



TITLE 24, PART 6

2028 CODE CYCLE



Compressed Air Dryers

Codes and Standards Enhancement (CASE) Proposal

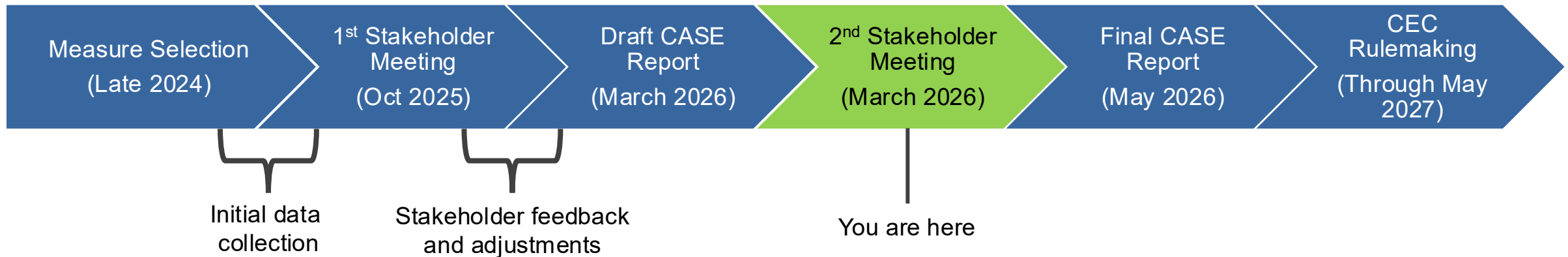


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March 19, 2026



Agenda and Timeline

1. Updated Proposal Description
2. Stakeholder Feedback and Response
3. Market and Technical Considerations
4. Energy and Cost Methodology
5. Compliance and Enforcement
6. Next Steps



Proposal Description

- Code Change Proposal
- Benefits
- Background Information



Proposed Code Change

1. Where plant compressed air dew point requirements are 35°F or greater, **refrigerated dryers** would be specified. (Desiccant dryers may be used for dew points below 35°F.)
2. Energy-saving refrigerated dryers would be specified (defined as dryers with any of: variable speed, cycling, digital scroll).
3. **Desiccant air dryers** would include **controls that reduce regeneration based on load** (dew point measurement and control).
4. **Desiccant air dryers** with rated capacity of 300 cfm or greater would be a **heated model**.
5. **Acceptance Test/Field Verification** by a field technician to confirm dryers are scheduled with air compressors and that dew point controls are properly commissioned.
6. Some existing language clean-up and new section in 141.1.

[See Title24stakeholders.com](https://www.title24stakeholders.com)
for proposal description,
justification, draft code
language, and requested data

When it applies: buildings with compressed air systems currently covered by Title 24, Part 6 (those with a total combined air compressor power of 25 hp and above) and with air dryers

Updates Since First Stakeholder Meeting

- Gathered additional measure cost data, market share data, refined proposed code language, and calculated per-unit and statewide impacts.
- Since the first meeting, the CASE Team has met with representatives from 10 entities, including a compressed air industry trade group and five air dryer manufacturers.
- We used these meetings to discuss code language feedback, technical considerations, measure costs, and market share for the various dryer technology options.
- Major changes to proposed language include:
 - Dropped dryer requirement specific to trim compressor
 - Added size threshold for heated desiccant dryer requirement
 - Dropped sizing requirement
 - Simplified compliance process

Benefits of the Proposed Change

Energy Savings

- Refrigerated air dryers use far less energy to condition plant air than desiccant dryers by avoiding inefficient, expensive use of compressed air.
- Energy-saving refrigerated dryers have much better part-load performance.
- When desiccant dryers are required, the use of heated models and load-following regeneration can both save significant compressed air energy.
- Estimated first year savings of 15 GWh/yr (about 19% of annual installed dryer energy consumption and 1.6% of annual compressed air system energy consumption).

Best Practices

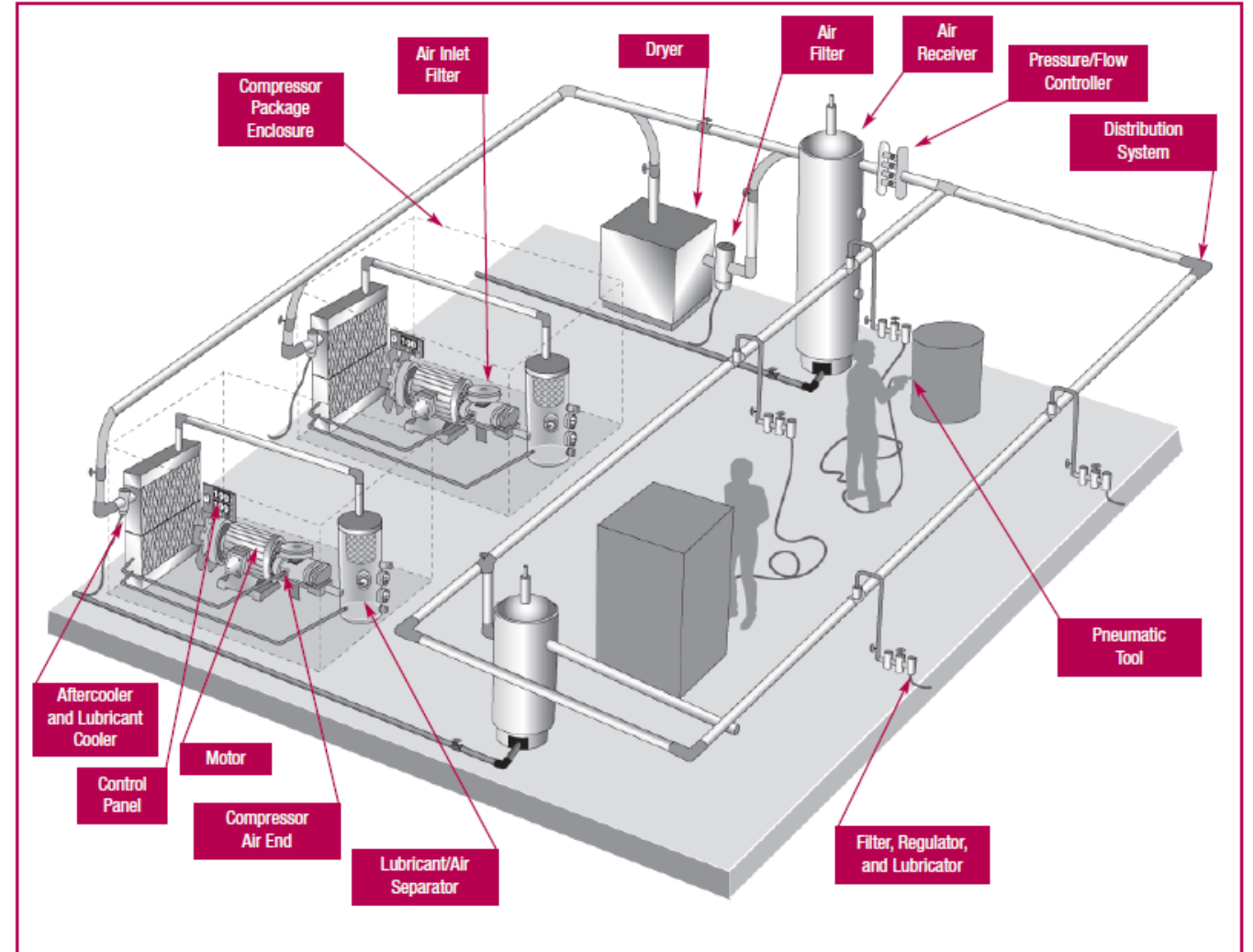
- Compressed air dryer language would ensure that well-accepted, proven best practices are followed in equipment selection.
- Field verification requirements would improve the commissioning practice of features that may otherwise go unused.

Background Information: Compressed Air Drying

- Air dryers **condition air after compression and before delivery** to storage or the plant.
- Moisture in the air needs to be removed to maintain dew point, determined based on plant needs.
- Whole plant air is dried using **refrigerated or desiccant dryers**:
 - **Refrigerated dryers** use a refrigeration cycle to condense moisture from the air
 - Energy saving refrigerated dryer models have better part-load efficiency than non-cycling options (vast majority of annual operation, even with constant load applications).
 - **Desiccant dryer** material properties adsorb moisture from the air, typically in two towers
 - One tower adsorbs while the second is regenerated using purge air, up to 20% of the rated flow. These dryers are often the largest air end-use in the plant!
 - Heating and load-following controls based on leaving air dew point can both reduce the energy consumption of this type of dryer.

Background Information: Regulations and Standards

- Compressed Air systems were first regulated by Title 24, Part 6 in 2013 and updated in 2022, covering all major, ubiquitous components except dryers.
- Air dryers were considered as part of the 2022 cycle CASE Team measure selection but left out of the Compressed Air CASE Report because other measures were deemed higher priority.
- **No public standard for compressed air dryer specification** exists to the team's knowledge.
- Compressed Air Gas Institute's (CAGI's) Compressed Air & Gas Handbook and Compressed Air Challenge articles include some dryer guidelines but with ample room for engineering judgement and no hard recommendations for equipment selection.



Marked-up Code Language

See Title24stakeholders.com for marked-up code language

The following sections would be modified

Title 24, Part 1

- No changes

Title 24, Part 6

- Section 100.1(b) – Definitions
- Section 120.6(e) – Mandatory Requirements for Compressed Air Systems
- Section 141.1(f) – Mandatory Requirements for Compressed Air Systems (**new**)

Reference Appendices

- NA7.13 – Compressed Air System Acceptance Tests



Market and Technical Considerations

- Current Conditions and Trends
- Potential Barriers and Solutions
- Technical feasibility

Current Market Conditions

- Compressed air systems account for about 10 percent of industrial electrical energy use. Roughly 70 percent of manufacturing facilities have full compressed air systems, across all industries.
- Dryers are roughly a \$1 Billion market in the United States.
- Proposed dryer technologies are matured, have widespread adoption, and are available from many providers and manufacturers.
- While the proposed code changes may be best practices, they are not ubiquitous according to interviews with subject matter experts. The proposed language will ensure adherence to efficient dryer selection.
- The team has relied on stakeholders to estimate market shares and adoption rates.

Current Market Shares

Market share: percentage of buildings that already use the proposed technology or design practice (at or above the proposed stringency level)

Standard Design	Proposed Design	Market Share without Natural Adoption
Non-cycling refrigerated dryer	Energy saving refrigerated dryer	10%
Heatless desiccant dryer without regeneration controls	Energy saving refrigerated dryer	5%
Heatless desiccant dryer without regeneration controls	Heatless desiccant dryer with regeneration controls	12%
Heatless desiccant dryer with regeneration controls	Heated desiccant dryer with regeneration controls	4%

Do you agree or disagree with these market shares? Please let us know!

Technical Considerations

The applicability and effectiveness of the proposed code changes must consider the nuances of industrial buildings and their compressed air needs:

- **Dew point** and air quality requirements can vary significantly by plant. Dew point is assumed to be a sufficient parameter for defining measure coverage. Can capture both critical end-use needs and ambient air temperature effects.
- Dryers may be specified for individual compressors or shared.
- Energy saving refrigerated dryers have higher part-load efficiency than non-cycling but non-cycling have higher full-load efficiency. However, annual operation is almost always at part-load conditions, even for constant flow.
- Energy use of the desiccant drying equipment depends on efficiency of the air compressors.

Per Unit Energy and Cost Impacts

Methodology and Assumptions

- Energy and Energy Cost Savings
- Incremental Costs



Energy and Energy Cost Savings Methodology

Methodology based on the work done in previous code cycles for compressed air measures.

- Compressed air profiles have been established for four prototype systems previously used in the 2013 and 2022 code cycles. Air dryer loads and compressed air efficiency based on these prototypes and load profiles, inclusive of all existing measures.
- Air dryer efficiency will be based on average performance as gathered from equipment specification sheets.
 - Refrigerated dryers: full- and part-load efficiencies with direct electrical energy consumption.
 - Desiccant dryers: heated and heatless purge rates with direct and indirect energy consumption from air compressors.
 - Dryers sized to match compressor capacities.
- CEC hourly factors for energy costs, source energy, and greenhouse gas emissions.
- Equipment and maintenance costs are based on list prices and diverse stakeholder input.

Energy Modeling Assumptions

- Simulating energy savings in Excel and AirMaster+
- Simulating using the following prototypical buildings and climate zones
- Purge rates, efficiency, heater power, and load-following abilities of different dryer types

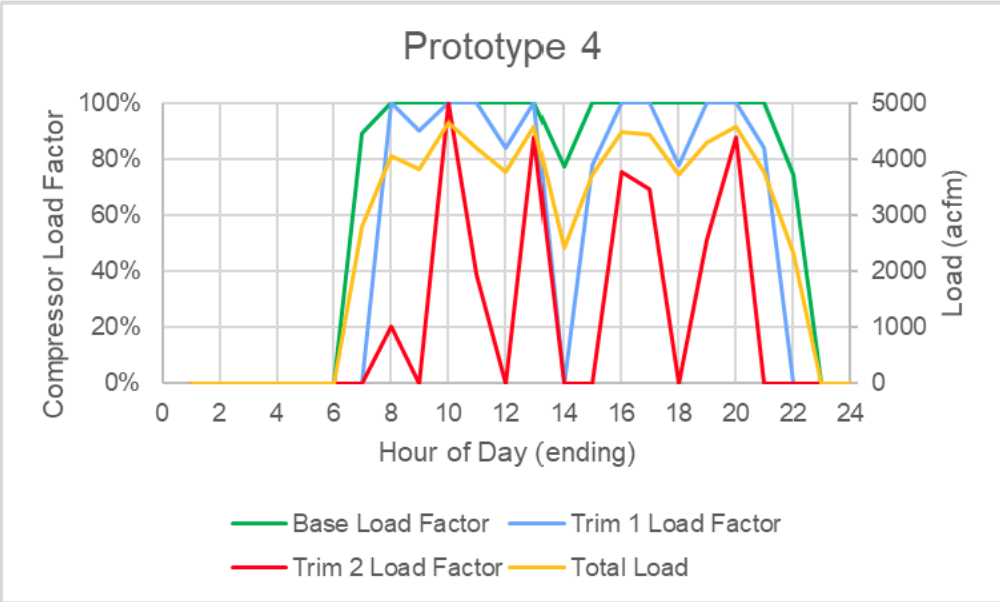
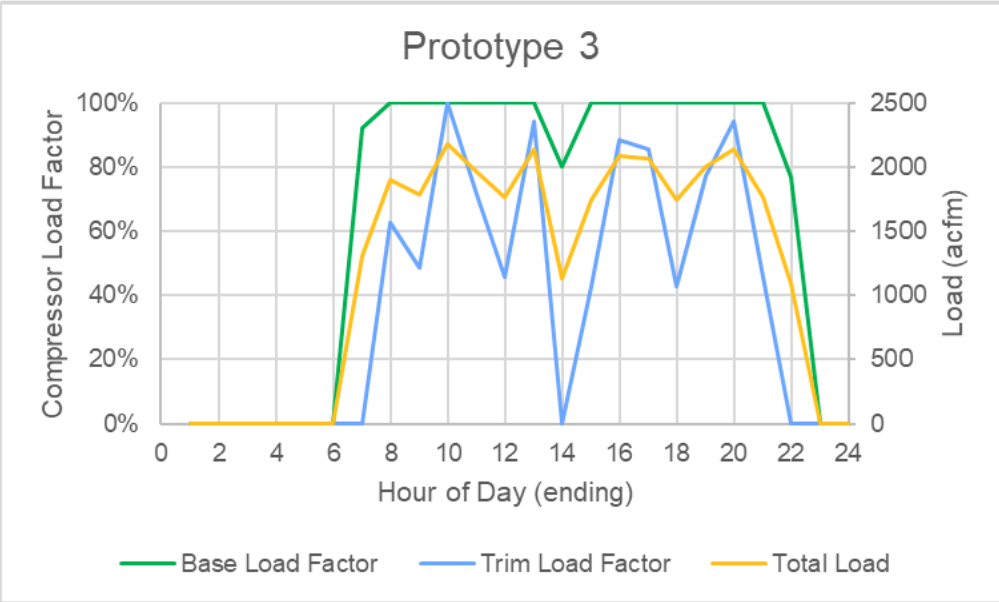
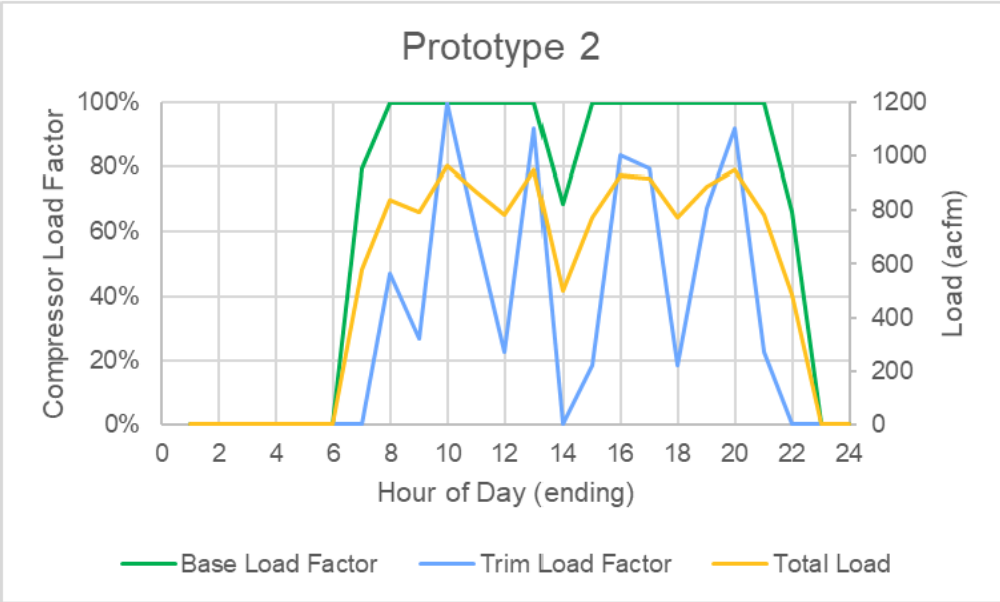
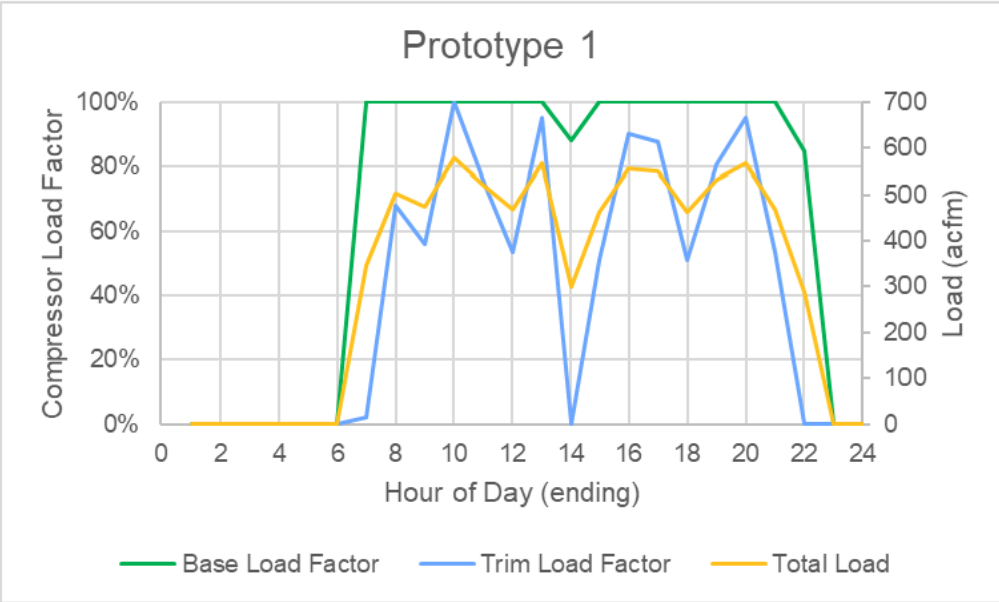
Prototypical Buildings

- Four established compressed air prototypes with varying capacity, trim, and baseload profiles:
 - 579 cfm
 - 966 cfm
 - 2,181 cfm
 - 4,666 cfm
- Load profiles based on empirical plant data aligned to previous code cycles.
- Two shift, 7-day operation

Climate Zones

- Hourly factors for GHG, LSC, and source energy vary by CZ

Energy Modeling Assumptions cont.



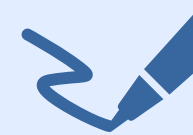
Key Modeling Assumptions



Standard Design

Code-compliant air compressors, controls, and distribution

1. Desiccant dryer selection for $DP \geq 35^\circ\text{F}$ →
2. Non-cycling refrigerated dryer →
3. Desiccant dryer on timed regeneration →
4. Heatless desiccant dryer →



Proposed Design

Code-compliant air compressors, controls, and distribution

1. Refrigerated dryer
2. Energy saving refrigerated dryer
3. Desiccant dryer on load-following regeneration
4. Heated desiccant dryer

Energy and Energy Cost Savings Methodology

Gathered from CAGI datasheets and manufacturer literature on 200 non-cycling refrigerated, 156 energy saving refrigerated, 215 heatless desiccant, and 135 heated desiccant dryers.

Design	Definition
Non-cycling refrigerated dryer	Specific power at full flow: 0.80 kW/100cfm Specific power at 10% flow: 7.35 kW/100cfm
Energy-saving refrigerated dryer	Specific power at full flow: 0.75 kW/100cfm Specific power at 10% flow: 2.23 kW/100cfm
Heatless desiccant dryer without regeneration controls	Purge rate: 15% of rated capacity Regeneration time: constant across all load conditions
Heatless desiccant dryer with regeneration controls	Purge rate: 15% of rated capacity Regeneration time: proportional to part-load conditions
Heated desiccant dryer with regeneration controls	Purge rate: 7.2% of rated capacity, proportional to part-load conditions Heater specific power: 1.2 kW/100cfm Regeneration time: proportional to part-load conditions

Do you agree or disagree with these values? Please let us know!

Incremental Cost Framework



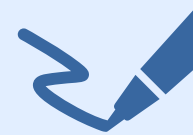
Baseline

First Cost

1. Equipment
2. Installation
3. Commissioning

30-Year Maintenance Costs

1. Equipment Replacement
2. Regular Maintenance



Proposed

First Cost

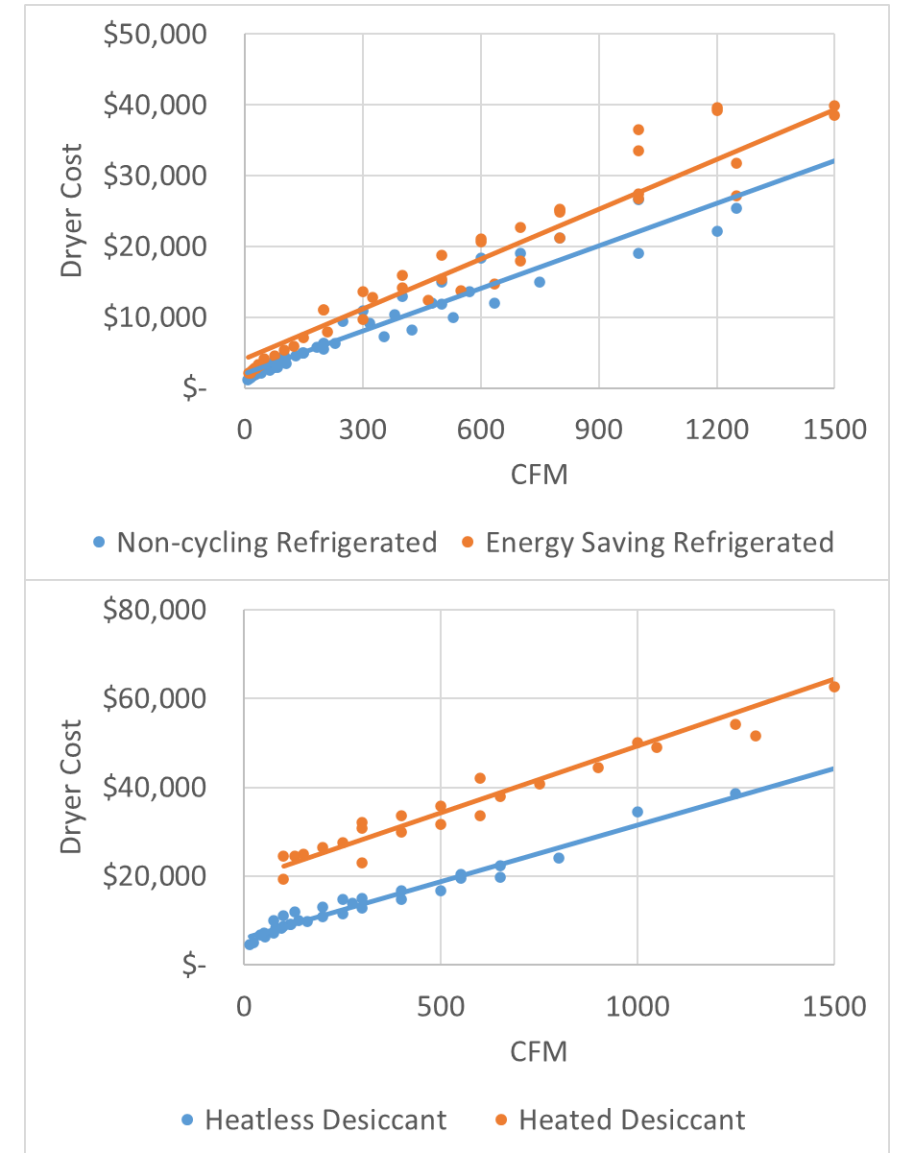
1. Equipment
2. Installation
3. Commissioning

30-Year Maintenance Costs

1. Equipment Replacement
2. Regular Maintenance

Incremental Costs

- Refrigerated dryer first costs collected via retail listings
- Maintenance costs negligible
- Estimated useful life of 13 years
- Heatless desiccant dryers estimated to cost \$1,650 per 100 cfm rated size with heated desiccant dryers having a 19% incremental cost premium
- Estimated useful life of 20 years
- Desiccant material replacement every ~10 years.
- \$430 per 100 cfm rated size
- Regeneration controls first cost \$2,625
- Probe recalibration every 3 years at \$567 and replacement every 10 years at \$1,900



Do you agree or disagree with these values? Please let us know! Incremental maintenance costs for heated dryers is still needed!

Cost Effectiveness Results

Standard Design	Proposed Design	Average Benefit-to-Cost Ratio
Non-cycling refrigerated dryer	Energy saving refrigerated dryer	94.9
Heatless desiccant dryer without regeneration controls	Energy saving refrigerated dryer	33.5
Heatless desiccant dryer without regeneration controls	Heatless desiccant dryer with regeneration controls	65.4
Heatless desiccant dryer with regeneration controls	Heated desiccant dryer with regeneration controls	8.9

Results vary by prototype and CASE team expects updates with new measure costs information.



Compliance Verification

- Key Aspects of Compliance Verification
- Barriers and Solutions
- Revisions to Compliance Software

Key Aspects of Compliance Verification

- Updates to NRCC-PRC-E (Process Certificate of Compliance form)
- Updates to NRCI-PRC-E (Process Certificate of Installation form)
- Updates to NRCA-PRC-01-F (Process Certificate of Acceptance form)
- Required plant dew point would be listed on compliance forms when desiccant dryers are specified
- Installing field technician verifies dew point controls in addition to existing compressed air testing
 - Observation of one regeneration cycle using dew point monitoring equivalent
- No updates to compliance software

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More information on

[CEC's 2028 proceeding website.](#)

We want to hear from you!

Next steps include:

- **Additional Stakeholder Engagement**
- **Final CASE Report Revisions**