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Amanda Stevens  
U.S. Environmental Protection Agency  
ENERGY STAR Program

Re: Honeywell Comments on EPA's ENERGY STAR Residential Refrigerators and Freezers  
Version 5.0 Specification Framework Document

Dear Ms. Stevens,

Honeywell is pleased to submit the following comments regarding the Environmental Protection Agency ("EPA") ENERGY STAR program Version 5.0 Residential Refrigerators and Freezers Specification Framework Document.

EPA is considering, among other things, to require that by 2013 ENERGY STAR qualified refrigerators and freezers be manufactured using low-global warming potential (GWP) foam blowing agents. If such a requirement is included in the ENERGY STAR criteria, given the timing of availability of low-GWP substitutes with superior environmental performance to today's options, manufacturers would essentially be required to adopt hydrocarbon blowing agent technology resulting in poorly insulated refrigerators and higher costs to manufacturers and consumers alike while also introducing safety concerns during manufacture and end of life disposal. If included, EPA should consider phasing in this requirement so that it takes effect no earlier than 2014.

#### I. Background: Honeywell's portfolio of low-GWP solutions

Honeywell has pioneered the development of hydrofluoroolefins (HFOs), which are a family of unique products that offer similar performance properties to today's most widely used refrigerants, blowing agents and aerosol propellants, but with the added benefit of having a lower impact on global warming. Since 2008, Honeywell has commercialized two HFOs: 1234ze and 1234yf.

- HFO-1234ze is primarily a replacement for HFC-134a, the refrigerant currently used in stationary refrigerators/freezers.<sup>1</sup> Honeywell recently announced plans to add commercial-scale

<sup>1</sup> EPA states in its Framework Document that HFO-1234ze is a replacement for HFCs in appliance foam-blowing applications. HFO-1234ze is a gaseous foam blowing agent, while not anticipated to be widely utilized in appliance and spray foam, the molecule is efficacious in one component PUR foam, as well as thermoplastic insulation, such as extruded polystyrene (XPS) and others. EPA has SNAP-listed 1234ze in certain of these foam insulation applications. Honeywell is currently developing HBA-2, which will be a replacement for HFC-245fa in appliance and spray foam applications.

production capability at its plant in Baton Rouge, LA. Production of HFO-1234ze is expected to begin in late 2013.

- HFO-1234yf is a low-GWP replacement for mobile air conditioning systems. Several global automakers are planning to use HFO-1234yf in new motor vehicles, including automakers in Europe, U.S., and Asia.
- Honeywell's latest addition to the suite of low-GWP replacements for HFCs is an unsaturated olefin for use in foam-blowing applications. This new alternative, called HBA-2, will replace HFC-245fa as the blowing agent for insulating foam in refrigerators and freezers. Honeywell expects to commercialize HBA-2 in the US after we are granted SNAP/ PMN approvals.

Benefits of HBA-2. HBA-2 is superior to other refrigerants in terms of environmental effect, efficiency, safety, workability, and cost.

Environmental Characteristics. HBA-2 has excellent environmental qualities. It has a GWP of only 7 and is not a volatile organic compound (VOC).<sup>2</sup>

Energy Efficiency. HBA-2 has a K-factor<sup>3</sup> (thermal conductivity) that is 18-20% better than hydrocarbons resulting in more energy efficient refrigerators. In trials with manufacturers of refrigerators and freezers, finished refrigerators with foam blown using HBA-2 have been shown to be two-to-four percent more energy efficient than those with foam blown with HFC-245fa. We expect that refrigerators made with HBA-2 foam will be 10-12%<sup>4</sup> better than those using foam blown with cyclopentane, based on experience with HFC-245fa and recent trials<sup>5</sup> conducted with manufacturers. These trials showed that CP foamed units perform 8-10% worse than those made with 245fa.

Safety. HBA-2 is non-flammable and non-toxic, making it safer than hydrocarbons both during manufacturer and at the end of life of a refrigerator.

Workability. HBA-2 has good polyol miscibility, and produces foam with better ancillary properties than those produced with hydrocarbons.

Cost. Refrigerators containing foam blown with HBA-2 rather than hydrocarbons will have lower capital and manufacturing costs per refrigerator. Redesigning or building a plant to manufacture refrigerators using hydrocarbons as the foam-blowing agent is expected to have capital costs of \$15-20 million, owing mostly to increased costs to manage flammability risks associated with using hydrocarbons. To improve energy efficiency of foam blown with hydrocarbons, manufacturers will have to install additional measures on each refrigerator such as vacuum insulated panels or advanced

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<sup>2</sup> HBA-2 has a very low maximum incremental reactivity rate (MIR). Consequently Honeywell expects HBA-2 to receive an exemption from VOC status. (Honeywell has submitted an application for such an exemption.)

<sup>3</sup> The K-factor indicates a substance's ability to transfer heat through conduction-lower is better.

<sup>4</sup> Note that improved K-factor (18-20% better vs. hydrocarbons) of the insulation material does not translate one to one when it comes to the energy efficiency of the overall refrigerator. Our experience with OEM trials and in Honeywell labs indicates that the refrigerators manufactured with HBA-2 blown foam will be 10-12% more efficient, all else being equal, to those made with foam blowing with cyclopentane.

<sup>5</sup> Measures can be taken to increase the efficiency of hydrocarbons, at additional cost to the manufacturer, and, ultimately, the consumer. Such measures include the addition of vacuum insulated panels and advanced compressors.

compressors, adding cost to the initial manufacture of the unit and to the cost to consumers. Furthermore, if a vacuum panel fails, it cannot be repaired and the entire refrigerator has to be replaced.

Honeywell also expects HBA-2 to have lower end-of-life management costs. The flammability risks of hydrocarbons require management both during manufacture of the refrigerator and at the end of the useful life of the refrigerator when the foam is either shipped to a landfill or subject to grinding and recycling. At both points in the refrigerator's lifecycle there would be an additional cost to address the flammability risks of hydrocarbons. These risks are not present with HBA-2 because it is not flammable.

In sum, compared to the only technically feasible low global warming solution available today, which is hydrocarbon cyclopentane, HBA-2 offers several benefits:

- Lowest manufacturing cost for energy efficiency
- Lower capital by ~\$15-20M per plant
- Safer: non-flammable and non-toxic
- Environmentally friendlier: GWP of 7; expected to be classified as non-VOC

## II. Comments on EPA framework proposing to specify that ENERGY STAR qualified refrigerators be manufactured with low-GWP foam blowing agents

### A. Item 1 for Comment & Discussion: EPA welcomes stakeholder comment on a potential requirement that ENERGY STAR qualified refrigerators be manufactured with low-GWP foam blowing agents

If EPA decides to include an ENERGY STAR requirement that refrigerators be manufactured with low-GWP foam blowing agents, the requirement should be phased-in no earlier than 2014, rather than 2013, to maximize efficiency gains and environmental benefit, and avoid added costs to manufacturers and consumers. To our knowledge the only viable low-GWP option available in 2013 will be cyclopentane (CP).<sup>6</sup> CP is not desirable for the many reasons listed above. If the ENERGY STAR requirement to use low-GWP foam blowing agents becomes effective in 2013, refrigerator manufacturers who want to retain their ENERGY STAR label will be forced to make a costly switch to CP, as described below. Given the substantial capital investment required to use CP, it is unlikely that manufacturers would make another switch in foam-blowing agent, even when a better material is available.

By waiting at least one year to require use of low-GWP refrigerant, EPA would afford manufacturers options that would be more efficient, better performing, and less costly over the life of the refrigerator than hydrocarbon alternatives – options such as HBA-2. Furthermore, since HBA-2 is a near drop-in replacement (no equipment modifications required), it lends itself to a quicker adoption than hydrocarbons like cyclopentane which require significant capital investment.

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<sup>6</sup> We are aware of other options, such as water. But water results in carbon dioxide in the cells and offers worse insulation performance than hydrocarbons.

B. Item 2 for Comment & Discussion: EPA also seeks stakeholder feedback on both the current and anticipated market availability of refrigerators that meet the proposed energy use requirements and do not contain high-GWP foam blowing agents.

Anticipated Market Availability. Honeywell expects HBA-2 to be available beginning in early 2014, assuming all regulatory approvals are completed by June 2012.<sup>7</sup> Honeywell expects construction of the commercial manufacturing plant for HBA-2 to follow EPA approval of the use of HBA-2.

While there are other low-GWP blowing agent options that would be available in 2013, such as water and CO<sub>2</sub>, that can be substituted for HFC-245fa in foam-blowing applications, c-Pentane is the most technically feasible. As described above, using CP has some serious drawbacks. A chief concern is that CP-blown foam is energy inefficient compared to other alternatives, such as foam blown with HFC-245fa today and HBA-2 when available. The energy efficiency penalty associated is even worse when using CO<sub>2</sub> and water (due to high vapor thermal conductivity), which would essentially rule them out as an option. The inefficiency of CP can only be addressed by redesigning the refrigerator to include additional components, such as vacuum insulated panels, at significant cost to the manufacturer and potentially significant cost to the consumer.

Use of hydrocarbons as a foam-blowing agent in refrigerators would increase the capital costs of the refrigerator manufacturing plant. One OEM has reported spending an additional \$15-20 million in capital at its plant to adequately address flammability risks of hydrocarbons. Adopting CP would also lessen the efficiency of new refrigerators in the U.S. market overall, increase the cost to consumers, and potentially lead to reduced U.S. competitiveness.

Energy Efficiency and Cost. If manufacturers were forced to use hydrocarbons to maintain their ENERGY STAR designation, the efficiency of the entire refrigerator “fleet” could be reduced rather than enhanced. Refrigerators using foam blown with hydrocarbons are expected to be 10-12% less energy efficient than had they used HBA-2, unless the refrigerator is redesigned and engineered. The redesign required to use hydrocarbons, such as CP, would include costly changes like vacuum insulated panels to make up for the deficiency in insulation properties and thus energy efficiency. In addition to being costly, if the vacuum seal in the panel leaked, the entire refrigerator would have to be replaced.

Because the changes required to manufacture refrigerators and freezers with hydrocarbons must be at the plant level, there would be a broad shift to hydrocarbons even for refrigerators and freezers that are not being built to meet ENERGY STAR specifications. Given the additional cost and potential unreliability of units equipped with vacuum panels, however, manufacturers using CP might abandon seeking the ENERGY STAR designation for many models. Those “abandoned” models would then be manufactured to baseline DOE efficiency specifications, rather than ENERGY STAR performance criteria. This would lower the overall efficiency of the U.S. “fleet” of 2013 refrigerators.

Making the new ENERGY STAR requirement effective in 2013 would assure the average new refrigerator would be less energy efficient for years. Given the cost of conversion to hydrocarbons, in addition to the expenditure required to comply with the 2014 DOE standards, it is

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<sup>7</sup> As mentioned previously, HBA-2, not HFO-1234ze, will replace HFC-245fa in appliance foam-blowing applications.

extremely unlikely that manufacturers would switch foam-blowing agents again in 2014 or 2015, abandoning their new platform designs and the capital invested to allow use of CP. Thus the entire “fleet” of U.S. refrigerators would be less efficient for a full design cycle than it would have been if the ENERGY STAR low-GWP criteria had been phased in during 2014, when alternatives such as HBA-2 will be available. A 2014 phase in would allow manufacturers to choose whether to make a substantial investment in redesigning refrigerators to use hydrocarbons or switch to a near drop-in alternative with superior environmental benefits, energy efficiency, and performance like HBA-2.

Should the new ENERGY STAR standard become effective in 2013, the energy efficiency penalty in the generation of new refrigerators and freezers built using hydrocarbon-blown foam would endure for decades, because of the long life of these appliances. Thus the nation would suffer a long-term loss in energy efficiency as a result of the premature imposition of the low-GWP ENERGY STAR requirement.

Effect on U.S. Competitiveness. A forced transition to hydrocarbons in 2013 could also mean reduced competitiveness for U.S. refrigerator and freezer manufacturers. In order to compensate for the energy inefficiency of hydrocarbons, manufacturers will be forced to use vacuum panels or complex compressors. This strategy will make U.S. refrigerators and freezers less appealing compared to appliances manufactured abroad using HBA-2. U.S. manufacturers may be forced to deal with a dilemma – either abandon their capital investments in hydrocarbons to switch to HBA-2 or other blowing agent alternatives not currently available, which will increase their cost-structure and damage their competitive position; or continue to suffer the competitive disadvantage of selling a less desirable product on the world market.

- C. Item 3 for Comment & Discussion: EPA is exploring the extent to which meeting this requirement could be demonstrated through participation in any existing initiatives and welcomes stakeholder feedback on this.

Honeywell has no comment on this issue at this time.

### III. Conclusion

If EPA includes a low-GWP requirement in ENERGY STAR specifications for residential refrigerators and freezers they should phase in the requirement no earlier than 2014, not 2013, and ensure that SNAP and PMN approvals are completed with sufficient time for manufacturers such as Honeywell to commercialize and operationalize production of the new molecules. Honeywell looks forward to providing EPA with further information about the development and timing of availability of HBA-2 and other new alternatives.

Sincerely,



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