APPENDIX B

Emissions Estimates

Emissions reductions were estimated by the California Air Resources Board (CARB) by estimating baseline emissions under two separate scenarios: (1) business-as-usual (BAU), and (2) comparing the BAU emissions to the expected lower emissions as a result of the U.S. Environmental Protection Agency's (U.S. EPA) Significant New Alternatives Policy (SNAP) Rules prohibiting certain high-global warming potential (GWP) hydrofluorocarbons (HFCs) in new and retrofitted refrigeration equipment.

The emissions under both scenarios were estimated using the peer-reviewed methodology used in the annual greenhouse gas (GHG) emissions inventory produced by CARB for the emissions sector "Ozone-depleting Substances Substitutes."

The emissions estimates methodology is summarized in the 2015 Edition of "California's High Global Warming Potential Gases Emission Inventory - Emission Inventory Methodology and Technical Support Document" (CARB 2016a). Additional descriptions of the methodology are in the 2016 edition of the CARB GHG Inventory Technical Document (CARB 2016b), and in Gallagher, et al., 2014.

The only emission factor change is the global warming potential (GWP) of the refrigerants used in retrofits and new equipment, which had been lowered as a result of the SNAP Rules. Although equipment refrigerant charge sizes, annual leak rates, and end-of-life refrigerant loss rates could theoretically change, these emissions factors have been kept the same to show only the effects of the SNAP refrigerant prohibitions. Estimating future changes in charge sizes, leak rates, and end-of-life loss rates is beyond the scope of this analysis.

The following table lists the emissions factors used to estimate HFC emissions and potential reductions. (Table shown on separate page.)

Summary Table B1: Estimated Emissions Reductions from the Proposed Regulation

SNAP Sector	Sub-sector Used for Emissions Reductions Calculations (if applicable)	Equipment Units in CA, 2017	Average Lifetime in Years	Number of New Units Annually	Average Charge (amount) of F-gas in lbs.	Average Annual Leak (loss) Rate	Average Loss Rate at End-of-Life
Commercial Refrigeration - Retail Food	Rule 20 Retail Food Refrigeration - Large Equipment (2,000 lbs. +)	650	15	45	3,635	18%	20%
	Rule 20 Retail Food Refrigeration - Medium Equipment (200 - 2,000 lbs.)	18,000	15	800	704	23%	20%
	Rule 20 Retail Food Refrigeration - Small Equipment (50-200 lbs.)	59,000	20	2,000	122	19%	20%
Rule 20 Remote Condensing Units		320,000	20	8,100	31	15%	34%
Rule 20 Stand-alone (Self-contained) Refrigeration		630,000	20	32,000	7	0.3%	98.5%
Rule 20 Vending Machines		470,000	15	36,000	0.7	0.3%	98.5%
Rule 20 Retrofit Existing R-22 Supermarkets		1,800	7.5	74	3500	21%	20%
Rule 20 Retrofit Existing R-404A Supermarkets		1,800	10	79	3500	21%	20%
Rule 20 Retrofit Existing R-22 Grocery Stores		400	7.5	78	1400	21%	20%
Rule 20 Retrofit Existing R-404A Grocery Stores		400	10	82	1400	21%	20%
Rule 21 Refrigerated Food Processing and Dispensing Equipment)		43,000	12	3,500	3	0.3%	98.5%
Rule 20 Foam End-Use Sectors		> 20 million cubic meters	30 - 50	300,000 cubic meters (m^3)	7 lbs per m^3	1%	15%

Summary Table B1 (continued)

SNAP Sector (repeated from previous page)	Sub-sector Used for Emissions Reductions Calculations (if applicable)	Baseline Refrigerant (pre-SNAP Rule)	GWP of Baseline Refrigerant	Refrigerant Post-SNAP Rule	GWP of Post-SNAP Refrigerant	Baseline Emissions Per Unit, Per Year ($MTCO_2E$)	Post-SNAP Emissions Per Unit, Per Year ($MTCO_2E$)	Emissions Reductions Per Unit, Per Year ($MTCO_2E$)	Total Emissions Reductions all New Units, Each Year of Operation ($MTCO_2E$)
Commercial Refrigeration - Retail Food	Large Equipment (2,000 lbs. +)	R-404A R-407A	3015	R-407A, R-448A, R-449A	1627	961	519	442	19,910
	Medium Equipment (200 - 2,000 lbs.)	R-404A R-407A	3015	R-407A, R-448A, R-449A	1627	234	126	108	86,282
	Small Equipment (50 - 200 lbs.)	R-404A R-407A	3015	R-407A, R-448A, R-449A	1627	33	18	15	30,724
Remote Condensing Units		R-404A	3922	R-407A	2107	9	5	4	34,523
Stand-alone (Self-contained) Refrigeration		HFC-134a, R-404A, R-507, R-600a	2394	HFC-134a, R-448A, R-449A, R-600a	982	0.4	0.2	0.2	7,496
Vending Machines		HFC-134a	1430	R-600a	3.3	0.03	0.0001	0.03	1,120
Retrofit Existing R-22 Supermarkets		R-22	1810	R-448A R-449A	1391	680	523	157	11,723
Retrofit Existing R-404A Supermarkets		R-404A	3922	R-448A R-449A	1391	1,432	508	924	72,891
Retrofit Existing R-22 Grocery Stores		R-22	1810	R-448A R-449A	1391	272	209	63	4,893
Retrofit Existing R-404A Grocery Stores		R-404A	3922	R-448A R-449A	1391	573	203	370	30,424
Refrigerated Food Processing and Dispensing Equipment)		R-404A	3922	R-448A R-449A	1391	0.5	0.2	0.3	1,026
Foam End-use Sectors		Low-GWP (various)	1 - 5	Low-GWP (various)	1 - 5	<0.1	<0.1	0 (zero)	0 (zero)
Total Reductions/year	**per operating yr.**								**301,010**

Table B2. Reductions ($MMTCO_2E$) each calendar year, shown by equipment production year for all emissions sectors covered by proposed regulation

	Emissions Reductions (All Covered Emissions Sectors): Calendar Year												
Production Year Below	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
2018	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
2019		0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
2020			0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
2021				0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
2022					0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
2023						0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
2024							0.35	0.35	0.35	0.35	0.35	0.35	0.35
2025								0.36	0.36	0.36	0.36	0.36	0.36
2026									0.36	0.36	0.36	0.36	0.36
2027										0.36	0.36	0.36	0.36
2028											0.37	0.37	0.37
2029												0.37	0.37
2030													0.37
Maximum Annual Reductions	0.29	0.59	0.92	1.26	1.61	1.97	2.32	2.68	3.04	3.40	3.76	4.13	4.50
Est. Overlap w/ Kigali Phasedown	0%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Adjusted Annual Reductions	0.3	0.4	0.7	0.9	1.2	1.5	1.7	2.0	2.3	2.5	2.8	3.1	3.4

Table Notes: The annual reductions from all emissions sectors are aggregated for each production year. The results are estimated emissions reductions per year. Due to the additive nature of emissions reductions achieved by each year of lower-GWP equipment operation, the reductions begin to accumulate greater than 301,000 $MMTCO_2E$ emissions reductions annually (0.3 million metric tonnes of CO_2-equivalent [$MMTCO_2E$]) by the year 2030. Potential emissions reductions also increase due to the annual growth rate of new equipment manufactured for use in California, which is correlated to the population growth rate of 0.75 percent annually through 2030 (California Department of Finance 2017). Emissions reductions can occur from more than one reduction measure, and the same reductions could be double-counted if not corrected.

Adjustments to Emissions Reductions - Avoiding a Double-Count of the Same Reductions:

Emissions reductions estimates are very sensitive to the initial assumptions used. To estimate HFC emissions reductions as a result of the regulations described in this Initial Statement of Reasons (ISOR), we modeled emissions from new and retrofit equipment following the regulation requirements, and compared the emissions to BAU emissions without the regulations. The emissions reductions results were 4.5 $MMTCO_2E$ annually by 2030.

CARB then modeled the estimated lower emissions in a new BAU baseline scenario that would result from implementation of the "Kigali Amendment" global phase-down in the production and consumption of HFCs, if the United States were to follow the agreement made October 15, 2016 (CARB 2017c). Adding the effects of the HFC phase-down resulted in lower BAU emissions estimates. CARB again modeled the HFC reductions from the proposed regulation and compared them to the new BAU that included the HFC phase-down. In this scenario, the HFC emissions reductions that were above and beyond the BAU with the HFC phase-down were estimated to be up to 3.4 $MMTCO_2E$ annually by 2030. The new estimate reflects the 25 percent "overlap" in reductions achieved by the phase-down and by the proposed regulation (CARB 2017c).

Fewer reductions (from BAU) occur when the Kigali phase-down is added to the baseline BAU, because the phase-down would begin to reduce the average GWP of HFCs used in new equipment and retrofits. A given piece of equipment can only be manufactured to use low-GWP one initial time. To avoid double-counting the same emissions reductions, those reductions from the Kigali Amendment HFC phase-down were counted first, followed by any added emissions reductions from the proposed regulation in this ISOR.

The following Kigali Amendment phase-down schedule for developed countries, including the United States, is provided for reference (UNEP 2016).

Table B3. The Kigali Amendment HFC Phase-down Schedule for Developed Countries.

Year	Production/Consumption Cap (relative to baseline)	Reductions in Production/Consumption
2017-2018	None	None
2019	90%	10%
2024	60%	40%
2029	30%	70%
2034	20%	80%
2036	15%	85%