Codes and Standards Enhancement (CASE) Initiative

2019 California Building Energy Efficiency Standards

Dock Seals – Final Report

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Nonresidential Envelope

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Authors:	John Arent P.E., Katie Gustafson P.E., Silas Taylor, and Kyra Weinkle (NORESCO)
Project Management:	California Utilities Statewide Codes and Standards Team: Pacific Gas and Electric Company, Southern California Edison, SoCalGas®, San Diego Gas & Electric Company, Los Angeles Department of Water and Power, and Sacramento Municipal Utility District

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EXECUTIVE SUMMARY

Introduction

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support California Energy Commission's (Energy Commission) efforts to update California's Building Energy Efficiency Standards (Title 24, Part 6 or Standards) to include new requirements or to upgrade existing requirements for various technologies. The four California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company, San Diego Gas and Electric, Southern California Edison, and SoCalGas® and two Publicly Owned Utilities (POUs) – Los Angeles Department of Water and Power and Sacramento Municipal Utility District – sponsored this effort. The program goal is to prepare and submit proposals that will result in cost-effective enhancements to improve energy efficiency and energy performance in California buildings. This report and the code change proposal presented herein is a part of the effort to develop technical and cost-effectiveness information for proposed requirements on building energy efficient design practices and technologies.

The Statewide CASE Team submits code change proposals to the Energy Commission, the state agency that has authority to adopt revisions to Title 24, Part 6. The Energy Commission will evaluate proposals submitted by the Statewide CASE Team and other stakeholders. The Energy Commission may revise or reject proposals. See the Energy Commission's 2019 Title 24 website for information about the rulemaking schedule and how to participate in the process: http://www.energy.ca.gov/title24/2019standards/.

Measure Description

The proposed measure adds a mandatory requirement for loading docks to be equipped with dock seals or shelters. Dock seals and shelters are designed to eliminate the gap between a truck trailer and the interior of a loading bay. Dock seals typically consist of foam with vinyl covering that is installed on the exterior perimeter, excluding the bottom of a dock door. When a truck trailer backs into the dock seal, the foam is compressed and a gasket is created that protects the loading bay, truck, and goods from the elements. Dock shelters are flexible curtains that surround the exterior perimeter, excluding the bottom of a dock door. When a truck backs into the shelter, the curtains are pushed into contact with the truck creating a seal. Dock shelters can accommodate a wider range of truck trailers than dock seals.

The proposed dock seal and shelter measure will primarily impact newly constructed warehouse facilities, though other newly constructed commercial buildings with loading docks and bays will also be impacted. The measure applies to exterior dock doors that are adjacent to spaces that are either heated and or cooled. Doors that enclose unconditioned spaces will not be impacted by the proposed change.

This measure is not recommended for additions and alterations, because dock doors currently do not have other requirements within the California Building Code, and would trigger a new requirement to apply for a building permit where one does not currently exist. This would create a significant compliance barrier and cost impact that could impact cost-effectiveness.

The proposed measure limits infiltration and subsequent energy loss in warehouse buildings, big box retail, and other commercial buildings that have loading dock doors. Air leakage through doors when trucks are at the loading dock can have significant energy impacts. ASHRAE 90.1-2016 has requirements for weather seals in the colder climate zones (ASHRAE Climate Zones 4 through 8). Although the energy use intensity (EUI) of warehouse buildings is lower than the EUI of other buildings, forecasted construction estimates indicate a significant statewide savings potential. This

measure could also move warehouses closer to an energy use target that allows for the design of zero net energy buildings.

Scope of Code Change Proposal

Table 1 summarizes the scope of the proposed changes and which sections of the Standards, Reference Appendices, Compliance Manuals, and compliance documents that will be modified as a result of the proposed change.

Table 1: Scope of Code Change Proposal

Measure Name	Type of Requirement	Modified Section(s) of Title 24, Part 6	Modified Title 24, Part 6 Appendices	Will Compliance Software Be Modified	Modified Compliance Document(s)
Dock Shelter or Seals	Mandatory	100.1, 110.7, and 120.6(a)6	JA 1	No	No documents will be modified or added

Market Analysis and Regulatory Impact Assessment

Dock seal and dock shelter products are readily available and used in the market today. In refrigerated warehouses, their use is common practice. In non-refrigerated warehouses, their use is less frequent, though still significant in the California market. In addition to energy savings, the attributes that attract facility owners include: increased ability for loading and unloading as the process is protected from the elements, a barrier against pest entry, and privacy while loading and unloading cargo.

Dock shelters are a common application for facilities that must accept trucks of varying heights. The shelters are typically reinforced fiberglass curtain panels that can withstand repeated impacts. Dock seals are typically vinyl covered foam that provides a good seal for trucks of a common size. Both types of products do not typically list air leakage performance data. The approach taken here is to evaluate a reasonably “worst case” scenario in terms of product cost and energy performance.

Cost-Effectiveness

The proposed code change was evaluated for cost-effectiveness in climate zones across California. This analysis includes the benefit-to-cost (B/C) ratio that compares the lifecycle benefits (cost savings) to the lifecycle costs. Measures that have a B/C ratio of 1.0 or greater are cost-effective. The larger the B/C ratio, the faster the measure pays for itself from energy savings. See Section 5 for a detailed description of the cost-effectiveness analysis.

Statewide Energy Impacts

Table 2 summarizes estimated energy savings over the first 12 months of implementation of the proposed code change. See Section 6 for more details.

Table 2: Estimated Statewide First-Year[a] Energy and Water Savings

Construction Type	First-Year Electricity Savings (GWh/yr)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Water Savings (million gallons/yr)	First-Year Natural Gas Savings (million therms/yr)
New Construction	0.076	-0.004	N/A	0.019
Additions and Alterations	N/A	N/A	N/A	N/A
Total	**0.076**	**-0.004**	**N/A**	**0.019**

a. First-year savings from all buildings completed statewide in 2020.

Compliance and Enforcement

The proposed changes will have some impact on the complexity of the standards or the cost of enforcement. When developing this code change proposal, the Statewide CASE Team interviewed building officials, Title 24 energy analysts, and others involved in the code compliance process to simplify and streamline the compliance and enforcement of this proposal.

The Statewide CASE Team continues to work with stakeholders to develop a recommended a compliance and enforcement process, and to identify the impacts this process will have on various market actors. The compliance process is described in Section 2.5. The impacts the proposed measure will have on various market actors is described in Section 3.3 and Appendix B. The key issues related to compliance and enforcement are summarized below:

- Building envelope designers would spend time researching, specifying, and drawing details of dock seal or dock shelter products.
- Although the time spent would be brief, building officials (plans examiner and building inspector) would spend some time verifying the presence of dock seal or dock shelter products in construction documents and onsite. It is understood that the additional time of verifying any new measure can be a burden, and if the measure is initially not able to be verified, a second review of the plans or re-inspection of the site could impact workflow for all parties and thus project schedule. For this and other prohibitively high cost reasons, testing is not recommended, nor is requiring the measure on additions or alterations.
- Owners of applicable buildings would be required to purchase and install dock seals or dock shelters, including paying for labor for installation. It is not recommended to require this measure on additions or alterations because dock doors do not currently have other requirements within the California Building Code. This could result in the addition or alteration of a dock door triggering application for a building permit where one is not currently triggered, adding significant cost impact compared to the cost savings of the measure.

Although a needs analysis has been conducted with the affected market actors while developing the code change proposal, the proposed code requirements may change between the time the final CASE Report is submitted and the time the 2019 Standards are adopted. The recommended compliance process and compliance documentation may also evolve with the code language. To effectively implement the adopted code requirements, a plan should be developed that identifies potential barriers to compliance when rolling-out the code change and approaches that should be deployed to minimize the barriers.

1. INTRODUCTION

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support California Energy Commission's (Energy Commission) efforts to update California's Building Energy Efficiency Standards (Title 24, Part 6 or Standards) to include new requirements or to upgrade existing requirements for various technologies. The four California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company, San Diego Gas and Electric, Southern California Edison, and SoCalGas® and two Publicly Owned Utilities (POUs) – Los Angeles Department of Water and Power and Sacramento Municipal Utility District – sponsored this effort. The program goal is to prepare and submit proposals that will result in cost-effective enhancements to energy efficiency in buildings. This report and the code change proposal presented herein is a part of the effort to develop technical and cost-effectiveness information for proposed requirements on building energy efficient design practices and technologies.

The Statewide CASE Team submits code change proposals to the Energy Commission, the state agency that has authority to adopt revisions to Title 24, Part 6. The Energy Commission will evaluate proposals submitted by the Statewide CASE Team and other stakeholders. The Energy Commission may revise or reject proposals. See the Energy Commission's 2019 Title 24 website for information about the rulemaking schedule and how to participate in the process: http://www.energy.ca.gov/title24/2019standards/.

The overall goal of this CASE Report is to propose a code change proposal for dock seals and shelters. The report contains pertinent information supporting the code change.

When developing the code change proposal and associated technical information presented in this report, the Statewide CASE Team worked with a number of industry stakeholders including building officials, manufacturers, builders, utility incentive program managers, Title 24 energy analysts, and others involved in the code compliance process. This final proposal incorporates feedback received during public stakeholder workshops that the Statewide CASE Team held on March 21, 2017, from an Energy Commission pre-rulemaking workshop held on June 6, 2017, and from written comments submitted to the Energy Commission in June 2017.

Section 2 of this CASE Report provides a description of the measure and its background. This section also presents a detailed description of how this change is accomplished in the various sections and documents that make up the Title 24, Part 6 Standards.

Section 3 presents the market analysis, including a review of the current market structure. Section 3.3 describes the feasibility issues associated with the code change, including whether the proposed measure overlaps or conflicts with other portions of the building standards such as fire, seismic, and other safety standards and whether technical, compliance, or enforceability challenges exist.

Section 4 presents the per-unit energy, demand, and energy cost savings associated with the proposed code change. This section also describes the methodology that the Statewide CASE Team used to estimate energy, demand, and energy cost savings.

Section 5 presents the lifecycle cost and cost-effectiveness analysis. This includes a discussion of additional materials and labor required to implement the measure and a quantification of the incremental cost. It also includes estimates of incremental maintenance costs. That is, equipment lifetime and various periodic costs associated with replacement and maintenance during the period of analysis.

Section 6 presents the statewide energy savings and environmental impacts of the proposed code change for the first year after the 2019 Standards take effect. This includes the amount of energy that will be

saved by California building owners and tenants, and impacts (increases or reductions) on material with emphasis placed on any materials that are considered toxic. Statewide water consumption impacts are also considered.

Section 7 concludes the report with specific recommendations with ~~strikeout~~ (deletions) and underlined (additions) language for the Standards, Reference Appendices, Alternative Calculation Manual (ACM) Reference Manual, Compliance Manual, and compliance documents.

2. MEASURE DESCRIPTION

2.1 Measure Overview

The proposed measure adds a new mandatory requirement for newly constructed buildings in Climate Zones 1 and 16, that loading docks adjacent to conditioned and indirectly conditioned spaces be equipped with dock seals or shelters. The change affects newly constructed non-refrigerated warehouse buildings, storage areas of big box retail facilities, and other buildings with loading dock doors. Doors that enclose unconditioned spaces will not be impacted by the proposed change. Refrigerated warehouses are not included in the scope of this measure, as loading dock seals are typically installed for refrigerated warehouses.

It is not recommended to require this measure on additions or alterations because dock doors do not currently have other requirements within the California Building Code. This could result in the addition or alteration of a dock door triggering application for a building permit where one is not currently triggered, adding significant cost impact compared to the cost savings of the measure.

Dock seals and shelters are designed to eliminate the gap between a truck trailer and the interior of a loading bay. Dock seals typically consist of foam with vinyl covering that is installed on the exterior perimeter, excluding the bottom, of a dock door. When a truck trailer backs into the dock seal, the foam is compressed and a gasket is created that protects the loading bay, truck, and goods from the elements. Dock shelters are flexible curtains that surround the exterior perimeter, excluding the bottom, of a dock door. When a truck backs into the shelter, the curtains are pushed into contact with the truck creating a seal. Dock curtains can accommodate a wider range of truck trailers than dock seals. Figure 1 is a picture of a typical loading dock with a dock seal. The intent of this CASE Proposal is not to specify products or individual features that must be used, but rather to increase the use of dock seal and dock shelter products in general.

The proposed change is a mandatory requirement, and does not modify the modeling algorithms in the performance approach. Dock seals and shelters have not previously been regulated by Title 24, Part 6. This proposed code change modifies the following sections of the existing Title 24, Part 6 requirements: 100.1, 110.7, and 120.6(a)6.

Figure 1: Loading dock with seal.

2.2 Measure History

This measure was proposed to address the energy consumption of non-refrigerated warehouses, applicable big box retail stores, and other commercial buildings containing conditioned spaces adjacent to exterior dock doors. The measure is based upon a recent code change to ASHRAE 90.1-2016, which requires weather seals on loading dock doors in the colder ASHRAE Climate Zones (4 through 8). There are no preemption concerns, as there are not federal requirements that apply. Dock seals and shelters have been used in warehouse and storage facilities nationwide and in California, not only for energy savings, but for pest protection, privacy, and security.

Since this proposal is a mandatory measure, no changes to compliance software rules or algorithms are required.

2.3 Summary of Proposed Changes to Code Documents

The sections below provide a summary of how each Title 24, Part 6 document will be modified by the proposed change. See Section 7 of this report for detailed proposed revisions to code language.

2.3.1 Standards Change Summary

This proposal modifies the sections of the Building Energy Efficiency Standards as shown below. See Section 7.1 of this report for the detailed proposed revisions to the code language.

SECTION 100.1 – DEFINITIONS AND RULES OF CONSTRUCTION

The proposal adds definitions for loading dock door, dock seal, and dock shelter.

SECTION 110.7 – MANDATORY REQUIREMENTS TO LIMIT AIR LEAKGE

The proposal adds a new requirement that loading dock seals be installed when the dock door is adjacent to conditioned or indirectly conditioned space. It also adds a requirement that all joints,

penetrations and other openings in the building envelope that are potential sources of air leakage shall be caulked, gasketed, weather stripped, or otherwise sealed to limit infiltration and exfiltration.

SECTION 120.6 – MANDATORY REQUIREMENTS FOR COVERED PROCESSES

Subsection 120.6(a)6: The proposed code remove Exception 2 to Section 120.6(a)6, which currently excludes dock doorways for trailers from infiltration barrier requirements. It also adds guidance to see Section 110.7(a) for dock door requirements.

2.3.2 Reference Appendices Change Summary

This proposal modifies Joint Appendix 1 Glossary to the Reference Appendices to add definitions for exterior loading dock door, dock seal, and dock shelter. See Section 7.2 of this report for the detailed proposed revisions to the text of the reference appendices.

2.3.3 Alternative Calculation Method (ACM) Reference Manual Change Summary

The proposed code change will not modify the ACM Reference Manual.

2.3.4 Compliance Manual Change Summary

The proposed code change will modify the following sections of the Title 24, Part 6 Compliance Manual:

- 3.2.1.1D Mandatory Requirements – Infiltration and Air Leakage
-
- 3.2.5.1 Mandatory Requirements - Doors

2.3.5 Compliance Documents Change Summary

This measure would be documented by including the dock seal or shelter on the existing nonresidential certificate of compliance (NRCC) document (NRCC-ENV-01-E in Section H, Mandatory Measures).

Although this measure will not require a new compliance documents, it is recommended that the Energy Commission consider creating a certificate of compliance document that contains a standard table of mandatory measures, which provides a way to mark measures that do not apply as "N/A", as well as a space to include sheet and specification numbers for reference, for designers to include on building plans. This would be similar in concept to the 2016 Low-Rise Residential Mandatory Measures Summary compliance document.

2.4 Regulatory Context

2.4.1 Existing Title 24, Part 6 Standards

There are no existing requirements for warehouse or dock doors in Title 24, Part 6. There is an exception to Section 120.6(a)6 that applies to dock doorways for trailers, which would be removed.

2.4.2 Relationship to Other Title 24 Requirements

The measure does not impact mechanical, seismic or fire and life safety codes. Applicable products are already installed in many warehouse facilities.

2.4.3 Relationship to State or Federal Laws

There are no conflicts or interactions with federal law.

2.4.4 Relationship to Industry Standards

This measure is included in the ASHRAE 90.1-2016 Standards. A weather seal is required for warehouse loading dock doors for ASHRAE Climate Zones 4 through 8. This corresponds California building standards Climate Zones 14 and 16, only to the coldest climates in California.

No industry test procedures directly address loading dock seals. Currently, product manufacturers do not report leakage rates.

2.5 Compliance and Enforcement

The Statewide CASE Team collected input during the stakeholder outreach process on what compliance and enforcement issues may be associated with these measures. This section summarizes how the proposed code change will modify the code compliance process. Appendix B presents a detailed description of how the proposed code change could impact various market actors. When developing this proposal, the Statewide CASE Team considered methods to streamline the compliance and enforcement process and how negative impacts on market actors who are involved in the process could be mitigated or reduced.

This code change proposal would primarily affect newly constructed buildings with exterior dock doors that use the prescriptive or performance approach to compliance. The key steps to the compliance process are summarized below.

As this measure is structured, compliance and enforcement is straightforward, as it requires verification of the presence of a dock seal on construction documents and installation in the field. Testing is not recommended as a requirement, because custom frames would have to be built onsite, and tractor trailers would need to be present for the tests. The high cost and difficulty in coordinating the components of the test procedure would result in a measure that is not cost-effective relative to the energy savings. It is not recommended to require this measure on additions or alterations, because dock doors do not currently have other requirements within the California Building Code. This could result in the addition or alteration of a dock door triggering application for a building permit where one is not currently triggered, adding significant cost impact compared to the cost savings of the measure.

- **Design Phase**: The envelope designer would be responsible for:
  - Including dock seal or shelter products in specifications.
  - Including dock seal or shelter details on drawings.
  - Include in mandatory measures note block with sheet and specification number.
  - Based on stakeholder feedback and examination of the compliance document NRCC-ENV-01-E, it is recommended that the Energy Commission consider creating a certificate of compliance document that contains a standard table of mandatory measures, which provides a way to mark measures that do not apply as NA, as well as a space to include sheet and specification numbers for reference, for designers to include on building plans. This document would be similar in concept to the 2016 Low-Rise Residential Mandatory Measures Summary, with some modifications to as described to capture which measures apply and their location on plans and specifications.
  - Coordinating with constructor and owner to ensure costs are included in project estimates.
- **Permit Application Phase**: The plans examiner would verify that dock seals or shelters are included in the mandatory measures note block as well as referenced sheet and specifications.
- **Construction Phase**: No change to the existing permit construction phase is anticipated other than installation of the dock seal or shelter products.

- **Inspection Phase**: The building inspector or a commissioning agent would verify the presence of dock seal or shelter during the inspection phase of a project using the NRCI-ENV-01-E document.

The feasibility of compliance is anticipated to be high. While it is understood that any additional item to verify does add burden to building officials, the verification process has been kept intentionally simple by not recommending testing of any kind. To further improve ease of implementation, it is recommended that example details and specification language be included in the Compliance Manual. Dock seals or shelters are already considered common in the marketplace, which indicates that implementation guidance can be easily developed.

If this code change proposal is adopted, the Statewide CASE Team recommends that information presented in this section (Section 2.5), Section 3 and Appendix B be used to develop a plan that identifies a process to develop compliance documentation and how to minimize barriers to compliance.

3. MARKET ANALYSIS

The Statewide CASE Team performed a market analysis with the goals of identifying current technology availability, current product availability, and market trends. The Statewide CASE Team considered how the proposed standard may impact the market in general and individual market actors. The Statewide CASE Team gathered information about the incremental cost of complying with the proposed measure. Estimates of market size and measure applicability were identified through research and outreach with stakeholders including utility program staff, Energy Commission staff, and a wide range of industry players who were invited to participate in utility-sponsored stakeholder meetings held on December 12, 2016 and March 21, 2017.

3.1 Market Structure

There are at least seven manufacturers in the United States and Canada who manufacture dock seals and dock shelters for use in California facilities. These companies offer a range of products with varying capabilities.

3.2 Technical Feasibility, Market Availability, and Current Practices

The market should be capable to adjusting production to meet with any increase in demand. There are seven manufacturers of loading dock seals and dock shelters that supply the North American market, and several distributors that offer products to the California market. One slight potential concern is that, with no product criteria specified, companies without durable, tested products could enter the market and undercut the established businesses. However, as the products that are already supplied provide a number of non-energy benefits, this should not affect the current market. With an array of manufacturers and suppliers across the United States, including multiple suppliers in California, these products are readily available in the current marketplace.

While there are many products available to the California market, the proposed standard does not differentiate between products from an energy performance standpoint. The reason for this is that dock seal and dock shelter products do not report leakage data, and there is no standardized test specific to dock doors. Also, some dock door configurations may require dock shelters, due to the need to support different truck heights and sizes. This CASE proposal applies the dock shelter costs, which are consistently higher than the dock seal costs, since the proposal cannot mandate one product type over another.

Dock seals are typically a good match for facilities with a fixed dock door height, and the gasket that results from the truck trailer pressure also provides a good compression seal. However, these products are susceptible to damage from repeated contact. Dock shelters are typically more expensive than dock seals, and because the construction consists of reinforced fiberglass panels, they are relatively durable. The main advantage of dock shelters over dock seals is shelters are compatible with a wider range of truck heights. The specification of either dock seals or dock shelters would meet the proposed code requirement.

Some products that are significantly more expensive provide a number of energy and non-energy benefits to facilities. These products are more readily adaptable to varying truck sizes, and provide better durability and resistance against repeated impact.

3.3 Market Impacts and Economic Assessments

3.3.1 Impact on Builders

It is expected that builders will not be impacted significantly by any one proposed code change or the collective effect of all proposed changes to Title 24, Part 6. Builders could be impacted for change in demand for new buildings and by construction costs. Demand for new buildings is driven more by factors such as the overall health of the economy and population growth than the cost of construction. The cost of complying with Title 24, Part 6 requirements represents a very small portion of the total building value. Increasing the building cost by a fraction of a percent is not expected to have a significant impact on demand for new buildings or the builders' profits.

In general, market actors will need to invest in training and education to ensure the workforce, including designers and those working in construction trades, know how to comply with the proposed requirements. Workforce training is not unique to the building industry, and is common in many fields associated with the production of goods and services. Costs associated with workforce training are typically accounted for in long-term financial planning and spread out across the unit price of many units as to avoid price spikes when changes in designs and/or processes are implemented.

3.3.2 Impact on Building Designers and Energy Consultants

Adjusting design practices to comply with changing building codes practices is within the normal practices of building designers. Building codes (including the Title 24, Part 6 and model national building codes published by the International Code Council, the International Association of Plumbing and Mechanical Officials, and ASHRAE 90.1) are typically updated on a three-year cycle. As discussed in Section 3.3.1, all market actors should (and do) plan for training and education that may be required to adjusting design practices to accommodate compliance with new building codes. As a whole, the measures the Statewide CASE Team are proposing for the 2019 Title 24, Part 6 code cycle aim to provide designers and energy consultants with opportunities to comply with code requirements in multiple ways, thereby providing flexibility in how the requirements can be met.

For the proposed code change described in this report, building envelope designers will need to be aware of instances where a loading dock door is adjacent to directly or indirectly to conditioned spaces. The development of a Nonresidential Mandatory Measures Summary compliance document as described in Sections 2.5 and 7.5 of this report would ease building envelope designers' identification of mandatory measures that apply to their project as well as simplify the creation of a Mandatory Measures note block on construction documents.

3.3.3 Impact on Occupational Safety and Health

The proposed code change does not alter any existing federal, state, or local regulations pertaining to safety and health, including rules enforced by the California Division of Occupational Safety and Health. All existing health and safety rules will remain in place. Complying with the proposed code

change is not anticipated to have adverse impacts on the safety or health of occupants, or those involved with the construction, commissioning, and maintenance of the building.

3.3.4 Impact on Building Owners and Occupants

Building owners and occupants will benefit from lower energy bills. For the dock seal measure, employees should benefit from improved thermal comfort, from a reduction of unintended air leakage and infiltration.

With this mandatory measure, building owners could experience increased maintenance costs in order to maintain the dock seals or shelters. The mechanism of a trailer pushing up against dock seal creates a gasket that can protrude into the truck. This can impede forklifts and slow the loading and unloading process. The positive impacts of the proposed measure include increased productivity by protecting the loading and unloading process from elements such as wind, rain, and snow. See Appendix B for detailed information on the impact this compliance process could have on building owners.

3.3.5 Impact on Building Component Retailers (Including Manufacturers and Distributors)

Distributors and retailers will need to adjust inventory in order to meet potential increase in demand.

3.3.6 Impact on Building Inspectors

Building inspectors will need to verify the presence of the loading dock seal or shelter onsite. They would need to be aware of the requirement and document verification on the NRCI-ENV-01-E and NRCC-PFR document, but this is not considered a significant impact to their workload. For buildings with greater than 10,000 square feet of conditioned space, a commissioning agent could also verify the presence of the loading dock seal or shelter as well. For smaller buildings or hotel/motel buildings with loading docks, a design review would verify the specification of a dock seal, and the building department can provide additional verification as needed.

3.3.7 Impact on Statewide Employment

Section 3.4.1 discusses statewide job creation from the energy efficiency sector in general, including updates to Title 24, Part 6.

There should not be a significant impact on statewide job creation. However, it is expected that an increased demand for products could translate to a small number of additional jobs for distributors and suppliers of dock seal products. This will be dependent upon how many climate zones and potential dock doors would be impacted by the proposed code change.

3.4 Economic Impacts

The estimated impacts that the proposed code change would have on California's economy are discussed below.

3.4.1 Creation or Elimination of Jobs

In 2015, California's building energy efficiency industry employed more than 321,000 workers who worked at least part time or a fraction of their time on activities related to building efficiency. Employment in the building energy efficiency industry grew six percent between 2014 and 2015 while the overall statewide employment grew three percent (BW Research Partnership 2016). Lawrence Berkeley National Laboratory's report titled *Energy Efficiency Services Sector: Workforce Size and Expectations for Growth (2010)* provides details on the types of jobs in the energy efficiency sector that are likely to be supported by revisions to building codes (Goldman, et al. 2010).

Building codes that reduce energy consumption provide jobs through *direct employment*, *indirect employment*, and *induced employment*.[1] Title 24, Part 6 creates jobs in all three categories with a significant amount from induced employment, which accounts for the expenditure-induced effects in the general economy due to the economic activity and spending of direct and indirect employees (e.g., non-industry jobs created such as teachers, grocery store clerks, and postal workers). A large portion of the induced jobs from energy efficiency are the jobs created by the energy cost savings due to the energy efficiency measures. For example, as mentioned in Section 3.3.4, the 2016 Standards are expected to save single family homeowners about $240 per year. Money saved from hundreds of thousands of homeowners over the entire life of the building will be reinvested in local businesses. Wei, Patadia, and Kammen (2010) estimate that energy efficiency creates 0.17 to 0.59 net job-years[2] per GWh saved. By comparison, they estimate that the coal and natural gas industries create 0.11 net job-years per GWh produced. Using the mid-point for the energy efficiency range (0.38 net job-years per GWh saved) and estimates that this proposed code change will result in a statewide first-year savings of 0.81 GWh, this measure will result in approximately 0.31 jobs created in the first year. See Section 6.1 for statewide savings estimates.

The proposed code change described in this report could result in a small increase in jobs depending on how many climate zones are affected by the proposed code change. With greater demand for dock shelter and dock seal products, additional staff may be needed to execute product orders, delivery and installation. This measure is not expected to eliminate any jobs because it is not eliminating any existing products.

3.4.2 Creation or Elimination of Businesses in California

There are approximately 43,000 businesses that play a role in California's advanced energy economy (BW Research Partnership 2016). California's clean economy grew ten times more than the total state economy between 2002 and 2012 (20 percent compared to two percent). The energy efficiency industry, which is driven in part by recurrent updates to the building code, is the largest component of the core clean economy (Ettenson and Heavey 2015). Adopting cost-effective code changes for the 2019 Title 24, Part 6 code cycle will help maintain the energy efficiency industry.

Table 3 lists industries that will likely benefit from the proposed code change classified by their North American Industry Classification System (NAICS) Code.

[1] The definitions of direct, indirect, and induced jobs vary widely by study. Wei et al. (2010) describe the definitions and usage of these categories as follows: "*Direct employment* includes those jobs created in the design, manufacturing, delivery, construction/installation, project management and operation and maintenance of the different components of the technology, or power plant, under consideration. *Indirect employment* refers to the ''supplier effect'' of upstream and downstream suppliers. For example, the task of installing wind turbines is a direct job, whereas manufacturing the steel that is used to build the wind turbine is an indirect job. *Induced employment* accounts for the expenditure-induced effects in the general economy due to the economic activity and spending of direct and indirect employees, e.g., non-industry jobs created such as teachers, grocery store clerks, and postal workers."

[2] One job-year (or ''full-time equivalent'' FTE job) is full time employment for one person for a duration of one year.

Table 3: Industries Receiving Energy Efficiency Related Investment, by North American Industry Classification System (NAICS) Code

Industry	NAICS Code
Residential Building Construction	2361
Nonresidential Building Construction	2362
Roofing Contractors	238160
Electrical Contractors	23821
Plumbing, Heating, and Air-Conditioning Contractors	23822
Boiler and Pipe Insulation Installation	23829
Insulation Contractors	23831
Window and Door Installation	23835
Asphalt Paving, Roofing, and Saturated Materials	32412
Manufacturing	32412
Other Nonmetallic Mineral Product Manufacturing	3279
Industrial Machinery Manufacturing	3332
Ventilation, Heating, Air-Conditioning, & Commercial Refrigeration Equip. Manf.	3334
Computer and Peripheral Equipment Manufacturing	3341
Communications Equipment Manufacturing	3342
Electric Lighting Equipment Manufacturing	3351
Household Appliance Manufacturing	3352
Other Major Household Appliance Manufacturing	335228
Used Household and Office Goods Moving	484210
Engineering Services	541330
Building Inspection Services	541350
Environmental Consulting Services	541620
Other Scientific and Technical Consulting Services	541690
Advertising and Related Services	5418
Corporate, Subsidiary, and Regional Managing Offices	551114
Office Administrative Services	5611
Commercial & Industrial Machinery & Equip. (exc. Auto. & Electronic) Repair & Maint.	811310

The proposed code change described in this report could results in more distributors or manufacturers depending on how many climate zones are affected by the proposed code change.

3.4.3 Competitive Advantages or Disadvantages for Businesses in California

In 2014, California's electricity statewide costs were 1.7 percent of the state's gross domestic product (GPD) while electricity costs in the rest of the United States were 2.4 percent of GDP (Thornberg, Chong and Fowler 2016). As a result of spending a smaller portion of overall GDP on electricity relative to other states, Californians and California businesses save billions of dollars in energy costs per year relative to businesses located elsewhere. Money saved on energy costs can be otherwise invested, which provides California businesses with an advantage that will only be strengthened by the adoption of the proposed code changes that impact nonresidential buildings.

3.4.4 Increase or Decrease of Investments in the State of California

The proposed changes to the building code are not expected to impact investments in California on a macroeconomic scale, nor are they expected to affect investments by individual firms. The allocation of resources for the production of goods in California is not expected to change as a result of this code change proposal.

3.4.5 Effects on the State General Fund, State Special Funds, and Local Governments

The suite of code changes being proposed by the Statewide CASE Team are not expected to have a significant impact on the California's General Fund, any state special funds, or local government funds.

Revenue to these funds comes from taxes levied. The most relevant taxes to consider for this proposed code change are: personal income taxes, corporation taxes, sales and use taxes, and property taxes. The proposed changes for the 2019 Title 24, Part 6 Standards are not expected to result in noteworthy changes to personal or corporate income, so the revenue from personal income taxes or corporate taxes is not expected to change.

3.4.5.1 Cost of Enforcement

Cost to the State

State government already has budget for code development, education, and compliance enforcement. While state government will be allocating resources to update the Title 24, Part 6 Standards, including updating education and compliance materials and responding to questions about the revised requirements, these activities are already covered by existing state budgets. The costs to state government are small when compared to the overall costs savings and policy benefits associated with the code change proposals.

Cost to Local Governments

All revisions to Title 24, Part 6 will result in changes to compliance determinations. Local governments will need to train building department staff on the revised Title 24, Part 6 Standards. While this re-training is an expense to local governments, it is not a new cost associated with the 2019 code change cycle. The building code is updated on a triennial basis, and local governments plan and budget for retraining every time the code is updated. There are numerous resources available to local governments to support compliance training that can help mitigate the cost of retraining, including tools, training and resources provided by the IOU Codes and Standards Program (such as Energy Code Ace). As noted in Section 2.5 and Appendix B, the Statewide CASE Team considered how the proposed code change might impact various market actors involved in the compliance and enforcement process and aimed to minimize negative impacts on local governments.

Care has been taken to develop an easy to follow compliance methodology in order to minimize time spent on compliance verification.

3.4.6 Impacts on Specific Persons

The code change proposed in this report would have some impact on building owners, occupants, and truck trailer operators. Overall, the suite of proposed changes to Title 24, Part 6 are not expected to have a differential impact on any groups relative to the state population as a whole, including migrant workers, commuters, or persons by age, race, or religion.

4. ENERGY SAVINGS

4.1 Key Assumptions for Energy Savings Analysis

The energy savings analysis uses the warehouse prototype building from the 2016 CBECC-Com compliance software. This prototype model contains three large spaces in a building that is approximately 50,000 square feet in floor area. Because of the range of conditions found in warehouse buildings and storage areas of other buildings, there are a number of base cases for the energy savings analysis. Table 4 below summarizes the conditions tested in parametric analysis. For the air leakage rate, there is one value for the base case and one value for the proposed case. Other building characteristics, such as the space conditioning type, loading and unloading frequency, and the operating schedule are code-neutral variations in inputs that affect the results. A survey was conducted with warehouse operators representing various market conditions and facility sizes to confirm that

assumptions are accurate. Note that the survey was launched in March, and remained open until April 30, 2017 to gather as much data as possible.

Table 4: Modeling Scope

	Variations	Description
Prototypes	1+	Warehouse.
Climate Zones	16	All California climate zones.
Conditioning Type	3	1-fully conditioned; 2-partially conditioned 60/80, 3-heated only.
Loading Frequency	3	Low-2x/day, medium-5x/day, high-10x/day.
Operating Schedule	2	Daily - 7/5; 24/7.
Total	**288**	

The base case air infiltration rate through the open dock door is based on a calculation procedure that uses crack opening and infiltration correlations to estimate air leakage. A study by Pacific Northwest National Laboratory (Liu 2007) estimated 783 cubic feet per minute (cfm) leakage through a dock door with no seal. However, both field measurements of air leakage, and physical measurements of typical crack opening indicate that the baseline air leakage rate is in reality much higher. An estimated 21 square feet of crack area opening on average led to a calculated baseline air leakage rate of 2,200 cfm. Leakage through dock doors with seals in place are based on measurements through doors at two stores.

The proposed case air leakage rate is based on a set of field measurements taken at multiple big-box retail warehouses in northern California. The ASTM E783 field test for air leakage was adapted for use in loading dock doors by constructing a custom framed to fit the loading dock door opening see Figure 2 below.

Figure 2: Dock door air leakage test apparatus.

Air was drawn into the building from the truck with the test blower fan to create a negative test pressure, and air leakage was measured at pressure difference levels of 25 Pascal (Pa), 50 Pa, and 75 Pa. These

measured air leakage rates were converted to an assumed building operating pressure of 4 Pa to establish the proposed air leakage rate. The average from these tests resulted in 416 cfm at 4 Pa building pressure.

These tests were performed to establish a typical air leakage rate for the proposed design case, for products that are not in perfect condition, but found as-installed. The test result is used to determine energy savings, but this test will not be required by the proposed standard.

At the test site, a significant gap appeared on either side of the dock leveler platform, even with the truck backed up so that the truck bumper was flush with the loading dock. The Statewide CASE Team ran a second test, this time with the two gaps on the sides of the leveler sealed. The air leakage rate at the same test pressure decreased by over 50 percent. However, Statewide CASE Team chose to use the 416 cfm air leakage of the as-found condition for the proposed case. The dock seals tested were in fair condition, but not new, likely two to three years old.

Figure 3: Gap between dock leveler and dock seal.

A second key assumption is the frequency at which trucks load and unload at the loading docks, exposing the building to higher air infiltration rates. While this loading frequency will vary by demand and other operational requirements, Statewide CASE Team applied an average loading frequency of two loading and unloading cycles daily. A survey instrument was developed and delivered to over fifty recipients in retail distribution centers, warehouse distribution centers, third-party logistics (3PL) companies, and product distributors. Appendix C has the survey that was delivered via email and phone correspondence to stakeholders. Limited responses were obtained on loading and unloading operating practice, and on expected life for dock seals.

Survey responses indicated that the loading frequency was as low as 1.5 cycles per day, while other responses indicated loading frequencies as high as four to five cycles daily. Statewide CASE Team ran parametric simulations with three loading frequency levels: low (two times daily), medium (five times daily), and high (11 times daily). For the cost-effectiveness analysis, Statewide CASE Team used the low loading frequency number as a conservative estimate of energy savings.

4.2 Energy Savings Methodology

To assess the energy, demand, and energy cost impacts, the Statewide CASE Team compared current design practices to design practices that will comply with the proposed requirements.

The proposed conditions are defined as the design conditions that will comply with the proposed code change. Specifically, the proposed code change will be based on building envelope component efficiency requirements that comply with the minimum prescriptive requirements for the applicable California climate zone.

The Energy Commission provided guidance on the type of prototype buildings that must be modeled. The warehouse building prototype model is being used in the energy savings analysis. The ASHRAE 90.1 prototype model was modified so that all envelope, lighting, and mechanical efficiency features match Title 24, Part 6 prescriptive requirements.

A research version of the nonresidential compliance software, CBECC-Com, was used to estimate energy savings. The warehouse prototype was used as a baseline for analysis. Slight modifications to the software included adjusting the infiltration levels and infiltration schedules, which are normally fixed for compliance, to a range of values comparable to those found in warehouse loading docks. The baseline infiltration rate was set to correspond to the open dock infiltration rate when trucks are present, according to the procedure specified in the PNNL study. The proposed infiltration rate is set to the levels recorded during field testing, adjusted to the building operating pressure.

A heating and ventilation-only system was used as the baseline heating, ventilation, and air conditioning system for testing, and a second set of tests were performed by adjusting the heating setpoint to 60°F during occupied hours. Each of the tests was performed in each of the 16 California climate zones using standard weather files.

Table 5: Prototype Buildings Used for Energy, Demand, Cost, and Environmental Impacts Analysis

Prototype ID	Occupancy Type	Area (ft^2)	Number of Stories	Statewide Area (million ft^2)
Prototype 1	Warehouse with heating-only storage	49,495	1	19.5

The energy savings from this measure varies by climate zone, due to effects of outdoor air temperatures on air infiltration. As a result, the energy impacts and cost-effectiveness are being evaluated by climate zone.

Energy savings, energy cost savings, and peak demand reductions are calculated using a time dependent valuation (TDV) methodology.

4.3 Per-Unit Energy Impacts Results

Energy savings and peak demand reductions per unit for new construction are presented in Table 6. The savings per dock seal are based on a warehouse prototype model with four 70 square foot loading dock doors, and baseline and proposed infiltration rates for the entire storage space are determined from a weighted average of infiltration through the dock doors and the Title 24 ACM baseline general infiltration rate through exterior walls. The savings per dock door are therefore one-fourth of the estimated energy savings for the entire 49,495 square foot prototype building.

Table 6: First-Year Energy Impacts Per Dock Seal or Dock Shelter

Climate Zone	Electricity Savings (kWh/yr)	Peak Electricity Demand Reductions[a] (kW)	Natural Gas Savings (therms/yr)	TDV Energy Savings (TDV kBtu/yr)
1	744	0.015	217.8	1.243
2	293	-0.025	81.8	0.454
3	579	-0.001	142.2	0.854
4	291	-0.036	79.4	0.421
5	459	0.000	109.7	0.673
6	305	0.001	58.8	0.388
7	262	-0.010	45.0	0.307
8	162	-0.074	36.1	0.209
9	152	-0.055	50.9	0.271
10	140	-0.017	47.1	0.257
11	496	-0.013	150.2	0.871
12	315	-0.054	102.7	0.560
13	77	-0.013	73.6	0.353
14	565	-0.013	147.1	0.885
15	121	0.003	32.0	0.210
16	942	-0.054	228.8	1.725

a. A negative demand reduction indicates an increase in peak electrical demand.

5. LIFECYCLE COST AND COST-EFFECTIVENESS

5.1 Energy Cost Savings Methodology

TDV energy is a normalized format for comparing electricity and natural gas cost savings that takes into account the cost of electricity and natural gas consumed during each hour of the year. The TDV values are based on long term discounted costs (30 years for all residential measures and nonresidential envelope measures and 15 years for all other nonresidential measures). In this case, the period of analysis used is 15 years. The TDV cost impacts are presented in 2020 present value (PV) dollars. The TDV energy estimates are based on PV cost savings but are normalized in terms of "TDV kBtu." Peak demand reductions are presented in peak power reductions (kW). The Energy Commission derived the 2020 TDV values that were used in the analyses for this report (Energy + Environmental Economics 2016).

The analysis will show where dock seals and shelters are cost-effective, which will inform whether the measure is deemed appropriate for Title 24, Part 6 and if so, which climate zones and building conditions would apply the requirement.

5.2 Energy Cost Savings Results

Per-unit energy cost savings for newly constructed buildings over the 15-year period of analysis are presented in Table 7. The TDV methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods.

Table 7: TDV Energy Cost Savings Over 15-Year Period of Analysis – Per Square Foot of Floor Area

Climate Zone	15-Year TDV Electricity Cost Savings (2020 PV $)	15-Year TDV Natural Gas Cost Savings (2020 PV $)	Total 15-Year TDV Energy Cost Savings (2020 PV $/ft^2)
1	$0.150	0.293	$0.4425
2	$0.045	0.117	$0.1615
3	$0.105	0.199	$0.3041
4	$0.036	0.114	$0.1500
5	$0.086	0.154	$0.2395
6	$0.051	0.087	$0.1380
7	$0.043	0.066	$0.1092
8	$0.021	0.053	$0.0744
9	$0.022	0.075	$0.0966
10	$0.022	0.070	$0.0915
11	$0.090	0.220	$0.3102
12	$0.051	0.149	$0.1995
13	$0.017	0.109	$0.1258
14	$0.101	0.214	$0.3151
15	$0.026	0.049	$0.0747
16	$0.283	0.331	$0.6139

5.3 Incremental First Cost

The Statewide CASE Team estimated the current incremental construction costs, which represents the incremental cost of the measure if a building meeting the proposed standard were built today. The incremental first cost for this measure was developed by obtaining multiple quotes from product distributors for products with a fixed description for dock seals and dock shelters. These cost estimates were all compared against estimates from RS Means, as a reference point. The incremental first cost (both material and installation cost) for dock seals is $1,400 for loading dock door, and $2,400 for dock shelters.

Per the Energy Commission's guidance, design costs are not included in the incremental first cost.

5.4 Lifetime Incremental Maintenance Costs

Incremental maintenance cost is the incremental cost of replacing the equipment or parts of the equipment, as well as periodic maintenance required to keep the equipment operating relative to current practices over the period of analysis. The PV of equipment and maintenance costs (savings) was calculated using a three percent discount rate (d), which is consistent with the discount rate used when developing the 2019 TDV. The PV of maintenance costs that occurs in the n^{th} year is calculated as follows (where d is the discount rate of three percent):

$$\text{PV of Maintenance Cost} = \text{Maintenance Cost} \times \left[\frac{1}{1+\text{d}}\right]^{\text{n}}$$

Based on initial interviews with facility operators and site visits conducted by the Statewide CASE Team it is assumed that dock seals and shelters do not have associated maintenance costs. This is because the nature of use of these products makes a complete replacement at the end of the product's life more effective than regular maintenance. Repeated impacts from trucks backing into the dock make it less practical to perform regular maintenance. Based on survey feedback from industry stakeholders, the average effective useful life (EUL) for the dock seals is 7.5 years. For the lifecycle cost-

effectiveness, maintenance costs are assumed to be the replacement cost of the unit, and this occurs once during the 15-year analysis period.

5.5 Lifecycle Cost-Effectiveness

This measure proposes a mandatory requirement for newly constructed buildings. As such, a lifecycle cost analysis is required to demonstrate that the measure is cost-effective over the 15-year period of analysis. While additions that add storage space and new loading dock doors would be covered under this change, alterations are not in the scope of this measure. This is in part because there is no clear alteration trigger that would initiate a requirement for the addition of a seal to an existing door.

The Energy Commission establishes the procedures for calculating lifecycle cost-effectiveness. The Statewide CASE Team collaborated with Energy Commission staff to confirm that the methodology in this report is consistent with their guidelines, including which costs were included in the analysis. In this case, incremental first cost and incremental maintenance costs over the 15-year period of analysis were included. The TDV energy cost savings from electricity and natural gas savings were also included in the evaluation.

Neither design costs nor the incremental cost of code compliance verification were included in the analysis.

According to the Energy Commission's definitions, a measure is cost-effective if the benefit-to-cost (B/C) ratio is greater than 1.0. The B/C ratio is calculated by dividing the total present lifecycle cost benefits by the present value of the total incremental costs.

Based on product warranties and interviews with facility operators with dock seals and filed verifications it is estimated that the EUL of dock seals and dock shelters is 7.5 years.

Table 8 represents lifecycle costs and energy savings. Using the high estimates received for dock seal installed costs ($2,400 per dock door), and the expected useful life of 7.5 years, the measure is shown to be cost-effective in Climate Zones 1 and 16.

Table 8: Lifecycle Cost-Effectiveness Summary Per Square Foot of Floor Area

Climate Zone	Benefits TDV Energy Cost Savings + Other PV Savings[a] (2020 PV $)	Costs Total Incremental PV Costs[b] (2020 PV $)	Benefit-to-Cost Ratio
1	$ 0.4425	$ 0.3491	1.27
2	$ 0.1615	$ 0.3491	0.46
3	$ 0.3041	$ 0.3491	0.87
4	$ 0.1500	$ 0.3491	0.43
5	$ 0.2395	$ 0.3491	0.69
6	$ 0.1380	$ 0.3491	0.40
7	$ 0.1092	$ 0.3491	0.31
8	$ 0.0744	$ 0.3491	0.21
9	$ 0.0966	$ 0.3491	0.28
10	$ 0.0915	$ 0.3491	0.26
11	$ 0.3102	$ 0.3491	0.89
12	$ 0.1995	$ 0.3491	0.57
13	$ 0.1258	$ 0.3491	0.36
14	$ 0.3151	$ 0.3491	0.90
15	$ 0.0747	$ 0.3491	0.21
16	$ 0.6139	$ 0.3491	1.76

a. **Benefits: TDV Energy Cost Savings + Other PV Savings:** Benefits include TDV energy cost savings over the period of analysis (Energy + Environmental Economics 2016, 51-53). Other savings are discounted at a real (nominal – inflation) three percent rate. Other PV savings include incremental first cost savings if proposed first cost is less than current first cost. Includes PV maintenance cost savings if PV of proposed maintenance costs is less than the PV of current maintenance costs

b. **Costs: Total Incremental PV Costs:** Costs include incremental equipment, replacement, and maintenance costs over the period of analysis. Costs are discounted at a real (inflation adjusted) three percent rate. Includes incremental first cost if proposed first cost is greater than current first cost. Includes PV of maintenance incremental cost if PV of proposed maintenance costs is greater than the PV of current maintenance costs. If incremental maintenance cost is negative, it is treated as a positive benefit. If there are no total incremental PV costs, the B/C ratio is infinite.

6. First-Year Statewide Impacts

6.1 Statewide Energy Savings and Lifecycle Energy Cost Savings

The Statewide CASE Team calculated the first-year statewide savings for new construction by multiplying the per-unit savings, which are presented in Section 4.3, by the statewide new construction forecast for 2020, which is presented in more detail in Appendix A. The first-year energy impacts represent the first-year annual savings from all buildings that were completed in 2020. The lifecycle energy cost savings represent the energy cost savings over the entire 15-year analysis period. The statewide savings estimates do not take naturally occurring market adoption or compliance rates into account. Results from new construction by climate zone are presented in in Table 9.

Given data regarding the new construction forecast for 2020, the Statewide CASE Team estimates that the proposed code change will reduce annual statewide electricity use by 0.114 GWh with no significant demand reduction. Natural gas use is expected to be reduced by 0.0278 million therms. The energy savings for buildings constructed in 2020 are associated with a PV energy cost savings of approximately $0.92 PV million in (discounted) energy costs over the 15-year period of analysis.

There would also be an additional benefit and energy savings to California if the requirement were extended to include refrigerated warehouses. However, it is likely that the majority of newly constructed

refrigerated warehouses will already include dock seals or shelters in the absence of any new regulations.

Table 9: Statewide Energy and Energy Cost Impacts[a]- New Construction

Climate Zone	Statewide New Construction in 2020 (million ft^2)[a]	First-Year[b] Electricity Savings (GWh)	First-Year[b] Peak Electrical Demand Reduction (MW)	First-Year[b] Natural Gas Savings (million therms)	Lifecycle[c] PV Energy Cost Savings (PV$ million)
1	0.1273	0.00765	0.000015	0.0023	0.06
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	1.3873	0.1065	-0.006	0.0255	0.855
TOTAL	**1.515**	**0.114**	**-0.006**	**0.0278**	**0.92**

a. Estimates subject to change: cost-effectiveness of measure in Climate Zones 2 through 15 is under review.

b. First-year savings from all buildings completed statewide in 2020.

c. Energy cost savings from all buildings completed statewide in 2020 accrued during 15-year period of analysis.

6.2 Statewide Water Use Impacts

The proposed code change will not result in direct water savings (secondary water savings at the source due to reduced electrical energy use is not considered).

6.3 Statewide Material Impacts

The statewide material impacts could include plastic, steel, and other materials. These impacts will depend on the number of climate zones where this measure is recommended.

Table 10: Impacts of Material Use

	Impact on Material Use (lb/yr)					
	Mercury	**Lead**	**Copper**	**Steel**	**Plastic**	**Others (Identify)**
Impact (I, D, or NC)[a]	NC	NC	NC	NC	I	NC
Per-Unit Impacts	NC	NC	NC	NC	Low	NC
First-Year[b] Statewide Impacts	NC	NC	NC	NC	Low	NC

a. Material Increase (I), Decrease (D), or No Change (NC) compared to base case (lbs/year).

b. First-year savings from all buildings completed statewide in 2020.

6.4 Other Non-Energy Impacts

Non-energy impacts could include increased productivity resulting in protection from elements, increased occupant comfort from decreased infiltration, and increased loading and unloading security.

7. PROPOSED REVISIONS TO CODE LANGUAGE

The proposed changes to the Standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2016 documents are marked with underlining (new language) and ~~strikethroughs~~ (deletions). These changes are subject to verification of cost-effectiveness of the measure through detailed energy simulations, informed by field data for proposed infiltration rates (work in progress).

7.1 Standards

SECTION 100.1 – DEFINITIONS AND RULES OF CONSTRUCTION

LOADING DOCK BAY is an area of a warehouse or other building where products are loaded and unloaded through one or more loading dock doors.

LOADING DOCK DOOR is an entryway, generally installed with a roll-up door, which opens directly to a platform where trucks or trailers can be loaded or unloaded.

DOCK SEAL is an air barrier, that includes compressible side and top panels made of foam or other materials, that is installed on the exterior perimeter of the loading dock door, excluding the bottom, to create a gasket when pushed into contact with the truck or trailer, and that protects the loading dock bay, truck and goods from the elements.

DOCK SHELTER is an enclosure that seals the exterior perimeter, excluding the bottom, of a loading dock door when connected to a trailer, typically with industrial fabric curtains. Dock shelters accommodate a wider range of truck trailers than dock seals can.

SECTION 110.7 – MANDATORY REQUIREMENTS TO LIMIT AIR LEAKGE

All joints, penetrations and other openings in the building envelope that are potential sources of air leakage shall be caulked, gasketed, weather stripped, or otherwise sealed to limit infiltration and exfiltration.

(a). Loading Dock Seal Requirement. Exterior loading dock doors where the truck or trailer will be flush with the building exterior in newly constructed buildings in Climate Zones 1 and 16 that are adjacent to conditioned or indirectly conditioned spaces shall have dock seals or dock shelters installed.

SECTION 120.6 – MANDATORY REQUIREMENTS FOR COVERED PROCESSES

In Subsection 120.6(a)6:

6. Infiltration Barriers. Passageways between freezers and higher-temperature spaces, and passageways between coolers and non-refrigerated spaces, shall have an infiltration barrier consisting of strip curtains, an automatically-closing door, or an air curtain designed by the manufacturer for use in the passageway and temperature for which it is applied. See Section 110.7(a) for loading dock door infiltration barrier requirements.

EXCEPTION 1 to Section 120.6(a)6: Openings with less than 16 square feet of opening area.

~~EXCEPTION 2 to Section 120.6(a)6: Dock doorways for trailers~~

7.2 Reference Appendices

Appendix JA1 Glossary

LOADING DOCK BAY is an area of a warehouse or other building where products are loaded and unloaded through one or more loading dock doors.

LOADING DOCK DOOR is an entryway, generally installed with a roll-up door, which opens directly to a platform where trucks or trailers can be loaded or unloaded.

DOCK SEAL is an air barrier, that includes compressible side and top panels made of foam or other materials, that is installed on the exterior perimeter of the loading dock door, excluding the bottom, to create a gasket when pushed into contact with the truck or trailer, and that protects the loading dock bay, truck and goods from the elements.

DOCK SHELTER is an enclosure that seals the exterior perimeter, excluding the bottom, of a loading dock door when connected to a trailer, typically with industrial fabric curtains. Dock shelters accommodate a wider range of truck trailers than dock seals can.

7.3 ACM Reference Manual

There are no proposed changes to the ACM Reference Manual.

7.4 Compliance Manuals

The proposed code change will modify the following sections of the Title 24, Part 6 Compliance Manual.

- Chapter 3, Subsection 3.2.1.1D, Infiltration and Air Leakage will need to have requirements for loading dock door seals or shelters added.
- Chapter 3, Subsection 3.2.5.1, Doors, Mandatory Requirements, will need language added to include loading dock door seals or shelters. It is recommended that example details and specification language is added on plans and specifications to aid in proper implementation
- In Chapter 10, Subsection 10.6.2.3, Example 10-33 will need to have language removed that says dock doors do not require infiltration barriers.
- The acceptance chapter of the compliance manual does not need to be revised.

7.5 Compliance Documents

The proposed code change will not modify the compliance document. This measure would be documented in NRCC-ENV-01-E in Section H. Envelope Mandatory Measures. Dock seals or shelters should be included in the Mandatory Measures Note Block that is included in building plans.

Although this measure will not require modification of the existing compliance document, it is recommended that the Energy Commission consider creating a Standard Note Block or similar documentation that contains a standard table of mandatory measures, which provides a way to mark measures that do not apply, as well as a space on building plans for designers to include the sheet and specification numbers for reference.

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Appendix A: STATEWIDE SAVINGS METHODOLOGY

The projected nonresidential new construction (in millions of square feet) that will be impacted by the proposed code change in 2020 is presented in Table 11.

To calculate first-year statewide savings, the Statewide CASE Team multiplied the per-unit savings by statewide new construction estimates for the first year the standards will be in effect (2020). The Energy Commission Demand Analysis Office provided the Statewide CASE Team with the nonresidential new construction forecast. The raw data presented annual total building stock and new construction estimates for twelve building types by forecast climate zones (FCZ). The Statewide CASE Team completed the following steps to refine the data and develop estimates of statewide floorspace that will be impacted by the proposed code changes:

1. Translated data from FCZ data into building standards climate zones (BSCZ). Since Title 24, Part 6 uses BSCZ, the Statewide CASE Team converted the construction forecast from FCZ to BSCZ using conversion factors supplied by the Energy Commission. The conversion factors, which are presented in Table 12, represent the percentage of building square footage in FCZ that is also in BSCZ. For example, looking at the first column of conversion factors in Table 12, 22.5 percent of the building square footage in FCZ 1 is also in BSCZ 1 and 0.1 percent of building square footage in FCZ 4 is in BSCZ 1. To convert from FCZ to BSCZ, the total forecasted construction for a specific building type in each FCZ was multiplied by the conversion factors for BSCZ 1, then all square footage from all FCZs that are found to be in BSCZ 1 are summed to arrive at the total construction for that building type in BSCZ 1. This process was repeated for every climate zone and every building type. See Table 14 for an example calculation to convert from FCZ to BSCZ. In this example, construction BSCZ 1 is made up of building floorspace from FCZs 1, 4, and 14.

Redistributed square footage allocated to the "Miscellaneous" building type. The building types included in the Energy Commissions' forecast are summarized in Table 13: Description of Building Types and Sub-types (Prototypes) in Statewide Construction Forecast

Energy Commission Building Type ID	Energy Commission Description	Prototype Description			
		Prototype ID	Floor Area (ft^2)	Stories	Notes
OFF-SMALL	Offices less than 30,000 square feet	Small Office	5,502	1	Five zone office **model with unconditioned** attic and pitched roof.
REST	Any facility that serves food	Small Restaurant	2,501	1	Similar to a fast food joint with a small kitchen and dining areas.
RETAIL	Retail stores and shopping centers	Stand-Alone Retail	24,563	1	Stand **Alone store similar to Walgreens or** Banana Republic.
		Large Retail	240,000	1	Big box retail building, similar to a Target or Best Buy store.
		Strip Mall	9,375	1	Four**-unit strip mall retail building. West end** unit is twice as large as other three.
		Mixed-Use Retail	9,375	1	Four**-unit retail representing the ground floor** units in a mixed use building. Same as the strip mall with adiabatic ceilings.
FOOD	Any service facility that sells food and or liquor	N/A	N/A	N/A	N/A
NWHSE	Non-refrigerated warehouses	Warehouse	49,495	1	High ceiling warehouse space with small office area.
RWHSE	Refrigerated Warehouses	N/A	N/A	N/A	N/A
SCHOOL	Schools K-12, not including colleges	Small School	24,413	1	Similar to an elementary school with classrooms, support **spaces and small dining area.**
		Large School	210,886	2	Similar to high school with classrooms, commercial kitchen, auditorium, gymnasium and support spaces.
COLLEGE	Colleges, universities, community colleges	Small Office	5,502	1	Five zone office model **with unconditioned attic** and pitched roof.
		Medium Office	53,628	3	Five zones per floor office building with plenums on each floor.
		Medium Office/Lab		3	Five zones per floor building with a combination of office and lab spaces.
		Public Assembly		2	TBD
		Large School	210,886	2	Similar to high school with classrooms, commercial kitchen, auditorium, gymnasium and support spaces.
		High Rise Apartment	93,632	10	75 residential units along with common spaces and a penthouse. Multipliers are used to represent typical floors.
HOSP	Hospitals and other health-related facilities	**N/A**	N/A	N/A	N/A
HOTEL	Hotels and motels	Hotel	42,554	4	Hotel building with common spaces **and 77 guest** rooms.

MISC	All other space types that do not fit another category	**N/A**	**N/A**	**N/A**	**N/A**
OFF-LRG	Offices larger than 30,000 square feet	Medium Office	53,628	3	Five zones per floor office building with plenums on each floor.
		Large Office	498,589	12	Five zones per floor office building with plenums on each floor. Middle floors represented using multipliers.

2. . The Energy Commission's forecast allocated 18.5 percent of the total square footage from nonresidential new construction in 2020 and the nonresidential existing building stock in 2020 to the miscellaneous building type, which is a category for all space types that do not fit well into another building category. It is likely that the Title 24, Part 6 requirements apply to the miscellaneous building types, and savings will be realized from this floorspace. The new construction forecast does not provide sufficient information to distribute the miscellaneous square footage into the most likely building type, so the Statewide CASE Team redistributed the miscellaneous square footage into the remaining building types in such a way that the percentage of building floorspace in each climate zone, net of the miscellaneous square footage, will remain constant. See Table 15 for an example calculation.
3. Made assumptions about the percentage of nonresidential new construction and additions/alterations in 2020 that will be impacted by proposed code change by building type and climate zone. The Statewide CASE Team's assumptions are presented in Table 16 and discussed further below.
4. Calculated nonresidential floorspace that will be impacted by the proposed code change in 2020 by building type and climate zone for both new construction and alterations. Results are presented in Table 11.

The statewide savings estimate conservative because it assumes a density of loading dock doors for warehouse spaces that is equal to that of the large retail assumption. Some respondents to surveys indicated that they have one dock door per 7,000 square feet of storage space, compared to a loading dock density of one dock door per 12,500 square feet of storage space for large retail spaces.

The statewide savings estimate assumes that the proposed requirement affects all new construction for large retail buildings and non-refrigerated warehouses in Climate Zones 1 and 16. Table 11 shows the estimated percentage of construction that will be impacted by this measure. Refrigerated warehouses are excluded, since it is assumed that buildings of this type will have dock seals or shelters installed in the absence of a code requirement. Climate Zones 1 and 16 represent approximately three percent of total construction for the state.

Table 11: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2020, by Climate Zone and Building Type (Million Square Feet)

Climate Zone	New Construction in 2020 (Million Square Feet)											
	OFF-SMALL	REST	RETAIL	FOOD	NWHSE	RWHSE	SCHOOL	COLLEGE	HOSP	HOTEL	OFF-LRG	TOTAL
1	0	0	0.0808	0	0.0465	0	0	0	0	0	0	0.1273
2	0	0	0.6672	0	0.5955	0	0	0	0	0	0	1.2628
3	0	0	2.9632	0	3.5733	0	0	0	0	0	0	6.5366
4	0	0	1.6035	0	1.3529	0	0	0	0	0	0	2.9563
5	0	0	0.3113	0	0.2627	0	0	0	0	0	0	0.5740
6	0	0	2.4835	0	2.7167	0	0	0	0	0	0	5.2002
7	0	0	1.5315	0	1.1428	0	0	0	0	0	0	2.6744
8	0	0	3.5842	0	3.8598	0	0	0	0	0	0	7.4440
9	0	0	3.7860	0	4.1325	0	0	0	0	0	0	7.9186
10	0	0	2.8736	0	3.2834	0	0	0	0	0	0	6.1570
11	0	0	0.6051	0	0.8004	0	0	0	0	0	0	1.4055
12	0	0	3.2954	0	3.7594	0	0	0	0	0	0	7.0548
13	0	0	1.3418	0	1.5334	0	0	0	0	0	0	2.8752
14	0	0	0.5677	0	0.6413	0	0	0	0	0	0	1.2089
15	0	0	0.4987	0	0.7179	0	0	0	0	0	0	1.2166
16	0	0	0.7175	0	0.6697	0	0	0	0	0	0	1.3873
TOTAL	0	0	26.911	0	29.088	0	0	0	0	0	0	56.00

Table 12: Translation from Forecast Climate Zone (FCZ) to Building Standards Climate Zone (BSCZ)

		Building Standards Climate Zone (BSCZ)																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**Total**
Forecast Climate Zone (FCZ)	**1**	22.5%	20.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.8%	33.1%	0.2%	0.0%	0.0%	13.8%	100%
	2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	22.0%	75.7%	0.0%	0.0%	0.0%	2.3%	100%
	3	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	20.9%	22.8%	54.5%	0.0%	0.0%	1.8%	100%
	4	0.1%	13.7%	8.4%	46.0%	8.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	22.8%	0.0%	0.0%	0.0%	0.0%	100%
	5	0.0%	4.2%	89.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.6%	0.0%	0.0%	0.0%	0.0%	100%
	6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100%
	7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	75.8%	7.1%	0.0%	17.1%	100%
	8	0.0%	0.0%	0.0%	0.0%	0.0%	40.1%	0.0%	50.8%	8.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	100%
	9	0.0%	0.0%	0.0%	0.0%	0.0%	6.4%	0.0%	26.9%	54.8%	0.0%	0.0%	0.0%	0.0%	6.1%	0.0%	5.8%	100%
	10	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	74.9%	0.0%	0.0%	0.0%	12.3%	7.9%	4.9%	100%
	11	0.0%	0.0%	0.0%	0.0%	0.0%	27.0%	0.0%	30.6%	42.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
	12	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	4.2%	95.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	100%
	13	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	69.6%	0.0%	0.0%	28.8%	0.0%	0.0%	0.0%	1.6%	0.1%	0.0%	100%
	14	2.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	97.1%	100%
	15	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	99.9%	0.0%	100%
	16	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%

Table 13: Description of Building Types and Sub-types (Prototypes) in Statewide Construction Forecast

Energy Commission Building Type ID	Energy Commission Description	Prototype Description			
		Prototype ID	Floor Area (ft^2)	Stories	Notes
OFF-SMALL	Offices less than 30,000 square feet	Small Office	5,502	1	Five zone office model with unconditioned attic and pitched roof.
REST	Any facility that serves food	Small Restaurant	2,501	1	Similar to a fast food joint with a small kitchen and dining areas.
RETAIL	Retail stores and shopping centers	Stand-Alone Retail	24,563	1	Stand Alone store similar to Walgreens or Banana Republic.
		Large Retail	240,000	1	Big box retail building, similar to a Target or Best Buy store.
		Strip Mall	9,375	1	Four-unit strip mall retail building. West end unit is twice as large as other three.
		Mixed-Use Retail	9,375	1	Four-unit retail representing the ground floor units in a mixed use building. Same as the strip mall with adiabatic ceilings.
FOOD	Any service facility that sells food and or liquor	N/A	N/A	N/A	N/A
NWHSE	Non-refrigerated warehouses	Warehouse	49,495	1	High ceiling warehouse space with small office area.
RWHSE	Refrigerated Warehouses	N/A	N/A	N/A	N/A
SCHOOL	Schools K-12, not including colleges	Small School	24,413	1	Similar to an elementary school with classrooms, support spaces and small dining area.
		Large School	210,886	2	Similar to high school with classrooms, commercial kitchen, auditorium, gymnasium and support spaces.
COLLEGE	Colleges, universities, community colleges	Small Office	5,502	1	Five zone office model with unconditioned attic and pitched roof.
		Medium Office	53,628	3	Five zones per floor office building with plenums on each floor.
		Medium Office/Lab		3	Five zones per floor building with a combination of office and lab spaces.
		Public Assembly		2	TBD
		Large School	210,886	2	Similar to high school with classrooms, commercial kitchen, auditorium, gymnasium and support spaces.
		High Rise Apartment	93,632	10	75 residential units along with common spaces and a penthouse. Multipliers are used to represent typical floors.
HOSP	Hospitals and other health-related facilities	N/A	N/A	N/A	N/A
HOTEL	Hotels and motels	Hotel	42,554	4	Hotel building with common spaces and 77 guest rooms.
MISC	All other space types that do not fit another category	N/A	N/A	N/A	N/A
OFF-LRG	Offices larger than 30,000 square feet	Medium Office	53,628	3	Five zones per floor office building with plenums on each floor.
		Large Office	498,589	12	Five zones per floor office building with plenums on each floor. Middle floors represented using multipliers.

Table 14: Converting from Forecast Climate Zone (FCZ) to Building Standards Climate Zone (BSCZ) – Example Calculation

Climate Zone	**Total Statewide Small Office Square Footage in 2020 by FCZ** (Million Square Feet) **[A]**	**Conversion Factor FCZ to BSCZ 1 [B]**	**Small Office Square Footage in BSCZ 1** (Million Square Feet) **[C] = A x B**
1	0.204	22.5%	0.046
2	0.379	0.0%	0.000
3	0.857	0.0%	0.000
4	1.009	0.1%	0.001
5	0.682	0.0%	0.000
6	0.707	0.0%	0.000
7	0.179	0.0%	0.000
8	1.276	0.0%	0.000
9	0.421	0.0%	0.000
10	0.827	0.0%	0.000
11	0.437	0.0%	0.000
12	0.347	0.0%	0.000
13	1.264	0.0%	0.000
14	0.070	2.9%	0.002
15	0.151	0.0%	0.000
16	0.035	0.0%	0.000
Total	**8.844**		**0.049**

Table 15: Example of Redistribution of Miscellaneous Category - 2020 New Construction in Climate Zone 1

Building Type	**2020 Forecast** (Million Square Feet) **[A]**	**Distribution Excluding Miscellaneous Category [B]**	**Redistribution of Miscellaneous Category** (Million Square Feet) **[C] = B × 0.11**	**Revised 2020 Forecast** (Million Square Feet) **[D] = A + C**
Small Office	0.049	12%	0.013	0.062
Restaurant	0.016	4%	0.004	0.021
Retail	0.085	20%	0.022	0.108
Food	0.029	7%	0.008	0.036
Non-Refrigerated Warehouse	0.037	9%	0.010	0.046
Refrigerated warehouse	0.002	1%	0.001	0.003
Schools	0.066	16%	0.017	0.083
College	0.028	7%	0.007	0.035
Hospital	0.031	7%	0.008	0.039
Hotel/motel	0.025	6%	0.007	0.032
Miscellaneous	**0.111**	---	-	---
Large Offices	0.055	13%	0.014	0.069
Total	0.534	100%	**0.111**	0.534

Table 16: Percent of Floorspace Impacted by Proposed Measure, by Building Type

Building Type *Building sub-type*	Composition of Building Type by Sub-types [a]	Percent of Square Footage Impacted [b]	
		New Construction	Existing Building Stock (Alterations) [c]
Small Office		0%	0%
Restaurant		0%	0%
Retail		50%	0%
Stand-Alone Retail	*10%*	0%	0%
Large Retail	*75%*	100%	0%
Strip Mall	*5%*	0%	0%
Mixed-Use Retail	*10%*	0%	0%
Food		0%	0%
Non-Refrigerated Warehouse		100%	0%
Refrigerated Warehouse		0%	0%
Schools		0%	0%
Small School	*60%*	0%	0%
Large School	*40%*	0%	0%
College		0%	0%
Small Office	*5%*	0%	0%
Medium Office	*15%*	0%	0%
Medium Office/Lab	*20%*	0%	0%
Public Assembly	*5%*	0%	0%
Large School	*30%*	0%	0%
High Rise Apartment	*25%*	0%	0%
Hospital		0%	0%
Hotel/Motel		0%	0%
Large Offices		0%	0%
Medium Office	*50%*	0%	0%
Large Office	*50%*	0%	0%

a. Presents the assumed composition of the main building type category by the building sub-types. All 2019 CASE Reports assumed the same percentages of building sub-types.

b. When the building type is composed of multiple sub-types, the overall percentage for the main building category was calculated by weighing the contribution of each sub-type.

c. Percent of existing floorspace that will be altered during the first year the 2019 Standards are in effect.

Appendix B: DISCUSSION OF IMPACTS OF COMPLIANCE PROCESS ON MARKET ACTORS

This section discusses how the recommended compliance process, which is described in Section 2.5, could impact various market actors. The Statewide CASE Team asked stakeholders for feedback on how the measure would impact various market actors during a public stakeholder meeting held on December 12, 2016 (Statewide CASE Team 2016). A second stakeholder meeting was held on March 21, 2017. Additional interviews with warehouse owners or operators, as well as a Survey Monkey® survey, were conducted to confirm common maintenance and replacement schedule needs. The key results from feedback received during stakeholder meetings and other target outreach efforts are detailed below.

Table 17 lists the market actors that will play a role in complying with the proposed change, the tasks for which they will be responsible, objectives in completing the tasks, how the proposed code change could impact their existing work flow, and ways negative impacts could be mitigated.

The compliance process proposed for loading dock seal and shelter requirements has been kept intentionally minimal.

- **Design Phase**: The envelope designer would be responsible for:
    - Including loading dock seal or shelter products in specifications.
    - Including loading dock seal or shelter details on drawings.
    - Include in Mandatory Measures Note Block with sheet and specification number.
        - Based on stakeholder feedback and examination of the compliance document NRCC-ENV-01-E, it is recommended that the Energy Commission consider creating a certificate of compliance document that contains a standard table of Mandatory Measures for designers to include on building plans, which provides a way to mark measures that do not apply as "NA", as well as a space to include sheet and specification numbers for reference. This document would be similar in concept to the 2016 Low-Rise Residential Mandatory Measures Summary, with some modifications to as described to capture which measures apply and their location on plans and specifications. Stakeholders have reported that at the energy code's level of complexity, it is a very difficult chore for those in the design community to assemble a comprehensive, and unambiguous, list of mandatory measures.
    - Coordinating with contractors and owner to ensure costs are included in project estimates.
- **Permit Application Phase**: The plans examiner would verify that loading dock seals or shelters are included in the Mandatory Measures Note Block as well as referenced sheet and specification numbers. Stakeholder feedback has expressed that without official mandatory measure lists, enforcement officials do not have an easy method to determine all mandatory measures that may be applicable to a given project.
- **Construction Phase**: No change to the existing permit construction phase is anticipated other than installation of the loading dock seal or shelter products.
- **Inspection Phase**: The building inspector or commissioning agent would verify the presence of loading dock seal or shelter during the inspection phase of a project using the NRCI-ENV-01-E document.

Table 17: Roles of Market Actors in the Proposed Compliance Process

Market Actor	Task(s) in Compliance Process	Objective(s) in Completing Compliance Tasks	How Proposed Code Change Could Impact Work Flow	Opportunities to Minimize Negative Impacts of Compliance Requirement
Building Owner	• Provide owner project requirements. • Provide appropriate budget for dock seals where required.	• Do this with minimal paperwork. • Do this virtually/ remote (with minimal meetings).	• Dock seal or shelter would now be mandatory, when it may have previously not been purchased and installed.	• Provide owners with information to efficiently use the dock shelter, as well as the advantages of use beyond energy savings (privacy, security, and pest deterrent).
General Contractor	• Manage construction of building or retrofit. • Coordinate and manage trades to purchase and install dock seal or shelter.	• Complete project on time and budget. • Complete project with no construction issues or change orders.	• Additional time and budget would need to be included in project cost estimates to cover purchase and installation of the product.	• Existing conditions documented via as-builts or photos or ATT. Do not require additional field visit by authority having jurisdiction. • Document compliance on documents in a way easily compared to plans.
Architect	• Specify appropriate dock seal or shelter that is compatible with dock doors. • Include dock seal or shelter details on drawings. • Include on Mandatory Measures Note Block on building plans per NRCC-ENV-01-E in Section H Envelope Mandatory Measures.	• Compliance document passes code check without comment. • Dock seal does not inhibit loading and unloading operations.	• Researching products, adding details to specifications and drawings, as well as including on NRCC document Mandatory Measures Note Block would add time to workflow (up to three hours?).	• Provide example spec language and details in compliance manual to ease documentation. • Strongly recommend to develop a compliance document that provides a standardized table of Nonresidential Mandatory Measures. • This table can indicate which measures apply, which are not applicable (NA), and have space to reference sheet and specification numbers.

Market Actor	Task(s) in Compliance Process	Objective(s) in Completing Compliance Tasks	How Proposed Code Change Could Impact Work Flow	Opportunities to Minimize Negative Impacts of Compliance Requirement
Commissioning Agent	• Performs installation checks and field measurements as needed.	• Review of applicable products. • Report to client and general contractor. • Verify that building meets code and design intent.	• Time would be spent to verify presence of dock seal or shelter.	• Verification could be done by the building inspector. • No testing is recommended.
Tenants	• Manage inventory and loading and unloading operations.	• Safe storage and transport of product. • Safe working conditions for operators.	• In the case of a dock curtain, a time would be spent inflating the bladder during the trailer docking process.	• Provide tenants with training to efficiently use the dock curtain, as well as the advantages of use beyond energy savings (privacy, security, and pest deterrent).
Manufacturer	• Develops products that meet Title 24 specifications. • Establishes price and sells to appropriate markets.	• Do this quickly. • Do this within current work tasks. • Do this cost-effectively.	• Do not foresee impact to workflow. If demand increases, there is an economic advantage.	• NA.
Building Enforcement Agency / Plans Examiner	• Verify dock seal is included on drawings and specifications and within Mandatory Measures Note Block. • Issue construction permit.	• Do this quickly. • Do this with minimal or no need to ask follow up questions.	• Time would be spent to verify inclusion of dock seal or shelter on documents and within Mandatory Measures Note Block.	• Strongly recommend to develop a compliance document that provides a standardized table of Nonresidential Mandatory Measures. • This table can indicate which measures apply, which are not applicable (NA), and have space to reference sheet and specification numbers.
Building Enforcement Agency / Inspector	• Verify dock seal equipment meets specs. • Issue Certificate of Occupancy.	• Do this quickly. • Do this with minimal paperwork. • Do this with minimal or no need to re-inspect.	• Time would be spent to verify presence of dock seal or shelter.	• NA.

APPENDIX C: WAREHOUSE OPERATIONS SURVEY

We are investigating the energy benefits and costs of dock seals and dock shelters for loading dock doors. We are evaluating a possible code change to the California Building Energy Efficiency Standards, Title 24, Part 6, which would require the dock seals for newly constructed facilities under certain climates and conditions.

1. What type of building or facility are you involved with? (check all that apply)

- [ ] Warehouse
- [ ] Refrigerated Storage
- [ ] Retail
- [ ] Other (please specify)

2. How many times a day, on average, do trucks load and unload material at your facility?

3. What percentage of dock doors at the facility are used on a daily basis?

4. How many loading dock doors does your facility have in total?

5. What are your facility's operating hours?

Weekdays

Weekends

6. Do your dock doors have either dock seals or dock shelters installed?

- ( ) Yes, dock seals are installed.
- ( ) Yes, dock shelters are installed.
- ( ) Yes, both dock seals and dock shelters are installed.
- ( ) No, neither dock seals nor dock shelters are installed.

Comments:

7. If you answered yes to Question 5, on average, how many years do the products last before they are replaced?

Dock Seals	
Dock Shelters	

Codes and Standards Enhancement (CASE) Initiative

2019 California Building Energy Efficiency Standards

Addendum to Dock Seals – Final Report

Measure Number**:** 2019-NR-MECH5-F

Nonresidential Envelope

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1. EXECUTIVE SUMMARY

This addendum is in support of the proposed measure to require loading dock seals on dock doors of non-refrigerated warehouses as a prerequisite to Title 24, Part 11 (California Green Building Standards or CALGreen). Dock seals have been shown to be cost effective in the CASE Report for the majority of California climate zones, when assuming a high frequency operating schedule. While a number of manufacturers offer products to meet the proposed standard, including the requirement in CALGreen could help improve product performance and reduce cost for building occupants of warehouses and large retail facilities. This measure would apply to loading dock doors of any building having a storage area utilizing loading docks that is either conditioned or adjacent to conditioned spaces.

2. INTRODUCTION

The efficiency measure requiring dock seals on loading dock doors for a limited set of climate zones was presented at the California Energy Commission (Energy Commission) pre-rulemaking meeting on June 6, 2017. At that time, no significant opposition was raised to the measure. However, the proposed geographic scope of the measure comprised only a fraction of the applicable statewide building stock.

In an effort to expand the reach of the measure to achieve a statewide impact, the Energy Commission and the Statewide CASE Team decided to revise this measure and recommend it as a requirement for CALGreen (Title 24, Part 11) instead of Title 24, Part 6. This will allow the measure to possibly gain acceptance in broad regions of the state, and use the proposed CALGreen requirement as a catalyst for industry adoption, allowing for possible future inclusion in Title 24, Part 6.

In addition to a significant energy savings over the product life-cycle, dock seals and dock shelters offer other benefits. They provide protection from the elements and privacy while loading and unloading cargo, and improve thermal comfort by reducing infiltration. Finally, they are a positive design detail towards a long-term goal of zero net energy buildings. While often not the focus of zero net energy (ZNE) projects, warehouses, which normally have low energy use intensity (EUI), low occupancy levels and predictable loads, are some of the buildings most compatible with ZNE goals today. This CALGreen requirement would provide a step forward towards ZNE buildings, and possibly provide the dock seal industry with incentive to meet the needs of an expanding market by improving products and reducing their cost.

3. REVISED METHODOLOGY

The analysis supporting the CALGreen proposed measure follows the same methodology as that used for the CASE Report, with one exception: the operating level was set to vary to a medium and high use rate. These rates (5 and 11 loading and unloading cycles for the medium and high use cases, respectively) were used with the same energy model to determine annual electricity, gas and TDV savings.

4. RESULTS

An expanded summary of results is shown in the tables in this addendum for a range of operating conditions. The “high use” case, which corresponds to the greatest frequency of loading and unloading cycles, shows the most energy savings, and is cost-effective in most climates. The CASE Report applied

conservative costs (i.e., higher costs) for the dock shelter, instead of the less expensive, but still viable dock seal, when evaluating cost-effectiveness. The original CASE Report proposed the same measure in a limited set of climate zones for Title 24, Part 6, and received no opposition at a public stakeholder workshop.

Table 1 shows the CASE Report's energy savings estimate per square foot of floor area after applying a conservative (low) estimate for the dock loading and unloading frequency. Since this is an operational input that cannot be regulated, assumptions were made based on industry surveys. As noted in the CASE Report, survey responses indicated that the loading frequency was as low as 1.5 cycles per day, while other responses indicated loading frequencies as high as four to five cycles daily. The medium frequency use case corresponds to five loading and unloading cycled daily, while the high frequency use case corresponds to ten loading and unloading cycles daily.

Table 2 and Table 3 show additional energy savings estimates from applying higher rates of loading dock unloading and loading frequency. As expected, the energy savings increased significantly using the greater operational input. As this is a new measure, there are several variables within building design and operation that affect the results:

- Occupancy: A 24-hour occupancy will show larger savings. The CASE Report assumed a daytime operating schedule.
- Loading and unloading frequency and duration: The dock seal provides savings by limiting infiltration when the truck is at the loading bay. An increased frequency or duration when the truck is docked will impact savings.
- Dock seal coverage: The dock seal reduces energy by limiting infiltration when the truck is docked. Field-tested products did show significant infiltration that was accounted for in the energy savings estimates. Improved products that further inhibit infiltration will increase savings.
- Conditioning type: The CASE Report applied a typical warehouse building prototype, with a heated only storage area. This limits savings primarily to reduction in heating loads. Buildings that are fully conditioned or those with some regular cooling will see greater benefits.

Table 1: First-Year Energy Impacts Per Dock Seal or Dock Shelter (Low Dock Use)

Climate Zone	Electricity Savings (kWh/ft^2)	Peak Electricity Demand Reductions[a] (kW/ft^2)	Natural Gas Savings (therms/ft^2)	TDV Energy Savings (TDV kBtu/ft^2)
1	0.043	-1.45E-06	0.0151	4.972
2	0.014	-2.80E-06	0.0054	1.815
3	0.035	-6.87E-08	0.0096	3.417
4	0.017	-2.25E-06	0.0056	1.685
5	0.027	-8.28E-09	0.0078	2.691
6	0.020	5.88E-08	0.0043	1.551
7	0.015	-7.23E-07	0.0032	1.227
8	0.009	-6.05E-06	0.0024	0.836
9	0.009	-4.69E-06	0.0036	1.086
10	0.007	-1.79E-06	0.0032	1.028
11	0.030	-1.49E-06	0.0098	3.485
12	0.020	-4.34E-06	0.0069	2.241
13	0.004	-1.44E-06	0.0051	1.413
14	0.038	-1.93E-06	0.0106	3.540
15	0.007	1.23E-07	0.0022	0.839
16	0.075	-4.61E-06	0.0153	6.898

a. A negative demand reduction indicates an increase in peak electrical demand.

Table 2: First-Year Energy Impacts Per Dock Seal or Dock Shelter (Medium Dock Use)

Climate Zone	Electricity Savings (kWh/yr)	Peak Electricity Demand Reductions[a] (kW)	Natural Gas Savings (therms/yr)	TDV Energy Savings (TDV kBtu/ft^2)
1	0.084	1.38E-05	0.0242	7.001
2	0.032	-1.61E-06	0.0084	2.399
3	0.069	-7.76E-08	0.0164	4.854
4	0.037	-3.06E-06	0.0087	2.472
5	0.059	-7.48E-09	0.0122	3.928
6	0.035	-4.61E-07	0.0061	2.072
7	0.031	-7.22E-07	0.0048	1.714
8	0.020	-6.06E-06	0.0041	1.258
9	0.019	-4.19E-06	0.0054	1.529
10	0.019	-4.99E-07	0.0052	1.507
11	0.051	-1.10E-07	0.0169	4.711
12	0.035	-1.61E-06	0.0108	3.036
13	0.019	1.21E-08	0.0081	2.229
14	0.059	7.84E-08	0.0166	4.869
15	0.015	2.34E-06	0.0032	1.125
16	0.097	-4.87E-06	0.0252	8.861

a. A negative demand reduction indicates an increase in peak electrical demand.

Table 3: First-Year Energy Impacts Per Dock Seal or Dock Shelter (High Dock Use)

Climate Zone	Electricity Savings (kWh/ ft^2)	Peak Electricity Demand Reductions[a] (kW/ ft^2)	Natural Gas Savings (therms/ft^2)	TDV Energy Savings (TDV kBtu/ ft^2)
1	0.108	1.58E-05	0.0151	0.0422
2	0.047	-1.27E-06	0.0054	0.0150
3	0.086	-8.57E-08	0.0096	0.0290
4	0.055	-2.23E-06	0.0056	0.0148
5	0.085	-1.60E-08	0.0078	0.0218
6	0.047	-7.01E-07	0.0043	0.0102
7	0.045	-9.48E-07	0.0032	0.0086
8	0.025	-6.01E-06	0.0024	0.0071
9	0.025	-5.23E-06	0.0036	0.0092
10	0.026	-8.06E-07	0.0032	0.0094
11	0.062	-6.69E-07	0.0098	0.0292
12	0.041	-1.55E-06	0.0069	0.0190
13	0.023	2.27E-07	0.0051	0.0147
14	0.072	1.68E-07	0.0106	0.0289
15	0.022	2.06E-06	0.0022	0.0059
16	0.100	-5.18E-06	0.0153	0.0393

a. A negative demand reduction indicates an increase in peak electrical demand.

Table 4 shows the TDV energy cost savings for the three different dock loading schedules. With a high frequency loading and unloading schedule, the measure is cost-effective in 9 of the 16 climate zones, using the lifecycle cost methodology established by the Energy Commission for Title 24, Part 6. These results apply a conservative cost estimate of $0.3491 per square foot for dock shelters. Dock shelters are more robust products than dock seals, providing a means to adapt to a range of truck heights. These products are also significantly more expensive than dock seals. Since the requirement was designed to be flexible enough to allow for either a dock seal or dock shelter, depending on the application, the higher cost estimate was used in the analysis.

Table 4: TDV Energy Cost Savings for Different Dock Loading Schedules

Climate Zone	Low Use 15-Year TDV Energy Cost Savings	Benefit-to-Cost Ratio: Low Use [a]	Medium Use 15-Year TDV Energy Cost Savings	Benefit-to-Cost Ratio: Medium Use	High Use 15-Year TDV Energy Cost Savings	Benefit-to-Cost Ratio: High Use
1	$ 0.443	1.27	$ 0.623	1.78	$ 0.995	2.85
2	$ 0.162	0.46	$ 0.214	0.61	$ 0.362	1.04
3	$ 0.304	0.87	$ 0.432	1.24	$ 0.692	1.98
4	$ 0.150	0.43	$ 0.220	0.63	$ 0.362	1.04
5	$ 0.240	0.69	$ 0.350	1.00	$ 0.579	1.66
6	$ 0.138	0.40	$ 0.184	0.53	$ 0.286	0.82
7	$ 0.109	0.31	$ 0.153	0.44	$ 0.250	0.72
8	$ 0.074	0.21	$ 0.112	0.32	$ 0.174	0.50
9	$ 0.097	0.28	$ 0.136	0.39	$ 0.219	0.63
10	$ 0.092	0.26	$ 0.134	0.38	$ 0.227	0.65
11	$ 0.310	0.89	$ 0.419	1.20	$ 0.655	1.88
12	$ 0.199	0.57	$ 0.270	0.77	$ 0.429	1.23
13	$ 0.126	0.36	$ 0.198	0.57	$ 0.319	0.91
14	$ 0.315	0.90	$ 0.433	1.24	$ 0.683	1.96
15	$ 0.075	0.21	$ 0.100	0.29	$ 0.168	0.48
16	$ 0.614	1.76	$ 0.789	2.26	$ 1.044	2.99

a. Incremental loading dock costs of $0.3491/ft^2.

The dock seal measure has been shown to be cost-effective in several climate zones. Products are used in California today, and several manufacturers offer products that meet industry needs. Therefore, the Statewide CASE Team recommends that this measure be included in the Title 24, Part 11 CALGreen Standards.

5. PROPOSED REVISIONS TO CALGREEN CODE LANGUAGE

The Statewide CASE Team recommends adding dock seals requirements as a prerequisite to the CALGreen Tier 1 and Tier 2 requirements. If adopted, this would mean that if pursuing compliance with the Tier 1 or Tier 2 requirements, the builder would need to install dock seals.

A5.203.1.1.4 Loading Dock Seals. Loading dock doors of warehouses and other facilities adjacent to either indirectly conditioned or conditioned spaces shall be equipped with dock seals or dock shelters at the time of permit.

The Statewide CASE Team does not recommend any changes to Title 24, Part 6 as a result of this CASE proposal. In this addendum, the focus is placed on including the dock seals CALGreen requirement in all climate zones, to allow beyond-code efforts to be a catalyst for adoption in Title 24, Part 6 in the future.