City of Richmond

# Report to Committee

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| **To:** | General Purposes Committee | **Date:** | September 16, 2020 |
| **From:** | James Cooper<br>Director, Building Approvals | **File:** | |
| | Peter Russell<br>Director, Sustainability and District Energy | | |
| **Re:** | **City of Richmond Concerns on Recent Changes to the BC Energy Step Code** | | |

## Staff Recommendation

That a letter be sent to the BC Minister of Municipal Affairs and Housing stating the City's concerns about, and suggested improvements to, the December 2019 revision to the BC Building Code as outlined in the report titled "City of Richmond Concerns on Recent Changes to the BC Energy Step Code", dated September 16, 2020, from the Director, Building Approvals and Director, Sustainability and District Energy.

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Director, Building Approvals
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Att. 3

| REPORT CONCURRENCE | |
|---|---|
| CONCURRENCE OF GENERAL MANAGER | |
| SENIOR STAFF REPORT REVIEW | INITIALS: |
| APPROVED BY CAO | |

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## Staff Report

### Origin

In July 2018, Council adopted the BC Energy Step Code (ESC) into local regulation, with requirements entering into force for new Building Permit applications on September 1, 2018.

Revision 2 of the *BC Building Code (BCBC) 2018* took effect on December 12, 2019. This code change introduced two new ways for Part 9 Residential buildings (e.g. single detached houses, townhouses and small apartment buildings) to meet the thermal performance requirements of the Energy Step Code (ESC). One of these options includes a new "Percent Better than EnerGuide Reference House" metric for assessing envelope performance. Subsequent analysis by City staff indicates that this new metric allows significantly lower performance and increased energy consumption compared to the absolute thermal envelope metrics in the ESC, potentially undermining the 'envelope first' approach of the ESC.

This report supports Council's Strategic Plan 2018-2022 Strategy #2 – A Sustainable and Environmentally Conscious City:

> *Environmentally conscious decision-making that demonstrates leadership in implementing innovative, sustainable practices and supports the City's unique biodiversity and island ecology;*
>
> *2.2 Policies and practices support Richmond's sustainability goals.*

### Analysis

#### BC Energy Step Code – Overview

The Province has committed to increase the energy performance of all new construction in the coming years, such that the BC Building Code will require net-zero energy ready performance for all new buildings by 2032. Local authorities can utilize the Energy Step Code (ESC) as a regulatory tool to shift the construction industry toward high-performance envelope and mechanical systems, and show leadership in transitioning new buildings toward a Net Zero standard. Richmond Council recognizes the potential of the ESC to reduce community-wide energy consumption and GHG emissions, and our Official Community Plan sets out a timetable for proposed increases in ESC requirements, in which the highest Step level (i.e., Net Zero Energy ready) will be required by 2025, well in advance of the 2032 provincial target.

#### City of Richmond's Leadership

Local builders have successfully transitioned to the ESC (see Attachment 1). The City of Richmond's support of the subsidized Airtightness Training Program and blower door tests on homes under construction, as well as Richmond's Builders Breakfast engagement series was critical to this success. Staff continue to engage builders by showcasing local projects, providing seminars on air barrier detailing, and reviewing proposed City policies with respect to energy and climate. Richmond builders have demonstrated they are able to meet enhanced performance requirements of the ESC.

The Energy Step Code was designed to use an "envelope first" approach

When the ESC was designed (2015-2017) and incorporated into the BC Building Code (2017-2018), it was strongly supported by building energy experts because of it's "envelope first" approach, through the use of absolute targets for building energy use.

The envelope first approach aligns with expert opinions that the most cost-effective and long-lasting way to improve building energy efficiency is through the envelope. The advantage of this approach is especially critical when designing to the top levels of the ESC, as a high-performance envelope greatly reduces the demand for heating and cooling energy, making it possible to 'right-size' mechanical systems, as well as making the use of on-site renewable energy cost-effective – a key consideration for Net Zero Energy ready buildings.

The ESC's "Thermal Energy Demand Intensity (TEDI)" metric sets out a maximum permissible amount of annual energy use per square meter of conditioned floor space. The absolute TEDI targets are straightforward to model, measure and verify, and are similar to the absolute performance targets used by other well-established high-performance building standards, such as Passive House.[1]

December 2019 Revision 2 changes to ESC weaken its effectiveness

Staff are concerned that the new (Percent Better) envelope performance metric would allow new houses in Climate Zone 4 (where Richmond is) to achieve Steps 2 and 3 with as little as one-quarter of the envelope improvements previously required for a Step 2 or Step 3 house. This change reduces the effectiveness of Richmond's energy efficiency and climate action policies with respect to Part 9 new residential buildings, and the utility of the ESC as a means of transitioning BC's construction industry towards achieving net-zero energy ready buildings.

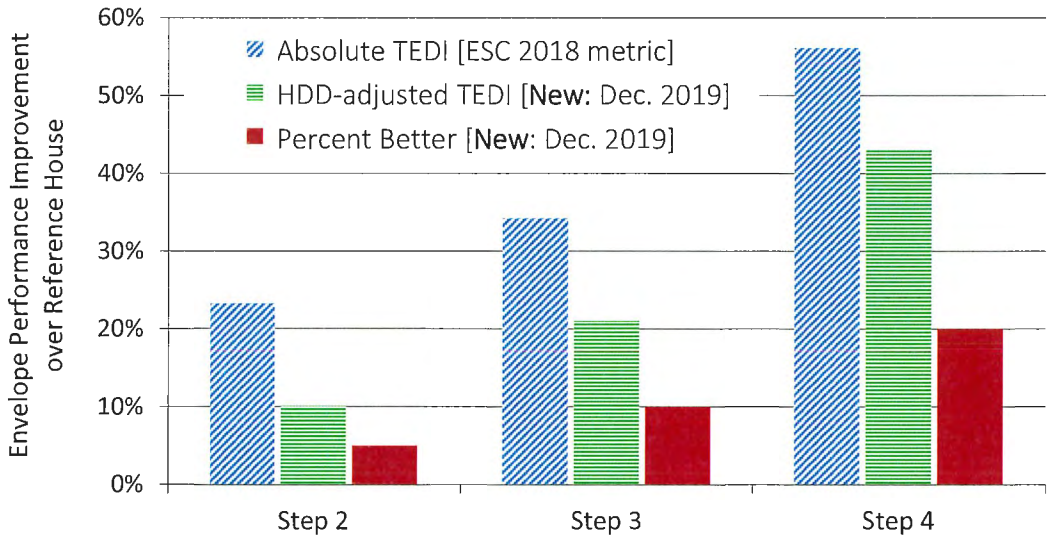
The Province adopted changes to the BCBC in December 2019 (i.e., Revision 2, 2018) in response to complaints from homebuilders in BC's Interior and Kootenay region (Climate Zone 5 and 6) that the envelope targets for Step 2 and higher were too stringent. These changes added two new ways to satisfy the thermal envelope requirement for Part 9 residential buildings within all climate zones:

- **Heating Degree Day-adjusted (HDD-adjusted)** Thermal Energy Demand Intensity targets adjusted to specific 'degree days' within each Climate Zone. Staff have no concerns with this change, as the absolute TEDI targets are consistent with the overall approach of the ESC.[2]
- **Percent Better than Reference House** that staff have shown will result in lower thermal performance and increased energy consumption compared to the TEDI target, as it can be achieved with minimal or no thermal improvements, thereby eroding the envelope-first intentions of the ESC.

[1] The Passive House standard influenced the performance metrics of the ESC with respect to absolute targets.
[2] In Richmond, the new 'Heating Degree Day-adjusted' target effectively return the TEDI targets to where they were before the TEDI targets were made more stringent through Revision 1 to the ESC in December 2018.

To compare the effectiveness of these envelope metrics, staff have 'translated' the Part 9 Step Code absolute building envelope targets into relative targets, using data from 37 completed energy models from Step 1 detached homes in Richmond (see Figure 1). Results clearly demonstrate that absolute energy targets result in a much more energy efficient home than the relative performance target. Given that achieving the TEDI targets may entail a higher investment in the building envelope relative to Percent Better (at the same Step Code level), it is likely that most builders will choose to pursue the Percent Better option (see Attachment 2 and 3 for additional details).

**Figure 1**: Improvement of the building envelope performance over Reference House (prescriptive baseline) by achieving the absolute TEDI targets (2018, 2019) and the new relative targets (2019)[3]




City of Richmond's response to date

City staff have verbally communicated concerns about the December 2019 changes to staff at the Ministry of Housing and Municipal Affairs, and to the Energy Step Code Council. Staff have also distributed these findings to other local governments implementing the ESC. Earlier this year, City of Vancouver staff informed the Energy Step Code Council that while Vancouver is committed to aligning its own building energy efficiency requirements with the ESC, it will exclude the "Percent Better than Reference House" pathway from the Vancouver Building Bylaw. To date, provincial staff have not made a commitment to addressing the concerns expressed by local governments.

Recently, there have been proposals to add a relative "Percent Better than Reference House" performance requirement to the National Building Code (NBC). Staff have provided feedback to Codes Canada highlighting the deficiencies of this approach. Given BC's leadership in creating Canada's first performance-based energy code, removal or revision to the relative performance path in the Step Code could also help prevent its inclusion in future updates to the National Energy Code for Buildings (NECB).

[3] Figure 1 shows *average* gains. To enable comparison between the absolute and relative targets, absolute targets were converted to percentage improvement over the Reference House (i.e. relative targets) based on the average of the Step 1 houses in Richmond completed to date.

Next Steps

With Council approval, staff will prepare a letter from the City, to be sent to the BC Minister of Municipal Affairs and Housing with a copy of this report. The letter will suggest the following options to address problematic aspects of the new envelope performance pathway:

1. Remove the "Percent Better than Reference House" building envelope metric as a compliance option from the Energy Step Code; or
2. Remove the "Percent Better than Reference House" building envelope metric as a compliance option from the Energy Step Code for Climate Zone 4 only.

## Financial Impact

None.

## Conclusion

The Energy Step Code is one of the City's most effective tools for achieving major energy efficiency improvements and significant GHG emission reductions in new buildings. However, in December 2019 revisions, the thermal efficiency for Part 9 residential buildings is compromised via the addition of a new, relative envelope performance metric. Staff are requesting that a letter be sent to Province of BC and the Energy Step Code Council relaying the results of analysis completed by the City of Richmond as well as suggestions to address the problem.

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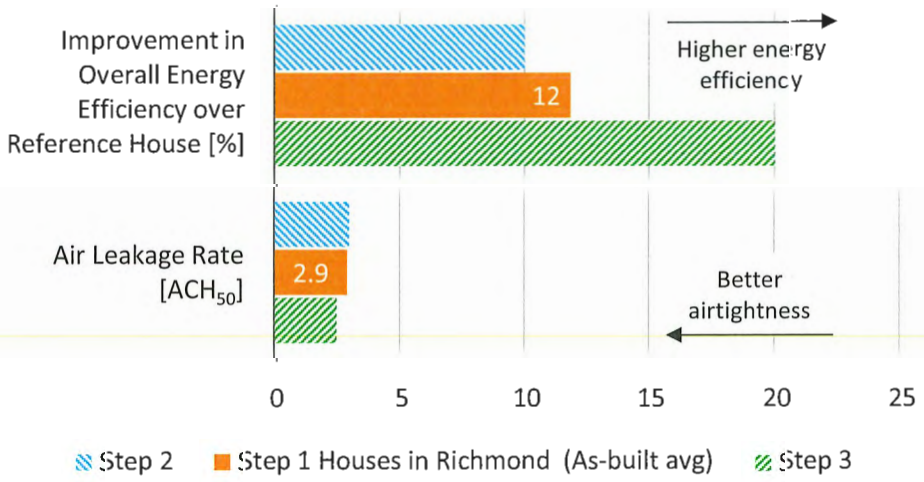
Att. 1: Energy Step Code results for single detached houses in Richmond
2: Revisions to envelope performance requirements for Part 9 Residential buildings (December 2019)
3: Comparative analysis of Energy Step Code building envelope performance pathways

**Attachment 1: Energy Step Code results for single detached houses in Richmond**

As of September 1, 2018, all new single detached dwellings and duplexes must comply with Step 1 of the BC Energy Step Code.[4] A Step 1 house is defined as a building that is at least as energy efficient as an identical house built to the minimum prescriptive requirements of the Building Code. The main difference between a Step 1 house and one built to prescriptive Code requirements (i.e. prior to the Energy Step Code) is that the airtightness of the Step 1 house has been tested and energy performance of the house has been evaluated using energy modeling tools.

More than 200 building permit applications for single detached dwellings and duplexes have been received. Early results from the 195 cases that have been reviewed and the 37 cases that have received occupancy thus far, suggested that homebuilders in Richmond have been successful in meeting, and exceeding, the requirements of Step 1. Builders in Richmond have successfully met the principal challenges of transitioning to the Energy Step Code at Step 1; namely integrating airtightness testing and building energy modeling into various stages of design and construction.

As shown in the figure below, Richmond builders have demonstrated particular success in building more airtight houses under the Energy Step Code. Whereas earlier studies suggested the average airtightness of new single detached houses in the Lower Mainland to be no better than 5.0 $ACH_{50}$, the completed Step 1 houses in Richmond have an average airtightness of 2.8 $ACH_{50}$, which is even better than the airtightness requirement of Step 2. The Step 1 single detached houses built in Richmond to date have, on average, 12% lower energy demand compared to the prescriptive Code minimum baseline.




[4] Townhouses, apartments, and high-rise buildings with issued and in-stream Development Permit and Building Permit applications were exempted from the Energy Step Code if a completed Building Permit application was submitted prior to January 2020.

**Attachment 2: Revisions to Envelope Performance Requirements for Part 9 Residential Buildings (December 2019)**

The BC Energy Step Code (ESC) is a compliance path within the BC Building Code that defines tiered sets of building energy performance targets that local government may choose to adopt as building standards for new construction. The envelope performance requirements in the ESC are defined in tables for each of BC's seven climate zones, with metrics adjusted according to each zone, in a step-wise fashion. Richmond is within Climate Zone 4, covering the Lower Mainland and southern Vancouver Island; including more than half of the province's total population.

Revision 2 to BC Building Code 2018, which took effect on December 12, 2019, introduced the following new compliance options for the building envelope:

**a) "Heating Degree-Day Adjusted Thermal Energy Demand Intensity (HDD-Adjusted TEDI)"** metric factors in the relatively wide range of climate conditions within each "climate zone" defined by the Building Code. While the addition of this option makes it easier to achieve various levels of the ESC compared to the original TEDI targets, the adjusted metric and performance targets are consistent with the ESC's overall approach.

**b) "Percent Better than EnerGuide Rating System Reference House (Percent Better)"** option, establishes *relative* improvement targets for the building envelope performance of the house, compared to how the same building would perform if built to the minimum prescriptive requirements of the Building Code (the so-called "Reference House"). This is a fundamentally different approach to measuring the energy performance of the building envelope.

The following table compares the new envelope performance criteria of the Energy Step Code.[5]

**Table 1 – Energy Step Code Envelope performance targets for Climate Zone 4: BC Building Code 2018 vs. BC Building Code 2018 – Revision 2 (2019) Targets**

| | Maximum Thermal Energy Demand Intensity [kWh/m$^2$/year] | | Minimum Envelope Performance Improvement Over Reference House |
|---|---|---|---|
| | BCBC 2018 | BCBC 2018 - Rev 2 (Richmond, 2800 HDD) | BCBC 2018 - Rev 2 |
| **Step 1** | N/A | N/A | 0% |
| **Step 2** | 35 | 41 | 5% |
| **Step 3** | 30 | 36 | 10% |
| **Step 4** | 20 | 26 | 20% |
| **Step 5** | 15 | 18 | 50% |

[5] For more details, see "Summary of Changes to the BC Energy Step Code: Part 9 Residential Buildings. BC Building Code 2018 Revision 2": http://energystepcode.ca/app/uploads/sites/257/2019/12/BCBC2018-Rev2-BCESC-Part9-vFIN-rev.pdf

**Attachment 3: Comparative Analysis of Energy Step Code Building Envelope Performance Pathways**

The 37 single detached houses in Richmond built to meet Step 1 of the Energy Step Code were re-evaluated based on the new envelope performance targets introduced in *Revision 2 to BC Building Code 2018*. The performance metrics were calculated based on "As-built" airtightness measurements and energy modeling information submitted to the City during building inspections.[6]

If evaluated under the new performance target options introduced in December 2019, 17 of the 37 Step 1 houses would now qualify as Step 2 or Step 3 houses. Sixteen cases (43%) would qualify for a higher Step using the "Percent Better" relative envelope performance pathway, whereas only 3 cases (8%) qualify for a higher Step based on both the adjusted absolute TEDI targets and the relative envelope performance targets.

All these buildings were designed and built just to meet Step 1, and despite good airtightness, none exceeded the performance criteria of Step 1 (as defined prior to December 2019). Moreover, none of the houses that would now qualify as Step 3 under the relative "Percent Better" envelope performance pathway contain the features of a high-performance building envelope. Aside from good airtightness and the use of heat-recovery ventilators, improvements over the baseline ("Reference") house are achieved through incremental upgrades to typical designs (e.g., using R24 batt insulation in walls instead of R20 batts). None of these "upgraded" houses have elements of energy efficient design (e.g. thicker walls, or optimization of house shape, orientation, and location of windows). The following table shows the details of the energy performance metrics and the thermal characteristics of the building envelope for the 37 houses evaluated in this study.

Staff are concerned that the use of the Percent Better than Reference House metric will lead to "Step Code inflation"; meaning that Step 3 houses built to the December 2019 version of the Code will be designed and built no more thermally efficiently than the Step 1 houses built under previous requirements. The new envelope performance metric in the ESC will widen the performance gap between lower / intermediate and higher Steps, effectively making it more challenging for the industry to transition to high-performance building techniques as the Building Code becomes more stringent in the lead-up to net-zero-energy ready (2032).

[6] Note that instead of the cumbersome relative envelope performance calculation methodology laid out in the *Energy Step Code Instruction Manual: BC Energy Compliance Reports For Part 9 Residential Buildings* (December 12, 2019), a much simpler metric, namely the difference in TEDI, was used in this analysis to quantify the envelope performance relative to the Reference House. Analysis by staff has shown this to have generally negligible impact on the outcome.

| Case | Heated Area [$m^2$] | Air Leakage Rate [$ACH_{50}$] | Rated Energy Consumption [GJ/yr] | % Better EnerGuide rating | TEDI [$kWh/m^2/yr$] | % Better Envelope | Built as (2018) | ESC 2019 Classification | | Building Envelope Characteristics* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Effective RSI | | | | Window USI | HRV Efficiency |
| | | | | | | | | HDD-adj TEDI | % Better TEDI | Walls | Roof | Slab | Exposed Floors | | |
| 1 | 348.1 | 2.5 | 88 | 12% | 57 | x | Step 1 | Step 1 | x | 3.06 | 7.72 | 2.11 | 5.02 | 1.6 | 66% |
| 2 | 190.1 | 2.1 | 42 | 17% | 38 | x | Step 1 | Step 2 | x | 2.61 | 7.79 | 2.11 | 5.26 | 1.7 | 70% |
| 3 | 292.7 | 2.9 | 109 | 10% | 85 | 0% | Step 1 | Step 1 | Step 1 | 2.78 | 7.02 | 2.32 | 4.98 | 1.8 | 80% |
| 4 | 286.1 | 3.4 | 97 | 2% | 76 | 5% | Step 1 | Step 1 | Step 1 | 2.88 | 6.68 | 2.11 | 5.75 | 1.5 | 79% |
| 5 | 446.0 | 2.8 | 141 | 3% | 74 | -35% | Step 1 | Step 1 | Step 1 | 3.17 | 8.17 | 2.11 | 5.07 | 1.5 | 65% |
| 6 | 301.0 | 3.1 | 93 | 2% | 71 | -4% | Step 1 | Step 1 | Step 1 | 3.31 | 7.51 | 2.11 | 5.48 | 1.6 | 75% |
| 7 | 336.0 | 3.2 | 96 | 3% | 62 | -8% | Step 1 | Step 1 | Step 1 | 2.86 | 7.00 | 2.11 | 4.87 | 1.6 | 66% |
| 8 | 377.4 | 3.2 | 111 | 7% | 61 | 2% | Step 1 | Step 1 | Step 1 | 3.18 | 6.60 | 2.11 | 5.99 | 1.3 | 61% |
| 9 | 203.0 | 2.8 | 62 | 7% | 61 | 10% | Step 1 | Step 1 | Step 1 | 2.95 | 7.09 | 2.11 | 5.17 | 1.6 | 63% |
| 10 | 282.0 | 2.3 | 77 | 10% | 58 | 3% | Step 1 | Step 1 | Step 1 | 2.89 | 6.92 | 2.11 | 4.85 | 1.6 | 65% |
| 11 | 310.0 | 3.2 | 89 | 12% | 57 | 6% | Step 1 | Step 1 | Step 1 | 3.20 | 6.91 | 2.11 | 4.86 | 1.5 | 64% |
| 12 | 290.3 | 3.4 | 78 | 13% | 55 | x | Step 1 | Step 1 | Step 1 | 2.31 | 6.20 | 2.11 | 5.02 | 1.5 | 65% |
| 13 | 212.0 | 2.6 | 62 | 7% | 55 | -10% | Step 1 | Step 1 | Step 1 | 3.10 | 9.00 | 2.3 | 4.93 | 1.4 | 67% |
| 14 | 291.3 | 2.8 | 77 | 10% | 53 | 4% | Step 1 | Step 1 | Step 1 | 3.04 | 6.81 | 2.11 | 5.07 | 1.6 | 72% |
| 15 | 204.0 | 3.1 | 61 | 17% | 53 | 2% | Step 1 | Step 1 | Step 1 | 2.99 | 7.26 | 2.11 | 5.39 | 1.8 | 75% |
| 16 | 200.0 | 3.5 | 54 | 6% | 53 | -11% | Step 1 | Step 1 | Step 1 | 2.81 | 7.07 | 2.11 | 5.17 | 1.6 | 66% |
| 17 | 241.0 | 3.2 | 66 | 13% | 52 | 7% | Step 1 | Step 1 | Step 1 | 2.86 | 7.26 | 2.11 | 4.89 | 1.4 | 63% |
| 18 | 308.5 | 4.3 | 70 | 15% | 51 | -7% | Step 1 | Step 1 | Step 1 | 2.95 | 8.89 | 2.11 | 5.02 | 1.7 | 65% |
| 19 | 305.1 | 3.3 | 78 | 13% | 51 | 11% | Step 1 | Step 1 | Step 1 | 3.44 | 6.67 | 2.11 | 5.16 | 1.6 | 66% |
| 20 | 167.0 | 3.3 | 48 | 12% | 51 | 4% | Step 1 | Step 1 | Step 1 | 2.74 | 8.40 | 2.11 | 5.10 | 1.7 | 71% |
| 21 | 352.3 | 3.0 | 73 | 14% | 39 | 0% | Step 1 | Step 2 | Step 1 | 2.63 | 8.78 | 2.11 | 4.22 | 1.3 | 65% |
| 22 | 284.8 | 2.3 | 81 | 13% | 58 | 9% | Step 1 | Step 1 | Step 2 | 3.28 | 6.85 | 2.11 | 5.05 | 1.6 | 65% |
| 23 | 402.6 | 2.8 | 97 | 10% | 56 | 9% | Step 1 | Step 1 | Step 2 | 2.80 | 7.00 | 2.6 | 5.20 | 1.8 | 82% |
| 24 | 288.5 | 3.0 | 76 | 19% | 55 | 18% | Step 1 | Step 1 | Step 2 | 2.98 | 8.70 | 2.11 | 4.96 | 1.4 | 65% |
| 25 | 429.6 | 2.5 | 105 | 14% | 53 | 11% | Step 1 | Step 1 | Step 2 | 2.68 | 7.69 | 2.11 | 5.54 | 1.6 | 65% |
| 26 | 328.7 | 2.9 | 84 | 13% | 52 | 12% | Step 1 | Step 1 | Step 2 | 3.10 | 6.66 | 2.11 | 5.09 | 1.7 | 66% |
| 27 | 307.7 | 2.5 | 78 | 14% | 52 | 21% | Step 1 | Step 1 | Step 2 | 1.99 | 8.89 | 2.46 | 6.29 | 1.6 | 65% |
| 28 | 167.0 | 2.6 | 44 | 11% | 52 | 17% | Step 1 | Step 1 | Step 2 | 2.74 | 8.40 | 2.11 | 5.10 | 1.7 | 71% |
| 29 | 284.7 | 3.0 | 69 | 17% | 50 | 16% | Step 1 | Step 1 | Step 2 | 3.48 | 7.39 | 2.11 | 5.40 | 1.3 | 65% |
| 30 | 200.0 | 3.0 | 54 | 5% | 47 | 15% | Step 1 | Step 1 | Step 2 | 2.80 | 5.81 | 2.11 | 5.21 | 1.8 | 75% |
| 31 | 287.1 | 2.6 | 69 | 14% | 45 | 9% | Step 1 | Step 1 | Step 2 | 2.72 | 7.31 | 2.11 | 5.90 | 1.8 | 63% |
| 32 | 301.8 | 3.1 | 65 | 19% | 41 | 13% | Step 1 | Step 2 | Step 2 | 2.91 | 6.71 | 2.32 | 5.02 | 1.8 | 65% |
| 33 | 309.0 | 2.6 | 74 | 22% | 50 | 23% | Step 1 | Step 1 | Step 3 | 3.26 | 8.75 | 3.52 | 5.17 | 1.4 | 65% |
| 34 | 285.0 | 2.2 | 70 | 23% | 50 | 26% | Step 1 | Step 1 | Step 3 | 2.76 | 8.34 | 2.11 | 5.30 | 1.5 | 66% |
| 35 | 224.2 | 0.7 | 53 | 20% | 46 | 21% | Step 1 | Step 1 | Step 3 | 2.72 | 5.28 | 2.5 | 6.03 | 1.8 | 65% |
| 36 | 197.3 | 2.0 | 43 | 19% | 38 | 32% | Step 1 | Step 2 | Step 3 | 2.96 | 7.31 | 2.11 | 5.17 | 1.7 | 63% |
| 37 | 174.7 | 2.5 | 40 | 19% | 37 | 18% | Step 1 | Step 2 | Step 3 | 2.96 | 7.31 | 2.11 | 5.17 | 1.7 | 63% |

x indicates missing data

* Characteristics better and worse than prescriptive Code requirements are shown by green and red highlights respectively.