

The Director of EPA's Office of Atmospheric Protection, Paul Gunning, signed the following notice on November 27, 2024 and EPA is submitting it for publication in the *Federal Register* (FR). While we have taken steps to ensure the accuracy of this Internet version of the document, it is not the official version. Please refer to the official version in a forthcoming FR publication, which will appear on the Government Printing Office's website (<https://www.govinfo.gov>) and on Regulations.gov (<http://www.regulations.gov>) in Docket Number EPA-HQ-OAR-2003-0118. Once the official version of this document is published in the FR, this version will be removed from the Internet and replaced with a link to the official version.

6560-50-P

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 82

[EPA-HQ-OAR-2003-0118; FRL-12145-01-OAR]

RIN 2060-AG12

Protection of Stratospheric Ozone: Determination 39 for the Significant New Alternatives Policy Program

AGENCY: Environmental Protection Agency (EPA).

ACTION: Determination of acceptability.

SUMMARY: This determination of acceptability expands the list of acceptable substitutes pursuant to the U.S. Environmental Protection Agency's Significant New Alternatives Policy program. This action lists four substitutes as acceptable additional substitutes for use in the refrigeration and air conditioning and foam blowing sectors.

DATES: This determination is applicable on **[Insert date of publication in the *Federal Register*]**.

ADDRESSES: EPA established a docket for this action under Docket ID No. EPA-HQ-OAR-2003-0118 (continuation of Air Docket A-91-42). All electronic documents in the docket are listed in the index at <https://www.regulations.gov>. Although listed in the index, some information is not publicly available, *e.g.*, confidential business information (CBI) or other information

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whose disclosure is restricted by statute. Publicly available docket materials are available either

electronically at <https://www.regulations.gov> or in hard copy at the EPA Docket Center

(EPA/DC), (Docket Nos. A-91-42 and EPA-HQ-OAR-2003-0118), William J. Clinton West,

Room 3334, 1301 Constitution Avenue, NW, Washington, DC 20460. The telephone number for

the Public Reading Room is (202) 566-1744, and the telephone number for the Air and Radiation

Docket is (202) 566-1742. The Docket Center's hours of operations are 8:30 a.m.-4:30 p.m.,

Monday-Friday (except Federal Holidays). For further information on the EPA Docket Center

services and the current status, please visit online at <https://www.epa.gov/dockets>.

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1. Listing of New Acceptable Substitutes

This action is listing as acceptable additional substitutes for use in the refrigeration and air conditioning and foam blowing sectors. This action presents EPA's most recent decisions under the Significant New Alternatives Policy (SNAP) program to list as acceptable several substitutes in different end-uses. The new substitutes are:

- R-471A in retail food refrigeration, industrial process refrigeration, and cold storage warehouses (retrofit equipment only);
- R-480A in cold storage warehouses, commercial ice machines, positive displacement chillers, refrigerated transport, and water coolers (retrofit equipment only);
- R-513A in residential and light commercial air conditioning and heat pumps – self-contained units (new equipment only);
- XPS foam blowing agent blends of 0 to 90 percent hydrofluoroolefin (HFO)-1336mzz(Z), 0 to 90 percent HFO-1234ze(E), 0 to 75 percent hydrofluorocarbon (HFC)-152a, and 0 to 90 percent carbon dioxide (CO₂) in polystyrene: extruded boardstock and billet.

Listing decisions in the end-uses in this document do not prejudice EPA's listings of these substitutes for other end-uses. For additional information on SNAP, visit the SNAP website at <https://www.epa.gov/snap>. The full lists of acceptable substitutes for ozone-depleting substances (ODS) in the industrial sectors covered by the SNAP program are available at <https://www.epa.gov/snap/substitutes-sector>. For more information on the Agency's process for administering the SNAP program or criteria for evaluation of substitutes, refer to the initial SNAP rulemaking (59 FR 13044; March 18, 1994). The regulations are codified at 40 CFR part

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82, subpart G. SNAP decisions and the appropriate *Federal Register* citations are available at:

<https://www.epa.gov/snap/snap-regulations>. Under the SNAP program, EPA may list a substitute as acceptable for specified end-uses where the Agency has reviewed the substitute and found no reason to restrict or prohibit its use. Substitutes listed as unacceptable; acceptable, subject to narrowed use limits; or acceptable, subject to use conditions are also listed in the appendices to 40 CFR part 82, subpart G.

This document discusses each substitute listing in detail and summarizes the results of EPA's assessment of the human health and environmental risks posed by each substitute. EPA's evaluation applies the criteria in 40 CFR 82.180(a)(7), including atmospheric effects and related health and environmental effects, ecosystem risks, occupational risks, consumer risks, flammability, and cost and availability of the substitute. EPA evaluates these criteria in risk screens, or technical documents that evaluate risks to human health and the environment from substitutes in specific end-uses, including comparisons to other available substitutes and evaluations against relevant thresholds of risk starting with protective assumptions. The risk screens cited in this document include evaluation of atmospheric effects, toxicity data, exposure assessments, flammability, and other environmental impacts such as ecotoxicity and local air quality impacts. You can find more information on the criteria used in the evaluation of substitutes in the SNAP program at <https://www.epa.gov/snap/snap-regulations>.

In this document, EPA determined the global warming potential (GWP) for a chemical or blend using the 100-year GWP values from the Intergovernmental Panel on Climate Change's

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(IPCC) Fourth Assessment Report (AR4)¹ for substances or components of blends if included.²

Note that Annex F to the *Montreal Protocol on Substances that Deplete the Ozone Layer* lists GWPs for HFCs that are numerically equivalent to the AR4 values.³ These HFC 100-year GWP values are also numerically equivalent to the exchange values listed in the American Innovation and Manufacturing Act of 2020 (hereafter referred to as “the AIM Act”). If no GWP is provided in AR4 for a substance, the SNAP program is using the 100-year GWP listed in World Meteorological Organization (WMO), 2022.⁴ To calculate the GWP of blends of chemicals, such as the listed refrigerant blends, this document weights the GWP of each component of the blend by its mass percentage. This method of calculating GWPs is consistent with the method used to calculate GWPs in the October 2023 Technology Transitions Rule as codified at 40 CFR 84.64.

Under section 612 of the Clean Air Act (CAA), the SNAP program reviews substitutes using a comparative risk framework in different industrial sectors. In making listing decisions, EPA considers overall risk to human health and the environment. As a general matter, the substitutes being added through this action to the acceptable lists have a similar or lower risk than other substitutes already listed as acceptable in those end-uses. However, certain substitutes may have a higher risk than certain other substitutes already listed as acceptable or acceptable

¹ IPCC, 2007: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K. B., Tignor M., and Miller, H. L. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Available at: https://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html.

² The IPCC, 2007 100-year GWP values are consistent with the exchange values for the regulated HFCs listed in subsection (c) of the AIM Act and with the GWPs in Annex F of the Montreal Protocol.

³ Annex F of the Montreal Protocol is available at: <https://ozone.unep.org/treaties/montreal-protocol/articles/annex-f-controlled-substances>.

⁴ WMO, *Scientific Assessment of Ozone Depletion: 2022*, GAW Report No. 278, 509 pp.; WMO: Geneva, 2022. Available at: <https://ozone.unep.org/system/files/documents/Scientific-Assessment-of-Ozone-Depletion-2022.pdf>. (WMO, 2022).

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Appendix A contains tables summarizing each listing decision in this action. The statements in the “Further Information” column in the tables provide additional information, but these are not legally binding under section 612 of the CAA. Although users are not required to follow recommendations in the “Further Information” column of the table under section 612 of the CAA, some of these statements may refer to obligations that are enforceable or binding under federal or state programs other than the SNAP program. The identification of other enforceable or binding requirements should not be construed as a comprehensive list of such obligations. In many instances, the information simply refers to standard operating practices in existing industry standards and/or building codes. When using these substitutes in the identified end-use, EPA strongly encourages you to apply the information in the “Further Information” column. Many of these recommendations, if adopted, would not require significant changes to existing operating practices.

It should be noted that a substitute listed as acceptable under the SNAP program may also be subject to requirements or limitations under other statutory or regulatory provisions. For example, there are relevant regulations under subsection (i) of the AIM Act that restrict the use of certain HFCs in a variety of sectors and subsectors. See 88 FR 73098 (October 24, 2023). Consequently, if a substitute listed as acceptable under the SNAP program is also subject to limitations on its use under other regulations, it may not be permitted for use in accordance with those other regulations. Those intending to use a substitute listed as acceptable under the SNAP

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program may need to consider restrictions under subsection (i) of the AIM Act, as well as other relevant authorities, and must also be followed.⁵

You can find submissions to EPA for the substitutes listed in this document, as well as other materials supporting the decisions in this action, in the docket (EPA-HQ-OAR-2003-0118) at <https://www.regulations.gov>.

A. Refrigeration and Air Conditioning

1. R-471A

EPA's decision: EPA finds R-471A acceptable as a substitute for use in:

- Cold storage warehouses (retrofit equipment only);
- Industrial process refrigeration (retrofit equipment only);
- Retail food refrigeration – Refrigerated food processing and dispensing equipment (retrofit equipment only);
- Retail food refrigeration – Remote condensing units (retrofit equipment only);
- Retail food refrigeration – Supermarket systems (retrofit equipment only).

R-471A, marketed under the trade name Solstice[®] N71, is a weighted blend of 78.7 percent HFO-1234ze(E), also known as *trans*-1,3,3,3-tetrafluoroprop-1-ene (Chemical Abstracts Service Registry Number [CAS Reg. No.] 29118-24-9); 17.0 percent HFO-1336mzz(E), also

⁵ For example, there may be restrictions or prohibitions in regulations issued under section 610 of the CAA at 40 CFR part 82 subpart C for nonessential products containing ODS, under the Toxic Substances Control Act, under the Occupation Safety and Health Act, and under state or local laws and regulations that warrant consideration.

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known as *trans*-1,1,1,4,4,4-hexafluoro-2-butene (CAS Reg. No. 66711-86-2); and 4.3 percent

HFC-227ea, which is also known as 1,1,1,2,3,3,3-heptafluoropropane (CAS Reg. No. 431-89-0).

You may find a copy of the applicant’s submission, with CBI redacted, providing the required health and environmental information for this substitute in this end-use in the docket (EPA-HQ-OAR-2003-0118) at <https://www.regulations.gov> under the name, “Supporting Materials for Notice 39 Listing of R-471A in Refrigeration and Air Conditioning. SNAP Submission Received September 15, 2023.” EPA performed assessments to examine the health and environmental risks of this substitute, and the results are summarized below. These assessments are available in the docket EPA-HQ-OAR-2003-0118:

- “Risk Screen on Substitutes in Retail Food Refrigeration (Retrofit Equipment) Substitute: R-471A (Solstice[®] N71).”
- “Risk Screen on Substitutes in Industrial Process Refrigeration and Cold Storage Warehouses (Retrofit Equipment) Substitute: R-471A (Solstice[®] N71).”

Environmental information: R-471A has an ozone depletion potential (ODP) of 0. Its components, HFO-1234ze(E), HFO-1336mzz(E), and HFC-227ea, have GWPs of 1,⁶ 26,⁷ and 3,220,⁸ respectively. When these values are weighted by mass percentage of the blend, R-471A has a GWP of about 144. The components of R-471A are excluded from the EPA’s regulatory definition of volatile organic compounds (VOC) under CAA regulations (see 40 CFR 51.100(s)) addressing the development of state implementation plans (SIPs) to attain and maintain the National Ambient Air Quality Standards (NAAQS). Knowingly venting or otherwise knowingly

⁶ WMO, 2022.

⁷ WMO, 2022.

⁸ Annex F to the Montreal Protocol.

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releasing this refrigerant blend is limited by the venting prohibition under section 608(c)(2) of the CAA, codified in EPA regulations at 40 CFR 82.154(a).

Flammability information: The component HFO-1234ze(E) has lower flammability as defined using the standard test method American Society of Testing and Materials (ASTM) E681.⁹ The other two components of R-471A are not flammable using the same method. R-471A is not flammable as formulated, in the worst-case formulation for flammability (WCF) and the worst-case of fractionation for flammability (WCFF). The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has assigned R-471A a flammability class of “1,” meaning it does not propagate a flame under standard test conditions.¹⁰

Toxicity and exposure data: Potential health effects of exposure to this substitute include drowsiness or dizziness. The substitute may also irritate the skin or eyes or cause frostbite in the case of rapid evaporation of the liquid. The substitute could cause asphyxiation if air is displaced by vapors in a confined space. Excessive exposure may cause central nervous system effects including drowsiness and dizziness. Excessive exposure may also cause cardiac arrhythmia. These potential health effects are common to many refrigerants.

ASHRAE has adopted an occupational exposure limit (OEL) for the blend of 710 ppm^{11,12} on an eight-hour time-weighted average (8-hr TWA) for HFO-1336mzz(E), the American Industrial Hygiene Association (AIHA) has established a WEEL of 1,000 ppm (8-hr TWA) for HFC-227ea, and ASHRAE has adopted an OEL of 800 ppm (8-hr TWA) for HFO-

⁹ ASTM, E681. Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases).

¹⁰ ASHRAE Standard 34-2022: Designation and Safety Classification of Refrigerants. (ASHRAE, 2022).

¹¹ ASHRAE, 2022.

¹² Trans-1,1,1,4,4,4-hexafluoro-2-butene (HFO-1336mzz-E) (2018). *Toxicology and Industrial Health*. 2019; 35(3):204-210. doi:10.1177/0748233719825529.

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1234ze(E).¹³ EPA anticipates that users will be able to meet these workplace guidance limits and address potential health risks by following recommendations in the manufacturer's safety data sheet (SDS), ASHRAE Standard 15,¹⁴ other industry standards, and other safety precautions common to the refrigeration and air conditioning industry.

Comparison to other substitutes in these end-uses: R-471A has an ODP of 0, comparable to or less than other listed substitutes in retrofits for these end-uses with ODPs ranging from 0 to less than 0.0004.

As a retrofit for supermarket systems, remote condensing units, and refrigerated food processing and dispensing equipment, R-471A with a GWP of 144 is lower than that of all other acceptable substitutes such as R-450A which has a GWP of 601; R-513A with a GWP of 630; R-448A with a GWP of 1,386; R-449A with a GWP of 1,396; R-449B with a GWP of 1,412; R-407C with a GWP of 1,770; R-407F with a GWP of 1,825; and R-407A with a GWP of 2,107.

For retrofits in industrial process refrigeration, R-471A's GWP of 144 is lower than that of other acceptable substitutes such as HFC-134a which has a GWP of 1,430; R-407C with a GWP of 1,770; and R-407F with a GWP of 1,825. Other alternatives in this sector have a lower GWP than R-471A such as CO₂ with a GWP of 1 and R-290 (propane) with a GWP of 3. There may be situations in which lower-GWP options may not be feasible for certain retrofitted industrial process refrigeration equipment. For example, CO₂, which has a GWP of 1 is a high-pressure refrigerant and cannot be used as a retrofit for low-pressure refrigerant systems. R-471A is a low-pressure refrigerant, making it more technically feasible to retrofit systems that use

¹³ ASHRAE, 2022.

¹⁴ ASHRAE 15. Safety Standard for Refrigeration Systems.

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similar low-pressure refrigerants. R-290 is an A3, highly flammable refrigerant and may not be feasible for certain retrofitted industrial process refrigeration equipment where flammability is a concern.

Further, refrigerants offer cooling within a specific temperature range. Adding R-471A to the list of available substitutes in industrial process refrigeration systems may offer a refrigerant that achieves a specific cooling temperature that other retrofit alternatives with lower GWPs cannot achieve.¹⁵ For retrofits of cold storage warehouses, R-471A's GWP of 144 is lower than that of all other acceptable substitutes such as R-450A with a GWP of 601; R-513A with a GWP of 630; HFC-134a with a GWP of 1,430; R-407C with a GWP of 1,770; and R-407F with a GWP of 1,825.

Flammability and toxicity risks are comparable to or lower than flammability and toxicity risks of other available substitutes in the same retrofit end-uses. Toxicity risks can be minimized by use consistent with the AIHA and OARS WEELs, ASHRAE OELs and ASHRAE 15, other industry standards, recommendations in the manufacturer's SDS, and other safety precautions common in the refrigeration and air conditioning industry.

Based on the considerations described above, EPA finds R-471A acceptable as a retrofit refrigerant for the following end-uses: cold storage warehouses, industrial process refrigeration, and retail food refrigeration (including supermarket systems, remote condensing units, and refrigerated food processing and dispensing equipment), because it does not pose greater overall environmental and human health risk than other available substitutes in the same end-uses.

¹⁵ The October 2023 Technology Transitions Rule does not restrict the use of HFCs (*i.e.*, establish GWP limits) in retrofit applications (See 88 FR 73127).

2. R-480A

EPA's decision: EPA finds R-480A acceptable as a substitute for use in:

- Cold storage warehouses (retrofit equipment only);
- Commercial ice machines (retrofit equipment only);
- Positive displacement chillers (retrofit equipment only);
- Refrigerated transport (retrofit equipment only);
- Water coolers (retrofit equipment only).

R-480A, marketed under the trade name RS-20, is a weighted blend of 5 percent CO₂ (CAS Reg. No. 124-38-9), 86 percent HFO-1234ze(E), also known as *trans*-1,3,3,3-tetrafluoroprop-1-ene (CAS Reg. No. 29118-24-9), and 9 percent HFC-227ea, also known as 1,1,1,2,3,3,3-heptafluoropropane (CAS Reg. No. 431-89-0).

You may find a copy of the applicant's submission, with CBI redacted, providing the required health and environmental information for this substitute in this end-use in the docket (EPA-HQ-OAR-2003-0118) at <https://www.regulations.gov> under the name, "Supporting Materials for Notice 39 Listing of R-480A in Refrigeration and Air Conditioning. SNAP Submission Received May 16, 2024." EPA performed assessments to examine the health and environmental risks of this substitute, and the results are summarized below. These assessments are available in the docket EPA-HQ-OAR-2003-0118:

- "Risk Screen on Substitutes in Cold Storage Warehouses (Retrofit Equipment).
Substitute: R-480A (RS-20)."
- "Risk Screen on Substitutes in Commercial Ice Machines (Retrofit Equipment).
Substitute: R-480A (RS-20)."

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- “Risk Screen on Substitutes in Chillers (Retrofit Equipment). Substitute: R-480A (RS-20).”
- “Risk Screen on Substitutes in Refrigerated Transport (Retrofit Equipment). Substitute: R-480A (RS-20).”
- “Risk Screen on Substitutes in Water Coolers (Retrofit Equipment). Substitute: R-480A (RS-20).”

Environmental information: R-480A has an ODP of 0. This blend consists of CO₂ with a GWP of 1,¹⁶ HFO-1234ze(E) with a GWP of 1,¹⁷ and HFC-227ea with a GWP of 3,220.¹⁸ Weighting these values by mass percentage results in a GWP of 291 for R-480A. The components of R-480A are excluded from EPA’s regulatory definition of VOC under CAA regulations (see 40 CFR 51.100(s)) addressing the development of SIPs to attain and maintain the NAAQS. Knowingly venting or otherwise knowingly releasing this refrigerant blend is limited by the venting prohibition under CAA section 608(c)(2), codified at 40 CFR 82.154(a).

Flammability information: The component HFO-1234ze(E) has lower flammability as defined using the standard test method ASTM E681, while the other two components of R-480A are not flammable using the same method. R-480A is not flammable as formulated, in the WCF and the WCFF. ASHRAE has assigned R-480A a flammability class of “1,” meaning it does not propagate a flame under standard test conditions.

Toxicity and exposure data: The substitute may be hazardous if inhalation, skin contact, or eye contact with the substitute occurs at sufficiently high levels. The substitute could cause

¹⁶ IPCC, 2007.

¹⁷ WMO, 2022.

¹⁸ Annex F to the Montreal Protocol.

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symptoms of asphyxiation if air is displaced by vapors in a confined space. These potential

health effects are common to many refrigerants.

ASHRAE has adopted an OEL for the blend of 900 ppm (8-hr TWA).¹⁹ For the components of R-480A, the U.S. Occupational Safety and Health Administration (OSHA) has established a permissible exposure limit (PEL) of 5,000 ppm (8-hr TWA) for CO₂, AIHA has established a WEEL of 1,000 ppm for HFC-227ea, and ASHRAE has adopted an OEL of 800 ppm (8-hr TWA) for HFO-1234ze(E).²⁰ EPA anticipates that users will be able to meet these workplace guidance limits and address potential health risks by following recommendations in the manufacturer's SDS, ASHRAE Standard 15, other industry standards, and other safety precautions common to the refrigeration and air conditioning industry.

Comparison to other substitutes in these end-uses: R-480A has an ODP of 0, comparable to or less than other listed substitutes in these end-uses with ODPs ranging from 0 to less than 0.0004.

For cold storage warehouses, R-480A with a GWP of 291 is lower than all other acceptable substitutes for retrofit equipment in this end-use, such as a number of HFC blends, including R-450A and R-513A, with GWPs of 601 and 630, respectively.

For commercial ice machines, R-480A's GWP of 291 is lower than all other acceptable substitutes for retrofit equipment in this end-use, such as a number of HFC blends, including R-450A and R-513A, with GWPs of 601 and 630, respectively.

¹⁹ ASHRAE, 2022, Addendum h.

²⁰ ASHRAE, 2022.

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For positive displacement chillers, R-480A's GWP of 291 is lower than that of certain other acceptable substitutes for retrofit equipment in this end-use, such as a number of HFC blends, including R-450A and R-513A, with GWPs of 601 and 630, respectively. The GWP of R-480A is higher than the GWPs of two other acceptable substitutes for retrofit equipment in this end-use, namely R-1224yd(Z) and R-514A, with GWPs of 1²¹ and 2,²² respectively. EPA is listing this substitute as acceptable because available lower-GWP options are not feasible to use in certain applications. For example, equipment retrofitted with R-480A can operate within a specific temperature range and pressure range that other retrofitted chillers using lower-GWP options such as R-1224yd(Z) and R-514A cannot achieve. For refrigerated transport, R-480A's GWP of 291 is lower than that of all other acceptable substitutes for retrofit equipment in this end-use, such as R-450A, R-513A, and HFC-134a, with GWPs of 601, 630, and 1,430, respectively.

For water coolers, R-480A's GWP of 291 is lower than that of all other acceptable substitutes for retrofit equipment in this end-use, such as R-450A, R-513A, R-426A, and R-411A, with GWPs of 601, 630, 1,510, and 1,600, respectively.

Flammability and toxicity risks are comparable to or lower than flammability and toxicity risks of other available substitutes in the same retrofit end-uses. Toxicity risks can be minimized by use consistent with the OSHA PEL, AIHA WEEL, ASHRAE OELs, ASHRAE 15 and other industry standards, recommendations in the manufacturer's SDS, and other safety precautions common in the refrigeration and air conditioning industry.

²¹ WMO, 2022.

²² This value is calculated by weighting the GWPs of HFO-1336mzz(Z) (2) and 1,2-dichloroethene(Z) (1) from WMO, 2022 by the mass percentages of the blend components of 74.7 percent and 25.3 percent, respectively.

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Based on the considerations described above, EPA finds R-480A acceptable in retrofit equipment in the following end-uses: cold storage warehouses, commercial ice machines, positive displacement chillers, refrigerated transport, and water coolers, because it does not pose greater overall environmental and human health risk than other available substitutes in the same end-uses.

3. R-513A

EPA's decision: EPA finds R-513A acceptable as a substitute for use in:

- Residential and light commercial air conditioning and heat pumps – self-contained units (new equipment only)

R-513A, marketed under the trade name Opteon® XP-10, is a weighted blend of 44 percent HFC-134a and 56 percent HFO-1234yf by weight. HFC-134a is an HFC and is also known as 1,1,1,2-tetrafluoroethane (CAS Reg. No. 811-97-2). HFO-1234yf is an HFO and is also known as 2,3,3,3 tetrafluoroprop-1-ene (CAS Reg. No.754-12-1).

You may find a copy of the applicant's submission, with CBI redacted, providing the required health and environmental information for this substitute in this end-use category in Docket EPA-HQ-OAR-2003-0118 at www.regulations.gov under the name, "SNAP Information Notice for R-513A as a Refrigerant. SNAP Submission Received January 9, 2024." EPA has performed an assessment to examine the health and environmental risks of this substitute and the results are summarized below. This assessment is available in Docket EPA-HQ-OAR-2003-0118:

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- “Risk Screen on Substitutes for Use in Residential and Light Commercial Air

Conditioning and Heat Pumps – Self-Contained Units (New Equipment) Substitute: R-513A (Opteon® XP-10).”

Environmental information: R-513A is a blend of HFC-134a and HFO-1234yf with an ODP of 0. HFC-134a has a GWP of 1,430²³ and HFO-1234yf has a GWP of 1.²⁴ The GWP of R-513A is 630 when the two components are weighted by mass percentage of their GWPs. All components of the blends are excluded from the EPA’s regulatory definition of VOC under CAA regulations (see 40 CFR 51.100(s)) addressing the development of SIPs to attain and maintain the NAAQS. Knowingly venting or otherwise knowingly releasing this refrigerant blend is limited by the venting prohibition under section 608(c)(2) of the CAA, codified in EPA’s regulations at 40 CFR 82.154(a).

Flammability information: The component HFO-1234yf has lower flammability as defined using the standard test method ASTM E681. HFC-134a is not flammable using the same method. R-513A is not flammable as formulated in the WCF and the WCFF. ASHRAE has assigned R-513A a flammability class of “1,” meaning it does not propagate a flame under standard test conditions.

Toxicity and exposure data: Potential health effects of exposure to this substitute include skin and eye irritation and frostbite upon contact. The substitute could cause asphyxiation if air is displaced by vapors in a confined space. These potential health effects are common to many refrigerants. EPA anticipates that R-513A will be used consistent with the recommendations

²³ Annex F to the Montreal Protocol.

²⁴ WMO, 2022.

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specified in the SDS. ASHRAE has adopted an OEL for the blend R-513A of 650 ppm as an 8-hr

TWA. The AIHA has established WEELs of 1000 ppm for HFC-134a and of 500 ppm for HFO-1234yf, both as an 8-hr TWA. EPA anticipates that users will be able to meet these workplace guidance limits and will address potential health risks by following requirements and recommendations in the manufacturer's SDSs, ASHRAE Standard 15, other industry standards, and other safety precautions common to the refrigeration and air conditioning industry.

Comparison to other refrigerants in this end-use category: R-513A has an ODP of 0, which is comparable to other acceptable substitutes in the residential and light commercial air conditioning and heat pumps – self-contained units end-use category with ODPs ranging from 0 to less than 0.0004. R-513A which has a GWP of 630 is lower than or comparable to those of some acceptable substitutes in the same end-use category for which we are finding it acceptable, such as R-452B which has a GWP of 700 and HFC-32 which has a GWP of 675. R-513A has a GWP of 630, which is higher than those of other acceptable substitutes in this end-use category such as R-290, which has a GWP of 3, R-454A, which has a GWP of 240, R-454B, which has a GWP of 470, R-454C, which has a GWP of 150, and R-457A, which has a GWP of 140.

While other acceptable substitutes have lower GWPs, EPA is listing R-513A as acceptable in this end-use category recognizing it likely will be used only in certain self-contained units that use R-134a where other available options are not technically feasible. Self-contained units can include but are not limited to window units, packaged terminal air conditioners, packaged terminal heat pumps, portable room air conditioning units, and portable

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air conditioners used to cool commercial aircraft interiors while on the ground.²⁵ As a general matter, the replacements for most of the equipment in the residential and light commercial air conditioning and heat pumps end-use category use refrigerants that mimic the thermodynamic qualities and high pressure of R-410A which was the dominant refrigerant used for the majority of equipment types in this end-use category. There are, however, some specific applications where R-134a was used in self-contained units because of its unique thermodynamic properties that make it a better choice. For example, self-contained portable air conditioners used to cool commercial aircraft while on the ground currently use R-134a. This refrigerant is used because R-134a is optimized for equipment that use screw compressors and need to be able to operate at extremely high ambient temperatures with high humidity. R-513A's thermodynamic properties closely mimic those of R-134a, making it an important option for applications where R-134a is used. As noted above, self-contained portable air conditioners used to cool the aircraft interior while on the ground must function in a wide range of ambient temperatures and humidities, making R-513A an important option for this specific use. Other available refrigerant options with lower GWPs do not have the correct thermodynamic properties to fit the technical needs for this specific use. In addition, R-513A and R-134a are both low pressure refrigerants. As a result, R-513A could replace R-134a in equipment with minimal modifications but it is not expected to replace R-410A due to the extensive re-engineering required.

²⁵ These are all examples of equipment defined as “factory sealed appliances” in the UL 60335-2-40 standard for electrical heat pumps, air-conditioners, and dehumidifiers, in which all refrigerating system parts have been sealed tight during the manufacturing process. Other equipment that meets the UL definition of factory sealed appliances are also self-contained units.

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EPA expects that use of R-513A in residential and light commercial air conditioning and heat pumps will be limited to a narrow set of specific applications because it is likely to be used only in those few applications where R-134a is currently used in self-contained units and where other available options are not technically feasible. Therefore, EPA is listing this refrigerant as acceptable for use in the residential and light commercial air conditioning and heat pumps—self-contained units end-use category.

Flammability and toxicity risks are comparable to or lower than flammability and toxicity risks of other available substitutes in the same end-use category. For example, R-513A is non-flammable and has comparable or lower flammability risk compared to other acceptable refrigerants in this end-use category, such as the lower flammability refrigerants R-454B and R-454C. Toxicity risks can be minimized by use consistent with the AIHA's WEELs, ASHRAE's OEL, ASHRAE 15 and other industry standards, recommendations in the SDS, and other safety precautions common in the refrigeration and air conditioning industry.

Based on the considerations described above, EPA finds R-513A acceptable in new self-contained units in the residential and light commercial air conditioning end-use because it provides a lower-GWP alternative for this end-use category. R-513A does not pose greater overall environmental and human health risk than other available substitutes in the same end-use category.

B. Foam Blowing

1. Extruded Polystyrene (XPS) Blowing Agent Blends of 0 to 90 percent HFO-1336mzz(Z), 0 to 90 percent HFO-1234ze(E), 0 to 75 percent HFC-152a, and 0 to 90 percent CO₂

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EPA's decision: EPA finds blends of 0 to 90 percent HFO-1336mzz(Z), 0 to 90 percent

HFO-1234ze(E), 0 to 75 percent HFC-152a, and 0 to 90 percent CO₂ ("HFO-

1336mzz(Z)/HFO-1234ze(E)/HFC-152a/CO₂ blends") acceptable as a substitute for use

as a foam blowing agent in:

- Polystyrene: extruded boardstock and billet.

HFO-1336mzz(Z) is an HFO and is also called (Z)-1,1,1,4,4,4-hexafluorobut-2-ene or *cis*-1,1,1,4,4,4-hexafluorobut-2-ene (CAS Reg. No. 692-49-9); it also goes by the trade names of FEA-1100 or Formacel® 1100. HFO-1234ze(E) is an HFO and is also known as *trans*-1,3,3,3-tetrafluoroprop-1-ene (CAS Reg. No. 29118-24-9). HFC-152a is an HFC and is also called ethane, 1,1-difluoro (CAS Reg. No. 75-37-6). CO₂ has CAS Reg. No. 124-38-9.

You may find a copy of the applicant's submission, with CBI redacted, providing the required health and environmental information for this substitute in this end-use in the docket (EPA-HQ-OAR-2003-0118) at <https://www.regulations.gov> under the name, "SNAP Information Notice for Extruded Polystyrene Blend of 0 to 90% HFO-1336mzz(Z), 0 to 90% HFO-1234ze(E), 0 to 75% HFC-152a, and 0 to 90% CO₂ as a Foam Blowing Agent SNAP Submission Received August 7, 2023." EPA has performed an assessment to examine the health and environmental risks of this substitute. This assessment is available in the docket EPA-HQ-OAR-2003-0118:

- "Risk Screen on Substitutes for Use in Extruded Polystyrene Boardstock and Billet Foam Substitute: HFO-1336mzz(Z)/HFO-1234ze(E)/HFC-152a/CO₂ Blends."

Environmental information: These HFO-1336mzz(Z)/HFO-1234ze(E)/HFC-152a/CO₂ foam blowing agent blends have an ODP of 0. The components, HFO-1336mzz(Z), HFO-

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1234ze(E), HFC-152a, and CO₂ have GWPs of 2,²⁶ 1,²⁷ 124,²⁸ and 1, respectively. The GWPs of the blowing agent blends using these components range from 1 to 94. These reflect the composition ranges that result in the lowest GWP of 1 to the highest GWP of 94 given the GWP and range of percentages for each component. The components of the HFO-1336mzz(Z)/HFO-1234ze(E)/HFC-152a/CO₂ blends are excluded from EPA's regulatory definition of VOC under CAA regulations (see 40 CFR 51.100(s)) addressing the development of SIPs to attain and maintain the NAAQS.

Flammability information: The component HFC-152a is flammable at standard temperature and pressure as defined by standard test method ASTM E681. HFO-1336mzz(Z) and HFO-1234ze(E) are not flammable at standard temperature and pressure using the same method. However, at higher temperatures, such as the temperatures typical for extruding XPS, HFO-1234ze(E) may also be flammable, particularly at higher humidity levels.²⁹ HFO-1336mzz(Z)/HFO-1234ze(E)/HFC-152a/CO₂ blends anticipated to be used in manufacturing polystyrene: extruded boardstock and billet are flammable at the temperatures typical for extruding XPS.

Toxicity and exposure data: Potential health effects of exposure to this substitute include skin or eye irritation or frostbite. At sufficiently high concentrations, the substitute may cause irregular heartbeat. The substitute could cause asphyxiation if air is displaced by vapors in a

²⁶ WMO, 2022.

²⁷ WMO, 2022.

²⁸ Annex F to the Montreal Protocol.

²⁹ Bellair and Hood, 2019. Comprehensive evaluation of the flammability and ignitability of HFO-1234ze, R.J. Bellair and L. Hood, Process Safety and Environmental Protection 132 (2019) 273–284. Available online at doi.org/10.1016/j.psep.2019.09.033.

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confined space. These potential health effects are common to many foam blowing agents.

Exposure may be possible during the blowing of the foam if the foam manufacturer does not take standard precautions such as the use of personal protective equipment. EPA anticipates that these HFO-1336mzz(Z)/HFO-1234ze(E)/HFC-152a/CO₂ blends will be used consistent with the recommendations specified in the SDS.

The AIHA has established a WEEL of 1,000 ppm for HFC-152a as an 8-hr TWA. The WEEL committee of the OARS has established a WEEL of 500 ppm³⁰ for HFO-1336mzz(Z). OSHA has established a PEL of 5,000 ppm on an 8-hr TWA for CO₂. The manufacturer of HFO-1234ze(E) recommends an OEL of 800 ppm³¹ (8-hr TWA) for this chemical. EPA anticipates that users will be able to meet the AIHA and OARS WEELs, OSHA PEL, and manufacturer's OEL and will follow requirements and recommendations in the manufacturer's SDSs and other safety precautions common to the foam blowing industry, thereby addressing potential health risks.

Comparison to other foam blowing agents in this end-use: These HFO-1336mzz(Z)/HFO-1234ze(E)/HFC-152a/CO₂ blends have an ODP of 0, comparable to other acceptable substitutes in the polystyrene: extruded boardstock and billet end-use, such as HFC-152a, HFO-1234ze(E), methyl formate, and CO₂. These HFO-1336mzz(Z)/HFO-1234ze(E)/HFC-152a/CO₂ blends' GWPs from 1 to 94 are lower than or comparable to those of other acceptable substitutes in the same end-use for which we are finding it acceptable. Examples include HFC-152a, HFO-1234ze(E), light saturated hydrocarbons C3-C6, and methyl

³⁰ Cis-1,1,1,4,4,4-hexafluoro-2-butene (HFO-1336mzz-Z) (2018). *Toxicology and Industrial Health*. 2019;35(3):180-188. doi:10.1177/0748233719825530.

³¹ ASHRAE, 2022.

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formate, with respective GWPs of 124,³² 1,³³ less than 4,³⁴ and 11.³⁵ Depending on the specific composition, the blend used may have a higher GWP than that of some individual chemicals that are acceptable substitutes in this end-use that are more flammable (*e.g.*, HFO-1234ze(E)) or are less able to meet standard specifications (*e.g.*, ASTM C578) than the blends because of properties such as solvency in the plastic resin (*e.g.*, HFO-1336mzz(Z)) or contributions to insulation value (*e.g.*, CO₂, water).

Flammability and toxicity risks are comparable to or lower than flammability and toxicity risks of other available substitutes in the same end-use. Toxicity risks can be minimized by use consistent with the AIHA's and OARS's WEELs, OSHA's PEL, recommendations in the SDS, and other safety precautions common in the foam blowing industry.

Based on the considerations described above, EPA finds blends of 0 to 90 percent HFO-1336mzz(Z), 0 to 90 percent HFO-1234ze(E), 0 to 75 percent HFC-152a, and 0 to 90 percent CO₂ acceptable in the polystyrene: extruded boardstock and billet end-use because they do not pose greater overall environmental and human health risk than other available substitutes in the same end-use.

List of Subjects in 40 CFR Part 82

Environmental protection, Administrative practice and procedure, Air pollution control, Reporting and recordkeeping requirements.

³² Annex F to the Montreal Protocol.

³³ WMO, 2022.

³⁴ IPCC, 2007.

³⁵ WMO, 2022.

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Dated: _____

Paul M. Gunning, Director,
Office of Atmospheric Protection.

APPENDIX A: SUMMARY OF DECISIONS FOR NEW ACCEPTABLE SUBSTITUTES

Refrigeration and Air Conditioning

End-Use	Substitute	Decision	Further Information ¹
Cold storage warehouses (retrofit equipment only)	R-471A	Acceptable	This substitute is a blend of 78.7 percent hydrofluoroolefin (HFO)-1234ze(E), which is also known as <i>trans</i>-1,3,3,3-tetrafluoroprop-1-ene; (Chemical Abstracts Service Registry Number [CAS Reg. No.] 29118-24-9); 17.0 percent HFO-1336mzz(E), also known as <i>trans</i>-1,1,1,4,4,4-hexafluoro-2-butene (CAS Reg. No. 66711-86-2); and 4.3 percent HFC-227ea, which is also known as 1,1,1,2,3,3,3-heptafluoropropane (CAS Reg. No. 431-89-0). R-471A has a global warming potential (GWP) of 144 and an ozone depletion potential (ODP) of 0. The blend is not flammable as it has an American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) flammability classification of “1”. ASHRAE has adopted an occupational exposure limit (OEL) for the blend of 710 ppm on an eight-hour time-weighted average (8-hr TWA). For the components of R-471A, the Workplace Environmental Exposure Limit (WEEL) Committee of the Occupational Alliance for Risk Science (OARS) has established a WEEL of 400 ppm on an 8-hr TWA for HFO-1336mzz(E), the AIHA has established a WEEL of 1,000 ppm for HFC-227ea (8-hr TWA), and ASHRAE has adopted an OEL of 800 ppm on an 8-hr TWA for HFO-1234ze(E).

End-Use	Substitute	Decision	Further Information ¹
Cold storage warehouses (<i>retrofit equipment only</i>)	R-480A	Acceptable	This substitute is a weighted blend of 5 percent CO₂, 86 percent HFO-1234ze(E), which is also known as <i>trans</i>-1,3,3,3-tetrafluoroprop-1-ene CAS Reg. No. 29118-24-9), and 9 percent HFC-227ea, which is also known as 1,1,1,2,3,3,3-heptafluoropropane (CAS Reg. No. 431-89-0). R-480A has a GWP of 291 and an ODP of 0. The blend is not flammable as it has an ASHRAE flammability classification of “1.” ASHRAE has adopted an OEL for the blend of 900 ppm (8-hr TWA). For the components of R-480A, the Occupational Safety and Health Administration (OSHA) has established a permissible exposure limit (PEL) for CO₂ of 5,000 ppm on an 8-hr TWA, AIHA has established a WEEL of 1,000 ppm for HFC-227ea (8-hr TWA), and ASHRAE has adopted an OEL of 800 ppm on an 8-hr TWA for HFO-1234ze(E).
Commercial ice machines (<i>retrofit equipment only</i>)	R-480A	Acceptable	This substitute is a weighted blend of 5 percent CO₂, 86 percent HFO-1234ze(E), which is also known as <i>trans</i>-1,3,3,3-tetrafluoroprop-1-ene CAS Reg. No. 29118-24-9), and 9 percent HFC-227ea, which is also known as 1,1,1,2,3,3,3-heptafluoropropane (CAS Reg. No. 431-89-0). R-480A has a GWP of 291 and an ODP of 0. The blend is not flammable as it has an ASHRAE flammability classification of “1.” ASHRAE has adopted an OEL for the blend of 900 ppm (8-hr TWA). For the components of R-480A, OSHA has established a PEL for CO₂ of 5,000 ppm on an 8-hr TWA, AIHA has established a WEEL of 1,000 ppm for HFC-227ea (8-hr TWA), and ASHRAE has adopted an OEL of 800 ppm on an 8-hr TWA for HFO-1234ze(E).

End-Use	Substitute	Decision	Further Information ¹
Industrial process refrigeration (<i>retrofit equipment only</i>)	R-471A	Acceptable	This substitute is a blend of 78.7 percent HFO-1234ze(E), which is also known as <i>trans</i>-1,3,3,3-tetrafluoroprop-1-ene; (CAS Reg. No. 29118-24-9); 17.0 percent HFO-1336mzz(E), also known as <i>trans</i>-1,1,1,4,4,4-hexafluoro-2-butene (CAS Reg. No. 66711-86-2); and 4.3 percent HFC-227ea, which is also known as 1,1,1,2,3,3,3-heptafluoropropane (CAS Reg. No. 431-89-0). R-471A has a GWP of 144 and an ODP of 0. The blend is not flammable as it has an ASHRAE flammability classification of “1”. ASHRAE has adopted an OEL for the blend of 710 ppm (8-hr TWA). For the components of R-471A, OARS has established a WEEL of 400 ppm on an 8-hr TWA for HFO-1336mzz(E), AIHA has established a WEEL of 1,000 ppm for HFC-227ea (8-hr TWA), and ASHRAE has adopted an OEL of 800 ppm on an 8-hr TWA for HFO-1234ze(E).
Positive displacement chillers (<i>retrofit equipment only</i>)	R-480A	Acceptable	This substitute is a weighted blend of 5 percent CO₂, 86 percent HFO-1234ze(E), which is also known as <i>trans</i>-1,3,3,3-tetrafluoroprop-1-ene CAS Reg. No. 29118-24-9), and 9 percent HFC-227ea, which is also known as 1,1,1,2,3,3,3-heptafluoropropane (CAS Reg. No. 431-89-0). R-480A has a GWP of 291 and an ODP of 0. The blend is not flammable as it has an ASHRAE flammability classification of “1.” ASHRAE has adopted an OEL for the blend of 900 ppm (8-hr TWA). For the components of R-480A, the Occupational Safety and Health Administration (OSHA) has established a permissible exposure limit (PEL) for CO₂ of 5,000 ppm on an 8-hr TWA, AIHA has established a WEEL of 1,000 ppm for HFC-227ea (8-hr TWA), and ASHRAE has adopted an OEL of 800 ppm on an 8-hr TWA for HFO-1234ze(E).

End-Use	Substitute	Decision	Further Information ¹
Refrigerated transport (<i>retrofit equipment only</i>)	R-480A	Acceptable	This substitute is a weighted blend of 5 percent CO₂, 86 percent HFO-1234ze(E), which is also known as <i>trans</i>-1,3,3,3-tetrafluoroprop-1-ene CAS Reg. No. 29118-24-9), and 9 percent HFC-227ea, which is also known as 1,1,1,2,3,3,3-heptafluoropropane (CAS Reg. No. 431-89-0). R-480A has a GWP of 291 and an ODP of 0. The blend is not flammable as it has an ASHRAE flammability classification of “1.” ASHRAE has adopted an OEL for the blend of 900 ppm (8-hr TWA). For the components of R-480A, OSHA has established a PEL for CO₂ of 5,000 ppm on an 8-hr TWA, AIHA has established a WEEL of 1,000 ppm for HFC-227ea (8-hr TWA), and ASHRAE has adopted an OEL of 800 ppm on an 8-hr TWA for HFO-1234ze(E).
Residential and light commercial air conditioning and heat pumps – self-contained units (<i>new equipment only</i>)	R-513A	Acceptable	This HFC-134a/HFO-1234yf blend R-513A has an ODP of 0. Its components include HFC-134a which has a GWP of 1,430 and HFO-1234yf which has a GWP of 1. If these values are weighted by mass percentage, then the blend would have a GWP of 630. All components of the blends are excluded from EPA’s regulatory definition of VOC under CAA regulations (see 40 CFR 51.100(s)). ASHRAE has assigned R-513A a flammability class of “1,” meaning it does not propagate a flame under standard test conditions. ASHRAE has adopted an OEL for the blend R-513A of 650 ppm (8-hr TWA). The AIHA has established WEELs of 1000 ppm for HFC-134a and of 500 ppm for HFO-1234yf, both as an 8-hr TWA.

End-Use	Substitute	Decision	Further Information ¹
Retail food refrigeration – Refrigerated food processing and dispensing equipment (<i>retrofit equipment only</i>)	R-471A	Acceptable	This substitute is a blend of 78.7 percent HFO-1234ze(E), which is also known as <i>trans</i>-1,3,3,3-tetrafluoroprop-1-ene; (CAS Reg. No. 29118-24-9); 17.0 percent HFO-1336mzz(E), also known as <i>trans</i>-1,1,1,4,4,4-hexafluoro-2-butene (CAS Reg. No. 66711-86-2); and 4.3 percent HFC-227ea, which is also known as 1,1,1,2,3,3,3-heptafluoropropane (CAS Reg. No. 431-89-0). R-471A has a GWP of 144 and an ODP of 0. The blend is not flammable as it has an ASHRAE flammability classification of “1”. ASHRAE has established an OEL for the blend of 710 ppm on an eight-hour time-weighted average (8-hr TWA). For the components of R-471A, OARS has established a WEEL of 400 ppm on an 8-hr TWA for HFO-1336mzz(E), AIHA has established a WEEL of 1,000 ppm for HFC-227ea (8-hr TWA), and ASHRAE has adopted an OEL of 800 ppm on an 8-hr TWA for HFO-1234ze(E).
Retail food refrigeration – Remote condensing units (<i>retrofit equipment only</i>)	R-471A	Acceptable	This substitute is a blend of 78.7 percent HFO-1234ze(E), which is also known as <i>trans</i>-1,3,3,3-tetrafluoroprop-1-ene; (CAS Reg. No. 29118-24-9); 17.0 percent HFO-1336mzz(E), also known as <i>trans</i>-1,1,1,4,4,4-hexafluoro-2-butene (CAS Reg. No. 66711-86-2); and 4.3 percent HFC-227ea, which is also known as 1,1,1,2,3,3,3-heptafluoropropane (CAS Reg. No. 431-89-0). R-471A has a GWP of 144 and an ODP of 0. The blend is not flammable as it has an ASHRAE flammability classification of “1”. ASHRAE has established an OEL for the blend of 710 ppm (8-hr TWA). For the components of R-471A, OARS has established a WEEL of 400 ppm on an 8-hr TWA for HFO-1336mzz(E), AIHA has established a WEEL of 1,000 ppm for HFC-227ea (8-hr TWA), and ASHRAE has adopted an OEL of 800 ppm on an 8-hr TWA for HFO-1234ze(E).

End-Use	Substitute	Decision	Further Information ¹
Retail food refrigeration – Supermarket systems (<i>retrofit equipment only</i>)	R-471A	Acceptable	This substitute is a blend of 78.7 percent HFO-1234ze(E), which is also known as <i>trans</i>-1,3,3,3-tetrafluoroprop-1-ene; (CAS Reg. No. 29118-24-9); 17.0 percent HFO-1336mzz(E), also known as <i>trans</i>-1,1,1,4,4,4-hexafluoro-2-butene (CAS Reg. No. 66711-86-2); and 4.3 percent HFC-227ea, which is also known as 1,1,1,2,3,3,3-heptafluoropropane (CAS Reg. No. 431-89-0). R-471A has a GWP of 144 and an ODP of 0. The blend is not flammable as it has an ASHRAE flammability classification of “1”. ASHRAE has established an OEL for the blend of 710 ppm (8-hr TWA). For the components of R-471A, OARS has established a WEEL of 400 ppm on an 8-hr TWA for HFO-1336mzz(E), AIHA has established a WEEL of 1,000 ppm for HFC-227ea (8-hr TWA), and ASHRAE has adopted an OEL of 800 ppm on an 8-hr TWA for HFO-1234ze(E).
Water coolers (<i>retrofit equipment only</i>)	R-480A	Acceptable	This substitute is a weighted blend of 5 percent CO₂, 86 percent HFO-1234ze(E), which is also known as <i>trans</i>-1,3,3,3-tetrafluoroprop-1-ene CAS Reg. No. 29118-24-9), and 9 percent HFC-227ea, which is also known as 1,1,1,2,3,3,3-heptafluoropropane (CAS Reg. No. 431-89-0). R-480A has a GWP of 291 and an ODP of 0. The blend is not flammable as it has an ASHRAE flammability classification of “1.” ASHRAE has adopted an OEL for the blend of 900 ppm (8-hr TWA). For the components of R-480A, OSHA has established a PEL for CO₂ of 5,000 ppm on an 8-hr TWA, AIHA has established a WEEL of 1,000 ppm for HFC-227ea (8-hr TWA), and ASHRAE has adopted an OEL of 800 ppm on an 8-hr TWA for HFO-1234ze(E).

¹ See recommendations in the manufacturer’s SDS and guidance for all listed refrigerants.

Foam Blowing

End-Use	Substitute	Decision	Further Information ¹
Polystyrene: Extruded boardstock and billet	Extruded polystyrene (XPS) foam blowing agent blends of 0 to 90 percent HFO- 1336mzz(Z), 0 to 90 percent HFO- 1234ze(E), 0 to 75 percent HFC-152a, and 0 to 90 percent CO ₂	Acceptable	HFO-1234ze(E) is also known as <i>trans</i>-1,3,3,3-tetrafluoroprop-1-ene (Chemical Abstracts Service Registry Number [CAS Reg. No.] 29118-24-9). HFO-1336mzz(Z) is also known as (Z)-1,1,1,4,4,4-hexafluoro-2-butene and <i>cis</i>-1,1,1,4,4,4-hexafluoro-2-butene (CAS Reg. No. 692-49-9). HFC-152a is also known as 1,1-difluoroethane (CAS Reg. No. 75-37-6). CO₂ has CAS Reg. No. 124-38-9. These blends have 100-year GWPs from 1 to about 94, depending on the specific composition. Blends of these compounds anticipated to be used in manufacturing are flammable. The AIHA has established a WEEL of 1,000 ppm for HFC-152a on an eight-hour Time-Weighted Average (8-hr TWA). The OARS has established a WEEL of 500 ppm (8-hr TWA) for HFO-1336mzz(Z). The manufacturer of HFO-1234ze(E) has established an OEL of 800 ppm (8-hr TWA) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers has adopted an OEL of 800 ppm (8-hr TWA) for this compound. The U.S. OSHA has established a PEL of 5,000 ppm on an 8-hr TWA for CO₂.

¹ See recommendations in the manufacturer's SDS and guidance for all listed foam blowing agents.