VDMA

ENVIRONMENT AND SUSTAINABILITY

Application for a temporary exemption pursuant to Article 11(5) of EU Regulation 2024/573

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Introduction

The mechanical and plant engineering industry provides the key technologies for the energy transition, the industry of the future and a functioning circular economy. This makes it a crucial part of the solution in the fight against climate change. The industry can actively contribute to climate protection in many ways – through technological innovations, efficiency improvements and the facilitation of sustainable processes in almost all sectors of the economy. This makes mechanical and plant engineering a key player in climate protection. It provides the “tools” that enable companies and societies to operate more sustainably – from energy generation and production to mobility. Without innovative machinery and equipment, a climate-neutral future is hardly conceivable.

With this document, the VDMA submits a substantiated application for a temporary exemption pursuant to Article 11(5) of Regulation (EU) 2024/573[1] .
Where alternatives are not available or cannot be used for technical or safety reasons, or where the use of such alternatives would entail disproportionate costs, it is possible for the Commission to authorise an exemption to allow the placing on the market of such products and equipment for a maximum period of 4 years. It is also possible to renew that exemption if, after assessment of a new substantiated exemption request, the Commission, through the committee procedure, concludes that alternatives are still not available.

The purpose of this exemption request is to temporarily exempt the requirements for **Embedded Refrigerant-Using Subsystems (ERUS) and the machinery and equipment in which these subsystems are integrated** from Regulation (EU) 2024/573. To this end, a specific product category is defined and it is demonstrated how disproportionate costs can arise within this category. This is justified by disproportionate implementation costs and conflicts between the requirements of the EU F-Gas Regulation, the EU Machinery Directive and the PFAS restriction proposal under the REACH Regulation.
With this document, the VDMA is applying for a corresponding temporary exemption for the proposed product category ERUS.

[1] Regulation - EU - 2024/573 - EN - EUR-Lex

Contents

Brief history

The placing on the market prohibitions listed in Annex IV of the EU F-Gas Regulation 2024/573 show that equipment containing refrigerants which is integrated as components in larger systems and machines was not considered as a separate product category when the EU F-Gas Regulation was drafted. Such equipment must therefore also comply with the technical rules for these systems. As a result, groups of equipment were combined, grouped according to capacity and subject to placing on the market prohibitions across product groups.
The dates of the prohibitions were synchronised with the milestones of the revised phase-down plan (see Annex VII of the EU F-Gas Regulation) for F-gases (50% steps in 2027 and 2030), whereby the prohibition on A2L refrigerants was also anticipated in the upcoming PFAS restriction initiative under the REACH Regulation.
In order to take into account the safety requirements already listed in the revision process, triggered by the substitution of F-gases with flammable refrigerants, exemptions have been introduced. The following definition must be considered in conjunction with Annex IV of the EU F-Gas Regulation:

> *Article 3 (42)*
> *'safety requirements' means requirements on the safety of using fluorinated greenhouse gases and natural refrigerants or products and equipment containing or relying on them, prohibiting the use of certain fluorinated greenhouse gases or their alternatives, including when contained in a product or in equipment at a specific place of intended utilisation due to site and application specificities that are set out in:*
> *(a) Union or national law; or*
> *(b) a non-legally binding act containing technical documentation or standards that have to be applied to ensure safety at the specific location, provided that they are in accordance with relevant Union or national law;*

The above-mentioned safety exemptions take into account safety requirements that apply at a specific place and can therefore be derived primarily from building regulations.
During the revision of the EU F-Gas Regulation in 2023, the VDMA pointed out that, for example, the use of switch cabinet cooling devices cannot be classified as state of the art in the same way as heat pumps and room air conditioners and must be considered in terms of fire and explosion protection in connection with their use.[2]

[2] **Risks arising from the revision of the F-Gas Regulation in the field of switch cabinet air conditioning units**, communication between [redacted]

It was demonstrated that:

- Equipment safety,
- machine and plant safety,
- safety in use,

must be addressed jointly for this class of products, and that the dates proposed in the draft regulation for placing on the market prohibitions ignore the necessary effort and requirements for this.
Exemptions based on safety requirements from standards and directives on product safety, which an integrator and also an operator of **refrigeration and air conditioning subsystems in machinery and equipment** must take into account, are missing from the current EU F-Gas Regulation, even though these have the same character for those affected as, for example, building regulations for the installer of a building air conditioning system.
Integrated refrigeration and air conditioning subsystems (ERUS) in machines and systems are consequently regulated by the same scale as, for example, heat pumps and air conditioning systems for room air conditioning, for which harmonised product standards exist that specify requirements right down to the application, provided that the state of the art is identical.

The wording of the placing on the market prohibitions in Annex IV made it impossible for the manufacturers concerned to determine with legal certainty the correct dates of the prohibitions applicable to them from the text of the Regulation.[3]
Article 3, paragraph 42, defines when safety requirements may serve as a legitimate basis for justifying an alternative with a higher global warming potential against an F-gas prohibition.

Criterion / Bullet point	Reference in the text of the regulation (Article 3(42) of the EU F-Gas Regulation)	Reasoning / Text reference
1. The safety requirements are legally established or state of the art.	"... that are set out in: (a) Union or national law; or (b) a non-legally binding act containing technical documentation or standards that have to be applied ... provided that they are in accordance with relevant Union or national law."	Point (a) = legally established; point (b) = technical standards which, despite not being legally binding, are to be applied as state of the art.
2. They are relevant at the specific place of intended use.	"... at a specific place of intended utilisation due to site and application specificities ..."	Safety requirements must relate to the specific installation situation (site and application specific).
3. They objectively and demonstrably prevent or restrict the safe use of an alternative (natural) refrigerant.	"... prohibiting the use of certain fluorinated greenhouse gases or their alternatives ... due to site and application specificities ..."	The definition allows safety requirements to be used as a reason for prohibiting or restricting alternatives if they cannot be used safely at the site.

[3] Communication between [redacted] on determining the date of application of the prohibitions.

Applicability is given if:

- the safety requirements are legally established or state of the art,
- they are relevant to the specific place of use,
- they objectively and demonstrably prevent or restrict the safe use of an alternative (natural) refrigerant.

The current version of Article 3(42) of the EU F-Gas Regulation focuses primarily on safety requirements in site-specific construction and installation regulations, thus disregarding safety-related requirements under machinery and product safety law. For integrated refrigeration and air conditioning components, this leads to an objectively unjustified disadvantage, as essential safety requirements resulting from the Machinery Directive/Regulation and relevant product standards are not obviously recognised as reasons for exemption. Furthermore, claiming these exemptions also requires a case-by-case assessment of each installation scenario, which contradicts the standardised approach commonly used in the relevant supply chain, which can only be changed at considerable economic cost. EU law must not allow regulations that effectively force manufacturers to develop or market products that do not correspond to the state of the art or pose obvious safety risks. Such requirements would be contrary to EU law. According to the established law practice of the Court of Justice of the European Union (CJEU), measures based on Article 114 of the Treaty on the Functioning of the European Union (TFEU) are only permissible if they ensure a high level of health and safety protection and do not lead to a lowering of existing safety standards.
It must therefore be examined to what extent measures such as

- placing on the market prohibitions, artificial shortages and increases in the price of operating materials, as well as the limitation of necessary licences,
- additional documentation and registration requirements,
- anticipating the results of parallel restriction procedures,

have a de facto coercive effect on the industry described in this application and whether the corrective mechanisms provided for in the EU F-Gas Regulation are actually suitable to compensate for this. This applies in particular to the general ban on F-gases, which is anticipated for 2030/2032 and thus effectively prevents the economically viable development of the next best state of the art for A1 refrigerants. The state of the art for A2L is only just beginning to develop.
Overall, manufacturers, integrators and operators of ERUS products will face short-term regulatory objectives at the beginning of 2026 that are incompatible with the economic

conditions, the current state of the art in the EU or the competitive situation on the global market [4] [5] [6].

Scope of the temporary exemption

The exemption requested herein should apply to all products listed in Annex IV that meet the following definition of an Embedded Refrigerant-Using Subsystem (ERUS) or contain an Embedded Refrigerant-Using Subsystem (ERUS) as a subcomponent.

Definition of Embedded Refrigerant-Using Subsystem (ERUS):

- The product is only intended for integration into a larger system; this is described as the sole intended use in the instructions.
- The product is installed as a subcomponent in a larger unit with its own conformity assessment.
- It contains or uses an F-gas as a working fluid.
- The ERUS manufacturer cannot assess the safe application after integration on its own, as it does not place the final application on the market or operate it.
- The lack of assessability results from indirect supply chains and a lack of visibility of the end use.
- The end product cannot be assigned to the same harmonised standards as the ERUS.
- The end product is not primarily intended for heating, cooling or air conditioning.

[4] Joint industry application, Pfannenberg, Texa, nvent, cosmotec - Application for two exemptions pursuant to Article 11(5) of EU Regulation 2024/573
[5] Discussion between [redacted] on 8 October 2025
[6] VDMA position paper: EU F-gas Regulation in the Omnibus Package (Omnibus IV)

Definition of economic operators covered by the exemption:

Across the ERUS supply and user chain, various economic operators contribute to its deployment and are impacted by the EU F-Gas Regulation.

Station in the supply chain for application	Economic operators affected	Product safety and regulatory requirements
ERUS are placed on the market for integration	ERUS manufacturers (series products and application-specific solutions), distributors	EU declaration of conformity (CE marking) for ERUS product according to the European Low Voltage Directive / Machinery Directive/Regulation and standard
Switchgear integration based on cooling capacity requirements	Switchgear manufacturer, integrator	EU declaration of conformity (CE marking) for switchgear according to the European Low Voltage Directive and product standard
Machine integration	Machine and plant manufacturer	EU declaration of conformity (CE marking) for the machine or plant
Logistics (import/export)	Logistics service providers, import/export service providers	Transport regulations (import/export on the EU F-gas Portal)
Installation at the site of deployment	Machine and plant manufacturers Operators	Ordinance on Industrial Safety and Health (German Betriebssicherheitsverordnung), Risk analysis, Mitigation of residual risks
Operation	Operator	
Maintenance work	Operator / maintenance service provider	

Reference to EU F-Gas Regulation 2024/573, Annex IV

Based on current knowledge, the product classes listed in Annex IV that are included in ERUS are:

STATIONARY CHILLERS		
(7) Chillers that contain, or whose functioning relies upon:	*(b) chillers up to and including a rated capacity of 12 kW*	*1 January 2027*
	(c) fluorinated greenhouse gases for chillers up to and including a rated capacity of 12 kW	*1 January 2032*
	(d) fluorinated greenhouse gases with a GWP of 750 or more for chillers above a rated capacity of 12 kW	*1 January 2027*
STATIONARY AIR-CONDITIONING EQUIPMENT AND STATIONARY HEAT PUMPS		
(8) Self-contained air-conditioning equipment and heat pumps, except chillers, that:		
	*(b) **other self-contained air-conditioning equipment** and self-contained heat pumps, with a maximum rated capacity of up to and including 12 kW that contain fluorinated greenhouse gases with a GWP of 150 or more,*	*1 January 2027*
	*(c) **other self-contained air-conditioning equipment** and self-contained heat pumps, with a maximum rated capacity of up to and including 12 kW that contain fluorinated greenhouse gases*	*1 January 2032*
	*(d) **other self-contained air-conditioning** equipment and heat pumps, with a maximum rated capacity of more than 12 kW but not exceeding 50 kW that contain fluorinated greenhouse gases with a GWP of 150 or more,*	*1 January 2027*
	*(e) **other self-contained air-conditioning equipment** and heat pumps that contain fluorinated greenhouse gases with a GWP of 150 or more,*	*1 January 2030*

Examples include series products and application-specific solutions such as switch cabinet cooling units, machine coolers/chillers for machine integration, cooling tunnels, process-integrated heat pumps and compressed-air refrigerated dryers[7] .

Exemptions requested under Article 11(5)

The exemption is intended to cover the following requirements of the EU F-Gas Regulation for ERUS manufacturers and users:

[7] Another exemption application for the product group "compressed-air refigerated dryers" was already submitted to the responsible authorities in September 2025. Overlaps derive from special designs (e.g. compressed-air refrigeration dryers integrated into compressors).

- Refrigeration and air conditioning subsystems for machinery and plant equipment are defined in the implementing act to be drawn up as a separate category of ERUS equipment in accordance with the above definition.

- The placing on the market of ERUS with a Global Warming Potential (GWP) below 750 is exempted from the prohibitions set out in Annex IV (7) b, c, d and (8) b, c, d, e, or the prohibition dates are postponed by four years.

- The simplified labelling requirement on the type plate: “(EU) 2024/573 – ERUS” is intended to enable the clear identification of products circulating on the market under the exemption. This removes the need for a user to perform a case-by-case assessment in order to document the applicability of an exemption.

  The exemption should apply for four years, or until completion of the forthcoming revision of the EU F-Gas Regulation that includes a corresponding amendment, whichever occurs first. It should be noted that, in the absence of an outcome from the PFAS restriction procedure under the REACH Regulation, affected manufacturers cannot plan investments with regulatory certainty regarding the future framework conditions.

Technical justification / safety considerations

Basic requirements from the EU Machinery Directive/Regulation

The EU Machinery Directive requires compliance with the fundamental safety requirements[8] described in Annex I. This also applies to the integration of ERUS products into machinery and plant equipment.

ANNEX I

Essential health and safety requirements relating to the the design and construction of machinery

GENERAL PRINCIPLES

1. The manufacturer of machinery or his authorised representative must ensure that a risk assessment is carried out in order to determine the health and safety requirements which apply to the machinery. The machinery must then be designed and constructed taking into account the results of the risk assessment.

By the iterative process of risk assessment and risk reduction referred to above, the manufacturer or his authorised representative shall:

— determine the limits of the machinery, which include the intended use and any reasonably foreseeable misuse thereof,

— identify the hazards that can be generated by the machinery and the associated hazardous situations,

— estimate the risks, taking into account the severity of the possible injury or damage to health and the probability of its occurrence,

— evaluate the risks, with a view to determining whether risk reduction is required, in accordance with the objective of this Directive,

— eliminate the hazards or reduce the risks associated with these hazards by application of protective measures, in the order of priority established in section 1.1.2(b).

[8] General requirements for machine safety:

- BAuA – Machines – Federal Institute for Occupational Safety and Health
- DGUV Test: Information on the EC Machinery Directive 2006/42/EC;
- DGUV Test: CE marking according to the Machinery Directive

For products in which flammable gases and liquids are used, Annex I 1.5.6 and 1.5.7 of the EU Machinery Directive/Regulation apply in particular:

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▼B

1. *ESSENTIAL HEALTH AND SAFETY REQUIREMENTS*

1.5.6. ***Fire***

Machinery must be designed and constructed in such a way as to avoid any risk of fire or overheating posed by the machinery itself or by gases, liquids, dust, vapours or other substances produced or used by the machinery.

1.5.7. ***Explosion***

Machinery must be designed and constructed in such a way as to avoid any risk of explosion posed by the machinery itself or by gases, liquids, dust, vapours or other substances produced or used by the machinery.

State of the art for ERUS

The current state of the art regarding the use of flammable refrigerants, particularly those of class A3, as alternatives in refrigeration, air conditioning and heat pump systems was last determined in September 2025 by the Technical Committee CEN/TC182 “Refrigerating systems, safety and environmental requirements”.[9]
In this document, which also describes the segmentation of the market, no explicit state of the art is defined for applications that would qualify as ERUS, nor for machinery and plant equipment incorporating ERUS.

This is also plausible, as prior to the revision of the EU F-Gas Regulation there was no general requirement to use flammable refrigerants in this specific niche, and fire and explosion risks associated with A1 refrigerants do not arise. ERUS manufacturers were therefore largely able to follow the state of the art for chillers (DIN EN 378 series) and air conditioning systems (IEC/UL/EN 60335-2-40) and apply the harmonised standards without inconsistencies. This has now changed under the current EU F-Gas Regulation.

[9] State of the art on the use of flammable refrigerants, in particular class A3, as alternatives in refrigeration, air conditioning and heat pump systems; German version CEN/TR 17608:2022

State of the art for refrigerants

A2L refrigerants are now considered a **climate-friendly alternative** to the previously used non-flammable A1 refrigerants such as R134a and R513A, as they are classified as mildly flammable and, if released, have a significantly lower global warming potential.

A2L refrigerants such as R1234yf require a very high minimum ignition energy, which is a hundred to a thousand times higher than that of R290, making spontaneous ignition much less likely. Their flammability range is also narrow: R1234yf only becomes ignitable at around 6 vol% in air and remains flammable only up to around 12 vol%. In addition, a flame spreads at a very low speed of around 1.5 cm/s with R1234yf, which leads to combustion but not to an explosion.

In contrast, R290 (propane), which is classified as an A3 refrigerant, has a significantly higher flammability. It can be ignited by minimal sparks below 1 mJ and forms an ignitable atmosphere at concentrations as low as approximately 2 vol%, i.e. at a much lower concentration. The flammability range is broad and typically extends to about 9.5 vol%. In addition, R290 has a very high flame speed of more than 40 cm/s, which leads to rapid flame propagation and a significantly more dynamic fire and explosion development.

By comparison, this means: R1234yf is considered a low-flammability refrigerant with low ignition and explosion risk, whereas R290, due to its very low ignition energy, its low lower flammability limit, and its high flame speed, must be classified as significantly more critical from a safety perspective.

At the same time, however, A2L refrigerants with a GWP < 150 fall within the scope of **the PFAS restriction proposal under the REACH Regulation** and, in anticipation of a possible ban, are only permitted under the current **EU-F-Gas Regulation**, **only permitted until an anticipated ban date around 2030**, which limits their long-term availability and planning certainty.

However, the PFAS restriction proposal is still in the scientific review phase and the most recently published draft of the Socio-Economic Analysis[10] includes restriction recommendations that do not necessarily lead to a foreseeable ban on A2L and A1 refrigerants. The analysis assesses, inter alia, different restriction options (see Chapter 2.3.1).
The following references in the document are relevant for refrigerants (A1 and A2L) in the ERUS scope of application:

[10] Committee for Risk Assessment (RAC), Committee for Socio-economic Analysis (SEAC) Background Document to the Opinion on the Annex XV dossier proposing restrictions on Per- and polyfluoroalkyl substances (PFASs)

1. Chapter 2.3.1 – *A 12-year derogation is proposed when sufficiently strong evidence is available that:*
    - ***points to the non-existence of technically and economically feasible alternatives on the market at the EiF date, e.g. Research and Development (R&D) efforts did not identify possible PFAS-free alternatives so that it is likely that they will not become available in the near future, or***
    - ***certification or regulatory approval of PFAS-free alternatives cannot be achieved within a five-year derogation period.***

    For some specific uses, there may be practical reasons on the basis of which time-unlimited derogations could be necessary. The dossier submitters consider such time-unlimited derogations justified for e.g. (i) ***use of PFASs in refrigerants in HVACR equipment in buildings where national safety standards and building codes prohibit the use of alternatives (see section 2.4.1.1),***

Here too, exemptions that are based on safety requirements arising from standards and product-safety legislation, which both an integrator and an operator of **refrigeration and air-conditioning subsystems in machinery and plant equipment** must comply with, are not clearly identifiable or explicitly listed, even though, for the affected parties, they have the same character as, for example, building law requirements do for an installer of a building air-conditioning system. A comment on this will be submitted in the upcoming consultation. In the assessment of restriction options in Chapter 2.4.1.1, costs are described as “very high” if the following definition is met:

“Costs are classified as 'very high' when

- *Substantial social costs due to health or* ***safety implications are expected****; and/or*
- ***Severe impacts on the competitiveness of EEA industry are expected****, e.g. PFASs are only relevant for the manufacturing stage of products and not contained in the final product and a ban would thus not affect imports, or market growth is expected to be high at the global level and price is expected to play a role that is beyond average in determining customer’s purchasing decisions (with a very limited possibility for EU companies to compete in such markets based on quality arguments).”*

As a result, the authors also conclude that this criterion is met for a total ban on PFAS in F-gas applications that also fall within the scope of the present application:

2. Page 118: Table 10. RO1 - Summary table of alternatives and cost impacts for PFAS use sectors resulting from a full ban of PFASs. – “***There is furthermore sufficiently strong evidence that there is a low substitution potential at EiF for ... Stationary air***

conditioning applications, where safety standards or building codes limit the use of alternatives;" *"Conclusion: As such, the overall costs associated with* ***RO1 for all relevant applications of fluorinated gases are concluded to be: Very high."***

This means that a total ban on A2L refrigerants is not recommended under current safety requirements. Instead, the authors propose the following in their assessment of a ban with a 5- to 12-year transition period:

3. *Pages 151 to 153: Table 11. RO2 – Summary table of derogations for PFAS use sectors, with substantiation for the derogation period (5 or 12 years) and with cost impacts for the 5- and/or 12-year derogation periods. "****Time-unlimited derogations are proposed for: Refrigerants in HVACR equipment in buildings where national safety standards and building codes prohibit the use of*** *alternatives."*

The authors provide a justification for the proposed time-unlimited derogation that is equally valid for this application:

> *"The above time-unlimited derogations are proposed for the following reasons: Building codes limiting the use of alternatives for certain HVACR equipment are reviewed and updated regularly. It is expected that they will over time be changed through recognition of technical developments and recognition of safe operation of alternatives. The time-unlimited derogation prevents costs to manufacturers and end-users until this happens. The time-unlimited derogation for maintenance and refilling of existing HVACR, ... will prevent costs related to the premature redundancy of relevant equipment. Most equipment has a typical lifetime of 15-25 years, with some industrial equipment potentially having lifetimes of up to 40 years. While the derogation is time-unlimited, in practice it will be limited by the replacement of equipment and the end of its lifetime. It will ensure that the equipment will gradually be phased out and replaced with non-PFAS equipment.*

In summary, it becomes clear that the state of the art for refrigerants is currently evolving, and that anticipating an F-gas restriction under the REACH Regulation is not appropriate for the products described in this application.

A recent EU analysis also recommends that F-gases should not be included in the scope of possible PFAS restrictions and that the regulatory treatment of F-gases should be located entirely within the existing EU F-gas Regulation[11] .

[11] The Per- and polyfluoroalkyl substances (PFAS) and their role as enablers in the competitiveness of European industry | Think Tank | European Parliament

In summary, given the current state of the art for refrigerants, it can be concluded that ERUS manufacturers and users have no planning certainty when it comes to making decisions regarding the use of low-GWP refrigerants. In addition to causing massive uncertainty with regard to long-term product strategies, this also has a negative impact on competitiveness.

State of the art for machine and plant manufacturers

Machinery and plant manufacturers face a multitude of complex legal and technical challenges in connection with the use of A2L and A3 refrigerants. They must simultaneously comply with product safety law, product liability and criminal law. If they cannot apply harmonised standards, they must provide full technical evidence of the safety of their products themselves.

The initial conditions at the respective operator sites often differ significantly, as factors such as spatial constraints or adjacent installations vary considerably. Therefore, an individual assessment of each machine is essential. This analysis is further complicated because the specific installation location may not yet be defined during the planning phase, or it may change over the course of the project. In addition, plant manufacturers sometimes distribute their machines via machinery dealers, or the machines are relocated to other sites at a later stage. As a result, the actual installation conditions may either change retrospectively or cannot be defined in advance with the required level of reliability.

A2L refrigerants are mildly flammable and A3 refrigerants are highly flammable, which is why additional design and organisational measures are mandatory when integrating ERUS systems. However, for this product group there are currently neither harmonised standards nor sufficiently robust technical guidance documents. Integrators therefore have to develop their own technical solutions without being able to rely on established standards. To minimise hazards as far as possible, integrators of ERUS systems must, for example, use explosion-protected components, integrate suitable gas detection systems, and incorporate ventilation and extraction concepts into the machine (see further information in Appendix 1). As a result, the concept phase alone already causes substantial additional costs and ties up development resources. In addition, there is increased effort required for the safety-related implementation, validation, and documentation of a project (see further information in Appendix 2).

The identification and evaluation of potential ignition sources is another key challenge and a critical element in minimising explosion risk in the event of a gas release.
The problem here is that the design of control cabinets and electrical installations varies greatly depending on the machine configuration. In addition, numerous potential ignition sources – including motors, sensors, valves and other actuators – are distributed throughout the entire machine. External ignition sources in the operator's environment must also be taken into account,

such as tools, lighting equipment, neighbouring systems or the process itself carried out on the machine. This multitude of influencing factors makes it difficult to carry out a reliable and complete risk assessment.
If it cannot be ruled out with absolute certainty that an ignitable gas-air mixture will be created as a result of malfunctions, leaks or damage, it must be assumed that an explosive area may be present. The spatial extent of such an area depends on a variety of parameters, such as the amount of refrigerant released, the air flow, the machine geometry, or the surrounding factors. In many cases, the hazardous area covers almost the entire machine and, depending on the layout, may also extend to neighbouring equipment (see Appendix 1 for further information).

In order to clarify the safety requirements for machine and plant manufacturers and make them more practicable in the future, the VDMA will use the requested exemption period to develop a VDMA standard (specification) for ensuring the long-term technical tightness (leak tightness) of ERUS systems over the next few years. This document is intended to provide manufacturers with basic guidelines for the design, testing and quality assurance of systems using A3 refrigerants, thereby also giving machine and plant manufacturers planning certainty during integration. Nevertheless, it should be noted that even with such a VDMA standard, complete technical safety cannot be guaranteed. Additional safety functions, redundant protective measures and careful case-by-case assessment remain essential.

State of the art for operators

For operators of systems containing ERUS with A2L and A3 refrigerants, the German Hazardous Substances Ordinance (Gefahrstoffverordnung) is particularly important. Even if a closed refrigerant system does not mean permanent exposure for employees, the following obligations always apply:

- A risk assessment must be carried out (e.g. danger in the event of leakage, explosion, suffocation).
    - Operating instructions in accordance with the German Hazardous Substances Ordinance are required (work on refrigeration systems is considered to be work with hazardous substances).
    - Employees must be instructed in the handling of refrigerants.
    - Technical protective measures (e.g. gas detection for A2L/A3, room monitoring).
    - Emergency plan for leaks.

Why?
Because even closed systems can *release substances* – leaks, maintenance work. Section 12 of the Hazardous Substances Ordinance is particularly relevant here:

Special protective measures to safeguard against physicochemical effects, particularly fire and explosion hazards
(1)
The employer is to implement measures to safeguard workers and other persons against physicochemical effects in accordance with the findings of the risk assessment. The employer must choose the measures in such a way that hazards are avoided or reduced to the greatest possible extent. This applies particularly to activities that may lead to fire and explosion hazards, including storage. The employer must observe Annex I numbers 1 and 5. This shall not affect the provisions of the Explosives Act (German Sprengstoffgesetz) and the statutory provisions arising from this Act.

(2)
To prevent fire and explosion hazards, the employer is to implement measures in the following order of priority:

1. *to avoid the occurrence of hazardous levels or concentrations of hazardous substances that lead to fire or explosion hazards,*
2. *to avoid ignition sources or conditions that give rise to fires or explosions,*
3. *to reduce the adverse effects of fires or explosions on the safety and health of workers and other persons to the greatest possible extent.*

(3)

Work areas, workplaces, work equipment and their connecting elements must be designed, built, assembled, installed, used and maintained in such a way that fire and explosion hazards do not occur.

The simplest and safest measure to meet these requirements is to use non-flammable A1 refrigerants.

Economic impact assessment

The following economic impact assessment shows that more extensive requirements in the area of application of Embedded Refrigerant-Using Subsystems (ERUS) in machines and systems would entail considerable additional costs. This assessment considers not only the pure component procurement, but also the total cost of implementation as the “total installed cost” – including engineering, integration into the machine tool, installation, acceptance/commissioning, and location- and operator-specific constraints.

An exact full-cost calculation across all ERUS variants is currently only reliable to a limited extent, as the additional costs are highly system-specific (including, among other factors, the degree of

integration into the machine tool, installation site, space constraints, safety concept, involvement of additional actors, and acceptance/approval processes). To nevertheless arrive at a robust statement, a plausibilised cost range is used, based on a credible cost signal from industry: chillers using R290 (propane) as the refrigerant become around 30% more expensive due to the regulatory framework and the associated technical adaptations required. For example, if chillers with a value of €15 million are needed, additional costs of roughly €5 million can be expected in the future. This figure is a suitable anchor, as the ERUS/chiller subsystem is directly affected by the transition to a flammable refrigerant.

In addition to the chiller-related cost increase, further efforts and costs arise at overall plant level: increased engineering and integration effort at the interfaces to the machine tool, more stringent requirements for safety and approval processes, additional documentation and acceptance procedures, and substantial coordination needs between the manufacturer, integrator and operator. Site-specific factors, such as additional equipment required for safe operation or the need for larger installation areas, can further increase costs.

At the same time, it is becoming apparent that the switch to A3 refrigerants such as R290 entails additional technical and organisational requirements for machine and plant manufacturers. Since each installation site has different initial conditions (e.g. distances to other systems, room volume, ventilation, ignition sources, environmental influences, internal occupational safety requirements), machines and systems will have to be designed on a case-by-case basis in future. This will lead to a loss of series production capability and a significant increase in the number of variants. The necessary measures include, in particular:

4. Risk analysis of potential fire and explosion hazards at the installation site
5. Exclusion of ignition sources and compliance with safety distances
6. Integration of additional sensor technology for gas detection
7. Explosion-proof ventilation (continuous operation)
8. Forced ventilation and encapsulation of refrigeration units
9. Mechanical impact protection
10. Comprehensive documentation in accordance with the Ordinance on Industrial Safety and Health (German Betriebssicherheitsverordnung) and, if applicable, the EU-F-Gas Regulation
11. Recurring inspections of the sensor technology and leak tests of the systems

As these measures have an integrative effect on the entire machine, larger installation areas are required, resulting in additional investment and operating costs.

The total cost increase (“total installed cost”) for a system in the ERUS application area is estimated at around +25% to +40%. The specific value is project-specific and depends on many factors, which is why this range was deliberately chosen. Overall, the analysis shows that the switch to flammable refrigerants not only leads to higher component prices, but also causes

considerable additional systemic costs. This means that disproportionate costs within the meaning of Article 11(5) of the EU F-Gas Regulation 2024/573 are understandable and support the requested exemption.

Industry position

The challenges addressed in this application do not only concern an individual case but are widespread in the industry for comparable applications. Pfannenberg GmbH has already submitted an application for exemption under Article 11(5) of the EU F-Gas Regulation 2024/573 to the BMUKN and is applying for an exemption for control cabinet air conditioners (Annex IV, categories 8(b) and 8(d)) and integrated (machine-mounted) chillers (Annex IV, category 7(b)). These categories correspond, among other things, to the product classes that are also named in the VDMA application as ERUS-relevant classes from Annex IV. Pfannenberg explicitly places the issue in an industry context and points out that other companies, such as nVent (Texa) and Stulz (Cosmotec), have also submitted exemption applications to the Italian authorities for the same product categories. Against this background, the approach within the industry is consistent: for the categories mentioned in this VDMA application, a temporary exemption is seen as an appropriate bridge until comprehensive implementation is possible.

Summary and conclusion

In summary, VDMA is applying for an exemption pursuant to Article 11(5) of EU F-Gas Regulation 2024/573 for Embedded Refrigerant-Using Subsystems (ERUS) in machinery and plant equipment, as an immediate transition to refrigerants with a GWP < 150 cannot be implemented safely and practicably across all affected applications under real operating conditions. ERUS are an integral part of complex systems; key safety- and design-related parameters only arise from the specific application, installation location and system integration, meaning that an isolated product assessment can lead to conflicting objectives. The economic impacts were assessed as total installed cost and indicate, supported by the established cost anchor for R290 (propane) chillers and the plausibilised range, substantial additional costs and significant project-specific variability. The application is therefore consistent with the industry-wide direction that is also reflected, inter alia, in the exemption request already submitted to BMUKN by Pfannenberg GmbH for comparable product categories. VDMA therefore requests a temporary exemption as a bridge until safe, practicable and broadly available alternatives have been established for the affected ERUS applications.

Appendix

Appendix 1

Example of a safety concept from a manufacturer of industrial coolers for machine tools

Due to the high flammability of A3, special safety measures are required.

Procedure

- Assessment of the categories of access areas in accordance with DIN EN 378-1

12. Monitored access area “b”

- Classification of refrigeration system installation sites
  - Class I: Mechanical equipment in areas where people are present

13. Determination of the maximum permitted refrigerant charge (R290)
  - A3 / Access area b / underground: 20% LFL x room volume (max. 1 kg)

Formel 2: Raumvolumen abhängig von der Füllmenge

$$Raumvolumen = \frac{Füllmenge}{0{,}2 \times LFL}$$

Assuming a maximum filling quantity of 1 kg R290 and an LFL value (lower flammability limit) of 0.038 kg/m³, the result is: **132 m³.**

Formel 6: Minimal benötigte Luftmenge Q_{min} (DIN IEC 60335-2-40 GG.15)

$$Q_{min} = 3600 \frac{8Y\sqrt{A_o}}{240} \left(\frac{m_c}{LFL}\right)^{3/4} \left(\frac{CF^{1/4}}{1 - CF}\right)$$

Accordingly, the required **air volume** is **234.5 m³/h** to safely dilute the leak and prevent an explosive atmosphere.

Image: Prototype with gas detector, warning horn, bubble separator (medium side) and ATEX fan

What does this mean for the customer?

- One person in the production hall must be familiar with the necessary safety measures when the alarm is triggered.
- The required room volume (approx. 132 m³ per kg of propane in the system) and adequate room ventilation must be guaranteed by the customer.
- Marking and compliance with the working area (**ATEX zone 1.5 m**) around the cooler.

Appendix 2

Expenses for planning and documentation from 2027 onwards in accordance with the F-Gas Regulation

Procedure for assessing whether flammable refrigerants can be used in a system

Steps in the life cycle	ERUS manufacturer	Integrator	Machine manufacturer	Dealer	Operator	F-Gas Regulation costs
Risk analysis of potential fire and explosion hazards at the installation site of a machine	1	1	1		1	~8h
Decision on the specification of a device with or without flammable refrigerant			2		2	~2h (Env. vs. Safety)
Documentation according to Operational Safety Ordinance and, if applicable, F-Gas Regulat.					3	~2 hours
Risk and variant management for machine builders/switchgear manufacturers		4	4			~1 hour
Requirements management Switchgear manufacturers / air conditioning unit manufacturers	5	5				~1h
Manufacture of a device (with individual labeling in the local language, if applicable)	6					(€ Special € Delivery)
Device delivery (dangerous goods delivery if applicable, no air freight for A3)	7	7		A3 only		(€ Delivery time)
Switchgear integration (taking into account A3 safety requirements, if applicable)		8				tbd
Machine integration taking into account safety requirements A3		9	9			tbd
Installation at the installation site			10		10	tbd
Acceptance at the installation site (additional safety ventilation, etc., if necessary)			11		11	2h
Maintenance work (taking explosion protection requirements into account, if applicable)	12	12	12		12	tbd
Regular leak checks (if necessary, with the system taken out of operation)	13		13		13	1h p.a.

- **Management, integration, and lifecycle costs for coordination, documentation, and planning >> Device value >> CO2 price (up to €300/t @2030)**
- Trade in series machines and components is made even more difficult... Break in the chain of implications
- Uncertainty among manufacturers, users, and operations managers, fear of lawsuits from climate activists, expenses delay order processing
- Not feasible to implement internationally!

VDMA e.V. – Europe's largest association of mechanical and plant engineering companies

The VDMA represents 3,500 German and European mechanical and plant engineering companies. The industry stands for innovation, export orientation and small and medium-sized enterprises. The companies employ a total of around 3 million people in the EU-27, more than 1.2 million of them in Germany alone. This makes mechanical and plant engineering the largest employer among the capital goods industries, both in the EU-27 and in Germany. It accounts for an estimated turnover of around 910 billion euros in the European Union. Around 80 per cent of the machines sold in the EU originate from a manufacturing facility in the internal market.

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