet (100%)</td>
<td></td>
</tr>
<tr>
<td>Toilets (100%)</td>
<td>Acoustic ceiling tile (100%)</td>
<td></td>
</tr>
<tr>
<td>Sink and faucets (50%)</td>
<td>Glass (100%)</td>
<td></td>
</tr>
</tbody>
</table>

References
Construction and Demolition Building Industry Recycling Toolkit.

Design Phase – Site Planning

Appropriate site selection

Description: The chosen site must not be any one of the following:

- Prime agricultural land
- Lower in elevation than 5 feet above the FEMA 100 year flood level
- Habitat for threatened or endangered species
- Within 100 feet of wetlands
- Prior parkland

Baseline Condition: Depends on the site.

LEED Impact: One LEED point if the site meets these requirements.

Costs: Should be zero cost unless the desired site does not comply and a more expensive site is necessary.


Highly reflective concrete paving

Description: Use light-colored concrete for driveways and parking areas to reduce absorption of solar heat. This measure assumes that at least 30% of the non-building and non-landscaping area on the site is concrete.

Shade trees or open grid parking systems are alternatives. An open grid parking system typically consists of concrete pavers with spaces for soil and plant growth (such as grass). This measure could be appropriate for employee parking areas, but it not likely to withstand heavy equipment traffic in the driveways.

Baseline Condition: Concrete is standard for fire stations to provide durability necessary for heavy equipment traffic.

LEED Impact: One point.

Costs: This measure is standard in typical fire stations and adds no cost.
Benefits
Higher surface reflectance reduces surface temperature on sunny days. Therefore, ambient air temperature is usually lower as well, and cooling energy consumption drops.

Storm water dry well
Description
Increase on-site infiltration by installing a drywell system, or equivalent, to collect storm water and distribute it into the local groundwater. If site conditions do not allow on-site infiltration, install a catch basin, or equivalent, capable of removing total suspended solids (TSS) and total phosphorous (TP). These techniques adhere to storm water requirements outlined in Los Angeles’s Standard Urban Storm Water Mitigation Plan (SUSWMP).

Baseline Condition
The majority of the site is covered with concrete. This allows for little on-site infiltration. There is a clarifier used to remove oil and grease from wash water runoff produced during truck washing, but no other water quality treatment is provided.

LEED Impact
Two points are possible.

The first point is given for a 25% decrease in the net imperviousness of previously developed site. If the site has not been developed before, the same first point is given for not increasing the net imperviousness of the site.

The second point is for filtering storm water. The point requires an 80% removal of total suspended solids (TSS) and 40% removal of total phosphorous (TP) from storm water before entering the storm drain system.

Costs
Drywell systems cost about $5-10,000. Catch basin system cost about $3-10,000. Some extra cost for maintenance may also be necessary.

Benefits
Improved watershed quality and reduced storm water treatment efforts required by municipalities. On-site infiltration also recharges local aquifers.

Important Issues
Incremental costs may be minimal if the developer is already planning to adhere to SUSWMP. Public buildings are encouraged, but not required, to adhere to SUSWMP.

The city requires wash water from vehicle washing to drain into a clarifier, which is connected to the sewer, rather than drain into the storm drain. Only wash water should enter a clarifier, and the city requires site design to prevent storm water from entering a clarifier.

References
City of Los Angeles, Bureau of Sanitation, Storm Water Program

Drip irrigation with local drought resistant landscaping
Description
Use a drip irrigation system for all landscaping. This measure assumes that the drip irrigation system will reduce water consumption by 50% compared to standard methods.

Baseline Condition
Standard irrigation.

---


8 Source: Peter Tonthat, Bureau of Sanitation, Los Angeles Storm Water Management Program 213 847 4843.

9 Source: Peter Tonthat, Bureau of Sanitation, Los Angeles Storm Water Management Program 213 847 4843.
**LEED Impact**

One point.

**Costs**

Installed cost should be comparable to a standard irrigation system. Water costs will be lower.

**Benefits**

Decreased water consumption cost.
Some plants prefer drip irrigation.

**Important Issues**

Some types of landscaping, such as lawns, are not compatible with drip irrigation.
The system should be carefully designed to ensure durability and prevent the system from being replaced by a standard irrigation system.

**References**

City of Santa Monica Green Building Design and Construction Guidelines.

---

**Bike rack**

**Description**

Provide secure and sheltered storage for at least one but preferably two bicycles.

**Baseline Condition**

No specific bicycle storage space.

**LEED Impact**

One point. The LEED point also requires that changing and shower facilities be installed, which is always true of fire stations.

**Costs**

The cost for two bike racks in a secure area should not exceed $1000. Actual costs could vary.

---

**Design Phase – Lighting and Daylighting**

The combined lighting and daylighting measures listed below provide 20% to 25% electricity savings compared to the California baseline lighting requirements (Title 24). The savings from these measures is just under 20% when considering the total regulated energy cost. These lighting and daylighting measures, along with the mechanical measures discussed in the following section, contribute an overall building energy reduction. LEED points are awarded for overall building energy reductions.

**Lighting power at least 20% under Title 24.**

**Description**

Use high efficiency lighting fixtures and efficient lighting design to reduce installed lighting power by at least 20% compared to Title 24 –2001. Table 3 lists estimated lighting power allowance for typical fire station spaces alongside design target for an efficient system. The overall allowance is 1.08 W/ft², and the design target is 0.82 W/ft², a savings of 24%. This target applies to actual installed lighting power, before taking any credits for automatic lighting controls.
<table>
<thead>
<tr>
<th>Fire Station Space Type</th>
<th>Title 24 Area Category</th>
<th>Fraction of total building area</th>
<th>Title 24 – 2001 Limit (W/sf)</th>
<th>Target Lighting Power Density (W/sf)</th>
<th>Savings (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dormitory</td>
<td>none (assume category D with 3.5 &lt; RCR &lt; 7.0)</td>
<td>16.0%</td>
<td>1.2</td>
<td>1.0</td>
<td>19%</td>
</tr>
<tr>
<td>Apparatus Bay</td>
<td>General commercial and industrial work - High bay</td>
<td>25.0%</td>
<td>1.2</td>
<td>0.8</td>
<td>33%</td>
</tr>
<tr>
<td>Dining area</td>
<td>Dining</td>
<td>2.5%</td>
<td>1.1</td>
<td>0.8</td>
<td>27%</td>
</tr>
<tr>
<td>Kitchen area</td>
<td>Kitchen, food preparation</td>
<td>2.5%</td>
<td>1.7</td>
<td>1.2</td>
<td>29%</td>
</tr>
<tr>
<td>Exercise rooms, handball courts</td>
<td>Exercise center, gymnasium</td>
<td>7.0%</td>
<td>1.0</td>
<td>1.0</td>
<td>0%</td>
</tr>
<tr>
<td>Offices and conference rooms</td>
<td>Office</td>
<td>14.0%</td>
<td>1.3</td>
<td>0.9</td>
<td>31%</td>
</tr>
<tr>
<td>Recreation rooms</td>
<td>Lounge/recreation</td>
<td>6.0%</td>
<td>1.1</td>
<td>0.9</td>
<td>18%</td>
</tr>
<tr>
<td>Electrical and Mechanical rooms</td>
<td>Electrical, mechanical rooms</td>
<td>2.4%</td>
<td>0.7</td>
<td>0.6</td>
<td>14%</td>
</tr>
<tr>
<td>Shops</td>
<td>Precision commercial or industrial work</td>
<td>4.0%</td>
<td>1.5</td>
<td>1.0</td>
<td>33%</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>Corridors, restrooms, stairs and support areas</td>
<td>8.2%</td>
<td>0.6</td>
<td>0.6</td>
<td>0%</td>
</tr>
<tr>
<td>Corridors, restrooms, stairs and support areas</td>
<td>Corridors, restrooms, stairs and support areas</td>
<td>7.4%</td>
<td>0.6</td>
<td>0.5</td>
<td>17%</td>
</tr>
<tr>
<td>Storage rooms</td>
<td>Commercial and industrial storage</td>
<td>4.5%</td>
<td>0.6</td>
<td>0.5</td>
<td>17%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100%</td>
<td>1.08</td>
<td>0.82</td>
<td>24%</td>
</tr>
</tbody>
</table>

The following measures are expected to be effective in meeting the design lighting power targets.

- For apparatus bays, linear parabolic reflectors with high output T-5 lamps mounted in rows between engines. The aim is to effectively illuminate the sides of the vehicles and the work areas in between. A continuous, single lamp fixture is likely to provide adequate illumination due to the brightness of the T-5 high output lamps. In general, fluorescent lamps are preferred over HID lamps for the apparatus bay because they can be turned on instantly.

- Compact fluorescent task lighting wall mounted at head of bed in dormitories.
Minimum Title 24 compliance: 1.08 W/ft².

One to two points.

LEED points are awarded based on total building energy performance. Lighting power typically accounts for about 50% or more of “regulated energy components”¹⁰. Therefore, a lighting power reduction of 20% is roughly equal to 10% overall electricity savings and about 8% of total energy cost (consider gas cost as well). These 8% savings equal 1 to 2 LEED points depending on the savings from other efficiency measures.

In some spaces costs will drop compared to the base case due to use of fewer luminaires. However, some efficient fixtures cost more than standard efficiency fixtures.

¹⁰ Energy end uses covered by Title 24 include lighting, heating, cooling, ventilation and water heating.
units. The total cost of improving lighting system efficiency is estimated to be roughly $15,000 or about $1/ft².

**Benefits**
Reduced operating cost.

**Important Issues**
Lighting efficiencies on their own do not provide enough savings to earn LEED rating points. Mechanical measures will also be necessary to further reduce building energy consumption. At least a 20% reduction in regulated building energy consumption is required to earn LEED points.

### Motion sensor lighting control

**Description**
Install motion sensor control for lights in the following spaces:
- Offices
- Conference rooms
- Kitchen
- Storage rooms
- Exercise rooms

These occupancy controls should be the manual-on/auto-off type for best savings and occupant satisfaction.

These spaces account for about 40% of total floor area and lighting power. Expected savings for occupancy control ranges from 20% to 40%. The overall lighting savings is estimated to be approximately 8%.

**Baseline Condition**
Manual lighting control and bi-level lighting control as required by Title 24.

**LEED Impact**
Lighting energy savings of 8% translates into total energy cost savings of about 3% which equals ½ to 1 LEED point.

**Costs**
A typical fire station requires about 14 sensors at an average cost of $140 each for a total cost of $2000. Sensors and power packs for large rooms cost about $200. For smaller rooms $125 is a typical cost.

**Benefits**
Energy savings are about 2,000 kWh per year, equal to about $200.

**Important Issues**
Occupancy sensors are most applicable in spaces without adequate daylighting and automatic photo sensor controls.

Occupancy sensors require commissioning in order to work properly.

**References**
Advanced Lighting Guidelines.

### Daylighting in apparatus bay

**Description**
Provide daylighting for the apparatus bay with skylights, north-facing clerestory glazing and/or south-facing clerestory glazing shaded by an overhang. A combination of these strategies may also work well.

A typical design would require about 12 skylights, 2’ x 6’ each for a 3,200 ft² bay. Skylight area would be about 5% of the floor area, providing adequate illumination for most daylight hours.

This measure also requires automatic on/off lighting photo sensor control. Automatic dimming controls are also an option, but the extra cost is not necessarily warranted in a space like the apparatus bay that is occupied intermittently. Dimming ballasts for fluorescent lamps cost an extra $40 to $60 each. Dimming controls are more appropriate for spaces like an office where the occupants would be significantly distracted by lights turning on and off.
Green Building Measures Report – Fire Station

No daylighting in apparatus bay and no automatic photocell control.

One to two points, based on savings of 10% of regulated energy consumption (see Benefits below).

12 skylights add roughly $12,000 to the construction cost. Automatic lighting controls add roughly $1.00 per square foot of controlled area, or about $3000 extra.\(^\text{11}\) Total daylighting project cost is about $15,000.

Lighting energy savings are roughly 4,500 kWh/year, equal to about 50% of the apparatus bay baseline consumption. Demand savings during the summer peak period is about 3 kW. Annual energy cost savings are roughly $450. These energy savings equal roughly 20% of the total lighting energy. Since lighting is about 50% of the regulated electric energy and 40% of regulated energy cost, the total energy savings impact is about 8%.

Must carefully design the layout of skylights or clerestories to provide light where it’s needed. In addition, the design must account for the location of bay doors (when open), vehicle exhaust removal systems and overhead electrical distribution (for diesel engine heaters) to make sure they do not obstruct daylight.

Clerestories are a good choice if they are facing directly north and/or directly south (with shading in the south-facing case), but skylights are a better choice if the apparatus bay cannot be oriented along the east/west axis due to site constraints.

Light colored wall and ceiling surfaces are important for good daylighting performance.

The apparatus bay is an ideal daylighting candidate because it is a single story space with high ceiling.

Automatic lighting controls require some commissioning to ensure they work properly.

Other candidates for daylighting with skylights include handball courts and bathrooms.

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Eley Associates, April 9, 2001
Skylights for illumination of high-bay work areas are common throughout Southern California.

References
Energy Design Resources Skylighting Handbook and Skycalc software.
http://www.energydesignresources.com

**View access to windows from 90% of high occupancy areas**

**Description**
Views of the outdoors must be provided from nearly all of the high occupancy areas. These spaces include:
- Dormitories
- Offices
- Conference rooms
- Kitchen/dining areas
- Training rooms
- Exercise rooms

Each room does not necessarily need its own window to outdoors as long as something like a transparent interior partition allows view access.

**Baseline Condition**
In a typical fire station, windows allow views from most high occupancy rooms except, perhaps conference rooms and some offices.

**LEED Impact**
One point.

**Costs**
There may be some additional cost to designing a floor plan that allows views from each room, but a typical cost is difficult to estimate. In some cases, glass partitions may satisfy the requirement. The range of costs is likely to be between zero and $15,000 depending on site conditions.

**Benefits**
Potential benefits to view access include greater employee productivity and lower absenteeism.

Potential lighting savings due to increased daylight penetration.

**Important Issues**
On small sites that require construction up to the lot line, it may be difficult to meet these requirements.

**Exterior lighting fixtures**

**Description**
Ensure that exterior lighting fixtures allow no direct beam radiation to the sky in order to reduce light pollution. In addition, design the exterior lighting system so that illumination levels do not exceed IESNA recommendations. Maximum recommended illumination for high traffic commercial areas is usually 1.5 foot-candles or less.

**Baseline Condition**
Some unshielded exterior fixtures are used.

**LEED Impact**
One point. This point also assumes that no direct beam radiation from indoor lighting fixtures reaches the sky.

**Costs**
There should be no additional construction cost. Some extra design cost for exterior illumination calculations may be necessary.

**Benefits**
Improved views of the night sky.

**Important Issues**
Consider security in the design of exterior lighting systems.

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12 Illuminating Engineering Society of North America
Use efficient light sources such as metal halide, high pressure sodium or low pressure sodium.

**References**


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**Design Phase – Architectural**

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**Photovoltaic system**

Approximately 2,000 ft$^2$\(^{13}\), equal to about 13 kW, costing roughly $80,000. Provides about 25,000 kWh/yr, equal to about 15%. Fire station 3 historically uses 210,000 kWh/yr. We have assumed 150,000 kWh/yr as a baseline for a Title 24 compliance building.

**Description**

A photovoltaic system converts sunlight into electricity. For a typical fire station, a 13 kW photovoltaic array will provide roughly 15% of the annual electricity consumption and will require 2,000 ft$^2$ of collector area. The approximate annual energy production would be 25,000 kWh per year.

The system should be connected to the electricity grid via an inverter rather than connected to battery storage.

**Baseline Condition**

No photovoltaic system

**LEED Impact**

Two LEED points are earned if 10% of the facilities annual energy consumption is provided by renewable energy sources.

**Costs**

The installed cost of this system would be roughly $80,000. However, the cost of the system will be covered by the LADWP.

**Benefits**

Reduced electricity cost. Reduced load on the electricity transmission system. Additional electricity supply to offset consumption during peak period.

**Important Issues**

A photovoltaic system might not be cost effective without incentives.

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**Cool roof**

**Description**

The term “cool roof” refers to the surface properties. A cool roof has a light color; to qualify as a cool roof under California’s Title 24 energy efficiency standard, it must have an initial reflectance of 70% or greater. A cool roof must also have a high emittance. The emittance is the ability of the surface to release heat to the sky through radiation. To qualify under Title 24, a cool roof must have an emittance of 75% or greater. Materials which are likely to have a low emittance (and not qualify) are shiny metallic finishes, such as galvanized metal or aluminized coatings.

There are several ways to achieve the light color and high emittance. One of the best methods is to use a single ply roofing membrane. The following are examples of single ply materials that would qualify as a cool roof.

- White EPDM (Ethylene-Propylene-Diene-terpolymer Membrane)
- White PVC (polyvinyl chloride)
- White CPE (chlorinated polyethylene)
- White CPSE (chlorosulfonated polyethylene, e.g. Hypalon)
- White TPO (thermoplastic polyolefin)

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\(^{13}\) LADWP requires approximately 2,000ft$^2$
The best single ply membrane from an environmental perspective is difficult to determine. However, some environmental groups discourage the use of PVC products and feel that synthetic rubber, such as EPDM, is preferable. Polyethylene and polyolefin are also considered preferable.

Another way to achieve the light color and high emmissivity necessary to qualify as a cool roof is to apply a coating to the surface of a non-qualifying roof membrane, such as modified bitumen. There are a number of products, including elastomeric coatings and white acrylic coatings. See Figure 5 for an example of a cool roof surface.

The U.S. EPA’s Energy Star program list of cool roof products is available on the Internet. However, the list includes some products with low emmissivity, which do not qualify as cool roofs in California. Any product without a metallic surface (e.g. galvanized steel and aluminum fiber coatings) should be acceptable.

Figure 5 – Cool Roof
This cool roof consists of an acrylic coating applied over a mineral cap sheet

<table>
<thead>
<tr>
<th>Baseline Condition</th>
<th>LEED Impact</th>
<th>Costs</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>The typical fire station has a conventional roof surface such as a built up roof with gravel ballast or a mineral cap sheet. The built-up roof is common because it is usually the lowest cost choice and can be installed with lower skilled labor than, for instance, single ply membranes. Codes do not require a cool roof.</td>
<td>LEED offers credits for cool roofs in two places. In the area of Energy and Atmosphere, cool roofs reduce energy use and help to optimize energy performance (Energy Credit 1). In addition, there is a credit under Sustainable Sites for reducing heat island effects.</td>
<td>Extra cost for a cool roof ranges from none to as much as $1 per square foot of roof area. Typical cost is around $0.50 per square foot, equal to roughly $5,000.</td>
<td>Cool roofs reduce cooling energy by reflecting solar radiation. They also keep the roof membrane at a lower temperature, which increases its useful life.</td>
</tr>
</tbody>
</table>

White exterior wall surface

Description
In the same way that cool roofs provide benefits, a white wall surface on east, south and west orientations reflects solar heat gain, reducing cooling energy and improving comfort. Exterior walls throughout a fire station are typically uninsulated.
Concrete masonry, which absorb solar heat during the day and radiate heat indoors during the afternoon and evening. A white external surface reflects the majority of solar radiation. Painting the wall is a less costly alternative to insulation.

Shading the wall is another alternative to using white paint to prevent solar heat gain. An overhang is effective on the south side, and trees, adjacent buildings or vertical fins can provide shade on the east and west orientations. A properly sized south overhang can provide winter heating while preventing summer heat gain.

If neither shading nor a light-colored surface is possible, then insulation of at least R-5.6 is recommended. The insulation will also reduce solar heat gain and will be most effective on the exterior side as in an exterior insulation finishing system (EIFS). However, the insulation also reduces beneficial heat loss at night during the cooling season. For this reason, a white uninsulated masonry wall may perform better in terms of cooling, while an insulated wall provides better heating performance.

Framed walls should be insulated to completely fill the framing cavity, e.g. R-13 in a 2x4 wall and R-19 in a 2x6 wall.

<table>
<thead>
<tr>
<th>Baseline Condition</th>
<th>Brown colored, unpainted concrete masonry walls.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEED Impact</td>
<td>The benefit of wall color is captured in the credit for optimizing energy performance.</td>
</tr>
<tr>
<td>Costs</td>
<td>Less expensive, uncolored masonry can be used, but painting will add some cost.</td>
</tr>
<tr>
<td>Benefits</td>
<td>Lower cooling energy. Smaller cooling equipment required.</td>
</tr>
<tr>
<td>Important Issues</td>
<td>Painted walls may require more maintenance.</td>
</tr>
</tbody>
</table>

**Operable windows**

**Description**

Provide operable windows for all normally occupied areas such as dormitories, offices and kitchen. Make sure that there is at least one operable opening for each 200 ft² of perimeter floor area and that the vent area in each room is at least 5% of the floor area. In addition, ensure that no point in these rooms is more than 20 feet from an operable opening.

**Baseline Condition**

Some operable windows but not enough to comply with LEED or to meet the Title 24 ventilation credit.

**LEED Impact**

LEED offers one indoor environment point for a minimum of one opening for each 200 ft² of perimeter area.

**Costs**

Operable windows are more expensive than fixed windows, adding roughly $5 per square foot of window area. Total extra cost will range from $5,000 to $10,000. However, any operable windows considered to be in the base case design would offset some of this cost.

**Benefits**

Spaces that meet Title 24’s minimum opening area requirement need not have mechanical outdoor air ventilation. Therefore, the ventilation system can be designed for intermittent operation, saving fan energy and conditioning energy. An economizer is not necessary for air conditioning systems serving naturally ventilated areas (because it would provide little additional benefit), and system cost will be somewhat lower.

Recent research shows that occupant comfort range expands in spaces with access to operable windows, and ASHRAE Standard 55, the thermal comfort standard, is in the process of being revised to expand the comfort envelope for such spaces. Therefore fewer system run hours are likely to be necessary. The comfort range varies based on average monthly outdoor temperature. For example, in December and January, when the average in Los Angeles is about 55°F, the comfort zone...
ranges from 68°F to 75°F. In August and September, when the monthly average is 70°F, the indoor comfort range is 73°F to 80°F.

**Figure 6 Adaptive Comfort Model for Spaces with Access to Natural Ventilation**

Source: A Field Based Thermal Comfort Standard for Naturally Ventilated Buildings, Gail Schiller Brager, Ph.D. and Richard de Dear, Ph.D.

<table>
<thead>
<tr>
<th>Important Issues</th>
<th>Consider security, rain intrusion, noise and dust issues in design of operable openings.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples</td>
<td>New office buildings are more commonly using operable windows to improve the occupant environment.</td>
</tr>
<tr>
<td><strong>Certified wood</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Choose wood products that are provided by companies that practice environmentally responsible forest management. Candidate materials for fire stations include framing (structural and partitions), flooring, cabinetry, finishes, furnishings, and non-rented temporary construction applications such as bracing, concrete formwork and pedestrian barriers. Most fire stations have a handball court which commonly has a wood flooring constructed of salvaged materials.</td>
</tr>
<tr>
<td><strong>Baseline Condition</strong></td>
<td>It is common practice for contractors to secure the lowest price for all products, with no consideration of the impact the extraction of these materials will have on the environment.</td>
</tr>
<tr>
<td><strong>LEED Impact</strong></td>
<td>The LEED rating system offers one credit when companies that practice environmentally responsible forest management provide a minimum of 50% of wood-based products or materials. To qualify, wood products must be certified by the Forest Stewardship Council (FSC)</td>
</tr>
<tr>
<td><strong>Costs</strong></td>
<td>Certified wood typically has a 7-15% cost premium. Douglas Fir, commonly used in roof and wall framing, carries a 15% premium. In a typical fire station project, the cost is around $1,600.</td>
</tr>
</tbody>
</table>
| **Benefits**     | The intent of using certified wood products is to protect our forestry resources and to ensure that they continually yield product, while protecting biodiversity of plant and animal life in forests, open space, and other natural resources. The benefit is
global or national in scale, since no commercial forests exist in the Los Angeles area.

**Important Issues**
- Requested certified wood may have a longer delivery time (up to 2-weeks).

**Examples**
- VeriFone Building, Costa Mesa, CA (Croxton Collaborative)
- The Ross School, Ross, CA (EHDD Architects)
- Gap Building, San Bruno, CA (McDonough + Partners)
- Ecotimber and Hayward Lumber, both large suppliers in California, provide certified wood to the Southern California area.

**References**
- Contact: Nady Maechling, Los Angeles Citywide Recycling Division (213) 473-8235

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### Local materials

**Description**
Use concrete masonry that is manufactured regionally and concrete source materials that are extracted regionally. Specifying other local materials, such as metals, wood, and finishes is also desirable.

**Baseline Condition**
The close proximity of Los Angeles to manufacturing activities indicates a significant portion of building materials came from regional locations.

**LEED Impact**
- One point is given for specifying that 20% of the building materials be manufactured within 500 miles of the site location. A second point is awarded if 50% of the regionally manufactured materials are extracted, harvested, or recovered within 500 miles of the site location. Both points should be attainable in Los Angeles.

**Costs**
No additional cost. Concrete is commonly sourced and manufactured within 500 miles of Los Angeles.

**Benefits**
- Reduces the economic cost and environmental impact of transportation. Supports local economies.

---

### Recycled content

**Description**
Use building materials with recycled content that are available in Southern California. This includes:
- Steel products
- Fly-ash concrete
- Concrete aggregate base
- Gypsum board
- Acoustical tile
- Insulation
- Ceramic tile
- Carpet

**Baseline Condition**
Information on the recycled content of materials used was not available.

**LEED Impact**
- One point is given for specifying that 25% of the building materials contain, on average, 20% post-consumer recycled material or 40% post-industrial recycled material.
Except for ceramic tile, all products listed above are competitively priced. Ceramic tile with recycled content may cost up to $6/ft² more than typical floor tile. Carpet may also have a slight premium (10% increase).

Using materials with recycled content diverts waste materials from filling landfill space and reduces the extraction of finite resources.

City ordinances\textsuperscript{14} give automatic preference to recycled content products as long as they meet the City's product standards and do not exceed the cost of the standard product by more than 10%.

Monterey Waste Management Authority, Monterey, CA. Recycled content products include insulation, floor tiles, carpet, and aggregate base.

Office of the Future, Los Angeles, CA. Recycled content products include steel studs, drywall, and acoustical tile.

Donald Bren School of Environmental Science & Management, Santa Barbara, CA. Recycled content products include fly-ash concrete, insulation, carpet, and ceramic tiles.

Los Angeles Bureau of Sanitation, Solid Resources Citywide Recycling Division.


**Design Phase – Mechanical**

Energy costs for cooling, heating, ventilation, and water heating accounts for roughly 50% of the regulated end uses.\textsuperscript{15} There are many options to exceed the minimum efficiency requirement of Title 24. The list of measures described here reduce energy costs by 5% to 10%. The combination of mechanical energy efficiency measures and lighting/daylighting energy efficiency measures reduce total energy consumption by more than 20%. A 20% savings in overall energy use is necessary for LEED credit. Not all these mechanical measures are chosen for the sake of energy savings. Several of the measures help improve indoor air quality and occupant comfort, both important factors in a LEED rating.

**High efficiency split system with HFC refrigerant**

For spaces that require heating and cooling use high efficiency split system gas/electric units with multi-stage fan, compressor, and furnace. These systems consist of an outdoor compressor and condenser connected by refrigerant lines to an indoor furnace and fan coil unit. These systems are typically available in higher efficiencies than packaged rooftop units and are also available with multiple stage heating and cooling.

Specify units with HFC refrigerants to reduce ozone-depletion impact.\textsuperscript{16}

Specify a two-stage thermostat to control the staging of heating and cooling.

Also choose units with a thermostatic expansion valve to ensure high efficiency if the refrigerant charge is lower than optimal.

---

\textsuperscript{14} Recycled Product Procurement Ordinance #168313, Purchasing Price Preference for Recycled Materials Ordinance #170485.

\textsuperscript{15} Energy end uses covered by Title 24 include lighting, heating, cooling, ventilation and water heating.

\textsuperscript{16} Carrier Corporation's “Puron” (140A) is an example of HFC refrigerant.
A typical fire station uses a packaged rooftop unit due to lowest initial cost. One point for HFC refrigerant. Contributes to energy efficiency points.

A split system installation adds about $2 per square foot of conditioned floor area compared to roof top packaged units, increasing the HVAC cost to roughly $13 per square foot.
Specifying an HFC refrigerant adds about 25% to the equipment cost, equal to an additional $0.30 per square foot. The total incremental cost is roughly $15,000, assuming about 7,000 ft² of conditioned area.

**Benefits**

**Important Issues**
- Place the outdoor units in a shaded location for best efficiency.
- If using horizontal units in an attic space, specify a cool roof surface and/or radiant barrier to reduce attic temperature.
- Outdoor air economizers should be specified for systems serving spaces without natural ventilation.
- HFC refrigerants may be less efficient than CFC or HCFC alternatives, but the air conditioning units can be manufactured for increased efficiency to compensate.

### Improved air distribution performance

**Description**
This measure includes two important components:
- Choose and locate supply air diffusers to ensure high ventilation effectiveness. One approach is to design the system to provide an air diffusion performance index (ADPI) of 80 or greater.
- Locate ducts in conditioned space or insulate, seal and test ducts for leakage.

**Baseline Condition**
Minimum cost diffusers are typically installed. Ducts are not tested and have 10% to 30% leakage.

**LEED Impact**
Designing for an air exchange effectiveness rate of at least 0.9 earns one LEED point.

Duct sealing and testing provides significant heating and cooling savings and contributes to the LEED energy credit.

**Costs**
Higher performance diffusers may add some cost, roughly $5 each. Total extra cost is only about $250. A few hours of extra design time may be required.

Duct testing and improved sealing adds about $300 per system, for a total cost of about $2,100.

The total cost for the combined measures is $2,350.

**Benefits**
A higher ADPI usually provides greater comfort due to more even space temperatures and fewer drafts. In addition, better mixing of ventilation air may provide better indoor air quality.

Lower duct leakage reduces energy costs. In addition, it increases system capacity and allows installation of smaller equipment.

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17 Source: Ronald Eng, Representative, Carrier Corporation, (650) 873-1660
18 ADPI describes the consistency of air temperature and air velocity within a zone.
19 Air Change Effectiveness describes the ability of an air distribution system to effectively deliver air to all areas within a zone. An Air Change Effectiveness of 1.0 refers to complete distribution.
21 Displacement air distribution is an alternative approach that can provide good ventilation effectiveness without mixing but is not applicable for most spaces in a fire station because occupancy is intermittent. This type of system works well in an office where occupants are often stationary.
Duct sealing is especially important if ducts are located in an uninsulated attic.

**High efficiency shower, toilet and lavatory fixtures**

**Description** Specify high efficiency fixtures rated for flow at least 20% below U.S. EPA requirements.

**Baseline Condition** Industry-standard low-flow fixtures required by city ordinance\(^22\).

<table>
<thead>
<tr>
<th>Fixtures</th>
<th>LA Flow Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilets</td>
<td>1.6 gal/flush</td>
</tr>
<tr>
<td>Urinals</td>
<td>1.5 gal/flush</td>
</tr>
<tr>
<td>Sink Faucets and Showerheads</td>
<td>2.5 gal/min</td>
</tr>
</tbody>
</table>

**LEED Impact** One LEED point for fixtures 20% better than EPA requirements. Two points for fixtures that are 30% better. The first point (20% better) is a more plausible target.

<table>
<thead>
<tr>
<th>Fixture</th>
<th>EPA requirements</th>
<th>20% reduction</th>
<th>30% reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilets</td>
<td>1.6 gal/flush</td>
<td>1.3 gal/flush</td>
<td>1.1 gal/flush</td>
</tr>
<tr>
<td>Urinals</td>
<td>1.0 gal/flush</td>
<td>0.8 gal/flush</td>
<td>0.7 gal/flush</td>
</tr>
<tr>
<td>Showerheads</td>
<td>2.5 gal/min</td>
<td>2.0 gal/min</td>
<td>1.8 gal/min</td>
</tr>
<tr>
<td>Faucets</td>
<td>2.5 gal/min</td>
<td>2.0 gal/min</td>
<td>1.8 gal/min</td>
</tr>
<tr>
<td>Replacement</td>
<td>2.5 gal/min</td>
<td>2.0 gal/min</td>
<td>1.8 gal/min</td>
</tr>
<tr>
<td>Aerators</td>
<td>2.5 gal/min</td>
<td>2.0 gal/min</td>
<td>1.8 gal/min</td>
</tr>
<tr>
<td>Metering Faucets</td>
<td>0.25 gal/cy</td>
<td>0.20 gal/cy</td>
<td>0.18 gal/cy</td>
</tr>
</tbody>
</table>

**Costs** Small incremental cost.

**Benefits** Lower water heating cost.

Lower water consumption.

**Important Issues** It is critical to carefully select low-flow shower heads for good performance in order to prevent their removal and replacement.

**Spot radiant heating in apparatus bay**

**Description** Install gas-fired radiant heaters for spot heating in critical portions of the apparatus bay. Radiant heaters are much more efficient that forced-air unit heaters in conditions like the apparatus bay with large doors are often open. The radiant heater heats surfaces within the space rather than the air. Therefore, less heat is lost when the doors are open. In addition, the radiant heaters can selective serve portions of the bay rather than heating the whole space.

To minimize losses, interlock heater operation with doors to shut off the heater when any of the doors are open. If there are areas within the bay where constant heating is critical, then specific heaters can be independently controlled. Timer control is another option, allowing fire fighters to turn on the heater for a specific amount of time before it shuts off automatically.

**Baseline Condition** Gas-fired unit heaters suspended from the apparatus bay ceiling. Heaters sometimes run even when doors are open.

**LEED Impact** Credit for the radiant heaters is included in the energy efficiency points.

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\(^{22}\) Los Angeles City Council Ordinance #172075

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Eley Associates, April 9, 2001
Radiant heaters are somewhat more expensive than unit heaters, but fewer might be installed to cover only a portion of the bay.

Lower energy consumption.
Improved comfort.

Commissioning plan

Description: Commissioning is the process of ensuring that systems work properly and as efficiently as intended. The process begins at the earliest project planning phases and continues through the occupancy period. The primary activities are design review, submittal review, construction inspection, functional testing and training. Additional functions may include design coordination and suggestions on system choices.

Baseline Condition: Designers review submittals and make visual inspections of construction to develop “punch lists”. Typically no formal testing occurs.

LEED Impact: Basic commissioning is a prerequisite for a LEED rating. “Best practices” commissioning earns one point.

Costs: A commissioning process typically adds $0.25 to $1.00 per square foot to the project cost. For a fire station, commissioning may cost up to $15,000. Common commissioning practices developed to cover all fire station projects will help to minimize cost. If separate commissioning agents are assigned to each project, and if separate commissioning plans are developed for each fire station, then the cost will be higher, probably about $25,000.

Benefits: Lower energy consumption.
Better occupant comfort.
Potentially better indoor air quality.

Important Issues:
Integrated Design Issues
Construction schedule impact
Design effort impact

References:
ASHRAE Guideline 1 – HVAC System Commissioning.

Purchase Green Power

Description: Specify that 50% of the electricity purchased from LADWP comes from renewable sources. Specifying a percentage of green power is currently an available option through LADWP’s program, Green Power for a Green LA.

Baseline Condition: No green energy is currently specified. Non-green energy is produced from finite sources that are environmentally harmful.

LEED Impact: One point is awarded for engaging in a two year contract to purchase power generated from renewable sources that meet the Center for Resource Solutions Green-E products certification requirements. The green Power offered by LADWP exceeds Green-E certification requirements.

Costs: LADWP green power carries an additional $0.03/kWh premium\(^{23}\). Specifying 50% green power will increase total electricity costs by $0.015/kWh. Annual electricity costs will increase by approximately $2,500 for a building that uses 150,000 kWh/yr.

\(^{23}\) Source: Don Cresse, LADWP, Green Power for a Green LA, 213-367-4390
(the baseline assumed for Title 24 compliance). This value may be lower due to energy efficiency measures and photovoltaics reducing reliance on grid energy.

**Benefits**
Promotes renewable energy markets. Reduces reliance on finite energy sources that emit pollutants and gases responsible for acid rain, smog, and global warming.

**References**
LADWP, Green Power for a Green LA, www.greenla.com

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**Thermal Comfort**
Design for a temperature range of 68-74F during the winter and 73-79F during the summer. Ensure a mean air speed of 30fpm and a 50% relative humidity.

| **Baseline Condition** | An air conditioned building in California that complies with Title 24 code will qualify for this LEED point. |
| **Costs** | No additional cost. Should be included in a base design. |

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**Paint**
Specify low-VOC paints

| **Baseline Condition** | Standard General Services paints were used |

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*Eley Associates, April 9, 2001*
One point is given for using paints that meet or exceed the VOC and chemical component limits of Green Seal requirement.

The costs of low VOC paints are becoming more competitive as demand and production increase. Low VOC paints currently have about a 10% cost premium\(^{24}\), equal to about $200.

Improved indoor air quality

Low VOC paints are widely available.

Donald Bren School of Environmental Science and Management

Green Seal, [www.greenseal.org](http://www.greenseal.org), 202-872-6400

**Carpet systems**

*Description* Specify durable commercial carpet made with recycled nylon. Choose low VOC emitting carpets, carpet cushions and carpet adhesives.

*Baseline Condition* Standard General Services issued carpet was used.

*LEED Impact* One point for using carpet systems that meet or exceed the Carpet and Rug Institute Green Label Indoor Air Quality Test Program. The recycled content of the carpet contributes to the recycled materials point.

*Costs* Green Label carpet is becoming the industry standard and is priced competitively\(^ {25}\). Recycled content carpet has a 10% premium. Recycled carpet usually costs between $2 -3/ ft\(^2\)\(^ {26}\), but can vary greatly depending on other carpet characteristics.

*Benefits* Improved indoor air quality

*Durable commercial carpet containing recycled nylon may only be produced by a few manufacturers.*

*Examples* Donald Bren School of Environmental Science and Management.

*References* The Carpet and Rug Institute (CRI), [http://www.carpet-rug.com](http://www.carpet-rug.com) 1-800-882-8846

**Entry way systems to capture dirt and particulates**

*Description* Install permanent walk-off mats at exterior doors and at entry ways between the apparatus bay and the rest of the building.

*Baseline Condition* No permanent walk-off mats or similar technology were observed.

*LEED Impact* One point when combined with an indoor air quality measure for negative pressure in chemical rooms and storage areas.

*Costs* Approximately $1,000

*Benefits* Walk-off mats help prevent contaminants from entering the living and administration areas of the fire station. This helps to improve indoor air quality.

*Examples* Hayden Island Fire Station 17, Portland, OR.

**Incorporating Salvaged materials**

*Description* Salvage and refurbish materials from old fire stations that are scheduled to be demolished. This includes handball court wood flooring, doors, and any architecturally decorative items.

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\(^{24}\) Contact: Danny Castro, Representative, Kelly Moore Paints, (650) 595-1654

\(^{25}\) Contact: Traci Donaldson, Representative, Mohawk Commercial Carpeting, 1-800-554-6637 ext 62557

\(^{26}\) California High Performance Schools, Best Practices Manual , 2001
In the past, handball court wood flooring and architecturally decorative items have been salvaged from old LA fire stations and reused in new LA fire stations. One point is given for using salvaged or refurbished materials for 5% of the total building materials. The material cost saved from salvaging materials of high economic worth will offset the involved labor costs. The actual costs will be highly variable. Traditionally, fire fighters contribute their own time to install salvaged hardwood floors in the handball courts.

Reusing old materials diverts waste materials from filling landfill space and reduces the extraction of finite resources.

Salvageable materials from the demolition of other building types should also be considered for use in the new fire stations.

EPA Region 10 Building, Seattle, WA. Materials salvaged from the existing building and reused include wood doors, wood door frames, insulation, sinks and faucets, signage, and a card reader system.

The California Material Exchange Website, www.ciwmb.ca.gov/calmax
Los Angeles Bureau of Sanitation, Solid Resources Citywide Recycling Division.

EPA region 10 building, Seattle WA. See more details earlier in the Demolition Phase waste management measures.

Aspen Ski Company building, Aspen CO

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**Construction Phase**

**Construction waste management plan**

**Description:** Design a waste management plan to separate (and quantify by weight) salvageable or recyclable material during the demolition and construction phase of a project.

**Baseline Condition:** There was no record of a construction waste management plan for the observed Los Angeles fire stations.

**LEED points:** The following points must be earned in combination with demolition phase waste management discussed earlier in this report. For this report, two points are counted.

- Recycle/salvage 50% of demo/construction site waste (1 point)
- Recycle/salvage 75% of demo/construction site waste (2 points)

**Costs:** Removal/recycling fees. These fees will depend on each material’s market value.

- Labor time for training and materials sorting.

**Benefits:** Reduced hauling and tipping fees because less material is trucked to landfills. These fees will vary between different site locations.

- Reduce landfill space required for the project debris.

- Redirect recyclable material back to the manufacturing process.

**Important Issues:** Site space will be needed to separate and store different materials. Documenting the weight of all debris leaving the site is necessary for LEED credit.

**Examples:** EPA region 10 building, Seattle WA. See more details earlier in the Demolition Phase waste management measures.

Aspen Ski Company building, Aspen CO
Storm water management during construction

**Description**
Mitigate on-site soil erosion and reduce storm water pollution created during construction.

**Baseline Condition**
The local Storm Water Pollution Prevention Plan\(^27\) (SWPPP) requirements imposed by the city cover this prerequisite.

**LEED Impact**
The prerequisite requires designing an erosion control plan that conforms to the EPA’s Storm Water Management for Construction Activities.

**Costs**
Since Los Angeles requirements cover this prerequisite, no additional cost is needed to adhere to LEED.

**Benefits**
Prevents soil erosion from the construction site and reduces the amount of sedimentation entering the storm drain system.

References
State Water Resources Board

Construction indoor air quality plan

**Description**
Develop a management plan to ensure air pollutants produced during construction are removed before the building is occupied.

**Baseline Condition**
There was no record of IAQ management plans for the observed Los Angeles fire stations.

**LEED Impact**
Two points are possible:

- The first point refers to the following: Schedule the installation of wet and odor-emitting materials, such as paints and sealants, before installing absorptive materials, such as acoustic tiles and carpet. Protect absorptive materials that are stored on-site. Replace air filters before building occupancy.

- The other point refers to conducting a two week flush out period prior to building occupancy.

**Costs**
There is some extra construction cost for the replacement of filters and some extra management costs to develop the IAQ plan and to ensure proper scheduling may be necessary. These costs might be roughly $2,000. The flush out period delays the building opening.

**Benefits**
Improved occupant health and comfort.

**Important Issues**
To prevent scheduling conflicts, incorporate an IAQ management plan into city’s internal construction administration procedures and make all project partners aware of the IAQ procedures.

References

Other Potential Measures – Not Required for Minimum LEED Certification

Each of the green building measures listed in this section may be applicable to specific fire station projects but are unlikely to be applicable in general. These measures provide the opportunity for higher LEED scores.

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Wall insulation

Wall insulation for concrete masonry walls can increase energy savings, but is not necessarily cost effective in the southern California climate.

Exterior or interior insulation for a concrete wall costs several dollars per square foot of wall area.

An alternative discussed above as one of the architectural design measures is a white wall or shading. If shading is not possible, then insulation is recommended.

ASHRAE Standard 90.1-1999 recommendations for Los Angeles are R-5.6 insulation for concrete walls in high-rise dwelling and no insulation in non-residential buildings.

For metal or wood framed walls insulation is required by Title 24 and is definitely a cost effective measure. The installed cost is about $0.40 per square foot of R-13 insulation in a 2x4 framed wall and about $0.75 for R-19 insulation in a 2x6 wall. 28

High efficiency water heater

High efficiency condensing water heaters are available with efficiencies between 90% and 95%, compared to standard water heaters with 80% efficiencies. While these condensing water heaters are more expensive and require a drain for condensation from exhaust gas, their flues may be cheaper due to the lower temperature exhaust air. Therefore, the overall cost may not be significantly higher in new construction. The installed cost for a 40 gallon water heater increases from about $450 for a standard unit to about $700 for a high efficiency unit.

Cabinet, furnishings, composite wood products with no added urea-formaldehyde

Description Specify Medite II, or equivalent, for all composite wood used inside the building. Medite II is a Medium Density Fiberboard29 (MDF).

Baseline Condition Standard composite wood bound with adhesives containing urea-formaldehyde.

LEED Impact One point for using composite wood and agrifiber products that contain no added urea-formaldehyde resins.

Costs Medite II costs approximately 50%30 more than typical MDF, and is approximately twice as much as lighter particle board31. Typical MDF cost approximately $20/sheet. Light particle board cost approximately $13/sheet. Specifying Medite should add approximately $2,000 to the cost of the project.

Benefits Improved indoor air quality.

Important Issues Distributors carry Medite II throughout California, but generally in smaller volumes than typical MDF. Specifying composite wood with no added urea-formaldehyde early in the project should prevent any availability problems.

MDF is considerably more expensive than light particle board, but is considered a higher quality, more durable, product.

Examples Thoreau Center for Sustainability.

References Natural Fiber Boards, LLC, (510) 471-4900

29 Medium Density Fiberboard refers to composite wood that weighs 49lbs/sheet.
30 Natural Fiber Boards, LLC, (510) 471-4900
31 Light particle board refers to composite wood that weighs 45lbs/sheet
**Solar water heating**

Solar thermal collectors used for water heating reduce energy consumption significantly and might be economically feasible in some cases. About 285ft² of thermal collectors would be needed to supply all of the building’s hot water needs during peak summer periods. Though cost will vary with the system type, a 285ft² system would cost approximately $15,000[^32], installed. The Architectural Division may be able to establish an MOU with LADWP to have these cost covered by the LADWP solar program.

**Kitchen makeup air exhaust hood**

Fire stations have commercial range hoods with relatively high airflow. If all of that air must be heated or cooled, there is a large energy penalty. Therefore, the range hood design should provide at least 50% of exhaust airflow as makeup air that is not mechanically heated or cooled.

Range hoods with an integral makeup air system are about twice as expensive as conventional range hoods[^33]. This extra cost, approximately $20,000, may be prohibitive. Ducting the exhaust system in the kitchen to strategically emit air that is not mechanically heated or cooled is another way to provide makeup air to the exhaust hood.

**Optimal roof insulation/radiant barrier**

The roof is an important component of the building envelope of fire stations and there are many opportunities for energy savings. The Title 24 building energy efficiency standards require a minimum U-factor of 0.078, which can be achieved with R-11 insulation. Additional insulation may be cost effective. To upgrade from R-11 to R-19, the material cost increases from $0.16 to $0.25 per square foot. To buy R-30 insulation, the cost increases to $0.39 per square foot.

**High performance windows**

**Description**

Use high performance windows, especially in the living areas of fire stations, to reduce heat loss during heating conditions and heat gain during cooling conditions. Windows should also be placed on the north or south orientations so that solar gain can be effectively controlled with fixed overhangs. It is very difficult to shade glazing located on east and west facades with fixed shading devices.

**Baseline Condition**

For new construction, the baseline condition is defined by the 2001 Title 24 energy efficiency standards. The recently adopted code requires that new fire stations have high performance windows. Fire stations are considered nonresidential buildings under Title 24.

The fenestration U-factor must be less than 0.81 for windows. The U-factor requirement for skylights depends on the type of construction: 1.18 for glass skylights mounted on a curb, 0.68 for glass skylights without a curb, and 1.30 for plastic skylights, which are assumed to be mounted on a curb. Double glazing will be required to meet these U-factor requirements.

The SHGC requirements depend on the area of glazing in the building and the orientation. The maximum SHGC for north facing windows is 0.61. The maximum SHGC for non-north orientations is 0.61 if the window-wall ratio is less than 10% and 0.55 if the WWR is less than 20%. For larger window areas on non-north

[^32]: Source: [www.NREL.gov](http://www.NREL.gov)

[^33]: Source: Berlin Food Equipment, (650) 589-4231
orientations, the maximum SHGC is 0.41. The 0.61 SHGC can be achieved with standard tinted glass, the 0.55 SHGC with a high performance tinted glass such as the Azurlite or Evergreen products. The 0.41 SHGC will require a special coating applied to either clear or tinted glass. There are many products available in the market place that can be used to satisfy these criteria.

**LEED Impact**

The benefit of high performance windows can be captured in the credit for optimizing energy performance (Energy Credit 1). Two additional credits are available in the Indoor Environmental Quality section of LEED for providing daylighting and views. The daylighting credit requires that a minimum daylight factor of 2% be provided in 75% of space where critical tasks are performed. The views credit requires that 90% of regularly occupied spaces have line-of-sight to a window.

**Costs**

The analysis performed to support the nonresidential energy efficiency standards shows that high performance windows are cost effective in all California climates, even the mild southern California climates considered in this study. Because relatively high performance windows are already required, there is no extra cost to the project.

**Benefits**

High performance windows have many benefits. First and foremost, they save energy, and with prices rapidly increasing in California, this is an important consideration. Secondly, they have a positive impact on the design of HVAC systems. At a minimum, smaller units can be purchased, but when multi-zone systems are used, it may be possible to eliminate reheat at perimeter zones, which can result in a very significant cost reduction. Finally, high performance windows improve comfort, since they provide more uniform surface temperatures in conditioned spaces, avoiding the cold areas typically associated with single glazed windows.

**Important Issues**

The U-factor for fenestration products should include the entire unit in its context. For windows, heat loss should include losses through the glass as well as the frame. For skylights, heat loss includes the glazing, the frame and even the curb that the skylight is mounted on. The National Fenestration Rating Council (NFRC) has developed procedures for determining both fenestration U-factor and SHGC and these procedures should be used whenever possible.

**References**

Information on the performance of specific fenestration products is available from manufacturers catalogs or websites. Most providers of manufactured fenestration products provide performance data including SHGC, U-factor and visible light transmittance.

Many manufactured window products are available with performance rating labels from the National Fenestration Rating Council (NFRC), and future rating standards should address site-built windows as well.

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**Utilize site with urban redevelopment potential**

Not likely to be applicable to fire stations which are low-rise buildings with exterior space required. Cannot meet a minimum density of 60,000 ft² per acre.

**Non-potable water for irrigation**

Would provide one more point for water conservation. Likely to be feasible only if a waste water treatment facility is nearby.

**Brownfield development**

Brownfield development might be possible for specific stations, but is unlikely to be applicable in general.
**Reduce footprint, limit site disturbance**

This LEED point does not seem applicable to urban areas where most of these stations will be located.

**Locate close to public transportation**

Difficult to require for all projects, but is still recommended. Site must lie within ½ mile of rail or ¼ mile of 2 bus lines.

**Daylighting**

The LEED point requires a minimum amount of daylighting in all perimeter spaces, but this is not likely to be desirable in spaces such as dormitories where fire fighters may sleep during the day.

**Bamboo floor, wheat board, possibly engineered lumber from fast growing poplar or Monterey pine**

Credit is available for the use of rapidly renewable materials. Other Potential Measures That Do Not Earn LEED Credit

There are a number of energy efficiency opportunities at fire stations that do not fall within the “regulated” energy end uses of lighting, cooling, heating and water heating. Therefore, they do not earn LEED points but may still have a large impact on actual energy cost. In addition, several environmentally beneficial design measures do not receive specific LEED credit.

**Minimize use of materials**

Consider eliminating floor coverings, wall coverings, ceilings and other interior finishes wherever possible to minimize the amount of material used in the building. Instead, allow roof decks to be exposed, place air distribution ducts within conditioned space and leave concrete floors uncovered.

**Efficient washing machines**

Horizontal axis washing machines use less hot water and soap.

**Energy star appliances**

Computers, printers, copiers.

**Efficient refrigerators**

Chose most efficient model available.
Figure 9 Fire Station Kitchen. Shows refrigerators and commercial range hood.

**Insulated coffee maker**

Reduces standby loss from coffee pot.

**Eliminate vending machines**

Use refrigerators instead of refrigerated vending machines

**Diesel engine heater control**

Appears to be a significant energy end use, but a more efficient alternative may not be available.

**Efficient ice maker**

Each station has one or more ice makers.