DIN EN 17893:2024-10 (E)

Thermal road vehicles - Temperature-controlled systems using flammable refrigerants for transport of goods - Requirements and risk analysis process

Contents

Page

European foreword 5

Introduction 6

1 Scope 7

2 Normative references 7

3 Terms and definitions 8

4 Symbols and abbreviated terms 18

5 Risk assessment 19
5.1 General 19
5.1.1 General requirements 19
5.1.2 Safety principles 19
5.1.3 Safety concept 19
5.2 Characteristics of Flammable refrigerants 20
5.3 Significant hazards 20
5.4 Protection against hazards 21
5.4.1 Protection against fire, flame propagation and explosion hazards 21
5.4.2 Protection against excessive internal system pressure 21
5.5 Operational mode risk assessment 21
5.5.1 General 21
5.5.2 Operational modes 22
5.5.3 Evaluation of leak rate and frequencies for characterization 24
5.5.4 Control volume 25
5.5.5 Risk assessment for flammable refrigerants 25
5.6 Tolerable risk 26
5.6.1 General 26
5.6.2 Risk reduction 26
5.6.3 Tolerable risk criteria 27
5.7 Auditing and effectiveness check of safety concepts 27

6 Requirements for design and construction of the TRU 28
6.1 General 28
6.2 Components and piping of refrigerating systems with flammable refrigerant 28
6.2.1 General 28
6.2.2 External fire relief device 29
6.3 Assembly of TRU on van, truck and trailer 29
6.4 Interior of the compartment volume 30
6.4.1 General 30
6.4.2 Inside compartment heat exchanger 30
6.4.3 Ventilation inside the compartment volume 31
6.4.4 Refrigerant detectors 31
6.4.5 Evaluation of surface temperatures 31
6.4.6 Electrical components 32
6.5 Outside electrical components (cabinet) 32
6.6 Refrigerant charge 32
6.7 Alarm system 32
6.7.1 General 32

6.7.2 Alarm system power ... 33
6.8 Testing ... 33
6.8.1 General ... 33
6.8.2 Testing of safety concept and protective devices ... 33
6.8.3 Testing the air tightness of the compartment volume to determine the dilution of release 34
6.8.4 Corrosion testing ... 34
6.8.5 Vibration type-test ... 34
6.8.6 Shock and impact type test ... 35
6.8.7 Final system test before putting into operation ... 35
6.9 Marking and documentation ... 36
6.9.1 General ... 36
6.9.2 Marking ... 36
6.9.3 Manuals and documentation ... 37

7 Requirements for the TRU manufacturer ensuring safe service, maintenance, repair ... 38
7.1 General ... 38
7.2 Providing education and training ... 39
7.3 Instruction for maintenance and repair ... 39
7.4 Providing safety instructions ... 39
7.5 Providing a self-check mechanism ... 40

8 Safe operation at different operating sites ... 40
8.1 General ... 40
8.2 Operating sites ... 42
8.3 Significant hazards at operating sites ... 44
8.4 Ventilating condition at operating sites ... 44
8.4.1 General ... 44
8.4.2 Requirements for operation in open air ... 45
8.4.3 Requirements for operation in well-ventilated areas ... 45
8.4.4 Requirements for operation in non-well-ventilated areas ... 45
8.4.5 Operation in non-ventilated areas ... 46
8.5 Requirements for opening of door(s) and for loading and unloading of goods ... 46
8.6 Electrical installations at operating sites ... 47
8.7 Operator instruction for handling of alarms ... 47
8.8 Accidents ... 48
8.8.1 General ... 48
8.8.2 Measures for accidents prevention ... 48
8.8.3 Measures after accidents ... 49
8.9 Operating instructions, manuals, guidelines at operating sites ... 50

9 Servicing recommendations and requirements at operating sites ... 50
9.1 General ... 50
9.2 Operating sites with service activities ... 50
9.2.1 General ... 50
9.2.2 General requirements ... 51
9.2.3 Instruction of personnel ... 51
9.2.4 General failure prevention ... 51
9.3 Assembly of TRU at the vehicle and inside the compartment volume ... 52
9.4 Repair and maintenance on the vehicle or the body structure ... 52
9.5 Repair and maintenance on the TRU including refrigerating system repair ... 52
9.5.1 General ... 52
9.5.2 Instruction of personnel ... 53
9.5.3 Work area requirements ... 54
9.5.4 Inspection ... 54
9.5.5 System failure indication ... 55
9.5.6 Actions and procedure for refrigerating system repair ... 55
9.5.7 Tools and equipment ... 58
9.5.8 Testing after repair ... 58
9.5.9 Failure prevention for maintenance and refrigerating system repair ... 58
9.5.10 Documentation ... 59
9.6 Handling, recovery, reuse and disposal of refrigerant ... 59

10 Decommissioning of the TRU 60

Annex A (informative) Specifications of control volumes for TRV 61

Annex B (informative) Description of mechanisms to reduce risk 64

B.1 General 64
B.2 Heat exchanger zoning concept 64
B.3 Indirect heat exchanger 64
B.4 Heat exchanger separation mechanism, shut-off devices 65
B.5 Ventilation mechanism 66
B.5.1 General 66
B.5.2 Outside ventilation mechanism 66
B.5.3 Inside ventilation mechanism 67
B.6 Refrigerant detection 67
B.7 Alarm system 68
B.7.1 General 68
B.7.2 Types of alarm 68
B.7.3 Visible and audible refrigerant leak alarm 69
B.7.4 Actions by the alarm system 69

Annex C (normative) Information on leak types and leak mass flow 70

Annex D (normative) Useful equations for the calculation of environment ventilation 72

D.1 General 72
D.2 Dilution of a flammable substance release with air 72
D.3 Additional examples 74
D.3.1 Small volume in open air situation 74
D.3.2 A Non-ventilated enclosure 75

Annex E (normative) Tracer gas measurement for determination of air exchange rate 76

E.1 General 76
E.2 Tracer gas measurement with CO2 77
E.3 Required air exchange rate for dilution of refrigerant releases inside the compartment volume 78

Annex F (informative) Typical ignition sources for risk assessment of TRU 79

Annex G (informative) Example process for risk evaluation 80

Bibliography 81