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COMPRESSORS IN ELECTRONIC LOGBOOK "LEAKLOG"

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1. ABSTRACT

Extension of the electronic logbook for equipment owners and operators is aimed on usage of the Leaklog software built for equipment owners and operators intended to enable collaboration and data sharing with service companies. This new web-based solution integrates with existing Leaklog databases managed by service companies and provides an electronic logbook of circuits and inspections for owners and operators. System offers fast access to circuit data for authorized persons via QR code labels attached to the equipment. The solution is replacing the existing paper-based workflow and encourage companies to maintain detailed and high-quality data.
Comparison of the leakage size according to IPCC methodology from the year 2006 and EU regulations on F gases has shown that the implemented precautions enabled a decrease in refrigerant consumption and a decrease of refrigerant consumption added in place of leaked refrigerants. Leaklog enables logging and aggregation of not only summarized amounts of leakages, but also refrigerant usage per cooling circuit and by category of usage. The latest extension of Leaklog enables service companies to easily share information from inspections on compressors with operators and/or owners of cooling circuits. Usage of Leaklog is presented on video.

This paper is based on the activities of the Slovak Association for Cooling and Air-Conditioning Technology started in the year 2003 supported by the Ministry of Environment. The electronic documentation was developed from the previous paper form. The evaluated data were collected from service organizations.

Keywords: Accuracy, Computer, Leak, Logging, Refrigerant, Reporting, Statistic.

2. INTRODUCTION

Using the implemented system, service engineers can get a quick survey of their customers, cooling circuits, details of all maintenance work and repairs, refrigerants in store, refrigerants added, recovered, reclaimed, and disposed of. This is possible directly at customer sites using tablet and smartphone applications, which also enable the service engineers to create electronic logs of inspections in the field. Experience from reporting of HFC refrigerant emissions shows that the data required by the IPCC methodology divided into several categories of use is difficult to obtain from companies in practice. The concept underlying this work is to take advantage of electronic data logging and reporting, the possibilities of automatic analysis, fast access to the full history and various forms of output.

Reported data consists of only aggregate values of leakages and amounts of refrigerants in equipment by category of usage. Leaklog does not report any sensitive information about customers.

A similar system is operated in Germany by the VDKF organization, which has published their results and so mutual comparison is possible. Leakage evaluation by VDKF was done in 2011 [4] and 2016 [5] from 260 enterprises and 111,000 pieces of equipment from approximately 15,000 customers with the total charge of 1,790,000 tons of refrigerant and an average charge of 16.7 kg of refrigerant per equipment. Web information systems for data collection are operated also in Hungary, Estonia, but their results are not published. Similar web-based information systems are already in development in many other countries.

In the past, leakage tracking was performed using paper-based logbooks. Operators would order inspections from service companies, and service technicians would manually write inspection data into paper logbooks kept by the operators.

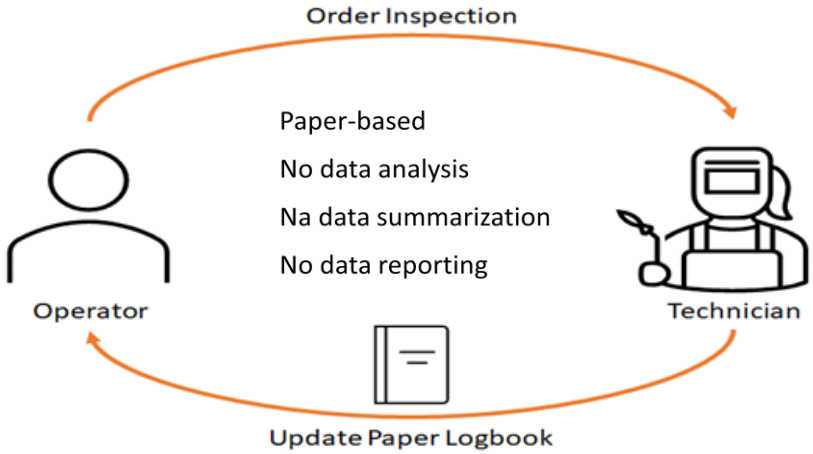

Figure 1. Leakage tracking in the past.

SOLUTION: ELECTRONIC LOGBOOK

The solution to the issues outlined in Figure 1 is an electronic logbook designed to replace the paper form of logging. In addition to solving the above issues, one of the primary goals of electronic logging is to increase the quality of logged data.

However, an important choice that was made at the outset was to design the initial version of the electronic logbook as a tool for service companies rather than circuit operators. While circuit operators are the ones responsible for refrigerant and the ones who order the services, they were not deemed sufficiently motivated to report their own leakages.

On the other hand, service companies, who are allowed to purchase and handle refrigerant, are much more motivated to gather and report correct data. In Slovakia, data reporting is a prerequisite for certificate renewal. In addition to that, there are far fewer service companies than circuit operators (thousands vs hundreds of thousands), which makes it a more attainable goal to train them to use new software.

Leaklog for service companies was first introduced in 2008 and training has been performed since then as part of the training for F gas certification.

However, because of the choice to initially build Leaklog as a tool for service companies, for the first 10 years of its existence, service companies had to send protocols from inspections in the form of PDFs, which the operators would print, effectively recreating a paper-based logbook from exported data.

In 2018, Leaklog for operators was introduced to replace this manual process and give read-only access to inspection data from service companies to operators.

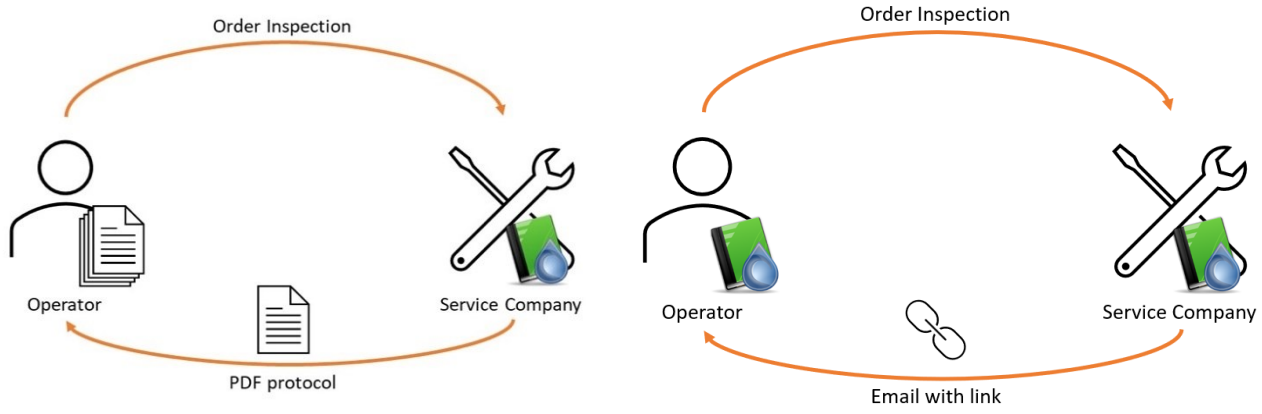

Figure 2. Leaklog with PDF form from inspections compared to Leaklog for operators.

2.1 EXTENSION OF LEAKLOG FOR EQUIPMENT OWNERS AND OPERATORS

Summary of the policy. According to EU regulation 517/2014 (Article 6: Record keeping, Article 10: Training and certification, Article 20: Collection of emissions data), the Slovak Republic, one of the EU member countries, has introduced an electronic system that links training and certification to reporting and data processing. The system includes a section dedicated to electronic recording of appliance data and information on leaktightness ('leaklog') and a section for electronic reporting and certification.
The following assumptions form the basis for the Slovak electronic tool.

1. F-gas trade only takes place between certified companies.
2. Customers can order services from certified companies only.
3. Certificates are valid for a limited time period only and need to be renewed.
4. Completion and submission of the reporting form on refrigerant imports and exports, including refrigerants contained in products and appliances, by certified companies, is a precondition for the renewal or update of company certificates.

As shown in Figure 16, the system offers fast access to circuit data for authorized persons via QR code labels attached to the equipment. The solution aims to replace the existing paper-based workflow and encourage companies to maintain detailed and high-quality data.

As input to the information system at szchkt.org, two approaches for reporting data are supported:

1. yearly reporting by organizations using Leaklog, and
2. yearly reporting by organizations without Leaklog.

The first approach enables aggregation of precise data from companies, which are logging data about refrigerant movement directly in Leaklog. Using such data, it is possible to calculate average weighted percentage of refrigerant leakage per refrigerant charges in equipment and added amounts of refrigerants. The data is possible to summarize by refrigerant and category of usage (e.g., commercial, industrial cooling, AC and heat pumps).

The second approach enables aggregation of less precise data from all certified companies that may not be using Leaklog. Such summarized data shows trends in purchase development and consumption of refrigerants added to circuits as new charge or due to leakage. The first approach is more precise as it enables calculation of average weighted percentage of refrigerant leakage by refrigerant and category of usage.

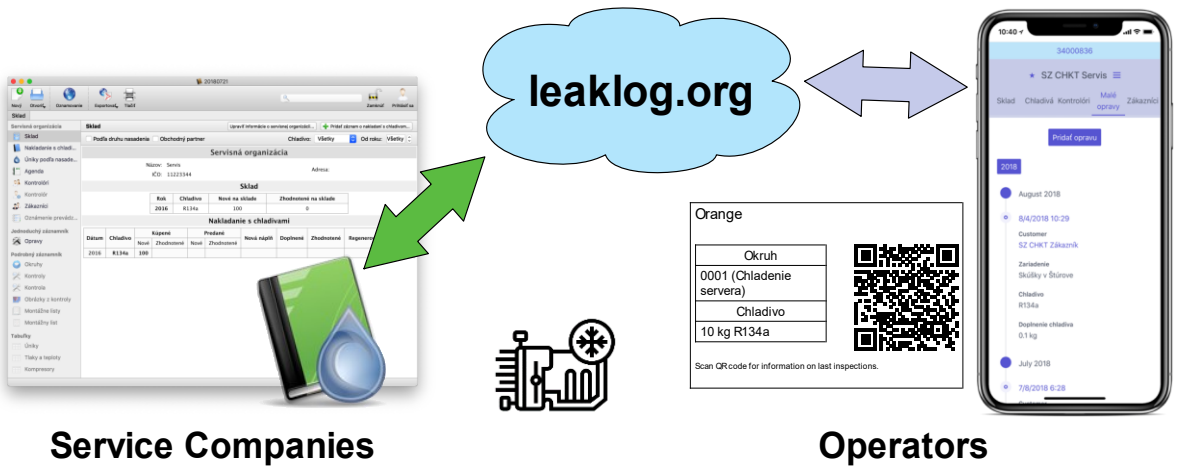

Figure 3. SZ CHKT introduced a new service named Leaklog.org that enables service companies and operators to share information about inspections of cooling equipment. Labels with QR codes placed on equipment link to logbooks with up-to-date information.

The logbook is based on

EN 378 6.4.3.5 Logbook REGULATION (EC) No 1516/2007 articles 2,3

Add inspection

- Regular inspection
- Nominal inspection
- Repair
- Inspection within one month
- Strength and tightness test
- Evacuation

Provides quick overview, survey of:

- Customers,
- Cooling circuits
- Details of all maintenance work and repairs
- Leakage ratio
- Refrigerants in store
- Refrigerants added, recovered, reclaimed, disposed of

Leaklog

a leakage control system

Leaklog is a leakage control system based on Regulation (EC) No 517/2014. It logs findings and parameters of leakage checks, shows a history of the development of parameters, compares them with nominal ones and calculates the percentage of leakage.

Enter as Service Company | Enter as Operator

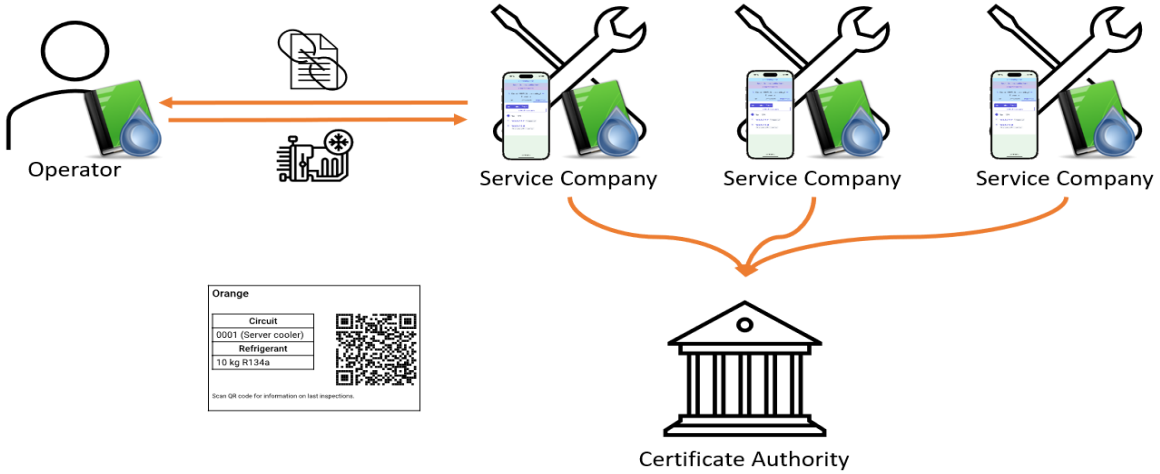

Figure 4. Leaklog accessible from mobile devices, with support for collaboration of multiple service technicians.

3. COMPRESSOR INSTALLED IN A SCHOOL FACILITY

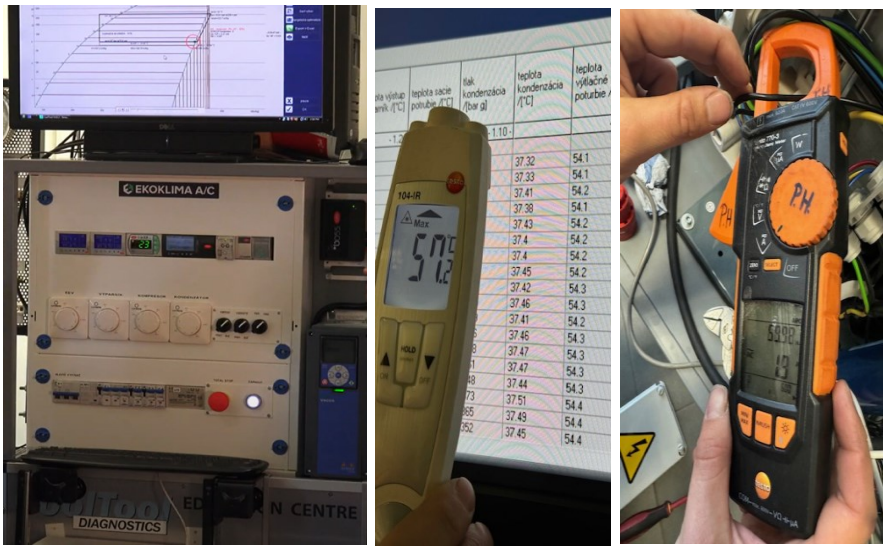

Figure 5. School facility with measured and assessed parameters automatically or manually speed-controlled compressor, fans, EEV1, EEV2. Parameters are followed on tables and lnp-h graph.

Compressors in Leaklog

Because each circuit is uniquely identified by a UUID, operators and service companies can generate labels with QR codes. This allows technicians and inspectors quick access to current data about a circuit. Because the labels only contain QR codes, they never go out-of-date and do not need to be replaced when circuit parameters change. The QR codes are also a very good starting point to enter inspection data. Technicians approaching a circuit can quickly scan the QR code, which takes them directly to Leaklog, where they can start entering data including about compressors.

User: 34000836

Service Company: SZ CHKT Service

Customer: SZ CHKT Customer

Circuit: 0006 (EKOKLIMA A/C)

Tables of Inspections

Leakages | Pressures and temperatures | Compressors

Date	Temperature sec. medium		Pressure evaporating	Temperature evaporating	ΔT (evaporating)	Temperature evap. out	Superheating		Pressu
	evap. in	cond. in					evap.	comp.	
	°C	°C	Bar	°C	°C	°C	°C	°C	Bar
2. 3. 2022 16:15	22	22	3.7	0.57	0.57	8	7.43	0	14.6
17. 3. 2023 9:45	22	22	3.7	0.57	0.57	8	7.43	0	14.6
17. 3. 2024 16:32	22	22	⌄ 2.4	⌄ -8.38	⌃ 8.38	⌃ 10	⌃ 18.38	0	⌄ 11.3
25. 3. 2024 9:47	22	22	3.7	0.57	0.57	8	7.43	0	⌄ 14.3

Figure 6. Leaklog table with pressure and temperatures on cooling circuit.

4. PERMISSIBLE DIFFERENCES IN VOLTAGES AND CURRENTS

In the electric motor of the compressor when operating a three-phase motor, it is desirable that the currents in the individual phases be the same. Ideally, they should have the same size and phase shift.

Permissible differences in currents and voltages depend on the specific type of motor, its construction and operating conditions. In general, current differences should be within 5% and voltage differences within 10%.

Consequences of unequal currents and voltages:

1. Uneven currents can lead to motor overheating, vibration and imbalance.
2. Uneven voltages can affect the motor's performance and ability to do work.

User: 34000836

Service Company: SZ CHKT Service

Customer: SZ CHKT Customer

Circuit: 0006 (EKOKLIMA A/C)

Tables of Inspections

Leakages | Pressures and temperatures | Compressors

Compressor 1,5 kW

Date	Temperature comp. in	Temperature discharge	Comp. el. power input	Electric current			Electric voltage			Oil shortage	Noise/Vibr	Compr
				L1	L2	L3	L1	L2	L3			
	°C	°C	kW	A	A	A	V	V	V			hours
2. 3. 2022 16:15	16	80	1.5	1.6	1.55	1.6	223	223	223	X	X	0
17. 3. 2023 9:45	16	80	1.5	1.6	1.55	1.6	223	223	223	X	X	0
17. 3. 2024 16:32	^ 17	^ 82	v 1.35	v 1.2	v 1.3	v 1.2	223	223	223	X	X	0
25. 3. 2024 9:47	v 15	^ 81.5	v 1.35	v 1.45	v 1.4	v 1.45	223	223	223	X	X	0

Figure 7. Leaklog table with compressor measured parameters.

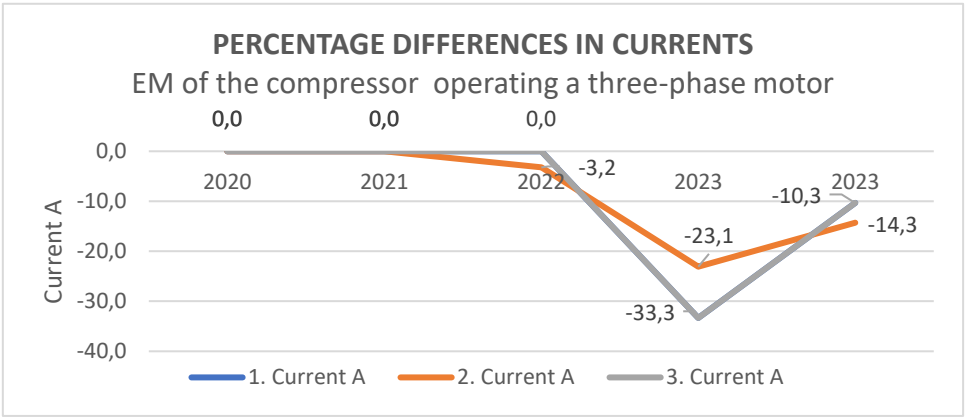

Figure 8. Current percentage differences in currents are more than 30 %, when the pressure before the compressor dropped from 3.8 bar to 2.4 bar due to pressure losses in the suction side. After replacing the BO filter, the pressure before the compressor increased to 3.7 bar.

5. DISCHARGE COMPRESSOR TEMPERATURE

It depends on several parameters. Because the cooling system is installed inside the workshop with a stable temperature of 22ºC, the effect of the change in the compressor's temperature lift is not significant. The condensing pressure decreased corresponding to the evaporation pressure in the range of 11 to 14 bar.

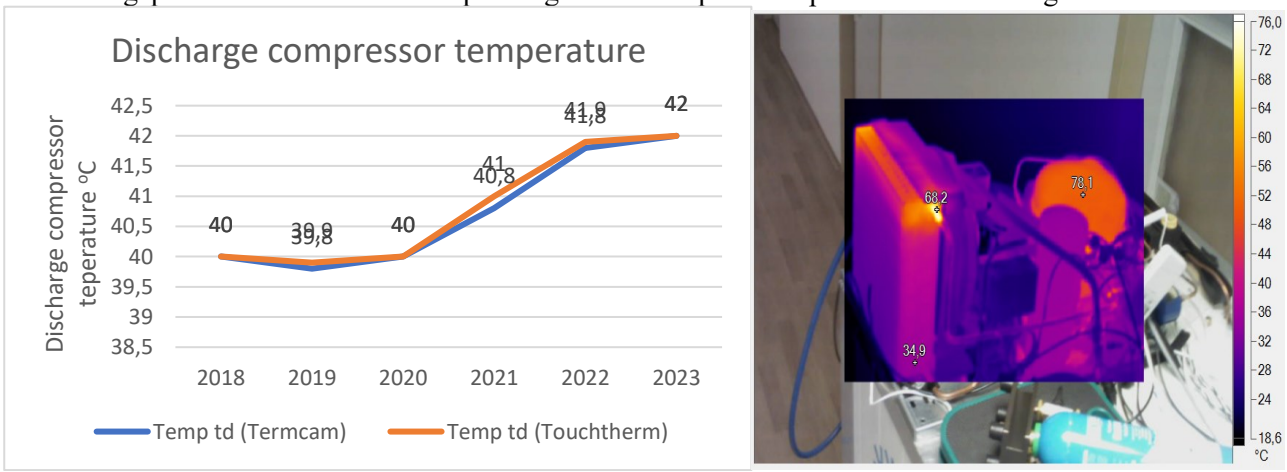

Figure 9. Discharge compressor temperature measured by thermal camera and touch thermometer showing an increase over six years.

6. MEASUREMENT OF WINDING RESISTANCES

Due to the differences in the consumption of currents on the individual phases of the motor, also the resistances of the stator windings at the terminals of the machine were measured by the ohmic method using a DC source. The stator windings are connected either in star or delta by connecting individual terminals. The measured resistance values are recorded in a table and the differences shown in the graph.

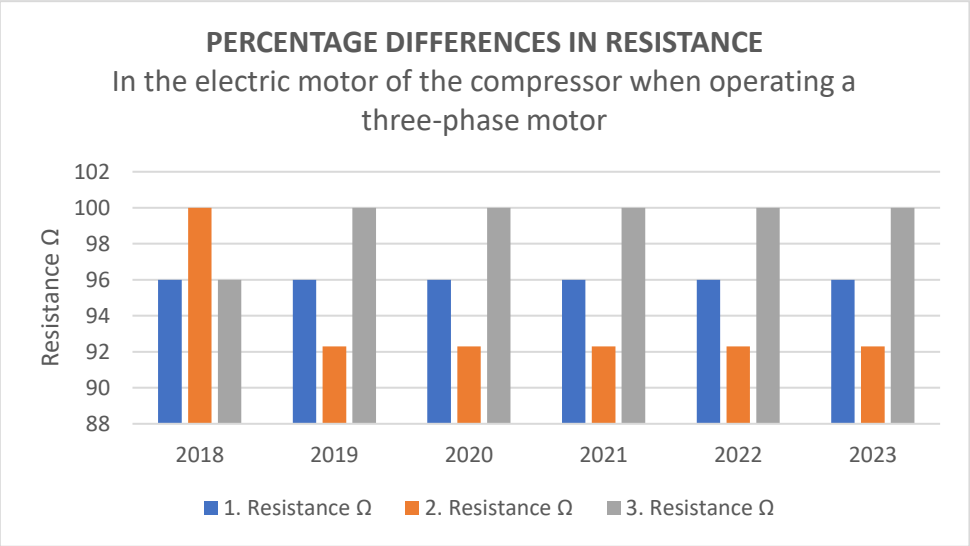

Figure 10. The electrical resistance of the compressor winding measured with a multimeter over six years varied within 4%.

Different problems can arise with unequal currents, winding resistance in three-phase motors. Here are a few of the most common:

- Uneven load: If the currents in the individual phases are not balanced, the motor may be unevenly loaded. This can lead to overheating or inefficient performance.
- Vibration and Imbalance: Unequal currents can cause vibration and imbalance in the rotating parts of the motor. This can affect its lifespan and reliability.
- Increased losses: Uneven currents can increase losses in the motor, which can result in reduced performance and increased power consumption.
- Overloading some phases: If one phase is significantly more loaded than the others, it can cause safety problems and damage the motor.

It is important that three-phase motors are operated with balanced currents to minimize these potential problems. In the case of a measured compressor installed in a school facility with frequent on/off operation at atypical temperatures, it is also possible to monitor the change of measured parameters during preventive maintenance and thus predict the lifespan of the compressor.

3. CONCLUSIONS

Leaklog makes it possible to record and aggregate not only the total amount of leaks, but also the consumption of coolant for cooling circuits and by category of use. Leaklog now allows service companies to share inspection information with operators and/or owners of refrigeration circuits.
One of the possibilities is the measurement and evaluation of compressors. Especially for larger compressors, when preventive maintenance and prediction of the technical condition is of economic importance. Although nowadays new devices already record most of the measurable parameters, there are still many devices in use that lack measurements. Leaklog allows the measured values to be recorded and historically evaluated with the potential of predicting the development of the technical condition of the compressor.

4. ACKNOWLEDGEMENTS

This paper is based on the activities of the Slovak Association for Cooling and Air-Conditioning Technology started in the year 2003 supported by the Ministry of Environment. The electronic documentation has been developed from the previous paper-based form. Electronic documentation is running since the year 2009.

5. NOMENCLATURE

AC	Air Conditioning	*HP*	Heat pumps
CC	Commercial cooling	*IC*	Industrial cooling
SZ CHKT	Slovak Association for RAC	*VDKF*	German Association for RAC

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