CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

Second Stakeholder Meeting for Warehouse Topics

Dock Seals

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John Arent
NORESCO
jarent@noresco.com
415-970-6513

1. Background

Introduction to Dock Seal Technology

- **Dock Seals and Dock Shelters**
  - Dock seals have a foam core designed to provide a sealed fit with a specific truck size
    - **Pros**: Less expensive and creates a good seal
    - **Cons**: Repeated impacts causes wear
  - Dock shelters consist of a fiberglass curtain and are designed to accommodate a wide array of truck heights and sizes
    - **Pros**: Able to adapt to a variety of truck heights and some materials have improved durability
    - **Cons**: Higher first cost and varying performance in sealing
- Dock seal products have energy benefits, but are typically specified for other reasons (privacy, inhibit rain/moisture, and/or pest control)

Dock Seal Examples

Measure Scope

- Determine air leakage rates and energy savings for dock seals and dock shelters
- Possible mandatory requirement for dock seals or shelters in warehouses and other buildings with storage
- Evaluated for each California Climate Zone separately

Relevant Code History

- There are no requirements in Title 24, Part 6
  - Requirement for weatherseals in ASHRAE Climate Zones 4-8

- Other Relevant Code Requirements
  - No specific relevant requirements

2. Proposed Code Changes

Potential Code Change

- *Potential* code change to add a requirement for dock seals and dock shelters in applicable warehouse storage spaces, where shown to be cost-effective
  - Measure is not building-specific, but applies to all spaces that have loading dock doors (includes some retail and other spaces)
  - Mandatory requirement considered for new construction
  - Climate Zone specific: initial study suggests most suitable for Climate Zones 1 and 16
  - Does not apply to alterations – no applicable trigger
  - Similar to ASHRAE 90.1-2016 requirement

Rationale for a Code Change

- Energy savings (heating, ventilation fan)
- Supports ZNE goals: warehouses and large retail have a potential for ZNE due to relatively low EUI and available space onsite for PV
- Increased energy savings potential over time, due to availability of products and improved practices
- Straightforward compliance verification

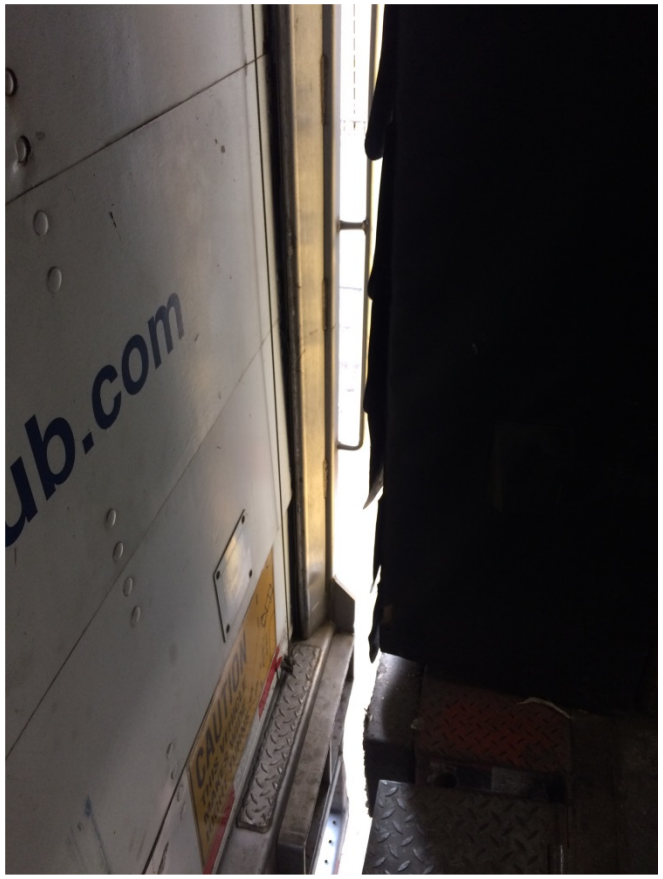
3. Technical and Market Barriers

Technical and Market Barriers (1 of 3)

- Performance Specification
  - No industry specification or metric or tested performance for air leakage **or durability**
  - For study, measured air leakage in field at multiple sites
  - Long-term resolution is performance test for products; however, actual in-field performance depends on installation
  - Short-term resolution is to specify requirement for a product, without detailed code requirements for a dock seal product

Technical and Market Barriers (2 of 3)

- Operational Performance
  - Trucks may not back up flush against stop, preventing good dock seal
  - Possible resolution are training on the customer side, or changes to products to accommodate this



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Technical and Market Barriers (3 of 3)

- Durability
  - Repeated truck impact and weather affect product life
  - Possible resolution are training on the customer side, or changes to products to accommodate this

What about technical and market barriers?

4. Compliance and Enforcement

Compliance Process

Design Phase

- What happens during design phase
  - Likely not part of design phase currently
  - Will have to be specified if requirement is added

Compliance Process

Permit Application Phase

- What happens in permit application phase?
  - Plan review should verify the presence of dock seal or shelters on doors for new construction
  - Likely not part of current scope
  - Recommend a simple verification and onsite physical check (field test of leakage likely too much additional scope for the measure)

Construction Phase

- What happens in construction phase?
  - Installation likely occurs at end of phase, but should be verified prior to occupancy
  - Responsibility likely lies with the general contractor

Inspection Phase

- What happens in permitting phase?
  - Recommend no field verification or acceptance test
  - May need additional entry on form to verify physical check has been made by Cx agent or similar

Compliance and Enforcement Barriers

- Field Verification Requirements
  - Dock seals are typically an after-market product
  - May require at least a physical verification for newly constructed buildings
  - No scope to require dock seals for alterations because no clear trigger exists
    - May be required for applicable additions

5. Cost-Effectiveness and Energy Impacts

Cost Effectiveness Analysis

Energy Savings (Benefits)

- Energy savings depends on air leakage reduction with dock seal
  - Air Leakage rate determined through ASTM E783 field test, at two different sites, and two different dock seal conditions

- Parametric energy simulations used to estimate savings
- Other parameters that are either code neutral or operational values were varied to determine impact on results:
  - Space conditioning Type (3): Heated, Partially Heated, Heated and Cooled
  - Operating Schedule (2): Daytime (7-6 M-F), 24/7 Operation
  - Loading Frequency: low (2), medium (5), high (11) trucks daily

Blower Door mounted in custom frame that fits dock opening with sealed test assembly

Draw air out with fan to create negative pressure

Measure air leakage at 25 Pa, 50 Pa, 75 Pa

Convert readings to building operating pressure of 4 Pa for simulation test

As-Found Conditions – bottom gaps by bumper and other leaks can increase leakage by as much as 100%

Dock Seal Leakage Test Results

(a) As-Found Conditions

Pressure (psf)	Pressure (Pa)	Flow (cfm)	CFM-4Pa
psf	Pa	cfm	
0.513	24.56259	1070	431.7941
1.02	48.83791	1445	413.5417
1.015	48.5985	1450	415.9935
1.56	74.69327	1780	411.9166
1.025	49.07731	1410	402.5397
0.53	25.37656	1070	424.8126
Average			**416.8**

(b) With bottom openings between loading dock leveler and truck stop sealed

Pressure	Pressure	Flow	CFM-4Pa
0.557	26.66933	477	184.7321
0.553	26.47781	483.5	187.9254
1.07	51.23192	627.5	175.3369
1.07	51.23192	624.5	174.4987
1.55	74.21447	770	178.7625
1.55	74.21447	772	179.2268
Average			**180.1**

Definition of Baseline and Proposed Conditions

- **Baseline Conditions**
  - Warehouse, minimally compliant with 2016 Standards
  - 49.495 ft^2 warehouse
  - 4 – 70 ft^2 loading dock doors
  - **2,250 cfm baseline infiltration (*based on 18 sf of crack area*)**
  - Wall area fixed at 0.0448 cfm/ft^2 infiltration
  - Assume varying loading/unloading frequency (2-11 times per day)

- **Proposed Conditions**
  - Warehouse, minimally compliant with 2016 Standards
  - 49.495 ft^2 warehouse
  - 4-70 ft^2 loading dock doors
  - **416 cfm proposed infiltration (measured field data)**
  - Wall area fixed at 0.0448 cfm/ft^2 infiltration
  - Assume varying loading/unloading frequency (2-11 times per day)

Cost Effectiveness Analysis

Incremental Costs

- Incremental First Cost
  - First Cost ($1,400-$2,400 per door installed)
  - **Total Incremental First Cost ($9,600) for 4 loading dock doors per model**
  - Assumes highest first cost for dock shelter
- Incremental Maintenance Costs over 15-year period of analysis
  - Estimated Expected Useful Life at 7.5 years
  - Total Incremental Maintenance Cost (estimated at $7,680) – complete seal replacement at end of EUL
  - Maintenance rarely done on seals, so assume a full replacement cost at midpoint of 15 year life-cycle analysis, adjusted per discount rate

Cost Effectiveness Analysis

Incremental Cost Savings (Benefits)

- Energy Cost Savings over 15-year period of analysis
  - **Total Energy Cost Savings calculated for each case and climate zone**
  - Results indicate that measure is cost effective for non-refrigerated warehouse and storage:
    - Climate Zones – only 1 (North Coast) and 16 (mountains)
    - High loading frequency or 24-hour occupancy
  - Review of baseline infiltration rate: published estimate used (PNNL), but field test suggests this estimate is much too low
    - PNNL study assumes baseline (no seal air leakage) of 783 cfm
    - NORESCO field tests saw air leakage as high as 850 cfm in some cases, **with seal present**
    - Revised baseline of 2250 cfm air leakage is based on 18 sf crack area

Annual Energy Savings and Cost Effectiveness: Low Dock Use Case

	Low	Sav Low	Cost	NPV Low	BCR Low
	kTDV/ft2	$/ft2	$/ft2		
1	4.972	0.4425	$ 0.3491	$ 0.09	1.27
2	1.815	0.1615	$ 0.3491	$ (0.19)	0.46
3	3.417	0.3041	$ 0.3491	$ (0.05)	0.87
4	1.6849	0.1500	$ 0.3491	$ (0.20)	0.43
5	2.6913	0.2395	$ 0.3491	$ (0.11)	0.69
6	1.5508	0.1380	$ 0.3491	$ (0.21)	0.40
7	1.2268	0.1092	$ 0.3491	$ (0.24)	0.31
8	0.8357	0.0744	$ 0.3491	$ (0.27)	0.21
9	1.0859	0.0966	$ 0.3491	$ (0.25)	0.28
10	1.0282	0.0915	$ 0.3491	$ (0.26)	0.26
11	3.485	0.3102	$ 0.3491	$ (0.04)	0.89
12	2.2414	0.1995	$ 0.3491	$ (0.15)	0.57
13	1.4132	0.1258	$ 0.3491	$ (0.22)	0.36
14	3.54	0.3151	$ 0.3491	$ (0.03)	0.90
15	0.8388	0.0747	$ 0.3491	$ (0.27)	0.21
16	6.898	0.6139	$ 0.3491	$ 0.26	1.76

Annual Energy Savings and Cost Effectiveness: Medium Dock Use Case

	Med	Sav Med	Cost	NPV Med	BCR Med
	kTDV/ft2	$/ft2	$/ft2		
1	7.001	0.6231	$ 0.3491	$ 0.27	1.78
2	2.3992	0.2135	$ 0.3491	$ (0.14)	0.61
3	4.854	0.4320	$ 0.3491	$ 0.08	1.24
4	2.4724	0.2200	$ 0.3491	$ (0.13)	0.63
5	3.9277	0.3496	$ 0.3491	$ 0.00	1.00
6	2.0724	0.1844	$ 0.3491	$ (0.16)	0.53
7	1.7139	0.1525	$ 0.3491	$ (0.20)	0.44
8	1.2579	0.1120	$ 0.3491	$ (0.24)	0.32
9	1.5293	0.1361	$ 0.3491	$ (0.21)	0.39
10	1.507	0.1341	$ 0.3491	$ (0.22)	0.38
11	4.7109	0.4193	$ 0.3491	$ 0.07	1.20
12	3.0361	0.2702	$ 0.3491	$ (0.08)	0.77
13	2.2289	0.1984	$ 0.3491	$ (0.15)	0.57
14	4.8685	0.4333	$ 0.3491	$ 0.08	1.24
15	1.1246	0.1001	$ 0.3491	$ (0.25)	0.29
16	8.861	0.7886	$ 0.3491	$ 0.44	2.26

Annual Energy Savings and Cost Effectiveness: Higher Dock Use Case

	High	Sav High	Cost	NPV High	BCR
	kTDV/ft2	$/ft2	$/ft2		
1	11.179	0.9949	$ 0.3491	$ 0.65	2.85
2	4.0656	0.3618	$ 0.3491	$ 0.01	1.04
3	7.7719	0.6917	$ 0.3491	$ 0.34	1.98
4	4.0701	0.3622	$ 0.3491	$ 0.01	1.04
5	6.502	0.5787	$ 0.3491	$ 0.23	1.66
6	3.2098	0.2857	$ 0.3491	$ (0.06)	0.82
7	2.8146	0.2505	$ 0.3491	$ (0.10)	0.72
8	1.9514	0.1737	$ 0.3491	$ (0.18)	0.50
9	2.4599	0.2189	$ 0.3491	$ (0.13)	0.63
10	2.552	0.2271	$ 0.3491	$ (0.12)	0.65
11	7.3547	0.6546	$ 0.3491	$ 0.31	1.87
12	4.8197	0.4290	$ 0.3491	$ 0.08	1.23
13	3.5832	0.3189	$ 0.3491	$ (0.03)	0.91
14	7.672	0.6828	$ 0.3491	$ 0.33	1.96
15	1.8902	0.1682	$ 0.3491	$ (0.18)	0.48
16	11.725	1.0435	$ 0.3491	$ 0.69	2.99

Cost Effectiveness Results Summary

Incremental Cost Savings (Benefits)

- Significant energy savings in several climates
- Demonstration of cost effectiveness for climate zones 1 and 16 under most conditions
- Cost effectiveness for other climates depend on operating conditions
- Product durability and expected useful life estimates will impact BCR

- Measure is under review by IOU C&S Team and the CEC

What about costs and benefits?

(3-2) 3. What is your feedback on the estimated expected useful life (EUL) of 7.5 years for these products?

a. Way too high
b. A little too high
c. About right
d. A little too low
e. Way too low
f. I don't know

If you indicated that the EUL is too high or too low, please note your thinking in (3-2) 3B below.

(3-2) 5. What is your reaction to measured air leakage results?

a. Savings are way too high
b. Savings a little too high
c. Savings about right
d. Savings a little too low
e. Savings way too low
f. I don't know

If you indicated that the measured air leakage savings are too high or too low, please note your thinking in (3-2) 4B below.

(3-2) 6. Where do you feel this measure *should* be cost-effective?

[for Reference pod]

(3-2) 4. What is your feedback on the estimated *baseline* air leakage rate for the case of no dock seals present?

a. Way too high
b. A little too high
c. About right
d. A little too low
e. Way too low
f. I don't know

If you indicated that the EUL is too high or too low, please note your thinking in (3-2) 3B below.

If you indicated that the measured air leakage savings are too high or too low, please note your thinking in (3-2) 4B below.

[for Reference pod]

Reference for Poll Question 3:

NORESCO Baseline: 2250 cfm per door (estimated)
NORESCO Proposed: 416 cfm per door (measured)

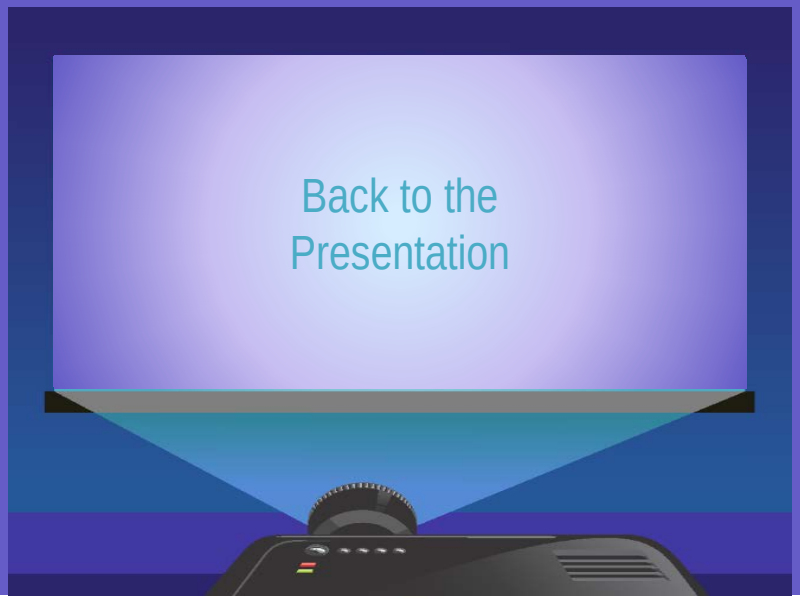
PNNL Baseline: 783 cfm (estimated)
PNNL Proposed: 203 cfm (estimated)

PNNL assumes a baseline air leakage rate of 783 cfm per loading dock door. This is based on an effective crack area of 6.27 ft^2.

The NORESCO field tests saw an air leakage rate in excess of 800 cfm with the dock seal present, under some conditions. Field observations resulted in an estimated crack area of 18 ft^2, which results in a baseline air leakage rate of 2,250 cfm per dock door.

Let's talk about…

Next Steps



6. Next Steps

Next Steps - Analysis

- Work with IOU C&S Team and CEC to determine suitability for code change
- Complete documentation of results
- Keep an eye on Title24Stakeholders.com for:
  - Presentations from today's meeting

Next Steps

- Please send any additional feedback within 2 weeks to:
  - CASE Author (see contact info at end of this presentation)
  - Info@title24stakeholders.com
- Keep an eye on Title24Stakeholders.com for:
  - Presentations from today's meeting
  - Draft Code Change Language
  - Notes from today's meeting
  - Draft CASE Report (will be posted in April)

Let's move on to…

Wrap Up

- **John Arent**
  NORESCO
  415-970-6513
  jarent@noresco.com

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Appendix:

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Dock Seals

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Will not include Appendix as download unless more than next slide is included (which is fine)

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NORESCO
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jarent@noresco.com

LA DWP Los Angeles Department of Water & Power | SMUD | SDGE A Sempra Energy utility | SoCalGas A Sempra Energy utility | Southern California Edison | Pacific Gas and Electric Company

References

- Title24Stakeholders.com
- EnergyCodeAce.com
  - See Reference Ace for 2016 Standards, Appendices, and Compliance Manuals
- California Energy Commission 2019 Standards Webpage