STATE OF WASHINGTON

STATE BUILDING CODE COUNCIL

Washington State Energy Code Development

Standard Energy Code Proposal Form

May 2018

Log No. 19-WSEC-R20

Code being amended: ☐ Commercial Provisions X Residential Provisions

Code Section # **R402.4.1.2 Testing**

Brief Description:

For the purpose of air leakage testing only, the volume of the living space shall be the conditioned floor area (square feet) multiplied by 8.5 (feet).

Proposed code change text:

R402.4.1.2 Testing. The building or dwelling unit shall be tested and verified as having an air leakage rate of not exceeding 5 air changes per hour. Testing shall be conducted with a blower door at a pressure of 0.2 inches w.g. (50 Pascals). For this test only, the volume of the home shall be the conditioned floor area ft^2 (m^2) multiplied by 8.5 ft. (2.6m). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope*. Once visual inspection has confirmed sealing (see Table R402.4.1.1), operable windows and doors manufactured by *small business* shall be permitted to be sealed off at the frame prior to the test.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures;
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures;
3. Interior doors, if installed at the time of the test, shall be open, access hatches to conditioned crawl spaces and conditioned attics shall be open;
4. Exterior or interior terminations for continuous ventilation systems and heat recovery ventilators shall be sealed;
5. Heating and cooling systems, if installed at the time of the test, shall be turned off; and
6. Supply and return registers, if installed at the time of the test, shall be fully open.

Exceptions:

1. Additions less than 500 square feet of conditioned floor area.
2. Additions tested with the existing home having a combined maximum air leakage rate of 7 air changes per hour. To qualify for this exception, the date of construction of the existing house must be prior to the 2009 Washington State Energy Code.

Purpose of code change:

The method for setting targets for air leakage control are not well aligned with the benefits of air leakage control. Under the current code, a home with a 10 foot average ceiling height is allowed a 20% higher blower door test result than a building with an average ceiling height of 8 feet. But the benefits of air sealing are greater for the taller home. Taller buildings are exposed to greater infiltration impacts related to stack pressure and wind exposure.

The effort required to air seal a home is not meaningfully related to ceiling height. The two illustrations provided below shows the dominant air leakage pathways in homes. You will note that the air leakage details called out in these illustrations are not related wall height. They illustrate air leakage pathways that exist in most homes regardless of height. (Pacific Northwest National Laboratory Buildings Technology Program, Air Leakage Guide, U.S. Department of Energy, 2011)

Any additional cost for air sealing a taller home is not related to meeting the air leakage requirements. Interior drywall required to create an interior air barrier will be installed regardless of this requirement. A taller wall using and exterior air barrier will require more structural board, weather resistive barriers or exterior insulation. But all will be installed to meet other building code requirements.

National studies show that wall heights are increasing. (Home Innovations Research Labs, Trends and opportunities in the U.S. Building Materials Market, 2018 International Builders' Show) This will increase allowable building energy use if the air leakage testing method is not modified as recommended by this proposal.

This proposal will simplify the code and improve code compliance. This method ties the formula for determining the blower door test result to the conditioned floor area printed on the design documents and a fixed multiplier, 8.5 feet. This addresses miscalculations of the ceiling height we have observed in some test results. In some cases we have observed cases where the ceiling height used in developing the target air leakage rate for the building have been overstated to increase the allowance.

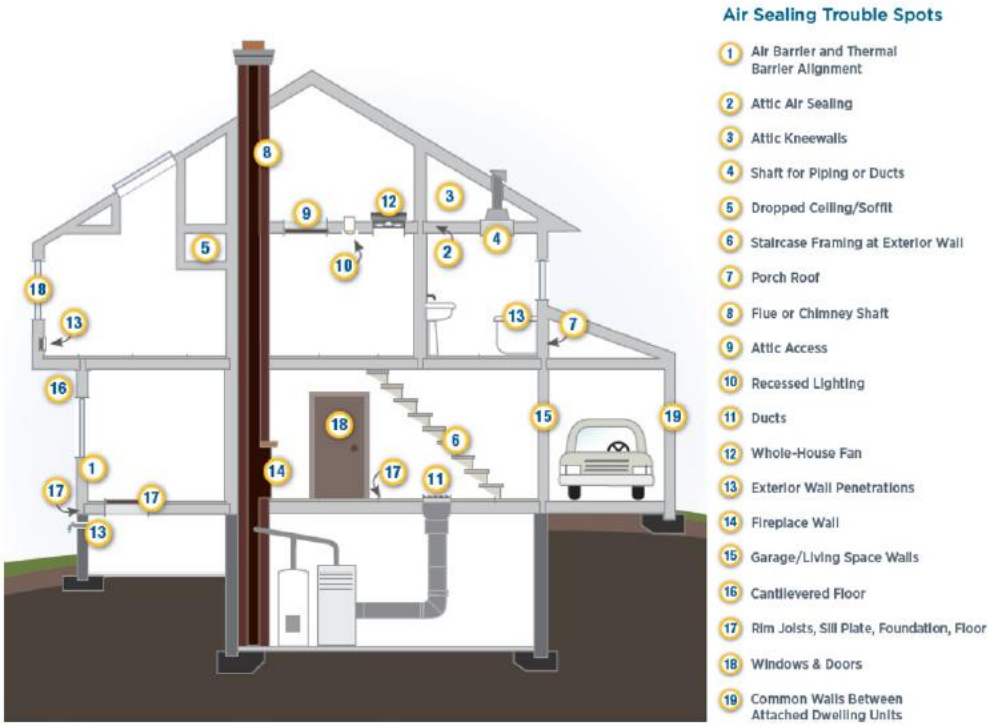
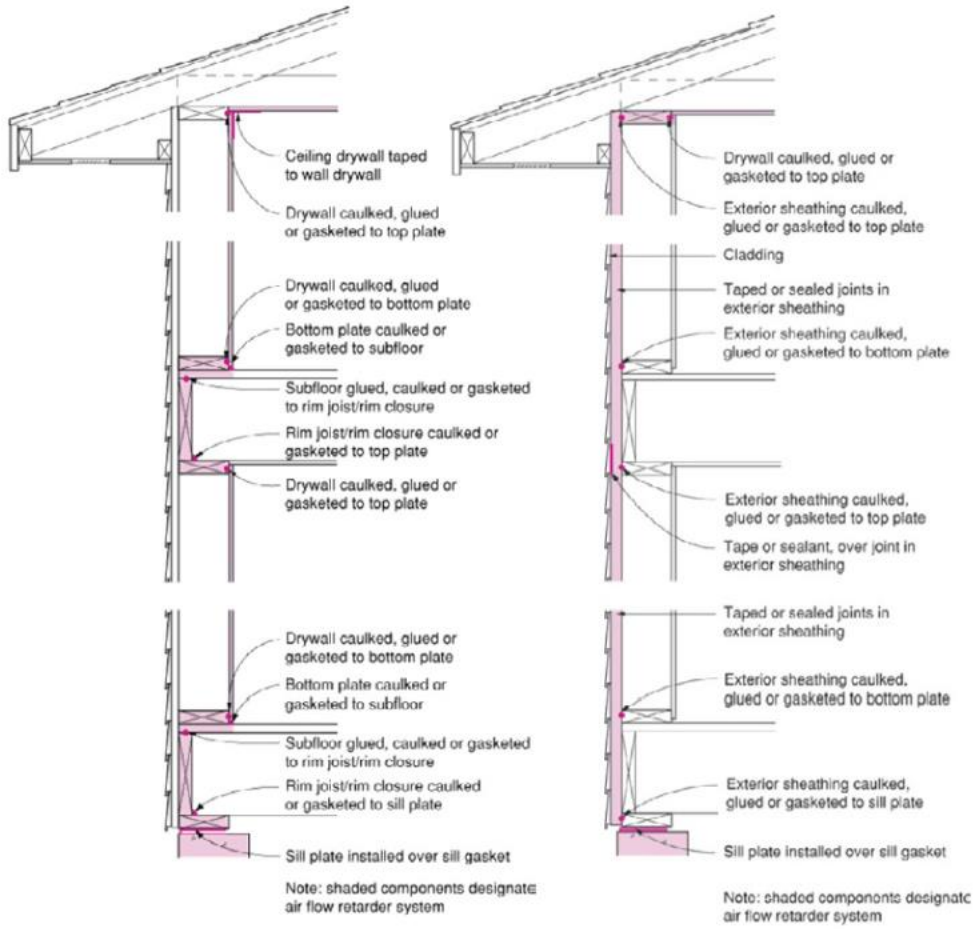


Figure 4: Building America—air sealing trouble spots

Envelope Air Sealing



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

☐ Addresses a critical life/safety need.

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

X 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:

X Single family/duplex/townhome

X Multi-family 1 – 3 stories

☐ Multi-family 4 + stories

☐ Commercial / Retail

☐ Institutional

☐ Industrial

Your name Chuck Murray

Your organization Commerce, State Energy Office

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Economic Impact Data Sheet

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

LCCA worksheet results are posted below. Three cases are illustrated. As noted in the explanatory statement above, Commerce does not believe there is a real difference in cost of air sealing a home with a taller wall. Most air leakage sites are not related with wall height. But, for the sake of this analysis we have added cost savings and increases to the life cycle assessment.

- Base= 2200 SF home with 8 foot wall height Cost savings $100
- Alt 1 = 2200 SF home with 8.5 foot wall height Cost $0
- Alt 2 = 2200 SF home with 10 foot wall height Cost for taller home $500

Results summary:

The results of the live cycle cost show that the home with the 8' wall will result in some increased energy use and life cycle cost.

The building with taller walls will have more than $1000 of energy savings, twice the value of the additional cost evaluated.

Energy Savings were adopted from SEEM runs developed in support of the C406 code change proposal.

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**)

$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

As noted in the introduction, and on the LCCT tables.

Provide your best estimate of the annual energy savings (or additional energy use) for your code change proposal?

Click here to enter text.KWH/ square foot (or) from -.27 to plus 1.18 KBTU/ square foot

(For residential projects, also provide 2600 KBTU / dwelling unit)

Show calculations here, and list sources for energy savings estimates, or attach backup data pages

Energy Savings were adopted from SEEM runs developed in support of the C406 code change proposal. Economic evaluation using the required LCCT model.

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

This will simplify code implementation. The conditioned floor area is typically on the plans, but not the home volume. The proposed method for setting the air leakage target will be based on the conditioned floor area X 8.5 feet tall. The existing system of calculating the volume of homes is more complex and subject to error.

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

Executive Report

Project Information	
Project:	Air Leakage - Medium Home - Gas
Address:	
Company:	
Contact:	
Contact Phone:	
Contact Email:	

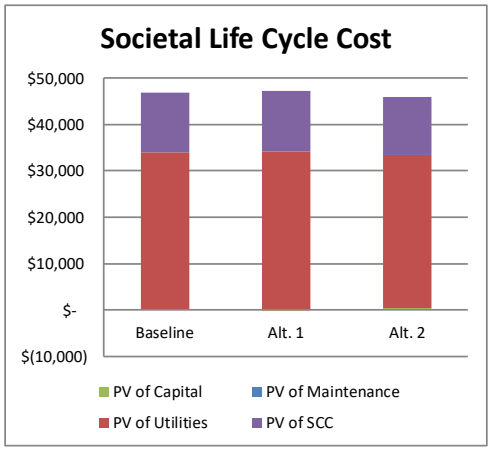
Key Analysis Variables		Building Characteristics	
Study Period (years)	50	Gross (Sq.Ft)	2,200
Nominal Discount Rate	5.00%	Useable (Sq.Ft)	2,200
Maintenance Escalation	1.00%	Space Efficiency	100.0%
Zero Year (Current Year)	2020	Project Phase	0
Construction Years	0	Building Type	0

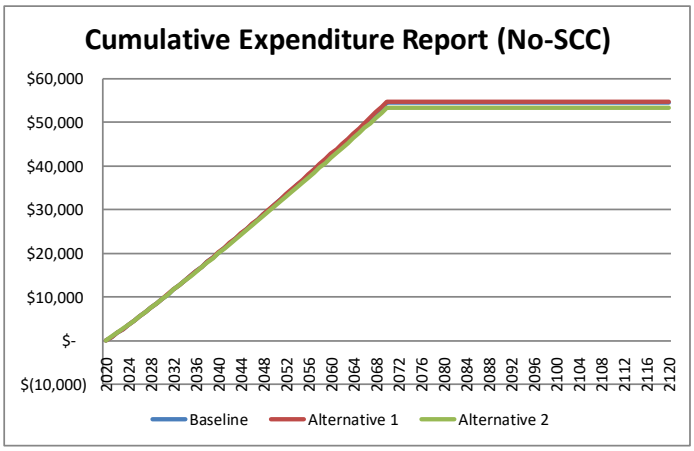
Life Cycle Cost Analysis			BEST
Alternative	Baseline	Alt. 1	Alt. 2
Energy Use Intenstity (kBtu/sq.ft)	25.8	26.1	24.6
1st Construction Costs	$ -	$ (100)	$ 500
PV of Capital Costs	$ -	$ (99)	$ 494
PV of Maintenance Costs	$ -	$ -	$ -
PV of Utility Costs	$ 34,002	$ 34,246	$ 32,942
Total Life Cycle Cost (LCC)	**$ 34,002**	**$ 34,148**	**$ 33,436**
Net Present Savings (NPS)	**N/A**	**$ (146)**	**$ 566**

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	203	205	197
% CO2e Reduction vs. Baseline	N/A	-1%	3%
Present Social Cost of Carbon (SCC)	$ 12,916	$ 13,017	$ 12,478
Total LCC with SCC	**$ 46,918**	**$ 47,165**	**$ 45,913**
NPS with SCC	**N/A**	**$ (247)**	**$ 1,004**

Warning: OFM Assigned Variables Not Used





Baseline Short Description
8 Foot Ceiling - 5 ach50
Alternative 1 Short Description
8.5 Foot Ceiling 5 ach50
Alternative 2 Short Description
10 Foot Ceiling 5 ach50

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

<- Primary Filter (Requires Level 1)

Office of Financial Management
Olympia, Washington - Version: 2018-Residential
Life Cycle Cost Analysis Tool

Baseline Input Page

Open Primary Filter and Click OK to Re-filter

☐ Show All Entered Units (Requires Re-Filter)

	Total Building Annual Utility Analysis	$ 879	Water (CCF)	Electricity (KWH)	Natural Gas (Therms)	Diesel/#2 (Gallons)
	Annual Utility Bill [$]			$ 443	$ 436	
	Annual Utility Consumption Not Entered Below			4,581	411	
	Sum of Annual Utility Consumption Below		-	-	-	
	Total Annual Utility Consumption		-	4,581	411	
	Annual Utility Bill ÷ Total Utility Consumption		$ -	$ 0.097	$ 1.062	$

SHOW	Uniformat II Elemental Classification for Buildings (Building Component List)		REF	# of Units	Useful Life (Yrs.)	Installed Cost ($/Unit)	1st Year Maintenance Cost ($/Unit)	Total Component Installed Cost ($'s)	Annual Water (CCF/Unit)	Annual Electricity (KWH/Unit)	Annual Natural Gas (Therm/Unit)	Annual Diesel (Gal/Unit)
	Primary Entries Below: # of Units must be > 0 to be counted; Useful Life must be >= 2							$ -	Entries Below for Component Specific Utility Analysis (Consum			
	A	**Substructure**										
	B	**Shell**										
x	B101098	8 Foot Ceiling - 5 ach50			50	$100.00					6	
x	B101097	8.5 Foot Ceiling 5 ach50		1	50	$0.00		$ -			0	
x	B102098	10 Foot Ceiling 5 ach50			50	$500.00					-26	
	C	**Interiors**										
	D	**Services**										
	E	**Equipment & Furnishings**										
	F	**Special Construction & Demolition**										
	G	**Building Sitework**										
	Z	**Other Project Costs**										
	Z10	**One Time - Upfront Costs**		1	50							
	Z30	**Re-Occurring Annual Cost (Track Inflation)**		1	1							

<- Primary Filter (Requires Level 1)

Office of Financial Management
Olympia, Washington - Version: 2018-Residential
Life Cycle Cost Analysis Tool

Alternative 1 Input Page

Open Primary Filter and Click OK to Re-filter

☐ Manual Special Selection Only (Requires Refilter)
● Show Baseline Fields and Entered Units (Requires Refilter)
☐ Show Differences Between Alternative and Baseline (Req. Refilter)

	Total Building Annual Utility Analysis	$ 885	Water (CCF)	Electricity (KWH)	Natural Gas (Therms)	Di (G
	Annual Utility Bill [$]			$ 443	$ 443	
	Annual Utility Consumption Not Entered Below			4,581	411	
	Sum of Annual Utility Consumption Below		-	-	6	
	Total Annual Utility Consumption		-	4,581	417	
	Annual Utility Bill ÷ Total Utility Consumption		$ -	$ 0.097	$ 1.062	$

Note: No Units Assigned to a Component with Entries

SHOW	Uniformat II Elemental Classification for Buildings (Building Component List)		REF	# of Units	Useful Life (Yrs.)	Installed Cost ($/Unit)	1st Year Maintenance Cost ($/Unit)	Total Component Installed Cost ($'s)	Annual Water (CCF/Unit)	Annual Electricity (KWH/Unit)	Annual Natural Gas (Therm/Unit)	Annua (Ga
	Primary Entries Below: # of Units must be > 0 to be counted; Useful Life must be >= 2								Entries Below for Component Specific Utility Analysis (C			
	Match Baseline: Filter to Select All & Drag Copy O14:S14 & U14:AG14							$ (100)				
	A	**Substructure**										
	B	**Shell**										
	B101098	8 Foot Ceiling - 5 ach50		1	50	$100		$ (100)			6	
	B101097	8.5 Foot Ceiling 5 ach50			50							
	B102098	10 Foot Ceiling 5 ach50			50	$500.00					-26	
	C	**Interiors**										
	D	**Services**										
	E	**Equipment & Furnishings**										
	F	**Special Construction & Demolition**										
	G	**Building Sitework**										
	Z	**Other Project Costs**										
	Z10	**One Time - Upfront Costs**		1	50							
	Z30	**Re-Occurring Annual Cost (Track Inflation)**		1	1							

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

<- Primary Filter (Requires Level 1)

Office of Financial Management
Olympia, Washington - Version: 2018-Residential
Life Cycle Cost Analysis Tool

Alternative 2 Input Page

Open Primary Filter and Click OK to Re-filter

- ○ Manual Special Selection Only (Requires Refilter)
- ● Show Baseline Fields and Entered Units (Requires Refilter)
- ○ Show Differences Between Alternative and Baseline (Req. Refilter)

Total Building Annual Utility Analysis	$ 851	Water (CCF)	Electricity (KWH)	Natural Gas (Therms)	Diese (Gallo
Annual Utility Bill [$]			$ 443	$ 409	
Annual Utility Consumption Not Entered Below		-	4,581	411	
Sum of Annual Utility Consumption Below		-	-	(26)	
Total Annual Utility Consumption		-	4,581	385	
Annual Utility Bill ÷ Total Utility Consumption		$ -	$ 0.097	$ 1.062	$

Note: No Units Assigned to a Component with Entries

SHOW	Uniformat II Elemental Classification for Buildings (Building Component List)		REF	# of Units	Useful Life (Yrs.)	Installed Cost ($/Unit)	1st Year Maintenance Cost ($/Unit)	Total Component Installed Cost ($'s)	Annual Water (CCF/Unit)	Annual Electricity (KWH/Unit)	Annual Natural Gas (Therm/Unit)	Annual D (Gal/U
	Primary Entries Below: # of Units must be > 0 to be counted; Useful Life must be >= 2								Entries Below for Component Specific Utility Analysis (Cons			
	Match Baseline: Filter to Select All & Drag Copy O14:S14 & U14:AG14							$ 500				
	A	**Substructure**										
	B	**Shell**										
	B101098	8 Foot Ceiling - 5 ach50			50	$100.00					6	
	B101097	8.5 Foot Ceiling 5 ach50			50							
	B102098	10 Foot Ceiling 5 ach50		1	50	$500.00		$ 500			-26	
	C	**Interiors**										
	D	**Services**										
	E	**Equipment & Furnishings**										
	F	**Special Construction & Demolition**										
	G	**Building Sitework**										
	Z	**Other Project Costs**										
	Z10	**One Time - Upfront Costs**		1	50							
	Z30	**Re-Occurring Annual Cost (Track Inflation)**		1	1							

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

Expenditure Report Page In Constant 2020 $'s

	Cumulative Expenditure Summary			Annual Expenditure Summary		
Year	Baseline	Alt. 1	Alt. 2	Baseline	Alt. 1	Alt. 2
2020	$ -	$ (20)	$ 100	$ -	$ (20)	$ 100
2021	$ 884	$ 865	$ 981	$ 884	$ 885	$ 881
2022	$ 1,772	$ 1,755	$ 1,866	$ 888	$ 890	$ 885
2023	$ 2,670	$ 2,654	$ 2,760	$ 898	$ 899	$ 894
2024	$ 3,615	$ 3,601	$ 3,699	$ 945	$ 947	$ 938
2025	$ 4,590	$ 4,580	$ 4,665	$ 976	$ 978	$ 967
2026	$ 5,575	$ 5,567	$ 5,641	$ 985	$ 988	$ 975
2027	$ 6,573	$ 6,569	$ 6,628	$ 998	$ 1,001	$ 988
2028	$ 7,576	$ 7,575	$ 7,620	$ 1,003	$ 1,006	$ 992
2029	$ 8,592	$ 8,594	$ 8,624	$ 1,016	$ 1,019	$ 1,004
2030	$ 9,617	$ 9,622	$ 9,635	$ 1,025	$ 1,028	$ 1,012
2031	$ 10,646	$ 10,656	$ 10,651	$ 1,029	$ 1,033	$ 1,016
2032	$ 11,680	$ 11,693	$ 11,670	$ 1,034	$ 1,038	$ 1,020
2033	$ 12,718	$ 12,736	$ 12,694	$ 1,038	$ 1,042	$ 1,024
2034	$ 13,766	$ 13,787	$ 13,726	$ 1,047	$ 1,051	$ 1,032
2035	$ 14,818	$ 14,843	$ 14,761	$ 1,052	$ 1,056	$ 1,036
2036	$ 15,874	$ 15,904	$ 15,801	$ 1,056	$ 1,061	$ 1,039
2037	$ 16,930	$ 16,964	$ 16,839	$ 1,056	$ 1,061	$ 1,039
2038	$ 17,995	$ 18,034	$ 17,886	$ 1,065	$ 1,070	$ 1,047
2039	$ 19,064	$ 19,108	$ 18,937	$ 1,070	$ 1,074	$ 1,051
2040	$ 20,138	$ 20,187	$ 19,992	$ 1,074	$ 1,079	$ 1,055
2041	$ 21,216	$ 21,270	$ 21,050	$ 1,078	$ 1,083	$ 1,059
2042	$ 22,299	$ 22,358	$ 22,113	$ 1,083	$ 1,088	$ 1,062
2043	$ 23,386	$ 23,450	$ 23,179	$ 1,087	$ 1,092	$ 1,066
2044	$ 24,478	$ 24,547	$ 24,249	$ 1,091	$ 1,097	$ 1,070
2045	$ 25,574	$ 25,648	$ 25,324	$ 1,096	$ 1,101	$ 1,074
2046	$ 26,674	$ 26,754	$ 26,401	$ 1,100	$ 1,106	$ 1,078
2047	$ 27,783	$ 27,869	$ 27,488	$ 1,109	$ 1,115	$ 1,086
2048	$ 28,892	$ 28,984	$ 28,573	$ 1,109	$ 1,115	$ 1,086
2049	$ 30,006	$ 30,103	$ 29,663	$ 1,114	$ 1,119	$ 1,090
2050	$ 31,124	$ 31,227	$ 30,757	$ 1,118	$ 1,124	$ 1,094
2051	$ 32,246	$ 32,358	$ 31,844	$ 1,122	$ 1,130	$ 1,087
2052	$ 33,373	$ 33,492	$ 32,936	$ 1,127	$ 1,135	$ 1,092
2053	$ 34,504	$ 34,632	$ 34,032	$ 1,131	$ 1,139	$ 1,096
2054	$ 35,640	$ 35,775	$ 35,132	$ 1,136	$ 1,144	$ 1,100
2055	$ 36,780	$ 36,923	$ 36,236	$ 1,140	$ 1,148	$ 1,104
2056	$ 37,924	$ 38,076	$ 37,345	$ 1,144	$ 1,153	$ 1,109
2057	$ 39,073	$ 39,233	$ 38,458	$ 1,149	$ 1,157	$ 1,113
2058	$ 40,226	$ 40,394	$ 39,575	$ 1,153	$ 1,161	$ 1,117
2059	$ 41,383	$ 41,560	$ 40,696	$ 1,157	$ 1,166	$ 1,121
2060	$ 42,545	$ 42,730	$ 41,822	$ 1,162	$ 1,170	$ 1,126
2061	$ 43,711	$ 43,905	$ 42,951	$ 1,166	$ 1,175	$ 1,130
2062	$ 44,882	$ 45,084	$ 44,085	$ 1,171	$ 1,179	$ 1,134
2063	$ 46,057	$ 46,268	$ 45,224	$ 1,175	$ 1,184	$ 1,138
2064	$ 47,236	$ 47,456	$ 46,366	$ 1,179	$ 1,188	$ 1,142
2065	$ 48,420	$ 48,648	$ 47,513	$ 1,184	$ 1,192	$ 1,147
2066	$ 49,609	$ 49,845	$ 48,664	$ 1,188	$ 1,197	$ 1,151
2067	$ 50,801	$ 51,046	$ 49,819	$ 1,193	$ 1,201	$ 1,155
2068	$ 51,998	$ 52,252	$ 50,978	$ 1,197	$ 1,206	$ 1,159
2069	$ 53,200	$ 53,462	$ 52,142	$ 1,201	$ 1,210	$ 1,164
2070	$ 54,405	$ 54,677	$ 53,310	$ 1,206	$ 1,215	$ 1,168

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