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Compressed Air Dryers



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Final CASE Report



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Executive Summary

Compressed air dryers can account for a significant share of compressed air system energy use, yet current Title 24 requirements do not address dryer efficiency or selection. This proposal introduces requirements intended to improve dryer efficiency, reduce unnecessary energy consumption, and better align dryer technologies with system dew point requirements. The Statewide Codes and Standards Enhancement (CASE) Team will submit this proposal to the California Energy Commission (CEC) for consideration in the 2028 California Energy Code (Title 24, Part 6 or Energy Code). To be adopted, the code change must be cost-effective and technically feasible. The proposed requirements support California's long-term energy efficiency and greenhouse gas (GHG) reduction goals.

The Statewide CASE Team developed the proposal through discussions with compressed air system manufacturers, consultants, and other industry specialists. Public stakeholder meetings were held on October 29, 2025 and March 19, 2026, and additional feedback was gathered through individual discussions. Stakeholder input informed the proposed code language, analysis assumptions, and compliance approach. The Statewide CASE Team revised assumptions and proposed code language in response to feedback offered during public meetings and in private discussions.

The Statewide CASE Team recognizes ongoing systemic inequities in environmental and social justice (ESJ) communities and is developing code change proposals with careful consideration of potential unintended impacts. The Statewide CASE Team evaluated each measure for potential impacts on ESJ communities, and those considerations and findings are documented in the CASE Report.

Proposed Code Change

The proposal would establish mandatory requirements for compressed air dryers in systems with a combined compressor capacity of 25 horsepower (hp) or greater, applicable to new construction, additions, and alterations. Dryer selection would be based on required system dew point. For systems with a dew point of 35°F or higher, energy-saving refrigerated dryers with load-matching features such as cycling, thermal mass, or variable-speed drives would be required.

For systems requiring dew points below 35°F, desiccant dryers would be required to include load-following regeneration controls to reduce energy use. Additionally, desiccant dryers with capacities greater than 300 cubic feet per minute (cfm) would be required to incorporate internal or external heating to reduce purge air consumption.

Compliance forms would require documentation of dew point requirements to ensure appropriate system design.

Benefits of Proposed Change

Many compressed air systems use dryers that provide lower dew points than required or rely on technologies that consume unnecessary energy. By requiring dryer selection based on actual dew point needs and incorporating energy-saving controls, the proposal reduces both dryer energy consumption and compressed air losses associated with purge air use. Modeling indicates substantial energy savings, including approximately 50 percent reductions for energy-saving refrigerated dryers compared to non-cycling models, 85 percent reductions for energy-savings refrigerated dryers replacing heatless desiccant models, and additional savings from load-following regeneration controls and heated desiccant technologies.

These improvements would lower operating costs for industrial facilities without negatively impacting system performance, capacity, or manufacturing flexibility. The proposal also improves code clarity, supporting consistent implementation and compliance.

Compliance and Enforcement

Compliance would build on existing compressed air requirements in Title 24 and is expected to be straightforward for designers, contractors, and enforcement agencies. Updated compliance forms (NRCC-PRC-E, NRCI-PRC-E, and NRCA-PRC-01-F) would capture dryer type, dew point requirements, and verification of control functionality. Plans would need to indicate the required dew point if it is less than 35°F.

The proposal would add checks during plan review and acceptance testing. Training for designers, installers, and inspectors would support implementation and effective enforcement.

Market Assessment

The compressed air market is mature, with broad availability of energy-saving refrigerated dryers and desiccant dryers with regeneration controls. Stakeholder interviews indicated that many facilities already use these technologies; however, adoption remains inconsistent despite their demonstrated cost-effectiveness.

Economic impacts are expected to be modest, with small increases in upfront costs offset by long-term energy savings. The proposal is not expected to disrupt jobs or create new job categories but may result in modest increases in employment.

Cost Effectiveness

Cost-effectiveness analysis showed benefit-to-cost ratios (BCR)¹ ranging from 1.9 to 75.3 depending on system configuration and modeling scenario, with some cases resulting in net incremental cost savings. These results demonstrate that energy savings would more than offset incremental costs in most scenarios.

Statewide Impacts

Table 1: Summary of Statewide Impacts

Metric ^a	Total Statewide Impacts
Annual Electricity Savings (GWh)	16.99
Peak Demand Reduction (MW)	1.58
Annual Natural Gas Savings (Million Therms)	N/A
Annual Source Energy Savings (Million kBtu)	23.25
30-Year Long-term System Cost Savings (Million 2029 PV\$)	138.96
Annual Avoided GHG (Metric Tons CO ₂ e/yr)	1,235.47

- a. Values represent impacts from buildings permitted during the first year the code is in effect. Positive values indicate savings or reductions.

¹ The benefit-to-cost ratio (BCR) compares benefits or cost savings to costs over the 30-year period of analysis. Proposed code changes with a BCR of 1.0 or greater are cost effective.

Acronyms

Table 2 presents a list of acronyms used in this report. Title24stakeholders.com also maintains a [glossary of terms](#).

Table 2: List of Acronyms

Acronym	Definition
acfm	Actual Cubic Feet Per Minute
ACM	Alternative Calculation Method
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
ATT	Acceptance Test Technician
BCR	Benefit-to-cost Ratio
BEM	Building Energy Modeling
Btu	British Thermal Units
CAGI	The Compressed Air & Gas Institute
CALGreen	California Green Building Standards Code
Cal/OSHA	California Division of Occupational Safety and Health
CARB	California Air Resources Board
CASE	Codes and Standards Enhancement
CBSC	California Building Standards Commission
CBECC	California Building Energy Code Compliance Software
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CBO	Community-Based Organization
cfm	Cubic Feet Per Minute
CO₂e	Carbon Dioxide Equivalent
CPUC	California Public Utilities Commission
CSE	California Simulation Engine
CTF	Conduction Transfer Functions
CZ	Climate Zone
DAC	Disadvantaged Community
DGS	California Department of General Services
DOAS	Dedicated Outdoor Air System
DOSH	Division of Occupational Safety and Health
ECC	Energy Code Compliance
EIR	Environmental Impact Report
EPIC	Electric Program Investment Charge

Acronym	Definition
ESJ	Environmental and Social Justice
EUL	End of Useful Life
FSOR	Final Statement of Reasons
GHG	Greenhouse Gas
GWh	Gigawatt-Hour
GWh/yr	Gigawatt-Hour Per Year
HVAC	Heating, Ventilation, and Air Conditioning
IDF	Input Data File
IOU	Investor-Owned Utility
ISO	International Organization for Standardization
ISOR	Initial Statement of Reasons
kBtu	Thousand British Thermal Units
Kg/s	Kilograms per Second
kWh	Kilowatt-Hour
kWh/year	Kilowatt-Hour Per Year
LED	Light Emitting Diode
LPD	Lighting Power Density
LSC	Long-term System Cost
MG	Million Gallons of Water
MW	Megawatt
NAICS	North American Industry Classification System
NPDI	Net Private Domestic Investment
OCx	Ongoing Commissioning
PEP	Public Engagement Plan
PLC	Programmable Logic Controller
psig	Pounds per Square Inch Gauge
PV	Present Value
SDD	Standards Data Dictionary
SOC	Standard Occupational Classification
SPMS	Saturation Pressure Measurement Sensors
SRIA	Standardized Regulatory Impact Assessment
TBtu/year	Tera British Thermal Unit Per Year
UL	Underwriters Laboratories
VSD	Variable Speed Drive
W	Watt

1. Introduction

1.1 Report Context

This proposal describes specific energy efficiency code changes (referred to as “measures”) aimed at reducing wasteful, uneconomic, inefficient, or unnecessary consumption of energy in California. These measures are submitted to the California Energy Commission (CEC) for consideration and potential inclusion in California’s Energy Code (Title 24, Part 6), which sets statewide energy efficiency requirements for newly constructed buildings and for additions and alterations to existing buildings. Measures may also be considered for inclusion in CALGreen (Title 24, Part 11) as voluntary energy efficiency standards, which would take effect only if adopted by a local jurisdiction seeking to exceed the minimum requirements of the Energy Code. Measures submitted to the CEC will be reviewed, may be modified, and may be incorporated into a broader regulatory package proposed and adopted by the CEC. To be included in the Energy Code, proposed measures must be both cost effective and technically feasible.

1.2 Proposal Sponsors

Three California Investor-Owned Utilities (IOUs)—Pacific Gas & Electric Company, San Diego Gas & Electric, and Southern California Edison jointly sponsored this effort. Where the term “Statewide CASE Team” is used in this report, it refers to the authors and State Building Codes Advocacy activities supported through the Codes and Standards program.

1.3 Stakeholder Engagement to Inform Proposal

When developing the code change proposal and associated technical information presented in this report, the Statewide CASE Team worked with many industry stakeholders, including manufacturers of compressed air dryers, compressed air system designers, industry association representatives, and others involved in the code compliance process. The proposal incorporates feedback received during a public stakeholder workshop that the Statewide CASE Team held on October 29, 2025 (Statewide CASE Team, 2025a) (Statewide CASE Team, 2025b).

After presenting the initial code language and proposal during the public stakeholder workshop, the Statewide CASE Team conducted extensive interviews with experts from five major manufacturers of compressed air dryers and representatives of the preeminent air compressor industry association: The Compressed Air & Gas Institute (CAGI). These subject matter experts have deep knowledge of air dryers and how entire

compressed air systems are designed, specified, operated, and maintained. The Statewide CASE Team also interviewed experts from four compressed air system consulting firms that provide design, specification, and energy-efficiency services. All these interviewees were already familiar with Title 24 and the California marketplace and were thereby able to provide feedback on the preliminary proposed code language.

The interviews were also instrumental in gathering information on design practices, market adoption rates, barriers, measure costs, technical considerations, and other details that only subject matter experts could fully explain. The Statewide CASE Team has incorporated this collective feedback into the code language included in this Final CASE Report and has accounted for the gathered information in the calculations underlying the proposal.

See Appendix E for details on the Statewide CASE Team's stakeholder engagement.

1.4 Addressing Energy Equity and Environmental Justice

The Statewide CASE Team recognizes, acknowledges, and accounts for a history of prejudice and inequality in environmental and social justice (ESJ) communities.² These issues persist today. To minimize the risk of perpetuating inequity, code change proposals were developed with intentional consideration of the unintended consequences on ESJ communities.

When analyzing impacts for nonresidential buildings, the Statewide CASE Team reviewed each nonresidential building type through the lens of the four criteria: cost, health, resiliency, and comfort. The Statewide CASE Team examined which building types are used by ESJ communities most frequently and evaluated the allocation of impacts related to the following areas among all populations. Some building types have unique environmental justice concerns due to their common uses, location, or other factors.

² The CPUC refers to ESJ communities as "low-income or communities of color that have been underrepresented in the policy setting or decision-making process, are subject to a disproportionate impact from one or more environmental hazards, and likely to experience disparate implementation of environmental regulations and socio-economic investments in their communities" (CPUC 2022). ESJ communities also include the CPUC definition for Disadvantaged Communities, which comprises "(1) Census tracts receiving the highest 25 percent of overall scores in CalEnviroScreen 4.0 (1,984 tracts); (2) Census tracts lacking overall scores in CalEnviroScreen 4.0 due to data gaps, but receiving the highest 5 percent of CalEnviroScreen 4.0 cumulative pollution burden scores (19 tracts); (3) Census tracts identified in the 2017 DAC designation as disadvantaged, regardless of their scores in CalEnviroScreen 4.0 (307 tracts); and (4) Lands under the control of federally recognized Tribes (OEHHA 2022).

The Statewide CASE Team will continue to build relationships with CBOs and other stakeholders to improve the identification of potential impacts for future code cycles and is open to additional resources that can contribute to this effort.

2. Measure Description

2.1 Proposed Code Change

This measure would add air dryer requirements for compressed air systems with total combined compressor horsepower (hp) greater than or equal to 25 hp. Efficient dryer selection and controls would be required for new compressed air systems or when dryers in existing systems are replaced or added. Since the dryer selection requirements depend on whether a system requires a dew point above or below 35°F, the proposal would require construction or compliance form documents to list the required dew point for a compressed air system if it is below 35°F. In addition to the required dew point, certain provisions would also depend on system size.

If the required dew point is 35°F or greater, an energy-saving refrigerated dryer is required. This threshold was chosen because refrigerated dryers cannot readily produce dew points below 35°F at typical conditions. An energy-saving refrigerated dryer is one that has load-matching features, such as cycling, thermal mass, digital scroll compressors, or variable-speed drive (VSD) compressors, rather than constant-speed operation with hot-gas bypass capacity control.

All desiccant air dryers serving dew points below 35°F would be required to have load-following regeneration controls that reduce energy consumption by limiting regeneration time and associated energy consumption from purge air, blowers, or heaters. This requirement would not apply to heat-of-compression dryers.

Finally, all desiccant dryers with a capacity greater than 300 cfm would be required to have internal or external heating to reduce purge air use during desiccant regeneration. This threshold was chosen because below this point, products are less available and may be less cost-effective due to reduced purge-air energy savings.

Table 3 summarizes the scope of the proposed code change.

Table 3: Scope of Proposed Code Change

A ☒ indicates the proposed code change is relevant.

Building Type(s)		Construction Type(s)	Type of Change
☐ Single Family		☒ New Construction	☒ Mandatory
☐ Multifamily		☒ Additions	☐ Prescriptive
☒ Nonresidential (not Group R uses)		☒ Alterations	☐ Performance
Application Climate Zones	Energy Code Sections	Compliance Forms	Sections of ACM Reference Manuals
Climate Zones 1-16	- Part 6, Section 201 [Section 100.1(b)] - Part 6, Section 905.1 [Section 120.5(e)] - Part 6, Section 905.4 [Section 141.1] - Nonresidential Reference Appendix Section NA7.13	- NRCC-PRC-E - NRCI-PRC-E - NRCA-PRC-01-F	N/A
Third Party Verification		Updates to Compliance Software	
☒ No changes to third party verification		☒ No updates	
☐ Update existing verification requirements		☐ Update existing feature	
☐ Add new verification requirements		☐ Add new feature	

2.2 Benefits of Proposed Change

This proposal builds on previous efforts to reduce the energy consumption of compressed air systems. Air compressor systems were first covered by Title 24, Part 6, in 2013. Mandatory measures stipulated sizing and control requirements for baseload and trim air compressors. The Statewide CASE Team recommended compressed air system requirements as part of the 2022 code cycle update, with a focus on optimization and sustained efficiency of the distribution and load-side components. The 2022 code changes added mandatory requirements for pipe sizing, monitoring, and leak testing.

The proposed 2025 air dryer code change proposals originated during the development of compressed air system measures for the 2022 Title 24, Part 6 code cycle. Air dryer measures were not pursued at that time because they did not align with the selected measures focus on the distribution system and load-side of compressed air. Air dryer requirements were identified as a possible measure during discussion and measure

selection amongst the Statewide CASE Team but were not prioritized at the time and were instead reserved for future efforts.

This proposal would advance this multi-cycle effort by substantially reducing energy consumption in compressed air systems and minimizing the unnecessary specification of energy-intensive dryers. The proposed language would reduce energy bills and consumption for industrial facilities without any negative impact on operating capacity or manufacturing flexibility. The proposed changes would also add definitions and clarity regarding the coverage of additions and alterations that would ease the compliance process for the existing compressed air measures.

In covered situations, the proposed measures would dramatically reduce dryer energy consumption. While the savings would depend on the prototype in question, energy savings are about 50 percent for an energy-saving versus non-cycling refrigerated dryer, 85 percent for an energy-saving refrigerated dryer versus a heatless desiccant dryer, 30 percent for a desiccant dryer with regeneration controls versus one without, and 15 percent for a heated desiccant dryer over a heatless desiccant dryer.

(Previously, “energy-saving” dryers were often referred to as “cycling.” In this report, “energy-saving” is used as it is more comprehensive and a better representation of the variety of techniques for reducing refrigerated air dryer energy consumption.)

2.3 Background Information

Compressed air systems greater than 25 hp in size (roughly equivalent to 100 cfm rated output) are typically found in industrial facilities. Industrial facilities use compressed air for motive power for pneumatic machinery, hand tools, controls, material handling, and automation. It is often called the “fourth utility” because it is commonly used in manufacturing facilities. It is present in about 82 percent of industrial buildings, accounting for about 10 percent of total industrial sector electrical energy use (Xenergy, 2001; Greenstone, et al., 2019; Beneditti, et al., 2016).

Compressed air systems are highly customized, and the design at any given location depends on process needs, space, and building environmental conditions. They typically include several primary components: one or more compressors, air treatment, storage volume, and distribution piping throughout the facility. This proposal targets the dryer, the primary energy consumer in the compressed air treatment section.

Compressed air dryers reduce the moisture content of compressed air to an acceptable level for the plant’s needs, typically expressed as a pressure dew point value. Dryers are essential in industrial compressed air systems to protect piping, equipment, and processes from the damaging effects of moisture. Dryers should be specified based on the plant’s needs and operating conditions. The plant’s necessary dew point or air quality level typically drives air dryer selection. The dew point is dictated by critical

moisture-sensitive end-uses or by piping exposed to ambient temperatures cold enough to cause condensation.

There are several kinds of dryers: refrigerated, regenerative desiccant, deliquescent, and membrane (CAGI, 2017). Each of these works under a different principle and has different applications:

- Refrigerated dryers use a refrigeration cycle to condense moisture out of the compressed air on condensing coils within the dryer. Because of the operating characteristics of refrigeration systems and the thermodynamic properties of common refrigerants, standard refrigerated air dryers generally cannot produce pressure dew points lower than 35°F under typical operating conditions. Accordingly, 35°F was selected as the threshold for applications that can be effectively served by refrigerated air dryers rather than lower-dew-point desiccant air dryers. Refrigerated air dryers are the most common type of compressed air dryers and are suitable for most operating conditions and plant needs.
- Regenerative desiccant dryers (hereafter called “desiccant dryers”) use a bed of desiccant material to adsorb moisture from the compressed air. Regenerative desiccant dryers use twin towers of material to adsorb moisture, alternating cycles so one tower dries air while the other regenerates. Delivering dew points from -40°F to -100°F, they are essential for plants with critical low-moisture processes or piping that is exposed to freezing temperatures (below 35°F) during operating hours.
- Deliquescent dryers absorb moisture with a consumable material that dissolves over time. They provide dew point suppression rather than a fixed rating and are rarely used for whole-plant treatment.
- Membrane dryers are not used for whole plant air treatment. They are more commonly used for point-of-use drying at a specific, critical end-use or for gas separation.

This proposal focuses on energy-efficiency improvements for refrigerated and desiccant dryers that provide plant-wide drying. Compressed air systems will virtually always have varying load and conditions with lower dryer demand than the design point. Refrigerated dryers with automatic capacity-control features take advantage of this variance to match capacity to load and reduce energy consumption. Desiccant dryers can use design and control features to limit the energy consumption of the necessary material regeneration process.

Refrigerated dryers operate either as non-cycling units (constant energy consumption) or energy-saving models that modulate to match load power via compressor cycling, digital scroll compressor controls, or variable-speed drives. Cycling refrigerated dryers use a thermal mass to retain drying capacity while the compressor turns on and off.

Digital scroll dryers load and unload the compressors to match drying power to the load. Variable-speed dryers do the same by varying the compressor speed. Thus, an energy-saving refrigerated dryer matches energy consumption to load, avoiding waste via the hot gas bypass typically used in non-cycling models.

When energy-saving refrigerated dryers are sized in accordance with manufacturer instructions for the design-point conditions (when loads and pressures are most extreme), they will operate below full-rated capacity at almost all times and use less energy by operating at part-load capacity. Non-cycling refrigerated dryers consistently consume energy at design-point conditions, without any part-load efficiency benefit.

Desiccant dryers must periodically regenerate the material once it becomes saturated. This can be done in a few different ways, each with its own energy intensity.

- The most energy-intensive method is heatless, purge air regeneration, where compressed air is passed through the tower being regenerated to remove water from the desiccant. Heatless purge air is typically about 17 percent of the total rated capacity of the dryer – a substantial consumption of compressed air, which is energy intensive to produce (DOE, 2016). As a result, heatless purge desiccant dryers can represent a significant continuous compressed air load in facilities where they are used.
- Internal or external heating of the purge air can amplify its drying ability and therefore reduce the amount of air needed. Purge air is heated via electrical resistance, but that additional electrical load reduces the energy-intensive purge air to about seven percent of the rated capacity. Other heat sources, such as waste heat from the air compressors (“heat of compression dryers”), can be used to heat purge air.
- Instead of compressed purge air, a blower can be added to pass heated ambient air through the desiccant. The combined energy of the blower and heater energy is less than the energy required to compress consumption air for purging.
- While basic fixed timers often cause excessive regeneration, demand-based controls monitor dew point or moisture levels to initiate cycles only when strictly necessary. This load-matching strategy significantly reduces energy consumption across all desiccant dryer types by aligning regeneration with actual air usage. Even dryers that serve compressed air systems with constant load conditions that face varying moisture loads.

These dryer design choices and controls are well-established and widely available in the California market.

There are no existing codes or standards that would conflict with the code change proposal. Cycling refrigerated dryers were once included in California programs via a

deemed measure workpaper, which has since expired (Southern California Edison, 2017).

The primary rating program for compressed air dryers has been developed by the Compressed Air and Gas Institute (CAGI). CAGI is a compressed air equipment manufacturer trade association that undertakes efforts to standardize the industry, provide training and documentation for market actors, and support high-quality, reliable compressed air products. CAGI has established a voluntary ratings program for refrigerated dryers and is working on a similar standard for desiccant dryers. Manufacturers of air compressors and compressed air dryers can, and often do, submit their equipment for rating under this program to produce independently verified performance data sheets. Refrigerated dryers are rated at standard conditions of 100 °F inlet saturated compressed air temperature, 100 psig (ISO, 2007).

The proposed Title 24, Part 6 code addresses scenarios where dryer selection ignores best practices, accelerating the adoption of proven but underutilized efficiency measures.

2.4 Modifications to Energy Code Documents

This section provides descriptions of how the proposed code change will affect each Energy Code document. See Section 7: Proposed Language of this report for detailed revisions to code language.

2.4.1 Energy Code Change Summary

SECTION 200 – DEFINITIONS AND RULES OF CONSTRUCTION

Section 201 [Section 100.1(b)] The proposed changes include removing the definition for Online Compressors since it no longer applies after the changes made in the 2022 code cycle and modifying the definitions for Compressed Air System and Trim Compressor for added clarity.

SECTION 905 – COMPRESSED AIR SYSTEMS (NEWLY CONSTRUCTED, ADDITIONS, ALTERATIONS)

Section 905.1 [Section 120.6(e)]: The proposed changes include new requirements for compressed air dryers. These include the use of energy-saving refrigerated dryers where applicable, the use of regeneration controls for desiccant dryers, and the use of heated desiccant dryers when desiccant dryers above a threshold of 300 cfm are specified. Existing exceptions related to additions and alterations are removed from this section and moved to Section 905.4.

Section 905.4 [Section 141.1]: The proposed changes include new language for compressed air systems in additions and alterations and moves existing language from 905.1 without increasing or decreasing stringency.

2.4.2 Reference Appendices Change Summary

NA7.13 Compressed Air System Acceptance Tests: The proposed changes add verification testing of the dryer desiccant regeneration controls to the existing compressed air reference appendix language in NA7.13.

2.4.3 Compliance Manuals Change Summary

The proposed code change would not modify the Compliance Manual.

2.4.4 Alternative Calculation Method Reference Manual Change Summary

The proposed code change would not modify the Alternative Calculation Method Manual.

2.4.5 Compliance Forms Change Summary

The proposed code change would modify some existing compliance forms (NRCC-PRC-E, NRCI-PRC-E, and NRCA-PRC-01-F) but would not require any new forms. These documents would require certification of the dryer type aligned with the specified required dew point. Model numbers would be listed on forms, allowing a plan checker to confirm that a model has the required features and for inspectors to verify that the correct model was installed. For refrigerated dryers, this would mean verifying that a model has compliant energy-saving features. Forms would also include results of the field verification test to be performed by a field technician if a desiccant dryer with regeneration controls is installed.

2.5 Measure Context

2.5.1 Comparable Model Codes or Standards

There are no relevant model codes or standards for the efficiency of compressed air dryers at the local, state, federal, or international level. Air dryers are not currently covered by any energy, mechanical, or appliance code.

2.5.2 Interactions with Other Regulations

There are no existing regulations at any level that would conflict with the proposed language for compressed air dryers. The proposed changes and resultant savings do

not overlap with existing Title 24, Part 6 compressed air requirements or savings attribution.

There is a single test standard for compressed air dryers, which establishes rating test conditions and procedures for refrigerated and desiccant models: ISO 7183 (ISO, 2007). However, this is not codified and can be voluntarily employed by manufacturers at their discretion. CAGI has established a voluntary program through which manufacturers can submit their products for independent testing and verification to produce data sheets that are then assured to be accurate and independent from the manufacturers themselves (CAGI, 2025). This program currently provides refrigerated dryer ratings and data sheets, while a similar desiccant dryer program is under development. The CAGI program does not conflict with the proposed code changes but does support market actors in their compliance by providing reliable performance data that can be used in the dryer specification process.

3. Compliance and Enforcement

3.1 Compliance Considerations

The Statewide CASE Team believes that compliance and enforcement of the proposed measure are feasible and would not add a significant compliance or enforcement burden on building code officials. Confirmation steps would need to be taken during the permit application to ensure compliance with the proposed compressed air dryer requirements. Plans must indicate the required dew point of a compressed air system if the required dew point is less than 35 °F. New fields in the Process Systems Certificate of Compliance document NRCC-PRC-E, the Process System Certificate of Installation document NRCI-PRC-E, and the Compressed Air Systems Acceptance document NRCA-PRC-01-F would need to be created and completed.

Designers: Designers would need to be aware of the new compressed air dryer requirements in section 905.1 [Section 120.6(e)] (for new systems) and 905.4 [Section 141.1] (for modifications) to design compliant compressed air systems. They would need to complete an updated NRCC-PRC-E form and submit design documents indicating a compliant design.

Plan Reviewers: During the permit application phase, reviewers would confirm that the design documents include the required dew point for the compressed air system and that the submitted NRCC-PRC-E form meets the requirements for compressed air dryers.

Installation contractors: Installation contractors would need to correctly install compliant compressed air dryers, which is already part of normal operating procedures. The installation contractor would also need to fill in the NRCI-PRC-E form.

Field technicians: The proposed measure would not substantially impact field technicians. They would be responsible for acceptance testing of desiccant dryer regeneration controls, though this would only entail verifying that the dew point regeneration controls are turned on. While this check is not expected to be burdensome, it may require navigating internal menus to access system settings and would thus likely be easier for a field technician than a building inspector. In addition, some maintenance would be necessary to maintain sensors associated with the required dew point controls.

AHJ building inspectors: The AHJ building inspector would need to verify the installation of a compliant compressed air dryer.

The Statewide CASE Team is not aware of any conflict with any existing definitions in other parts of Title 24.

3.2 Impact on Market Actors

Table 4 summarizes impacts on market actors and suggests outreach and education that might be helpful to support market actors as they prepare for the effective date of the requirements.

Table 4: Impacts on Market Actors and Suggested Training and Education Opportunities

Market Actor	Impact(s)	Suggested Outreach and Education
Owner/Developer^a	Be aware of compressed air dryer requirements, and plan for additional costs where relevant.	Additional training likely unnecessary.
Design Professional^b	Be aware of new requirements and code triggers when designing compressed air systems. Ensure that dew point requirements are included on plans or procurement documents, so that they can be referenced when completing dew point fields in compliance documentation. Complete new fields of NRCC-PRC-E Compressed Air section.	Industrial process compressed air design firms should be provided training on the energy code including compliance requirements and compliance documentation.
Construction Team^c	Install a compressed air dryer consistent with the proposed requirements, consistent with standard practice. Complete fields in compressed air dryer section of NRCI-PRC-E. Perform verification testing to confirm controls comply with requirements. Put results on NRCA-PRC-01-F form and submit to building inspector and building owner.	System installers should be provided training on energy code updates and supporting documentation, compliance requirements, acceptance testing, and compliance documentation.
Building Department^d	Plan Reviewers will have an additional requirement to check when reviewing NRCC form and design documents. Building inspectors will need to review NRCA and NRCI forms and confirm that installed air dryers meet new requirements.	Provide education and training to local building department plans examiners to familiarize them with new code language.
Verification Tester^e	No impact.	Additional outreach likely unnecessary.
Manufacturers and Distributors	Be aware of compressed air dryer requirements when working with clients on product selection.	Outreach to manufacturers and distributors to make sure they are aware of requirements. Consider developing a compressed air Fact Sheet.

- Owner/Developer is funding the project and is the primary decision maker.
- Design professionals include architects, engineers (mechanical, electrical, plumbing, structural), specification writers, cost estimators, commissioning agents, lighting designers, and energy consultants.
- Construction team includes general contractors, design-build contractors, installation contractors (e.g., HVAC, plumbing, electrical), commissioning agents, and tradespeople.
- Building departments include plan reviewers, building inspectors, specialty inspectors, permit counter technicians and third-party plan review and inspection.

- e. Verification testers include commissioning agents, ECC Raters, and Acceptance Test Technicians.

The [2028 CASE Methodology Report](#) presents a quantitative assessment of how changes to the California building code impact builders, building designers and energy consultants, and building owners and occupants. While the analysis in the methodology report is not specific to the code change(s) presented in this report, this measure focuses on construction teams and building occupants, since these market actors are expected to experience the most direct impacts from compressed air dryer requirements. The following provides a qualitative description of how this specific code change affects various market actors and additional quantitative analyses of its potential impacts on building industry subsectors.

Construction team. The proposed change would likely affect industrial and commercial construction teams; however, it would likely not impact firms focused on the construction or retrofitting of industrial buildings, utility systems, public infrastructure, or other heavy construction. The proposed change would not affect all firms and workers in the industrial and commercial building industries equally; instead, it would primarily affect specific subsectors within the industry. Table 5 shows the commercial building subsectors that the Statewide CASE Team expects to be impacted by the changes proposed in this report.

Building occupants (owners and tenants). The proposed code change would have incremental costs and would reduce building owners' utility bills throughout the measure lifetime. See the [2028 CASE Methodology Report](#) for a description of how LSC savings relate to occupant utility bill savings.

Table 5: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to Code/Standard by Subsector in 2025 (Estimated)

Construction Subsector	Establishments*	Employment	Annual Payroll (Billions \$)
Commercial Building Construction	5,491	87,450	10.6
Other Nonresidential Exterior Contractors	234	2,259	0.1
Nonresidential Electrical Contractors	3,245	72,794	7.8
Nonresidential Plumbing & HVAC Contractors	2,270	55,182	5.8
Other Nonresidential Equipment Contractors	580	9,749	1.1
Nonresidential Site Preparation Contractors	1,147	19,273	1.9
All Other Nonresidential Trade Contractors	948	17,084	1.7

Source: (State of California, n.d.)

*An establishment is a single economic unit, typically at one physical location, that engages in one, or predominantly one, type of economic activity for which a single industrial classification may be applied. Many businesses are composed of multiple establishments. US Bureau of Labor Statistics, Handbook of Methods. <https://www.bls.gov/opub/hom/cew/concepts.htm>

Manufacturers. As discussed in Section 4.1.1, multiple manufacturers and installers of compressed air systems operate in California, and these businesses would sell and install compressed air dryers. Refer to Section 4.4 for more information on the resultant impact on California jobs.

3.3 Compliance Software Updates

Compliance software updates are not required for this measure proposal.

3.4 Cost of Enforcement

The Statewide CASE Team acknowledges that changes to the code will impact enforcement costs. This report is an evaluation of specific measures, and the collective impact of all proposed changes for the 2028 Title 24, Part 6 may represent an increase in training and/or workload for enforcement personnel.

Enforcement costs would include training enforcement officials to ensure they can adequately enforce the proposed measure.

The incremental enforcement requirement additions are small, as Title 24, Part 6 already includes requirements for compressed air systems that mandate plan reviews and acceptance testing. Additional costs include providing education and training to local building officials to enable them to adequately enforce the proposed measure. Plans examiners would need to review the plans to ensure the correct dryer, dew point,

and desiccant specification. System installers would also need training on the requirements for measure compliance. Field technicians would need to confirm verification of the dryer desiccant regeneration controls through acceptance testing. Because requirements for compressed air systems already exist, additional steps would be added to existing inspections, but no additional inspections will be required.

Plan review would consist of reviewing the Process Systems Certificate of Compliance document NRCC-PRC-E, ensuring that it meets the new code requirements and is consistent with the drawings and specifications.

Inspection review would consist of reviewing the Process System Certificate of Installation document NRCI-PRC-E, and the Compressed Air Systems Acceptance document NRCA-PRC-01-F and ensuring that the information on the forms is consistent with the approved NRCC-PRC-E forms and with what is actually installed.

4. Market and Economic Analysis

4.1 Market Structure and Availability

4.1.1 Current Market Structure and Availability

The market for compressed air systems includes air compressor manufacturers, auxiliary equipment manufacturers, equipment distributors, contractors, architect-engineering firms, compressed air system users, and trade associations. Air compressor manufacturers sell compressors and packages, while auxiliary manufacturers supply components like dryers, filters, and piping. Air compressor and equipment distributors provide information and bids and sell compressor system components to end users, service providers, or design-build contractors. Distributors may provide design services, but otherwise contractors and architect-engineering firms provide planning and specifications for the given needs and loads, including the dew point required for a particular compressed air application.

Compressed air system owners and operators are typically responsible for the operation and maintenance of compressed air systems. Trade associations are organizations of industry representatives that collaborate to promote cooperation among stakeholders, provide training and best practices, develop standards, and improve the quality of compressed air dryer marketplace offerings for the general public. In addition to these stakeholders, various consultants provide services such as energy efficiency, design services, and performance assessments to practice end users.

The relationship between these stakeholders is shown in Figure 1.

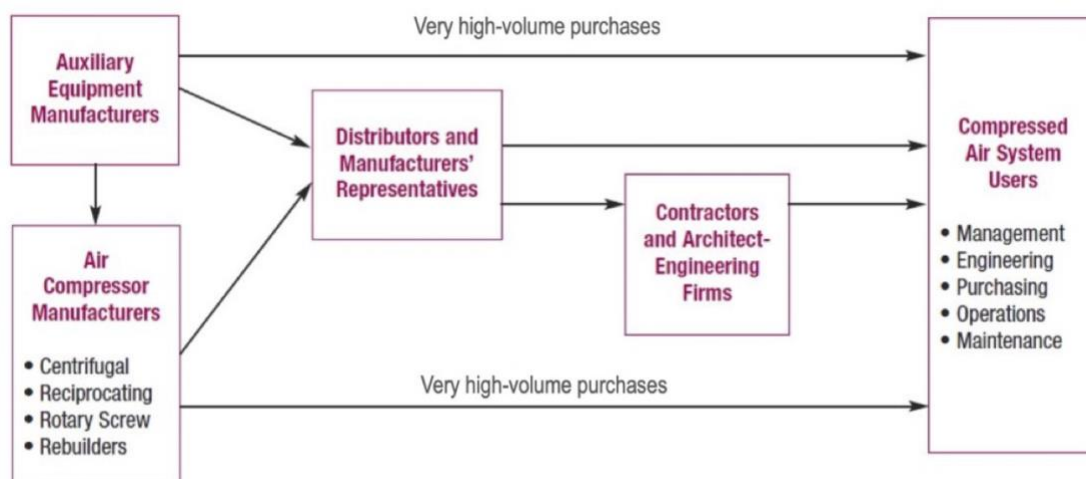


Figure 1: Compressed air system market.

Source: DOE 2016

The market for compressed air systems is mature, with multiple manufacturers and suppliers offering designers and contractors many options for systems and auxiliary equipment. Multiple air dryer manufacturers serve the refrigerated and desiccant markets and offer load-following controls for desiccant regeneration. Table 6 lists companies that the Statewide CASE Team has identified as major market actors.

Table 6: Major Compressed Air System Market Actors

Company	Market Actor Type	Product Offering	Headquartered in California
Atlas Copco	Manufacturer	Compressor and auxiliary equipment	No
Blueline Air Systems	Supplier	Air compressor	Yes
CASEI	Distributor	Compressor and auxiliary Equipment	Yes
CAGI	Trade Association	-	No
California Air Tools	Manufacturer	Compressor and auxiliary equipment	Yes
Champion Air Dryers	Manufacturer	Air dryers	No
Compressed Air Challenge	Trade Association	-	No
Compressed Air Consultants	Compressed air system experts	-	No
Elgi North America	Manufacturer	Compressor and auxiliary equipment	No
Ingersoll-Rand	Manufacturer and Distributor	Compressor and auxiliary equipment	No
Kaeser	Manufacturer and Supplier	Compressor and auxiliary equipment	No
KSI	Manufacturer	Compressor and auxiliary equipment	No
Thomasnet	Distributor	Compressor and auxiliary equipment	No
Machine Tools	Distributor	Compressor and auxiliary equipment	No
Q Air California	Manufacturer	Compressed air auxiliary equipment	Yes
Pattons	Distributor	Compressor and auxiliary equipment	Yes
ZEKS	Manufacturer and Supplier	Auxiliary Equipment	No

The Statewide CASE Team originally proposed a requirement for a dedicated air dryer per trim compressor but has dropped this requirement based on this stakeholder input. However, stakeholder interviews indicated that optimization of the number of compressors per air dryer is an emerging trend in the compressed air system market. Previously, market actors preferred a dedicated air dryer for each compressor, but more recently, they have opted for a single air dryer for multiple compressors. Another emerging trend is the ongoing commissioning (OCx), pursued as an energy management practice through compliance with ISO 50001 (Clean Energy Ministerial, 2021). Energy-saving regeneration controls and ongoing commissioning mutually reinforce facility benefits.

4.1.2 Market Challenges and Solutions

See Section 3 for a description of workforce training that may be needed to ensure effective design, installation, and commissioning.

The Statewide CASE Team surveyed manufacturer websites and interviewed manufacturers to confirm the availability of dew-point controls and dryer types that comply with this code proposal. Through these stakeholder interviews, the Statewide CASE Team confirmed that manufacturers offer various types of dryers, and dew point controls are widely available as part of a package or as aftermarket items.

The specification of dew point to determine dryer type needs, sizing dryers based on peak loads, and incorporating load-based dew point controls are all common practice in design strategy in the current market. These practices avoid overspecification which leads to higher initial and ongoing maintenance costs and promote energy efficiency by reducing purge air usage. However, many site practices for dryer specification often do not align with these best practices. Through stakeholder outreach, the Statewide CASE Team determined that overspecification is due to a lack of awareness on how to properly specify a compressed air system, including dew point and varying load capacities, resulting from a lack of standardized documentation. Stakeholder education and development of public documentation would address this challenge. These practices could be addressed in future compliance manual updates. The Statewide CASE Team is also aware of CAGI developing performance standards for desiccant dryers, which may complement the code in the future.

4.2 Design and Construction Practices

4.2.1 Current Design and Construction Practices

The proposed measure introduces several requirements; each aligned with established best practices to enhance energy efficiency in compressed air systems.

Energy-Saving Refrigerated Dryers

The first part of this measure would require energy-saving refrigerated dryers to be specified for applications with dew point requirements of 35°F or higher. This approach supports current design standards and prevents the unnecessary use of desiccant dryers, which demand additional equipment and higher energy consumption. Energy-saving refrigerated dryers incorporate capacity control features that adjust energy consumption in response to varying compressor loads. Energy-saving refrigerated dryers include cycling, thermal mass, digital scroll, and variable speed drive technologies. Although not always specified for baseload or trim compressor applications, these dryers are widely available and commonly used in the market. They may require increased floorspace for auxiliary equipment, such as thermal mass or glycol reservoirs, and enhanced ventilation due to longer cycling periods. Additionally, they involve greater electrical demand to support advanced sensors and control logic, but they achieve overall energy savings by reducing compressor operation in proportion to actual load.

Dew-Point Controllers

The second requirement would be the use of dew point controllers on a desiccant air dryer to optimize energy use by matching operation to the drying load. According to manufacturer input during a stakeholder interview, approximately 50 percent of desiccant dryers are currently sold with dew-point controls. While the added sensors, controllers, and wiring for dew point controllers introduce minimal electrical requirements, their incorporation into dryer control design is justified by the energy savings achieved through load-based operation.

Heated Desiccant Dryers

The third requirement would be to specify an internally or externally heated desiccant dryer with a capacity of at least 300 cfm. Below this threshold, heated desiccant dryers are less common and may not be cost-effective due to smaller purge-air energy savings. Above this threshold, purge-air energy losses become large enough that heated regeneration approaches are generally commercially available and cost-effective. Heated desiccant dryers require additional floorspace to accommodate additional heating equipment, as well as increased electrical capacity for heaters and blowers.

Together, these requirements ensure that compressed air systems are designed to meet actual operational needs, reinforce current product availability and best practices and minimize unnecessary energy expenditure.

4.2.2 Health and Safety Considerations

This 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 (DOSH). All existing health and safety rules would remain in place. Occupants and those involved with the construction, commissioning, and maintenance of the site would not experience any adverse impacts on safety or health associated with the proposed code change. The proposed code change would reduce GHG emissions associated with a reduction in electrical energy consumption.

4.2.3 Design and Construction Challenges and Solutions

See Table 4: Impacts on Market Actors and Suggested Training and Education Opportunities in Section 3.2 for a description of workforce trainings that could support effective design, installation, and commissioning.

The Statewide CASE Team identified two potential challenges in the design and construction of the compressed air system. The first consideration was that operational needs beyond the required dew point for end uses may necessitate the use of desiccant dryers. Through stakeholder outreach, the Statewide CASE found that outdoor equipment in freezing conditions or certain specialized processes may require extremely low dew points. However, manufacturer and system designer stakeholders also confirmed that such needs can be addressed directly through dryer specification. The second challenge identified by the Statewide CASE Team was the feasibility of add-on load-matching controls and dew-point measurement. Several manufacturers confirmed the availability of dew point controls as an option for a baseline compressed air dryer design, as well as after-market options, allowing purchasers flexibility while preserving existing product lines.

Several of the requirements for this measure would also affect maintenance practices. Replacing overspecified desiccant dryers with refrigerated units lowers overall maintenance. Dew point controllers require regular calibration and dew point sensor replacement, increasing maintenance required compared to a system without these controls.

4.3 Energy Equity and Environmental Justice

Each measure in this CASE Report was evaluated for ESJ impacts using 4 criteria: cost, health, resiliency, and comfort. The details of that evaluation can be found in Section 1.4 and the [2028 CASE Methodology Report](#). Based on a preliminary review, the Statewide CASE Team does not expect this proposal to have significant impacts on ESJ communities. Although there are costs associated with this proposal, they are substantially outweighed by the benefits. Based on the analysis described in the Cost Effectiveness section, the Statewide CASE Team does not believe that the increase in costs would present a financial burden for companies. Cost increases are small relative to the overall cost of a compressed air system. The energy savings associated with the

proposal would contribute to lower energy prices. Although general reductions in GHG emissions are similarly expected due to reduced energy consumption as a result of this measure proposal, it was not identified as having a significant impact on any ESJ communities. There are no identified impacts relating to health, resiliency, or comfort that would arise because of improved compressed air dryer efficiency.

The Statewide CASE Team has not identified any ways in which the proposal would affect the health or safety of ESJ communities, nor affect their disaster preparedness.

4.4 Impacts on Jobs and Businesses

The Statewide CASE Team does not anticipate significant employment or financial impacts on any particular sector of the California economy from this proposed measure. However, the proposed change may have modest impacts on employment in California. The Statewide CASE Team anticipates that the proposed change would directly and indirectly affect statewide employment and economic output through its impact on builders. Because the Statewide CASE Team does not expect an appreciable amount of additional time to be spent by designers or inspectors, there are no projected economic impacts for these parties to report. Table 7 outlines the statewide implications for builders. For more information on the Statewide CASE Team's economic impacts methodology, see the [2028 CASE Methodology Report](#).

The Statewide CASE Team does not anticipate that the proposed changes would lead to the creation of new types of jobs or the elimination of existing types of jobs. In other words, the Statewide CASE Team's proposed change would not result in economic disruption to any sector of the California economy. Rather, it would lead to modest increases in the employment of existing jobs.

Table 7: Estimated Impact that Adoption of the Proposed Measure Would Have on the California Nonresidential Construction Sector

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
Direct Effects (Additional spending by Commercial Builders)	8.2	646,485.0	973,347.5	2,106,029.0
Indirect Effect (Additional spending by firms supporting Commercial Builders)	4.7	\$373,697	\$641,556	\$1,123,183
Total Economic Impacts	12.9	\$1,020,182	\$1,614,904	\$3,229,212

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

The proposed change represents a modest adjustment to compressed air dryer installation, which is not expected to excessively burden or competitively disadvantage

California businesses, nor is it expected to lead to a competitive advantage for California businesses. Therefore, the Statewide CASE Team does not expect the proposed code changes to result in the creation of new businesses or the elimination of existing ones.

The proposed code changes would apply to all businesses operating in California, regardless of whether they are incorporated inside or outside of the state.¹¹ Therefore, the Statewide CASE Team does not anticipate that the proposed changes would have an advantageous or adverse effect on the competitiveness of California businesses.

The Statewide CASE Team derived a reasonable estimate of the change in investment by California businesses based on the estimated change in economic activity associated with the proposed measure and its expected effect on business income. The Statewide CASE Team's IMPLAN modeling resulted in an estimated \$222,248 increase in California business income due to the proposed code change. The Statewide CASE Team assumed that net business investment is positively correlated with business income and that a portion of business income will be allocated to net business investment.¹²

The Statewide CASE Team analyzed national data on corporate profits and net capital investment by businesses that expand a firm's capital stock (referred to as net private domestic investment, or NPDI).¹³ As Table 8 shows, between 2020 and 2024, NPDI as a percentage of corporate profits ranged from a low of 18 percent in 2020 due to the worldwide economic slowdowns associated with the COVID-19 pandemic, to a high of 28 percent in 2022, with an average of 23 percent. While only an approximation of the proportion of business income used for net capital investment, it provides a reasonable estimate of the proportion of proprietor income that business owners would reinvest into expanding their capital stock.

Table 8: Net Private Domestic Investment and Corporate Profits, U.S.

Year	Net Domestic Private Investment by Businesses, Billions of Dollars	Corporate Profits After Taxes, Billions of Dollars	Ratio of Net Private Investment to Corporate Profits (Percent)
2020	\$389	\$2,212	18%
2021	\$545	\$2,888	19%
2022	\$825	\$2,951	28%
2023	\$836	\$3,069	27%
2024	\$885	\$3,441	26%
5-Year Average	-	-	23%

Source: (Federal Reserve Economic Data (FRED) n.d.).

Given the estimated total increase in California business income and net business investment ratio described above, the Statewide CASE Team estimates the proposed code change would result in an estimated \$52,170 increase in net private investment by California businesses.

4.5 Economic and Fiscal Impacts

The Statewide CASE Team does not anticipate that the economic impacts associated with the proposed measure would lead to a significant change (increase or decrease) in investment, directly or indirectly, in any affected sectors of California's economy. The proposed change would not result in economic disruption to any sector of the California economy. For more information on the Statewide CASE Team's economic and fiscal impacts methodology, see the [2028 CASE Methodology Report](#).

Adoption of this code change proposal would result in relatively modest economic impacts through additional direct spending by or on industrial contractors, energy consultants, and building inspectors. The Statewide CASE Team does not anticipate that money saved by businesses or other organizations affected by the proposed 2028 code cycle regulations would result in additional spending by those businesses.

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

The Statewide CASE Team does not expect the proposed code changes to have a measurable impact on California's General Fund, any state special funds, or local government funds.

Cost to State: The state government already has a budget for code development, education, and compliance enforcement. While the state government would 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 for the state government are small when compared to the overall cost savings and policy benefits associated with the code change proposals. State buildings do not typically operate compressed air dryers of qualifying size and so would not be directly impacted by this proposed measure.

Cost to Local Governments: All proposed code changes to Title 24, Part 6 would result in changes to compliance determinations. Local governments would need to train building department staff on the revised Title 24, Part 6 Standards. While this retraining is an expense to local governments, it is not a new cost associated with the 2028 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 3, 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.

4.5.2 Mandates on Local Agencies or School Districts

There are no relevant mandates to local agencies or school districts because local agencies and schools do not typically operate compressed air dryers of qualifying size.

4.5.3 Costs to Local Agencies or School Districts

There are no costs to local agencies or school districts because local agencies and schools do not typically operate compressed air dryers of qualifying size.

4.5.4 Costs or Savings to Any State Agency

There are no costs or savings to any state agencies because local agencies do not typically operate compressed air dryers of qualifying size.

4.5.5 Other Non-Discretionary Cost or Savings Imposed on Local Agencies

There are no added non-discretionary costs or savings to local agencies because local agencies do not typically operate compressed air dryers of qualifying size.

4.5.6 Costs or Savings in Federal Funding to the State

The Statewide CASE Team did not identify any costs or savings to federal funding provided to the state.

5. Cost Effectiveness

5.1 Cost Effectiveness Methodology

The Statewide CASE Team collaborated with CEC staff to confirm that the cost-effectiveness methodology aligns with CEC guidelines, including cost inclusion parameters. The [2028 CASE Methodology Report](#) and Appendix A provide reproducibility details.

Per California Law (Public Resources Code 25000), a measure is considered cost effective if its Benefit-Cost Ratio (BCR) is 1.0 or greater, amortized over the economic life of the structure. The Statewide CASE Team calculates BCR by dividing total dollar benefits by total dollar costs over a 30-year analysis period.

Benefits are based on Long-term System Cost (LSC), which assigns an hourly dollar value to energy use. LSC hourly factors weigh the long-term value of each hour differently, with peak-demand hours valued more than off-peak hours. These factors are not utility rates, forecasts, or bill estimates. The CEC develops and publishes LSC hourly conversion factors for each code cycle.

Costs include first costs and ongoing maintenance costs assessed over the 30-year period. Benefits and costs are evaluated incrementally, relative to the most recently adopted Energy Code. The analysis excludes design costs and incremental code compliance verification costs.

Energy usage calculations were built upon the previous methodology used in the 2013 and 2022 code cycles (Statewide CASE Team, 2020). Four prototype compressed air systems and their respective load profiles were previously established based on program data, engineering judgement, and stakeholder engagement. The four prototypes represent a range of system sizes found in industrial settings with baseload and trim load shapes derived from empirical program data. The systems range in size from 125 to 800 total combined horsepower, each with two or three compressors and a shared single dryer.

5.2 Energy and Energy Cost Savings Results

To remain consistent with those methods and with savings attributed to existing code measures, the analysis for air dryer energy usage and savings use these same load profiles and code compliant prototypes.

Appendix A outlines the energy savings calculation methodology and prototypes, in detail.

The Standard Design (baseline) and Proposed Design (measure) conditions for the air dryer measures are the same for new construction, additions, and alterations, and use the same prototype systems and load profiles. Although outdoor air conditions at the compressor and dryer inlets could have a small impact on equipment efficiency, the effect is marginal, and equipment is typically located inside buildings, thereby buffering it from weather impacts in the prototype cases. Therefore, climate zones do not impact the modeled energy usage or savings.

Energy savings are presented on a per-hp basis for the total installed air compressor power. Horsepower is a natural base unit for compressed air systems, which are often referred to and characterized by their total system and compressor hp. Per-hp savings for the first year vary across cases and prototypes, as shown in Table 9. Table 10 lists these same per-hp first-year savings in source energy savings in kBtu. Refrigerated dryers and air compressors will likely experience similar maximum instantaneous peak demand despite overall energy savings, though the measures would result in small peak demand reductions according to the methodology outlined in the 2028 CASE Methodology Report.

Table 11 presents total per-hp energy cost savings for newly constructed buildings, alterations, and additions in terms of LSC savings realized over a 30-year period, in 2029 present value dollars (2029 PV\$). The LSC methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods.

These savings will persist throughout the equipment's lifetime with proper maintenance and management of the dryers. These maintenance practices are largely driven by the need for reliable, dry air in any given plant and are thus dependable. For both refrigeration and desiccant dryers, energy usage is inherent to the equipment's operating principles and does not need much ongoing commissioning or attention to setpoints. However, the regeneration controls will require proactive maintenance and attention by plant staff to ensure persistence of savings. The necessary costs for this maintenance are further detailed in Section 5.4.

In Table 9 through Table 11, each column relates to the proposed changes to Title 24 as follows:

- * Section 905.1.6.1, Section 905.1.6.2

- † Section 905.1.6.1, Section 905.1.6.2

- ‡ Section 905.1.6.3

- § Section 905.1.6.4

Table 9: First Year Electricity Savings (kWh) Per hp – All Measures

Prototype	Non-cycling Refrigerated Dryer to Energy-Saving Refrigerated Dryer *	Heatless Desiccant Dryer without Regeneration Controls to Energy-Saving Refrigerated Dryer †	Heatless Desiccant Dryer without Regeneration Controls to Heatless Desiccant Dryer with Regeneration Controls ‡	Heatless Desiccant Dryer to Heated Desiccant Dryer §
Prototype 1	227.6	592.4	200.7	65.7
Prototype 2	237.4	586.0	210.8	51.4
Prototype 3	238.2	570.7	204.4	46.3
Prototype 4	286.6	528.6	196.9	25.8

Table 10: First Year Source Energy Savings (kBtu) Per hp – All Measures

Prototype	Non-cycling Refrigerated Dryer to Energy-Saving Refrigerated Dryer *	Heatless Desiccant Dryer without Regeneration Controls to Energy-Saving Refrigerated Dryer †	Heatless Desiccant Dryer without Regeneration Controls to Heatless Desiccant Dryer with Regeneration Controls ‡	Heatless Desiccant Dryer to Heated Desiccant Dryer §
Prototype 1	309.0	772.9	294.0	83.7
Prototype 2	322.2	774.8	312.8	68.1
Prototype 3	323.3	752.3	302.4	61.2
Prototype 4	389.1	689.3	288.1	33.7

Table 11: Total 30-Year LSC Savings (2029 PV\$) Per hp – All Measures

Prototype	Non-cycling Refrigerated Dryer to Energy-Saving Refrigerated Dryer*	Heatless Desiccant Dryer without Regeneration Controls to Energy-Saving Refrigerated Dryer†	Heatless Desiccant Dryer without Regeneration Controls to Heatless Desiccant Dryer with Regeneration Controls‡	Heatless Desiccant Dryer to Heated Desiccant Dryer§
Prototype 1	\$1,848	\$4,813	\$1,669	\$527
Prototype 2	\$1,927	\$4,791	\$1,761	\$416
Prototype 3	\$1,934	\$4,705	\$1,706	\$375
Prototype 4	\$2,327	\$4,436	\$1,637	\$208

5.3 Incremental First Cost

Incremental first costs were modelled for each prototype in Table 25 and set of Standard and Proposed Design cases defined in Table 26. Four baseline and proposed measure cases were evaluated based on the measures in the proposed code language for each of the four prototypes.

The first scenario baseline is a non-cycling refrigerated dryer, with the proposed case being an energy-saving refrigerated dryer. The incremental first cost between the baseline and proposed scenarios is the upfront cost difference between a prototypical non-cycling refrigerated dryer and an energy-saving refrigerated dryer. Air dryer cost data was collected from compressed air equipment distributor websites in February 2026 and used to establish a relationship between dryer cost and rated capacity through linear regression of the baseline and proposed equipment cost datasets.

The resulting regression model of dryer first cost as a function of rated capacity was then used to determine the incremental first cost of each prototype based on the rated common dryer capacity that corresponds to the prototype. This methodology was utilized to determine the incremental first costs for all subsequent scenarios. Examples of the dryer cost models for the baseline and proposed equipment are shown in Figure 2 for cycling and energy-saving refrigerated types. The Statewide CASE Team assumes that all shipping, handling, and installation costs are the same for both types.

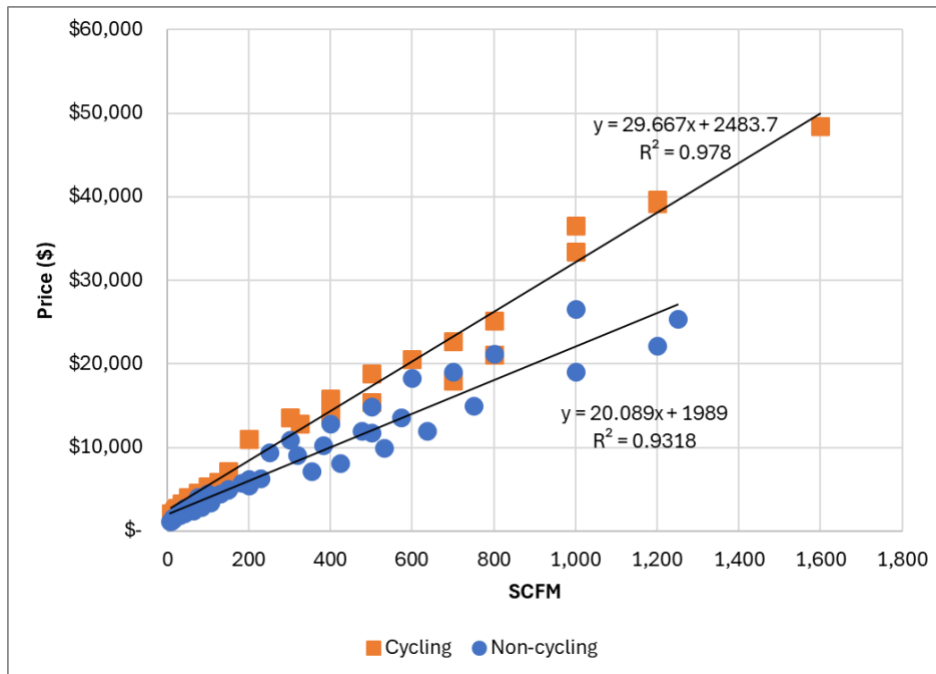


Figure 2: Submeasure 1 first costs.

The second scenario baseline was a heatless desiccant dryer without dew point regeneration controls, and the proposed case was an energy-saving refrigerated dryer. The incremental first cost between the baseline and proposed case is the cost difference between a heatless desiccant dryer and an energy-saving refrigerated dryer. The same methodology that was previously used to model dryer first cost as a function of rated airflow capacity for the prior scenarios was leveraged to model the baseline and proposed equipment first costs for each prototype. These costs were gathered in February of 2026. The incremental first cost for this scenario is negative because refrigerated dryers are lower cost than equivalently sized desiccant dryers, as seen in Figure 3.

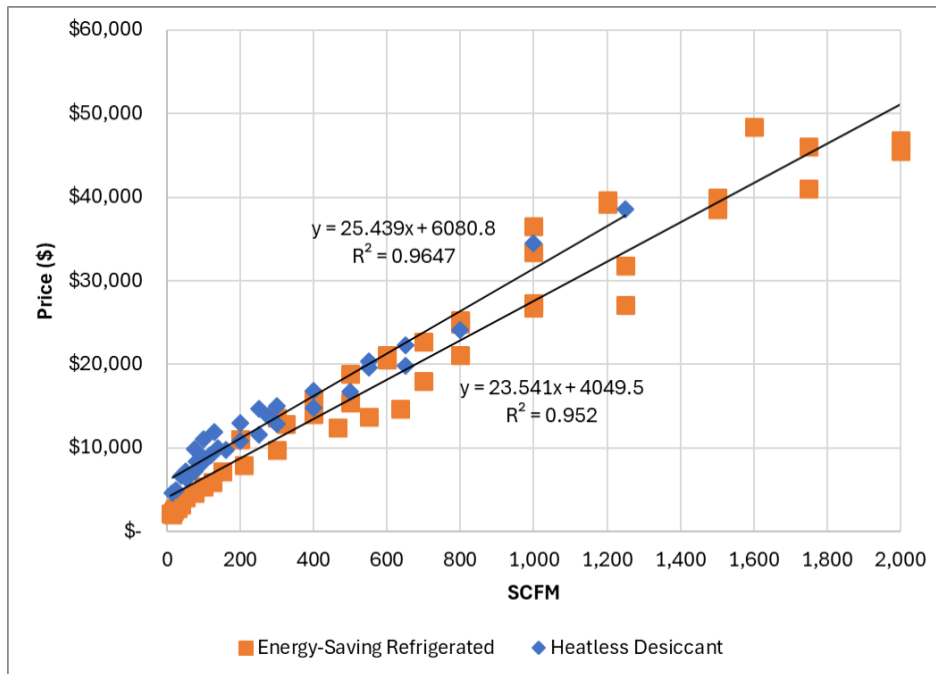


Figure 3: Submeasure 2 first costs.

The third scenario baseline was a heatless desiccant dryer without dew-point regeneration controls, and the proposed case was a heatless desiccant dryer with dew-point regeneration controls. The incremental first cost corresponds to the addition of dew point regeneration controls to the baseline dryer system. Regeneration controls are added to equipment during manufacturing and thus do not incur additional installation labor costs. Incremental first costs were calculated as the difference between modeled baseline and proposed dryer costs for each prototype. The dryer costs were modeled using the same methodology outlined in the above scenarios, with data gathered in February 2026. The incremental first cost for this scenario is seen in Figure 4.

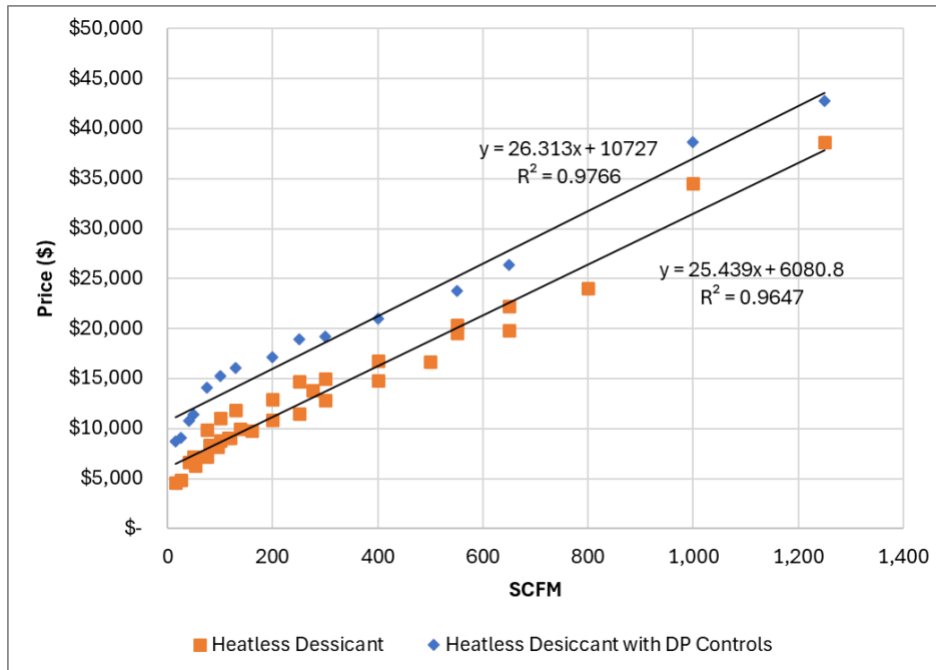


Figure 4: Submeasure 3 first costs.

The fourth baseline case was a heatless desiccant dryer with dew-point regeneration controls, and the proposed case was a heated desiccant dryer with dew-point regeneration controls. The incremental first cost for this scenario corresponds to the additional factory-installed dryer upgrades required to heat the purge air for desiccant regeneration. Incremental first costs were calculated as the difference between modeled baseline and proposed dryer costs for each prototype. The dryer costs were modeled using the same methodology outlined in the above scenarios, with costs gathered in February of 2026. The incremental first cost for this scenario is seen in Figure 5.

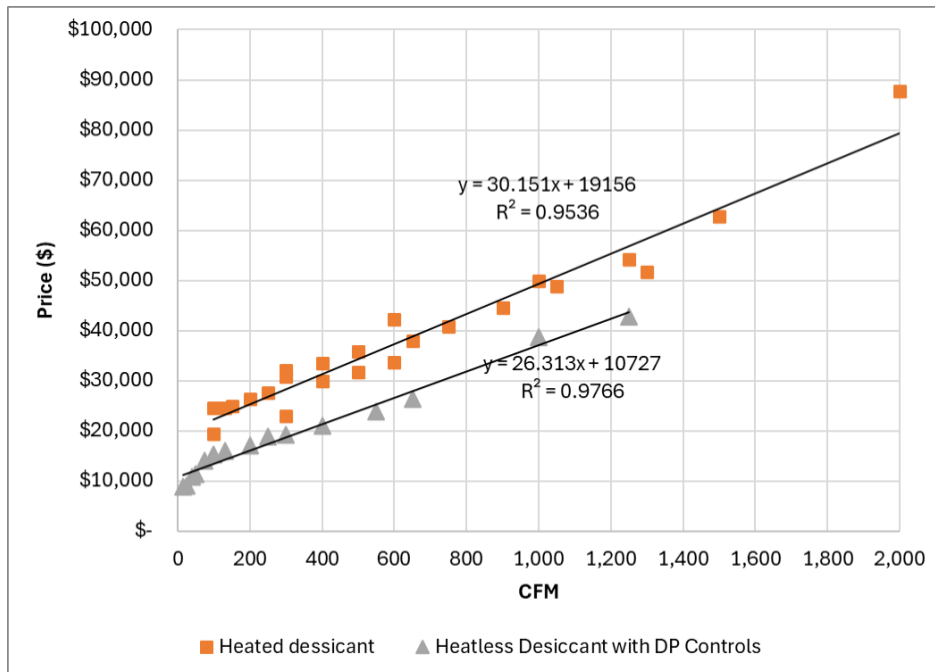


Figure 5: Submeasure 4 first costs.

The incremental costs for these four system types and baseline cases are summarized in Table 12 on a per-prototype basis and in Table 13 on a per-hp basis. Per-hp impacts were calculated by dividing each per-prototype result by the total installed air compressor hp system as listed in Table 25. Labor, material, and electrical costs were assumed not to vary among prototype buildings.

Table 12: Compressed Air System Incremental First Cost (\$) by Prototype

Prototype	Non-cycling Refrigerated Dryer to Energy-Saving Refrigerated Dryer *	Heatless Desiccant Dryer without Regeneration Controls to Energy-Saving Refrigerated Dryer †	Heatless Desiccant Dryer without Regeneration Controls to Heatless Desiccant Dryer with Regeneration Controls ‡	Heatless Desiccant Dryer to Heated Desiccant Dryer §
Prototype 1	\$6,040.36	-\$3,130.24	\$5,152.25	\$10,651.20
Prototype 2	\$9,747.05	-\$3,864.77	\$5,490.48	\$12,136.51
Prototype 3	\$21,384.32	-\$6,170.84	\$6,552.39	\$16,799.68
Prototype 4	\$45,185.65	-\$10,887.37	\$8,724.28	\$26,337.11

Table 13: Compressed Air System Incremental First Cost (\$) by Prototype per hp

Prototype	Non-cycling Refrigerated Dryer to Energy-Saving Refrigerated Dryer *	Heatless Desiccant Dryer without Regeneration Controls to Energy-Saving Refrigerated Dryer †	Heatless Desiccant Dryer without Regeneration Controls to Heatless Desiccant Dryer with Regeneration Controls ‡	Heatless Desiccant Dryer to Heated Desiccant Dryer §
Prototype 1	\$48.32	-\$25.04	\$41.22	\$85.21
Prototype 2	\$48.74	-\$19.32	\$27.45	\$60.68
Prototype 3	\$47.52	-\$13.71	\$14.56	\$37.33
Prototype 4	\$56.48	-\$13.61	\$10.91	\$32.92

5.4 Incremental Maintenance and Replacement Costs

Incremental maintenance costs were evaluated for each submeasure between the baseline and the proposed cases. The first scenario incurs no additional maintenance cost over the 30-year analysis period for the measure. It was assumed that refrigerated dryers require minimal maintenance and that the difference in ongoing maintenance costs between noncycling and energy-saving cycling refrigerated dryers is negligible. However, refrigerated dryers do have an EUL of 13 years and therefore replacement costs in years 14 and 27 were included. Replacement costs were calculated using the same method and data as first costs, with a real (inflation-adjusted) three percent discount rate applied.

For the second submeasure, the modeled incremental maintenance cost was negative, representing net savings. This is because desiccant dryers require desiccant material replacement every 10 years, while refrigerated dryer maintenance costs are negligible. This replacement frequency was assessed based on manufacturer stakeholder interviews on desiccant material lifetimes. The cost of desiccant media replacement was estimated at approximately \$1,900 for a 580-cfm dryer (i.e., Prototype 1) based on input gathered from October to November 2025. The incremental maintenance costs for the other prototypes were derived from the incremental cost of the first scenario and the percentage increase in rated capacity going from Prototype 1 to the next prototype (i.e., ratio of rated capacities). Replacement costs in years 14 and 27 were again included based on the EUL for refrigerated dryers and the first-cost methodology described above.

For the third submeasure, the incremental maintenance cost comprises the costs associated with the regular sensor recalibration and periodic replacement of the dew

point or temperature probe. Through manufacturer stakeholder interviews, the Statewide CASE Team obtained costs for sensor recalibration, calibration frequency, and probe replacement. The probe was estimated to need recalibration every three years and replacement every ten years, resulting in six recalibrations and two replacements after initial installation over the 30-year evaluation period. The average sensor recalibration cost was assumed to be \$400 in present value, and the average probe replacement cost was assumed to be \$1,350 in present value based on stakeholder estimates. The sensor recalibration and probe replacement costs were assumed to be the same across the modeled dryer prototypes, which subsequently results in the same incremental maintenance cost across prototypes. Again, replacement costs were included. For desiccant dryers with an EUL of 15 years, the incremental replacement cost was included in year 16 using the same methodology as the first cost described above.

For the fourth scenario, the incremental maintenance costs are associated with the additional upkeep for the blower, heating element, PLC controller, and additional valves that a heated desiccant dryer includes. Based on stakeholder input gathered from October to November 2025, the ongoing annual maintenance costs of the baseline equipment and proposed equipment were assumed to be 5% and 4% of their modelled first costs, respectively. The incremental ongoing cost for each scenario is the difference between the baseline system ongoing maintenance costs and the proposed system ongoing maintenance costs. The incremental maintenance costs for the scenario were every year for the 30-year evaluation period. For desiccant dryers with an EUL of 15 years, the incremental replacement cost was included in year 16 based on the same methodology for the first cost described above.

The incremental maintenance costs for these four system types and baseline cases are summarized in Table 14 on a per prototype basis and in Table 15 on a per-hp basis. Per-hp impacts were calculated by dividing each per-prototype results by the total installed system air compressor hp as listed in Table 25.

Table 14: Compressed Air System Incremental Maintenance Cost by Prototype

Prototype	Non-cycling Refrigerated Dryer to Energy Saving Refrigerated Dryer	Heatless Desiccant Dryer without Regeneration Controls to Energy Saving Refrigerated Dryer	Heatless Desiccant Dryer without Regeneration Controls to Heatless Desiccant Dryer with Regeneration Controls	Heatless Desiccant Dryer to Heated Desiccant Dryer
Prototype 1	\$6,712.70	-\$5,855.15	\$6,449.27	\$20,560.65
Prototype 2	\$10,831.96	-\$8,259.87	\$6,660.05	\$24,581.27
Prototype 3	\$23,764.54	-\$15,809.56	\$7,321.80	\$37,204.14
Prototype 4	\$50,215.12	-\$31,250.70	\$8,675.25	\$63,021.29

Table 15: Compressed Air System Incremental Maintenance Cost by Prototype per hp

Prototype	Non-cycling Refrigerated Dryer to Energy Saving Refrigerated Dryer	Heatless Desiccant Dryer without Regeneration Controls to Energy Saving Refrigerated Dryer	Heatless Desiccant Dryer without Regeneration Controls to Heatless Desiccant Dryer with Regeneration Controls	Heatless Desiccant Dryer to Heated Desiccant Dryer
Prototype 1	\$53.70	-\$46.84	\$51.59	\$164.49
Prototype 2	\$54.16	-\$41.30	\$33.30	\$122.91
Prototype 3	\$52.81	-\$35.13	\$16.27	\$82.68
Prototype 4	\$62.77	-\$39.06	\$10.84	\$78.78

5.5 Cost Effectiveness

Results of the per-unit cost-effectiveness analyses are presented in Table 16 through Table 19 for each of the requirements and prototypes. Cost-effectiveness results are the same for new construction, additions, and alterations. Cost-effectiveness will vary slightly across climate zones due to variation in the LSC with climate zone, but this effect on cost-effectiveness is negligible. A weighted average of each hourly LSC energy cost factor was used for calculating cost benefits. The factor was weighted by existing market size across each climate zone from the CEC Construction Forecast.

The proposed measures would be cost effective for each prototype and climate zone. The proposed measures save money over the 30-year period of analysis relative to the Standard Design conditions based on the analysis conducted for this Final CASE Report.

Some of the BCRs below are relatively large, which suggests that many businesses may already choose to comply with these practices. This is supported by interviews with stakeholders. However, these stakeholders also emphasized that a significant number of businesses do not implement these practices despite the cost-effectiveness as evidenced in the market adoption rates in Table 34. This may be due to several factors. For example, some stakeholders discussed users who may have had negative experiences with undersized refrigerated dryers, leading to a mistaken belief that it was necessary to switch to more expensive desiccant dryers.

In the tables below, all values are presented in 2029 present value dollars (2029 PV\$). Benefits represent 30-year LSC savings and other savings, including incremental first-cost savings if the proposed first cost is less than the current first cost, incremental maintenance cost savings if the proposed maintenance costs are less than the current maintenance costs, and incremental residual value if the proposed residual value is greater than the current residual value at the end of the 30-year period of analysis. Costs represent the total incremental PV cost, including incremental equipment, replacement, and maintenance costs over the period of analysis. The analysis treats a negative incremental maintenance cost as a positive benefit. If total incremental costs are zero or a net benefit, the benefit-cost ratio (BCR) is considered infinite, as is the case for the requirement presented in Table 17. Costs and other savings are discounted at a real (inflation-adjusted) three percent rate.

BCRs evaluate cost-effectiveness from a societal perspective using the Long-Term System Cost (LSC) framework. As such, they are intended to assess the overall value of a measure to California's energy system rather than to predict customer utility bills, project paybacks, or equipment adoption decisions.

Because BCRs are based on a society-wide perspective, they do not mirror the calculations or decision-making that an individual firm or facility may undertake when evaluating a potential investment. Companies may base decisions on factors including facility-specific utility tariffs, demand charges, cost of capital, maintenance considerations, operational constraints, production impacts and internal investment criteria. For these reasons, a high BCR should not be interpreted as evidence that a measure would necessarily be adopted absent a standard, nor as a prediction of the payback period that would be calculated by an individual facility. Differences between CASE BCR results and observed customer adoption behavior reflect the distinction between system-level valuation and site-specific investment decision-making.

While the BCRs for the proposed measures are high, multiple stakeholder interviews emphasized that despite the cost-effectiveness and prior industry education efforts, market inertia has led some facilities to not adopt these practices. As a result, the Statewide CASE Team believes that a meaningful percentage of the market will not adopt these energy-saving practices absent the proposed standards.

Table 16: 30-Year Cost-Effectiveness Summary Per hp – Non-cycling Refrigerated Dryer to Energy Saving Refrigerated Dryer

Building Prototype	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
Prototype 1	\$1,848	\$102	18.1
Prototype 2	\$1,927	\$103	18.7
Prototype 3	\$1,934	\$100	19.3
Prototype 4	\$2,327	\$119	19.5

Table 17: 30-Year Cost-Effectiveness Summary Per hp – Heatless Desiccant Dryer without Regeneration Controls to Energy Saving Refrigerated Dryer

Building Prototype	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
Prototype 1	\$4,830	-\$72	infinite
Prototype 2	\$4,791	-\$61	infinite
Prototype 3	\$4,658	-\$49	infinite
Prototype 4	\$4,310	-\$53	infinite

Table 18: 30-Year Cost-Effectiveness Summary Per hp – Heatless Desiccant Dryer without Regeneration Controls to Heatless Regeneration Dryer with Regeneration Controls

Building Prototype	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
Prototype 1	\$1,669	\$93	18.0
Prototype 2	\$1,761	\$61	29.0
Prototype 3	\$1,706	\$31	55.3
Prototype 4	\$1,637	\$22	75.3

Table 19: 30-Year Cost-Effectiveness Summary Per hp – Heatless Desiccant Dryer to Heated Desiccant Dryer

Building Prototype	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
Prototype 1	\$527	\$250	2.1
Prototype 2	\$416	\$184	2.3
Prototype 3	\$375	\$120	3.1
Prototype 4	\$208	\$112	1.9

6. Statewide Impacts

6.1 Statewide Energy and Energy Cost Savings

Statewide energy and energy cost impacts were calculated for the proposed measures as they would apply to both new construction in the manufacturing sector as well as replacements in the existing manufacturing building stock (i.e., alterations). The existing and new construction market sizes in compressed air hp were determined based on several datapoints including total U.S. manufacturing compressed air energy usage, California statewide share of total U.S. manufacturing, market distribution across prototype sizes based on previous code cycle CASE Reports, and available market shares that are available for code influence.

Appendix C presents these details and assumptions in further detail. Additionally, see the [2028 CASE Methodology Report](#) for details on how statewide new construction growth rates are calculated.

The tables below present the first-year statewide energy and LSC savings from newly constructed buildings and additions (Table 20) and alterations (Table 21) by climate zone.

Table 22 presents first-year statewide savings from new construction, additions, and alterations.

Table 20: Statewide Energy and LSC Impacts – New Construction and Additions

Climate Zone	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction	First -Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV\$)
1	0.00	0.000	-	0.00	\$0.01
2	0.02	0.002	-	0.03	\$0.18
3	0.05	0.004	-	0.06	\$0.38
4	0.08	0.008	-	0.11	\$0.68
5	0.01	0.001	-	0.02	\$0.12
6	0.03	0.003	-	0.04	\$0.23
7	0.02	0.002	-	0.03	\$0.15
8	0.04	0.004	-	0.05	\$0.32
9	0.05	0.005	-	0.08	\$0.45
10	0.09	0.008	-	0.12	\$0.75
11	0.01	0.001	-	0.01	\$0.07
12	0.05	0.005	-	0.07	\$0.42
13	0.04	0.004	-	0.05	\$0.31
14	0.02	0.002	-	0.03	\$0.16
15	0.01	0.001	-	0.01	\$0.08
16	0.01	0.001	-	0.01	\$0.07
Total	0.53	0.050	-	0.73	\$4.36

Table 21: Statewide Energy and LSC Impacts – Alterations

Climate Zone	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction	First -Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV\$)
1	0.09	0.01	-	0.12	\$0.70
2	0.37	0.03	-	0.50	\$2.98
3	1.23	0.11	-	1.69	\$9.95
4	1.75	0.16	-	2.41	\$14.20
5	0.12	0.01	-	0.16	\$0.94
6	1.70	0.16	-	2.33	\$13.59
7	0.77	0.07	-	1.06	\$6.21
8	2.87	0.27	-	3.95	\$23.65
9	3.92	0.37	-	5.39	\$32.45
10	1.11	0.10	-	1.53	\$9.21
11	0.24	0.02	-	0.33	\$1.95
12	1.06	0.10	-	1.46	\$8.66
13	0.53	0.05	-	0.73	\$4.32
14	0.38	0.04	-	0.53	\$3.15
15	0.11	0.01	-	0.15	\$0.89
16	0.21	0.02	-	0.29	\$1.73
Total	16.46	1.53	-	22.62	\$134.60

Table 22: Statewide Energy and LSC Impacts – New Construction, Additions, and Alterations

Construction Type	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First -Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV\$)
New Construction & Additions	0.53	0.05	-	0.73	4.36
Alterations	16.46	1.53	-	22.62	134.60
Total	16.99	1.58	-	23.25	138.96

6.2 Statewide Greenhouse Gas Emissions Reductions

Table 23 presents the estimated first-year reduction in GHG emissions resulting from the proposed code change. In this initial year, the Statewide CASE Team expects to avoid 1,235.47 metric tons of carbon dioxide equivalent (CO₂e) emissions. These reductions, along with their associated monetary value, were calculated using hourly GHG emissions factors published alongside the LSC hourly factors and source energy hourly factors in the research versions of CBECC, as well as data from the CEC's 2028 Metrics Report. See the [2028 CASE Methodology Report](#) for additional information.

Table 23: First-Year Statewide GHG Emissions Impacts

Construction Type	Reduced GHG Emissions from Electricity Savings (Metric Tons CO ₂ e)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO ₂ e)	Total Reduced GHG Emissions (Metric Ton CO ₂ e)	Total Monetary Value of Reduced GHG Emissions (\$)
New Construction & Additions	38.76	0	38.76	6,297.43
Alterations	1,196.71	0	1,196.71	194,416.72
Total	1,235.47	0	1,235.47	200,714.15

6.3 Statewide Water Use Impacts

The proposed code change will not result in water use impacts.

6.4 Statewide Material Impacts

The primary material contribution for this measure is associated with the dew point controls. These controls rely on dew point sensors, whose main material component is the stainless-steel housing (ATO, n.d.). For estimation purposes, a conservative assumption was applied: one pound of stainless steel per dew point sensor probe, allocated to 50 percent of the forecasted new desiccant dryers to account for current market adoption. For more information on the Statewide CASE Team's methodology and assumptions used to calculate embodied GHG emissions, see the [2028 CASE Methodology Report](#).

Table 24: First-Year Statewide Impacts on Material Use

Material	Impact (response options: Increase, Decrease, No Change)	Per-Unit Impacts (Pounds per Square Foot)	First-Year Statewide Impacts (Pounds)	Embodied GHG emissions saved (Metric Tons CO2e)
Mercury	NC	0.000000	0	0
Lead	NC	0.000000	0	0
Copper	NC	0.000000	0	0
Steel	I	0.004589	295	-0.1623
Plastic	NC	0.000000	0	0
TOTAL	N/A	0.004589	295	-0.1623

6.5 Environmental Impacts

This measure aims to reduce the overspecification of desiccant dryers in cases where refrigerated dryers, which consume less energy, can adequately meet system dew point requirements. This measure also calls for the use of dew point controls to minimize compressed air consumption during desiccant dryer regeneration, thereby lowering overall energy demand. The reduction in energy consumption through lower electricity usage results in lower GHG emissions and improved local air quality.

The Statewide CASE Team considered opportunities to minimize the environmental impact of the proposal, including evaluation of “specific economic, environmental, legal, social, and technological factors” (Cal. Code Regs., tit. 14, § 15021). The Statewide CASE Team did not determine this measure would result in significant direct or indirect adverse environmental impacts and therefore did not develop any mitigation measures.

6.6 Other Non-Energy Impacts

The Statewide CASE Team did not identify any other non-energy impacts of the proposed code language. Productivity and reliability of compressed air quality in manufacturing facilities would be the same for each set of Standard and Design conditions.

7. Proposed Language Code

7.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2025 documents should be marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions). New to the 2028 energy code is to *italicize defined terms* when the terms are being used in its defined context. In-line comments that are not part of the proposed code language but are used to help describe the purpose of what is proposed are included *with greyed highlight and italics*.

Markups are provided to the restructured 2025 Energy Code that the CEC developed in response to feedback that aligning the structure of Title 24, Part 6 with other parts of the California Building Standards Code (Title 24) would improve readability, usability, and navigation.⁸ New section numbers are shown as bold followed square brackets that document the section in the 2025 Title 24, Part 6 section numbers prior to the restructuring. For example, “**Section 601.1** [Section 130.0(a)] **General**” contains the content that is in the current Section 130.0(a).

Posting the proposed code language in this format is useful as it helps describe how the Energy Code changes proposed for nonresidential occupancies are isolated from the requirements for residential occupancies which are prohibited from being changed until the 2031 code cycle by Assembly Bill 130.

7.2 Administrative Code (Title 24, Part 1)

No changes are proposed to Title 24, Part 1.

7.3 Energy Code (Title 24, Part 6)

SUBCHAPTER 2 – DEFINITIONS

Section 201 – DEFINITIONS

COMPRESSED AIR SYSTEM is a system of at least one compressor providing compressed air at 40 psig or higher and all its components upstream of pneumatic end uses.

LARGEST NET CAPACITY INCREMENT is the largest increase in capacity when switching between combinations of base compressors that is expected to occur under the compressed air system control scheme.

~~ONLINE COMPRESSORS are all the compressors that are physically connected to compressed air piping and are available to serve peak load. Online compressors do not include back up compressors whose only purpose is to be available when an online compressor fails.~~

TRIM COMPRESSOR is a compressor that is designated for part-load operation handling the short-term variable trim load of end uses, ~~in addition to the~~ contrast to always fully loaded base compressors.

SUBCHAPTER 9 – PROCESS SYSTEMS AND EQUIPMENT

SECTION 900 – NONRESIDENTIAL, HOTEL/MOTEL, AND MULTIFAMILY OCCUPANCIES (NEWLY CONSTRUCTED, ADDITIONS, ALTERATIONS)

905.1 [Section 120.6(e)] Mandatory requirements for compressed air systems.

All new *compressed air systems* where the total combined horsepower (hp) of the compressor(s) is 25 hp or more shall meet the requirements of Sections 4905.1.1 through 5905.1.7.

These requirements apply to the compressors, related piping systems, air dryers, and related controls that provide compressed air and do not apply to any equipment or controls that use ~~or process~~ the compressed air.

EXCEPTION 1 to Section 905.1: Medical gas *compressed air systems* serving *healthcare facilities*.

905.1.1 Trim compressor and storage.

The compressed air system shall be equipped with an appropriately sized *trim compressor* and *primary storage* to provide acceptable performance across the range of the system and to avoid control gaps. The *compressed air system* shall comply with either option below.

1. The *compressed air system* shall include one or more variable speed drive (VSD) compressors. For systems with more than one compressor, the total combined capacity of the VSD compressor(s) acting as *trim compressors* must be at least 1.25 times the *largest net capacity increment* between combinations of compressors. The *compressed air system* shall include *primary storage* of at least one gallon per actual cubic feet per minute (acfm) of the largest *trim compressor*; or,
2. The *compressed air system* shall include a compressor or set of compressors with total effective trim capacity at least the size of the *largest net capacity increment* between combinations of compressors, or the size of the smallest compressor, whichever is larger. The total effective trim capacity of single compressor systems shall cover at least the range from 70 percent to 100 percent of rated capacity. The

effective trim capacity of a compressor is the size of the continuous operational range where the specific power of the compressor (kW/100 acfm) is within 15 percent of the specific power at its most efficient operating point. The total effective trim capacity of the system is the sum of the effective trim capacity of the *trim compressors*. The system shall include *primary storage* of at least 2 gallons per acfm of the largest *trim compressor*.

EXCEPTION 3 to Section 905.1.1: *Compressed air systems* that have been approved by the *Energy Commission Executive Director* as having demonstrated that the system serves loads for which typical air demand fluctuates less than 10 percent.

905.1.2 Controls.

Compressed air systems with three or more compressors and a combined horsepower rating of more than 100 hp shall operate with controls that are able to choose the most energy efficient combination and loading of compressors within the system based on the current compressed air demand.

905.1.3 Monitoring.

Compressed air systems having a combined horsepower rating equal to or greater than 100 hp shall have an energy and air demand monitoring system with the following minimum requirements:

1. Measurement of system pressure.
2. Measurement of amps or power of each compressor.
3. Measurement or determination of total airflow from compressors in cfm.
4. Data logging of pressure, power in kW, airflow in cfm, and compressed air system specific efficiency in kW/100 cfm at intervals of 5 minutes or less.
5. Maintained data storage of at least the most recent 24 months.
6. Visual trending display of each recorded point, load, and specific energy.

905.1.4 Leak testing of compressed air piping.

Compressed air system piping greater than 50 adjoining feet in length shall be pressure tested after being isolated from the compressed air supply and end uses. The piping shall be pressurized to the design pressure, and test pressures shall be held for a length of time at the discretion of the authority having jurisdiction, but in no case for less than 30 minutes, with no perceptible drop in pressure.

If dial gauges are used for conducting this test, these gauges must conform with California Plumbing Code Sections 318.3, 318.4, and 318.5.

Piping less than or equal to 50 adjoining feet in length shall be pressurized and inspected. Connections shall be tested with a noncorrosive leak-detecting fluid or other leak detecting methods at the discretion of the Authority Having Jurisdiction.

905.1.5 Pipe sizing.

Compressed air piping greater than 50 adjoining feet in length shall be designed and installed to minimize frictional losses in the distribution network. These piping installations shall meet the requirements of Section 905.1.5.1 and either Section 905.1.5.2 or 905.1.5.3:

905.1.5.1 Service line piping minimum size.

Service line piping shall have inner diameters greater than or equal to $\frac{3}{4}$ inch. Service line piping are pipes that deliver compressed air from distribution piping to end uses.

905.1.5.2 Piping section average velocity.

Compressor room interconnection and main header piping shall be sized so that at coincident peak flow conditions, the average velocity in the segment of pipe is no greater than 20 ft/sec. Compressor room interconnection and main header piping are the pipes that deliver compressed air from the compressor outlets to the inlet to the distribution piping. Each segment of distribution and service piping shall be sized so that at coincident peak flow conditions, the average velocity in the segment of pipe is no greater than 30 ft/sec. Distribution piping are pipes that deliver compressed air from the compressor room interconnection piping or main header piping to the service line piping.

905.1.5.3 Piping total pressure drop.

Piping shall be designed such that piping frictional pressure loss at coincident peak loads is less than 5 percent of operating pressure between the compressor and end use or end use regulator.

905.1.6 [New section] Compressed air dryers.

Compressed air dryers, other than point-of-use dryers, and their controls shall comply with Section 905.1.6.1, Section 905.1.6.2, and Section 905.1.6.3.

A point-of-use air dryer is defined as an air dryer that is dedicated to conditioning air for a single end-use that requires a pressure dew point that differs from the rest of the plant and is installed in close proximity to that end-use.

905.1.6.1 Refrigerated air dryers.

A refrigerated air dryer is defined as an air dryer that uses a refrigeration cycle to remove moisture from compressed air. This includes equipment with a hot gas bypass to prevent freezing at low loads.

Where the required facility compressed air dew point is greater than 35°F, compressed air dryers shall be refrigerated air dryers.

Each refrigerated air dryer shall include automatic capacity-control features that reduce energy consumption during part-load operation. Such features may include:

1. Thermal mass cycling;
2. Digital scroll modulation;
3. Variable speed drives; or
4. Other capacity control features that reduce energy consumption in response to varying compressed air load.

EXCEPTION 1 to 905.1.6.1: Refrigerated air dryers specified for applications with documented process requirements requiring precise dew point control across operating conditions.

905.1.6.2 Desiccant air dryers.

A desiccant air dryer is defined as an air dryer that uses regenerative desiccant material to remove moisture from compressed air with or without supplemental heat and with or without purge air supplied by the air compressor for regenerating the desiccant material.

All desiccant air dryers shall meet one of the following:

1. Each desiccant air dryer shall have dew point regeneration controls that maximize use of desiccant drying capacity and delay regeneration cycling based on measurement of the desiccant material moisture load; or
2. Each desiccant air dryer shall be a heat-of-compression dryer that uses recovered waste heat from air compressors to aid in regeneration of the desiccant material.

905.1.6.3 Desiccant air dryer heating.

Desiccant air dryers with capacity of 300 cfm or greater shall have internal or external heating to reduce purge air consumption.

EXCEPTION 1 to 905.1.6.3: Compressed air dryers serving applications requiring dew points less than -40°F.

EXCEPTION 2 to 905.1.6.3: Air dryers specified for applications that must maintain a precise dew point across all operating conditions.

EXCEPTION TO 905.1.6: Hotel/motel buildings and nonresidential buildings with Group R occupancies.

905.1.6 905.1.7 Compressed Air System Acceptance.

Before an occupancy permit is granted for a *compressed air system* subject to Section 905.1, the *equipment* and systems shall be certified as meeting the *acceptance requirements for code compliance*, as specified by the Reference Nonresidential Appendix NA7.

A Certificate of Acceptance shall be submitted to the *enforcement agency* that certifies that the *equipment* and systems meet the acceptance requirements specified in NA7.13.

905.4 [141.1] –Additions and alterations to existing buildings.

All *additions* or *alterations* ~~of to existing buildings that include new~~ *compressed air systems* where the total combined horsepower (hp) of the compressor(s) is 25 hp or more in existing *buildings* that will be *nonresidential*, *hotel/motel*, or *multifamily* occupancies shall comply with the applicable requirements of Section 905.1.

Alterations to *compressed air systems* in existing buildings shall comply with the requirements of Sections 905.4.1 through 905.4.4, as determined by the scope of the alteration.

905.4.1 [New section] Alterations to air compressors. For *alterations* to existing compressor systems where air compressors are added or replaced, all added or replaced compressors shall meet the requirements of Section 905.1.1, Section 905.1.2, and Section 905.1.3.

EXCEPTION 1 to Section 905.4.1: *Alterations* where the total combined added or replaced compressor horsepower is less than the average per-compressor horsepower of all compressors in the system do not need to comply with *trim compressor* and storage requirements in Section 905.1.1.

EXCEPTION 2 to Section 905.4.1: *Alterations* where all added or replaced compressors are variable speed drive (VSD) compressors and *compressed air system* includes *primary storage* of at least one gallon per actual cubic feet per minute (acfm) of the largest *trim compressor* do not need to comply with *trim compressor* and storage requirements in Section 905.1.1.

EXCEPTION 3 to Section 905.4.1: *Alterations* of existing *compressed air systems* that include one or more centrifugal compressors do not need to comply with *trim compressor* and storage requirements in Section 905.1.1.

EXCEPTION 4 to Section 905.4.1: *Alterations* that have been approved by the *Energy Commission Executive Director* as having demonstrated that the system serves loads for which typical air demand fluctuates less than 10 percent do not need to comply with *trim compressor* and storage requirements in section 905.1.1.

EXCEPTION 5 to Section 905.4.1: *Alterations where all added or replaced compressors have less than a combined 100 hp in air compressor capacity do not need to comply with controls requirements in section 905.1.2, monitoring requirements in section 905.1.3, or applicable portions of NA7.*

905.4.2 [New section] *Alterations to compressed air piping. For alterations with added or replaced compressed air piping greater than 50 adjoining feet in length, all added or replaced piping shall meet the requirements of Section 905.1.4, Section 905.1.5, and applicable portions of NA7.*

905.4.3. [New section] *Alterations to compressed air dryers. For alterations with added or replaced compressed air dryers, all added or replaced compressed air dryers shall meet the requirements of 905.1.6 and applicable portions of NA7.*

7.4 Reference Appendices

The Statewide CASE Team recommends the following changes to the compressed air NA7.13 reference appendix.

REFERENCE APPENDICES

APPENDIX NA7 – INSTALLATION AND ACCEPTANCE REQUIREMENTS FOR NONRESIDENTIAL BUILDINGS AND COVERED PROCESSES

NA7.13 Compressed Air System Acceptance Tests

NA7.13.1 Compressed Air Control System

Acceptance tests for compressed air controls in accordance with Section 905.1.2.

NA7.13.1.1 Construction Inspection

Verify and document the following prior to functional testing:

- a. Size (hp), rated capacity (acfm), and control type of each air compressor
- b. Total system capacity (the sum of the individual capacities).
- c. System operating pressure.
- d. Compressor(s) designated as trim compressors.
- e. Method for observing and recording the states of each compressor in the system, which shall include at least the following states:

Off

Unloaded

Partially loaded

Fully loaded

Short cycling (loading and unloading more often than once per minute)

Blow off (venting compressed air at the compressor itself)

NA7.13.1.2 Functional Testing

Step 1: As specified by the test methods outlined in the Construction Inspection, verify that these methods have been employed, so that the states of the compressors and the current air demand (as measured by a flow sensor or otherwise inferred by system measurements) can be observed and recorded during testing.

Step 2: Run the compressed air supply system steadily at as close to the expected operational load range as can be practically implemented, for a duration of at least 10 minutes.

Step 3: Observe and record the states of each compressor and the current air demand during the test.

Step 4: Confirm that the combinations of compressors states meet the following criteria:

- a. No compressor exhibits short cycling (loading and unloading more often than once per minute).
- b. No compressor exhibits blowoff (venting compressed air at the compressor itself).
- c. For new systems, the trim compressors shall be the only compressors partially loaded, while the base compressors will either be fully loaded or off by the end of the test.

NA7.13.2 Compressed Air Monitoring

Acceptance tests for compressed air monitoring installed in accordance with Section 905.1.3.

NA7.13.2.1 Construction Inspection

Verify and document the following monitoring system capabilities prior to functional testing:

- a. Measurement of header or compressor discharge pressure.
- b. Measurement of amps or power of each compressor.
- c. Measurement or determination of airflow in cfm.
- d. Data logging of pressure, power, airflow, and calculated compressed air system specific efficiency in kW/100 cfm at intervals of 5 minutes or less.
- e. Maintained data storage.

- f. Visual trending display of each recorded point, load, and specific efficiency.

NA7.13.2.2 Functional Testing

Verify and document the following monitoring system capabilities:

- a. Data observed during test is being recorded to a log file that can be opened and viewed to see trend of airflow, power, and specific efficiency in at least 5-minute intervals.
- b. Airflow and compressor power data vary with loading and unloading of the compressor within typical performance expectations. Measurements should be observed across various loading, whether manually varied in response to actual operational loads.

NA7.13.3 Compressed Air Dryers

NA7.13.3.1 Construction Inspection

Verify and document that for all desiccant air dryers, either:

- a. The desiccant air dryer has been installed with a dew point sensor or other sensor that measures the state of the desiccant material, and dew point regeneration controls are enabled and turned on, which may be activated with manual switching or in software; or
- b. The desiccant air dryer is a heat-of-compression dryer.

7.5 Compliance Manuals

There are no proposed changes to compliance manuals.

7.6 ACM Reference Manual

There are no proposed changes to the ACM Reference Manual.

7.7 Compliance Forms

As discussed in Section 2.4.5, the NRCC-PRC-E, NRCI-PRC-E, and NRCA-PRC-01-F compliance forms would be updated to reflect the proposed change. The Statewide CASE Team can support the CEC in implementing these updates if the proposed change is adopted.

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Appendix A: Assumptions for Cost-effectiveness Analysis

Key Assumptions for Energy Savings Analysis

Key assumptions for the energy savings analysis include:

- No climate zone dependence on dryer energy usage. This would be the case for the typical compressed air system, which is installed inside a building with relatively constant ambient air conditions.
- Each prototype shares a common dryer for all the associated air compressors.
- Prototypes and air compressor loads are consistent with previous code cycles.
- There is no peak demand reduction due to the proposed measures. Equipment will still reach the same instantaneous peak electrical demand despite energy savings.
- Because interactive effects with other energy uses in the building, such as HVAC equipment, are expected to be minimal, the model assumes no interactive effects.
- The location of the dryer will be consistent with the ISO7183 rated conditions.
- Dryer specifications are based on average equipment performance across the market and available products.
- The performance curve of energy-saving refrigerated dryers is linear across load. In other words, the electrical energy demand is linearly proportional between the ten percent and full load conditions as reported on CAGI datasheets.
- Regeneration energy consumption is also linearly proportional to load fractions when regeneration load-following controls are installed.

Energy Savings Methodology per Prototypical Building

The four prototype systems are shown in Table 25.

Table 25: Compressed Air System Prototypes

Variable	Prototype 1	Prototype 2	Prototype 3	Prototype 4
Rated Flow (cfm)	579	966	2,181	4,666
Nominal Operating Base Load (cfm)	342	729	1,417	3,138
Nominal Trim Load (cfm)	237	237	764	1,528
Primary Receiver Size (gall)	474	474	1,528	3,050
Compressor 1 (baseload)	75 hp, load/unload, single stage, lubricant injected, reciprocating	150 hp, load/unload, single stage, lubricant injected, reciprocating	300 hp, load/unload, single stage, lubricant injected, reciprocating	500 hp, inlet vane, multiple stage, centrifugal
Compressor 2 (trim)	50 hp, VSD, single stage, lubricant injected, rotary screw	50 hp, VSD, single stage, lubricant injected, rotary screw	150 hp, VSD, single stage, lubricant injected, rotary screw	150 hp, VSD, single stage, lubricant injected, rotary screw
Compressor 3 (trim)	N/A	N/A	N/A	150 hp, VSD, single stage, lubricant injected, rotary screw

Each prototype has two load profiles, one for weekdays and one for weekends, to match two-shift, seven-day operation. Figure 6 through Figure 9 show weekday profiles, and Figure 10 through Figure 13 show weekend profiles. The load profile shapes shown are the same across prototypes, scaled to match the capacity of each system.

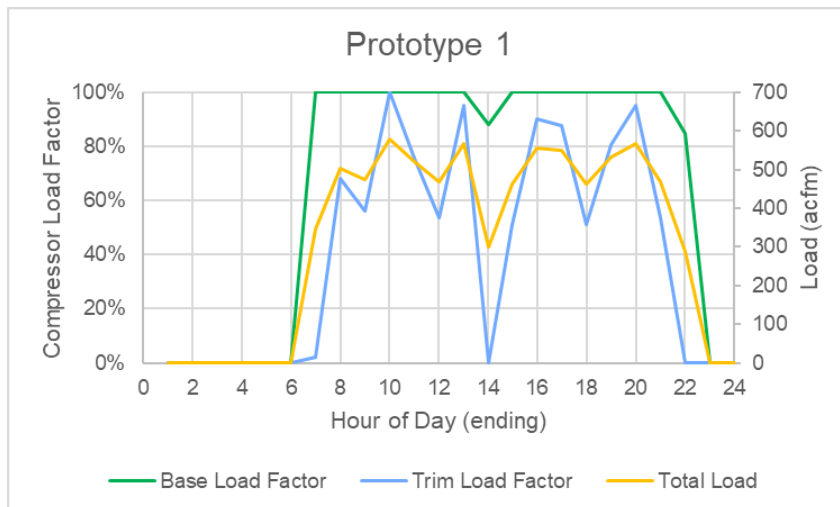


Figure 6: Weekday load profile for Prototype 1.

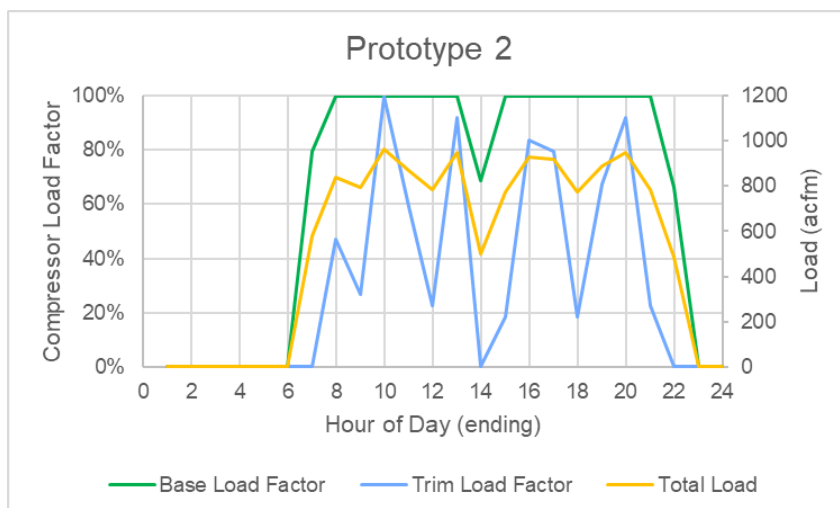


Figure 7: Weekday load profile for Prototype 2.

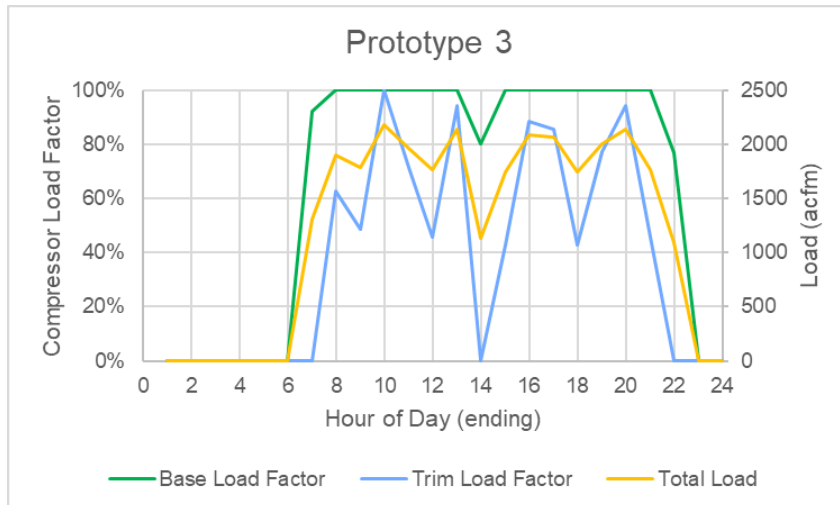


Figure 8: Weekday load profile for Prototype 3.

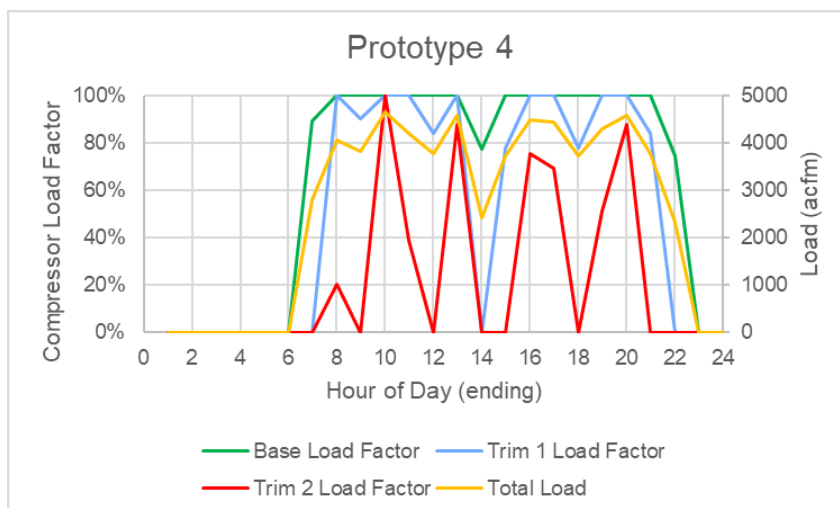


Figure 9: Weekday load profile for Prototype 4.

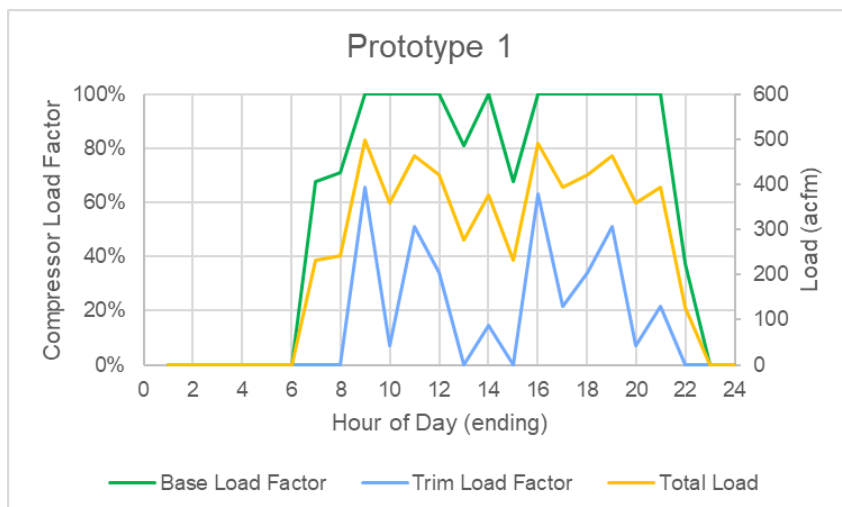


Figure 10: Weekend load profile for Prototype 1.

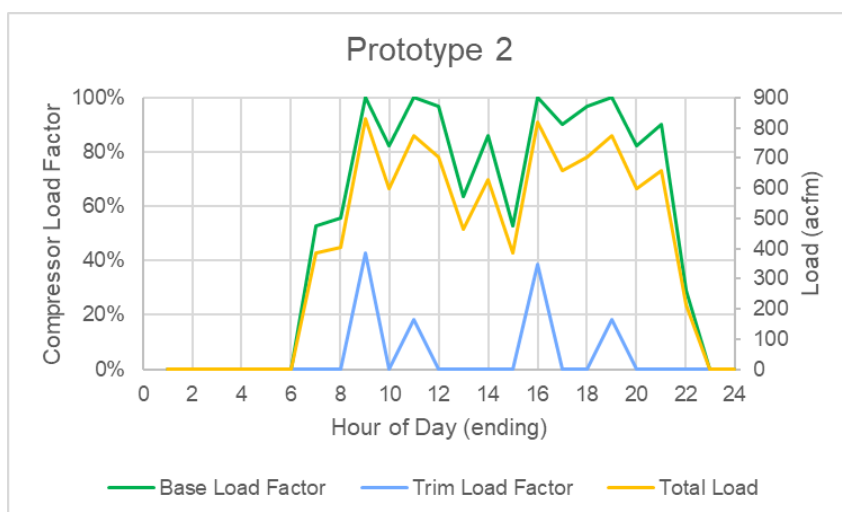


Figure 11: Weekend load profile for Prototype 2.

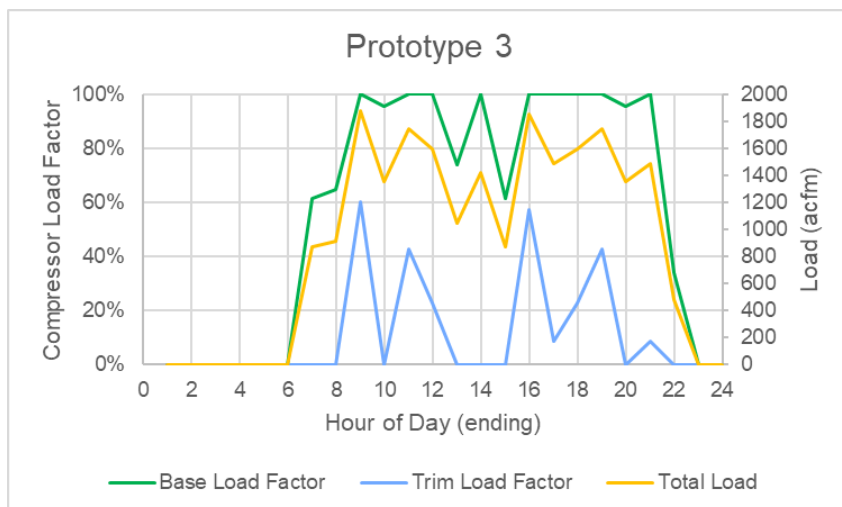


Figure 12: Weekend load profile for Prototype 3.

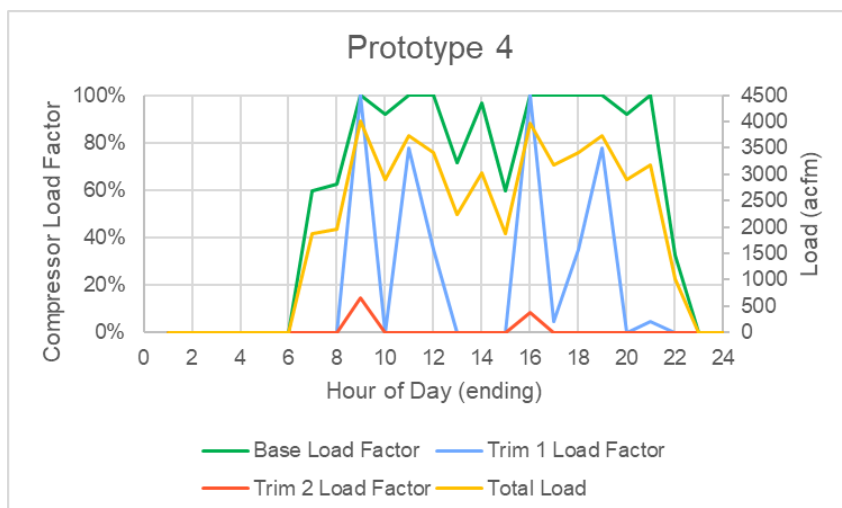


Figure 13: Weekend load profile for Prototype 4.

Dryer equipment was not included in the air compressor prototypes in previous code cycles, so the Statewide CASE Team specified this equipment for each prototype for the cost effectiveness analysis. It is assumed that the compressed air system shares a common dryer, sized to match the total plant peak airflow at ISO 7183 conditions.

There are four dryer cases needed for the Standard and Proposed Designs to enable the calculation of energy usage and savings of the proposed changes across the four prototypes. These four submeasures are defined in Table 26 and were analyzed for each of the four prototype systems.

Table 26: Standard and Proposed Designs

Submeasure	Standard Design	Proposed Design
Submeasure 1	Non-cycling refrigerated dryer	Energy-saving refrigerated dryer
Submeasure 2	Heatless desiccant dryer without regeneration controls	Energy-saving refrigerated dryer
Submeasure 3	Heatless desiccant dryer without regeneration controls	Heatless desiccant dryer with regeneration controls
Submeasure 4	Heatless desiccant dryer with regeneration controls	Heated desiccant dryer with regeneration controls

The specifications for each of these submeasure, shown in Table 27, were determined by gathering performance data for available dryer equipment across the market. Purge rates, heater power, blower power, and specific power were obtained from specification sheets and equipment literature for dryers available in the market. This data came from information for 200 non-cycling refrigerated dryers, 156 cycling refrigerated dryers, 215 heatless desiccant dryers, and 135 heated desiccant dryers from both CAGI and manufacturer product literature.

Table 27: Standard and Proposed Air Dryer Specifications

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

Energy usage for each hour of the weekday and weekend profiles was calculated for each dryer design. For the refrigerated dryer cases, direct energy usage of the dryer was calculated based on the load fraction for each hour of the daily profiles and the specific power as applied to that hourly load:

$$\text{Hourly refrigerated dryer kWh} = (\text{Load Fraction} * a + b) * (\text{Load Fraction} * \text{Rated Flow}) / 100$$

Where *Load Fraction* is defined hourly by the profiles in Figure 6 and Figure 7, *Rated Flow* is total system capacity listed in Table 25 for each prototype, and *a* and *b* are the linear fit coefficients to the average refrigerated dryer performance curves shown in Figure 14.

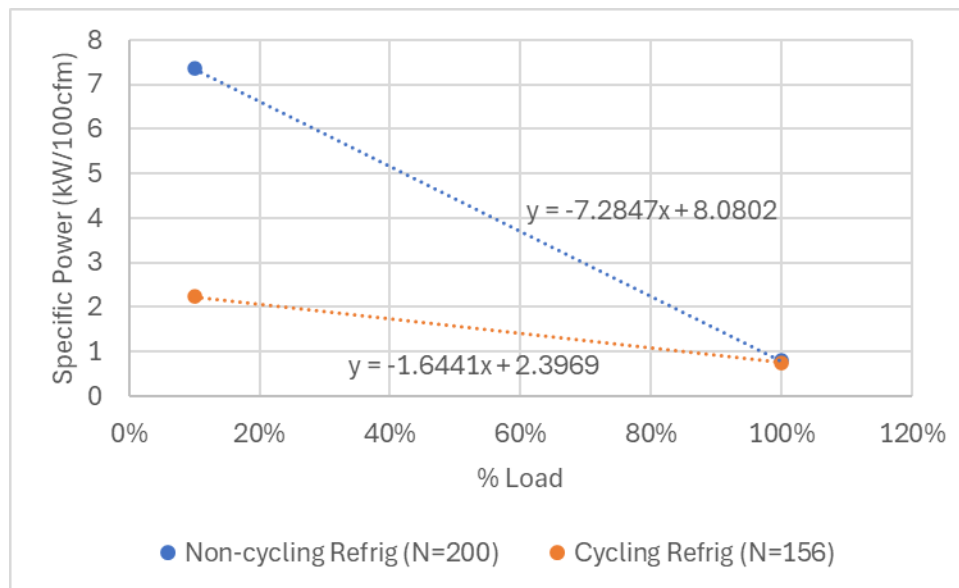


Figure 14: Refrigerated dryer performance curves.

For the desiccant dryer cases, purge air energy was calculated based on the hourly air compressor specific energy, load fraction, and purge rate:

Hourly desiccant dryer kWh

$$= \left(\left(\text{Purge rate} * \text{Air Compressor Specific Power} \right. \right. \\ \left. \left. + \begin{cases} 0, & \text{if heatless} \\ \text{Heater specific power}, & \text{if heated} \end{cases} \right) * \text{Rated Flow}/100 \right) \\ * \begin{cases} 1, & \text{without regeneration controls} \\ \text{Load Fraction}, & \text{with regeneration controls} \end{cases}$$

where the air compressor specific power is determined by the hourly air compressor energy consumption and load profiles defined in previous code cycles after compliance with the existing requirements.

Energy usage for each dryer case was calculated for each hour of the weekend and weekday profiles and then extrapolated to a single calendar year with ten Federal holidays observed. Energy savings for each submeasure in Table 26 are then calculated by comparison of the respective Standard and Proposed Designs.

Appendix B: Purpose and Necessity of Proposed Code Changes

Introduction

The sections below provide the purpose and necessity of proposed changes to Title 24, Part 1; Title 24, Part 6; and the reference appendices. This section intends to provide the CEC with the information needed for the Initial Statement of Reasons.

See Section 7 of this report for marked-up code language.

Purpose and Necessity of Changes to Title 24, Part 1

No changes are proposed to Title 24, Part 1.

Purpose and Necessity of Changes to Title 24, Part 6

Section: 201 [*Section: 100.1*]

Purpose: The purpose of these changes is to aid in the interpretation and implementation of new requirements for compressed air dryers in Title 24, Part 6, Section 905.1 by modifying existing definitions.

Necessity: These changes remove a definition for online compressors that is no longer necessary and modify definitions for compressed air system and trim compressor.

Section: 905.1 [*Section: 120.6(e)*]

Purpose: The purpose of these changes is to require new compressed air dryers to meet several new requirements. The system's required dew point must be stated in the design documents, and it governs whether a refrigerated dryer or desiccant dryer should be used. In addition, all refrigerated dryers must be an energy-saving type. The 35°F threshold reflects established industry operating limits for refrigerated air dryers and distinguishes applications requiring low-dew-point desiccant drying from those that can be effectively served by lower-energy refrigerated drying technologies. All desiccant dryers with a capacity of at least 300 cfm must have controls to adjust regeneration depending on measured moisture load. The 300-cfm threshold reflects the point at which purge-air energy losses from large desiccant dryers become substantial enough that heated regeneration approaches are generally cost-effective and commercially common. These changes also move some language relating to compressed air dryer system modifications to Section 905.4. Finally, an exception for devices that use compressed air was modified to cover devices that process it.

Necessity: These changes are intended to reduce compressed air dryer energy consumption. The change to the exception for using processed compressed air is necessary because drying compressed air is a form of processing it. These adjustments align with the mandated cost-effective building design standards outlined in the California Public Resources Code, specifically Sections 25213 and 25402.

Section: 905.4 [Section: 141.1]

Purpose: The purpose of these changes is to add language corresponding to the proposed changes to 905.1, regarding new requirements for compressed air dryers. The changes to 905.4 would ensure that modifications to compressed air dryer systems trigger the same requirements unless an exception applies. Exceptions relating specifically to system modifications that were originally in 905.1 have also been moved to 905.4

Necessity: These changes are intended to reduce compressed air dryer energy consumption. These adjustments align with the mandated cost-effective building design standards outlined in the California Public Resources Code, specifically Sections 25213 and 25402.

Purpose and Necessity of Changes to the Reference Appendices

Section: NA7

Purpose: The purpose of this change is to add acceptance testing requirements for compressed air dryer dew point controls.

Necessity: This change is necessary in order to implement and enforce the proposed requirements for compressed air dryers. The savings desiccant regeneration controls depend on those controls being enabled. It is therefore necessary to verify they are turned on.

Appendix C: Assumptions for Statewide Savings Estimates

The California compressed air market, construction, and growth rates are not captured in the California Energy Commission construction forecast, which is used as a default for 2028 CASE Reports. Compressed air systems covered by code predominantly exist in industrial facilities. While these facilities are captured in the existing manufacturing floorspace and project new construction floorspace, these do not correlate with compressed air system capacity. So, an alternate approach to calculating total market size was developed by the Statewide CASE Team.

The total compressed air energy footprint for U.S. manufacturing was calculated for the Department of Energy by Energetics using data from the U.S. Energy Information Administration's 2018 Manufacturing Energy Consumption Survey (Energetics, 2022) (U.S EIA, 2021). The total national manufacturing sector electrical energy consumption for compressed air was determined to be 263 TBtu per year. Using California's 14.5 percent share of all U.S. manufacturing output, California's compressed air energy usage is about 38.1 TBtu per year or 11,177 GWh/yr³.

Table 28: Existing statewide compressed air market energy footprint

Data	Variable Name	Value	Source
U.S. Compressed Air Electrical Energy Consumption (TBtu/yr)	A	263	(Energetics, 2022)
California Share of U.S. Manufacturing	B	14.5%	(California Manufacturing Technology Consulting, 2022)
California Compressed Air Energy Consumption (TBtu/yr)	C	38.1	A*B
California Compressed Air Energy Consumption (GWh/yr)	D	11,176.7	C*unit conversion

To estimate statewide potential energy savings for the proposed measures, it was necessary to estimate the distribution of compressed air system hp in the existing building stock. The Statewide CASE Team estimated this installed capacity distribution

³ Using a slightly different approach, the 2022 Final CASE Report for compressed air included an estimated 9,784 GWh/yr based on 2001 survey data. The two market size estimates are in rough agreement, accounting for annual growth rate.

by combining the total California market size, prototype annual energy consumption, and market statistics as reported in a Department of Energy compressed air survey (Xenergy, 2001).

Table 29: Existing statewide compressed air market horsepower

Data	Variable Name	Prototype 1	Prototype 2	Prototype 3	Prototype 4	Source
Approximate energy footprint fraction of installed systems by prototype	E	18.6%	53.4%	12.2%	15.7%	(Statewide CASE Team, 2020)
California existing market energy footprint by prototype size (GWh/yr)	F	2,075.8	5,985.2	1,361.2	1,754.5	E*D
Annual energy consumption per prototype (kWh/yr)	G	501,836	793,903	1,762,067	3,195,834	(Statewide CASE Team, 2020)
Statewide number of sites by prototype	H	4,136	7,359	772	549	F*10 ⁶ /G
Prototype hp	I	125	200	450	800	(Statewide CASE Team, 2020)
Statewide installed hp by prototype	J	517,055	1,507,804	347,624	439,190	H*I

Table 30: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026, by Climate Zone and Building Type (Million Square Feet)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Manufacturing	0.01	0.13	0.40	0.19	0.06	0.13	0.09	0.11	0.10	0.11	0.06	0.16	0.02	0.02	0.02	0.01	1.62

Table 31: Estimated Existing Nonresidential Floorspace Impacted by Proposed Code Change in 2026 (Alterations), by Climate Zone and Building Type (Million Square Feet)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Manufacturing	3.28	13.51	49.54	63.64	4.47	58.66	26.62	98.16	134.48	39.66	10.29	45.61	20.78	13.58	4.12	7.42	593.83

Having obtained an estimate of the distribution of installed compressed air hp using California’s compressed air energy consumption, the market size for compressed air in California, prototype energy consumption, and DOE’s market statistics in its published compressed air energy survey, the Statewide CASE Team used the distribution of existing floorspace in the manufacturing sector in Table 28 and the new construction forecast in Table 27 to establish growth rates across climate zones. This was then used to calculate the installed and new construction compressed air system hp by prototype. The existing and new-construction market sizes in horsepower for each prototype are shown in Table 32 and

Table 33. These tables represent the entire California compressed air market.

Table 32: Estimated New Nonresidential hp in 2026, by Climate Zone and Prototype (hp)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Prototype 1	2.0	50.3	107.7	192.6	33.7	65.9	42.4	89.9	126.0	208.2	20.5	118.1	87.6	45.4	21.3	19.8	1,231.4
Prototype 2	5.7	146.7	314.1	561.7	98.1	192.2	123.5	262.1	367.5	607.2	59.7	344.5	255.5	132.3	62.2	57.6	3,590.6
Prototype 3	1.3	33.8	72.4	129.5	22.6	44.3	28.5	60.4	84.7	140.0	13.8	79.4	58.9	30.5	14.4	13.3	827.8
Prototype 4	1.7	42.7	91.5	163.6	28.6	56.0	36.0	76.4	107.0	176.9	17.4	100.3	74.4	38.5	18.1	16.8	1,045.9

Table 33: Estimated Existing Nonresidential hp in 2026, by Climate Zone and Prototype (thousand hp)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Prototype 1	2.70	11.49	38.61	55.01	3.64	53.27	24.13	90.23	123.26	34.98	7.53	33.43	16.67	12.09	3.45	6.56	517.05
Prototype 2	7.87	33.51	112.59	160.43	10.61	155.33	70.36	263.13	359.44	102.01	21.97	97.50	48.61	35.26	10.06	19.14	1,507.8
Prototype 3	1.81	7.73	25.96	36.99	2.45	35.81	16.22	60.67	82.87	23.52	5.06	22.48	11.21	8.13	2.32	4.41	347.62
Prototype 4	2.29	9.76	32.79	46.73	3.09	45.24	20.49	76.65	104.70	29.71	6.40	28.40	14.16	10.27	2.93	5.57	439.19

Only a portion of this market could be influenced by the proposed code changes. The Statewide CASE Team interviewed stakeholders on the naturally occurring adoption rate of the proposed measures in the compressed air market. From these interviews, the percentage of sites that are not already including the proposed measures is shown in Table 34.

Table 34: Natural Adoption Rates of Proposed Measures

Submeasure	Standard Design	Proposed Design	Market Share without Natural Adoption	EUL (years)
Submeasure 1	Non-cycling refrigerated dryer	Energy-saving refrigerated dryer	10%	13
Submeasure 2	Heatless desiccant dryer without regeneration controls	Energy-saving refrigerated dryer	5%	13
Submeasure 3	Heatless desiccant dryer without regeneration controls	Heatless desiccant dryer with regeneration controls	11.9%	15
Submeasure 4	Heatless desiccant dryer with regeneration controls	Heated desiccant dryer with regeneration controls	4%	15

Applying these adoption rates for the proposed measures for the new construction market size and the existing market size with an annual replacement rate of 1/EUL, shown in Table 35 , the Statewide CASE Team calculated the total annual impacted horsepower for each submeasure across prototypes and climate zones, shown in Table 36 through Table 43.

Table 35: EUL and replacement rate-All Measures

Submeasure	EUL (years)	Replacement Rate
Submeasure 1	13	7.7%
Submeasure 2	13	7.7%
Submeasure 3	15	6.7%
Submeasure 4	15	6.7%

Table 36: Estimated Impacted New Nonresidential hp in 2026, by Climate Zone and Prototype (hp) – Submeasure 1

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Prototype 1	0.2	5.03	10.77	19.26	3.37	6.59	4.24	8.99	12.6	20.82	2.05	11.81	8.76	4.54	2.13	1.98	123.14
Prototype 2	0.57	14.67	31.41	56.17	9.81	19.22	12.35	26.21	36.75	60.72	5.97	34.45	25.55	13.23	6.22	5.76	359.06
Prototype 3	0.13	3.38	7.24	12.95	2.26	4.43	2.85	6.04	8.47	14	1.38	7.94	5.89	3.05	1.44	1.33	82.78
Prototype 4	0.17	4.27	9.15	16.36	2.86	5.6	3.6	7.64	10.7	17.69	1.74	10.03	7.44	3.85	1.81	1.68	104.59

Table 37: Estimated Impacted Existing Nonresidential hp in 2026, by Climate Zone and Prototype (hp) – Submeasure 1

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Prototype 1	20.7	88.4	297.0	423.2	28.0	409.7	185.6	694.1	948.1	269.1	57.9	257.2	128.2	93.0	26.5	50.5	3,977.3
Prototype 2	60.5	257.8	866.1	1,234.1	81.6	1,194.9	541.2	2,024.1	2,764.9	784.7	169.0	750.0	373.9	271.2	77.4	147.2	11,598.5
Prototype 3	13.9	59.4	199.7	284.5	18.8	275.5	124.8	466.7	637.5	180.9	39.0	172.9	86.2	62.5	17.8	33.9	2,674.0
Prototype 4	17.6	75.1	252.3	359.5	23.8	348.0	157.7	589.6	805.4	228.6	49.2	218.5	108.9	79.0	22.5	42.9	3,378.4

Table 38: Estimated Impacted New Nonresidential hp in 2026, by Climate Zone and Prototype (hp) – Submeasure 2

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Prototype 1	0.10	2.52	5.39	9.63	1.69	3.30	2.12	4.50	6.30	10.41	1.03	5.91	4.38	2.27	1.07	0.99	61.57
Prototype 2	0.29	7.34	15.71	28.09	4.91	9.61	6.18	13.11	18.38	30.36	2.99	17.23	12.78	6.62	3.11	2.88	179.53
Prototype 3	0.07	1.69	3.62	6.48	1.13	2.22	1.43	3.02	4.24	7.00	0.69	3.97	2.95	1.53	0.72	0.67	41.39
Prototype 4	0.09	2.14	4.58	8.18	1.43	2.80	1.80	3.82	5.35	8.85	0.87	5.02	3.72	1.93	0.91	0.84	52.30

Table 39: Estimated Impacted Existing Nonresidential hp in 2026, by Climate Zone and Prototype (hp) – Submeasure 2

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Prototype 1	10.4	44.2	148.5	211.6	14.0	204.9	92.8	347.1	474.1	134.5	29.0	128.6	64.1	46.5	13.3	25.2	1,988.7
Prototype 2	30.3	128.9	433.0	617.0	40.8	597.4	270.6	1,012.1	1,383	392.3	84.5	375.0	187.0	135.6	38.7	73.6	5,799.2
Prototype 3	7.0	29.7	99.8	142.3	9.4	137.7	62.4	233.3	318.7	90.5	19.5	86.5	43.1	31.3	8.9	17.0	1,337.0
Prototype 4	8.8	37.5	126.1	179.7	11.9	174.0	78.8	294.8	402.7	114.3	24.6	109.2	54.5	39.5	11.3	21.4	1,689.2

Table 40: Estimated Impacted New Nonresidential hp in 2026, by Climate Zone and Prototype (hp) – Submeasure 3

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Prototype 1	0.24	5.99	12.82	22.92	4.01	7.84	5.05	10.70	14.99	24.78	2.44	14.05	10.42	5.40	2.53	2.36	146.54
Prototype 2	0.68	17.46	37.38	66.84	11.67	22.87	14.70	31.19	43.73	72.26	7.10	41.00	30.40	15.74	7.40	6.85	427.28
Prototype 3	0.15	4.02	8.62	15.41	2.69	5.27	3.39	7.19	10.08	16.66	1.64	9.45	7.01	3.63	1.71	1.58	98.51
Prototype 4	0.20	5.08	10.89	19.47	3.40	6.66	4.28	9.09	12.73	21.05	2.07	11.94	8.85	4.58	2.15	2.00	124.46

Table 41: Estimated Impacted Existing Nonresidential hp in 2026, by Climate Zone and Prototype (hp) – Submeasure 3

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Prototype 1	21.4	91.2	306.3	436.4	28.9	422.6	191.4	715.9	977.9	277.5	59.8	265.2	132.2	95.9	27.4	52.1	4,102.0
Prototype 2	62.4	265.8	893.2	1,272.7	84.1	1,232.3	558.2	2,087.5	2,851.6	809.3	174.3	773.5	385.6	279.7	79.8	151.8	11,961.9
Prototype 3	14.4	61.3	205.9	293.4	19.4	284.1	128.7	481.3	657.4	186.6	40.2	178.3	88.9	64.5	18.4	35.0	2,757.8
Prototype 4	18.2	77.4	260.2	370.7	24.5	358.9	162.6	608.1	830.6	235.7	50.8	225.3	112.3	81.5	23.2	44.2	3,484.2

Table 42: Estimated Impacted New Nonresidential hp in 2026, by Climate Zone and Prototype (hp) – Submeasure 4

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Prototype 1	0.08	2.01	4.31	7.70	1.35	2.64	1.70	3.60	5.04	8.33	0.82	4.72	3.50	1.82	0.85	0.79	49.26
Prototype 2	0.23	5.87	12.56	22.47	3.92	7.69	4.94	10.48	14.70	24.29	2.39	13.78	10.22	5.29	2.49	2.30	143.62
Prototype 3	0.05	1.35	2.90	5.18	0.90	1.77	1.14	2.42	3.39	5.60	0.55	3.18	2.36	1.22	0.58	0.53	33.11
Prototype 4	0.07	1.71	3.66	6.54	1.14	2.24	1.44	3.06	4.28	7.08	0.70	4.01	2.98	1.54	0.72	0.67	41.84

Table 43: Estimated Impacted Existing Nonresidential hp in 2026, by Climate Zone and Prototype (hp) – Submeasure 4

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Prototype 1	7.2	30.6	103.0	146.7	9.7	142.0	64.3	240.6	328.7	93.3	20.1	89.2	44.5	32.2	9.2	17.5	1,378.8
Prototype 2	21.0	89.4	300.2	427.8	28.3	414.2	187.6	701.7	958.5	272.0	58.6	260.0	129.6	94.0	26.8	51.0	4,020.8
Prototype 3	4.8	20.6	69.2	98.6	6.5	95.5	43.3	161.8	221.0	62.7	13.5	59.9	29.9	21.7	6.2	11.8	927.0
Prototype 4	6.1	26.0	87.5	124.6	8.2	120.7	54.7	204.4	279.2	79.2	17.1	75.7	37.8	27.4	7.8	14.9	1,171.2

Appendix D: Environmental Analysis

Potential Significant Environmental Effect of Proposal

The Statewide CASE Team has considered the environmental benefits and adverse impacts of its proposal, including—but not limited to—an evaluation of factors contained in the California Code of Regulations, Title 14, section 15064, and has determined that the proposal will not result in a significant effect on the environment.

Direct Environmental Impacts

Direct Environmental Benefits

Specifying desiccant dryers where refrigerated units satisfy process requirements results in unjustified energy consumption. Similarly, the absence of dew-point controls prolongs regeneration cycles, incurring unnecessary energy expenditure. Improving the specification process for and the operation of compressed air dryers will therefore save energy and reduce GHG emissions from the production of electricity.

The direct environmental benefits of this proposal are demonstrated by the estimated energy reductions, as discussed in Sections 2.5.1 and 2.5.2.

Direct Adverse Environmental Impacts

The Statewide CASE Team has not identified any direct adverse environmental impacts.

Indirect Environmental Impacts

Indirect Environmental Benefits

The Statewide CASE Team has not identified any indirect environmental benefits.

Indirect Adverse Environmental Impacts

The Statewide CASE Team has not identified any indirect adverse environmental impacts.

Mitigation Measures

The Statewide CASE Team has considered opportunities to minimize the environmental impact of the proposal, including an evaluation of “specific economic, environmental, legal, social, and technological factors” (Cal. Code Regs., tit. 14, § 15021). The Statewide CASE Team did not determine this measure would result in significant direct

or indirect adverse environmental impacts and therefore, did not develop any mitigation measures.

Reasonable Alternatives to Proposal

The Statewide CASE Team has considered opportunities to minimize the environmental impact of the proposal, including an evaluation of “specific economic, environmental, legal, social, and technological factors” (Cal. Code Regs., tit. 14, § 15021). The Statewide CASE Team did not determine this measure would result in significant direct or indirect adverse environmental impacts and therefore did not develop any mitigation measures.

Water Use and Water Quality Impacts Methodology

There are no water use or water quality impacts for this measure.

Appendix E: Summary of Stakeholder Engagement

Introduction to Stakeholder Engagement

Collaborating with stakeholders who may be affected by proposed code changes is a core component of the Statewide CASE Team's process. The Statewide CASE Team engages interested parties to identify and address issues related to the proposals, with the goal of submitting recommendations to the CEC in this Final CASE Report that reflect broad support. Public stakeholders provide valuable feedback on draft analyses and help identify and address adoption challenges, including cost effectiveness, market and technical barriers, compliance and enforcement, and potential impacts on human health or the environment. Some stakeholders also provide data that the Statewide CASE Team uses to support analyses.

This appendix summarizes the stakeholder engagement conducted by the Statewide CASE Team during the development and refinement of the report's recommendations.

Utility-Sponsored Stakeholder Meetings

Utility-sponsored stakeholder meetings provide an opportunity to learn about the Statewide CASE Team's role in the advocacy effort and to hear about specific code change proposals that the Statewide CASE Team is pursuing for the 2025 code cycle. The goal of these meetings is to solicit input on proposals from stakeholders early enough to ensure the proposals and the supporting analyses are vetted and have as few outstanding issues as possible. To promote transparency in the development of code change proposals, the Statewide CASE Team uses stakeholder meetings to solicit feedback on:

- Proposed code changes
- Draft code language
- Draft assumptions and results of analyses
- Data to support assumptions
- Compliance and enforcement
- Technical and market feasibility

The Statewide CASE Team hosted one stakeholder meetings for compressed air drying via webinar as described in Table 44. Please see below for dates and links to event pages on Title24Stakeholders.com. Materials from each meeting, such as slide presentations, proposal summaries with code language, and meeting notes, are included in the bibliography section of this report (Statewide CASE Team, 2025a) (Statewide CASE Team, 2025b) (Statewide CASE Team, 2025c).

Table 44: Utility-Sponsored Stakeholder Meetings

Meeting Name and Link to Materials	Meeting Date	Summary of Items Discussed
First Round Compressed Air Utility-Sponsored Stakeholder Meeting	Wednesday, October 29, 2025	• Market shares • Data collection processes • Code change intent • Calculation methodology • Market, technical, and compliance barriers and solutions • Requests for input
Second Round of Compressed Air Utility-Sponsored Stakeholder Meeting	March 19, 2026	• Revisions to proposal after first stakeholder meeting.

The first round of utility-sponsored stakeholder meetings began in October 2025 and served as an early forum to promote transparency and gather stakeholder feedback on measures under consideration by the Statewide CASE Team.

The objectives of the first round of stakeholder meetings were to solicit input on the scope of the 2025 code cycle proposals; request data and feedback on the specific approaches, assumptions, and methodologies for energy-impact and cost-effectiveness analyses; and understand potential technical and market barriers. The Statewide CASE Team also presented the initial draft code language for stakeholders to review.

The second Compressed Air Dryer utility-sponsored stakeholder meeting was held on March 19, 2026, to provide updated details on proposed code changes. This meeting introduced early results of energy, cost effectiveness, and incremental cost analyses, and solicited feedback on refined draft code language.

Utility-sponsored stakeholder meetings were open to the public. For each stakeholder meeting, two promotional emails were distributed from info@title24stakeholders.com. One email was sent to the full Title 24 Stakeholders listserv, which includes over 3,000 individuals. A second email targeted specific recipients based on their subscription preferences.

The Title 24 Stakeholders listserv is an opt-in service comprising participants from a diverse industries and trades, such as manufacturers, advocacy groups, local government, and building and energy professionals. Each meeting was announced on the Title 24 Stakeholders LinkedIn page and cross-promoted on the CEC LinkedIn page approximately two weeks in advance to engage individuals, organizations, and broader channels outside beyond the listserv. The Statewide CASE Team conducted extensive personal outreach to stakeholders identified in initial work plans who had not yet opted in to the listserv. Exported webinar meeting data captured attendance numbers,

individual comments, and results from live attendee polls to help evaluate stakeholder participation and support.

Statewide CASE Team Communications

The Statewide CASE Team held personal communications over email, phone, and videoconference with numerous stakeholders when developing this report, listed in Table 45. Most stakeholders preferred to be anonymous.

Table 45: Engaged Stakeholders

Organization or Individual Name	Market Role	Mentioned in CASE Report Sections
Anonymous Stakeholder 1	Manufacturer, Dryer Subject Matter Expert	2.1 Proposed Code Language 3. Compliance and Enforcement 4.1.1 Current Market Structure and Availability 5.3 Incremental First Cost 5.4 Incremental Maintenance and Replacement Costs
Anonymous Stakeholder 2	Industry Trade Association	2.1 Proposed Code Language 3. Compliance and Enforcement 4.1.1 Current Market Structure and Availability
Anonymous Stakeholder 3	Industry Consultant and Compressed Air System Designer	2.1 Proposed Code Language 5.3 Incremental First Cost 5.4 Incremental Maintenance and Replacement Costs
Anonymous Stakeholder 4	Manufacturer, Dryer Subject Matter Expert	5.3 Incremental First Cost 5.4 Incremental Maintenance and Replacement Costs
Anonymous Stakeholder 5	Manufacturer, Dryer Subject Matter Expert	2.1 Proposed Code Language 4.1.1 Current Market Structure and Availability 4.1.2 Market Challenges 5.4 Incremental Maintenance and Replacement Costs
Anonymous Stakeholder 6	Manufacturer, Dryer Subject Matter Expert	5.3 Incremental First Cost 5.4 Incremental Maintenance and Replacement Costs
Anonymous Stakeholder 7	Industry Consultant and Compressed Air System Assessor	2.1 Proposed Code Language 5.3 Incremental First Cost 5.4 Incremental Maintenance and Replacement Costs
Anonymous Stakeholder 8	Manufacturer, Dryer Subject Matter Expert	2.1 Proposed Code Language 3. Compliance and Enforcement 4.1.1 Current Market Structure and Availability

Engagement with ESJ communities

The Statewide CASE Team did not conduct stakeholder outreach specifically targeted towards ESJ communities for this proposed code change. The proposed measures would have no direct impact on residential communities in California, and the only indirect anticipated impact is decreased exposure to air pollution due to reduced need to generate electricity.

Appendix F: Code Language Markup (Non-restructured)

The language below is from the Draft CASE Report and in the non-restructured 2025 Title 24 Part 6 Code Language.

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2025 documents should be marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions).

8.1 Administrative Code (Title 24, Part 1)

8.2 Energy Code (Title 24, Part 6)

SECTION 100.1 – DEFINITIONS AND RULES OF CONSTRUCTION

Section 100.1(b) – Definitions: Recommends new or revised definitions for the following terms:

COMPRESSED AIR SYSTEM is a system of at least one compressor providing compressed air at 40 psig or higher and all its components upstream of pneumatic end uses.

LARGEST NET CAPACITY INCREMENT is the largest increase in capacity when switching between combinations of base compressors that is expected to occur under the compressed air system control scheme.

~~ONLINE COMPRESSORS are all the compressors that are physically connected to compressed air piping and are available to serve peak load. Online compressors do not include back-up compressors whose only purpose is to be available when an online compressor fails.~~

TRIM COMPRESSOR is a compressor that is designated for part-load operation handling the short-term variable trim load of end uses, in addition to the contrast to always fully loaded base compressors.

DESICCANT AIR DRYER is an air dryer that uses regenerative desiccant material to remove moisture from compressed air with or without supplemental heat and with or without purge air supplied by the air compressor for regenerating the desiccant material.

POINT-OF-USE AIR DRYER is an air dryer that operates at the same single end-use location at which compressed air is intended to be used.

REFRIGERATED AIR DRYER is an air dryer that uses a refrigeration cycle to remove moisture from compressed air. This includes equipment with a hot gas bypass to prevent freezing at low loads.

ENERGY-SAVING REFRIGERATED AIR DRYER is a refrigerated dryer that includes capacity control features to reduce energy consumption in response to varying compressed air load. Capacity control features can include cycling, thermal mass, digital scroll, and variable speed drives.

DESICCANT REGENERATION CONTROLS are controls that reduce energy consumption during the regenerative process of the desiccant material in a desiccant air dryer. These controls maximize use of desiccant drying capacity and reduce overall energy consumption in response to the direct measurement of air pressure dew point directly or indirectly via other measures of desiccant material moisture and absorption.

SUBCHAPTER 3 – NONRESIDENTIAL, HOTEL/MOTEL OCCUPANCIES, AND COVERED PROCESSES – MANDATORY REQUIREMENTS

SECTION 120.6 – MANDATORY REQUIREMENTS FOR COVERED PROCESSES

(e) Mandatory requirements for compressed air systems.

All new compressed air systems, ~~and all additions or alterations of compressed air systems~~ where the total combined horsepower (hp) of the compressor(s) is 25 hp or more shall meet the requirements of Subsections 1 through 57. These requirements apply to the compressors, related piping systems, dryers, and related controls that provide compressed air and do not apply to any equipment or controls that use ~~or process~~ the compressed air.

EXCEPTION 1 to Section 120.6(e): Medical gas compressed air systems serving healthcare facilities.

1. Trim compressor and storage. The compressed air system shall be equipped with an appropriately sized trim compressor and primary storage to provide acceptable performance across the range of the system and to avoid control gaps. The compressed air system shall comply with Subsection A or B below:

A. The compressed air system shall include one or more variable speed drive (VSD) compressors. For systems with more than one compressor, the total combined capacity of the VSD compressor(s) acting as trim compressors must be at least 1.25 times the largest net capacity increment between combinations of compressors. The compressed air system shall include primary storage of at least one gallon per actual cubic feet per minute (acfm) of the largest trim compressor; or,

B. The compressed air system shall include a compressor or set of compressors with total effective trim capacity at least the size of the largest net capacity increment between combinations of compressors, or the size of the smallest compressor, whichever is larger. The total effective trim capacity of single compressor systems shall cover at least the range from 70 percent to 100 percent of rated capacity. The effective trim capacity of a compressor is the size of the continuous operational range where the specific power of the compressor (kW/100 acfm) is within 15 percent of the specific power at its most efficient operating point. The total effective trim capacity of the system is the sum of the effective trim capacity of the trim compressors. The system shall include primary storage of at least 2 gallons per acfm of the largest trim compressor.

~~EXCEPTION 1 to Section 120.6(e)1: Alterations where the total combined added or replaced compressor horsepower is less than the average per compressor horsepower of all compressors in the system.~~

~~EXCEPTION 2 to Section 120.6(e)1: Alterations where all added or replaced compressors are variable speed drive (VSD) compressors and compressed air system includes primary storage of at least one gallon per actual cubic feet per minute (acfm) of the largest trim compressor.~~

EXCEPTION 3₁ to Section 120.6(e)1: Compressed air systems that have been approved by the Energy Commission Executive Director as having demonstrated that the system serves loads for which typical air demand fluctuates less than 10 percent.

~~EXCEPTION 4 to Section 120.6(e)1: Alterations of existing compressed air systems that include one or more centrifugal compressors.~~

2. Controls. Compressed air systems with three or more compressors and a combined horsepower rating of more than 100 hp shall operate with controls that are able to choose the most energy efficient combination and loading of compressors within the system based on the current compressed air demand.

3. Monitoring. Compressed air systems having a combined horsepower rating equal to or greater than 100 hp shall have an energy and air demand monitoring system with the following minimum requirements:

- A. Measurement of system pressure.
- B. Measurement of amps or power of each compressor.
- C. Measurement or determination of total airflow from compressors in cfm.
- D. Data logging of pressure, power in kW, airflow in cfm, and compressed air system specific efficiency in kW/100 cfm at intervals of 5 minutes or less.
- E. Maintained data storage of at least the most recent 24 months.

F. Visual trending display of each recorded point, load, and specific energy.

4. Leak testing of compressed air piping. Compressed air system piping greater than 50 adjoining feet in length shall be pressure tested after being isolated from the compressed air supply and end uses. The piping shall be pressurized to the design pressure, and test pressures shall be held for a length of time at the discretion of the authority having jurisdiction, but in no case for less than 30 minutes, with no perceptible drop in pressure.

If dial gauges are used for conducting this test, these gauges must conform with California Plumbing Code Sections 318.3, 318.4, and 318.5.

Piping less than or equal to 50 adjoining feet in length shall be pressurized and inspected. Connections shall be tested with a noncorrosive leak-detecting fluid or other leak detecting methods at the discretion of the Authority Having Jurisdiction.

5. Pipe sizing. Compressed air piping greater than 50 adjoining feet in length shall be designed and installed to minimize frictional losses in the distribution network. These piping installations shall meet the requirements of Section 120.6(e)5A and either Section 120.6(e)5B or 120.6(e)5C:

A. Service line piping shall have inner diameters greater than or equal to $\frac{3}{4}$ inch. Service line piping are pipes that deliver compressed air from distribution piping to end uses.

B. Piping section average velocity. Compressor room interconnection and main header piping shall be sized so that at coincident peak flow conditions, the average velocity in the segment of pipe is no greater than 20 ft/sec. Compressor room interconnection and main header piping are the pipes that deliver compressed air from the compressor outlets to the inlet to the distribution piping. Each segment of distribution and service piping shall be sized so that at coincident peak flow conditions, the average velocity in the segment of pipe is no greater than 30 ft/sec. Distribution piping are pipes that deliver compressed air from the compressor room interconnection piping or main header piping to the service line piping.

C. Piping total pressure drop. Piping shall be designed such that piping frictional pressure loss at coincident peak loads is less than 5 percent of operating pressure between the compressor and end use or end use regulator.

6. Compressed air dryers. Compressed air dryers, other than point-of-use dryers, and their controls shall comply with Subsections A, B, C, and D below:

A. Any refrigerated air dryer shall be an energy-saving refrigerated air dryer.

B. Where required facility dew points are greater than 35°F, refrigerated air dryers shall be specified.

EXCEPTION 1 to 120.6(e)6B: Air dryers specified for applications that must maintain a precise dew point across all operating conditions.

C. All desiccant air dryers shall have desiccant regeneration controls that maximize use of desiccant drying capacity and delay regeneration cycling based on measurement of the desiccant material moisture load.

EXCEPTION 1 to 120.6(e)6C: Heat of compression air dryers that recover waste heat from air compressors to aid in regeneration of the desiccant material.

D. Desiccant air dryers with capacity of 300 cfm or greater shall have internal or external heating to reduce purge compressed air.

EXCEPTION 1 to 120.6(e)6D: Air dryers that are supplying conditioned air to plants that need dew points less than or equal to -40 °F.

EXCEPTION 2 to 120.6(e)6D: Air dryers specified for applications that must maintain a precise dew point across all operating conditions.

67. Compressed Air System Acceptance. Before an occupancy permit is granted for a compressed air system subject to Section 120.6(e), the equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.13.

SUBCHAPTER 6 NONRESIDENTIAL, AND HOTEL/MOTEL OCCUPANCIES – ADDITIONS, ALTERATIONS, AND REPAIRS

SECTION 141.1 –REQUIRMENTS FOR COVERED PROCESSES IN ADDITIONS, ALTERATIONS TO EXISTING NONRESIDENTIAL, AND HOTEL/MOTEL BUILDINGS

(f) Mandatory requirements for compressed air systems.

All added or replaced compressed air systems where the total combined horsepower (hp) of the compressor(s) is 25 hp or more shall meet the requirements of Subsections 1 through 7. These requirements apply to the compressors, related piping systems, dryers, and related controls that provide compressed air and do not apply to any equipment or controls that use the compressed air.

EXCEPTION 1 to Section 141.1(f): Medical gas compressed air systems serving healthcare facilities.

1. Trim compressor and storage. All added and replacement air compressors shall meet the requirements of 120.6(e)1.

EXCEPTION 1 to Section 141.1(f)1: Alterations where the total combined added or replaced compressor horsepower is less than the average per-compressor horsepower of all compressors in the system.

EXCEPTION 2 to Section 141.1(f)1: Alterations where all added or replaced compressors are variable speed drive (VSD) compressors and compressed air system includes primary storage of at least one gallon per actual cubic feet per minute (acfm) of the largest trim compressor.

EXCEPTION 3 to Section 141.1(f)1: Compressed air systems that have been approved by the Energy Commission Executive Director as having demonstrated that the system serves loads for which typical air demand fluctuates less than 10 percent.

EXCEPTION 4 to Section 141.1(f)1: Alterations of existing compressed air systems that include one or more centrifugal compressors.

2. Controls. All added and replacement air compressors shall meet the requirements of 120.6(e)2.

EXCEPTION 1 to Section 141.1(f)2: Additions or replacements of less than a combined 100 hp in air compressor capacity.

3. Monitoring. All added and replacement air compressors shall meet the requirements of 120.6(e)3.

EXCEPTION 1 to Section 141.1(f)3: Additions or replacements of less than a combined 100 hp in air compressor capacity.

4. Leak testing of compressed air piping. All added and replacement compressed air piping greater than 50 adjoining feet in length shall meet the requirements of 120.6(e)4.

5. Pipe sizing. All added and replacement compressed air piping greater than 50 adjoining feet in length shall meet the requirements of 120.6(e)5.

6. Compressed air dryers. All added or replacement compressed air dryers shall meet the requirements of 120.6(e)6.

7. Compressed Air System Acceptance. Before an occupancy permit is granted for a compressed air system subject to Section 141.1(f), the equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.13.