



STATE OF WASHINGTON
STATE BUILDING CODE COUNCIL

May 2018
Log No. _____

1. State Building Code to be Amended:

- | | |
|---|---|
| <input checked="" type="checkbox"/> International Building Code | <input type="checkbox"/> International Mechanical Code |
| <input type="checkbox"/> ICC ANSI A117.1 Accessibility Code | <input type="checkbox"/> International Fuel Gas Code |
| <input type="checkbox"/> International Existing Building Code | <input type="checkbox"/> NFPA 54 National Fuel Gas Code |
| <input type="checkbox"/> International Residential Code | <input type="checkbox"/> NFPA 58 Liquefied Petroleum Gas Code |
| <input type="checkbox"/> International Fire Code | <input type="checkbox"/> Wildland Urban Interface Code |
| <input type="checkbox"/> Uniform Plumbing Code | |

For the Washington State Energy Code, please see specialized [energy code forms](#)

Section(s):

202 Definitions
1903 Specifications for Tests and Materials

Title: Concrete Greenhouse Gas Emissions Reduction

(e.g: Footings for wood foundations)

2. Proponent Name (Specific local government, organization or individual):

Proponent: New Buildings Institute
Co-Proponents: Carbon Leadership Forum and RMI
Title: Non profit organization
Date: April 8, 2022

3. Designated Contact Person:

Name: Webly Bowles
Title: Senior Project Manager
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E-Mail address: webly@newbuildings.org

4. Proposed Code Amendment. Reproduce the section to be amended by underlining all added language, striking through all deleted language. Insert new sections in the appropriate place in the code in order to continue the established numbering system of the code. If more than one section is proposed for amendment or more than one page is needed for reproducing the affected section of the code, additional pages may be attached.

Clearly state if the proposal modifies an existing amendment or if a new amendment is needed. If the proposal modifies an **existing amendment**, show the modifications to the existing amendment by underlining all added language and striking through all deleted language. If a new amendment is needed, show the modifications to the **model code** by underlining all added language and striking through all deleted language.

Code(s) _Washington State Building Code_____ **Section(s)** __202, 1903

Enforceable code language must be used.

Amend section to read as follows:

Chapter 2 Definitions

Section 202 Definitions

Add new definitions as follows:

Cementitious material: materials that have cementing value where used in grout, mortar, or concrete, including, but not limited to, Portland cement, blended hydraulic cements, hydraulic expansive cement, raw or calcined clay and natural pozzolan, fly ash, slag cement, and silica fume.

Concrete. Mixture of cementitious material, fine aggregate, coarse aggregate and water, with or without admixture.

Concrete, lightweight. Concrete containing lightweight aggregate and having an equilibrium density determined by ASTM C567.

Carbon dioxide equivalent (CO₂e). A measure used to compare the impact of various greenhouse gases based on their global warming potential (GWP). CO₂e approximates the time-integrated warming effect of a unit mass of a given greenhouse gas relative to that of carbon dioxide (CO₂). GWP is an index for estimating the relative global warming contribution of atmospheric emissions of 1 kg of a particular greenhouse gas compared to emissions of 1 kg of CO₂. The following GWP values are used based on a 100-year time horizon: 1 for CO₂, 25 for methane (CH₄), and 298 for nitrous oxide (N₂O).

Chapter 19 Concrete

Section 1901 General

Add new section as follows:

1901.8 Documentation of CO₂e. All Environmental Product Declarations (EPDs) for products used in the building shall be provided to the AHJ prior to certificate of occupancy.

1901.8.1 Requirements for EPD. CO₂e content shall be documented for each concrete mix by a product-specific cradle-to-gate Type III EPD complying with the goal and scope for the cradle-to-gate requirements in accordance with ISO Standards 14025 and 21930.

Exception: Where Type III industry-wide EPDs are allowed in Section 1903.5.

Section 1903 Specifications for Tests and Materials

Add new section as follows:

1903.5 Embodied CO2e of concrete materials. Concrete products used in the building shall comply with Sections 1903.5.1 or 1903.5.2.

Exceptions:

- 1) Precast, shotcrete, or auger cast concrete.
- 2) Projects under 50,000 square feet.
- 3) Projects where the total volume of concrete is less than 50 cubic yards.
- 4) Concrete with product strengths for which the nearest supplier with a cradle to gate Type III product-specific EPD is located more than 100 miles from the project site.

1903.5.1 CO2e Limit Method - Mixture. The maximum CO2e of the individual concrete mixes used in the building shall not exceed the values specified in Table 1903.5.1 based on the compressive strength of an individual mix.

Table 1903.5.1 CO2e Limits in Concrete Mixtures

<u>Procured compressive strength f'c, psi</u>	<u>Maximum kg/m³(SI)</u>	<u>High-early strength Maximum kg/m3 (SI)^a</u>	<u>Lightweight concrete Maximum kg/m3 (SI)^b</u>
<u>up to 2499</u>	<u>302</u>	<u>408</u>	<u>578</u>
<u>2500-3499</u>	<u>375</u>	<u>516</u>	<u>578</u>
<u>3500-4499</u>	<u>405</u>	<u>583</u>	<u>626</u>
<u>4500-5499</u>	<u>419</u>	<u>649</u>	<u>675</u>
<u>5500-6499</u>	<u>434</u>	<u>682</u>	<u>N/A</u>
<u>6500 and higher</u>	<u>482</u>	<u>680</u>	<u>N/A</u>

a: High-early strength concrete achieves a compressive strength could achieve structural concrete quality within 24 hours to seven days.

b: Lightweight concrete contains *lightweight aggregate* and has an equilibrium density determined by ASTM C567.

1903.5.2 CO2e Limit Method - Project. Total CO2e (CO2eproj) of all concrete placed at the building project shall not exceed the project limit (CO2emax) determined using Table 1903.5.1 and Equation 1903.5.2.

Equation 1903.5.2

$$CO2eproj < CO2Emax$$

where: $CO2Eproj = \sum CO2En vn$ and $CO2Emax = \sum CO2Elim vn$

and

n = the total number of concrete mixtures for the project

CO2En = the global warming potential for mixture n per mixture EPD, kg/m3

CO2Elim = the global warming potential limit for mixture n per Table 1903.5, kg/m3

vn = the volume of mixture n concrete to be placed

6. **Briefly explain your proposed amendment, including the purpose, benefits and problems addressed.** Specifically note any impacts or benefits to business, and specify construction types, industries and services that would be affected. Finally, please note any potential impact on enforcement such as special reporting requirements or additional inspections required.

Summary:

This code change proposal will support Washington's climate goals. Washington has been a leader in sustainable building practices, including recent legislation to study the procurement of low carbon building materials in state projects. This proposal uses existing policy mechanisms to safeguard the public from the hazards associated with the creation of building materials and supports state GHG emission reduction goals. **This proposal requires all concrete mixes to meet specific global warming potential (GWP) limits and document compliance through environmental product declarations (EPD).**

Problem:

Building operations and building construction are responsible for 39% of today's global carbon emissions.¹ About 11% of these emissions are embodied carbon emissions, the emissions associated with the creation of building materials and construction activities.¹ Unlike operational emissions, which can be improved over the lifespan of a building through deep-energy retrofits and the decarbonization of the electric grid, embodied carbon emissions occur before a building is occupied and cannot be reduced over time. Therefore, addressing embodied carbon in the construction of buildings presents an urgent and valuable opportunity to reduce carbon emissions in Washington.

As the Washington energy code continues to improve building energy efficiency and the grid energy becomes cleaner, operational carbon emissions will be reduced, and embodied carbon will become a larger part of a building's total carbon emissions. The materials chapters of the IBC have been in place and used by the design and construction industry to ensure that building materials in the built environment preserve public health and safety.

This proposal looks to expand the impact of the IBC to further safeguard the public from the hazards associated with the creation of building materials. The approach presented within this code change proposal, EPD reporting and GWP targets for the highest embodied carbon and most used construction products, supports a path toward a decarbonized built environment. **The proposed language will encourage the worst 10% of steel product manufacturers to reduce the carbon content of their materials to be more competitive in the market.**

Aligned State Policy:

In 2019, Washington ranked fifth in the U.S. for commercial construction growth at \$8.5 billion. Building permits grew 7.6% from 2014 to 2019 and are expected to continue to grow across the state, purchasing billions in high carbon construction products.

To meet state GHG goals, both operational and embodied carbon should be addressed, as stated in the State 2021 Energy Strategy. Washington legislators know the vital role that embodied carbon plays in a carbon neutral future because they have reviewed the facts. In 2018, 2021, and 2022, Buy clean policies were introduced in the Washington legislature. Those same years, Governor Jay Inslee signed executive orders and announced activities surrounding low carbon construction for state projects.

Additionally, in 2021, the WA legislature funded two provisos to support the creation of a Buy Clean Buy Fair Reporting Database. Cities and counties are also introducing policies and programs to reduce embodied

¹ [Bringing Embodied Carbon Upfront: Coordinated Action for the Building and Construction Sector to Tackle Embodied Carbon](#), World Green Building Council, 2019.

carbon, such as the King County Climate Action Plan and the City of Seattle Green Building Incentive Program, which both include requirements related to embodied carbon.

The Opportunity:

Concrete is one of the most widely used materials in building construction and a primary contributor to embodied carbon in buildings. A recent case study analysis by RMI shows that simply by specifying concrete products with lower CO2e content, a commercial construction project's embodied carbon can be reduced up to 33%.²

To build a building, construction professionals buy concrete (which contains cement used with water as a binder to adhere particles of sand and rock, known as aggregate) from a ready-mix supplier. Although each of concrete's constituent materials offers opportunities for reductions in embodied carbon, the high carbon concrete is primarily driven by the manufacture of one key ingredient—ordinary Portland cement. Portland cement is the most common cementitious binder used in concrete mixtures in the U.S., and the U.S. cement industry is one of the most significant contributors to U.S.-borne emissions at 68.3 million metric tons (MMT) of CO2 eq. per year.³ The building construction industry's demand for concrete accounts for an estimated 51% of total Portland cement produced in the U.S.⁴

GWP Value Methodology:

GWP is the most common metric for measuring and evaluating materials' greenhouse gas emissions over a product or building's lifecycle. In addition, third-party rating systems like LEED, and procurements policies like the U.S. General Services Administration's (GSA) Recommendations for Procurement of Low Embodied Carbon Materials⁵ have put a demand on building product manufacturers to disclose the environmental impacts of their products.

The proponent collected the publicly available concrete EPDs to analyze what GWP limits would support the design and construction industry's awareness of embodied carbon and indicate what percentage of construction material suppliers could comply with the values proposed. The values presented encourage the worst 25% performing ready mixed concrete mixes to reduce the carbon content of their materials to be more competitive in the market.

The table below illustrates the Washington ready-mixed concrete EPDs studied. This table illustrates that the most popular concrete strengths (3500-6500 psi) have the largest number of EPDs compared to the other categories. However, not all strength categories provide the data sufficiency needed to confidently use Washington-specific concrete EPDs. Therefore, the proponent compared the Washington concrete GWP values against the group of national EPDs at the 75th percentile. Washington values are, on average, 8% lower than the national values. This is in line with what is known about the high quality of concrete aggregates in Washington.⁶ Because the Washington concrete EPD dataset includes a limited number "of up to 2499 psi" EPDs, the national 75th percentile GWP value was substituted in its place, providing a more conservative GWP value.

Washington State EPDs - kg-Co2e/cubic meter						
	Up to 2499 psi	2500-3499 psi	3500-4499 psi	4500-5499 psi	5500-6499 psi	6500+ psi
90% Percentile	220	413	445	486	506	551

² Matt Jungclaus, Rebecca Esau, Victor Olgyay, and Audrey Rempher, *Low-Cost, High-Value Opportunities to Reduce Embodied Carbon in Buildings*, RMI, forthcoming 2021.

³ *Inventary of U.S. Greenhouse Gas Emissions and Sinks: 1990–2018*, US Environmental Protection Agency, 2020.

⁴ *2019 U.S. Cement Industry Annual Yearbook*, Portland Cement Association, 2019.

⁵ *GSA Green Building Advisory Committee Advice Letter: Policy Recommendations for Procurement of Low Embodied Energy and Carbon Materials by Federal Agencies*, U.S. General Services Administration, 2021.

⁶ *A Brief History of Long-Life WSDOT Concrete Pavements*, Washington State Department of Transportation, 2010.

80% Percentile	156	386	415	447	447	489
75% Percentile (PROPOSED)	148	375	405	419	434	482
50% Percentile	100	338	342	343	342	382
<i>Total WA EPD Count</i>	<i>46</i>	<i>171</i>	<i>520</i>	<i>469</i>	<i>278</i>	<i>104</i>
<i>Number of EPDs that meet 75%</i>	<i>34</i>	<i>128</i>	<i>390</i>	<i>351</i>	<i>208</i>	<i>78</i>

GSA followed a similar methodology to develop their Low Embodied Carbon Concrete specification. The difference between these two specifications is that the GWP limits for concrete in the GSA spec are about 12% higher.⁷

Reporting:

Anticipated reporting requirements might include a summary table of concrete mix GWP. AHJ may request that a plan for reporting material GHG emissions be provided at the time of permit. This proposal will not impact the inspection process.

Design, construction, and product manufacturers will need to work together to achieve and report the embodied carbon results. Designers will include the concrete mix global warming potential (GWP) requirements in project specifications and review the cutsheets as contractors select and provide submittals for the designers to review. Contractors will work with concrete suppliers to identify concrete mixes products that meet the GWP values. With over 1,600 EPDs available from Washington concrete providers, many of which meet the GWP limits proposed within.

7. Specify what criteria this proposal meets. You may select more than one.

- The amendment is needed to address a critical life/safety need.
- The amendment clarifies the intent or application of the code.
- The amendment is needed to address a specific state policy or statute.
- The amendment is needed for consistency with state or federal regulations.
- The amendment is needed to address a unique character of the state.
- The amendment corrects errors and omissions.

8. Is there an economic impact: Yes No

If no, state reason:

The impact of the embodied carbon considerations in code to project teams has been shown to be cost-neutral when the requirements are specified and administered efficiently.

GWP limits for concrete mixes were set by evaluating national EPDs and their GWP values; data available for concrete regional suppliers indicate that the local market outperforms this national average and is well-positioned to meet the code criteria. The optimizations needed to produce compliant concrete mixes can be achieved primarily by reducing cement in concrete mixes, through strategies like high performance aggregate selection or cement substitution. These interventions can be made without a cost impact on the individual project if the criteria are effectively communicated to ready-mixed suppliers. Low embodied carbon concrete does not require onerous changes to upstream industrial processes. To comply with the code, small product manufacturers and/or suppliers will see a small financial impact from developing EPDs for their products. A study by Energy Transitions Commission showed that the company pass-through cost to the individual projects to create the initial \$5-30K EPD is negligible.⁸

⁷ [Low Embodied Carbon Concrete Standards for all GSA Projects](#), U.S. General Services Administration, 2021.

⁸ Mission Possible: Reaching Net-Zero Carbon Emissions From Harder-to-Abate Sectors by Mid-Century, Energy Transitions Commission, 2018.

If yes, provide economic impact, costs and benefits as noted below in items a – f.

- a. **Life Cycle Cost.** Use the OFM Life Cycle Cost [Analysis tool](#) to estimate the life cycle cost of the proposal using one or more typical examples. Reference these [Instructions](#); use these [Inputs](#). Webinars on the tool can be found [Here](#) and [Here](#)). If the tool is used, submit a copy of the excel file with your proposal submission. If preferred, you may submit an alternate life cycle cost analysis.
- b. **Construction Cost.** Provide your best estimate of the construction cost (or cost savings) of your code change proposal.

\$Click here to enter text./square foot

(For residential projects, also provide \$Click here to enter text./ dwelling unit)

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

- c. **Code Enforcement.** List any code enforcement time for additional plan review or inspections that your proposal will require, in hours per permit application:
- d. **Small Business Impact.** Describe economic impacts to small businesses:
- e. **Housing Affordability.** Describe economic impacts on housing affordability:
- f. **Other.** Describe other qualitative cost and benefits to owners, to occupants, to the public, to the environment, and to other stakeholders that have not yet been discussed:

Please send your completed proposal to: sbcc@des.wa.gov

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