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Austrian survey on the frequency, location, and detection of leaks in heat pump and cooling systems up to 50 kW nominal capacity

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Abstract

The use of climate-friendly but flammable refrigerants, driven by the EU F-Gas Regulation and the proposed REACH Regulation, presents new challenges for the heat pump and air conditioning sector. These challenges include stricter safety requirements that combine technical, legal, and practical aspects. The international IEA HPT Project 64 contributes to a safe use of flammable refrigerants by increasing the understanding of the risks related to flammable refrigerants, and maintaining the risks at acceptable levels.

One focus is on the collection and analysis of field-based data to assess the current state of safety practices, identify common industry patterns, and uncover potential for improvement. This data lays the groundwork for informed decision-making and further recommendations. To support this, the national Project 64 team of Austria conducted a practice-oriented online survey with experts from manufacturers, distributors, installers, and refrigeration services companies. Tailored questionnaires addressed leak frequency, -location, and -detection. Additional questions gathered context on company structure and service models. The responses were analyzed descriptively using frequency distribution and proportions, supplemented by qualitative insights.

Results show that expert assessments align only partially across stakeholder groups, which are likely due to differences in roles and service approaches. Notably, 47% of respondents reported that refrigerant circuit leaks occurred in only 1–5% of all service incidents, suggesting such events are relatively rare. When asked about leak locations, 14 potential sources were suggested, with Schrader valves, connection points to components, and evaporator heat exchangers emerging as the most common across all groups. Other sources followed closely. All suggested locations showed variations depending on stakeholder type.

The survey offers valuable insights into the frequency and typical causes of system failures. These findings can help guide the development of technical standards, product design, training programs, and service procedures and ultimately reducing environmental risks and enhancing operational safety.

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Keywords: Refrigerants; Leakage; Survey;

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1. Introduction

The use of climate-friendly but flammable refrigerants, driven by the EU F-Gas Regulation and the proposed REACH Regulation, presents new challenges for the heat pump and air conditioning sector. These challenges include stricter safety requirements that combine technical, legal, and practical aspects. The international IEA HPT Project 64 [1] contributes to a safe use of flammable refrigerants by increasing the understanding of the risks related to flammable refrigerants, and maintaining the risks at acceptable levels.

One focus is on the collection and analysis of field-based data to assess the current state of safety practices, identify common industry patterns, and uncover potential for improvement. This data lays the groundwork for informed decision-making and further recommendations. To support this, the national Project 64 team of Austria conducted a practice-oriented online survey with 113 experts from manufacturers, distributors, installers, and refrigeration services companies.

Existing studies from America and Asia show that refrigerant leakage is widely recognized as one of the most common faults in refrigeration, air-conditioning and heat pump systems, and maintenance practice is pivotal. Good servicing can reduce existing leaks, whereas inadequate procedures may increase leak risk and associated environmental impacts. [3], [4] In field and service contexts, leakage is reported to occur predominantly at joints and connection points, with flare fittings and brazed joints frequently identified among the most commonly observed leak sources. [4] Consistent with this, practitioner-oriented syntheses of “common leak points” emphasize recurring leakage at shut-off/ball valves, Schrader (service) valves, flare joints, mechanical joints/flanges and elastomeric seals (e.g., O-rings), and also highlight components such as condensers/evaporators, capillary tubes and return bends as recurrent locations of refrigerant loss. [3]

2. Approach

For the data collection, an online survey was designed aiming at various target groups and carried out from October 2024 until March 2025. A differentiation was made into four groups of experts, for each of which a specific questionnaire was developed. Each of these questionnaires consisted of a selection of 8 standardised questions, each of which was tailored to the respective target group.

The classification of the target groups was based on the different functions and roles within the participating industry companies and their employees. The following target groups were distinguished:

- Manufacturer (8 out of 8 questions)
- Sales companies (8 out of 8 questions)
- Service technician / refrigeration technician with refrigeration qualification (5 out of 8 questions)
- Installers without refrigeration qualification (4 out of 8 questions)

The survey design took into account that on the one hand the test persons do not always have access to detailed internal company evaluations and, on the other hand, that answering the questionnaire should not cause unnecessary time expenditure. Since the survey is based on empirical values in some parts, investigation of trends was aimed for rather than for exact figures. For such questions, the answer options were ranges such as "1-20%" or "21-40%". The resulting bandwidth is taken into account accordingly.

2.1. Sample description

The participating project partners were able to draw on existing networks of experts when sending out the survey. The network consists mainly of members of the associations Wärmepumpe Austria (WPA) and Österreichische Gesellschaft der Kältetechnik (ÖGKT) and on resulting multipliers such as partners of manufacturers or distributors.

The surveys were sent to 937 email addresses of manufacturers, importers, sales companies, distributors and installers and refrigeration technicians. The press release asked that the survey be forwarded to internal persons or departments as well as to external partners or customers. This presumably reached other people who are not included in the numbers mentioned and cannot be recorded.

All recipients are employed by companies that are based and active in Austria. The basic distinguishing features of the companies or the test persons are the size of the company, the organizational structure of the technical customer service, and the qualification of the respective person. The role of the company results in different areas of responsibility and thus different areas of experience, which are relevant for the survey, e.g., product developers vs. technical customer service.

The rate of feedback is shown in Table 1, whereby manufacturers and sales companies are considered under one group in the response rate.

Table 1: Rate of response

Persons from	Feedback from
Manufacturers / Sales Companies	48
Installers (without refrigeration qualification)	23
Service technician / refrigeration technician (with refrigeration qualification)	42

2.2. Description of survey questions

A questionnaire consisting of three general questions and five detailed questions was created for each target group. Table 2 shows an overview of the questions and their group assignment.

Table 2: Use of 3 general and 5 detailed questions in the respective target groups

	Question	Manufacturers	Sales companies	Service technicians	Installers
1	Company Information	x	x		
2	Refrigerants used in sold units	x	x		x
3	Service Structure	x	x		x
4	Triggers of Troubleshooting	x	x	x	x
5	Occurrence of Leaks	x	x	x	x
6	Leak location	x	x	x	
7	Leak location - Comment	x	x	x	
8	Leak testing and leakage detection	x	x	x	

The same questions were deliberately formulated for all groups of participants to enable an evaluation of a question across all groups.

1. Please select the number of employees in the following areas of your company in Austria
2. How many of the heat pumps and/or air conditioners sold in Austria in the past 3 years do you assign to the following refrigerants?
3. Have you organized technical customer service for troubleshooting or maintenance at the end customer's premises in Austria?
4. How often have the following events triggered a service call in the past 3 years, regardless of the cause of the fault?
5. In how many of all service calls over the past 3 years was a leak detected in the refrigeration circuit?
6. How many of the leaks/leakages in the past 3 years have occurred in the following locations?
7. Would you like to comment on your answers to the previous question or indicate other points in the refrigeration cycle where leaks/leakage could be detected?
8. Which of the following leak testing and leak detection methods have you used in the manufacture and servicing of your heat pumps and/or air conditioning units over the past 3 years?

All but one of the questions was formulated as closed questions in the single-choice, multiple-choice and rating scale questions. Only question 7 was presented as an open-ended question in order to offer the possibility of freely formulated additions to question 6. The survey was limited to the following criteria:

- Heat pumps, cooling/air conditioning units up to approx. 50 kW nominal output
- primarily used for the conditioning of residential buildings
- only Austria
- Approximate period of the last 3 years,

3. Results and Discussion

Based on numbers from the GET database of building energy technology products [2], Figure 1 shows the development of market launches of heat pumps in the last 15 years for the four most common refrigerants. The

diagram illustrates the structural transition: Since around 2020 there is a shift from R-410A towards R-32 and R-290, which is consistent with regulatory signals and safety and sustainability discourses, reflecting the increasing market diffusion of alternative refrigerants in new product generations. According to question 2, in the past 3 years, the refrigerant mix of units sold was dominated by R-410A, R-32 and R-290, see Figure 2. Compared to the newly available R-290 heat pump models (Figure 1), the sales shares of R-290 heat pumps reported by the respondents are relatively high, pointing to demand-driven effect for natural refrigerants (including the regulatory discourse of the F-Gas Regulation) with simultaneous sales of older R-410A series. This divergence between existing sales and new product portfolios is important for safety-related planning, because different refrigerant qualifications are required in the field at the same time.

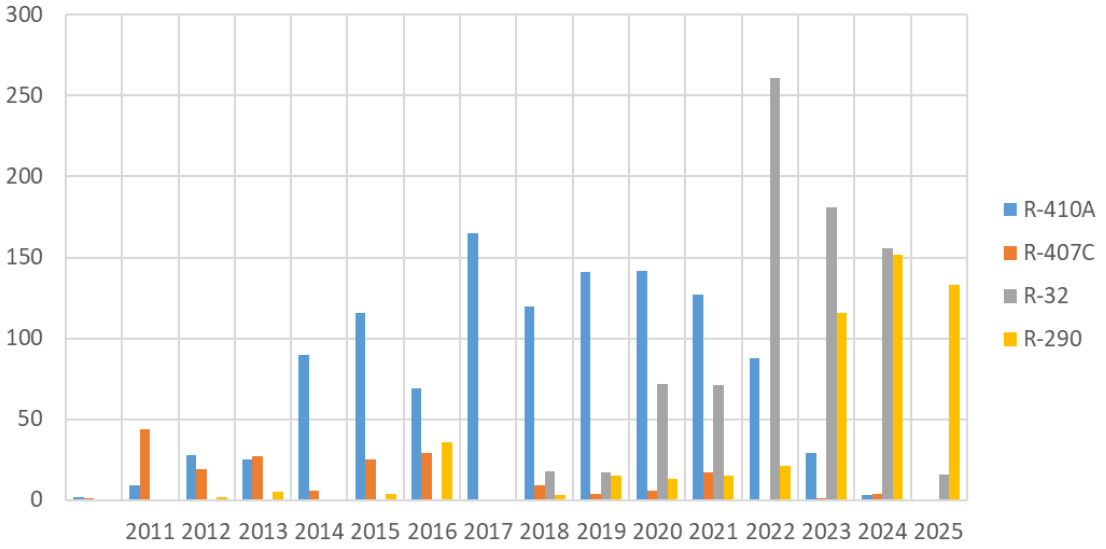

Figure 1: Market launches of heat pumps with the four main refrigerants (Source: GET database, [2], 12.08.2025)

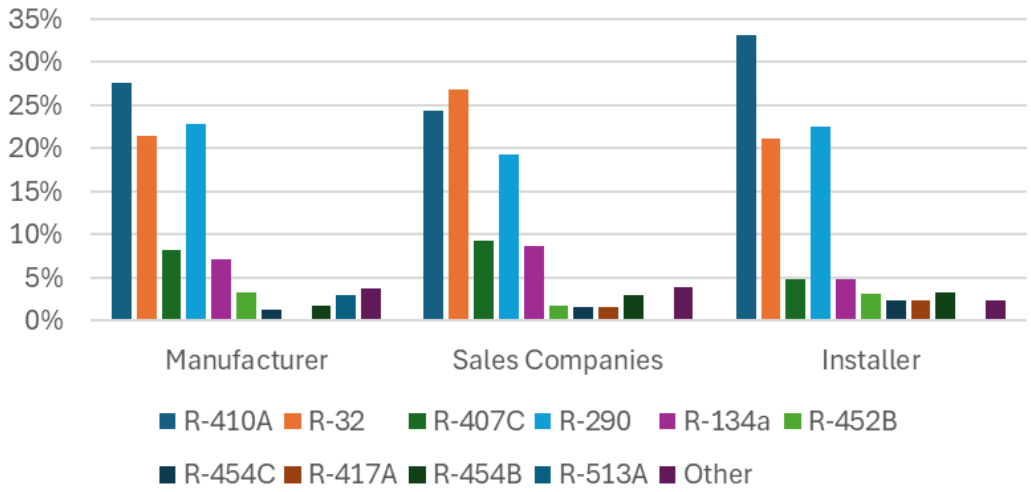

Figure 2: Refrigerant distribution per group (question 2, 71 answers)

With regard to the organization of technical customer service (question 3), the evaluation shows that structured service is standard in the industry. 73% of the participants state that they have their own customer service for faults and maintenance - this means that direct handling of flammable refrigerants is likely on a regular basis and corresponding qualification and protection requirements must be addressed, see Figure 3, left. In terms of groups, the data confirms the typical division of roles in the industry: installation companies often use products from one manufacturer, and the manufacturer takes over the after-sales service for the

systems installed by the installer. This widespread structure is supported by the results (higher proportions of internal/combined service organisation at manufacturers; more external solutions at distributors and installers).

When it comes to triggers of troubleshooting (question 4), the report by end customers is by far the most common starting point and explains >50% of the interventions, see Figure 3, right. Own diagnoses, diagnoses of external partners and automated error messages share the remaining shares in roughly equal orders of magnitude and are also the answer options, which are sometimes classified as "never occurring". In practice, this implies that initial contacts and safety briefings must affect end customers and service technicians to the same extent.

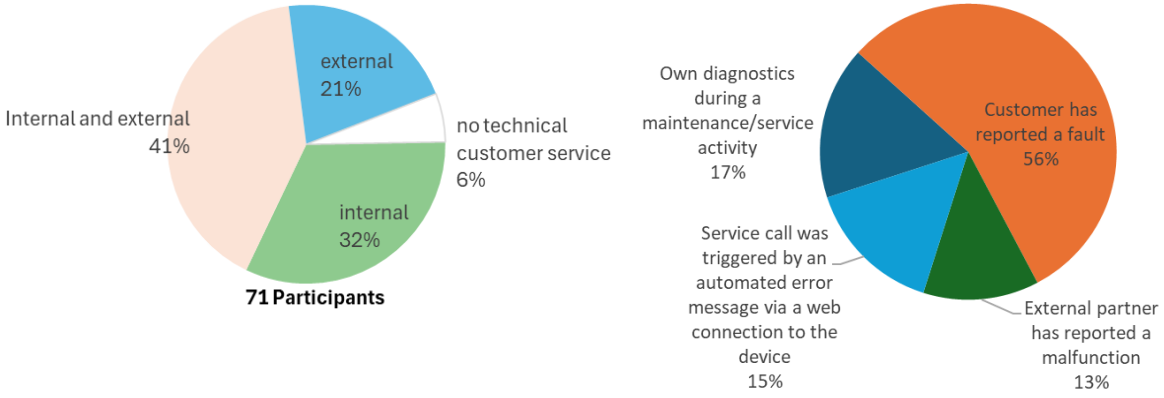

Figure 3: Left: Organization of customer service across all groups (question 3, 71 answers).
Right: Distribution of the triggering options for troubleshooting operations across all groups (question 4, 94 answers)

The occurrence of leakage (question 5) is estimated to be rare but present: 88% report at least one case in three years; 47% locate leaks in 1–5% of incidents, and a further 23% in 6–10%, see Figure 4. Manufacturer responses are narrowly clustered at 1–5%, while service technicians show a broader dispersion—plausible against the background of heterogeneous job profiles. Neither different company sizes nor the different service structures show significant divergent patterns in the distribution of incidents; individual extreme values (e.g. 21–30%) should be interpreted cautiously due to the small number of responses.

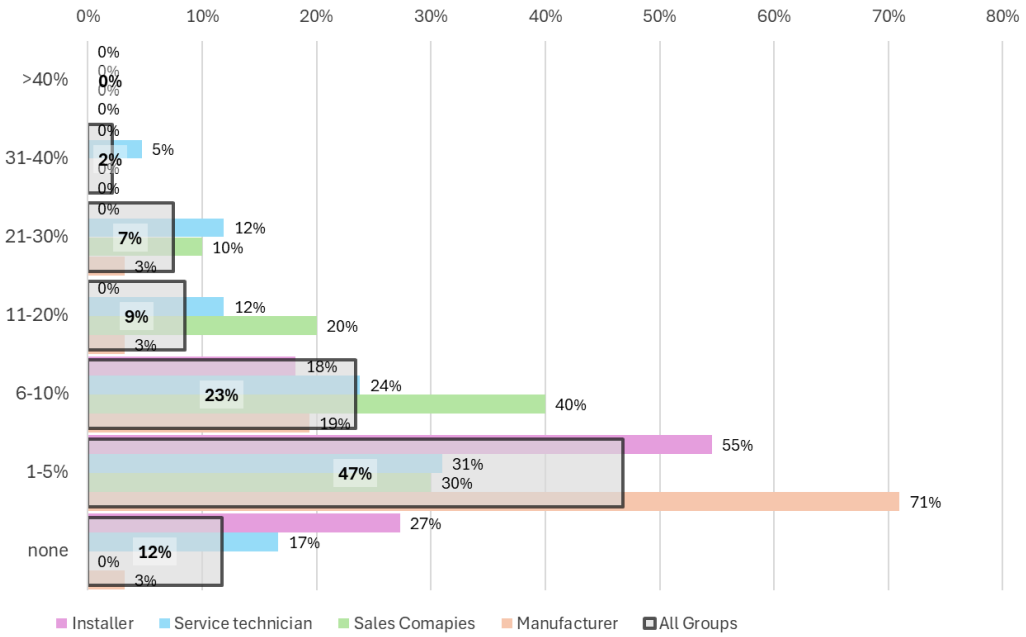

Figure 4: Leaks during malfunctions (question 5, 94 answers)

The local assignment of leaks (questions 6/7) identifies three main areas: Schrader valves, connection points to components and evaporator heat exchangers. These findings suggest that design improvements, assembly/quality requirements and training content should be prioritised towards these areas; less frequent mentions (e.g. expansion valve, capillary tube) are to be included as answer options in the future.

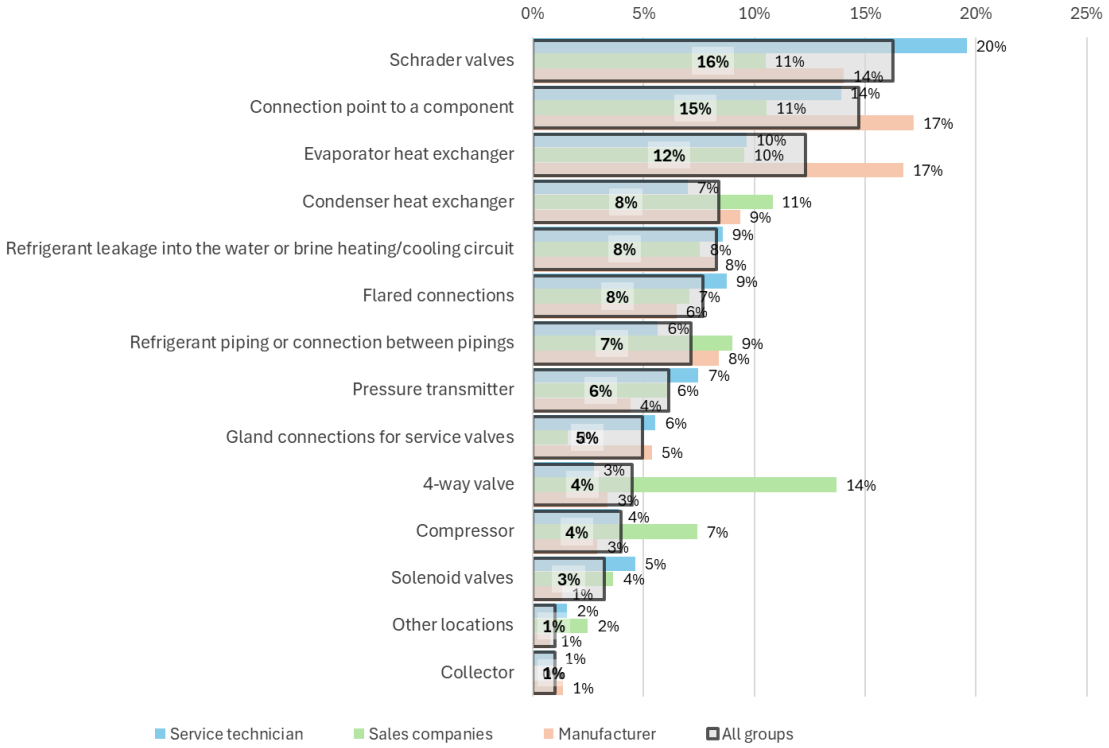

Figure 5: Local allocation of leaks to all groups (question 6, 83 answers)

Among the test and search methods used (question 8), electronic hand-leak-detectors, pressure drop tests and foam-forming agents dominate in all groups; Immersion bath bladder test and ultrasound are rarely used. The preference reflects practicality, sensitivity, time/cost profile and application limits, highlighting the need for robust, field-ready standard methods.

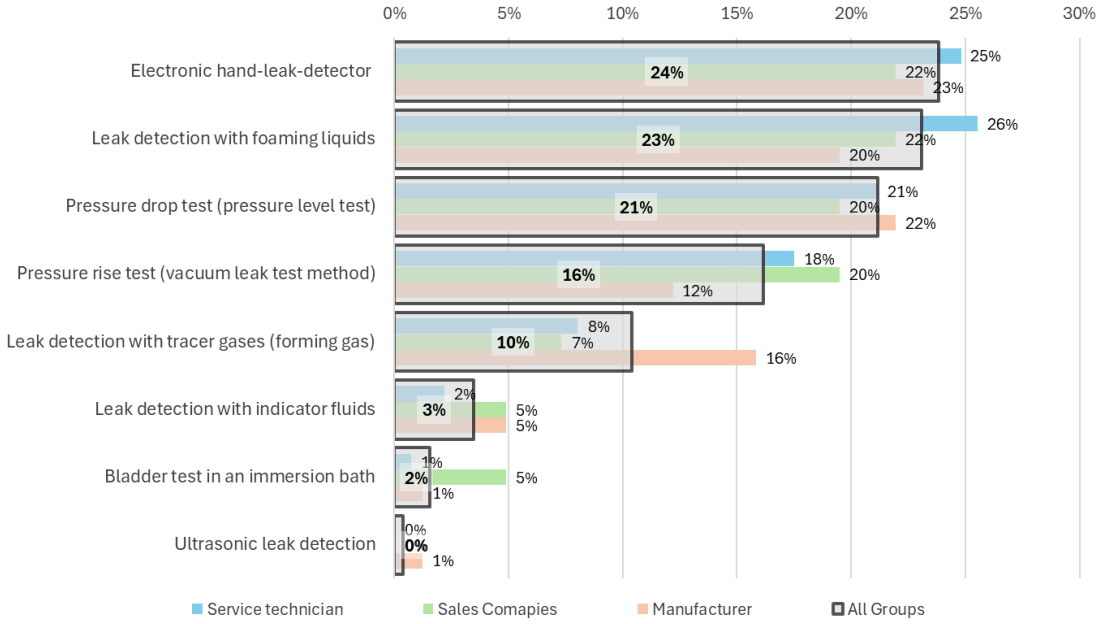

Figure 6: Methods of leak testing and leakage detection (question 8, 83 answers)

4. Conclusions

The present survey provides a consistent picture of the situation, organisation, causal patterns and leakage events in heat pump and cooling/air conditioning systems in the Austrian residential buildings sector. Methodologically, it is based on a structured online survey of several industry groups with differentiated questionnaires for experts from heat pump manufacturers, heat pump distributors, heat pump installers, and refrigeration services companies.

Results show that expert assessments align only partially across stakeholder groups, which are likely due to differences in roles and service approaches. Notably, 47% of respondents reported that refrigerant circuit leaks occurred in only 1–5% of all service incidents, suggesting such events are relatively rare. When asked about leak locations, 14 potential sources were suggested, with Schrader valves, connection points to components, and evaporator heat exchangers emerging as the most common across all groups. Other sources followed closely. All suggested locations showed variations depending on stakeholder type.

Even though the results cannot be directly transferred to other countries, the survey still offers valuable insights into the frequency and typical causes of system failures. These findings can help guide the development of technical standards, product design, training programs, and service procedures and ultimately reducing environmental risks and enhancing operational safety. Further outcomes of the Austrian team of IEA HPT Project 64 – e.g., a more detailed analysis of the presented survey, and an additional survey with other groups of experts – are / will be published on the official Project 64 website. [1]

Acknowledgements

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