



Prohibitions on Use of Certain Hydrofluorocarbons in Stationary Refrigeration, Stationary Air-conditioning, and Other End-Uses.

Application for a Variance from the requirements of California Code of Regulations, Title 17, sections 95374 and 95375.

Note: the requirements for a variance application are listed in California Code of Regulations, Title 17, section 95378, Use of this application template is optional.

- A. Name of applicant: The Boeing Company (Boeing)
Ownership status (e.g., parent, subsidiary): Publicly held
Address: 14441 Astronautics Lane, Huntington Beach, CA
Telephone number: 714-896-3178
E-mail address: HBEHS@boeing.com
- B. Please describe your business activity or product description.
Use of high-pressure polyurethane spray foam containing HFC-245fa for space vehicle research and development in support of the NASA Space Launch System (SLS) program.
- C. Please describe your relationship to the product.
End user of spray foam insulation for NASA SLS research, development, and qualification.
- D. List the specific section(s) of the regulation from which a variance is being requested.
California Code of Regulations, Title 17, Section 95374, Table 2, Foams, Rigid polyurethane (PU) high-pressure two-component spray foam.
- E. Provide an explanation and description of the reasons for seeking a variance.
Boeing requests a variance to continue using HFC-245fa-based high-pressure spray foam insulation due to the absence of a qualified alternative. Per the EPA's exemption in Federal Register Vol. 88, No. 204 (October 24, 2023), foams containing HFC-245fa are permitted for space vehicle applications. Because of the EPA exemption, NASA is not revising program requirements or specifications to mandate a replacement foam free of HFC-245fa, nor is it funding the SLS program to develop and qualify such a foam. Consequently, Boeing must continue using the HFC-245fa-based foam to comply with program requirements. If the NASA SLS program approves a lower risk substitute for HFC-245fa spray foam, Boeing will transition to using that substitute.
- F. Identify what type of variance is being requested:
 Impossibility (the Applicant exercised best efforts but still was unable to comply with the regulatory requirements of the regulation for reasons beyond his or her control despite exercising foresight to prevent the noncompliance.)



Force Majeure Event (a sudden and unforeseeable event involving a clear danger, demanding action to prevent or mitigate the loss of, or damage to, life, health, property, or essential public services, arising from causes beyond the control of the Applicant, which delays or prevents the performance of any obligation under the regulation, despite the Applicant's best efforts to fulfill the obligation. This includes events where the local government, State of California, or federal government issues a declaration of emergency, such as war, wildfires, floods, hurricanes, tornadoes, earthquakes, volcanic eruptions, and pandemics. This does not include negligent acts or the Applicant's financial inability to perform that is unrelated to an event as defined in this section.)

Both Impossibility and Force Majeure Event

G. If seeking an Impossibility variance please provide clear and convincing evidence demonstrating how all of the following Impossibility variance criteria have been met:

1. A lower risk substitute is not currently or potentially available.

A high-pressure spray foam compliant with California Code of Regulations, Title 17, Section 95374 (which prohibits foams containing HFC-245fa) has not been approved by NASA's SLS program. Consequently, Boeing must continue using the HFC-245fa-based formulation to meet program requirements. Materials for the SLS, such as this high-pressure spray foam, are qualified to specifications that document specific requirements and standards for materials, processes, and products. These specifications ensure consistency, quality, and safety in the design and production of aerospace components. As a contractor to NASA, any updates to these specifications require not only Boeing engineering approval but also NASA approval. In 2019, Boeing received a contract from NASA which included funding for an eight-year project to develop and qualify a spray foam free of HFC-245fa. The planned timeline for this development and qualification effort was as follows: Development (2 years), Qualification (2 years), Engineering Documentation Updates (1.5 years), Scale-up and Verification and Validation (2.5 years). Boeing experienced numerous technical issues identifying a suitable alternative during the three plus year development phase, and no foam free of HFC-245fa was identified that met program requirements. In advance of the EPA's NPRM for the "Phasedown of Hydrofluorocarbons: Restrictions on the Use of Certain Hydrofluorocarbons Under the American Innovation and Manufacturing Act of 2020" NASA communicated to EPA that it had not approved the use of any foam substitute material due to the absence of a readily available, drop-in replacement. In response to the supporting information provided by NASA, EPA included exemption language under the final rule, asserting that spray and pour foams that are for use in space vehicles as defined in §84.3, are not subject to the use restriction. In response to this exemption, the development and qualification effort for an HFC-245fa-free spray foam was discontinued while still in the development phase. If EPA had not granted this exception, the SLS program would have been suspended following the



implementation of the foam prohibition until an alternative was identified, given the critical role the foam plays in protecting all structural components of SLS during launch and flight. As such, it is impossible for Boeing to continue to work on the SLS program in California without a variance from CARB.

2. An exemption will not increase the overall risk to human health or the environment.

Boeing uses a minimal amount of spray foam containing HFC-245fa and this step in the SLS development process is infrequent. Boeing estimates that one kit per year of the two-part spray foam is needed to ensure adequate support for the SLS program through the duration of the variance, resulting in approximately 15.54 MTCO_{2e} per year and 217.56 MTCO_{2e} in total over the length of the requested variance (calculations in Section N). Given the limited amount and infrequency in use of HFC-245fa in the SLS development process, as well as our plan to obtain 217.56 MTCO_{2e} of verified carbon offsets (as discussed in Section P) to cover potential emissions as part of the variance, the exemption will not increase the overall risk to human health or the environment.

The Boeing spray foam process has protections to minimize risk to human health. All personnel who work spray foam operations are provided with proper personal protective equipment (PPE), and the spray operations take place in a spray booth that is exhausted outside the building. These controls reduce the likelihood of personnel exposure to HFCs during the spray operation.

3. The Applicant has used best efforts to anticipate and address the impossibility and any potential noncompliance.

In 2019, the NASA SLS program received a federal contract which included funding for an eight-year project to develop and qualify a spray foam free of HFC-245fa. This effort was discontinued after the EPA issued an exemption for space vehicle foams containing HFC-245fa in Federal Register Vol. 88, No. 204 (October 24, 2023). As a contractor to NASA, Boeing is required to use qualified spray foam material that meets SLS requirements and therefore must continue to use foam containing HFC-245fa as no qualified alternative exists.

H. If seeking a Force Majeure Event variance please provide clear and convincing evidence demonstrating how all of the following Force Majeure variance criteria has been met:

1. Non-compliance is due to a Force Majeure event.

N/A

2. The Applicant has used best efforts to anticipate and address any force majeure event and any potential noncompliance, including minimizing any adverse effects of the greenhouse gas emissions related to noncompliance.

N/A



- I. Please attach supporting documentation for attributing noncompliance to Impossibility or a Force Majeure Event. Supporting documentation must be written in English. Please list the supporting documentation that is attached to this application.

None

- J. Provide a description of all efforts made to timely fulfill the requirements of the section(s) from which a variance is being requested.

When NASA was alerted that the EPA was phasing out use of certain HFC blowing agents, including HFC-245fa, under its Significant New Alternatives Policy (SNAP) Program, in 2016 and again in 2018, NASA issued a technical justification for the Continued Use of HFC-245fa Blown Foams. The final rule [81 FR 22809, 12/1/2016], which went into effect 01/03/2017, included a “narrowed use limit” for certain space and aeronautics related foam applications. Under this time-limited exception, SLS was allowed to continue its current uses of HFC-245fa-blown spray and pour foams through 01/01/2025. To qualify for this continued foam usage, SLS must document the results of the technical investigation of alternatives to demonstrate regulatory compliance. Specifically, documentation must include descriptions of:

- Process or product in which the substitute is needed
- Substitutes examined and rejected
- Reason for rejection of other alternatives, e.g., performance, technical or safety standards
- Anticipated date other substitutes will be available and projected time for switching

Knowing there could be a ban or a phase-down of the HFC-245fa blowing agent by 2025, NASA began to review alternates and down-select materials that could be of future use in lieu of HFC-245fa-blown spray and pour foams.

In 2019, Boeing received a contract from NASA which included funding for an eight-year project to develop and qualify a spray foam free of HFC-245fa. The planned timeline for this development and qualification effort was as follows: Development (2 years), Qualification (2 years), Engineering Documentation Updates (1.5 years), Scale-up and Verification and Validation (2.5 years). Boeing experienced numerous technical issues identifying a suitable alternative during the three plus year development phase, and no foam free of HFC-245fa could be identified that met program requirements. The effort to develop and qualify a suitable alternative was discontinued by NASA after the EPA issued an exemption for space vehicle foams containing HFC-245fa in Federal Register Vol. 88, No. 204 (October 24, 2023).

As part of our contractual obligation, we are required to notify the Government about obsolescent material and provide them with watch lists complete with recommendations for resolutions. We continue to alert NASA to the risk of an eventual ban and limited production by suppliers of our spray foam with HFC-245fa. Until NASA gives us contractual action and direction, Boeing is bound by the provisions of its current contract with NASA to



exclusively use NCFI 16-009 spray-on foam insulation (SOFI) containing HFC-245fa on the NASA SLS program.

The contractual flow-down for this requirement is shown below:

NASA Government Contract

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NASA Technical Justification

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Boeing Source Control Drawings

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Boeing Material Specification for Foam, Spray-on, Polyisocyanurate

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Space Launch System hardware

- K. Please provide the length of the variance requested as well as the earliest date when compliance will be achieved.

Variance is requested until January 1, 2040. Since the EPA has allowed the continued use of HFC-245fa containing foams for space vehicles, Boeing is unsure when NASA will fund a task for the development and qualification of foam compliant with California Code of Regulations, Title 17, Section 95374. The proposed variance length assumes the NASA SLS program funds the development and qualification of a compliant foam by 2030, which affords Boeing 10 years to develop and qualify a compliant foam. This timeline adds a two-year buffer to the original eight-year development and qualification timeline, which takes into account issues encountered during the previous effort that took place from 2019 to 2023. In the event Boeing anticipates using HFC-245fa beyond January 1, 2040, Boeing will inform CARB as soon as possible.

- L. Provide a compliance plan which describes in detail how, if a variance is granted, compliance will be achieved as expeditiously as possible including all of the following:

- (i) The method by which compliance will be achieved

Compliance will be achieved through the development and qualification of an HFC-245fa free high-pressure spray foam. As discussed in Section J, this can only be accomplished through a NASA-funded contractual development and qualification effort, which is expected to take at least eight years once initiated. It consists of the following phases: Development (2 years), Qualification (2 years), Engineering Documentation Updates (1.5 years), and Scale-up and Verification and Validation (2.5 years).

- (ii) Milestone dates

As discussed in Section P, Boeing plans to obtain 217.56 MTCO₂e of carbon offsets within one year of being granted a variance to account for GHG emissions from the continued use of qualified HFC-245fa spray foam. Milestone dates for developing and qualifying an HFC-245fa free spray foam for the SLS program are dependent on



NASA SLS funding and approval of the qualified alternative. Boeing expects this development and qualification process to take at least eight years after it is initiated, and is requesting a variance until January 1, 2040, to account for this process. The schedule for the development and qualification program is described in Section L(i).

(iii) Milestone achievements

The first milestone achievement will be obtaining carbon offsets to account for GHG emissions from the continued use of qualified HFC-245fa spray foam. The second potential milestone will be transitioning from the NASA SLS qualified HFC-245fa spray foam to a lower risk substitute. A rough estimate of milestones for this development and qualification effort (which assumes an alternative that meets engineering specifications is identified) is as follows: Development (2years), Qualification (2 years), Engineering Documentation Updates (1.5 years), Scale-up and Verification and Validation (2.5 years). This timeline could be significantly extended based on challenges encountered in any step of the process (which was experienced when Boeing initiated the effort in 2019) and is contingent on NASA having the budget and willingness to continue funding the effort.

- M. Provide a description of the damage or harm that will result to the Applicant from immediate compliance with the regulatory requirements, including if compliance would result in an extraordinary economic hardship, such as closure of the entire facility or loss of a large portion or the revenue:

Boeing in Huntington Beach, California is the sole research and development lab supporting the SLS program, and restricting the ability to address emergent foam spray needs by prohibiting the use of HFC-245fa-based foam will prevent Boeing from fulfilling contractual obligations to the NASA SLS customer. Not only could this lead to termination of contract and loss of local jobs in California, but this will also introduce significant human and vehicle safety risks to the SLS program.

- N. If applying for an Impossibility variance please provide quantification of current Greenhouse Gas (GHG) emissions resulting from normal business-as-usual operations as it directly relates to the continued use of any substance in end-uses listed in Table 1, section 95374 (a); Table 2, section 95374 (b); Table 3, section 95374 (c); or Table 4, section 95374 (d). This includes quantification of the direct GHG emissions resulting from refrigerant leaks or HFC emissions and indirect GHG emissions resulting from energy use (where applicable), with all calculations, based on the average lifetime of the equipment or product that will continue to use prohibited substances. Applicant must include all calculations used to calculate GHG emissions estimates, including emission factors (i.e., charge size as defined in section 95373, leak rate as defined in *40 C.F.R. Part 82.152*, and refrigerant used over the average lifetime of the equipment, system, or product). Please see the bottom of this application template for an example calculation.

Boeing estimates that one kit per year of the two-part spray foam insulation is needed to ensure adequate support for the SLS program through the duration of the variance. The



projected annual usage is included in Table 1 and is based on specific gravity, weight percent, mix ratio and kit container size of the two-part spray foam insulation. The average annual leak rate emissions are included in Table 2 and are based on an average lifetime for parts in a research and development setting of one year. This lifetime encompasses part creation (foam spraying), fabrication into coupons, and destructive testing. The end-of-life emissions are included in Table 3. The emissions factors identified in Table 2 and Table 3 were obtained from CARB ISOR Appendix B. The total annual emissions are included in Table 4 and the cumulative emissions for the duration of the variance are included in Table 5.

Table 1: Projected Annual HFC-245fa Usage

Component	S.G.	HFC-245fa (wt %)	Mix Ratio	Container Size (gal)	HFC-245fa (lb)
A	1.24	4	2	55	46
B	1.18	30	1	55	162
Total					208

$$\text{HFC-245fa (lb)} = \text{S.G.} \times \rho_{\text{H}_2\text{O}} \left(\frac{\text{lb}}{\text{gal}} \right) \times \text{wt\%}_{\text{HFC-245fa}} \times \text{Mix Ratio} \times \text{Container Size (gal)}$$

Table 2: Average Annual Leak Rate Emissions

HFC-245fa (lb)	Average Lifetime (yr)	Average Annual Leak Rate (% loss) ¹	Leak Rate Emissions (lb)
208	1	1	2.08

$$\text{Leak Rate Emissions (lb)} = \text{HFC-245fa (lb)} \times \text{Average Lifetime (yr)} \times \text{Annual leak rate \%}$$

Table 3: End-of-Life Emissions

HFC-245fa (lb)	Average Loss Rate at End-of-Life (% loss)	End-of-Life Emissions (lb)
208	15	31.18

$$\text{End of Life Emissions (lb)} = \text{HFC-245fa (lb)} \times \text{End-of-Life leak rate \%}$$

Table 4: Annual CO₂e Emissions

Leak Rate Emissions (lb)	End-of-Life Emissions (lb)	Total Emissions (lb)	GWP	CO ₂ e Emissions (MT/yr)
2.08	31.18	33.26	1030	15.54

$$\text{CO}_2\text{e (MT/yr)} = \frac{[\text{Leak Rate Emissions (lb)} + \text{End-of-life Emissions (lb)}] \times \text{GWP}}{2203.62 \text{ lb/MT}}$$

Table 5: Variance Cumulative CO₂e Emissions

Variance Length (yr)	CO ₂ e Emissions (MT/yr)	Cumulative CO ₂ e Emissions (MT)
14	15.54	217.56



- O. Provide a description of any negative impacts to human health or the environment that may result from the granting of a variance.

Boeing acknowledges that HFC-245fa and other greenhouse gas emissions cause negative impacts to human health and the environment. To minimize impacts to the environment, Boeing plans to obtain carbon offsets as discussed in Section P. To minimize the risk to human health, the engineering and PPE controls described in Section G will continue to be followed during spray foam operations.

- P. Provide a mitigation plan that demonstrates how you will reduce excess GHG emissions to a level equal to or below what would have been emitted had you been in compliance and how you will mitigate any negative impacts to human health or the environment. You must include all calculations used to calculate GHG emission estimates including emission factors (i.e., charge size as defined in section 95373, leak rate as defined in *40 C.F.R. Part 82.152*, and refrigerant used over the average lifetime of the equipment, system, or product). This may include an analysis of prohibited substances, efforts to reduce leaks or venting of prohibited substances, and options to recycle or destroy high-Global Warming Potential refrigerants.

To mitigate excess GHG emissions from continued spray foam usage, Boeing will obtain 217.56 MTCO_{2e} of carbon offsets from a verified provider, which is equivalent to the estimated total amount of CO_{2e} emissions for the duration of the variance. Please refer to Section N for these calculations.

- Q. Provide a detailed explanation of efforts that may be implemented to curtail noncompliance in lieu of obtaining a variance

There is not a spray foam free of HFC-245fa that is qualified by NASA for use on the SLS program, therefore there are no actions Boeing can take to curtail noncompliance. The only way to comply would be to stop spraying HFC-245fa foam, which could lead to termination of the SLS contract, subsequent loss of local jobs in California, and the introduction of significant human and vehicle safety risks to the SLS program.

- R. By signing below, you (the Applicant) certify under penalty of perjury that you are a Responsible Official with full authority to submit the application and implement any provision of an Executive Order, and that all information provided is true and accurate to the best of your knowledge, after conducting due diligence. (Applications without this certification will be automatically denied.)

Signature 

David Herman

Date 3/25/2026



- S. Submit your application and documentation relating to the variance to CARB at the following email address:
HFCREDUCTION@ARB.CA.GOV

- T. Any Applicant submitting information to the Executive Officer You may claim information as “confidential” by clearly identifying it as “confidential.” Any claim of confidentiality must be based on your belief that the information marked as confidential is either trade secret or otherwise exempt from public disclosure under the California Public Records Act (*Government Code, section 6250 et seq.*). All such requests for confidentiality shall be handled in accordance with the procedures specified in *California Code of Regulations, title 17, sections 91000 to 91022.*



Example Emission Calculation

Company X will produce 200 vending machines, and each machine will include 0.7 lbs. of HFC-134a. The average annual leak rate is 0.3%, and the average loss rate at end-of-life is 98.5%. The average lifetime is 15 years. The IPCC AR4, 100-year GWP value for HFC-134a is 1,430. Emission factors were obtained from

<https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2018/casnapp/isorappb.pdf>.

Average annual leak rate emissions

$$200 \text{ vending machines} \times 0.7 \text{ lbs} \times 0.3\% \times 1,430 \text{ GWP} \times 15 \text{ years} = 9,009 \text{ lbs. CO}_{2e}$$

End-of-Life emissions

$$200 \text{ vending machines} \times 0.7 \text{ lbs} \times 98.5\% \times 1,430 \text{ GWP} = 197,197 \text{ lbs. CO}_{2e}$$

Total emissions

$$197,197 \text{ lbs. CO}_{2e} + 9,009 \text{ lbs. CO}_{2e} = 206,206 \text{ lbs. CO}_{2e}$$

Convert to metric tons

$$1 \text{ metric ton} = 2204.62 \text{ lbs.}$$

$$206,206 \text{ lbs. CO}_{2e} / 2204.62 \text{ lbs} = 93.53 \text{ MTCO}_{2e}$$