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STATE OF WASHINGTON

STATE BUILDING CODE COUNCIL

Washington State Energy Code Development

Standard Energy Code Proposal Form

Code being amended: ☒ Commercial Provisions ☐ Residential Provisions

Code Section # C412 (new section)

Brief Description:

Adds new code section regulating compressed air systems. Language it taken from proposed Title 24 2022 language and is similar but much more comprehensive to City of Seattle requirements. Intent is that this would apply to process loads.

Proposed code change text: (Copy the existing text from the Integrated Draft, linked above, and then use underline for new text and ~~strikeout~~ for text to be deleted.)

[New Definitions]

Definitions

COMPRESSED AIR SYSTEM. A system of at least one compressor providing compressed air at 40 psig or higher.

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

PRIMARY STORAGE. Compressed air storage located upstream of the distribution system and any pressure flow regulators.

[Edit to previously approved reformatting of the process equipment exception (21-GP1-129)]

C401.2.2 Application to process equipment. Energy using equipment used by a manufacturing, industrial or commercial process other than for conditioning spaces or maintaining comfort and amenities for the occupants shall comply with C403.3.2, Tables C403.3.2(1) through (16) inclusive, C403.7.7, C403.9.2.1, C403.10.3, C403.11.2, and C403.11.3, C404.2, Table C404.2, C405.8, ~~and~~ C410, and C412.

[All New Section]

Section C412 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 this section. These requirements apply to the compressors, related piping systems, and related controls that provide compressed air and do not apply to any equipment or controls that use or process the compressed air.

Exception: Medical gas compressed air systems in healthcare facilities.

C412.1 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 1 or 2 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.

Exceptions:

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.
2. 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.
3. Compressed air systems that have been pre-approved by the jurisdiction as having demonstrated that the system serves loads for which typical air demand fluctuates less than 10 percent.
4. Alterations of existing compressed air systems that include one or more centrifugal compressors.

C412.2 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.

C412.3 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 efficiency.

C412.4 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 local 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, for pressure tests less than or equal to 100 psi (689 kPa) gauges shall be incremented in units of 1 psi (7 kPa) less, for pressure tests greater than 100 psi (689 kPa) gauges shall be incremented in units less than 2 percent of the test pressure. Test gauges shall have a pressure range not exceeding twice the test pressure.

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 as pre-approved by the local jurisdiction.

C412.5 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 1 and either 2 or 3 below:

1. Service line piping shall have inner diameters greater than or equal to ¾ inch. Service line piping are pipes that deliver compressed air from distribution piping to end uses.
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.
3. Piping total pressure drop. Piping shall be designed such that piping frictional pressure loss at coincident peak loads are less than 5 percent of operating pressure between the compressor and end use or end use regulator.

C412.6 Compressed air system acceptance. Before an occupancy permit is granted for a compressed air system, a certificate of acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the requirements of this code.

Purpose of code change:

Adds new code section regulating compressed air systems. Language it taken from proposed Title 24 2022 language and is similar but much more comprehensive to City of Seattle requirements. Intent is that this would apply to process loads.

Your amendment must meet one of the following criteria. Select at least one:

☐ Addresses a critical life/safety need.

☐ The amendment clarifies the intent or application of the code.

☒ Addresses a specific state policy or statute.
(Note that energy conservation is a state policy)

☒ Consistency with state or federal regulations.

☐ Addresses a unique character of the state.

☐ Corrects errors and omissions.

Check the building types that would be impacted by your code change:

☐ Single family/duplex/townhome ☐ Multi-family 4 + stories ☒ Institutional

☐ Multi-family 1 – 3 stories ☒ Commercial / Retail ☒ Industrial

Your name	Mike Kennedy	Email address	mikekennedy@energysims.com
Your organization	Mike Kennedy, Inc	Phone number	3603010098
Other contact name	Nick O'Neil		

Economic Impact Data Sheet

Briefly summarize your proposal's primary economic impacts and benefits to building owners, tenants and businesses.

Increased first costs and decreased utility bills. The costs and saving are determined from Title 24 CASE Reports. In both reports portions of the requirements were evaluated in 4 prototypes. For each requirement, data from the prototype where it was least cost effective was used to evaluate the measure in the OFM calculator. Thus the estimate cost benefit is very conservative

Pipe Sizing, Monitoring, and Leak Testing for Compressed Air Systems. Final Case Report. Sept 2020. Prepared by AESC, Inc. and Energy Solutions. Available at: https://title24stakeholders.com/wp-content/uploads/2020/06/NR-Compressed-Air_Draft-CASE-Report.pdf

Available at: https://title24stakeholders.com/wp-content/uploads/2020/01/T24-2013-Final-CASE-Report-AirCompressors.pdf

Provide your best estimate of the construction cost (or cost savings) of your code change proposal? (See OFM Life Cycle Cost **Analysis tool** and **Instructions;** use these **Inputs**. **Webinars on the tool can be found Here and Here**)
$0/square foot (For residential projects, also provide $0/ dwelling unit)

Show calculations here, and list sources for costs/savings, or attach backup data pages

No independent cost estimate was made. Costs and saving are determined from Title 24 Case reports.

Requirement	T24 Worst Case	Initial Cost	Annual Energy Savings	Ongoing expense
Auto-shut down timer	Prototype 3	$6173	7025kWh	
Trim Compressor	Operating Profile 3 / 25 hp	$4000	8293kWh	
Pipe Sizing	Prototype 4	$272982	210147 kWh	
Monitoring	Prototype 1	$10685	42058 kWh	$300/yr data services for 2 comps + $500 every 5 for calibration
Leak Testing	Prototype 3	$3342	6548 kWh	

OFM Calculator Summary

Smart Controls

Life Cycle Cost Analysis		BEST	
Alternative	Baseline	Alt. 1	Alt. 2
Energy Use Intenstity (kBtu/sq.ft)	#DIV/0!	#DIV/0!	#DIV/0!
1st Construction Costs	$ -	$ 6,173	$ -
PV of Capital Costs	$ -	$ 15,237	$ -
PV of Maintenance Costs	$ -	$ -	$ -
PV of Utility Costs	$ 333,677	$ 310,236	$ 333,677
Total Life Cycle Cost (LCC)	**$ 333,677**	**$ 325,474**	**$ 333,677**
Net Present Savings (NPS)	**N/A**	**$ 8,204**	**$ -**

Societal LCC takes into consideration the social cost of carbon dioxide emissions caused by operational energy consumption

(GHG) Social Life Cycle Cost		BEST	
GHG Impact from Utility Consumption	Baseline	Alt. 1	Alt. 2
Tons of CO2e over Study Period	2,059	1,915	2,059
% CO2e Reduction vs. Baseline	N/A	7%	0%
Present Social Cost of Carbon (SCC)	$ 130,707	$ 121,525	$ 130,707
Total LCC with SCC	**$ 464,385**	**$ 446,999**	**$ 464,385**
NPS with SCC	**N/A**	**$ 17,386**	**$ -**

Trim Compressor

Life Cycle Cost Analysis		BEST	
Alternative	Baseline	Alt. 1	Alt. 2
Energy Use Intenstity (kBtu/sq.ft)	#DIV/0!	#DIV/0!	#DIV/0!
1st Construction Costs	$ -	$ 4,000	$ -
PV of Capital Costs	$ -	$ 9,873	$ -
PV of Maintenance Costs	$ -	$ -	$ -
PV of Utility Costs	$ 333,677	$ 306,005	$ 333,677
Total Life Cycle Cost (LCC)	**$ 333,677**	**$ 315,879**	**$ 333,677**
Net Present Savings (NPS)	**N/A**	**$ 17,798**	**$ -**

Societal LCC takes into consideration the social cost of carbon dioxide emissions caused by operational energy consumption

(GHG) Social Life Cycle Cost		BEST	
GHG Impact from Utility Consumption	Baseline	Alt. 1	Alt. 2
Tons of CO2e over Study Period	2,059	1,888	2,059
% CO2e Reduction vs. Baseline	N/A	8%	0%
Present Social Cost of Carbon (SCC)	$ 130,707	$ 119,868	$ 130,707
Total LCC with SCC	**$ 464,385**	**$ 435,747**	**$ 464,385**
NPS with SCC	**N/A**	**$ 28,638**	**$ -**

All questions must be answered to be considered complete. Incomplete proposals will not be accepted.

Pipe Sizing

Life Cycle Cost Analysis		BEST	
Alternative	Baseline	Alt. 1	Alt. 2
Energy Use Intenstity (kBtu/sq.ft)	#DIV/0!	#DIV/0!	#DIV/0!
1st Construction Costs	$ -	$ 272,982	$ -
PV of Capital Costs	$ -	$ 673,819	$ -
PV of Maintenance Costs	$ -	$ -	$ -
PV of Utility Costs	$ 3,336,772	$ 2,635,559	$ 3,336,772
Total Life Cycle Cost (LCC)	**$ 3,336,772**	**$ 3,309,378**	**$ 3,336,772**
Net Present Savings (NPS)	**N/A**	**$ 27,394**	**$ -**

Societal LCC takes into consideration the social cost of carbon dioxide emissions caused by operational energy consumption

(GHG) Social Life Cycle Cost		BEST	
GHG Impact from Utility Consumption	Baseline	Alt. 1	Alt. 2
Tons of CO2e over Study Period	20,592	16,265	20,592
% CO2e Reduction vs. Baseline	N/A	21%	0%
Present Social Cost of Carbon (SCC)	$ 1,307,074	$ 1,032,396	$ 1,307,074
Total LCC with SCC	**$ 4,643,845**	**$ 4,341,774**	**$ 4,643,845**
NPS with SCC	**N/A**	**$ 302,071**	**$ -**

Monitoring

Life Cycle Cost Analysis		BEST	
Alternative	Baseline	Alt. 1	Alt. 2
Energy Use Intenstity (kBtu/sq.ft)	#DIV/0!	#DIV/0!	#DIV/0!
1st Construction Costs	$ -	$ 10,685	$ -
PV of Capital Costs	$ -	$ 26,374	$ -
PV of Maintenance Costs	$ -	$ 13,601	$ -
PV of Utility Costs	$ 3,336,772	$ 3,196,434	$ 3,336,772
Total Life Cycle Cost (LCC)	**$ 3,336,772**	**$ 3,236,409**	**$ 3,336,772**
Net Present Savings (NPS)	**N/A**	**$ 100,362**	**$ -**

Societal LCC takes into consideration the social cost of carbon dioxide emissions caused by operational energy consumption

(GHG) Social Life Cycle Cost		BEST	
GHG Impact from Utility Consumption	Baseline	Alt. 1	Alt. 2
Tons of CO2e over Study Period	20,592	19,726	20,592
% CO2e Reduction vs. Baseline	N/A	4%	0%
Present Social Cost of Carbon (SCC)	$ 1,307,074	$ 1,252,101	$ 1,307,074
Total LCC with SCC	**$ 4,643,845**	**$ 4,488,510**	**$ 4,643,845**
NPS with SCC	**N/A**	**$ 155,335**	**$ -**

Leak Detection

Life Cycle Cost Analysis		BEST	
Alternative	Baseline	Alt. 1	Alt. 2
Energy Use Intenstity (kBtu/sq.ft)	#DIV/0!	#DIV/0!	#DIV/0!
1st Construction Costs	$ -	$ 3,342	$ -
PV of Capital Costs	$ -	$ 8,249	$ -
PV of Maintenance Costs	$ -	$ -	$ -
PV of Utility Costs	$ 3,336,772	$ 3,314,923	$ 3,336,772
Total Life Cycle Cost (LCC)	**$ 3,336,772**	**$ 3,323,172**	**$ 3,336,772**
Net Present Savings (NPS)	**N/A**	**$ 13,600**	**$ -**

Societal LCC takes into consideration the social cost of carbon dioxide emissions caused by operational energy consumption

(GHG) Social Life Cycle Cost		BEST	
GHG Impact from Utility Consumption	Baseline	Alt. 1	Alt. 2
Tons of CO2e over Study Period	20,592	20,457	20,592
% CO2e Reduction vs. Baseline	N/A	1%	0%
Present Social Cost of Carbon (SCC)	$ 1,307,074	$ 1,298,515	$ 1,307,074
Total LCC with SCC	**$ 4,643,845**	**$ 4,621,687**	**$ 4,643,845**
NPS with SCC	**N/A**	**$ 22,159**	**$ -**

All questions must be answered to be considered complete. Incomplete proposals will not be accepted.

List any code enforcement time for additional plan review or inspections that your proposal will require, in hours per permit application:

This proposal will require jurisdictions to review compressed air designs and verify testing and monitoring. A complete guess but maybe 4 hours per permit that has systems of this scale which is a small fraction of the total permits.

All questions must be answered to be considered complete. Incomplete proposals will not be accepted.