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January 14, 2020

Richie Kaur
California Air Resources Board
1001 I Street
P.O. Box 2815
Sacramento, CA 95812
(Submitted via email to **richie.kaur@arb.ca.gov**)

Re: AHRI Letter Responding to CARB's Request for Input and Clarifications Following the August 6, 2019 Public Meeting for Industrial Process Refrigeration and Transport Refrigeration Equipment

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Dear Ms. Kaur,

On December 12, 2019, AHRI submitted comments to CARB regarding GWP levels and feedback from original equipment manufacturers regarding CARB-proposed regulations on industrial process refrigeration and transport refrigeration equipment. CARB responded with several questions. This letter contains AHRI member company responses and a revised proposal for the equipment, with AHRI responses shown in blue:

1. For Refrigerated Transport Units (TRUs), AHRI included a size threshold of < 50 lb. While the TRU regulation is being developed separately, there is no size threshold for that proposal. It seems highly unlikely that a TRU would have a refrigeration system above that size, so a size threshold seems redundant but we still wanted to point out that there is no size threshold for that proposal. Unless you are suggesting that there should be one. Please let us know.
   AHRI response: AHRI agrees to not specify a threshold charge size in the regulation, as all TRUs have < 50 lbs. of refrigerant.

2. For AC/Comfort cooling chillers, AHRI included a size threshold of > 50 lb. The A/C proposal has no size threshold for any equipment used for air-conditioning, chillers or otherwise. Was this an error or is AHRI recommending that size threshold for comfort cooling chillers?
   AHRI response: AHRI agrees to not specify a threshold charge size for AC/comfort cooling chillers to remain consistent with states and the former SNAP rules.

3. Do we need to define a term "Refrigeration Chillers"? Chillers as an equipment type can be used for multiple end-uses and operating temperature seem like a good way to distinguish their end-uses. For e.g., aren't comfort cooling chillers

just chillers operating above 35°F? Won't it be simpler to use temperature ranges throughout (except in the case of ice rinks)?
AHRI response: AHRI agrees with CARB that except for ice rinks, leaving fluid operating temperatures are an acceptable way to distinguish product categories. Temperature range of the equipment ultimately defines the equipment and refrigerant being used and allows for consistent definitions between states. However, chillers have different applications and end-uses which can result in overlapping operating temperatures. We have modified the proposal table to reflect this change.

AHRI Proposal for New Equipment - January 2020			
Equipment Type	**Fluid leaving operating temp [°F]**	**GWP [100yr AR4]**	**Date**
Refrigerated Transport units	n/a	2200	2025
Chillers - AC/Comfort Cooling/Heating	>36	750	2024
Chillers - Ice rinks	+5 to +15	750	2024
IPR equipment and Chillers - Industrial process	-10 to +35	1500	2024
IPR equipment and Chillers - Industrial process	-50 to -10	2200	2024
IPR equipment	< -50	exempt	
Medical, scientific or research equipment	n/a	exempt	

Notes:

1. Cold storage warehouses are outside the scope of industrial process refrigeration equipment.
    a. As defined by EPA, cold storage warehouses are temperature-controlled facilities used to store meat, produce, dairy and other products that are delivered to other locations for sale to the ultimate consumer.

4. What is the typical operating temperature of chillers in ice rinks?
AHRI response: +10°F to +15°F, as indicated in the revised proposal table.

   Ice rinks typically operate around 5°F to 15°F depending upon grade of ice making required. ASHRAE design recommendation is 10°F chilled glycol. ASHRAE's Refrigeration Handbook Chapter 44 has a summary of all the requirements for ice skating rinks. Condenser saturated temperatures are based on air-cooled or water-cooled and must be operable up to 120°F while maintaining 10°F glycol for reheat purposes to improve energy efficiency.

5. AHRI's recommended GWP limit for 'chillers operating above –10°F' is 1500. For all 3 refrigerants immediately above that GWP limit (i.e., R-448A/R-449A/R-134a), will R-513A or R-32 not work? Our understanding is that the

refrigerant will most likely be located in a machine room with chillers, so an A2L can be used for that. In that case, won't a GWP limit of 750 suffice?
AHRI response:

- *R-32*: Manufacturers do not have control over how and where the chiller is installed in the field. R-32 as a flammable refrigerant may not be qualified as an option considering the additional safety requirements needed for A2L refrigerants. For example, chillers such as the bakery chillers in supermarkets may be installed indoors and not necessarily in a separate machine room. In addition, UL does not have a standard of construction for A2L refrigerants. ASHRAE 15 covers stick builds but lacks enough detail for A2L refrigerant construction requirements. A2Ls are not appropriate for industrial process refrigeration as the refrigerant is not guaranteed to be in a confined space with appropriate safety measures.
- *R-513A*: R-513A is a replacement refrigerant for R-134A. The manufacturer of the R-513A states that its performance closely matches that of R-134A, but R134A has much less capacity than R-448A. For example, the design operating conditions of some chillers are at 30°F evaporating and 100°F condensing temperatures. At this condition, the rated capacity of a specific compressor is 93,000 Btu/hr for R-448A and 57,200 Btu/hr for R-134A. The capacity of the system with R-134A is about 40% lower than the one with R-448A.
- R-513A and R-32 are not viable replacements between "-10°F and 0°F" either. For medium pressure systems, anything with saturation temperatures below -10°F to 0°F will move the system below atmospheric pressures that will require use of purges and the capacity of these systems will be reduced significantly. Typically, most medium pressure fluids are not designed for less than atmospheric conditions and most available compressors begin to have application issues in that range. This is especially true with glycol systems where approach temperatures become larger. For the high-pressure fluids (R-410A, R-32, R-454B), the issue becomes more capacity and commercial limitations of the compressors themselves and their ability to overcome the high discharge superheat. This is especially true for R-32 but less so for R-454B, which are higher than R-410A. Though the fluids may be viable in that range, there has been little to no commercialization of R-410A and thus R-410A replacements will not be viable as well. R-404A was designed to be uniquely suited to deliver enough capacity with low compressor discharge and low glide in this application ranges. The low GWP alternatives available with enough capacity (R-454A, R-454C) do not have low compressor discharge temperature and low glide like R-404A to meet these application requirements.

6. AHRI's recommended GWP limit for 'chillers operating between –10°F to –50°F' is 2200. Based on your letter, this is primarily to allow R-410A in those chillers. Why can't R-32 be used as a replacement for R-410A in that temperature range? It has zero glide and a dew point slightly lower than R-410A. Again, A2Ls are permitted in machine rooms so we don't see the reason for this exemption. In this case again, won't a GWP limit of 750 suffice?

AHRI response: As mentioned above, some industrial process refrigeration applications are outside of confined space with appropriate safety measures. For medium pressure systems, anything with saturation temperatures below -10°F will move the system below atmospheric pressures that will necessitate use of purges and the capacity of these systems will be reduced significantly. At those low temperatures, commercial applications have not been developed for these systems, nor have compressors been developed for these low temperature systems.

For high pressure systems like R-32 and R-454B, the lower temperature range systems have not been developed commercially due to compressor application range issues. R-32 has high discharge superheat issues at these extremely low temperatures and even R-454B does as well. As such, little to no commercialization in this space for R-410A replacements has been conducted and likely will not occur because of the high compressor discharge temperatures. To enable R-32, it will have to be coupled to a cascade refrigeration system which will increase complexity and cost significantly. R404A/R507A was designed to be uniquely suited to deliver enough capacity with low compressor discharge and low glide in these application ranges. The low GWP alternatives available have enough capacity (R454A, R454C) but do not have low compressor discharge temperature and low glide like R-404A to meet these application requirements.

7. By the term “IPR equipment”, does AHRI mean IPR refrigeration systems except chillers? If yes, what type of equipment is this? If these are “rack” type systems, why do they need a 2200 GWP limit above -50°F for new systems? Why can’t they meet a GWP limit of 150 for new systems? To our knowledge, majority of the IPR and cold storage systems currently use ammonia. For those who cannot use ammonia, CO2 is emerging as a viable A1 option when enhancements like adiabatic condensers are employed to improve energy efficiency in hot climates.

   AHRI response: Other types of equipment could be ice makers, frozen food makers (ice cream), blast freezers, ice rinks, or industrial refrigeration in warm climates. Large plants may use R-717 or CO_2. Smaller plants won’t want to use those refrigerants because of safety concerns with R-717 or material cost to design high-pressure evaporators. Ice rinks or industrial refrigeration in warm climates cannot meet a GWP limit of 150 because they may struggle to meet equivalent energy efficiencies to today’s systems with CO_2 without considerable expense or move to A2Ls. For example, efficiency and temperature delivery will be impacted by high glide of new A2Ls (R-454C, R-455A, etc.) Ammonia systems cannot be sited in many cases due to proximity to the general public or county or city-specific restrictions. Hydrocarbon systems do not deliver enough capacity because they are restricted to low refrigerant charges (fractions of tons.) Some equipment using R-507 requires complete system redesigns as neither ammonia nor CO_2 can be used as a drop-in replacement.

8. The current proposed effective date for non-chiller refrigeration systems (i.e., “IPR equipment”) is January 1, 2022 (like supermarkets). Any reason why they need a 2024 date instead?

   AHRI response: From the time that a decision is made on new GWP limits to HFCs, manufacturers will need at least two years to complete new designs and process through inventory in place. A large portion of the time needed will depend on component manufacturers’ ability to adjust to new refrigerant requirements. For manufacturers to design, test, and certify products with low-GWP alternative refrigerants, updated safety standards must be adopted into state building codes. Time is also required to train technicians on updated safety and servicing requirements during the transition to low GWP refrigerants and equipment.

As always, AHRI greatly appreciates the opportunity to provide these comments. Should you have any questions, please contact Helen Walter-Terrinoni [hwalter-terrinoni@ahrinet.org, (302) 598-4608] and Jennifer Kane [jkane@ahrinet.org, (703) 600-0304].

Respectfully,

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Cc: Helen Walter-Terrinoni