Risk analysis for refrigeration systems and heat pumps with A2L- refrigerants in accordance with the Machinery Directive, DIN EN 378 and the Pressure Equipment Directive

1. Introduction

This risk analysis deals with the potential hazards associated with refrigeration systems and heat pumps which use F-gases of safety class A2L and were manufactured by Rox-Klimatechnik GmbH from Weitefeld in Germany.

The analysis is carried out in accordance with the requirements of the Machinery Directive (2006/42/EC), DIN EN 378 and the Pressure Equipment Directive (2014/68/EU) to ensure that the systems meet the relevant safety requirements.

2. Identification of hazards

2.1. Risk of refrigerant leakage

Potential hazard: Uncontrolled leakage of A2L refrigerants (e.g. R32) from the refrigeration system due to leaks or malfunctions. A2L refrigerants are highly flammable, which requires additional precautions.

2.2. Danger due to high pressures

Potential hazard: Pressure build-up in the refrigeration system due to overload or insufficient maintenance, which can lead to possible ruptures or explosions.

2.3. Fire hazard

Potential hazard: Due to the flammability of A2L refrigerants, there is an increased risk of fire in the event of a refrigerant leak. A fire in the vicinity of the refrigeration system can result in damage to the system and an increased risk to persons in the vicinity of the affected system.

2.4. Toxic effects

Potential hazard: Refrigerants can have toxic effects if released into the environment or if handled improperly (e.g. by displacing the ambient air and thus the ambient oxygen or indirectly through the formation of toxic decomposition products during combustion). These effects can lead to health risks for people in the vicinity of the affected system.

3. Risk assessment

3.1. Refrigerant leakage

Probability of occurrence:	medium
Extent of damage:	high
Risk level:	high

3.2. High pressure

Probability of occurrence:	low
Extent of damage:	high
Risk level:	low

3.3. Fire hazard

Probability of occurrence:	low
Extent of damage:	high
Risk level:	low

3.4. Toxic effects

Probability of occurrence:	medium
Extent of damage:	high
Risk level:	high

4. Risk reduction measures in accordance with the Machinery Directive, DIN EN 378 and the Pressure Equipment Directive

4.1. Refrigerant leakage in accordance with the Pressure Equipment Directive and DIN EN 378

- Carrying out a leak test in accordance with the requirements of the Pressure Equipment Directive and DIN EN 378 to ensure that the refrigeration system or heat pump has no leaks.
- Installation of gas detectors for early detection of refrigerant leaks, in particular for monitoring highly flammable A2L refrigerants in accordance with DIN EN 378.
- Installation of safety valves and pressure relief valves in accordance with the specifications of the Pressure Equipment Directive and DIN EN 378 to prevent unwanted and uncontrolled pressure increases.
- Marking of pipes and fittings in accordance with the requirements of the Machinery Directive to enable clear identification and handling in all operating states and in the event of a fault or accident.

4.2. High pressure in accordance with the Pressure Equipment Directive and DIN EN 378

- Checking the refrigeration system for conformity with the requirements of the Pressure Equipment Directive with regard to the design and operating pressure.
- Regular inspection and maintenance of the pressure relief valves and safety valves in accordance with the requirements of the Pressure Equipment Directive.
- Training of the manufacturer's personnel and the operator with regard to the safe operation of the refrigeration system or heat pump and the detection of overloads.

4.3. Fire hazard in accordance with the Machinery Directive and DIN EN 378

- Compliance with the requirements of the Machinery Directive with regard to fire protection, for example through the use of fire-resistant materials in the vicinity of the refrigeration system.
- Implement a fire safety plan that includes firefighting and evacuation measures in accordance with the requirements of the Machinery Directive.
- Training of personnel in fire protection measures and evacuation procedures in accordance with the requirements of the Machinery Directive.
- Compliance with the requirements of DIN EN 378, in particular the safety-relevant use of gas warning devices (such as Bacharach MGS-400) and, if necessary, the use of further. Emergency protection measures (such as emergency ventilation, etc.)

4.4. Toxic effects in accordance with the Machinery Directive and DIN EN 378

- Compliance with the requirements of the Machinery Directive regarding the use and labelling of toxic substances, including refrigerants.
- Training of personnel in the safe handling of refrigerants and the use of personal protective equipment in accordance with the requirements of the Machinery Directive.
- Training of personnel with regard to the indicated behaviour when a refrigerant leak is detected (manufacturer, operator).

5. Conclusion

Based on the risk analysis carried out for refrigeration systems and heat pumps and taking into account the requirements of the Machinery Directive, DIN EN 378 and the Pressure Equipment Directive, potential hazards were identified and evaluated.

The risk ratings for refrigerant leakage and toxic effects were assessed as high, while the risk levels for high pressure were recognized as low and those for fire hazard as medium.

Appropriate risk mitigation measures are recommended to adequately minimize these risks.

This includes:

- Regular leak tests in accordance with the requirements of the Pressure Equipment Directive and DIN EN 378.
- Installation or presence of gas detectors, safety valves, pressure relief valves and sufficient ventilation and venting options.
- Training of the manufacturer's and operator's personnel for safe operation and the detection of overloads as well as what to do if leaks are detected.
- Fire protection measures in accordance with the requirements of the Machinery Directive and DIN EN 378 as well as training on fire protection.

Furthermore, the following expressly applies:

Maintenance and repair work on refrigeration systems and heat pumps must only be carried out by qualified specialist personnel.